Documents of the World Administrative Radio Conference on the use of the geostationary-satellite orbit and the planning of the space services utilizing it (1st session)
(WARC ORB-85 (1)) (Geneva, 1985)

Document DL/1-E
7 August 1985

AGENDA

OF THE

MEETING OF HEADS OF DELEGATIONS

Thursday, 8 August 1985 at 10.30 hrs

(Room II)

		Document No.
1.	Opening by the Secretary-General and designation of the Chairman of the meeting	-
2.	Approval of the agenda of the meeting	-
3.	Proposals for the election of the Chairman of the Conference	-
4.	Proposals for the election of the Vice-Chairmen of the Conference	-
5.	Conference structure	DT/1
6.	Proposals for the election of the Chairmen and Vice-Chairmen of the Committees	-
7.	Draft agenda of the first Plenary Meeting	DT/2
8.	Allocation of documents to Committees	DT/3
9.	Other business	

R.E. BUTLER
Secretary-General

INTERNATIONAL TELECOMMUNICATION UNION

ORB-85 WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT

FIRST SESSION, GENEVA, AUGUST/SEPTEMBER 1985

Document DL/2-E
8 August 1985
Original: English

Note by the Secretary-General

Proposed Modifications to item 1 of the Terms of Reference of Committee 6

1. In order to meet the objectives of decides 2.3 of Resolution No. 1 of the Plenipotentiary Conference, Nairobi, 1982 and Resolution No. 504 of WARC-79, and subject to any advice which is sought from Committee 4:

a) to consider the relevant decisions of the Regional Administrative Radio Conference for the Planning of the Broadcasting-Satellite Service in Region 2, particularly the incompatibilities between Regions and services;

b) to consider the incompatibilities between assignments in the Region 2 Plan and those in Appendix 30 to the Radio Regulations, as well as existing assignments in other services, with a view to resolving them;

c) to prepare, as appropriate, the texts of the necessary provisions to be incorporated in the Radio Regulations;

(Agenda item 6.1)

d) to prepare, as appropriate, for consideration by the Plenary appropriate final acts to achieve this objective (agenda item 6.2).

R.E. BUTLER
Secretary-General

INTERNATIONAL TELECOMMUNICATION UNION

ORB-85 WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT

FIRST SESSION, GENEVA, AUGUST/SEPTEMBER 1985

Document DL/3(Rev.1)-E
15 August 1985

STEERING COMMITTEE

DRAFT

GENERAL SCHEDULE OF THE WORK OF THE CONFERENCE

Week 1 (8 Aug. - 9 Aug.)
Organization and commencement of work

Week 2 (12 Aug. - 16 Aug.)
Continuation of work in Working Groups and Committees *

Week 3 (19 Aug. - 23 Aug.)
Continuation of work in Working Groups and Committees*

Week 4 (26 Aug. - 30 Aug.)
Continuation of work in Working Groups and Committees *

Week 5 (2 Sept. - 6 Sept)

Tuesday, 3 Sept. - End of work of Working Groups of Committee 4

Wednesday, 4 - End of work of Working Groups of Committee 6

Thursday, 5 - End of work of Working Groups of Committee 5

Friday, 6 - End of work of Committees 4 and 6

Week 6 (9 Sept. - 13 Sept.)

Monday 9 - End of work of Committee 5

Tuesday 10 - End of work of Ad Hoc Working Group of Plenary

" " Report of Committee 2

Wednesday 11 - Report of Committee 3

First reading by Plenary of the last texts of the Report to the Second Session and of the Final Acts.**

Thursday 12 - Second reading by Plenary of last texts of the Report of the Second Session and of the Final Acts.**

Friday 13 - Adoption of the Report, Signing Ceremony** and Closing.

* Plenary meetings, as appropriate.

** Final Acts relating to decisions of BC-SAT-R2 Conference (see item 6 of Agenda).

INTERNATIONAL TELECOMMUNICATION UNION

ORB-85 WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT

FIRST SESSION, GENEVA, AUGUST/SEPTEMBER 1985

Document DL/3-E
8 August 1985

STERRING COMMITTEE

DRAFT

GENERAL SCHEDULE OF THE WORK OF THE CONFERENCE

Week 1 (8 Aug. - 9 Aug.)
Organization and commencement of work

Week 2 (12 Aug. - 16 Aug.)
Continuation of work in Working Groups and Committees

Week 3 (19 Aug. - 23 Aug.)
Continuation of work in Working Groups and Committees

Week 4 (26 Aug. - 30 Aug.)
End of work of Committee 6 (Region 2)

Friday , 30 Aug. - End of work of Working Groups of Committee 4

Week 5 (2 Sept. - 6 Sept.)
End of work of Committee 4

Thursday, 5 Sept. -- End of work of Working Groups of Committee 5

Week 6 (9 Sept. - 13 Sept.)

Monday 9 - End of work of Committee 5

Tuesday 10 - End of work of Ad Hoc Working Group of Plenary

" " Report of Committee 2

Wednesday 11 - Report of Committee 3

First reading by Plenary of the last texts of the Report to the Second Session and of the Final Acts.*

Thursday 12 - Second reading by Plenary of last texts of the Report of the Second Session and of the Final Acts*

Friday 13 - Adoption of the Report, Signing Ceremony* and Closing

* Final Acts relating to decisions of BC-SAT-R2 Conference (see item 6 of Agenda).

INTERNATIONAL TELECOMMUNICATION UNION

ORB-85 WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT

FIRST SESSION, GENEVA, AUGUST/SEPTEMBER 1985

Document DL/4-E
12 August 1985
Original: English

WORKING GROUP 4C

Working Group 4C

FORESEEN CONTENT OF THE WORKING GROUP 4C OUTPUT

1. General issues

1.1 The need for efficient orbit and spectrum utilization, having due regard to economic and operational issues

1.2 Time-phased introduction of measures for conserving orbit and spectrum

1.3 Means of achieving efficient harmonization of orbit and spectrum use

1.4 Computer tools for harmonization and planning

1.5 Homogeneity of orbit utilization

1.6 Multi-band and multi-service factors

1.7 Systematic use of frequency bands

1.8 Orbit segmentation

1.9 Generalized parameters for planning purposes

2. Specific parameters and criteria

2.1 Visible arc and service arc, including specific consideration of geographical factors and flexibility in the position of satellites

2.2 Satellite station-keeping

2.3 Satellite antenna radiation pattern

2.4 Satellite antenna pointing accuracy

2.5 Earth station radiation pattern

2.6 Off-axis e.i.r.p. density limits for earth station antennas

2.7 Polarization characteristics

2.8 Reverse band working

2.9 Maximum level of permissible interference

2.10 Characteristics of transmission systems, including susceptibility to interference and liability to cause interference

D.J. WITHERS
Chairman of Working Group 4C

INTERNATIONAL TELECOMMUNICATION UNION

ORB-85 WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT

FIRST SESSION, GENEVA, AUGUST/SEPTEMBER 1985

Document DL/5-E
13 August 1985
Original: English

SUB-WORKING GROUP 6B-1

Proposal by the Chairman of Sub-Working Group 6B-1

ELEMENTS FOR CONSIDERATION WITH RESPECT TO THE APPROPRIATE FREQUENCY BANDS WHERE THE FREQUENCY PLAN FOR FEEDER LINKS SHOULD BE ESTABLISHED

1. Introduction

In the second meeting of Working Group 6B, it was decided to establish a Sub-Working Group 6B-1. The terms of reference of Sub-Working Group 6B-1 are to summarize proposals and the initial discussion in Working Group 6B on the question of frequency bands for planning the broadcasting-satellite feeder links. This will enable Working Group 6B to make a choice on the band(s).

2. Available frequency bands for planning

The following frequency bands are available for planning the broadcasting-satellite feeder links (see Resolution No. 101).

Region 1		Region 3
10.7 - 11.7 GHz		
14.5 - 14.8 GHz	limited to countries outside Europe and to Malta	14.5 - 14.8 GHz
17.3 - 18.1 GHz		17.3 - 18.1 GHz

3. Summary of proposals

All administrations, who have submitted proposals on this item, propose to make use of the frequency band 17.3 - 18.1 GHz when preparing the plan for feeder links.

Also, it is generally accepted that the band 14.5 - 14.8 GHz could be used for some feeder links. The difference of opinions are whether this band should be used in planning or coordination. Most administrations propose that this band should only be used in exceptional cases.

Very few administrations propose to make use of the band 10.7 - 11.7 GHz.

4. Summary of discussion in Working Group 6B

4.1 There was general agreement that:

- the band 17.3 - 18.1 GHz should be subject to planning;

- the band 10.7 - 11.7 GHz should not be considered for planning.

4.2 The majority view was that the plan should primarily be prepared for the band 17.3 - 18.1 GHz, and that the band 14.5 - 14.8 GHz should be available (in accordance with the Table of Frequency Allocations) in exceptional cases.*

Some delegations were in favour of preparing the plan, making use of both bands 17.3 - 18.1 GHz and 14.5 - 14.8 GHz, based on the preference of each administration.

4.3 Considerations on the band 17.3 - 18.1 GHz

This band, which is 800 MHz wide, would enable a direct frequency translation of the channels of Appendix 30, for a given country. This would have economic advantages.

It would make better use of the frequency spectrum and the geostationary satellite orbit to concentrate all (or as much as possible) of the feeder links in one band. This is only possible in the band 17.3 - 18.1 GHz, which has the additional advantage of being chosen in Region 2 in the Plan of 1983. Interregional sharing constraints will thus be minimized.

4.4 Considerations on the band 14.5 - 14.8 GHz

This band, which is 300 MHz wide, would be insufficient to provide feeder links for all channels of Appendix 30.

One argument put forward for the band 14.5 - 14.8 GHz is that the rainfall attenuation is less than in the band 17.3 - 18.1 GHz. Also, the technique is well established in this band. These factors could in some cases lead to cost savings by using the band 14.5 - 14.8 GHz. These savings are, in the opinion of some delegations, likely to be marginal. Recent information provided by one administration shows only 1.5 dB higher attenuation due to rainfall (worst case) in the 17 GHz band compared to 14 GHz. As to the cost of equipment production, the disadvantage of using the higher band may be offset by the advantage of large-scale production if feeder links are established in the 17 MHz band.

There are more sharing constraints in this band than in the 17.3 - 18.1 GHz band, partly because of the allocation situation and partly because the band 14.5 - 14.8 GHz is more extensively utilized.

5. Concluding remarks

The frequency plan should provide for feeder links to all channels of Appendix 30, based on the requirements of the administrations.

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* The definition of exceptional cases should be elaborated further.

The majority opinion, is that the planning should try to satisfy, as far as possible, the requirements by making use of frequencies in the band 17.3 - 18.1 GHz. If this should prove impossible, the band 14.5 - 14.8 GHz should also be utilized, as appropriate.

From the economic point of view, it would be disadvantageous for a given country to have their feeder links partly in one band and partly in the other. This should therefore be avoided, as far as possible.

Some delegations favoured the use of the 14 GHz band on equal terms with the 17 GHz band. It should be clarified in what cases the 14 GHz band should be used (in exceptional cases or at the choice of each administration).

L. GRIMSTREIT
Chairman of Sub-Working Group 6B-1

INTERNATIONAL TELECOMMUNICATION UNION

ORB-85 WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT

FIRST SESSION, GENEVA, AUGUST/SEPTEMBER 1985

Document DL/6-E
13 August 1985
Original: English

WORKING GROUP 4C

THE CHARACTERISTICS OF TYPICAL IN-SERVICE SATELLITE NETWORKS

1. Fixed-satellite service (FSS)

1.1 Introduction

The FSS has evolved considerably over the last 20 years and handles a wide range of traffic. It is the most heavily utilized of all the space services and probably the most highly developed.

The FSS networks currently in operation vary considerably with regard to technical parameters, operational techniques and the services provided. For example, the capacity of the radio carriers may vary from a single telephone channel (SCPC) up to several thousand channels; the corresponding bandwidths of the carriers range from several dozen kHz to several dozen MHz and modulation may be analogue or digital. These systems are used to provide telephony, television, teleconferencing, data transmissions, intracompany services, communications between computers, telecommunication services for isolated regions and weather forecasting services. The services and characteristics will continue to change in the future with technical progress, which will mean an increase in the capacity of the GSO.

Today's satellite services are implemented in several ways, viz: by independent space networks, by consortia or by lease of space segment from operating organizations. The choice can be related to need or economic viability, although technical characteristics may be similar. The existing systems mainly use the 6/4 and 14/11-12 GHz frequency ranges.

Some FSS networks use spacecraft with multiservice, and/or multi-frequency telecommunication payloads. This situation may introduce additional constraints to the harmonization process, especially if the orbital position of the satellite is determined by a previous plan (for example, BSS).

Another fundamental characteristic of the FSS is the wide range of service areas. In general, there are three categories of coverage: global, regional and national.

Initial exploitation of the FSS was largely for trans-oceanic communications and this continues to be a growing and very important use of the GSO.

