

**INTERNATIONAL CIVIL AVIATION ORGANIZATION
South American Regional Office**

**UNDP/ICAO REGIONAL PROJECT RLA/98/019
IMPLEMENTATION OF THE SAM DIGITAL NETWORK (REDDIG)**

**FIRST MEETING OF THE TASK FORCE OF THE REDDIG
(Lima, Peru, 4 to 5 November 2002)**

Agenda item 2: **Development of the Option 1 identified by RCC/2 Meeting to establish a multinational mechanism for the management of the REDDIG**

Principles to establish the NCC in the REDDIG Digital Network

(Presented by ICAO)

1. Introduction

1.1 Background

1.1.1 The immediate objective No. 2 of the Project RLA/98/019 SAM REDDIG is to carry out the initial management of the REDDIG and to establish a multinational mechanism for its later administration.

1.1.2 With this purpose, during the second meeting of the coordination committee of the REDDIG, the meeting examined working papers presented by some States, offering their installations to execute the future management of the REDDIG, as well as a working paper of the Secretariat presenting an analysis to study the options selected by the REDDIG/4 Meeting.

1.1.3 This working paper presents some technical and administrative elements that should be considered for the discussion of the Task Force for the establishment of a definite multinational mechanism.

1.2 Management Options

1.2.1 Among the options for the REDDIG management, the following were the alternatives considered:

a) Option 1: through an ICAO technical cooperation project.

b) Option 2: through the services provided by a State.

1.2.2 Likewise, it was noted that Option 1 could be subdivided in:

a) Option 1a: Through an ICAO regional project in which the totality of resources would be financed equitably by all the participating States; or

b) Option 1b: Through an ICAO regional project, with a strong contribution of the participating States in the project resources, such as technical personnel, offices and other required facilities or others;

c) Option 1c: Other alternatives.

1.2.3 Also, its was taken note that Option 1b could considerably reduce costs with respect to **Option 1a.**

1.2.4 The meeting decided that more judgement elements were needed to define the final management system, therefore it decided to conform a Task Force to support with human resources and consensus schemes the search of a definite solution.

1.3 **Transitory character of the ICAO technical cooperation projects**

1.5 It is important to point out the transitory character of the technical cooperation projects that should be understood not as that the principal purpose by as a mean to reach a more ample purpose. In this sense, the technical cooperation project for the management of the REDDIG should be conceived as a transitory instrument to achieve a final purpose, which is to count with a multinational mechanism for the management of the REDDIG without the need of ICAO technical cooperation.

2. Description of the operation of the NMS network management system of the REDDIG

2.1 Such as indicated in the Technical Specifications Document of the REDDIG (TSD), the management of the REDDIG, through the NMS, is carried out in two levels:

- a) Global management of all the network;
- b) Local management of the node.

2.2 The global management of the network is unique, and it has been established that this function is carried out from one of the NCC nodes. The NMS management system provides the capacity to carry out the supervision, programming and equipment control in all the nodes, with the exception to the configuration of the management of the TDMA plot and the assignment of the satellite band width, which is carried out through the NCC. The capacity of the NMS is available to all the nodes of the network, but the authorization to act as the global administrator of the network should be assigned only to one user.

2.3 The NCC of the Linkway system (satellite modem) includes a server through which the access and information on the satellite segment and NCC is provided to all the nodes of the network. The NMS, besides providing supervision and local control of the equipment of the node, provides access to the WEB service offered by the NCC.

2.4 Through the WEB, and depending of the available functions, the following NCC windows would be available:

- a) Geographical map of the VSAT stations operational situation;
- b) Detailed state, events and alarms of the VSAT network operations;
- c) Dynamic display of the assigned band width;
- d) Details of utilization and invoicing;
- e) Display of the service history with the events of the VSAT network (log file);
- f) Implementation of diagnostic tests;
- g) Alarms; and
- h) Configuration, maintenance and display of the configuration. However, by definition, only the global administrator has de attributes to make changes in the configuration of the NCC

2.5 The NCC has been established in a configuration with geographical redundancy, which means that only one of them could be active at a time, administering the satellite information. It has been foreseen that the NCC nodes operate alternatively during the year, with the purpose of minimizing the transferences of control between the NCC.

3. Criteria for the election of the sites to establish the NCC of the REDDIG

3.1 To establish the nodes where the REDDIG nodes will be located, it will be necessary to consider the following aspects:

- a) Geographical conditions of the NCC nodes;
- b) Climate conditions;
- c) Sponsoring country and characteristics of the building and the room of the NCC Network Control Center;
- d) Communications facilities of the NCC Network Control Center; and
- e) Contributions of the States relating the personnel requirement of the NCC;

4. Geographical conditions to establish the location of the NCC nodes of the REDDIG

4.1 The criteria obtained for the location of the NCC nodes should be independent to any of the alternatives that could have been indicated by the coordination committee of the REDDIG, and the principles of these criteria should be totally applicable to any case. The REDDIG is a network that uses a method of access to the satellite known as TDMA, based in which a station selected as principal station organizes and optimizes the utilization of the satellite segment among the earth stations that compose the network, and permits the creation of a network architecture completely woven, favoring the communication between all the users. Therefore, it is fundamental to maintain the operativity of the NCC nodes to ensure the network healthy operation.

