AERONAUTICAL TELECOMMUNICATION NETWORK OF THE SAM REGION (REDDIG II)

ROUTING POLICY FOR THE SAM REGION

April 2013

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REFERENCES

- Doc 9855 – Guidelines on the Use of the Public Internet for Aeronautical Applications
- Doc 9896 – Manual for the Aeronautical Telecommunication Network (ATN) using IPS Standards and Protocols
- Guidance for the Implementation of National Digital Networks that Use the IP Protocol to Support Current and Future Aeronautical Applications (SAM Region)
- Air Navigation Plan for the Caribbean and South American Regions – FASID – Tables CNS1A and CNS1C
- SAM Regional IP Addressing Plan
- RFC 4271 –BGP-4 Specifications
- RFC 4360 – BGP Extended Communities Attribute
- CNS Table 1Ba – Regional Router Plan / SAM Region

GLOSSARY OF ACRONYMS

- AMHS ATS Message Handling System
- ANSP Air Navigation Service Provider
- ARIN American Registry for Internet Numbers
- ATN Aeronautical Telecommunication Network
- BER Bit Error Rate
- BGP Border Gateway Protocol
- EGP Exterior Gateway Protocol
- ES End System
- EUR/NAT European and North Atlantic Region
- FASID Facilities and Services Implementation Document
- GREPECAS Caribbean/South American Regional Planning and Implementation Group
- IANA Internet Assigned Numbers Authority
- IGP Interior Gateway Protocol
- IPS Internet Protocol Suite
- ISO International Organization for Standardization
- MPLS Multiprotocol Label Switching
- OSI Open System Interconnection
- OSPF Open Shortest Path First
- PBR Policy-Based Routing
- QoS Quality of Service
- REDDIG South American Digital Network
- RFC Request for Comments
- RIP Routing Information Protocol
- RIR Regional Internet Registry
- SAM South American Region
- SLA Service Level Agreement
- SICAS Secondary Surveillance Radar Improvements and Collision Avoidance Systems
- SICASP SICAS Panel (ICAO)
- TCP Transmission Control Protocol
- TSP Telecommunication Service Provider
- VoIP Voice Over IP
- VPN Virtual Private Network
- UDP User Datagram Protocol
- WACAF Western and Central African Region
- WAN Wide Area Network

DEFINITIONS

The following definitions are applicable for purposes of this document:

Bandwidth: maximum packet rate from a dedicated connection port, expressed in kbits/s or Mbits/s.

REDDIG II Applications: services to be provided by REDDIG II as defined in the main body of the document.

Physical Layer (Level 1): The physical layer defines the technical characteristics of the system's electrical and optical (physical) devices. It contains the cabling or other communication channels that communicate directly with the network interface controller. Accordingly, it is concerned with allowing for simple, reliable communication, in most cases with basic error control:

Layer functions:

- It moves bits (or bytes, in accordance with the transmission unit) through a transmission medium;
- It defines the electrical and mechanical characteristics of the medium, the bit transfer rate, voltages, etc.
- It executes or controls the data transmission volume and rate.

The physical layer is not responsible for dealing with issues like transmission errors, which are addressed by other layers of the OSI model.

Network Layer (Level 3): This is the network layer responsible for addressing network packets, also known as datagrams, by associating logical addresses (IP) with physical addresses, so that network packets reach their destination properly. This layer also determines the routes packets will take to reach their destination, based on elements like network traffic conditions and priorities.

This layer is used when the network has more than one segment and, as a result, a packet can take more than one path from origin to destination.

Layer functions:

- To move packets from their original source to their destination over one or more links.
- To define how network devices discover each other and how packets are routed to their final destination.

Availability: performance measurement parameter consisting of the percentage of time the PP/node (as the case may be) is operational within a specified service provision time period.

Router: equipment endowed with IP processing capacity for the purpose of determining the routes over which packets must be routed.

Inter-regional Routers: this is equipment that interconnects the routers with other ICAO Regions. In practical terms, these are routers belonging to a State AS that link up the Region with the EUR/NAT and WACAF Regions by means of the CAFSAT network, with the CAR Region via the interconnection of the MEVA II and REDDIG networks and with the APAC Region through contractual Telecommunication Service Providers (TSP).

Intra-regional Routers: for purposes of this document, these are the routers used for communication within the SAM Region.

Inter-domain routing*:* Data packet routing by an AS with different administrative authorities.

Intra-domain routing: Data packet routing by a single AS.

Path Vector Protocol: Protocol used for routing information interchanges among different Autonomous Systems (AS), as in the case of BGP-4. The term "path vector" bears in mind that BGP-4 routing information has a sequence of AS numbers that indicate the path taken by a given route.

Routing Protocol: that used among routers to exchange information about the network topology. It permits the updating of the routing table used by routers to choose the best path for sending a packet between network segments.

Internet Gateway Protocol (IGP): routing protocol that exchanges information within an Autonomous System (AS); for example: RIP (Routing Information Protocol) and OSPF (Open Shortest Path First).

Exterior Gateway Protocol (EGP): routing protocol that interconnects different Autonomous Systems (AS). BGP is a type of EGP.

REDDIG II Member States' Network: set of interconnected equipment, cables and software belonging to those represented by the Contracting Party.

Delay (or latency): service performance measurement parameter consisting of the average transit time of a 64-byte packet between two of the Contracting Party's PPs.

Delay: in this document, delay is understood to be an inherent characteristic of statistical and deterministic networks that consists of the end-to-end application propagation time.

Physical security of the data: for purposes of this tender, physical security is understood to mean protection against unauthorized access to the successful bidder's communication circuits and devices. Inclusion of cryptography in the communication circuits by the successful bidder is not part of this process.

Autonomous System: set of systems administered by a single administrative authority following an internal policy established by the authority. In the SAM Region, this could be a State or an Air Navigation Service Provider (ANSP). Autonomous Systems can also be called Routing Domain systems.

1. INTRODUCTION

1.1 Background

1.1.1 When referring to the Aeronautical Telecommunication Network (ATN), it is necessary to return to the year 1989, when the Secondary Surveillance Radar Improvements Panel (SICASP), at the instruction of the Special Committee on Future Air Navigation Systems (FANS), started developing documents for voice and data interchanges via different digital communication platforms.

1.1.2 To ensure the success of the SICASP's endeavours, the FANS Committee recommended adoption of open protocol principles--International Organization for Standardization's (ISO) Open Systems Interconnection (OSI)--, so as to provide for the interoperability of existing network platforms.

1.1.3 It is important to stress that many ICAO provisions were developed, insofar as air-ground and ground-ground applications are concerned, based on the OSI platform. Furthermore, although ICAO Member States gave significant support to the use of the OSI topology, the industry promoted equipment based on the Internet Protocol Suite (IPS) platform.

1.1.4 The International Civil Aviation Organization (ICAO) Air Navigation Committee (ANC) created the Aeronautical Communications Panel (ACP) in 2003 by combining the Aeronautical Mobile Communications Panel (AMCP) and the Aeronautical Telecommunication Network Panel (ATNP).

1.1.5 One of the main recommendations made, from the very beginning of the Panel's activities, was that ICAO should concern itself with developing ATN documentation based on TCP/IP protocols.

1.1.6 The ACP Working Group I (IP) (WG-I) was set up to effectively support development of the new provisions. Among its functions are security matters and the convergence and adaptation of ATN/OSI provisions for ATN/IP. It also deals with the development of documents for new applications directly based on ATN/IP.

1.1.7 The Caribbean/South American Regional Planning and Implementation Group (GREPECAS), through the former CNS/ATM Subgroup, already had the ATN Task Force (ATN/TF) operating to develop guidance material based on TCP/IP protocols for the CAR/SAM States.

1.1.8 One of the ATN/TF deliverables was the preparation of an addressing system based on version 4 of the IP protocol (IPv4) for all CAR/SAM States; it is currently under implementation in those Regions, as reflected in **Appendix A** to this document, insofar as the SAM States are concerned.

1.1.9 The CAR/SAM addressing plan was presented at the First Meeting of the ACP Working Group of the Whole, held in September 2008. Emphasis was placed on the fact that the ultimate purpose was to implement IPv6, but that IPv4 would be used as a way to further implementation of ATN applications in the CAR and SAM Regions, especially of the ATS Message Handling System (AMHS).

1.1.10 It should be stressed that the provisions being developed by ICAO Headquarters in Montreal are based on IPv6. Nevertheless, ICAO itself is seeking ways to make the acquisition of address blocks viable for use in all Regions.

1.1.11 It is also noted that the routers implemented in the SAM States that need to exchange data with other Regions are dual stack, meaning that they can handle IPv4 or IPv6 packets.

1.1.12 Once ICAO and the Internet Assigned Numbers Authority (IANA), responsible for worldwide provision of addresses, and its regional offices, called Regional Internet Registry (RIR) are able to obtain IP addressing blocks, the conditions will be favourable for implementation of the new IP addressing system for the SAM Region through a transition plan to be developed in due time.

1.2 Document Organization

1.2.1 The initial part of this document consists of References, the Glossary of Acronyms and Definitions that serve as a guide to the entire document, in view of the large amount of information this policy encompasses. Section 1.1 of the Background, in Chapter 1, supplements this segment with a historical account of ICAO activities to promote ATN/IPS use in communication networks.

1.2.2 Chapter 2 contains a general description of the SAM Regional IPv4 addressing plan, developed as a transitional phase toward the future implementation of the IPv6 addressing system.

1.2.3 Considering that the core IP structure links up a series of Autonomous Systems (AS) of different States and other Regions, Chapter 3 sets out the main concepts of the Border Gateway Protocol (BGP) in the version being currently implemented (BGP-4).

1.2.4 To conclude, Chapter 4 covers the use of BGP-4 routing as specifically applied to the South American Region and its interconnection with other ICAO Regions.

2. THE SAM ATN

2.1 SAM IPv4 Addressing Plan

2.1.1 With a view to the adoption of the IP addressing plan, the ATN/TF of the former CNS/ATM conducted a study contemplating the application of IPv4 in all ICAO Regions. Accordingly, an analysis was conducted of the number of States/Territories per Region, the number of addresses that each State/Territory could use and the number of addresses reserved for the interconnection of States/Territories.

2.1.2 It should be noted, first, that in order for the networks assigned to each State/Territory to be private networks (RFC 1918), the first of the four bytes that make up the assigned addresses will always have a decimal value equal to 10. The three other bytes will be used to hierarchically distribute the address blocks corresponding to each State.