International systems provide a wide range of telecommunication services. INTELSAT and INTERSPUTNIK are examples of the use of frequency ranges 6/4 GHz and 14/11 GHz.

Regional systems in the FSS are operated by specific groups of countries to provide joint telecommunication services. Current systems use the frequency ranges 6/4 and 14/11 GHz. The EUTELSAT regional network will soon begin operation in the 14/11-12 GHz bands for European international traffic and has already come into service to meet certain domestic and international requirements, with the lease of standby capacity. The ARABSAT regional network will shortly begin operation in the 6/4 GHz bands.

National satellite networks are used by various countries to satisfy their national telecommunication needs. Demands for such networks are increasing in all regions. Such systems mainly use the 6/4 and 14/11-12 GHz frequency ranges. However, there is at least one operational system which utilizes the 30/20 GHz FSS band.

Apart from the technical differences, an important difference between international and national networks is that the most suitable orbit locations are usually not the same, thus minimizing conflicts in that sense. On the other hand, the technical differences often lead to difficulties in coordination despite the orbit separations that are feasible.

Another major difference between international and national networks relates to the coverage areas. The former can require wide coverages, while the latter might conform approximately to the boundaries of the country itself. This leads to some of the technical disparity between the two types of networks. In the case of domestic systems, where the coverage areas are sufficiently separated, satellites can operate in close proximity.

1.2 FSS operating networks

1.2.1 FSS networks operating at 6/4 GHz

By far the most highly developed, both in technology and in utilization, this pair of bands is used on nearly all the commercial FSS networks in service as well as those in the planning stage.

Space stations at 6/4 GHz

The earliest FSS space stations were in international service and provided global coverage capabilities. Within ten years, domestic coverage satellites were in service while regional coverage systems are a more recent development as more countries begin to use satellite technology for domestic services or as a supplement to regional terrestrial systems.

Along with the growth in numbers of satellites, the capacity of a single satellite has been increased by frequency reuse accomplished by the use of orthogonal polarization in the same coverage area and/or spatial isolation between narrow spot beams on the same satellite serving different coverage areas. This is generally a characteristic of international networks. Domestic FSS systems, on the other hand, have utilized orthogonal polarization to achieve a two-fold frequency use.

The predominant transponder bandwidth of 6/4 GHz FSS satellites is 36 MHz, with 40 MHz spacing between transponder centre frequencies, for a total of 12 transponders on a single polarization in a single antenna beam. Use of orthogonal polarizations would therefore provide a total of 24 transponders. Bandwidths up to 80 MHz are used in some FSS networks in the 6/4 GHz band and provide for high bit rate digital transmissions.

Transponders presently operating in the 6/4 GHz bands commonly use 5 W travelling-wave tube amplifiers (TWTAs). Some planned satellites will carry transponder TWTAs with powers up to 30 W and solid-state amplifiers with powers up to 8.5 W. Table 1 presents some typical FSS space station parameters.

TABLE 1

Typical parameters of 6/4 GHz FSS space stations

Parameter	Type of coverage		
	Global	Regional	National
Satellite antenna gain (dBi)			
Transmit	17-19	21-25	28-32
Receive	17-19	21-24	30-34
e.i.r.p. (dBW)	22-24	26-31	30-39
Receiver noise temperature (K)	800-2 000	800-2 000	800-2 000
G/T (dB(K^{-1}))	-17 to -14	-12 to -5	-3 to +5

It is common for present-day FSS space stations to have the capability to maintain station keeping within tolerances of ±0.05° in both latitude and longitude. Such tolerances are often met in actual operations, particularly for domestic networks with large numbers of earth stations for which steerable antennas are economically unattractive.

Expected satellite lifetimes have increased substantially over the past twenty years, with the design lifetimes of ten years being currently most common for satellites to be launched during the mid-1980s. It should be noted, however, that the design lifetime of a space station may not be the same as its operational life at a particular orbit location. This may occur in a particular satellite network where traffic is rapidly growing and a higher capacity design is introduced before the design life of the first spacecraft is reached. In such cases the earlier launched satellite may be relocated to satisfy other traffic requirements.

Earth stations at 6/4 GHz

As the FSS space station e.i.r.p. has increased, lower-cost, smaller diameter earth-station antennas have become operationally feasible. Table 2 provides typical parameters of earth stations presently operating in 6/4 GHz FSS networks.

TABLE 2

Typical parameters of 6/4 GHz FSS earth stations

Parameter	Type of coverage		
	Global	Regional	National
Antenna size (m)	4.5-30	4.5-25	3-30
Gain (dBi) Transmit	47-64	47-62	43-63
Receive	43-61	43-59	40-59
Receiver noise temperature (K)	50-150	50-150	50-200
G/T (dB(K-1))	23-41	23-38	17-41
Typical output power (kW)	1-12	0.3-3	0.005-1
e.i.r.p. (dBW)	46-95	46-74	45-84

The largest antennas are used primarily in global coverage systems although they may also find applications in domestic networks for high capacity links. Antennas with diameters in the range 10 to 15 m are common for medium capacity routes or special service applications in global coverage systems. Smaller antennas in the 3 to 7 m range are particularly suited for services in regional and national coverage systems, as well as for receive-only applications.

1.2.2 FSS networks operating at 8/7 GHz

Several FSS networks are presently in operation in the 8/7 GHz bands and a number of new networks are expected to become operational in the near future. It should be noted that many of these systems also operate in the mobile satellite service. It should also be noted that these networks are primarily used for Government communications within and among a number of administrations.

Because of the nature of the services provided, the types of coverage may vary from world-wide to domestic. There is also no uniformity in transponder arrangements, each named satellite being different from all others. A number of these satellites also have redirectable narrow beam antennas or variable beam-forming antennas which can be changed by telecommand. These systems generally have a large range of earth station figure-of-merit (G/T) within each system.

1.2.3 FSS networks operating at 14/11 GHz and 14/12 GHz

International networks have primarily used the 14/11 GHz bands.

On the other hand, 14/12 GHz have been used primarily for domestic systems and differ in specific frequency bands for the ITU Regions. In Region 2, the band is 11.7-12.2 GHz, while in Region 1, the usual band is 12.5-12.75 GHz.

In general, the frequency plans for space stations operating in the 14/11 and 14/12 GHz bands incorporate fewer channels with larger bandwidths. For example, transponder bandwidths of 40 MHz to 80 MHz channels are common. Typical space station receiving system figure-of-merit ranges up to about 9 dB(K^{-1}) and per transponder channel e.i.r.p.s are on the order of 43 to 50 dBW (at edge of coverage area) to 46 to 53 dBW (at boresight) using spot beams.

Antenna diameters of 1.2 m to 19 m are typical for earth stations operating in the 14/11 and 14/12 GHz bands. Receiving system figures-of-merit of 13 to 40 dB(K^{-1}) are typical for regional or domestic systems in the 11/12 GHz bands. Earth station e.i.r.p. ranges from about 40 to 95 dBW.

1.2.4 Frequencies above 15 GHz

Studies are in progress to define the parameters of space stations operating in the 30/20 GHz band, and two administrations have launched experimental space stations operating in these bands. In general, the use of frequency bands around 20 GHz and 30 GHz, where 3.5 GHz of bandwidth is available, would make possible the provision of very high capacity systems using narrow spot beam antennas and high speed digital transmissions.

The research and development of 30/20 GHz band FSS systems have been promoted in many countries, for example Japanese CS-1 experimental system, NASA's advanced 30/20 GHz system, ESA's OLYMPUS (formerly L-SAT) project, ITALSAT system, ATHOS experimental satellite project, German DFS and other experimental satellite projects.

In Japan, the first operational domestic FSS systems using CS-2a and 2b satellites started from the end of May 1983. The 30/20 GHz band is used for transmitting telephone signals using TDMA and FM-TV signals between regional centres with 11.5 m diameter offset Cassegrain antennas. Small transportable 30/20 GHz band earth stations with 3 m diameter antennas are used for emergency communications for telephone and TV signals.

Diversity earth stations may be required (in areas of high precipitation rates) in order to ensure that service availability is high. It is also expected that very broadband transponders will be used at these frequencies.

1.3 Common user systems

Various networks in the FSS are used by more than one administration on a common basis to satisfy their domestic and/or international communication services.

A particular example of such a user system is the INTELSAT system. Other examples of common user systems are mentioned in § 1.1 above.

INTELSAT provides satellite communication services to all nations on a non-discriminatory basis. At the end of 1983, the space segment consisted of 14 satellites and the earth segment consisted of a total of 750 antennas at 603 earth-station sites in 149 countries, providing more than 30 000 full-time voice and data circuits and over 26 000 hours of television transmissions. Additionally, allotments amounting to some 36 transponders are leased to 24 nations for domestic communications.

Since the launching of "Early Bird" (Intelsat-I) in 1965, eight generations of INTELSAT satellites have evolved. Each new generation has incorporated major technical advantages over the previous generation in order to derive more capacity. The evolution of INTELSAT systems has been characterized by the increasingly efficient use of spectrum and orbit resources through the application of advanced spacecraft technologies. The most recent INTELSAT satellites use approximately 500 MHz of spectrum for up link and down link in both the 6/4 GHz and the 14/11 GHz FSS bands. Advanced spacecraft antennas with spatial and polarization isolated beams are used to achieve 4-fold reuse of the 6/4 GHz spectrum in INTELSAT V and a 6-fold reuse in INTELSAT VI services (see Table 3). In the earth segment, some INTELSAT users have introduced TDMA-PCM-DSI, which achieves a bandwidth utilization efficiency of about 35 channels/MHz as compared to 15 channels/MHz in the FDM-FM transmission mode.

In addition, modified INTELSAT-VA series of satellites under construction will use the 14/12 GHz band for the provision of international business services directly to urban centres in many countries, while the INTELSAT-VI series satellites will be equipped to use 75 MHz of spectrum in the 6/4 GHz bands newly allocated at the WARC-79.

There are 18 positions in the GSO which are presently in the various stages of the IFRB registration process for existing or planned INTELSAT satellites.

Special issues of relevance to common-user systems

Service arc considerations

The choice of orbital locations for a common-user system may be more constrained by the geographical locations of the various users of the system than would be the case for a national system. The choice of orbital locations for a satellite system which must have the capability to connect all users in a given region is limited by the need to provide visibility, at satisfactory angles of elevation, for earth stations at the edge of the coverage area.

In the Atlantic Region for INTELSAT, for example, the primary location cannot be varied by more than 1.5° without reducing the elevation angle of the limiting earth stations to less than 5°, i.e., the minimum for satisfactory operation in the 6/4 GHz band. In the Indian and Pacific Ocean Regions the service arc for the primary satellite is only 3° wide.

At 14/11 GHz and higher frequency bands, the service arc restrictions are even more severe for INTELSAT since earth stations in these bands normally require operation at higher elevation angles than 6/4 GHz in order to minimize rain attenuation and depolarization effects to acceptable levels.

Space station coverage considerations

The size of satellite antenna beam coverage may also be affected by the geographic extent of the user administrations. The largest such beam would occur in systems providing service on a global basis. In such a case, a beam which covers all administrations served by the common user system, whether global or regional, is particularly useful for TV distribution services, in which several widely dispersed earth stations which are not located in other coverage beams require simultaneous reception of a certain telecast. Such beams can also provide connectivity for widely distributed, thin-route earth stations throughout the service area and the trend is to limit the bandwidth required for use in such beams to the minimum.

TABLE 3

Characteristics of INTELSAT satellites

Satellite	No. of transponders	Frequency spectrum (MHz)	Total bandwidth (MHz)	Frequency reuse	Achievable channel capacity
Intelsat-IVA	20	5 925-6 425 3 700-4 200	800	2 x 6/4	6 000 2-way voice + 2 TV channels
Intelsat-V(1)	27	5 925-6 425 14 000-14 500 3 700-4 200 10 950-11 200 11 450-11 700	2 137	4 x 6/4 2 x 14/11	12 000 2-way voice + 2 TV channels
Intelsat-VA(2)	32	5 925-6 425 14 000-14 500 3 700-4 200 10 950-11 200 11 450-11 700	2 252	4 x 6/4 2 x 14/11	15 000 2-way voice + 2 TV channels
Intelsat-VI	50	5 850-6 425 3 625-4 200 14 000-14 500 10 950-11 200 11 450-11 700	3 200	6 x 6/4 2 x 14/11	35 000 2-way voice(3) + 2 TV channels

(1) Intelsat-V F5-F9 are equipped to provide Maritime Communications Service using the frequency spectrum:
1 636.5-1 644.5 MHz; 1 535.0-1 542.5 MHz
6 417.5-6 425.0 MHz; 4 192.5-4 200.5 MHz

(2) Intelsat-VA F13-F15 are equipped to provide INTELSAT Business Service using the frequency spectrum:
14 000-14 500 MHz; 12 500-12 750 MHz (Europe), 11 700-11 950 MHz (North America).

(3) This assumes an increased number of digital links using SS-TDMA.