4.2 The REDDIG network counts with two NCC nodes that are completely redundant, with the purpose of minimizing as much as possible the occurrence of any fault. However, a natural phenomenon is generally produced during two periods every year, which affects the operation capacity of the earth stations, this phenomenon is known as sun outage. The date of occurrence of this phenomenon is predictable with quite precision, which makes possible to take the necessary contingency measures. The effect of the sun outage is harmful to satellite communications and produces the degradation and cut off of the satellite communications.

4.3 The sun outage phenomenon is due, fundamentally, to the orbital position of the communications satellite in the equatorial plan, and to the variation of the earth equatorial plan with respect to the sun direction. This annual variation of the earth equatorial plan is given by the following formula:

$$ie(t) \text{ deg} = 23.4 \sin(2\pi t/T)$$

Where T is the annual period of 365 days. This behavior gives as result that during two periods of the year, the sun is located above the equatorial plan during the equinoxes of spring (March 21) and autumn (21 September) of the northern hemisphere; and that the inclination angle of the equatorial plan with respect to the sun be maximum (23.4 °) during the solstices of summer (21 June) and winter (21 December) of the northern hemisphere.

4.4 When occurring this variation, the equatorial plan with respect to the sun direction, following the typical characteristic of an harmonic movement, originates that during two periods a year an alignment of the sun with the communications satellite and with the communications earth station (node). When this alignment occurs, the energy that is radiated from the sun is so intense that it increments the floor of the noise signal received in the earth station, concealing the satellite signal and making impossible to recuperate the weak communications signal coming from the communications satellite.

4.5 The duration of this interference (sun outage) in an earth station is inversely dependent from the diameter of its antenna, and the duration depends also of the amount of power in the signal coming from the satellite, which is of limited power. The antennas used in the communications via satellite are highly directive, and are constructed to receive the signal not only in the principal light rays in the direction of its main point while in the other lateral space the reception is practically null. However, the opening angle above which the antenna receives the electromagnetic signal (3db of attenuation) is given by approximately:

$$\phi \text{ (deg)} = 21.3/(F\text{GHz} * D \text{ mts})$$

4.6 This is the fundamental reason why, being the opening angle bigger in an antenna of 2.4 m de 2.4 m ($\phi=2.21^\circ$) with respect to an antenna of 3.7 m ($\phi=1.43^\circ$), the duration of the sun outage is greater in a station that uses an antenna of 2.4 m than in a one of 3.7 m. There are also other parameters that influence the sun outage duration, such as the antenna noise temperature, G/T degradation, LNA noise temperature, etc. Based on these technical factors, the contractor SEEE presented during the 2DRM, carried out in Lima, a table where the effects of the sun outage in the REDDIG nodes could be easily observed. The table was presented, likewise, to the RCC/2 meeting, carried out in Lima last August, which is included as **Appendix A** of this working paper.

4.7 From the results observed in the table provided by the contractor, it results evident that the only way to provide protection to the network is avoiding the simultaneous occurrence of sun outage in the NCC nodes, which only is possible through the latitudinal separation between stations. It is important to note that it could be erroneously established that, only with the longitudinal separation between stations the same effect could achieved since the occurrence of the sun outage interference would not be simultaneous in time. Although this concepts appear to be correct, which is required for the network health is that in the sun outage period at least one control transference is produced between the NCC centers, which would not be possible to attain through the concept of implementation of the

geographical separation based, principally, in the longitudinal separation, where it would be required more that one control transference between the NCC during the period of sun outage.

4.8 From the observations done to the tables and to the geographical data of the location of the REDDIG stations, it results evident that more than 20° of latitudinal separation between the nodes selected as NCC is required to avoid the simultaneous sun outage interference.

4.9 Based on what has been indicated above, the first principle for the geographical election of the NCC nodes can be established:

FIRST PRINCIPLE: to establish the geographical separation of the NCC nodes, it is necessary that these nodes be latitudinally separated at least in 20° (geographical degrees).

4.10 From the observation done to the sun outage table presented by the contractor SEEE, a summary table can be obtained, which is included below as Table No. 1. In this table, the dark boxes (red) indicate that the possibility to establish the NCC nodes between the stations that produce convergence above the box is not possible since simultaneous sun outage occurs in the same day, and the light boxes (light green) indicate those combinations of stations between which the NCC nodes could be located without simultaneous sun outage interference occurring in the same day. The values contained in the green boxes indicate the separation in number of days occurring sun outage in the first and second annual period respectively. The two last rows of the table indicate, respectively, the number of possibilities that the node indicated in the column showing the NCC pair possibilities with other stations; and the last row indicates the average of the available time between sun outage occurrences with the pair NCC station.