2.1.3 The conclusions of that study were that:

a) The first four bits of the second byte (4 bits) would be used to identify the Regions into which the world's States/Territories are grouped:
   - SAM: South American Office.
   - NACC: North American, Central American and Caribbean Office.
   - APAC: Asia and Pacific Office.
   - MID: Middle East Office.
   - WACAF: Western and Central African Office.
   - ESAF: Eastern and Southern African Office.
   - EUR/NAT: European and North Atlantic Office.

b) Seven bits would be used at the State/Territorial level. This means that it is possible to have up to 128 States per Region. To give a real example, even the most numerous region, EUR/NAT, has only 53 States/Territories; this would leave many numbers vacant.

c) The last five bits of the third byte, and the eight bits comprising the fourth byte (13 bits), would be reserved for the hosts. This would make it possible to address 8,190 hosts per State/Territory. It should be noted that this figure was considered because of current requirements and possible future applications to be implemented, mainly in the more developed States.

2.1.4 In the light of the foregoing, the scheme adopted has the format set out in Table 1:

IPv4 Address							
10		Region	State/Territory		Host		
0 0 0 0 1 0 1 0	.	0 0 0 0 0 0 0 0	.	0 0 0 0 0 0 0 0	.	0 0 0 0 0 0 0 1	
1st Byte	.	2nd Byte	.	3rd Byte	.	4th Byte	

Table 1: IPv4 Addressing Scheme

2.1.5 In summary, the proposed assignment scheme could cover:

a) 16 Regions.

b) 128 States/Territories per Region.
c) 8,190 hosts per State/Territory.

2.1.6 The corresponding addresses have been assigned to each SAM State/Territory, bearing in mind the contents of the table attached as Appendix A. In said table, the last available network is labeled "RESERVED," so that it can be used for inter- and intra-regional links.

2.1.7 Although planned for possible application in all Regions, the IP addressing plan was only adopted and is being used massively by the SAM Region, while ICAO and IANA are working to obtain IPv6 addressing blocks for all Regions.

2.1.8 REDDIG is the communication platform used in South America. It links up State routers for transmission of IP applications based on the addressing plan that has been developed. The characteristics of the existing REDDIG and the data for modernizing its infrastructure are to be found in **Appendix C**.

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3. THE BASICS OF ROUTING BY DOMAIN

3.1 BGP Protocol

3.1.1 The BGP protocol, in its most recent version (4), is a path vector protocol used for the exchange of routing information between different autonomous systems.

3.1.2 The main features of BGP-4 are:

a) Origin: reports the origin of the BGP-4 route. If generated by an Internet gateway protocol (IGP), the metric is so announced in the BGP route (the router always chooses the path with the lowest metric generated by the IGP).
b) AS-Path: indicates the ASs traversed by the route. The BGP-4 databank keeps all path alternatives, but chooses the one that traverses the smallest number of ASs.
c) Next-hop: indicates the interface of the originating router where the BGP-4 route was announced. All BGP-4 routers will route the route data if there is connectivity with the IP address described in the NEXT-HOP attribute.
d) Local-preference: this attribute has a local significance and ensures that BGP-4 selects the best exit path based on the available WAN links.
e) Multi-exit-discriminator*:* defines the path along which neighbouring BGP-4 routers will send packets addressed to their internal networks.

3.1.3 Unlike other interior routing protocols that use the User Datagram Protocol (UDP), BGP-4 employs the Transmission Control Protocol (TCP) as its transport protocol. This means that the circuit is connection-oriented and guarantees reliable packet delivery. As a result, BGP-4 has no need for relay mechanisms, inasmuch as the TCP fulfills that function.

3.1.4 In order for BGP-4 to establish router adjacency, the neighbourhood must be explicitly configured. In that way, relationships are formed among routers configured as neighbours, with the result that the exchange of keepalive messages at regular time intervals reveals the conditions of each.

3.1.5 Once the adjacencies have been established, routers send neighbours the BGP-4 routes in their routing tables, so that those neighbours will be able to successfully establish the referred adjacencies. Each router adds to its BGP-4 topology databases all routes learned from neighbours.

3.1.6 The BGP protocol was originally used for routing between different ASs. Nonetheless, it can be used in routers belonging to the same AS and in that case is known as IBGP. Figure 4 illustrates the case in which routers B, C and D of AS 65000 are considered IBGP neighbours.

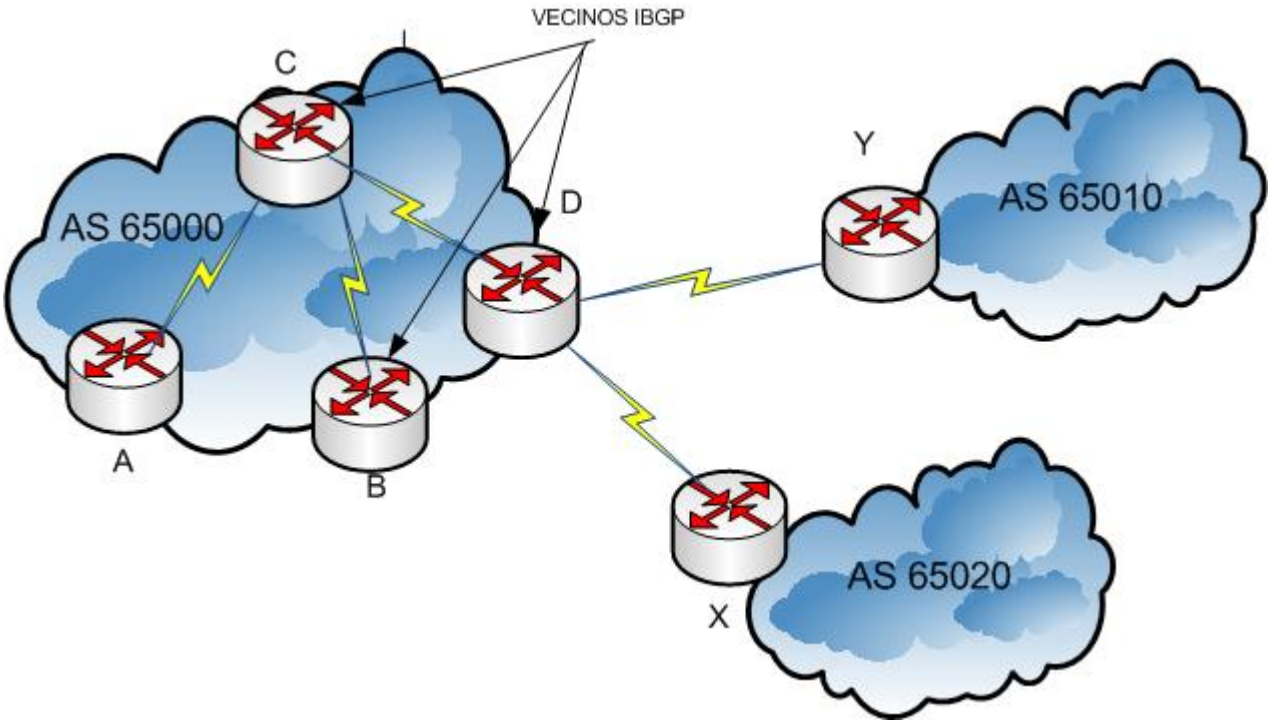

Figure 4: Internal BGP Neighbouring Routers

3.1.7 Figure 5 shows the neighbourhood between routers belonging to ASs with different administrative domains. In this case, D and Y are exterior neighbours and the same thing holds true with routers B and X.

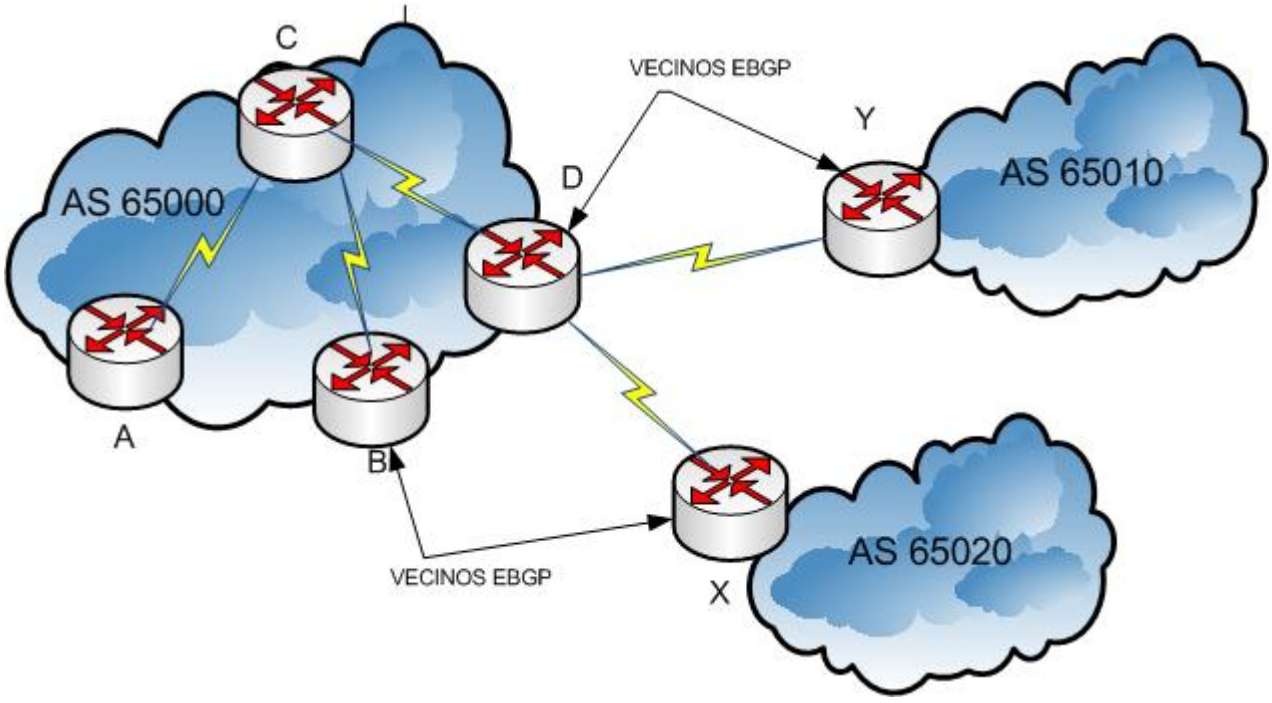

Figure 5: Exterior BGP Neighbouring Routers

3.2 BGP Autonomous Systems

3.2.1 As previously defined, an Autonomous System represents a collection of networks and their routers under a single administration. That said, the main objective of BGP-4 is to guarantee the interchange of routing information between different ASs.