1.4 Current technology and operational characteristics in the FSS

1.4.1 Earth-station technology

The most important earth-station technologies are those associated with antenna characteristics and transmitter/receiver techniques. These factors affect the satellite network characteristics, and some of them have much to do with the efficiency of utilization of the geostationary-satellite orbit/spectrum.

Antenna characteristics

The most relevant earth-station element, amongst those mentioned above, is the antenna sub-system. Two important performance parameters of an earth-station antenna have a direct effect on orbit utilization: side-lobe and polarization characteristics.

Side-lobe characteristics

The antennas used in most earth stations are of the axisymmetric Cassegrain type. It is known that for this type of antenna the effect of blockage and diffraction due to the sub-reflector and its supports results in increased side-lobe levels. Nevertheless, many antennas now in use have improved side-lobe performance, particularly those of D/λ greater than 150. There are also new small asymmetric type antennas that are being installed with better side-lobe performance.

Polarization characteristics

Polarization discrimination depends on the polarizer characteristics and the surface accuracy of the main and sub-reflectors, the former being the major contributor. A typical value of polarization discrimination required for earth-station antennas is 30 dB (axial ratio of approximately 0.5 dB for circular polarization) and earth-station antennas with polarization discrimination of more than 30 dB are currently feasible. On the other hand, improvement in polarization discrimination beyond a certain threshold (approximately 30 dB), while feasible, does not result in a significant increase in capacity. This is the case, for example, of small-sized earth stations with low traffic requirements, that usually have reduced polarization isolation performance.

High power amplifiers (HPAs)

Klystrons and travelling wave tubes (TWTs) are used at the present time for earth-station high power amplifiers. Though the signal bandwidths of klystrons are about 40 MHz to 70 MHz, a band of 500 MHz can be covered by tuning the cavity in the 6, 14 or 30 GHz bands. Regarding the maximum saturated output power, klystrons of 14 kW in the 6 GHz band, 3 kW in the 14 GHz band and 500 W in the 30 GHz band have been developed. TWTs have signal bandwidths of 500 MHz in the 6, 14 and 30 GHz frequency bands respectively and do not require tuning. Regarding the maximum saturated output power, TWTs of 14 kW in the 6 GHz band, 3 kW in the 14 GHz band and 700 W in the 30 GHz band have been developed.

To reduce the level of intermodulation products produced in the HPA for multi-carrier operation, a linearizer of the pre-distortion type has been developed and used in some earth stations. By using such a linearizer, the level of intermodulation products will be reduced by more than 10 dB in the range of output back-off equal to or larger than about 6 dB.

Receiver techniques

Use of a receive chain with a low system noise temperature at an earth station is an essential requirement in a satellite communication system. The receiving system noise temperature is mostly determined by the noise contribution of the antenna and the first stage amplifier. At present, parametric amplifiers either cooled by gaseous helium or thermo-electrical devices or at ambient temperature are in use. Low noise amplifiers using a GaAs FET have been developed. The noise temperature achieved in the 4 GHz frequency band by these four kinds of low noise amplifiers is less than 20 K, 45 K, 80 K and 80 K respectively. The bandwidth of LNAs currently being used in the 4 GHz frequency band is 500 MHz. In the 11 GHz frequency band, parametric amplifiers with a bandwidth of 750 MHz and a noise temperature of about 90 K and an FET amplifier with a noise temperature of about 120 K are available. In the 20 GHz frequency band, parametric amplifiers with a bandwidth of 2.5 GHz and a noise temperature of about 80 K (cooled by gaseous helium), 200 K (cooled by a thermo-electrical device) and FET amplifiers with a noise temperature of about 220 K (cooled by a thermo-electrical device) or 300 K (ambient temperature) are feasible.

1.4.2 Technology related to space stations

The most important space station technologies are those associated with antenna characteristics and transponder components. These factors affect the satellite network characteristics and also contribute to the increase of the efficiency of utilization of the geostationary-satellite orbit/spectrum. In particular, satellite antenna technology provides the major technique for the provision of increased frequency reuse from a single orbit location, whether on the same satellite or on different satellites.

Antenna technology

While spot beam antennas provide for more frequency reuse of a given bandwidth, this is limited by the need for coverage and by the separation of the covered areas. Shaped beam technology offers some possibilities to enhance the application of spot beam technology for a wide variety of requirements.

Shaped beam antennas offer the potential for improved side-lobe control particularly where the coverage area itself is rather large thus improving the possibility of frequency reuse between coverage areas closer to each other. However, it should be noted that discrimination beyond-the-edge-of-coverage is a function of satellite antenna dimensions; launch vehicle constraints may be a factor here.

The orbital positions of existing satellites may have to change to accommodate new satellite systems. To cope with this situation, space-station antennas would have to be designed to take this fact into account. The direction of the radiation patterns would probably have to be changeable by control from the ground. In some cases it may be desirable to reshape beams in service in order to allow for a large change of location. However, the cost and operational impact of introducing such capabilities have not been sufficiently studied.

Transponder components

Since the introduction of communication satellites, there has been continuous improvement in the e.i.r.p. The higher e.i.r.p. levels translate into higher down-link C/N and correspondingly increased channel capacity, for a given size earth station. A domestic satellite concentrates its radiated power onto a single country, and achieves a higher e.i.r.p. than an international system with global or large area coverage, for the same size TWTA. In addition, these higher e.i.r.p. levels result from the use of higher power amplifiers in the satellites.

Solid-state devices such as field effect transistors (FETs) are generally less efficient than TWTs as power amplifiers but provide better linearity than TWTs. Thus, higher capacity may be achievable for multiple access systems because of better carrier-to-intermodulation ratios.

1.4.3 Multiple-access and modulation techniques

Multiple-access techniques and modulation techniques are inter-related. These techniques affect the bandwidth efficiency of systems.

Multiple access

Multiple access is the technique which enables respective transmission links of a large number of earth stations to be interconnected through the same satellite. This technique is essential to exploit the unique geometric properties of wide-area visibility and multiple connectivity which are the features of satellite communication systems.

Multiple-access techniques can be classified into the following two systems in respect of circuit utilization:

- pre-assigned multiple access;

- demand assigned multiple access.

In the former system the channels required among earth stations are assigned permanently. In the latter system the channels are assigned to the stations only on occasion of demand and satellite channels are therefore shared amongst users in time.

Moreover, multiple-access techniques can be classified into the following three systems:

- FDMA: frequency division multiple access;

- TDMA: time division multiple access;

- CDMA: code division multiple access.

In FDMA, the usual practice is pre-assigned multiple access, therefore carrier frequencies are assigned exclusively to each earth station and multiple carriers of different frequencies share a common satellite repeater. Such a multiple carrier operation always results in less capacity being available as compared to the single-access mode due to the power back-off which is required to reduce the level of intermodulation products. The base modulation techniques associated with FDMA can be either single sideband AM, frequency modulation or various digital modulations such as 2-PSK or 4-PSK.

In TDMA, a carrier of the same frequency is shared by multiple stations on the basis of non-overlapping (in time) burst transmissions through a satellite repeater. From the viewpoint of traffic, a TDMA system has greater flexibility than an FDMA system.

The CDMA system is one where signals occupy the same location in both the frequency domain and the time domain, but can be distinguished from others by proper signal processing. Spread spectrum multiple access (SSMA) is one example of a CDMA. The SSMA makes use of a deterministic noiselike signal structure to spread the narrow-band information over a relatively wide band of frequencies. The spectrum spreading is achieved by modulating each signal by a unique code, so that demodulation of a wanted signal can be done by means of correlation detection in which signals having different codes will not be correlated.

Modulation techniques

From the viewpoint of the efficient utilization of the geostationary-satellite orbit/spectrum, it is desirable to adopt bandwidth efficient modulation methods. The modulation methods which are widely used in current satellite communication systems are frequency modulation (FM) and phase shift keying (PSK). Recent developments include the use of the SSB-AM in conjunction with compandors.

Frequency modulation is presently the predominant form of modulation in FSS networks. Bandwidths of individual RF carriers presently in use range from about 25 kHz to 36 MHz; (see Table 4).

TABLE 4

Bandwidth of typical FM RF carriers

Bandwidth	Application
25-45 kHz	SCPC
100-250 kHz	Broadcast quality audio programme distribution
1.25-36 MHz	FDM-FM, 12 to 1 800 channel telephony
17-36 MHz	Television, possibly with multiple audio bandwidth sub-carriers

PSK modulation uses digital signals which for voice requires analogue-to-digital conversion. The resulting digital signal is processed and coded usually into 64 kbit/s per channel. The PSK can be accomplished using any number of phase pairs to distinguish the binary state. Theoretically, 4-PSK requires the same power, but half the bandwidth per bit, as compared to 2-PSK for a given link performance. Higher order (greater than 4-phase) PSK systems are more susceptible to noise and, therefore, need more power than either 2- or 4-phase systems to achieve the same standard of performance. A decrease in the number of phases permits closer satellite spacing, however, the utilization of the GSO tends to be optimized when the number of phases is in the range of 4 to 8 and the orbit utilization efficiency tends to decrease as either a higher or a lower number of phases are utilized.

Typical bandwidths and applications of digital modulation (2-PSK and 4-PSK) are as shown in Table 5.

TABLE 5

Bandwidth of typical digital RF carriers

Bandwidth	Application
30-60 kHz	SCPC for thin-route voice applications, and 48-64 kbit/s data with or without FEC
100-8 000 kHz	TDM data and/or digitized voice channels, (high speed digital channels) "thin-route" TDMA
30-72 MHz	High capacity single access or TDMA systems, with or without digital speech interpolation (DSI)

The SSB-AM provides a high-density analogue modulation alternative to digital systems. The development of highly stable, solid-state linear amplifiers for satellite transponders has given new life to this technique.

Other digital modulation techniques, amplitude-shift keying (ASK), frequency-shift keying (FSK) and composite modulation techniques involving both amplitude and phase-shift keying have been studied. Of these techniques, ASK and hybrid techniques involving ASK are not appropriate to TDMA because the transponder non-linearities and power-efficiency effects usually constrain the modulation format to have a constant envelope. In the case of FDMA, the use of ASK and hybrid techniques involving ASK is also restricted because of its greater sensitivity to co-channel interference.

Recently, new modulation techniques such as minimal shift keying (MSK) and tamed frequency modulation (TFM), in which the envelopes of modulated carriers are constant, have been studied. Because these modulation techniques are expected as desirable candidates for future systems, further studies are required.

The above are modulation techniques used in the RF domain. Also of importance are baseband and channel modulation techniques. In digital systems, it is possible to use 32 kbit/s delta modulation and work on 16 kbit/s appears promising. A draft new Recommendation of CCITT Study Group XVIII for 32 kbit/s ADPCM is currently being proposed. These techniques can yield up to four times the capacity, relative to 64 kbit/s PCM.

It is also possible to gain another factor of two to three in capacity using digital speech interpolation (DSI) in conjunction with any of the above modulation techniques.

Another common technique in use in satellite communication systems is single-channel-per-carrier (SCPC) on selected transponders for use with low-capacity earth stations. Typically PCM (digital) or companded FM (analogue) equipment is used to modulate a single voice transmission, but delta modulation 2-PSK as 4-PSK units are also in service. SCPC type carriers are also in operation for medium speed data (56 kbit/s) and audio distribution.

In satellite video transmissions FM with frame-rate energy dispersal is typical. The baseband may include multiple audio/data sub-carriers. Techniques are under development for dual television signal transmission through interframe interleaving of independent video signals. Such techniques will allow a single satellite transponder to support two independent television transmissions with a quality comparable to today's single television transmission per transponder.

1.4.4 Some trends in system characteristics

Several other factors will have a significant impact on the changes that can be expected in the future of FSS characteristics affecting orbital utilization.

1.4.4.1 Traffic growth

FSS system characteristics are probably most affected by the growth in traffic volume carried over the system, the changing pattern of this traffic, and the introduction of new services. Initial loading may consist of a relatively few high density links between major traffic centres. In time, additional links may be established to lower density traffic centres and thin-route services provided to remote locations. Moreover, demand for services may be greatly stimulated by the availability of high quality communication facilities at a given location. Once earth stations are installed to provide basic services to a community, it is also relatively easy and economical to expand the range of services provided. Such additional services might include video and audio programme distribution and data services. Also, it is often more economical for a country to initially lease capacity in an existing, larger capacity satellite. Eventually, traffic may grow to the point where a dedicated satellite is economically justified. Where several near-by countries have been leasing capacity on a global satellite system, such a dedicated satellite system might initially take the form of a regional system, rather than individual national systems, to reduce space segment costs. It is expected that each system will have its own unique pattern of development over time.

1.4.4.2 Modulation type and transmission parameters

Changing traffic volumes and patterns, as well as the introduction of new services and types of earth stations, can be expected to affect the types of modulation and carrier transmission parameters associated with the FSS system. These changes may result in transmissions having greater or lesser susceptibility to interference and greater or lesser potential to cause interference. For example, as traffic grows on high traffic density links, it is usually more economical to increase the RF carrier capacity by use of more bandwidth efficient modulation techniques than to allocate additional transponders. In addition, SCPC-FDMA transponder configurations are common as lower density, thin-route locations are added to the FSS network. However, low capacity TDMA systems are also under development where several such systems may access a transponder in an FDMA mode.