Table No 1: Summary of sun outage effects

NODES	SAEZ	SLLP	SBMN	SBRF	SBCT	SCEL	SKED	SEGU	SYGC	SOCA	SGAS	SPIM	SMPM	SUMU	SVMI
SAEZ	N	N	4/4	2/2	N	N	8/8	5/5	9/8	8/8	N	1/0	8/8	N	10/10
SLLP	N	N	N	N	N	N	0/1	N	1/1	0/1	N	N	0/2	N	2/3
SBMN	4/4	N	N	N	0/1	3/3	N	N	N	N	0/0	N	N	5/4	N
SBRF	2/2	N	N	N	N	1/1	N	N	N	N	N	N	N	3/2	N
SBCT	N	N	0/1	N	N	N	4/5	1/2	5/5	4/5	N	N	4/5	N	6/7
SCEL	N	N	3/3	1/1	N	N	7/7	4/4	8/7	7/7	N	N	7/7	N	9/9
SKED	8/8	0/1	N	N	4/5	7/7	N	N	N	N	4/4	N	N	9/8	N
SEGU	5/5	N	N	N	1/2	4/4	N	N	N	N	1/1	N	N	6/5	N
SYGC	9/8	1/1	N	N	5/5	8/7	N	N	N	N	5/4	N	N	10/8	N
SOCA	8/8	0/1	N	N	4/5	7/7	N	N	N	N	4/4	N	N	9/8	N
SGAS	N	N	0/0	N	N	N	4/4	1/1	5/4	4/4	N	N	4/4	N	6/6
SPIM	1/0	N	N	N	N	N	N	N	N	N	N	N	N	2/1	0/1
SMPM	8/8	0/2	N	N	4/5	7/7	N	N	N	N	4/4	N	N	9/8	N
SUMU	N	N	5/4	3/2	N	N	9/8	6/5	10/8	9/8	N	2/1	9/8	N	11/10
SVMI	10/10	2/3	N	N	6/7	9/9	N	N	N	N	6/6	0/1	N	11/10	N
PAIR	9	5	5	3	7	8	6	5	6	6	7	3	6	9	7
TIME	6/6	½	2/2	2/2	3/4	6/6	5/6	3/3	6/6	5/6	3/3	1/1	5/6	7/6	6/7

4.11 It results evident that in the measure that more time is available between the sun outage occurrence among stations, the personnel of the management centers of the NCC will count with more time to carry out the control transference proceeding between the NCCs and to correct any technical difficulty in case this is presented. A period of at least 4 days could be considered as satisfactory. Based in this consideration, the second principle for the geographical selection of the NCC nodes can be established:

SECOND PRINCIPLE: The NCC should be selected in such a way that the short period that separated the sun outage occurrence between the NCC stations is the larger possible. This principle could be satisfied if the mentioned period is at least of 4 days.

4.12 Other aspect to be considered in the election of the NCC is that the node that has the largest capacity to generate valid combinations of stations that could be operated as NCC should be selected, and that, at the same time, the shorter periods that separate the sun outage occurrence be the most. The adoption of this concept would permit a great flexibility in determining the pair station of the NCC, which, at the same time, will facilitate in the future, if necessary, the relocation of the NCC pair station. Based in this concept, the third principle for the selection of one or more NCC nodes can be established:

THIRD PRINCIPLE: It should be selected as one of the NCC nodes, the node that permits to establish more combinations of NCC pair stations for the network control, and, at the same time, that the short period that separate the sun outage occurrence between NCC pair stations be the most possible.

4.13 Other aspect to be considered in the election of the NCC nodes is the one referred to the access facility for transportation of personnel and equipment to the other nodes of the network. This is a principle that is related, in general, to the facility to provide technical assistance to a node of the network in case being necessary. Based on this concept, the fourth principle for the selection of the NCC node can be established:

FOURTH PRINCIPLE: After applying the above principles, preference to establish a NCC node should be given to those places that permit an easy transportation of material and technical personnel to the other nodes of the network.

4.14 Based on the three first PRINCIPLES, it results evident that the nodes of SAEZ and SUMU result to be the most convenient to be selected as one of the NCC nodes. After applying the fourth principle, the node of SAEZ result to be the most convenient as first option.

4.15 It is important to note that the election of the node SAEZ covers the TSD requirement of establishing one of the NCC nodes in Lima, and that the same (SAEZ and SPIM) would not be affected by the effect of the simultaneous sun outage.

5. Climatic conditions

5.1 Other fundamental aspect to be considered is the one referred to the climatic zone where earth satellite stations are located, and specially, the NCC. This is due to the attenuation effect of rain interference in transmission and reception, as well as to the increment of the noise level in reception caused by the rain temperature.

5.2 Although the design margins considered in the links, the intensity of the rain could exceed the intensity of the maximum rain considered for each one of the hydro-meteorological zones (0.01%). Based on this concept, the fifth principle for the selection of the NCC could be established:

FIFTH PRINCIPLE: The NCC, preferentially, should be established in places where the maximum rain intensity be less to the value of the design considered for the network. As alternative, the NCC should be established in places where the duration of the maximum rain intensity exceeds during the less possible period of time the maximum value of the rain intensity with which the network was designed.

5.3 According to the classification of the hydro-meteorological zones of the UIT, the nodes of the REDDIG would be classified in the following way:

Table 2: Hydro-meteorological zones, rain intensity exceeded

NODE	ZONE	Time Percentage 1%	Time Percentage 0.1%	Time Percentage 0.01%
SAEZ	K	1.5 mm/h	12 mm/h	42 mm/h
SLLP	N	5.0 mm/h	35 mm/h	95 mm/h
SBMN	P	12.0 mm/h	65 mm/h	145 mm/h
SBRF	N	5.0 mm/h	35 mm/h	95 mm/h
SBCT	P	12.0 mm/h	65 mm/h	145 mm/h
SCEL	E	2.1 mm/h	6.0 mm/h	22 mm/h
SKED	N	5.0 mm/h	35 mm/h	95 mm/h
SEGU	P	12.0 mm/h	65 mm/h	145 mm/h
SYGC	P	12.0 mm/h	65 mm/h	145 mm/h
SOCA	P	12.0 mm/h	65 mm/h	145 mm/h
SGAS	P	12.0 mm/h	65 mm/h	145 mm/h
SPIM	C	0.7 mm/h	5.0 mm/h	15 mm/h
SMPM	P	12.0 mm/h	65 mm/h	145 mm/h
SUMU	K	1.5 mm/h	12 mm/h	42 mm/h
SVMI	P	12.0 mm/h	65 mm/h	145 mm/h