3.2.2 Autonomous systems can use more than one IGP, resulting in a series of different metrics associated with each of the interior protocols in the BGP-4 AS exit router. Nonetheless, the most important characteristic of the AS is that, to other BGP-4 routers, there would seem to be only one IGP within the AS and external routers will easily know how to reach the connected internal destinations.

3.2.3 The Internet Assigned Numbers Authority (IANA) is the organization responsible for allocating AS numbers. The American Registry for Internet Numbers (ARIN) is the IANA Regional Office (RIR Regional Internet Registry) that performs that task specifically in the Americas. AS numbers range from 1 to 65535, with those in the range of 64512 to 65535 being reserved for private use.

3.3 BGP-4 Routing

3.3.1 An interior routing protocol seeks the fastest path between one point on a corporate system and another, based on metrics.

3.3.2 BGP-4, which is an exterior routing protocol, uses a different mechanism from that employed by IGPs. BGP is a policy-based routing protocol (PBR) that allows for traffic flow control over the network by using, *inter alia*, the attributes defined in 3.1. This enables the network administration to handle preferential paths.

3.3.3 BGP-4 is known as a path vector, for it takes into account that BGP-4 routing information has a sequence of AS numbers, indicating the path crossed by a given route and the routers announce the hop-by-hop path to the destination AS. Figure 6 contains a simple example of BGP routing.

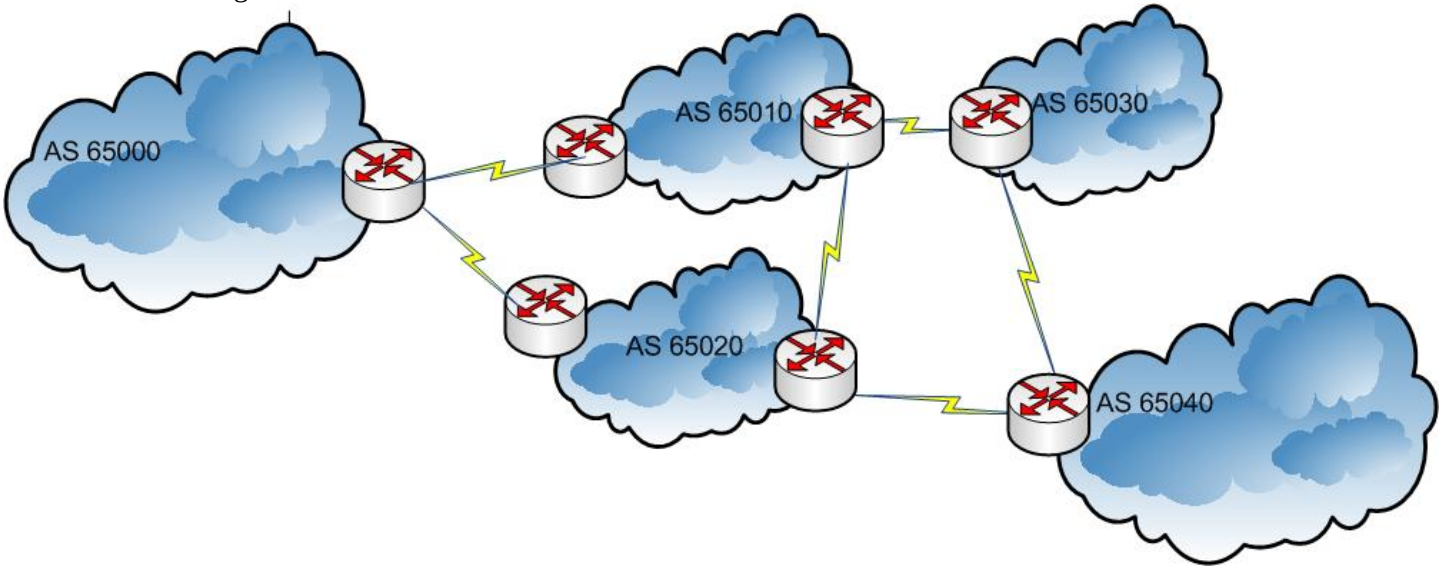

Figure 6: Routing between different ASs

3.3.4 According to Figure 6, it may be concluded that the following paths can be taken for AS 65000 to reach AS 65040 networks:

a) 65020-65040;

b) 65010-65030-65040;
c) 65010-65020-65040;
d) 65020-65010-65030-65040.

3.3.5 BGP-4 routers choose the path neighbours should use to send their packets. Accordingly, the most that AS 65000, which is the origin, can do is to decide which AS to traverse in its exit.

3.3.6 By way of example, if the AS 65000 exit router chooses to reach 65040 via AS 65020, the path to be taken from AS 65020 onward is internally chosen by the latter. In the given example, AS 65020 informs AS 65000 that the path to reach AS 65040 is 65020-65040, even if there is another path available, which, however, AS 65020 does not disclose to AS 65000, unless there is a problem with the main path.

4. ROUTINGS THROUGH SAM DOMAINS

4.1 Routing Domains

4.1.1 Private AS numbers, defined in Doc 9896 and described in **Appendix F**, are recommended for use in the SAM Region as a means for utilizing the BGP-4 routing protocol and safely guaranteeing the isolation of autonomous systems.

Note: The BGP-4 protocol makes it possible to adopt a series of optional and extension parameters. It is accordingly recommended that use of those attributes be defined in the future, in order to make the most of the protocol resources. As BGP-4 was originally developed for IPv4 use, however, its initial application will create no major problems.

4.1.2 From an administrative point of view, the SAM ATN/IPS consists of a series of administrative domains that can be represented, in the SAM Region, by a State or by a State's Air Navigation Service Provider (ANSP).

4.1.3 In terms of technical routing concepts, the interconnection of administrative domains rests on the exchange of information between different autonomous systems, each with a series of IP addresses. SAM ASs are interconnected by means of the REDDIG platform and, in the future, will be by REDDIG II.

4.1.4 Appendix C shows the basic characteristics of the existing REDDIG platform, as well as those of the future REDDIG II. The aforementioned architecture supports the existing and future services that are or will be instituted in the SAM Region. **Appendix D** describes the applications that should be transmitted via the cited communication network.

4.2 Domain Routing in the SAM Region

4.2.1 Appendix A shows the assignment of IP address ranges to be followed by the Aeronautical Authorities of each State in the Region in the national routers that link up with REDDIG. It represents the SAM Region's existing IP addressing plan.

4.2.2 As mentioned earlier, when ICAO, acting in favour of the States, together with IANA, acquires the IPv6 address blocks, it will be necessary to prepare a new SAM IP addressing plan. Furthermore, the routers used in the SAM Region are dual stack with regard to the possibility of routing inter-regional packets in which the destination is already using IPv6. Figure 7 illustrates that possibility for AMHS application.

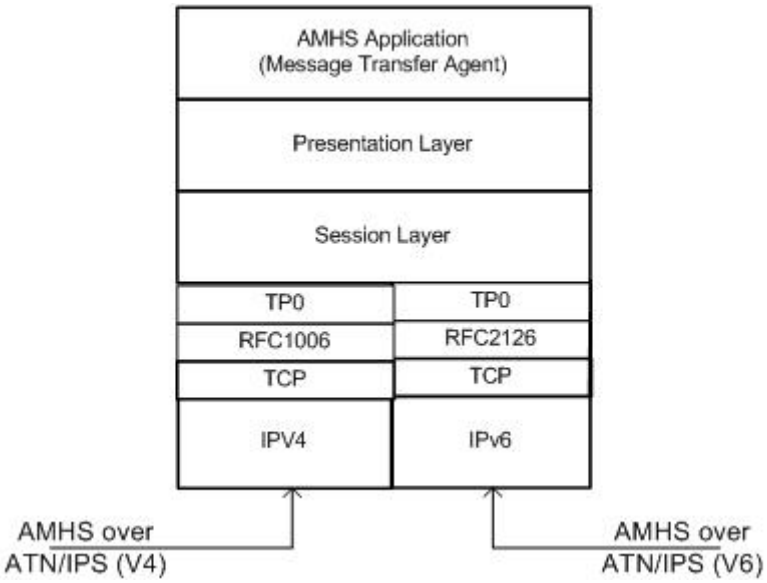

Figure 7: Translation of IPV4/IPv6 Addresses

4.2.3 The REDDIG, it is known, is used to link up the ASs of different States in such a way that one end system (ES) can reach another in a different State. Intra-regional routers are used for that purpose, as shown in Figure 8.