1.4.4.3 Trend to limited coverage and beam shaping

Spot beams on space stations in the FSS increase satellite G/T and e.i.r.p. and permit frequency reuse. The use of narrow antenna beams that concentrate gain over the coverage area helps to reduce the earth segment costs and increase satellite capacity.

Such spot beams are becoming almost universal for national coverage FSS systems. When coupled with fast roll-off characteristics of side lobes, a substantial increase in orbit utilization can be achieved. This is because the orbital separation between narrow-beam satellites serving non-overlapping coverage areas can be reduced due to the satellite antenna discrimination. With sufficiently distant coverage areas and/or fast enough roll-off characteristics, such satellites can be located at the same nominal orbital locations.

The use of spot beams covering different portions of a satellite's service area can also lead to greater orbit utilization. The spatial isolation between narrow beams permits frequency reuse at the orbital location.

In addition, advances in satellite antenna design technology permit shaping of the satellite antenna beam. Such shaping may be used to adapt the contours of the antenna beams to better fit the required coverage areas.

1.4.4.4 Increase in e.i.r.p. and sensitivity

There is a distinct trend towards increased satellite e.i.r.p. and decreased space-station and earth-station receiver noise temperatures. This trend tends to encourage increased transponder capacity and lower-cost earth stations.

Also, the trend towards higher e.i.r.p. satellites may also be used to advantage to improve orbit utilization by permitting an increase for all FSS systems in the portion of the noise budget allocated to interference from other satellite systems.

1.4.4.5 Trend towards bandwidth limited and interference limited operation

In many systems, one satellite may be required to serve an increasing number of earth stations. The ability of a single satellite to satisfy such growing requirements may be limited by the bandwidth available in the satellite. In the case of satellites using multiple spot beams for frequency reuse, available capacity may also be limited by interference levels between the various spot beams.

1.4.4.6 Higher frequency bands

FSS systems will increasingly use the higher frequency bands for a number of reasons. First, the addition of higher frequency bands to an FSS system may be more economically and technically attractive than more intensive frequency reuse techniques. Additionally, increasing orbital congestion in the lower frequency bands will also lead to the use of the higher bands. In particular, the greater antenna directivities available at the higher frequencies will permit smaller satellite spacings and thus a greater number of satellites to be accommodated. Consideration of terrestrial interference may also lead to an increasing use of higher frequency bands, especially if terrestrial systems are not highly developed in the higher bands. Finally, the higher frequency bands tend to have higher bandwidths available. Thus, while 500 MHz is currently in use at 6/4 GHz or 8/7 GHz, 1 000 MHz is available between 10 and 14.5 GHz and 3 500 MHz is available between 17 and 31 GHz.

INTERNATIONAL TELECOMMUNICATION UNION

ORB-85 WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT

FIRST SESSION, GENEVA, AUGUST/SEPTEMBER 1985

Document DL/7-E
13 August 1985
Original: English

SUB-WORKING GROUP 6A-1
AD HOC 1

ELEMENTS FOR CONSIDERATION WITH RESPECT TO THE LIMITS OF POWER FLUX-DENSITY OF SPACE STATIONS IN THE BSS OF REGION 2 TO PROVIDE PROTECTION OF TERRESTRIAL SERVICES IN OTHER REGIONS

The table presented below contains consolidated pfd limits from the Radio Regulations, Final Acts of conferences and administrative proposals applicable for the consideration of possible incompatibilities between BSS Region 2 plan and the terrestrial services of Regions 1 and 3.

G.H. RAILTON
Chairman of Sub-Working Group 6A-1
Ad Hoc 1

TABLE 1

	Frequency band	Power flux-density limit	Territory where the limit is applied	Source
1.	12.2-12.5 GHz	-125 dB $(W/m^2/4kHz)$	Region 1 and 3	WARC-77 WARC-79
2.	12.2-12.5 GHz	-132 dB $(W/m^2/5MHz)$; for $0 \leq \gamma \leq 10^\circ$ $-132+4.2(\gamma-10)$ dB $(W/m^2/5MHz)$; for $10^\circ \leq \gamma \leq 15^\circ$ -111 dB $(W/m^2/5MHz)$; for $15^\circ < \gamma \leq 90^\circ$	Regions 3 and part of Region 1 to the west of 30°E	WARC-77 WARC-79
3.	12.2-12.7 GHz	-134 dB $(W/m^2/5MHz)$; for $\gamma = 0^\circ$ $-134+4.6975\gamma^2$ dB $(W/m^2/5MHz)$; for $0^\circ < \gamma \leq 0.8^\circ$ $-128.5+25 \lg \gamma$ dB $(W/m^2/5MHz)$; for $\gamma > 0.8^\circ$	Part of Region 1 to the east of 30°E	CCIR preparatory meeting 1982 Documents 9, 16 and Reports 789-1 and 631
4.	12.5-12.7 GHz	-148 dB $(W/m^2/4kHz)$; for $0^\circ \leq \gamma \leq 5^\circ$ $-148+0.5(\gamma-5)$ dB $(W/m^2/4kHz)$; for $5^\circ \leq \gamma \leq 25^\circ$ -138 dB $(W/m^2/4kHz)$; for $25^\circ \leq \gamma \leq 90^\circ$	Region 3 and territories of countries of Region 1 enumerated in NN 848 and 850, RR	Radio Regulations Documents 9, 16

INTERNATIONAL TELECOMMUNICATION UNION

ORB-85 WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT

FIRST SESSION, GENEVA, AUGUST/SEPTEMBER 1985

Document DL/8-E
14 August 1985
Original: French

COMMITTEE 1

Note by the Chairman of Committee 7

PREPARATION OF A DRAFT STRUCTURE OF THE REPORT
OF THE FIRST SESSION OF THE CONFERENCE

1. As part of the organization of their work, some Working Groups have already prepared a draft of the probable contents of their respective reports (see in the annex the draft prepared by Working Group 4C).

2. In order to establish a draft structure for the final report to be prepared by the first session of the Conference for submission to the second session, it would be useful to have a plan of the parts which each of the Committees concerned intends to include in the report.

3. This information could be used to prepare a preliminary draft table of contents for the final report to be submitted to the Steering Committee for comment.

J.L. BLANC
Chairman of Committee 7

Annex: 1

ANNEX

Document DL/4-E
12 August 1985
Original: English

WORKING GROUP 4C

Working Group 4C

FORESEEN CONTENT OF THE WORKING GROUP 4C OUTPUT

1. General issues

1.1 The need for efficient orbit and spectrum utilization, having due regard to economic and operational issues

1.2 Time-phased introduction of measures for conserving orbit and spectrum

1.3 Means of achieving efficient harmonization of orbit and spectrum use

1.4 Computer tools for harmonization and planning

1.5 Homogeneity of orbit utilization

1.6 Multi-band and multi-service factors

1.7 Systematic use of frequency bands

1.8 Orbit segmentation

1.9 Generalized parameters for planning purposes

2. Specific parameters and criteria

2.1 Visible arc and service arc, including specific consideration of geographical factors and flexibility in the position of satellites

2.2 Satellite station-keeping

2.3 Satellite antenna radiation pattern

2.4 Satellite antenna pointing accuracy

2.5 Earth station radiation pattern

2.6 Off-axis e.i.r.p. density limits for earth station antennas

2.7 Polarization characteristics

2.8 Reverse band working

2.9 Maximum level of permissible interference

2.10 Characteristics of transmission systems, including susceptibility to interference and liability to cause interference

D.J. WITHERS
Chairman of Working Group 4C

INTERNATIONAL TELECOMMUNICATION UNION

ORB-85

WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT

FIRST SESSION, GENEVA, AUGUST/SEPTEMBER 1985

Document DL/9-E
15 August 1985
Original: English

WORKING GROUP 6B

Draft first report of Sub-Working Group 6B-2 to Working Group 6B

TECHNICAL PARAMETERS FOR BROADCASTING SATELLITE SERVICE FEEDER-LINK PLANNING IN REGIONS 1 AND 3 (17.3 - 18.1 GHz BAND)

Item No.	Parameter	Conference proposal	Comments	CPM ref.	Proposals Docs
1*	Carrier-to-noise ratio	24 dB	CPM value	Annex 6, 6.2.2	-
2*	Co-channel carrier-to-interference ratio	40 dB			-
3	Adjacent channel carrier-to-interference ratio	21 or 24 dB	CPM value is 21 dB, one administration requests the higher value (24 dB)	Annex 6, 6.2.3	9, 18
4	e.i.r.p.	Uniform value in the range 78-87.4 dBW or determine by link budget to achieve carrier-to-noise ratio value	Subject to further discussion	Annex 6, 6.2.4	14, 18, 40, 90
5	Earth station antenna diameter	5 m	Two administrations wish to make further comments	Annex 6, 6.2.5.1	-
6*	Earth station antenna gain		Not discussed, CPM value is 57 dBi	Annex 6, 6.2.5.2	-
7*	Earth station antenna, co-polar response pattern	32-25 log θ dBi for $1° < \theta < 48°$, -10 dBi for $\theta > 48°$ (Note 1)	Reduce by 3 dB where necessary (see Note 1)	Annex 6, 6.2.5.2 a)	40
8	Earth station antenna, cross-polar response pattern	-30 dB relative to co-polar on-axis gain, for $0° \leqslant \theta \leqslant 0.48°$, 19-25 log θ dBi for $0.48° < \theta \leqslant 14.45°$ -10 dBi for $\theta > 14.45°$ or -30 dB relative to co-polar on-axis gain, for $0° \leqslant \theta \leqslant 1.6°$, 32-25 log θ dBi for $1.6° < \theta \leqslant 48°$, -10 dBi for $\theta > 48°$ (see Note 1)	Subject to further discussion	Annex 6, 6.2.5.2 b)	15, 18
9*	Earth station antenna mispointing loss		Not discussed, CPM value is 1 dB	Annex 6, 6.2.5.4	-
10*	Satellite receiving antenna, co-polar response pattern		Not discussed	Annex 6, 6.2.6.2 a)	-
11*	Satellite receiving antenna, cross-polar response pattern		Not discussed	Annex 6, 6.2.6.2 b)	-
12*	Satellite receiving antenna, pointing accuracy	0.2°		Annex 6, 6.2.6.3	40
13*	Satellite noise temperature	1500 - 2500 K	CPM values	Annex 6, 6.2.7	18

Item No.	Parameter	Conference proposal	Comments	CPM ref.	Proposals Docs
14*	Type of polarization	Circular assumed	As CPM	Annex 6, 6.2.8	-
15*	Sense of polarization	Either, but must all be the same at each orbit position (relative to down-link)	As CPM	Annex 6, 6.2.8	18, 40
16	AGC		To be discussed	Annex 6, 6.2.9	40
17	Power control		To be discussed	Annex 6, 6.2.10	40
18	Earth station location		Under discussion	Annex 6, 6.3	18, 40
19	Methods of reducing incompatibilities in planning		To be discussed	Annex 6, 6.3.3	18, 40
20	Propagation model		To be discussed	Annex 2	40, 97

Note 1 - In circumstances where independent planning of orbit positions are adversely affected, the side-lobe off-axis response pattern should be limited to 29-25 log θ dBi. For values of θ in the regions of the nearby orbital separations in the plane of the geostationary orbit, i.e. $\theta \simeq \pm 6^{\circ}$, $\pm 12^{\circ}$.

* Discussion of these parameters has concluded.

R.M. BARTON
Chairman of Sub-Working Group 6B-2

INTERNATIONAL TELECOMMUNICATION UNION

ORB-85 WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT

FIRST SESSION, GENEVA, AUGUST/SEPTEMBER 1985

Document DL/10-E
19 August 1985
Original: English

WORKING GROUP 4C

PROVISIONAL CONCLUSIONS ON "HOMOGENEITY AND ORBIT SECTORIZATION"

(Work programme items 2.3 and 2.6)

(pending decisions of principle to be taken in Committee 5)

The most efficient orbit utilization would be obtained if all satellites utilizing the GSO, particularly those illuminating the same geographical area and using the same frequency bands, had the same characteristics, i.e. if they formed a homogeneous ensemble. However, in practice, satellite systems will have differences.

The extent to which inhomogeneity may represent an inefficient utilization of the GSO is dependent on many factors in the design of satellite systems. It is possible for the orbit to be more effectively utilized if inhomogeneity is taken into account during satellite system design. The system parameters in particular which should be given consideration are satellite and earth-station e.i.r.p.s, the service area, the transponder gain, the earth-station figure of merit (G/T), the relative immunity of the modulation method to interference, etc. Even when these basic parameters remain inhomogeneous it may be feasible to mitigate their effect on the orbital separation requirements of satellites by a careful trade-off between the e.i.r.p.s and receiver sensitivities of networks using adjacent satellites. Thus, inhomogeneity is to be reduced, where feasible, although the complete elimination of it is not compatible with the economic use of the FSS for the wide diversity of applications for which it is needed.