5.4 Taking into account what has been established above, and what was established in paragraph 4.14 in which the location of one of the NCC nodes in SAEZ is established, and according to pair nodes principle, it results to be that the places where the second NCC node could established is the following:

Table 3: Summary of possible nodes in which the second NCC node be located

2nd NCC NODO	TIME INTERVAL BETWEEN SUN OUTAGE	PORCENTAGE OF TIME 0.01% RAIN INTENSITY
SBMN	4/4	145 mm/h
SBRF	2/2	95 mm/h
SKED	8/8	95 mm/h
SEGU	5/5	145 mm/h
SYGC	9/8	145 mm/h
SOCA	8/8	145 mm/h
SPIM	1/0	15 mm/h
SMPM	8/8	145 mm/h
SVMI	10/10	145 mm/h

6. Site characteristics and required installations for the room of the Control Center of the NCC Network

6.1 The sponsoring country where it would be installed a NCC node should have an adequate political and social stability to avoid risking the integrity of the system operation. Likewise, the sponsoring country should count with enough financial resources to support the operation of the control center of the NCC network and of its own node.

6.2 The building where the room of the Control Center of the NCC Network would be established should be a modern building. The principal characteristics of the building, NCC room and furniture should be at least the following:

- a) The building should be a modern construction, with ample and clear rooms. Preferentially, the location of the NCC room should permit the direct connection of the NCC to the local equipment of the REDDIG. In case of remote location of the local node of the REDDIG, the means to establish a redundant communication through independent routes;
- b) If this is the case, the building should have an appropriate construction for seismic zones and to support the hydro-meteorological conditions proper of the zone;
- c) The electric feeding system should count with backup commercial power supported by a Generator Group and conditioned for the UPS. The wall plugs of the NCC room should be polarized and with earth connection. A wall plug of general use (duly identified) should be available in the room;
- d) Access security to the building and equipment room should be available. No restriction to the access of authorized personnel to the NCC room should exist;
- e) The equipment room should count with structured cabling, with access to public communications facilities;

- f) The access room should count with wall plugs fed with uninterrupted power, such as described in paragraph c) above;
- g) The dimensions of the room should be of approximately 5x5 m², with the purpose of facilitating the computer equipment and office furniture;
- h) If necessary, a warehouse area for the spare equipment of the REDDIG of at least 3x2 m². This area should be installed in the surrounding areas and should count with controlled access;
- i) The NCC room should count with the equipment of environment conditioning and protection against dust and pollution;
- j) The NCC room should be equipped with fire detection equipment and should count with manual fire extinguisher, for the appropriate kind of fire, or be equipped with automatic equipment against fire.
- k) The construction and decoration materials of the room as well as furniture should be fire-resistant and/or fire-retardant;
- l) The NCC room should count with appropriate light for the office and for the operation of a room of for information technology equipment (IT);
- m) The NCC room should count with daily cleaning service, supervised by the maintenance personnel.

6.3 The furniture of operation of the NCC should be modular and ergonomic, to permit the operator a comfortable development of his duties. The furniture should permit a comfortable location of the servers, two screens and a laser printer.

6.4 The office furniture should be the following:

- a) one desk and seat for the NCC chief;
- b) a desk for the secretarial support staff;
- c) an auxiliary table;
- d) two chairs for the visiting personnel;
- e) water and coffee dispenser;
- f) shelves for documents; and
- g) closet for the measuring instruments.

6.5 Based on the above indicated, in this section the sixth principle for the NCC selection could be established:

SIXTH PRINCIPLE: The NCC nodes should be established in States that count with and adequate political and social stability, and with the sufficient financial resources to backup the operation of the NCC node, facilitating the installation and resources required by the NCC.

7. Communication facilities of the NCC nodes

7.1 Other important aspect to be considered in the election of the NCC node is that related to the existing communications facilities through public and private networks different to the REDDIG, which should be available in the node. In this requirement we can find that it should be necessary to establish voice and data communication to carry out the coordination among the technical maintenance personnel of the REDDIG and/or with the technical personnel of the satellite segment supplier; and, at the same time, to maintain the network control in case of failure of the principal mean of transmission of the REDDIG.

7.2 When considering this aspect, digital communications facilities to establish high speed switched data links with the other nodes of the network in case of failure of the principal transmission mean of the REDDIG should also be considered, and, in this way, maintain the function of control of the NCC network in the affected node. Likewise, facilities of existing digital communications to establish high speed data links between the NCC in order that the active NCC could access the resources of the alternate NCC without interruption, as well as also to foresee the facilities for the remote access of the NCC system by the supplier. Based on these requirements, we could establish the seventh principle for the NCC selection:

SEVENTH PRINCIPLE: The NCC should be established in places where digital communication facilities area offered to permit the establishment of high speed switched data links with the other nodes of the REDDIG, and high speed permanent data links between the NCC, and internet connection for remote access to the supplier. These communications facilities should be established with public or private communications networks, independent from the principal mean of the REDDIG. Likewise, public telephone service should be available (POTS) to carry out coordinations with the supplier of the satellite segment and with the other nodes of the REDDIG in case of contingency.