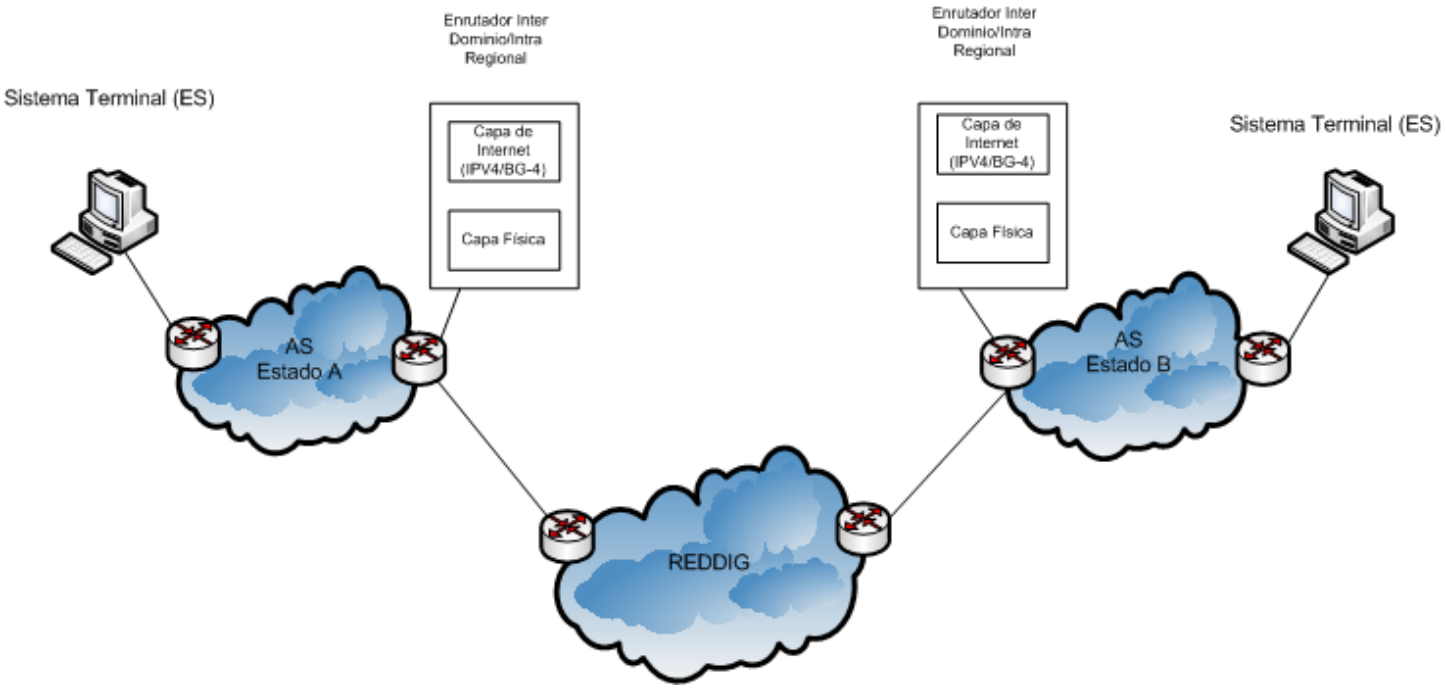

Figure 8: SAM Intra-Regional Routing

4.2.4 Figure 9 presents the basic routing topology for the SAM Region based on the requirements present in the FASID and in the Table, together with the future requirements as presented in Appendix D. Inasmuch as REDDIG II is a core IP network, the services will be transmitted from origin to destination seamlessly, using end system IP addresses and numbers of the ASs involved.

4.2.5 With the use of BGP-4, the concepts presented in Section 3.3, Routing with BGP-4, will logically have to be considered, inasmuch as it is not the origin router that chooses the path to the destination, but the router (Next hop).

4.2.6 Consequently, Figure 9 reflects the following SAM Region routings, bearing in mind the origin and destination of the applications, shown in different colors, as well as CNS Table IBa (Regional Router Plan) that appears in **Appendix E**.

a) In purple: intra-regional links using inter-domain routers (AS) of the States linked up by REDDIG;
b) In red: inter-regional links using the MEVA II/REDDIG interconnection; and
c) In black: inter-regional links in which the routers belonging to a SAM AS reach their destination via a PST or through interconnection with the CAFSAT network.

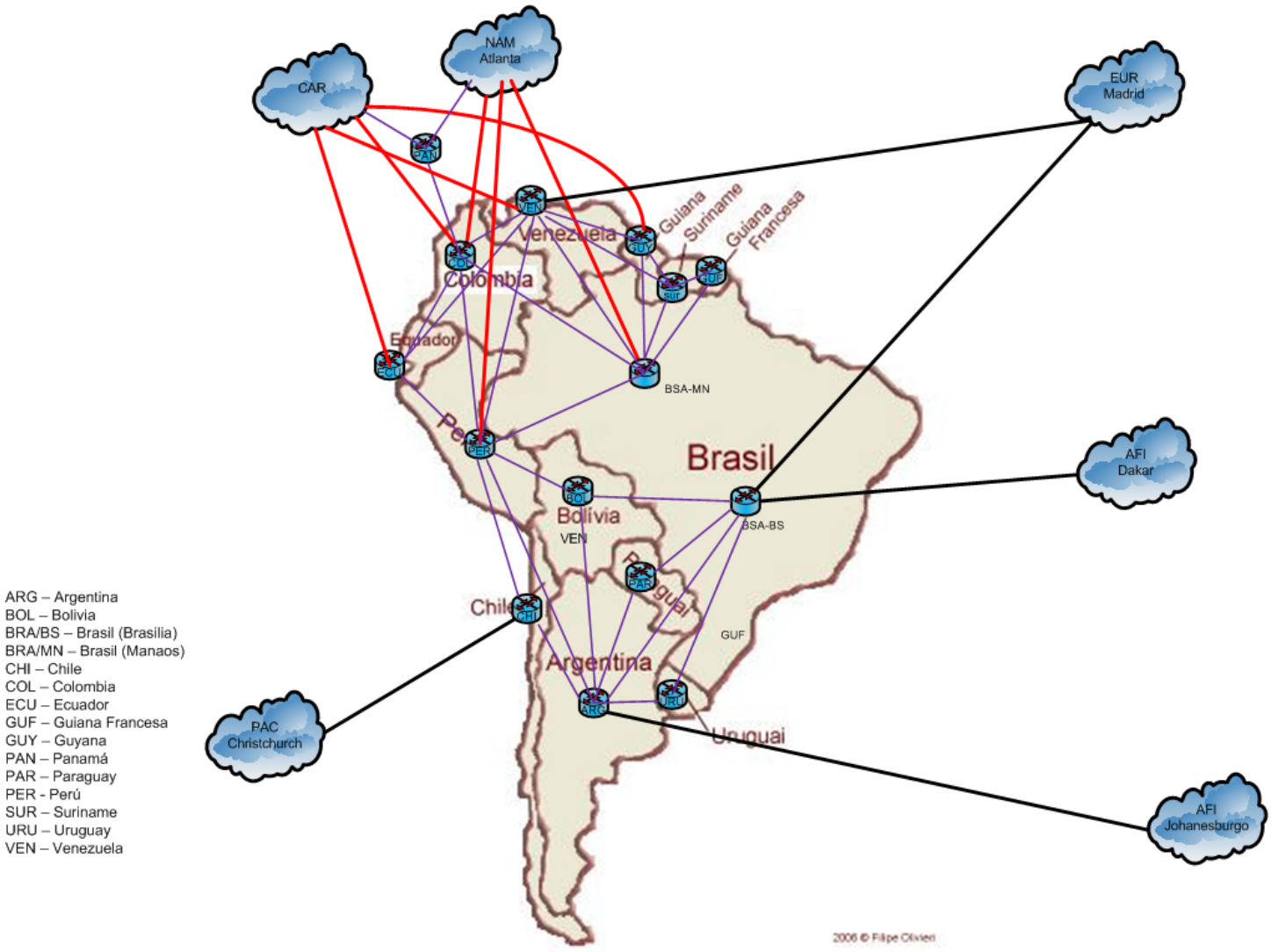

Figure 9: Basic SAM Routing Topology

4.2.7 The following BGP-4 routing policies should be observed in the SAM Region:

a) If a router has several possible paths to reach its destination, it should choose the one crossing the fewest ASs.

Note: REDDIG employs the satellite network, which operates as a deterministic network with a single hop. In the future, REDDIG II will use the satellite network as its main network, but the ground network, supplied by a PST, will have an infrastructure that could involve several different ASs.

b) All routers in the SAM Region (REDDIG and States) that are configured using the BGP-4 protocol shall do their authentication with their configured neighbours.
c) In order to reduce the size of routing tables, SAM BGP-4 routers should be configured to accept route aggregation.
d) BGP-4 routers belonging to an administrative domain should be configured to receive the aggregation of all internal AS routes.
e) The Local-Preference attribute should be configured in such a way that the BGP-4 router will choose the best exit path when the router is connected to more than one WAN.

4.2.8 In addition to the aforementioned policies, each State or ANSP has its own policies that will supplement those covered in this document.

APPENDIX A

ASSIGNMENT OF NETWORKS BY STATE/TERRITORY

Asignación de Redes por Estado/Territorio.

Región	Nro	Estado / Territorio	Red	Direcciones utilizables	Notacion Decimal	Notacion Binaria		
						Región	Estado / Territorio	Host's
SAM	1	Argentina	10.0.0.0 / 19	Primera	10 . 0 . 0 . 1	0 0 0 0 1 0 1 0 .	0 0 0 0	0 0 0 0 . 0 0 0 0 0 0 0 1
				-	-		-	
				-	-		-	
				Ultima	10 . 0 . 31 . 254	0 0 0 0 1 0 1 0 .	0 0 0 0	0 0 0 . 1 1 1 1 1 . 1 1 1 1 1 1 1 0
	2	Chile	10.0.32.0 / 19	Primera	10 . 0 . 32 . 1	0 0 0 0 1 0 1 0 .	0 0 0 0	0 0 1 . 0 0 0 0 0 . 0 0 0 0 0 0 0 1
				-	-		-	
				-	-		-	
				Ultima	10 . 0 . 63 . 254	0 0 0 0 1 0 1 0 .	0 0 0 0	0 0 1 . 1 1 1 1 1 . 1 1 1 1 1 1 1 0
	3	Brasil	10.0.64.0 / 19	Primera	10 . 0 . 64 . 1	0 0 0 0 1 0 1 0 .	0 0 0 0	0 1 0 . 0 0 0 0 0 . 0 0 0 0 0 0 0 1
				-	-		-	
				-	-		-	
				Ultima	10 . 0 . 95 . 254	0 0 0 0 1 0 1 0 .	0 0 0 0	0 1 0 . 1 1 1 1 1 . 1 1 1 1 1 1 1 0
	4	Uruguay	10.0.96.0 / 19	Primera	10 . 0 . 96 . 1	0 0 0 0 1 0 1 0 .	0 0 0 0	0 1 1 . 0 0 0 0 0 . 0 0 0 0 0 0 0 1
				-	-		-	
				-	-		-	
				Ultima	10 . 0 . 127 . 254	0 0 0 0 1 0 1 0 .	0 0 0 0	0 1 1 . 1 1 1 1 1 . 1 1 1 1 1 1 1 0
	5	Paraguay	10.0.128.0 / 19	Primera	10 . 0 . 128 . 1	0 0 0 0 1 0 1 0 .	0 0 0 0	1 0 0 . 0 0 0 0 0 . 0 0 0 0 0 0 0 1
				-	-		-	
				-	-		-	
				Ultima	10 . 0 . 159 . 254	0 0 0 0 1 0 1 0 .	0 0 0 0	1 0 0 . 1 1 1 1 1 . 1 1 1 1 1 1 1 0
	6	Bolivia	10.0.160.0 / 19	Primera	10 . 0 . 160 . 1	0 0 0 0 1 0 1 0 .	0 0 0 0	1 0 1 . 0 0 0 0 0 . 0 0 0 0 0 0 0 1
				-	-		-	
				-	-		-	
				Ultima	10 . 0 . 191 . 254	0 0 0 0 1 0 1 0 .	0 0 0 0	1 0 1 . 1 1 1 1 1 . 1 1 1 1 1 1 1 0
	7	Peru	10.0.192.0 / 19	Primera	10 . 0 . 192 . 1	0 0 0 0 1 0 1 0 .	0 0 0 0	1 1 0 . 0 0 0 0 0 . 0 0 0 0 0 0 0 1
				-	-		-	
				-	-		-	
				Ultima	10 . 0 . 223 . 254	0 0 0 0 1 0 1 0 .	0 0 0 0	1 1 0 . 1 1 1 1 1 . 1 1 1 1 1 1 1 0
	8	Ecuador	10.0.224.0 / 19	Primera	10 . 0 . 224 . 1	0 0 0 0 1 0 1 0 .	0 0 0 0	1 1 1 . 0 0 0 0 0 . 0 0 0 0 0 0 0 1
				-	-		-	
				-	-		-	
				Ultima	10 . 0 . 255 . 254	0 0 0 0 1 0 1 0 .	0 0 0 0	1 1 1 . 1 1 1 1 1 . 1 1 1 1 1 1 1 0
	9	Colombia	10.1.0.0 / 19	Primera	10 . 1 . 0 . 1	0 0 0 0 1 0 1 0 .	0 0 0 0	0 0 1 . 0 0 0 0 0 . 0 0 0 0 0 0 0 1
				-	-		-	
				-	-		-	
				Ultima	10 . 1 . 31 . 254	0 0 0 0 1 0 1 0 .	0 0 0 0	0 0 1 . 1 1 1 1 1 . 1 1 1 1 1 1 1 0
	10	Venezuela	10.1.32.0 / 19	Primera	10 . 1 . 32 . 1	0 0 0 0 1 0 1 0 .	0 0 0 0	0 0 1 . 0 0 0 0 0 . 0 0 0 0 0 0 0 1
				-	-		-	
				-	-		-	
				Ultima	10 . 1 . 63 . 254	0 0 0 0 1 0 1 0 .	0 0 0 0	0 0 1 . 1 1 1 1 1 . 1 1 1 1 1 1 1 0
	11	Guyana	10.1.64.0 / 19	Primera	10 . 1 . 64 . 1	0 0 0 0 1 0 1 0 .	0 0 0 0	0 1 0 . 0 0 0 0 0 . 0 0 0 0 0 0 0 1
				-	-		-	
				-	-		-	
				Ultima	10 . 1 . 95 . 254	0 0 0 0 1 0 1 0 .	0 0 0 0	0 1 0 . 1 1 1 1 1 . 1 1 1 1 1 1 1 0