Studies have shown that, in principle, the impact of inhomogeneity can be reduced by segregating highly incompatible emissions by orbit sectorization or spectrum segmentation.

Orbit sectorization would probably permit a reduction of inhomogeneity without constraining system characteristics. However, it is likely to impose constraints on the choice of orbital locations for satellites. Such constraints may not be significant in arcs of the orbit where the demand for access is light, but severe problems might be raised for networks with very large service areas or those serving high latitudes, since such networks have narrow service arcs. Orbit sectorization might considerably reduce the benefits which might otherwise be obtained by the use of cross-beam geometry to enhance the capacity of the orbit for spot-beam satellites. In addition, to avoid severe inhomogeneity at the interfaces between sectors, there might be a need for guard arcs which would significantly reduce the benefits which would arise from the reduction of inhomogeneity within the sectors.

On the other hand, orbit sectorization might provide other benefits, in particular where the services required within a discrete geographical area are harmonious or where there are regional differences in frequency allocations. There is a need for further study of the benefits which orbit sectorization could provide and the disadvantages which it would raise. This study should be undertaken during the inter-sessional period in order that the results may be made available to the second session of this Conference.

Spectrum segmentation is also likely to permit a significant reduction in inhomogeneity. This subject is discussed further in section ....

Another possible approach is to apply constraints to certain system characteristics in some of the frequency bands allocated to the FSS, by the use of unified technical parameters and criteria as far as possible. The economic impact on systems of this approach could be reduced by combining it with orbit sectorization and/or spectrum segmentation.

D.J. WITHERS
Chairman of Working Group 4C

INTERNATIONAL TELECOMMUNICATION UNION

ORB-85 WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT

FIRST SESSION, GENEVA, AUGUST/SEPTEMBER 1985

Document DL/11-E
19 August 1985
Original: English

WORKING GROUP 4C

PROVISIONAL CONCLUSIONS ON "EFFICIENCY OF USE OF ORBIT"

(Work programme items 1.1 and 1.2)

(pending decisions of principle to be taken in Committee 5)

The demand world-wide for fixed-satellite service facilities is growing rapidly and it is expected to continue to grow in the foreseeable future. The total capacity of the geostationary satellite orbit and of the frequency bands allocated to the FSS can be increased very greatly, by technical and administrative means, to meet this future demand. Many factors can contribute to this growth of available capacity; perhaps the most important are:

- the use of efficient procedures for regulating access to the radio spectrum for space services;
- effective harmonization of the characteristics of networks which use adjacent orbital locations;
- the adoption of guidelines applicable to the use of different frequency bands which will reduce the inhomogeneity of networks which interfere with one another;
- limitation of satellite antenna coverage to the required service area, accompanied by a rapid roll-off of antenna gain outside the coverage area;
- improvement in earth station antenna side-lobe suppression;
- limitation of the spectral radiation density outside the main beam of earth station antennas;
- good satellite station-keeping;
- the use of transmission techniques which carry a large amount of information per unit of bandwidth, which are relatively unsusceptible to interference and which produce a well-dispersed power spectrum;
- the acceptance of substantial circuit interference noise from other networks of the service within the overall noise budget;
- use of polarization discrimination within or between networks.

In general, these factors can give benefit only if all or most satellite networks operating in a frequency band support them; the burden must be shared. It is, however, of the greatest importance that any regulatory process that is required to achieve this burden-sharing is not so rigid that it prevents the development of the FSS to provide economically the very great diversity of user applications which it is a good medium for providing.

The stringent application of these factors will tend to increase system costs, and so it may make the benefits of space radio services less available. This may be particularly true for countries which exhibit certain special geographical situations. Thus, it is necessary to take economic factors carefully into account when deciding how, and to what degree, these factors which enhance orbit/spectrum capacity should be applied by the ITU. The following possible approaches to the optimization of the balance between the costs of individual networks and the total capacity of the orbit and spectrum have been identified:

a) The cost of efficient harmonization of satellite networks is likely to be small relative to the cost of building and running the networks themselves, yet the benefits of efficient harmonization will be large. Accordingly, efficient harmonization is cost-effective.

b) The regulation of access to the radio spectrum in the geostationary satellite orbit should be based on accurate forecasts of requirements, so that the technical performance of equipment is not required to be needlessly stringent.

c) The demand for satellite networks will vary between different frequency band pairs and, in a given frequency band pair, in different arcs of the geostationary satellite orbit. Thus, where constraints are applied to satellite network characteristics, it may be feasible to set mild constraints for some frequency bands and orbital arcs, where the demand is low, even though more stringent constraints may have to be applied where the demand is high.

d) The Radio Regulations, Article 29, apply constraints on certain network characteristics, such as accuracy of satellite station-keeping and the CCIR establishes Recommendations on key network characteristics, such as antenna performance and carrier energy dispersal. These measures have done much to increase the efficiency of the use of the geostationary satellite orbit. Much more improvement will, no doubt, be achieved by such means in the future. However, if it becomes necessary to impose new mandatory constraints on satellite networks, consideration should be given to constraining, not single characteristics, but the combined performance of groups of characteristics. In this way it would be possible to achieve the objective of limiting interference from one network to another, yet the designer of a network could conform to the constraint by whatever combination of these characteristics was most economic in the particular circumstances of the network in question.

e) When it can be foreseen that it will be necessary to introduce more stringent performance recommendations or more stringent mandatory constraints, a long period of notice should be given, to give sufficient time for the necessary equipment to be developed and manufactured. Where a large improvement in performance is foreseen to be necessary over a long period, it may be desirable to introduce the improvement in two or more phases. It would be desirable for such changes to be determined at regular intervals, perhaps at the Plenary Assemblies of the CCIR or at periodic administrative radio conferences which might be scheduled to follow the CCIR Plenary Assemblies.

f) It is essential that the introduction of more stringent mandatory constraints on networks should provide for the continued use of equipment, already in service, which has not completed its economic working life, even though it may not achieve the new standards. Similar provision may be necessary for equipment which is in an advanced stage of manufacture at the time when the new constraints are agreed.

D.J. WITHERS
Chairman of Working Group 4C

INTERNATIONAL TELECOMMUNICATION UNION

ORB-85 WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT

FIRST SESSION, GENEVA, AUGUST/SEPTEMBER 1985

Document DL/12-E
20 August 1985
Original: English

WORKING GROUP 4C

PROVISIONAL CONCLUSIONS ON "MULTI-BAND AND MULTI-SERVICE FACTORS" (WORK PROGRAMME ITEM 2.4) PENDING DECISIONS OF PRINCIPLE TO BE TAKEN IN COMMITTEE 5

In some satellite networks it may be technically necessary for two pairs of frequency bands to be used by the satellite. The use by maritime mobile satellites of FSS frequency bands for feeder links is a good example of this need. In the similar case of broadcasting satellites, it is necessary to use an FSS frequency band for feeder links also.

In other situations it may be economically advantageous or operationally desirable to use two or more pairs of frequency bands on a satellite, for example:

- the working bandwidth of a satellite network can be increased in this way without major loss of connectivity, cross-strapping between the frequency bands being used as necessary;

- the technology and practice of combining several space services on a single satellite is attractive in certain cases and is emerging. It is particularly attractive for countries requiring several space services but where capacity requirements in any particular service are limited space stations serving two or more purposes may separately require only part of the minimum payload mass and power supply that is economically viable for a satellite; by putting both space stations on a single spacecraft, the total cost of the space segment may be significantly reduced, since heavier satellites tend to cost less per unit of payload mass and power to construct, put in orbit and control.

The use of several frequency bands on one satellite in such ways will, of course, have to be taken into account in coordination or planning, but it may have little impact on the efficiency of use of the geostationary-satellite orbit. This may be true, for example, when only one of the frequency bands which are used, or two conventionally-paired bands, are heavily loaded in the vicinity of the satellite in question and the services provided in lightly loaded bands are not closely constrained to a particular orbital position, by operational requirements or a frequency/orbital position allotment plan.

However, this practice may reduce the efficiency of orbit utilization in other situations. The minimum angular separation required in the different frequency bands to prevent inter-network interference exceeding the permissible value will probably be different, raising the possibility that full use will be made of the orbit in only one frequency band or pair of frequency bands. If different satellites were used for each pair of frequency bands or each different service, optimum orbital positions could be used for each of these satellites after coordination or planning. When a single satellite is carrying all of these facilities, a compromise orbital position must be used, and this is not likely to allow optimum coordination or planning with all other networks.

Two strategies have been suggested for reducing the impact of this problem where it could lead to inefficient usage, namely:

- for certain multiple-band configurations it is possible to adjust system parameters to minimize the overall orbit/spectrum capacity losses. This generally corresponds to equalizing the required separation angles in the various bands;

- it may be feasible to make room in between two multi-band satellites for an additional satellite operating in only one pair of the frequency bands used on the multi-band satellites. This, however, may involve adjustment of the characteristics and parameters of the satellite networks.

It is recommended that these two possible strategies should be taken into account in determining the characteristics and parameters of satellite networks using more than one pair of frequency bands. In addition, it should be noted that the techniques of harmonization method M3 may be employed to optimize the utilization of the orbit in the vicinity of a complex satellite.

Nevertheless, such strategies are not likely to be generally applicable, and it is recommended that administrations should give careful consideration to the advantages and disadvantages of this practice, where it is technically avoidable.

D.J. WITHERS
Chairman of Working Group 4C

INTERNATIONAL TELECOMMUNICATION UNION

ORB-85 WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT

FIRST SESSION, GENEVA, AUGUST/SEPTEMBER 1985

Document DL/13-E
20 August 1985
Original: English

WORKING GROUP 4C

Draft Element
Working Group 4C Report

PROVISIONAL CONCLUSIONS ON SYSTEMATIC USE OF FREQUENCY BANDS

WORK PROGRAMME 2.5

(Pending decisions of principle to be taken in Committee 5)

2.5 Systematic use of frequency bands

2.5.1 Frequency band pairing

The typical fixed satellite service communication link involves transmission from an earth station to a space station and retransmission from the space station to another earth station. Accordingly, the ITU Table of Frequency Allocations allocates several frequency bands to the fixed satellite service for either Earth-to-space or space-to-Earth use. Although these frequency bands are used in pairs, the Radio Regulations do not require a satellite to use a specific Earth-to-space band with a specific space-to-Earth band. However, it is recognized that utilization of the GSO and the frequency spectrum would be more efficient, and coordination of networks would be facilitated, if specific Earth-to-space and space-to-Earth bands are designated in pairs.

Existing FSS systems show a high degree of standardization of frequency band pairing based mainly on frequency allocations as they existed before WARC-79, the difficulties of coordination with terrestrial services, and the requirements of the FSS themselves. It is clearly necessary that this existing situation be respected as much as possible and that due account is taken of the requirements of satellite networks for which other pairings are operationally essential.

Additional frequency bands newly allocated to the FSS at WARC-79 are being considered for the implementation of future satellite systems. Any band pairing arrangements in these additional frequency bands will have to take account of operational requirements of future fixed satellite systems, the different frequency allocations in the different regions, and the sharing constraints that exist in the relevant bands. Accordingly, any specific list of frequency pairings that can be developed should be used as a guide to be followed whenever feasible, and not as a regulatory requirement.

2.5.2 Translation frequency for narrow-band satellites

Some satellites, for example FSS feeder links for mobile satellites, need to use only a part of the bandwidth of the allocated FSS band. In such cases the coordination of several narrow-band satellites occupying the same part of the GSO would be facilitated if all the satellites used the same effective translation frequency between the up-link and the down-link. In addition, it is desirable to keep to a minimum the number of translation frequencies.

2.5.3 Use of multiple frequency band pairs in satellites

In some satellite networks, it may be economically and operationally advantageous to use more than one pair of frequency bands; for example, to enable the working bandwidth of the network to be increased, to enable several different functions to be performed by one satellite, or to improve network connectivity by enabling communications to be established between users with different earth segments. Strapping of transponders is essential for some applications and should not be prevented by any formal scheme of band pairing.

2.5.4 Conclusions and recommendations

From the foregoing considerations, it is clear that there would be benefit from studies on this topic and it is therefore recommended that additional studies be undertaken during the intersessional period for WARC ORB(2) with a view to:

1) determining the potential value of frequency band pairings in the work of the Conference, and

2) providing, if possible, a specific list of FSS frequency band pairings which may be used as a guide for administrations to follow, to the extent possible, when designing and implementing future satellite systems,

for consideration by WARC ORB(2).

The following list of technical considerations should be taken into account when developing any list of frequency band pairings:

- The ratio of mid-band frequencies of up-link and down-link bands should preferably be not so great that antenna design is made difficult, nor so small that duplexer design is made difficult.

- The paired bands, which will not necessarily include the full bandwidth of frequency allocations, should in most cases have equal bandwidth, and the number of translation frequencies for the paired bands should be kept to a minimum.

- Where it is possible to avoid it, no frequency in one band should be a simple multiple of any frequency in its paired band.

- Pairings already well established in practice should be retained.

- To the extent that it is feasible and necessary, consideration should be given to feeder links, having due regard for present utilization by the FSS.