7.3 Table 4 presents a summary of the communications facilities available in the REDDIG nodes.

Table 4: Communications facilities in the REDDIG nodes

NODE	PSTN	ISDN	Digital Leased Line (DLL)	DLL (DESTINATION SAM)
SAEZ	YES	YES	YES	SLLP, SCEL, SPIM, SUMU
SLLP	YES	NO	YES	SAEZ
SBMN	YES	YES	YES	----
SBRF	YES	YES	YES	----
SBCT	YES	YES	YES	----
SCEL	YES	NO	YES	SAEZ
SKED	YES	YES	YES	SEGU
SEGU	YES	NO	YES	SKED
SYGC	YES	NO	NO	----
SOCA	YES	YES	NO	----
SGAS	YES	NO	YES	SAEZ
SPIM	YES	YES	YES	SAEZ
SMPM	YES	NO	NO	----
SUMU	YES	YES I	YES	SAEZ
SVMI	YES	NO	NO	----

8. Personnel requirements and qualifications of the NCC personnel

8.1 The personnel required in the NCC control center, who, by the nature of its origin requires to be international, should cover the following posts:

- a) 01 International Technical Manager, administrative schedule and attention in emergency situations;
- b) 01 Office Assistant (national personnel), administrative schedule;
- c) 04 Technicians for the operations control in each NCC (national/international personnel) with shifts schedule and attention 7 days a week per 24 hours a day.

8.2 The Technical Manager of the NCC control center should manage an absolutely transparent operation as well as management of the control center of the REDDIG network. Among the principal qualifications of this manager the following should be considered:

- a) Knowledge of the REDDIG network, and of telecommunications networks and systems of the States or similar systems;
- b) Knowledge of the international norms and standards, such as UIT-T, UIT-R, ETSI, ECMA, and others;
- c) Knowledge of the ICAO annexes and of the methods and techniques recommended by ICAO, and of the documents about CNS/ATM systems;
- d) Knowledge of computer technology and programming;
- e) To have a degree in Engineering, with more that 10 years of experience in the development and maintenance of digital and analogical networks;
- f) Languages: Spanish and English.

8.3 The technical personnel required to operate the control center of the REDDIG should count with the following qualifications:

- a) Knowledge of the REDDIG network, and of the telecommunications networks and systems of the States or similar systems;

- b) Knowledge of the international telecommunications techniques, norms and standards;
- c) Knowledge of the ICAO annexes and of the methods and techniques recommended by ICAO, and of the documents about CNS/ATM systems;
- d) Degree in Engineering or technician with more than 5 years of experience in the operation and maintenance of digital networks similar to the REDDIG;
- e) Languages: Spanish and English.

8.4 The personnel selected for the post of Office Assistant should count with the following qualifications:

- a) Knowledge of office documents management;
- b) Knowledge of management of computer skills tools to be produced by the Office;
- c) Language: Spanish and English

8.5 When selecting a place to establish de NCC, the contributions that can be provided by the national personnel to the States in support of the control center of the NCC network should be considered. Based in this consideration, we could establish the eighth and last principle for the election of the NCC site:

EIGHTH PRINCIPLE: After considering the above principles, preference should be given to establish the NCC in those sites where the sponsoring country could provide the national personnel, adequately qualified for the NCC operation.

9. Election of the sites to establish the NCC of the REDDIG

9.1 Taking in consideration the eight principles to select the REDDIG nodes, it seems that the first node to be selected as NCC would be the node of SAEZ, and as better pair for the NCC operation it results to be the SBMN node, and as a second option, the SKED node. Establishing the final configuration of the NCC, the possible costs of transferring the NCC from SPIM to SMBN should be taken into account. In this respect, the contractor has indicated a referential cost of US\$115,000.

9.2 **Recommendation No. 01:** Considering the analysis carried out to determine the location of the two NCC nodes of the REDDIG, the Project Office recommends that the first option to be considered is the SAEZ and SBMN nodes.

10. Operation and Maintenance Manuals of the REDDIG network

10.1 The operation and maintenance manuals of the REDDIG network should define the procedures to be followed by the technical personnel that should be responsible for the REDDIG. The

procedure manuals should take as a base the manuals of the supplier of the network and of the operators of communications services. The procedure manuals to be considered should be the following:

- a) Procedures of the NCC with the satellite segment supplier (Operation manual SNOC-NCC);
- b) Procedures of the REDDIG Node with the satellite segment supplier (Operation Manual SNOC-NODE);
- c) Procedures of the NCC and the Node with the public telecommunication porters (PTT-NCC/NODE);
- d) Procedures between the NCC and the REDDIG node (Operation manual NCC-NODE); and
- e) The domestic procedures in the REDDIG node and interaction with the communications systems and CAA terminals, to which the REDDIG provides communications service (Operation manual NODE-USER).