Asignación de Redes por Estado/Territorio.

Región	Nro	Estado / Territorio	Red	Direcciones utilizables	Notacion Decimal	Notacion Binaria		
						Región	Estado / Territorio	Host's
SAM	12	Surinam	10.1.96.0 / 19	Primera	10 . 1 . 96 . 1	0 0 0 0 1 0 1 0 . 0 0 0 0	0 0 0 1 . 0 1 1	0 0 0 0 0 . 0 0 0 0 0 0 0 1
				-	-		-	
				-	-		-	
				Ultima	10 . 1 . 127 . 254	0 0 0 0 1 0 1 0 . 0 0 0 0	0 0 0 1 . 0 1 1	1 1 1 1 1 . 1 1 1 1 1 1 1 0
	13	Guyana Francesa (France)	10.1.128.0 / 19	Primera	10 . 1 . 128 . 1	0 0 0 0 1 0 1 0 . 0 0 0 0	0 0 0 1 . 1 0 0	0 0 0 0 0 . 0 0 0 0 0 0 0 1
				-	-		-	
				-	-		-	
				Ultima	10 . 1 . 159 . 254	0 0 0 0 1 0 1 0 . 0 0 0 0	0 0 0 1 . 1 0 0	1 1 1 1 1 . 1 1 1 1 1 1 1 0
	-	VACANTE	10.1.160.0 / 19	Primera	10 . 1 . 160 . 1	0 0 0 0 1 0 1 0 . 0 0 0 0	0 0 0 1 . 1 0 1	0 0 0 0 0 . 0 0 0 0 0 0 0 1
				-	-		-	
				-	-		-	
				Ultima	10 . 1 . 191 . 254	0 0 0 0 1 0 1 0 . 0 0 0 0	0 0 0 1 . 1 0 1	1 1 1 1 1 . 1 1 1 1 1 1 1 0
	-	VACANTE	10.1.192.0 / 19	Primera	10 . 1 . 192 . 1	0 0 0 0 1 0 1 0 . 0 0 0 0	0 0 0 1 . 1 1 0	0 0 0 0 0 . 0 0 0 0 0 0 0 1
				-	-		-	
				-	-		-	
				Ultima	10 . 1 . 223 . 254	0 0 0 0 1 0 1 0 . 0 0 0 0	0 0 0 1 . 1 1 0	1 1 1 1 1 . 1 1 1 1 1 1 1 0
	-	VACANTE	10.1.224.0 / 19	Primera	10 . 1 . 224 . 1	0 0 0 0 1 0 1 0 . 0 0 0 0	0 0 0 1 . 1 1 1	0 0 0 0 0 . 0 0 0 0 0 0 0 1
				-	-		-	
				-	-		-	
				Ultima	10 . 1 . 255 . 254	0 0 0 0 1 0 1 0 . 0 0 0 0	0 0 0 1 . 1 1 1	1 1 1 1 1 . 1 1 1 1 1 1 1 0
	-	VACANTE	10.2.0.0 / 19	Primera	10 . 2 . 0 . 1	0 0 0 0 1 0 1 0 . 0 0 0 0	0 0 1 0 . 0 0 0	0 0 0 0 0 . 0 0 0 0 0 0 0 1
				-	-		-	
				-	-		-	
				Ultima	10 . 2 . 31 . 254	0 0 0 0 1 0 1 0 . 0 0 0 0	0 0 1 0 . 0 0 0	1 1 1 1 1 . 1 1 1 1 1 1 1 0
	-	-	-	-	-		-	
				-	-		-	
				-	-		-	
				-	-		-	
				-	-		-	
	-	-	-	-	-		-	
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				-	-		-	
				-	-		-	
				-	-		-	
				-	-		-	
	126 (ULTIMA)	RESERVADA	10.15.224.0 / 19	Primera	10 . 15 . 224 . 1	0 0 0 0 1 0 1 0 . 0 0 0 0	1 1 1 1 . 1 1 1	0 0 0 0 0 . 0 0 0 0 0 0 0 1
				-	-		-	
				-	-		-	
				Ultima	10 . 15 . 255 . 254	0 0 0 0 1 0 1 0 . 0 0 0 0	1 1 1 1 . 1 1 1	1 1 1 1 1 . 1 1 1 1 1 1 1 0

APPENDIX B

INTER/INTRA REGIONAL LINKS

Red	Enlace				
	Nro.	Subred	Extremos	Direcciones a utilizar	
10.15.224.0 / 19	1	10.15.224.0 / 30	Argentina-Bolivia	-	10 . 15 . 224 . 0 / 30
				Argentina	10 . 15 . 224 . 1 / 30
				Bolivia	10 . 15 . 224 . 2 / 30
				-	10 . 15 . 224 . 3 / 30
	2	10.15.224.4 / 30	Argentina-Chile	-	10 . 15 . 224 . 4 / 30
				Argentina	10 . 15 . 224 . 5 / 30
				Chile	10 . 15 . 224 . 6 / 30
				-	10 . 15 . 224 . 7 / 30
	3	10.15.224.8 / 30	Argentina-Paraguay	-	10 . 15 . 224 . 8 / 30
				Argentina	10 . 15 . 224 . 9 / 30
				Paraguay	10 . 15 . 224 . 10 / 30
				-	10 . 15 . 224 . 11 / 30
	4	10.15.224.12 / 30	Argentina-Peru	-	10 . 15 . 224 . 12 / 30
				Argentina	10 . 15 . 224 . 13 / 30
				Peru	10 . 15 . 224 . 14 / 30
				-	10 . 15 . 224 . 15 / 30
	5	10.15.224.16 / 30	Argentina-Uruguay	-	10 . 15 . 224 . 16 / 30
				Argentina	10 . 15 . 224 . 17 / 30
				Uruguay	10 . 15 . 224 . 18 / 30
				-	10 . 15 . 224 . 19 / 30
	6	10.15.224.20 / 30	Argentina-AFI	-	10 . 15 . 224 . 20 / 30
				Argentina	10 . 15 . 224 . 21 / 30
				AFI (Johannesburgo)	10 . 15 . 224 . 22 / 30
				-	10 . 15 . 224 . 23 / 30
	7	10.15.224.24 / 30	Brasil-Colombia	-	10 . 15 . 224 . 24 / 30
				Brasil	10 . 15 . 224 . 25 / 30
				Colombia	10 . 15 . 224 . 26 / 30
				-	10 . 15 . 224 . 27 / 30
	8	10.15.224.28 / 30	Brasil-Guyana	-	10 . 15 . 224 . 28 / 30
				Brasil	10 . 15 . 224 . 29 / 30
				Guyana	10 . 15 . 224 . 30 / 30
				-	10 . 15 . 224 . 31 / 30
	9	10.15.224.32 / 30	Brasil-Guyana Francesa	-	10 . 15 . 224 . 32 / 30
				Brasil	10 . 15 . 224 . 33 / 30
				Guyana Francesa	10 . 15 . 224 . 34 / 30
				-	10 . 15 . 224 . 35 / 30