- Continuation of provision for the established practice of cross-strapping from one pair of bands to another in a multi-band satellite is necessary.

- ITU regional variations exist in the FSS allocations for Earth-to-space and space-to-Earth use.

T.S. TYCZ
Chairman of Drafting Group 4C-3

INTERNATIONAL TELECOMMUNICATION UNION

ORB-85 WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT

FIRST SESSION, GENEVA, AUGUST/SEPTEMBER 1985

Document DL/14(Rev.1)-E
21 August 1985
Original: English

SUB-WORKING GROUP 4B-1

Note from the Chairman of Working Group 4B

TERMS OF REFERENCE

SUB-WORKING GROUP 4B-1

1. Within the terms of reference of item a) of Working Group 4B to analyze current sharing situations and identify the current availability of sharing information and areas requiring further study with particular reference to the technical criteria for inter-service sharing.

Note 1 - In considering the above the Sub-Working Group will review the contributions of administrations, the CCIR/CPM report and the relevant reports from the IFRB.

Note 2 - While the Drafting Group has considered a number of items already, specific issues outstanding include a) technical considerations of reverse band working as related to sharing possibilities and b) spurious emissions.

2. To prepare a report to Working Group 4B.

TERMS OF REFERENCE

SUB-WORKING GROUP 4B-2

1. Identify, those bands selected by Committee 6 under agenda item 3.1, the sharing criteria between services (space or terrestrial) which need to be developed during the inter-sessional period (agenda item 3.3).

2. To prepare a report to Working Group 4B.

K. KOSAKA
Chairman of Working Group 4B

INTERNATIONAL TELECOMMUNICATION UNION

ORB-85 WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT

FIRST SESSION, GENEVA, AUGUST/SEPTEMBER 1985

Document DL/14-E
20 August 1985
Original: English

SUB-WORKING GROUP 4B-1

Note from the Chairman of Working Group 4B

PROPOSED TERMS OF REFERENCE

SUB-WORKING GROUP 4B-1

1. To analyze current sharing situations and identify the current availability of sharing information and areas requiring further study with particular reference to the technical criteria for inter-service sharing;

Note 1 - In considering the above the Sub-Working Group will review the contributions of administrations, the CCIR/CPM report and the relevant reports from the IFRB.

Note 2 - While the Drafting Group has considered a number of items already, specific issues outstanding include a) technical considerations of reverse band working as related to sharing possibilities and b) spurious emissions.

2. To prepare a report to Working Group 4B.

K. KOSAKA
Chairman of Sub-Working Group 4B

INTERNATIONAL TELECOMMUNICATION UNION

ORB-85 WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT

FIRST SESSION, GENEVA, AUGUST/SEPTEMBER 1985

Document DL/15(Rev.1)-E
26 August 1985
Original: English

SUB-WORKING GROUP 5B-1

PROVISIONAL GUIDELINES CONCERNING ARTICLE 14 IN RESPECT OF SPACE SERVICES

I. Factors which need to be taken into account

I.1 The procedure of Article 14 must be applied to assignments being made under different kinds of footnote allocations including the space and terrestrial services and in certain situations to allocations in the frame of the Table of Frequency Allocations (Article 8).

I.2 This Conference does not have the competence to effect any changes to the Table nor to any of the footnotes thereto, nor otherwise alter the status of the services concerned. However, it has been noted that the precise interpretation of certain footnotes which refer to Article 14 is ambiguous or unclear.

II. Tentative guidelines

The following tentative guidelines are recommended for consideration by the second session and any intersessional work which may be scheduled:

II.1 The provisions of Article 14 should be reviewed and modified in such a way that they are applicable to a satellite network instead of individual assignments.

II.2 The relevance of Article 14 to assignments for reception should be considered and clarified.

II.3 The procedure must include a means by which "affected administrations" are identified. During the intersessional period administrations should review the Technical Standards adopted by the IFRB, and if necessary propose standards to be incorporated in the Radio Regulations.

II.4 Objections to agreement under Article 14 must be based on valid technical grounds which demonstrate non-compatibility. It is noted that decisions of the Board have supported this principle /_(see Document 4, section 4.3.2.4)_/. The second session should consider the matter of technical information to be supplied in such cases.

II.5 The meaning of the term "planned assignment" (RR 1617 and RR 1618) should be considered. It is suggested that assignments on which an objection has been based would normally be expected to be brought into use within a /_period of /_3_/ years/ reasonable period_/. Such assignments should have to be notified to the IFRB in accordance with RR 1214 or RR 1488, as appropriate, in order to ensure that the objection raised on the basis of these assignments continues to be valid.

II.6 The procedure to be applied in unresolved cases of disagreement must be included in the Regulations.

II.7 The question of modification to assignments which have successfully completed the Article 14 procedure should be considered. The second session might decide that if the modification

- results in a reduction of potential interference, and
- the administration accepts the probability of increased interference to its assignment,

then Article 14 need not be reapplied in respect of the modified assignment.

II.8 The second session should consider the matter of priority of dates (paragraph 4.3.2.3.1 of the IFRB report refers). Radio Regulations should specify whether or not an assignment which has successfully completed the Article 14 procedure is to be taken into account by an administration applying the procedure at a later date in respect of an assignment which would achieve the same status after successful completion.

II.9 The second session, if it is declared competent to do so, should review footnote allocations insofar as the space services are concerned with a view to clarifying the wording used to the maximum extent possible, without in any way altering the substance of the text or the status of an assignment in respect of which the procedure has been successfully applied.

II.10 Noting that an assignment notified under RR 342 is recorded with the same status as an assignment which after application of Article 14 is subject to not causing harmful interference, it is for consideration whether such an assignment may be regarded as having successfully applied Article 14.

II.11 The second session should consider whether an administration with which agreement is sought for an assignment which according to the footnote concerned would achieve secondary status, may grant primary status, in respect only of the two administrations concerned.

A.V. CAREW
Chairman of Sub-Working Group 5B-1

INTERNATIONAL TELECOMMUNICATION UNION

ORB-85 WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT

FIRST SESSION, GENEVA, AUGUST/SEPTEMBER 1985

Document DL/15-E
21 August 1985
Original: English

SUB-WORKING GROUP 5B-AD HOC 1

PROVISIONAL RECOMMENDATIONS CONCERNING ARTICLE 14

I. Factors which need to be taken into account

1. The procedure of Article 14 must be applied to assignments being made under different kinds of footnote allocation including the space and terrestrial services and in certain situations to allocations in the frame of the Table of Frequency Allocations (Article 8).

2. This Conference does not have the competence to effect any changes to the Table nor to any of the footnotes thereto, nor otherwise confer any status not intended by these services.

3. Further clarification from the Board would be useful, with respect to interpretation of the status of assignments made pursuant to various footnotes citing Article 14 (reference Document 4, section 4.3.1.3).

II. Tentative guidelines: The following tentative guidelines are recommended for consideration by the second session and any intersessional work which may be scheduled:

1. The procedure must include a means by which "affected administrations" are identified (e.g. RR 1616 and RR 1617). It is noted that the current procedure of Advanced Publication under Article II, Section I, does, to a certain extent, perform this same function.

2. Objections to agreement under Article 14 must be based on valid technical grounds which demonstrate non-compatibility. It is noted that decisions of the Board have supported this principle (see Document 4, section 4.3.2.4).

3. A possible simplification of the process might be considered for assignments to be notified in space services subject to RR 342. Under such circumstances, the requirement to obtain "agreement of any other administration" (RR 1610) may be considered to have been effected by virtue of acceptance of the provisions of RR 342.

4. Future discussion of RR 1617 and RR 1618 should consider the desirability of clarifying the meaning of "planned assignment". It has been suggested that such assignments might normally be expected to be brought into use within three to five years. The requirement for such assignments to then comply with the provisions of RR 1217 and RR 1491 needs to be considered in order to ensure the future integrity of any objection.

5. The second session, if it is declared competent to do so, might wish to review footnote allocations insofar as the space services are concerned with a view to reducing the number of such allocations and standardizing the wording used to the maximum extent possible.

6. The information required to enable the effective application of the procedure must be specified in the Regulations [in order to avoid requests for supplementary information by the Board].

7. The technical criteria necessary to determine if the services of another administration are affected must also be specified.

8. The procedure to be applied in cases of disagreement in terms of the examination of notices must be included in the Regulations.

A.V. CAREW
Chairman of Sub-Working Group 5B-Ad hoc 1

INTERNATIONAL TELECOMMUNICATION UNION

ORB-85 WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT

FIRST SESSION, GENEVA, AUGUST/SEPTEMBER 1985

Document DL/16(Rev.1)-E
23 August 1985
Original: English

WORKING GROUP 4A

Draft outline of Working Group 4A contribution to ORB(1) Report

CHAPTER (ZZ)

SATELLITE SOUND BROADCASTING SYSTEMS FOR INDIVIDUAL RECEPTION BY PORTABLE AND AUTOMOBILE RECEIVERS

(Agenda item 4)

1. Introduction

Resolution No. 505 - WARC-79

Resolution No. 895 - Administrative Council

CCIR work and studies by administrations

This chapter:

Technical characteristics of example systems

Quality and availability objectives

Bandwidth and frequency sharing

Conclusions: Based on information available

Recommendations: to ORB(2)

2. Results of studies and analyses

2.1 System description - Refer to Annex

Types of reception

Two example models of systems

Service quality and objectives

Cost estimates URS/9/9, URS/137 + Corr.1

2.2 Frequency bandwidth and frequency sharing E/32/6, CVA/32(Add.1), SMR/148/1

Studies and conclusions on bandwidth required MEX/60/6

Analogue versus digital

Sharing {URS 9/9, E/32/6, CVA/32(Add.1), SMR/148/1
MEX/41/§ 3.2, MEX/61/13}

Other users

Sharing possibilities - effect of high power flux-density

Conclusion - exclusive allocation needed, based on models examined HOL/24/p.2
MEX/60/6, MEX/61/14, CTI/95/§ 7

3. Technical conclusions

3.1 Technical feasibility

3.2 Sharing difficulties require exclusive use

4 Further work (study) - to define practical system parameters

Digital systems
Up-links
Appropriate sharing criteria
Provision 2674 of Radio Regulations - ability to comply
} From CPM Report Chapter 11

Frequency

Adequate bandwidth

Costs - economics

Effect of receiver

Quality

5. Recommendations - Refer to Resolution

5.1 Additional studies

5.2 On basis of present information, recommend that no allocation be made in band 0.5 - 2.0 GHz

5.3 ORB(2) be authorized to make appropriate decisions concerning allocations for sound broadcasting satellites

5.4 ORB(2) examine additional information and make appropriate decisions.

E.F. MILLER
Chairman of Working Group 4A

INTERNATIONAL TELECOMMUNICATION UNION

ORB-85 WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT

FIRST SESSION, GENEVA, AUGUST/SEPTEMBER 1985

Document DL/16-E
22 August 1985
Original: English

WORKING GROUP 4A

Draft outline of Working Group 4A contribution to ORB(1) Report

CHAPTER (ZZ)

SATELLITE SOUND BROADCASTING SYSTEMS FOR INDIVIDUAL RECEPTION BY PORTABLE AND AUTOMOBILE RECEIVERS

(Agenda item 4)

1. Introduction

Resolution No. 505 - WARC-79

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CCIR work and studies by administrations

This chapter:

Technical characteristics of example systems

Quality and availability objectives

Bandwidth and frequency sharing

Conclusions: Based on information available

Recommendations: to ORB(2)

2. System description - Refer to Annex

Types of reception

Two example models of systems

Service quality and objectives

*Choice of frequency

*Cost estimates

3. <u>Bandwidth and frequency sharing</u>

Studies and conclusions on bandwidth required

Analogue versus digital

Sharing

- Other users
- Sharing possibilities - effect of high power flux density

Conclusion - exclusive allocation needed, based on models examined

4. <u>Conclusions</u>

4.1 Technical feasibility

4.2 Sharing difficulties require exclusive use

4.3 Further work (study) - to define practical system parameters

- Digital systems
- Up-links
- Appropriate sharing criteria
- Provision 2674 of Radio Regulations - ability to comply

(From CPM Report Chapter 11)

- Frequency
- Adequate bandwidth
- Costs - economics
- Effect of receiver
- Quality

5. <u>Recommendations</u> - Refer to Resolution

5.1 Additional studies

5.2 On basis of present information, recommend that no allocation be made in band 0.5 - 2.0 GHz

5.3 ORB(2) be authorized to make appropriate decisions concerning allocations for sound broadcasting satellites

5.4 ORB(2) examine additional information and make appropriate decisions.

E.F. MILLER
Chairman of Working Group 4A

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* New information required.