10.2 The operation manuals SNOC-NCC and SNOC-NODE should cover basically all the procedures to be followed with the supplier of the satellite segment and its operations control center. These procedures cover basically the following aspects:

- a) Coordination of the operation frequencies of the network;
- b) Coordination of the transmission plan;
- c) Registry of the station to access the satellite;
- d) Control of the radio-electric emissions;
- e) Control and monitoring of the transmission and signal quality;
- f) Control of the radio-electric interference;
- g) Pointing out and adjusting of the polarization and transmission parameters;
- h) Coordination and authorization to initiate and finish the transmission;

10.3 The operation manual PTT-NCC/NODE, should cover basically the following aspects:

- a) Verification of the quality of service in the lines;
- b) Routine tests for the establishment of calls in switched lines; and
- c) Procedures to solve failures.

10.4 The operation manual NCC-NODE should cover the following principal aspects:

- a) The monitoring and control of porters;
- b) The control of the TDMA plots and the assignment of the band weigh of the satellite;
- c) The definition, assignment, creation and maintenance of the database and circuit programming, PVC y SVC, in the equipment;
- d) The supervision and control of the equipment in the nodes;
- e) The measuring and invoicing of the services;
- f) The procedures of test in base band and in the circuit;

- g) The verification procedures of backup equipment;
- h) The transference of control between the NCCs.

10.5 The operation manual NODE-USER should comprehend all the domestic procedures that permit the verification, identification, isolation and fault solution in the REDDIG interfaces with the user equipment and in the REDDIG equipment. In general, the following procedures should be established:

- a) Verification and testing of interfaces of REDDIG users;
- b) Verification and testing of the switching and multiplexing system;
- c) Verification and testing of the VSAT system (Modem, Transceiver, Antenna);
- d) Verification and testing of the interfaces with the PTT circuits;
- e) Verification and testing of the backup equipment;
- f) Verification and use of the NMS system; and
- g) Replace of the REDDIG equipment.

11. Management and maintenance of the network

11.1 The management, operation and procedures of maintenance of the REDDIG will be carried out according to what is indicated in sections 2 and 9 of this working paper.

11.2 In general, the maintenance of the nodes will be carried out by the technical personnel of the CAAs, trained through the training programme (that includes in-the-job theoretical and practical courses) that would be provided by the contractor of the REDDIG. The personnel would be trained for:

- a) Detect and correct problems in the cabling systems of the installation;
- b) Operate and reinitiate the communications systems and equipment of the REDDIG;
- c) Manage effectively the REDDIG documentation for the search and correction of failures in the systems and equipment, at equipment or module level;
- d) Utilize the NMS local management system to carry out the functions of supervision, control, diagnosis of the node and of the satellite segment, and issue reports;
- e) Utilize the global management system and NCC to carry out the functions of supervision, control and diagnosis of the nodes and of the satellite segment, and the principles for the maintenance of the configuration, and issue reports;
- f) Verify the operation of the interfaces, and carry out measuring to verify the quality of the service; and
- g) Adjustment and noting of the satellite antenna and of the transmission parameters of the porters.

11.3 To carry out an adequate maintenance of the network, instruments for the supervision and verification of porters will be necessary (spectrum analyzer), as well as analyzers of protocols for the verification of the circuits operation and the quality of service. Likewise, other instruments of common use in transmission systems (signal generators and decibels measurement device) should be required. Each NCC node should count with this type of verification instruments. Likewise, it would be convenient that the other REDDIG nodes count with a spectrum analyzer appropriate to measure the IF signal of the

satellite modem in L band, and common equipment for transmission testing, this would facilitate the network maintenance.

11.4 Regarding the policies to follow with the spare parts, these could be the following:

- a) Contract for the purchase of spares at demand;
- b) Spare parts warehouse centralized in the NCC nodes;
- c) Spare parts warehouse distributed in the nodes; and
- d) A combination of the above.

11.4.1 The first alternative, related to the management of the spares, this would be sustained in the fact that all the equipment is redundant in the nodes, reason why it would be possible to establish a contract with an enterprise that would permit maintaining the conditions of warranty of the spare parts provision, similarly to that indicated in the TSD.

11.4.2 The second alternative would be sustained by the same principle above, but with the difference that a minimal spare stock should be ensured, kept in the NCC nodes. The advantage of this policy with respect to the first would consist in that the spare parts could be purchased at a less price and, also, the spare part would be available in an almost immediate. However, the same as in the above alternative, customs procedures should have to be considered.

11.4.3 The third alternative would permit each node to count with own spare parts. The advantage of this procedure would be in the immediate availability of the spare parts necessary in the nodes, which would facilitate the maintenance tasks. The disadvantage is that it is required a larger investment at global level to implement this type of policy. However, due to the different customs procedures in each State, as well as the internal regulations of the administrations, the adoption of this policy would appear to be attractive.

11.4.4 Finally, the combination of the second with the third alternative would permit to establish a balance in the investment of the spare parts for each one of the nodes, and would facilitate as well the creation of a spare parts bank for assisting the network.

11.5 **Recommendation No. 02:** With the purpose of operation reducing costs, the Project Office re commends to adopt the second alternative regarding the spare parts policy, which consists in implementing a centralized spare parts warehouse in the NCC nodes.

12. **Operation costs**

12.1 In this section, the estimated REDDIG recurrent costs will be discussed. Among the operation recurrent costs we could establish the following:

- a) Satellite segment;
- b) Rental of the office for the NCCs, including basic services;
- c) Coordination and backup lines;
- d) Office miscellaneous;
- e) Personnel;
- f) Missions, technical visits to the nodes;
- g) Spare parts;
- h) Improvement of the network, updating and outsourcing; and
- i) Incidental expenses.