Enlaces Inter/Intra Regionales correspondientes a la Región SAM

Red	Enlace				
	Nro.	Subred	Extremos	Direcciones a utilizar	
10.15.224.0 / 19	10	10.15.224.36 / 30	Brasil-Peru	-	10 . 15 . 224 . 36 / 30
				Brasil	10 . 15 . 224 . 37 / 30
				Peru	10 . 15 . 224 . 38 / 30
				-	10 . 15 . 224 . 39 / 30
	11	10.15.224.40 / 30	Brasil-Surinam	-	10 . 15 . 224 . 40 / 30
				Brasil	10 . 15 . 224 . 41 / 30
				Surinam	10 . 15 . 224 . 42 / 30
				-	10 . 15 . 224 . 43 / 30
	12	10.15.224.44 / 30	Brasil-Venezuela	-	10 . 15 . 224 . 44 / 30
				Brasil	10 . 15 . 224 . 45 / 30
				Venezuela	10 . 15 . 224 . 46 / 30
				-	10 . 15 . 224 . 47 / 30
	13	10.15.224.48 / 30	Brasil-AFI (tentativo)	-	10 . 15 . 224 . 48 / 30
				Brasil	10 . 15 . 224 . 49 / 30
				AFI (Dakar)	10 . 15 . 224 . 50 / 30
				-	10 . 15 . 224 . 51 / 30
	14	10.15.224.52 / 30	Brasil-EUR (tentativo)	-	10 . 15 . 224 . 52 / 30
				Brasil	10 . 15 . 224 . 53 / 30
				EUR (Madrid)	10 . 15 . 224 . 54 / 30
				-	10 . 15 . 224 . 55 / 30
	15	10.15.224.56 / 30	Brasil-NAM	-	10 . 15 . 224 . 56 / 30
				Brasil	10 . 15 . 224 . 57 / 30
				NAM(Atlanta)	10 . 15 . 224 . 58 / 30
				-	10 . 15 . 224 . 59 / 30
	16	10.15.224.60 / 30	Brasil-Argentina	-	10 . 15 . 224 . 60 / 30
				Brasil	10 . 15 . 224 . 61 / 30
				Argentina	10 . 15 . 224 . 62 / 30
				-	10 . 15 . 224 . 63 / 30
	17	10.15.224.64 / 30	Brasil-Bolivia	-	10 . 15 . 224 . 64 / 30
				Brasil	10 . 15 . 224 . 65 / 30
				Bolivia	10 . 15 . 224 . 66 / 30
				-	10 . 15 . 224 . 67 / 30
	18	10.15.224.68 / 30	Brasil-Paraguay	-	10 . 15 . 224 . 68 / 30
				Brasil	10 . 15 . 224 . 69 / 30
				Paraguay	10 . 15 . 224 . 70 / 30
				-	10 . 15 . 224 . 71 / 30

Enlaces Inter/Intra Regionales correspondientes a la Región SAM

Red	Enlace				
	Nro.	Subred	Extremos	Direcciones a utilizar	
10.15.224.0 / 19	19	10.15.224.72 / 30	Brasil-Uruguay	-	10 . 15 . 224 . 72 / 30
				Brasil	10 . 15 . 224 . 73 / 30
				Uruguay	10 . 15 . 224 . 74 / 30
				-	10 . 15 . 224 . 75 / 30
	20	10.15.224.76 / 30	Chile-PAC	-	10 . 15 . 224 . 76 / 30
				Chile	10 . 15 . 224 . 77 / 30
				PAC(Christchurch)	10 . 15 . 224 . 78 / 30
				-	10 . 15 . 224 . 79 / 30
	21	10.15.224.80 / 30	Chile-Peru	-	10 . 15 . 224 . 80 / 30
				Chile	10 . 15 . 224 . 81 / 30
				Peru	10 . 15 . 224 . 82 / 30
				-	10 . 15 . 224 . 83 / 30
	22	10.15.224.84 / 30	Colombia-NAM	-	10 . 15 . 224 . 84 / 30
				Colombia	10 . 15 . 224 . 85 / 30
				NAM (Atlanta)	10 . 15 . 224 . 86 / 30
				-	10 . 15 . 224 . 87 / 30
	23	10.15.224.88 / 30	Colombia-Ecuador	-	10 . 15 . 224 . 88 / 30
				Colombia	10 . 15 . 224 . 89 / 30
				Ecuador	10 . 15 . 224 . 90 / 30
				-	10 . 15 . 224 . 91 / 30
	24	10.15.224.92 / 30	Colombia-Peru	-	10 . 15 . 224 . 92 / 30
				Colombia	10 . 15 . 224 . 93 / 30
				Peru	10 . 15 . 224 . 94 / 30
				-	10 . 15 . 224 . 95 / 30
	25	10.15.224.96 / 30	Colombia-Venezuela	-	10 . 15 . 224 . 96 / 30
				Colombia	10 . 15 . 224 . 97 / 30
				Venezuela	10 . 15 . 224 . 98 / 30
				-	10 . 15 . 224 . 99 / 30
	26	10.15.224.100 / 30	Ecuador-Peru	-	10 . 15 . 224 . 100 / 30
				Ecuador	10 . 15 . 224 . 101 / 30
				Peru	10 . 15 . 224 . 102 / 30
				-	10 . 15 . 224 . 103 / 30
	27	10.15.224.104 / 30	Ecuador-Venezuela	-	10 . 15 . 224 . 104 / 30
				Ecuador	10 . 15 . 224 . 105 / 30
				Venezuela	10 . 15 . 224 . 106 / 30
				-	10 . 15 . 224 . 107 / 30

Enlaces Inter/Intra Regionales correspondientes a la Región SAM

Red	Enlace				
	Nro.	Subred	Extremos	Direcciones a utilizar	
10.15.224.0 / 19	28	10.15.224.108 / 30	Guyana Francesa-Surinam	-	10 . 15 . 224 . 108 / 30
				Guyana Francesa	10 . 15 . 224 . 109 / 30
				Surinam	10 . 15 . 224 . 110 / 30
				-	10 . 15 . 224 . 111 / 30
	29	10.15.224.112 / 30	Guyana-C-CAR	-	10 . 15 . 224 . 112 / 30
				Guyana	10 . 15 . 224 . 113 / 30
				C-CAR (Piarco)	10 . 15 . 224 . 114 / 30
				-	10 . 15 . 224 . 115 / 30
	30	10.15.224.116 / 30	Guyana-Surinam	-	10 . 15 . 224 . 116 / 30
				Guyana	10 . 15 . 224 . 117 / 30
				Surinam	10 . 15 . 224 . 118 / 30
				-	10 . 15 . 224 . 119 / 30
	31	10.15.224.120 /30	Guyana-Venezuela	-	10 . 15 . 224 . 120 / 30
				Guyana	10 . 15 . 224 . 121 / 30
				Venezuela	10 . 15 . 224 . 122 / 30
				-	10 . 15 . 224 . 123 / 30
	32	10.15.224.124 / 30	Peru-NAM	-	10 . 15 . 224 . 124 / 30
				Peru	10 . 15 . 224 . 125 / 30
				NAM (Atlanta)	10 . 15 . 224 . 126 / 30
				-	10 . 15 . 224 . 127 / 30
	33	10.15.224.128 / 30	Peru-Bolivia	-	10 . 15 . 224 . 128 / 30
				Peru	10 . 15 . 224 . 129 / 30
				Bolivia	10 . 15 . 224 . 130 / 30
				-	10 . 15 . 224 . 131 / 30
	34	10.15.224.132 / 30	Peru-Colombia	-	10 . 15 . 224 . 132 / 30
				Peru	10 . 15 . 224 . 133 / 30
				Colombia	10 . 15 . 224 . 134 / 30
				-	10 . 15 . 224 . 135 / 30
	35	10.15.224.136 / 30	Peru-Venezuela	-	10 . 15 . 224 . 136 / 30
				Peru	10 . 15 . 224 . 137 / 30
				Venezuela	10 . 15 . 224 . 138 / 30
				-	10 . 15 . 224 . 139 / 30
	36	10.15.224.140 / 30	Surinam-Venezuela	-	10 . 15 . 224 . 140 / 30
				Surinam	10 . 15 . 224 . 141 / 30
				Venezuela	10 . 15 . 224 . 142 / 30
				-	10 . 15 . 224 . 143 / 30

Enlaces Inter/Intra Regionales correspondientes a la Región SAM

Red	Enlace				
	Nro.	Subred	Extremos	Direcciones a utilizar	
10.15.224.0 / 19	37	10.15.224.144 / 30	Venezuela-CAM	-	10 . 15 . 224 . 144 / 30
				Venezuela	10 . 15 . 224 . 145 / 30
				CAM (San Juan)	10 . 15 . 224 . 146 / 30
				-	10 . 15 . 224 . 147 / 30
	38	10.15.224.148 / 30	Venezuela-EUR	-	10 . 15 . 224 . 148 / 30
				Venezuela	10 . 15 . 224 . 149 / 30
				EUR (Madrid)	10 . 15 . 224 . 150 / 30
				-	10 . 15 . 224 . 151 / 30
	39	10.15.224.152 / 30	Venezuela-Trinidad y Tobago	-	10 . 15 . 224 . 152 / 30
				Venezuela	10 . 15 . 224 . 153 / 30
				Trinidad y Tobago	10 . 15 . 224 . 154 / 30
				-	10 . 15 . 224 . 155 / 30
	40	10.15.224.156 / 30	VACANTE	-	10 . 15 . 224 . 156 / 30
					10 . 15 . 224 . 157 / 30
					10 . 15 . 224 . 158 / 30
				-	10 . 15 . 224 . 159 / 30
	41	10.15.224.160 / 30	VACANTE	-	10 . 15 . 224 . 160 / 30
					10 . 15 . 224 . 161 / 30
					10 . 15 . 224 . 162 / 30
				-	10 . 15 . 224 . 163 / 30
	42	10.15.224.164 / 30	VACANTE	-	10 . 15 . 224 . 164 / 30
					10 . 15 . 224 . 165 / 30
					10 . 15 . 224 . 166 / 30
				-	10 . 15 . 224 . 167 / 30
	-	-	-	-	-
					-
					-
				-	-
	-	-	-	-	-
					-
					-
				-	
	2048 (última)	10.15.31.252 / 30	VACANTE	-	10 . 15 . 31 . 252 / 30
					10 . 15 . 31 . 253 / 30
					10 . 15 . 31 . 254 / 30
				-	10 . 15 . 31 . 255 / 30

APPENDIX C

1. C1 – Present Architecture of the SAM Network

1.1 ICAO, the Contracting Party on behalf of the Member States, under Technical Cooperation Project RLA03/901, is the organization responsible for coordination, tendering and management of the SAM Digital Communication Network (REDDIG).

1.2 The countries and nodes, together with their basic geographic coordinates, that are a part of this tender, are listed in Table 2.