INTERNATIONAL TELECOMMUNICATION UNION

ORB-85 WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT

FIRST SESSION, GENEVA, AUGUST/SEPTEMBER 1985

Document DL/17(Rev.1)-E
22 August 1985
Original: English

SUB-WORKING GROUP 4B-1

Working Group 4B

DRAFT ELEMENT OF REPORT OF WORKING GROUP 4B,

INTERSERVICE SHARING

1. Introduction

/ Committee 4 / has reviewed those portions of the Report of the Conference Preparatory Meeting (CPM) of the CCIR (Document 3) relevant to its terms of reference: specifically, Chapters 8 and 10 of Part 1 of the report, and all of Annex 5 and section 6.1.3.4 of Part 2. The Committee also reviewed the following contributions to ORB-85: 4 (the report of the IFRB), 8 (New Zealand), 18 (United Kingdom), 27 (China), 35 (Canada) and 37 (Brazil).

This is an interim report, describing the work of the / Committee / to date on item a) of its terms of reference set forth in Document DT/7: under agenda item 2.6, "Analyze current sharing situations in frequency bands to be discussed in Committee 5 under agenda item 2.2, based on input from administrations and results of studies in the CCIR, identifying the current availability of sharing information and areas requiring further study". Both down-link and feeder-link sharing situations have been considered.

2. The Report of the CPM

The / Committee / has decided not to summarize here, these relevant sections of the CPM Report, knowing that such an effort would probably not do justice to a report which itself summarizes source documents of the CCIR. Rather, the / Committee / incorporates in this report, by reference, the pertinent sections of the Report of the CPM cited above.

/ Committee 4 / endorses the material contained in those chapters and annexes, including the sharing principles, the discussion of performance requirements and interference criteria, the available sharing criteria for sharing between services and the conclusions set forth. We refer it to other Committees of this Conference for the information and guidance it offers, particularly to Committee 5 in its consideration of bands and services to be planned, planning principles and criteria.

Among the principles and conclusions of particular importance are the following:

2.1 Interference and sharing criteria are necessary to permit the equitable sharing of a band by services having primary allocations in that band. Such criteria have been developed for many bands and services, and are responsible for the successful and intensive use now being made of shared bands. / CPM 8.3 /.

2.2 Services, whether space or terrestrial, having primary allocations in a particular band, have equal rights with respect to the use of the spectrum. Their requirements must be taken into account while planning a space service, without changing their existing sharing status - regardless of the planning method or approach employed. /̄ CPM 8.2_7.

2.3 In order for the development of terrestrial services in shared bands to continue, as a corollary or consequence of the principle set forth immediately above, earth station locations should not be planned in bands shared on a primary basis with terrestrial services. /̄ CPM 8.2_7.

2.4 Techniques that may be necessary or desirable to facilitate sharing, also bring about the more efficient use of the spectrum by all services. /̄ CPM Annex 5, 5.3.1.3_7.

2.5 The planning of bands shared by space services operating in different directions of transmission (i.e. "Reverse-Band Working"), could well impose additional constraints on both services, particularly when a terrestrial, fixed service is also a primary service in those bands. Further study is required on the extent of these constraints. /̄ CPM 8.2_7.

2.6 The report of the CPM indicates that further study may be needed for a number of combinations of services which may share a band or bands. These combinations include:

a) BSS/FSS at 2.5 GHz;
b) BSS/FSS at 12 GHz - Interregional;
c) FSS/EESS (passive) at 18.6 - 18.8 GHz;
d) FSS/MetSS at around 8 GHz and at 18 GHz;
e) ISS/BSS at 22.5 - 23 GHz;
f) FSS/FS in bidirectional bands;
g) MSS/FS at 1.6/1.5 GHz;
h) BSS/FS at 22 GHz.
/̄i) FSS/MSS at 8 GHz and at 20/30 GHz_7
/̄j) FSS/EES at 8 GHz_7

3. <u>Other views on interservice sharing situations</u>

3.1 Interference limits and sharing criteria must permit a continuation of at least the same level of sharing between services in a particular band. However, certain planning methods could adversely affect the ability of these sharing criteria to ensure the same level of sharing.

3.2 It may be possible to increase the overall use of some FSS/FS shared bands through Reverse Band Working (RBW), without significantly affecting terrestrial services or significantly reducing the capacity in the forward-band working sense, if the initial indications can be confirmed through studies to be conducted during the intersessional period, that the favourable geometry associated with the high elevation angles (above 40^{o}) significantly ameliorates the constraints outlined in section 2.5 above.

3.3 Criteria have not yet been adopted for certain sharing situations. While they will eventually be necessary in any event, a decision to plan one or more space services in a band implies that relevant criteria must be developed and adopted and then employed in the planning process.

3.4 WARC-79, by Recommendation No. 66, recommended that the CCIR study, as a matter of urgency, the question of spurious emissions from space stations. It is important that intersessional studies provide the second session of the Conference with information to be able to take appropriate action at that time.

3.5 Once ORB-85 has identified bands and services to be planned, new sharing criteria must be developed for situations where no criteria exist, and existing criteria should be reviewed for their adequacy in light of the particular planning method to be employed. It is contemplated that those criteria requiring further study should be identified for consideration during the intersessional period.

3.6 /‾Committee 4_/ is of the opinion that the CCIR can provide a knowledgeable and efficient forum for the development of new criteria and the examination of existing ones; however, special arrangements may be necessary to enable CCIR to provide the information required within the limited available time.

3.7 A review of Document 4, the report of the IFRB (as supplemented by DT/21), indicates that, in situations where none had been incorporated in the Radio Regulations, the Board developed and applied, on a provisional basis, interference and sharing criteria for use in applying Article 14 to space services.

[The Committee notes certain inconsistencies and omissions in the sharing criteria developed by the IFRB. These are listed and discussed in section 3.9.1 below. (This paragraph to be included only if Sub-Working Group 4B-1 concludes, after further discussion, that there are, in fact, any such inconsistencies and/or omissions.)]

The /‾Committee_/ urges review of these sharing criteria during the intersessional period, and that appropriate recommendations be made to the second session of WARC-ORB.

The /‾Committee_/ also requests the IFRB to identify, as early in the intersessional period as practicable, all cases where formal sharing criteria are not available, or have not been adopted.

[3.7.1 Inconsistencies and omissions, if any, in the criteria developed by the IFRB and used by it on a provision basis.]

RICHARD G. GOULD
Chairman of Sub-Working Group 4B-1

INTERNATIONAL TELECOMMUNICATION UNION

ORB-85 WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT

FIRST SESSION, GENEVA, AUGUST/SEPTEMBER 1985

Document DL/17-E
21 August 1985
Original: English

SUB-WORKING GROUP 4B-1

Working Group 4B

DRAFT ELEMENT OF REPORT OF WORKING GROUP 4B,

INTERSERVICE SHARING

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[2.1 Interference and sharing criteria are necessary to permit the equitable sharing of a band by services having primary allocations in that band. Such criteria have been developed for many bands and services, and are responsible for the successful and intensive use now being made of shared bands. / CPM 8.3 /.]

2.2 Services, whether space or terrestrial, having primary allocations in a particular band, have equal rights with respect to the use of the spectrum. Their requirements must be taken into account while planning a space service, without changing their existing sharing status - regardless of the planning method or approach employed. /¯CPM 8.2_7.

[2.3 In order for the development of terrestrial services in shared bands to continue, as a corollary or consequence of the principle set forth immediately above, earth station locations should not be planned in bands shared on a primary basis with terrestrial services. /¯CPM 8.2_7.]

2.4 Techniques that may be necessary or desirable to facilitate sharing, also bring about the more efficient use of the spectrum by all services. /¯CPM Annex 5, 5.3.1.3_7.

2.5 The planning of bands shared by space services operating in different directions of transmission (i.e. "Reverse-Band Working"), could well impose additional constraints on both services, particularly when a terrestrial, fixed service is also a primary service in those bands. Further study is required on the extent of these constraints. /¯CPM 8.2_7.

2.6 The report of the CPM indicates that further study may be needed for a number of combinations of services which may share a band or bands. These combinations include:

a) BSS/FSS at 2.5 GHz;
b) BSS/FSS at 12 GHz - Interregional;
c) FSS/EESS (passive) at 18.6 - 18.8 GHz;
d) FSS/MetSS at around 8 GHz and at 18 GHz;
e) ISS/BSS at 22.5 - 23 GHz;
f) FSS/FS in bidirectional bands;
g) MSS/FS at 1.6/1.5 GHz;
h) BSS/FS at 22 GHz.

3. <u>Other views on interservice sharing situations</u>

3.1 Interference limits and sharing criteria must permit a continuation of at least the same level of sharing between services in a particular band. However, certain planning methods could adversely affect the ability of these sharing criteria to ensure the same level of sharing.

[3.2 It may be possible to increase the overall use of some FSS/FS shared bands through Reverse Band Working (RBW), without significantly affecting terrestrial services or significantly reducing the capacity in the forward-band working sense, if the initial indications can be confirmed (during the intersessional period) that the favourable geometry associated with the high elevation angles (above 40%) proposed in Document 18 significantly ameliorates the constraints outlined in section 2.5 above.]

[Post-CPM studies by one administration suggest that it may be possible to increase the overall use of some FSS/FS shared bands through Reverse Band Working (RBW), without significantly affecting terrestrial services or significantly reducing the capacity in the Forward Band Working (FBW) sense, by taking advantage of the favourable geometry associated with high elevation angles above 40° to ameliorate the constraints outlined in section 2.5 above. Additional intersessional studies should be conducted by the ITU to quantify the nature and extent of possible FS and FBW service area reduction and satellite spacing variation due to the RBW presence (and FBW effects on RBW), and to determine the cumulative effect of the added RBW interference to a primary terrestrial fixed service sharing the FSS band.

3.3 Criteria have not yet been adopted for certain sharing situations. While they will eventually be necessary in any event, a decision to plan one or more space services in a band implies that relevant criteria must be developed and adopted and then employed in the planning process.

3.4 WARC-79 also urged the CCIR to study (as a matter of urgency) the question of spurious emissions from space stations. It is important that the second session of the Conference should establish, where feasible, limits for maximum permissible level of spurious emissions outside FSS bands. A Resolution to this effect is given in Annex 1 to this report.

WARC-79, by Recommendation No. 66, recommended that the CCIR study, as a matter of urgency, the question of spurious emissions from space stations. It is important that intersessional studies by the ITU provide the second session of the Conference with information to be able to take appropriate action at that time.

3.5 Once ORB-85 has identified bands and services to be planned, new sharing criteria must be developed for situations where no criteria exist, and existing criteria should be reviewed for their adequacy in light of the particular planning method to be employed. It is contemplated that those criteria requiring further study should be identified for consideration during the intersessional period.

3.6 [Committee 4] is of the opinion that the CCIR can provide a knowledgeable and efficient forum for the development of new criteria and the examination of existing ones; however, special arrangements may be necessary to enable CCIR to provide the information required within the limited available time.

3.7 A review of Document 4, the report of the IFRB (as supplemented by DT/21), indicates that, in situations where none had been incorporated in the Radio Regulations, the Board developed and applied, on a provisional basis, interference and sharing criteria for use in applying Article 14 to space services.

The Committee notes certain inconsistencies and omissions in the sharing criteria developed by the IFRB. These are listed and discussed in section 3.9.1 below. (<u>This paragraph to be included only if Sub-Working Group 4B-1 concludes, after further discussion, that there are, in fact, any such inconsistencies and/or omissions.</u>)

The [Committee] urges review of these sharing criteria during the intersessional period, and that appropriate recommendations be made to the second session of WARC-ORB.

The [Committee] also requests the IFRB to identify, as early in the intersessional period as practicable, all cases where formal sharing criteria are not available, or have not been adopted.

3.7.1 Inconsistencies and omissions, if any, in the criteria developed by the IFRB and used by it on a provision basis.

/ ANNEX 1 /

/ Draft Resolution relating to the establishment of maximum permitted spurious emission power levels for stations in the space services /

/ (Taken from Document ORB-85/35, CAN/35/30: pages 23 and 24 in the English language version.) /.

RICHARD G. GOULD
Chairman of Sub-Working Group 4B-1

INTERNATIONAL TELECOMMUNICATION UNION

ORB-85 WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT

FIRST SESSION, GENEVA, AUGUST/SEPTEMBER 1985

Document DL/18-E
22 August 1985
Original: English

WORKING GROUP 5A

Note by the Chairman of Working Group 5A Ad hoc 1 to the Chairman of Working Group 5A

The texts on planning principles from DT/27,, those contained in DT/27(Add.1), and those forwarded to the ad hoc Group in writing have been considered and combined where possible.

This document relates broadly to the first three categories of principles, but it should be recognized that some principles overlap or fall into more than one specific category.

I.R. HUTCHINGS
Chairman of Working Group 5A Ad hoc 1

Guarantee of access

1) To guarantee for all countries equitable access to the geostationary orbit and the frequency bands allocated to the space services utilizing it.

2) To guarantee for all countries equitable access to the geostationary orbit and the frequency bands allocated to the space services utilizing it, having regard to the rights, interests and special needs of the developing countries.

3) To guarantee for all countries, whatever their level of technological development, equitable access to the geostationary orbit and the frequency bands allocated to the space services utilizing it, on the basis of the principles of justice and equity.

4) An administrations's requirement for access shall be accommodated as and when needed.