12.2 Regarding the rental of the space segment, the annual cost of the segment hired for 10 years is of US\$210,240; for 5 years, US\$231,264, and for one year, US\$249,660. For the effects of cost analysis, a contract of 5-year duration will be considered.

12.3 In order to maintain the recurrent costs to the minimum possible, it is expected that the sponsoring countries of the NCC nodes fulfill favorably the SIXTH PRINCIPLE for the selection of the NCC nodes. In this sense, the rental cost of the office for the NCC would be US\$0.0. In other case, it would be necessary to consider an annual rental cost for the office of the two NCC nodes for approximately US\$24, 000.

12.4 Regarding the costs associated to the communications lines of the NCC, it would be necessary to consider a POTS line, INTERNET, and one line for the coordination between the NCC. The estimated costs for the POTS line and INTERNET would be approximately US\$3,600 annually for the two NCC nodes. The cost of the line for coordinations between the NCCs is estimated in a value of approximately US\$3,600 annually. The cost for the line for coordination between the NCCs is estimated in a value of US\$1,200 monthly. However, this line could be provided by the sponsoring countries according to what has been established in the SEVENTH PRINCIPLE for the selection of the NCC nodes.

12.5 The Office annual miscellaneous costs are estimated in US\$6,000. It is expected that the sponsoring countries of the NCC nodes cover these costs as integrated part of the SIXTH PRINCIPLE for the selection of the NCC nodes.

12.6 In order to maintain at the minimum possible the recurrent costs, it is expected that the sponsoring countries of the NCC nodes provide the technical personnel for the NCC operation in conformity with the EIGHTH PRINCIPLE for the NCC selection.

12.7 It has been foreseen that, in case necessary, 4 technical visits be carried out to maintain corrective maintenance per year, and each visit with an average duration of 3 days. The number of visits has been determined considering an average value of MTBF of 50,000 hours and the rotation of the NCC. The annual amount for this activity has been estimated is of US\$6,000.

12.8 Regarding the annual recurrent cost of the spare parts used by the entire network, the amount we can consider is the one indicated in the contract, which is of approximately US\$134,000 to cover two years of operations.

12.9 Regarding the improvement and update of the network, as well as outsourcing, the cost is estimated in approximately US\$36,000 annually.

12.10 In terms of incidental expenses, we can consider 10% of the annual amount estimated for spare parts.

12.11 Considering the above regarding estimated recurrent costs, the three options to establish a management systems is described below:

- a) **Option 1:** rental of the satellite segment for 5 years, and none of the costs is assumed by the sponsoring countries of the NCC;
- b) **Option 2:** rental of the satellite segment for 5 years, and that the sponsoring countries of the NCC nodes assume the costs of Office rental, coordination and backup lines, providing national personnel;
- c) **Option 3:** is similar to the one above with the exception that the sponsoring countries of the NCC nodes provide all personnel required to operate the network.

Table No 5: Recurrent costs estimated for the operation of the network in a period of one year, includes AOS

Line	OPTION 1	OPTION 2	OPTION 3
Satellite Segment	234,733	234,733	234,733
Office Rental	24,360	0	0
Coordination and Backup Lines	19,800	0	0
Office Miscellaneous	6,600	0	0
Personnel	371,580	199,980	0
Missions	12,100	12,100	12,100
Spare Parts	73,700	73,700	73,700
Improvement, Updating and Outsourcing	39,600	39,600	39,600
Incidental Expenses	7,700	7,700	7,700
Total	790,173	567,813	367,833

13. Invoicing

13.1 In this section the possible structures for sharing recurrent costs for the network operation will be analyzed. When considering this item, the following possibilities could be identified:

- a) Distribution of costs with respect to the number of nodes of the network;
- b) Distribution of costs based in the number of circuits of each one of the nodes and its associated bandwidth; and
- c) Distribution of costs based in the real traffic of each node.

13.2 The first possibility of costs distributions is the most simple to apply, since the total cost of the network operation that corresponds to be paid by each node would equal to 1/15 of the total amount

of the network operation. Although this scheme is simple to apply, the operation costs would not be distributed of an equitable way regarding the utilization of the network among its users.

13.3 The second possibility considers the distribution of the operation costs in terms of the number of implemented circuits in each node and the equivalent associated bandwidth. This scheme, which is simple to apply, would consider as its fundament the tables of the TSD, and would permit a more equitable distribution of the operation cost if compared with the first possibility above. Table No. 6 presents a summary of circuits implemented by the REDDIG and its equivalent bandwidth consumed. For ATSD circuits, a value equivalent to 8 units is being considered; for ATSa circuits, a value equivalent to 2.4 units; for administrative and service circuits, a value equivalent to 4 units; for AFTN circuits, a value equivalent to 2.4 units; for radar circuits, a bandwidth equivalent to 9.6 units, for ATN circuits, a bandwidth equivalent to 0 units, for GNSS circuits, a bandwidth equivalent to 4.8 units, and for the NMS, a bandwidth equivalent to 16 units. On the table, it can be appreciated that the Grand Total (GT) of the equivalent bandwidth consumed by the network would be 1233.6 units. The monthly contribution of each node would be directly proportional to the reason of total consumption of the node of the Grand Total of the equivalent bandwidth consumed by the network.