Country	Node	Indicative	Latitude	Longitude
Argentina	Ezeiza	SAEZ	34° 49’ 25” S	58° 31’ 43” W
Bolivia	La Paz	SLLP	16° 30’ 29” S	68° 11’ 24” W
Brazil	Manaos	SBMN	03° 02’ 19” S	60° 02’ 59” W
	Recife	SBRE	08° 07’ 36” S	34° 55’ 23” W
	Curitiba	SBCT	25° 31’ 43” S	49° 10’ 33” W
Chile	Santiago	SCEL	33° 23’ 26” S	70° 47’ 09” W
Colombia	Bogota	SKED	04° 42’ 05” N	74° 08’ 48” W
Ecuador	Guayaquil	SEGU	02° 09’ 29” S	79° 53’ 02” W
Guyana	Georgetown	SYGC	06° 29’ 56” N	58° 15’ 16” W
French Guiana	Cayenne	SOCA	04° 49’ 11” N	52° 21’ 38” W
Paraguay	Asuncion	SGAS	25° 14’ 24” S	57° 31’ 09” W
Peru	Lima	SPIM	12° 01’ 19” S	77° 06’ 52” W
Suriname	Paramaribo	SMPM	05° 27’ 10” N	55° 11’ 16” W
Trinidad and Tobago	Piarco	TTZP	10° 35’ 44” N	61° 20’ 36” W
Uruguay	Montevideo	SUMU	34° 50’ 15” S	56° 01’ 49” W
Venezuela	Maiquetia	SVMI	10° 36’ 12” N	66° 59’ 26” W

Table 2: Location of the REDDIG Nodes

1.3 Figure 1 shows the basic topology of the current REDDIG with its sixteen nodes.

Figure 1: Current REDDIG Topology

In addition to that outlined in Figure 1, the REDDIG is also interconnected with the MEVAII network that serves the Central American and Caribbean countries and the United States. REDDIG uses the nodes of Bogota (Colombia) and Maiquetia (Venezuela), as described in Figure 2, to make that interconnection.

1.4

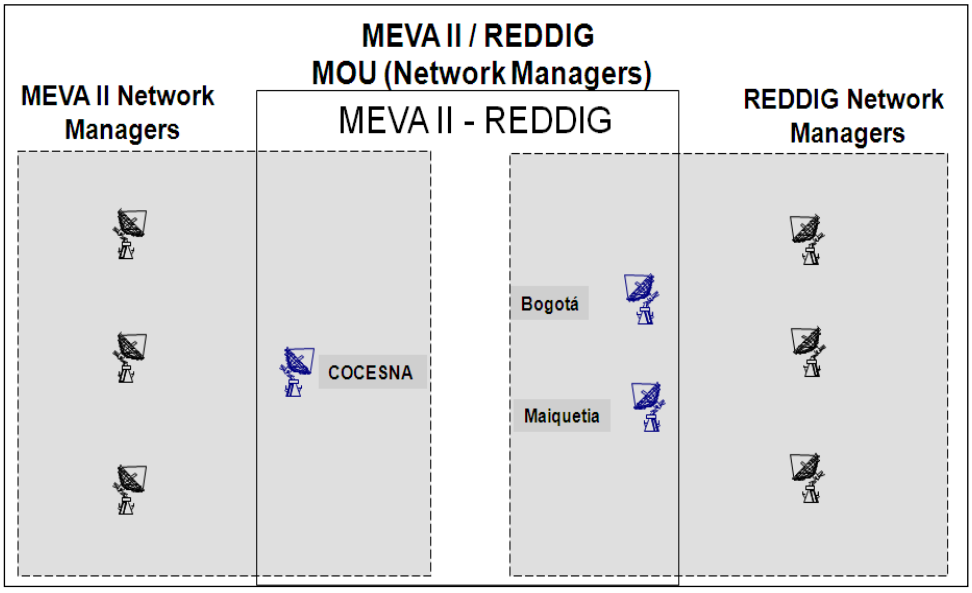

Figure 2. MEVA II - REDDIG Interconnection

1.5 The basic characteristics of the current network are the following:

a) REDDIG is a meshed network that uses VSAT (Very Small Aperture Terminal) technology with 3.7m antennas and Band C (4-6 GHz), utilizing the INTELSAT IS-14 satellite that is located at 315°E. At present, a 4.4 MHz capacity is rented to meet REDDIG application requirements.
b) REDDIG possesses a total of 1,328 Kbps to handle traffic between all network terminals, which are equivalent to 83 16 Kbit/s bursts.
c) INTELSAT is the current satellite provider, since the International Civil Aviation Organization (ICAO), as a United Nations (UN) Organization, is an INTELSAT signatory by law and thus responsible for reserving and paying for the required bandwidth.
d) The REDDIG network uses band C (4-6 GHz) because some of its nodes are located in zones where weather conditions make that use necessary.
e) The main equipment (indoor and outdoor), together with the software used, are described in Appendix A, while the main voice and data services are described in Appendix B.
f) The network also supports RC&M (Remote Control & Monitoring) for the efficient management of its resources. There are two network control centres (NCCs), the main one being located in Manaus (Brazil) and the alternate in Ezeiza (Argentina).
g) The interconnection between the MEVA II and REDDIG networks maintains the individual basic characteristics of the two networks insofar as management and control are concerned. Nevertheless, it adds a MEVA II modem in the Bogota (Colombia) and Maiquetia (Venezuela) REDDIG nodes and a REDDIG modem to the COCESNA (Honduras) MEVA II node.

2. C2 – Future network architecture

2.1 REDDIG II arose from the need to maintain air navigation communications and services among the various air traffic units of the Region that are currently being served by the REDDIG, and to implement the backbone of the Aeronautical Telecommunication Network (ATN).

2.2 Figure 3 presents an outline of the basic topology required for REDDIG II.

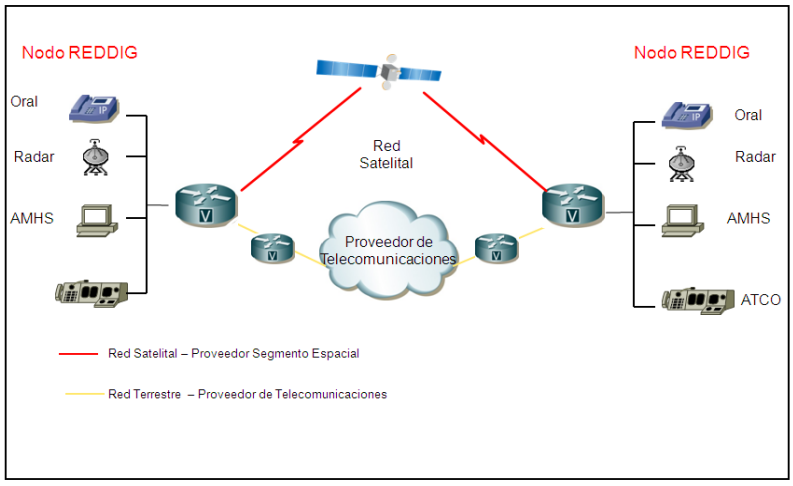

Figure 3: Basic REDDIG II Topology

2.3 As can be seen in Figure 3, REDDIG II will have two segments: a satellite transmission (VSAT) segment, and a ground segment based on Multiprotocol Label Switching (MPLS) technology. The satellite backbone will be the main system, and the ground segment, being IP, will increase flexibility for the loading of new applications, and will also increase the network's overall availability. If the main network fails, switching to the ground backbone will be automatic.

2.4 The topology of the satellite and terrestrial networks will be fully meshed, flexible and scalable in order to facilitate infrastructure growth. In addition, it will be highly available, thanks to: intelligence distributed within its nodes and with no common failure point, traffic prioritization, dynamic bandwidth management and management by demand, automatic alternate traffic routing in the event of a failure and a global, integrated, "future-proof" common network management system (NMS) to allow for migration to other network technologies.

2.5 The routing system to be implemented has important characteristics for purposes of this document, inasmuch as it must support internal gateway protocols (IGP), such as RIP (Versions 1 and 2) and OSPF, and external border gateway protocol BGP-4.

2.6 The main requirements of the VSAT system will be:

a) Hubless network with no common failure point. All stations will be identical and no specialized stations must exist. Each station must be capable of acting as a time reference station for the satellite network, with only occasional updating of software.
b) Secure control system via pre-established and programmable rotation defined by the master and supporting terminals, automatic switching if the master station fails, or synchronized architecture that does not require a master station.
c) Full-meshed topology: the necessary links should be established to satisfy network topology and communication requirements.
d) All communications should be established through a simple satellite hop.
e) Satellite links will have a better bit error rate (BER) than 1 E-7.
f) Band C operation.

2.7 The REDDIG II terrestrial backbone will operate as a multiservice infrastructure and should be provided by a Multiservice IP Platform that is logically independent and isolated from any other network, particularly the public environment of the Internet. The main requirements are described as follows:

a) Monthly availability of each link at least 99.5% of the time.
b) Delay of less than 60 m.
c) RTT for a 64-byte packet in a communication between two stations of no more than 150 m in 95% of the measurements made during a 10-second minimum time window.
d) BER smaller than 10^{-7} 99.5% of the time.

APPENDIX D

1. **D1 – Air navigation support service requirements in the SAM Region, including those foreseen for the short, medium and long term.**

1.1 The list of air navigation support service requirements in the SAM Region, including those foreseen for the short, medium and long term, to be transported over the new digital network, consist of the:

1.1.1 Current services

1.1.1.1 Those deriving from the requirements contained in the Air Navigation Plan for the Caribbean and South American Regions, almost all of which are operational, as follows:

a) Table CNS1A (AFTN Plan).
b) Table CNS1C (ATS direct speech circuits).

1.1.2 Future services

a) Those stemming from the MEVA II – REDDIG interconnection.
b) Teleconferencing Service for flow management units (FMU) or flow management positions (FMP), to be carried out daily among all of the Region's units, initially for twenty users.
c) Exchange of flight plans and/or radar information using conventional methods, in accordance with the respective MoUs (Memorandums of Understanding) that have been or are to be signed.
d) AMHS interconnection requirements, which will progressively replace the AFTN service, in accordance with the respective MoUs (Memorandums of Understanding) that have been or are to be signed.
e) AIDC interconnection requirements, which will progressively replace the ATS speech service.
f) Exchange of ADS-B data and their multilateration among all ACCs of adjacent FIRs.
g) Interconnection of automated systems among the ACCs of adjacent FIRs, using Asterix 62 and 63.
h) AIM requirements: no specific requirement is as yet available in this regard.

1.2 Table B-1 describes the minimum interfaces that routers to be installed in each State should have for REDDIG II implementation.