Table No. 6 - Implemented circuits and equivalent bandwidth consumed

NODE	ATSD 8	ATSa 2.4	ADM/SRV 4	AFTN 2.4	RADAR 9.6	ATN 0	GNSS 4.8	NMS 16	Nodo consumption
SAEZ	5	5	2	6	3	2	2	1	128.8
SLLP	2	2	2	3	1	2	2	1	71.2
SBMN(*)	5	3	2	5	2	2	2	1	112.0
SBRF	0	3	2	1	0	2	2	1	43.2
SBCT	2	3	2	4	2	2	2	1	85.6
SCEL	2	4	2	2	1	2	2	1	73.6
SKED	7	3	2	4	2	2	2	1	125.6
SEGU	2	1	2	3	2	2	2	1	78.4
SYGC	0	1	2	3	0	2	2	1	43.2
SOCA (*)	0	3	2	2	0	2	2	1	45.6
SGAS	1	1	2	2	0	2	2	1	48.8
SPIM	4	1	3	6	4	2	2	1	124.8
SMPM	0	1	2	3	0	2	2	1	43.2
SUMU	5	2	3	5	2	2	2	1	113.6
SVMI	3	1	2	7	2	2	2	1	96.0
GRAND TOTAL									1233.6

(*) The number of ATSD and ATSa circuits takes into consideration the adjustment done with CAA and the contractor.

13.4 The third possibility for the distribution of costs takes into consideration the real traffic of the nodes. The NCC system would provide the detailed information of the real traffic of each node. Based in the information provided by the NCC, the Grand Total of the network could be calculated from month to month, and apply a calculation similar to the one indicated in the above paragraph to establish the monthly contribution of each node. This modality of cost sharing would permit the most equitable possible distribution. However, its implementation could not be started immediately, since it requires a

more detailed study of the reported information by the NCC and the development of method to generate the information required for invoicing.

13.5 Considering what has been indicated in the above paragraphs of this section, the Project Office recommends the initial adoption of the second cost sharing scheme, while the necessary actions are carried out to implement the scheme of invoicing based in the real traffic of the nodes during the period of management of the network by project RLA/98/019.

14. Technical and coordination committee

14.1 As every technical cooperation project, it will be necessary to maintain the present structure of the technical and coordination committee. In this regard, it is important to note that costs associated with the meeting of the technical and coordination committee have not been considered in the project recurrent costs analysis indicated in section 11.

15. Other related items

15.1 The REDDIG network is a modern digital network, of advanced technology, that would facilitate in the future the implementation of the CNS/ATM systems and the interconnection with other regional networks. It is important to note in this aspect that the ICAO Regional Office is coordinating with the MEVA task force an interconnection environment of the networks, based in the utilization of similar technology and in the use of the same communications satellite.

15.2 One of the most important reasons that conducted to the implementation of the REDDIG was to establish a modern digital platform to facilitate the implementation of CNS/ATM applications. In this sense, the future management of the REDDIG, in base of an ICAO technical cooperation scheme should impel this subject in base of CNS/ATM applications available in the markets, as AMSH and AIDC. In this regard, coordination should be made with regional project RLA/98/003 to implement this issue in basis of this project resources and of those of the future management of the REDDIG.

15.3 Other issue of importance is the one related to the hiring of the satellite segment for 5 years. The proposal received by PanamSat has a validity term to December of the present year, and permits its extension to 5 years, at an annual cost of US\$231,264, and grants also three months of operation without cost. This item should be treated as subject urgency in the RCC/3 Meeting of the REDDIG.

16. Conclusion

16.1 Considering the study carried out to determine the better location of the NCC nodes and the recommendations that have been done, the following conclusion should be formulated:

Conclusion 01: The control centers of the NCC network of the REDDIG should be established in the nodes SAEZ and SBMN. The operation of the same should be carried out in an alternate way with the purpose of minimizing the control transference between the NCC.

16.2 Considering the conclusions of the second meeting of the coordination committee of the REDDIG RCC/2 related to the future scheme of management of the network, the analysis and recommendations of this working paper is that one State only could not have the responsibility of the operation of the two NCC nodes and, also, considering that it does not exist a present offering, the following conclusions are being formulated:

- Conclusion 02:** The transitory scheme of management of the REDDIG should be carried out by an ICAO project of technical cooperation.
- Conclusion 03** The objective of the technical cooperation project would be to assist in the creation of a definite multinational mechanism for the management of the REDDIG and to facilitate the operation of the network while this scheme is being developed.
- Conclusion 04** Option 2 of the project recurrent cost sharing should be adopted, which considers the rental of the satellite segment for 5 years, that the sponsoring countries of the NCC nodes assume the costs of office rental, coordination and backup lines, and provide national personnel in support to the operation of the node. Likewise, a policy that permits the implementation of a spare parts warehouse centralized in the NCC should be adopted.
- Conclusion 05** The initial contribution of the States should cover the satellite segment that would permit ICAO to subscribe a contract for 5 years with the supplier of the satellite segment, that would permit warranting to the States a continuous service of satellite segment rental during the complete period.
- Conclusion 06** That the future technical cooperation project that would manage the REDDIG could coordinate with project RLA/98/003 to use resources of both projects in order that the CNS/ATM applications, such as AMHS and AIDC be implemented in the REDDIG platform..

17. Suggested action

17.1 The meeting is invited to discuss this working paper and to adopt the conclusions formulated in section 16 of this working paper to elaborate the final material to be presented to the third meeting of the coordination committee of the REDDIG RCC/3.

END