State	Site	Minimum interfaces					
		Universal I/O	Ethernet	Digital	E&M	FXO	FXS
Argentina	Ezeiza	11	1	0	11	0	1
Bolivia	La Paz	4	1	0	4	0	4
Brazil	Curitiba	4	1	0	6	2	1
	Manaos	6	1	0	7	0	5
	Recife	1	1	0	7	0	1
Chile	Santiago	2	1	0	8	0	0
Colombia	Bogota	7	1	1	0	0	0

State	Site	Minimum interfaces					
		Universal I/O	Ethernet	Digital	E&M	FXO	FXS
Ecuador	Guayaquil	3	1	1	0	0	0
French Guiana	Rochambeau	2	1	0	0	0	5
Guyana	Georgetown	4	1	0	0	0	5
Paraguay	Asuncion	3	1	0	3	0	3
Peru	Lima	9	1	1	0	0	0
Suriname	Panamaribo	3	1	0	0	0	4
Trinidad and Tobago	Piarco	2	1	0	0	0	6
Uruguay	Montevideo	2	1	0	0	4	5
Venezuela	Maiquetía	10	1	0	7	0	4

Table B-1: Future Interfaces for REDDIG II

1.3 Table B-2 presents the estimated bandwidth needed to support the new services to be implemented in the SAM Region for REDDIG II.

State	Site	Service (each in Kbps)			
		AFTN	Radar	AMHS	ADS-B
Argentina	Ezeiza		76.8	28.8	19.2
Bolivia	La Paz		115.2	14.4	19.2
Brazil	Curitiba		76.8	19.2	19.2
	Manaos	9.6	134.4	33.6	19.2
	Recife		0	4.8	19.2
Chile	Santiago		57.6	9.6	19.2
Colombia	Bogota	19.2	76.8	38.4	19.2
Ecuador	Guayaquil		38.4	14.4	19.2
French Guiana	Rochambeau		38.4	9.6	19.2
Guyana	Georgetown		57.6	19.2	19.2
Paraguay	Asuncion		57.6	9.6	19.2
Peru	Lima	9.6	96	43.2	19.2
Suriname	Panamaribo		76.8	14.4	19.2
Trinidad and Tobago	Piarco		19.2	9.6	19.2
Uruguay	Montevideo		19.2	9.6	19.2
Venezuela	Maiquetia		76.8	38.4	19.2
Partial figures (Kbps)		38.4	1017.6	316.8	307.2
Partial global figure (Kbps)		1680			
AFTN difference		-103.2			

State	Site	Service (each in Kbps)			
		AFTN	Radar	AMHS	ADS-B
Net increase in bandwidth		1576.8			

Table B-2: Estimated additional bandwidth

APPENDIX E

TABLE CNS 1Ba – ROUTERS REGIONAL PLAN
SAM REGION

Administration and Location	Type of Router	Type of Interconnection	ConnectedRouter	Link Speed	Link Protocol	Via	Target Date	Remarks
1	2	3	4	5	6	7	8	9
Argentina/Buenos Aires	IP	Inter Regional	AFI (Johannesburg)	64K	IPv6	CAFSAT	TBD	
	IP	Intra Regional	Bolivia (La Paz)	64K	IPv4	REDDIG	2014	
	IP	Intra Regional	Chile (Santiago)	64K	IPv4	REDDIG	2012	
	IP	Intra Regional	Brazil (Brasilia)	64K	IPv4	REDDIG	2012	
	IP	Intra Regional	Paraguay (Asuncion)	64K	IPv4	REDDIG	2012	
	IP	Intra Regional	Peru (Lima)	64K	IPv4	REDDIG	2011	
	IP	Intra Regional	Uruguay (Montevideo)	64K	IPv4	REDDIG	2011	
Bolivia/La Paz	IP	Intra Regional	Argentina (Buenos Aires)	64K	IPv4	REDDIG	2014	
	IP	Intra Regional	Brazil (Brasilia)	64K	IPv4	REDDIG	2014	
	IP	Intra Regional	Peru (Lima)	64K	IPv4	REDDIG	2014	
Brazil/Brasilia	IP	Inter Regional	AFI (Dakar)	TBD	IPv6	CAFSAT	TBD	
	IP	Intra Regional	Argentina (Buenos Aires)	64K	IPv4	REDDIG	2012	
	IP	Intra Regional	Bolivia (La Paz)	64K	IPv4	REDDIG	2014	
	IP	Inter Regional	EUR (Madrid)	64K	IPv6	PTT	2014	
	IP	Inter Regional	NAM (Atlanta)	64K	IPv4	MEVA II/ REDDIG	2014	Circuit via Bogota
	IP	Intra Regional	Paraguay (Asuncion)	64K	IPv4	REDDIG	2014	
	IP	Intra Regional	Uruguay (Montevideo)	64K	IPv4	REDDIG	2014	
Brazil/Manaus	IP	Intra Regional	Colombia (Bogota)	64K	IPv4	REDDIG	2014	
	IP	Intra Regional	Guyana (Georgetown)	64K	IPv4	REDDIG	2014	
	IP	Intra Regional	French Guiana (Cayenne)	64K	IPv4	REDDIG	2014	
	IP	Intra Regional	Peru (Lima)	64K	IPv4	REDDIG	2012	
	IP	Intra Regional	Suriname (Paramaribo)	64K	IPv4	REDDIG	2014	
	IP	Intra Regional	Venezuela (Caracas)	64K	IPv4	REDDIG	2012	
Chile/Santiago	IP	Intra Regional	Argentina (Buenos Aires)	64K	IPv4	REDDIG	2012	
	IP	Inter Regional	PAC (Christchurch)	TBD	IPv4	PTT	TBD	
	IP	Intra Regional	Peru (Lima)	64K	IPv4	REDDIG	2014	
Colombia/Bogota	IP	Intra Regional	Brazil (Manaus)	64K	IPv4	REDDIG	2014	

Administration and Location	Type of Router	Type of Interconnection	ConnectedRouter	Link Speed	Link Protocol	Via	Target Date	Remarks
1	2	3	4	5	6	7	8	9
	IP	Inter Regional	CAR	64K	IPv4	MEVAII/REDDIG	2014	
	IP	Intra Regional	Ecuador (Guayaquil)	64K	IPv4	REDDIG	2014	
	IP	Inter Regional	NAM (Atlanta)	2x 64K	IPv4	MEVA II / REDDIG	2014	Connection of Colombia and Brazil
	IP	Intra Regional	Panama	64k	IPv4	MEVAII/REDDIG	2014	
	IP	Intra Regional	Peru (Lima)	64K	IPv4	REDDIG	2010	
	IP	Intra Regional	Venezuela (Caracas)	64K	IPv4	REDDIG	2014	
Ecuador/Guayaquil	IP	Inter Regional	CAR	64K	IPv4	MEVA II / REDDIG	2014	
	IP	Intra Regional	Colombia (Bogota)	64K	IPv4	REDDIG	2014	
	IP	Intra Regional	Peru (Lima)	64K	IPv4	REDDIG	2012	
	IP	Intra Regional	Venezuela (Caracas)	64K	IPv4	REDDIG	2014	
French Guiana/Cayenne	IP	Intra Regional	Brazil (Manaus)	64K	IPv4	REDDIG	2014	
	IP	Intra Regional	Suriname (Paramaribo)	64K	IPv4	REDDIG	2014	
Guyana/Georgetown	IP	Intra Regional	Brazil (Manaos)	64K	IPv4	REDDIG	2014	
	IP	Inter Regional	CAR	64K	IPv4	REDDIG	2014	
	IP	Intra Regional	Suriname (Paramaribo)	64K	IPv4	REDDIG	2011	
	IP	Intra Regional	Venezuela (Caracas)	64K	IPv4	REDDIG	2014	
Panama/Panama	IP	Inter Regional	CAR	64K	IPv4	CAMSAT	2012	
	IP	Intra Regional	Colombia (Bogota)	64K	IPv4	MEVAII / REDDIG	2014	
	IP	Inter Regional	NAM (Atlanta)	64K	IPv4	MEVA II	2014	
Paraguay/Asuncion	IP	Intra Regional	Argentina (Buenos Aires)	64K	IPv4	REDDIG	2012	
	IP	Intra Regional	Brazil (Brasilia)	64K	IPv4	REDDIG	2014	
Peru/Lima	IP	Intra Regional	Argentina (Buenos Aires)	64K	IPv4	REDDIG	2011	
	IP	Intra Regional	Bolivia (La Paz)	64K	IPv4	REDDIG	2014	
	IP	Intra Regional	Brazil (Manaos)	64K	IPv4	REDDIG	2012	
	IP	Intra Regional	Chile (Santiago)	64K	IPv4	REDDIG	2014	

Administration and Location	Type of Router	Type of Interconnection	ConnectedRouter	Link Speed	Link Protocol	Via	Target Date	Remarks
1	2	3	4	5	6	7	8	9
	IP	Intra Regional	Colombia (Bogota)	64K	IPv4	REDDIG	2010	
	IP	Intra Regional	Ecuador (Guayaquil)	64K	IPv4	REDDIG	2012	
	IP	Inter Regional	NAM (Atlanta)	64K	IPv4	MEVAII/REDDIG	2014	Via Bogota, Colombia
	IP	Intra Regional	Venezuela (Caracas)	64K	IPv4	REDDIG	2014	
Suriname/Paramaribo	IP	Intra Regional	Brazil (Manaos)	64K	IPv4	REDDIG	2014	
	IP	Intra Regional	French Guiana (Cayenne)	64K	IPv4	REDDIG	2011	
	IP	Intra Regional	Venezuela (Caracas)	64K	IPv4	REDDIG	2014	
Uruguay/Montevideo	IP	Intra Regional	Argentina (Buenos Aires)	64K	IPv4	REDDIG	2011	
	IP	Intra Regional	Brazil (Brasilia)	64K	IPv4	REDDIG	2014	
Venezuela/Caracas	IP	Inter Regional	CAR	128K	IPv4	MEVA II / REDDIG	2014	
	IP	Inter Regional	EUR (Madrid)	64K	IPv6	PTT	2014	
	IP	Intra Regional	Brazil (Manaus)	64K	IPv4	REDDIG	2012	
	IP	Intra Regional	Colombia (Bogota)	64K	IPv4	REDDIG	2014	
	IP	Intra Regional	Ecuador (Quito)	64K	IPv4	REDDIG	2014	
	IP	Intra Regional	Guyana (Georgetown)	64K	IPv4	REDDIG	2014	
	IP	Intra Regional	Suriname (Paramaribo)	64K	IPv4	REDDIG	2014	

APPENDIX F

PRIVATE AS NUMBERS

STATE	TYPE OF ROUTER	AS NUMBER
Argentina	IP	64517
Bolivia	IP	64529
Brazil	IP	64531
Chile	IP	64543
Colombia	IP	64545
Ecuador	IP	64558
Guyana	IP	64574
French Guiana	IP	64575
Panama	IP	65261
Paraguay	IP	65263
Peru	IP	65264
Suriname	IP	65288
Uruguay	IP	65302
Venezuela	IP	64528