5) At least one "optimal Orbital Position" and the associated frequencies should be allotted for all countries on an equal basis to meet their national telecommunication requirements.

6) Orbit positions and frequency bands must be assigned by means of a priori planning "guaranteeing" access to the OSR at the time when the country concerned is ready to establish its system, without higher cost or more complex technical facilities than those involved for the first users.

Source of principle

1) Several administrations

2) CLM/70, ARG/101/3C2)

3) MEX/96/28

4) USA/5/7, KEN/20, AUS/7/6

5) IRQ/87/5

6) CLM/106/

Sharing with other services

1) Where frequency bands allocated to one space service using the geostationary-satellite orbit are also allocated to other space services and/or to terrestrial services on an equal primary basis any planning methods adopted must fully respect the equality of rights to operate in these bands.

2) Any revision of the regulations must not impose undue additional constraints on terrestrial services sharing the band on an equal basis.

3) Any revision of the regulations for a given space service and band must take into account restrictions which are imposed by or on other space services sharing the band.

4) Any planning method adopted by the Conference for a space service can only be applied to the bands which are allocated to the planned service as the sole primary space service.

5) As the result of the adoption of a plan for not too long a period, it may not be necessary to provide for the protection of systems in operation or in active development against unplanned services.

Source of principle

1) Several administrations

2) CAN/35/2.10

3) CAN/35/2.11

4) NZL/8

5) CLM/106/6.7

Reservation of resources

1) The planning method should allocate the frequency/orbit resource to the fullest without any spare capacity reserved.

2) Certain portions of frequency bands in the planned frequency bands should be reserved for accommodating unforeseen requirements within the planning period.

3) The excess capacity of the GSO/spectrum resource not utilized by the plan should be available for use for all countries and regional or global satellite organizations in accordance with a "Modified Radio Regulations" which should be established by the Conference. Such use shall not affect the planned networks beyond the specified limits adopted by the drawing of the plan.

4) Access to resources should not be restricted by long term reservations.

5) Special arrangements for access to certain expansion bands should be adopted to provide a practical guarantee of the satisfaction of long term requirements. Administrations with numerous space stations in the FSS bands should voluntarily refrain from using these expansion bands.

6) The plan must contain a reserve for future Members of the Union.

7) The equatorial states shall preserve the corresponding segments of the geostationary orbit superjacent to their territories for the opportune and appropriate utilization of the orbit by all states, particularly the developing countries.

8) Any planning approach must be consistent with the universally accepted principle, that administrations or groups of administrations are not entitled to permanent priority in the use of particular frequencies and GSO positions in such a way as to foreclose access by other administrations to the GSO and frequency bands allocated to space services.

Source of principle

1) MLA, SNG, THA/82/4(41)

2) CHN/28/17

3) IRQ/87/9

4) AUS/7/6(ii)

5) USA/30/36, USA/30/41

6) ALG/75/4

7) KEN/63/1B

8) USA/5

Note 1 - The ad hoc Group was unable to agree whether or not the principles 7 and 8 above should be included under this particular category, or under some other category.

INTERNATIONAL TELECOMMUNICATION UNION

ORB-85 WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT

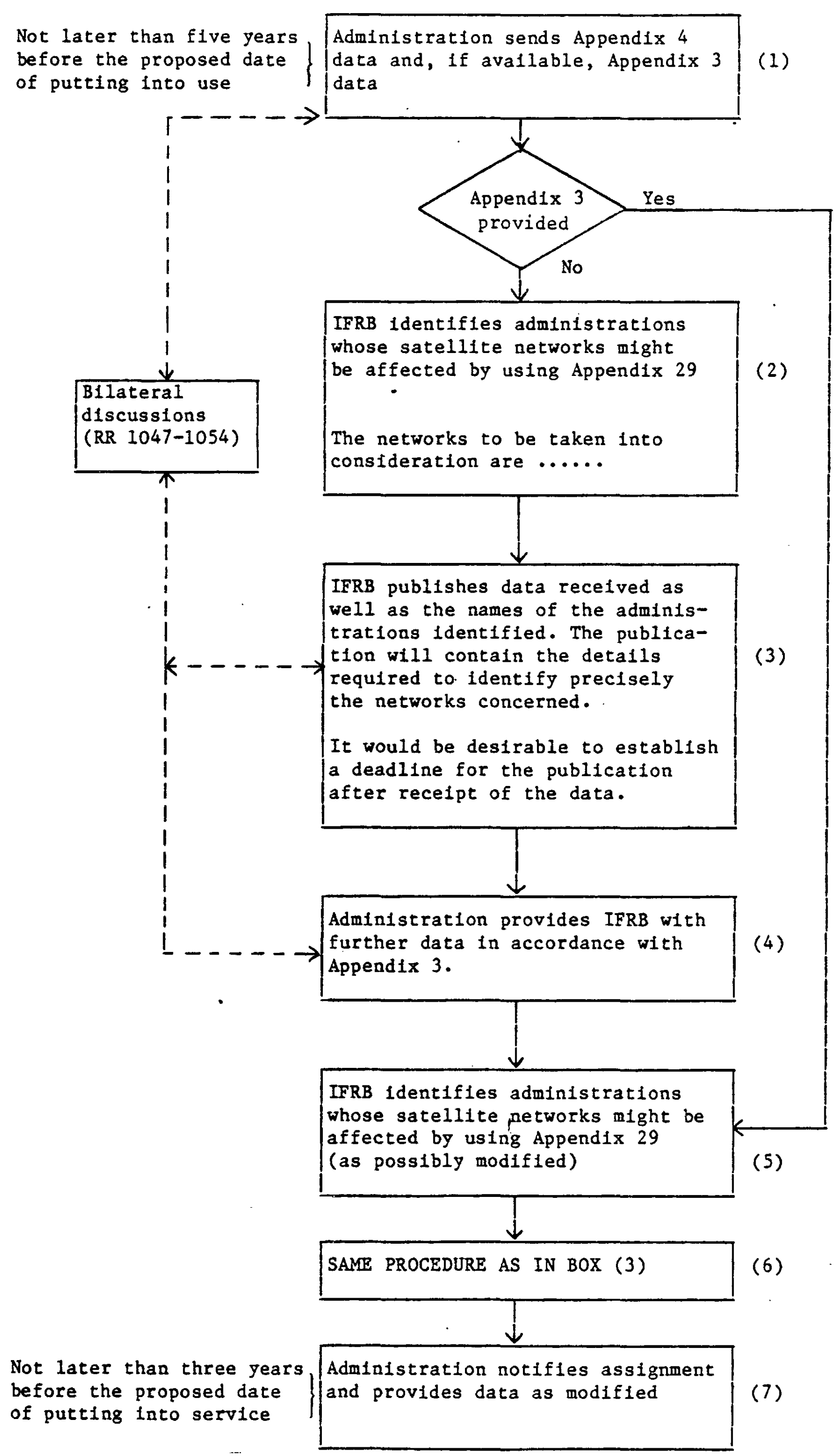
FIRST SESSION, GENEVA, AUGUST/SEPTEMBER 1985

Document DL/19(Rev.2)-E
26 August 1985
Original: French

SUB-WORKING GROUP 5B-2

Note by the Chairman

POSSIBLE MODIFICATIONS OF SECTIONS I AND II OF ARTICLE 11



Remarks

- Appendices 3 and 4 are merged in order to avoid duplication of information: Appendix 4 is the first section of Appendix 3. It will relate not to the frequency assignment level, but to the satellite network level;

- Only one Special Section to be published per network, this Special Section being updated as the definition of the characteristics become more precise.

- An improved Appendix 29, (to be used in box (5)), may permit identification of the networks affected with more precision, and so reduce the number of cases where coordination is required.

To be defined

At which stage will the planned network be given protection from the new incoming networks? (Presently, this protection is given from the date of receipt by the IFRB of the Appendix 3 information.)

How will the amendments received at different stages be treated?

J.-L. BLANC
Chairman of Sub-Working Group 5B-2

INTERNATIONAL TELECOMMUNICATION UNION

ORB-85 WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT

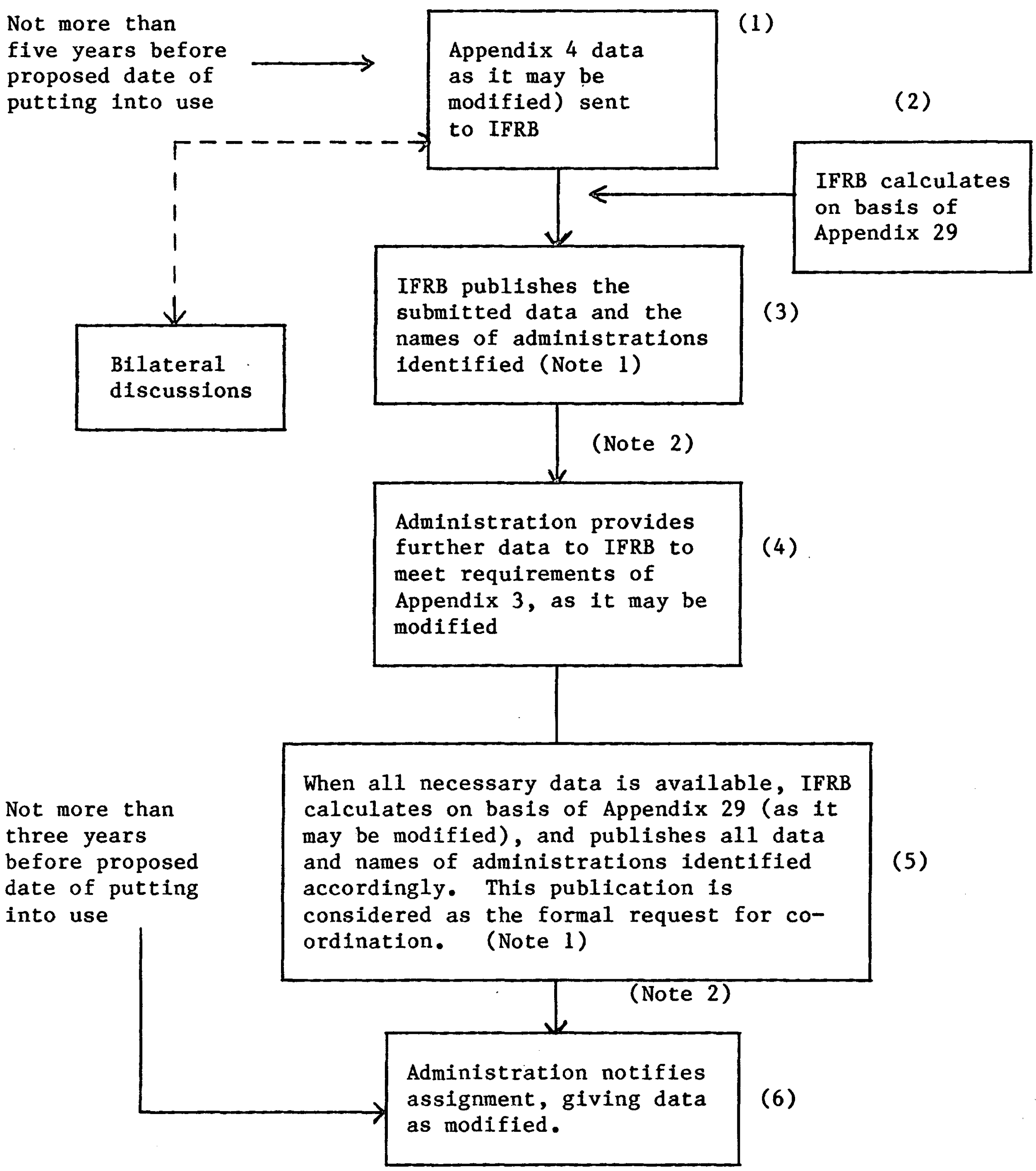
FIRST SESSION, GENEVA, AUGUST/SEPTEMBER 1985

Document DL/19(Rev.1)-E
24 August 1985
Original: English

SUB-WORKING GROUP 5B AD HOC 2

Note by the Chairman

POSSIBLE MODIFICATIONS OF SECTIONS I AND II OF ARTICLE 11



One way to simplify the system would consist in the following:

- Appendices 3 and 4 are merged in order to avoid duplication of information, e..g. Appendix 4 could be the first section of Appendix 3;

- the merged Appendices could relate, not to the frequency assignment level, but to the satellite network level;

- only one Special Section to be published per network, this Special Section being updated as the definition of the characteristics become more precise;

- an improved Appendix 29, to be used in box (5), may permit identification of the countries affected with more precision, and so reduce the number of cases where coordination is required.

<u>Notes</u> :

(1) Consideration should be given to the stage at which the planned network will be given protection from the new incoming networks. (Presently, this protection is given from the date of receipt by the IFRB of the Appendix 3 information.)

(2) Consideration should be given to the treatment of amendments received at different stages.

J.-L. BLANC
Chairman of Sub-Working Group 5B Ad Hoc 2

INTERNATIONAL TELECOMMUNICATION UNION

ORB-85 WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT

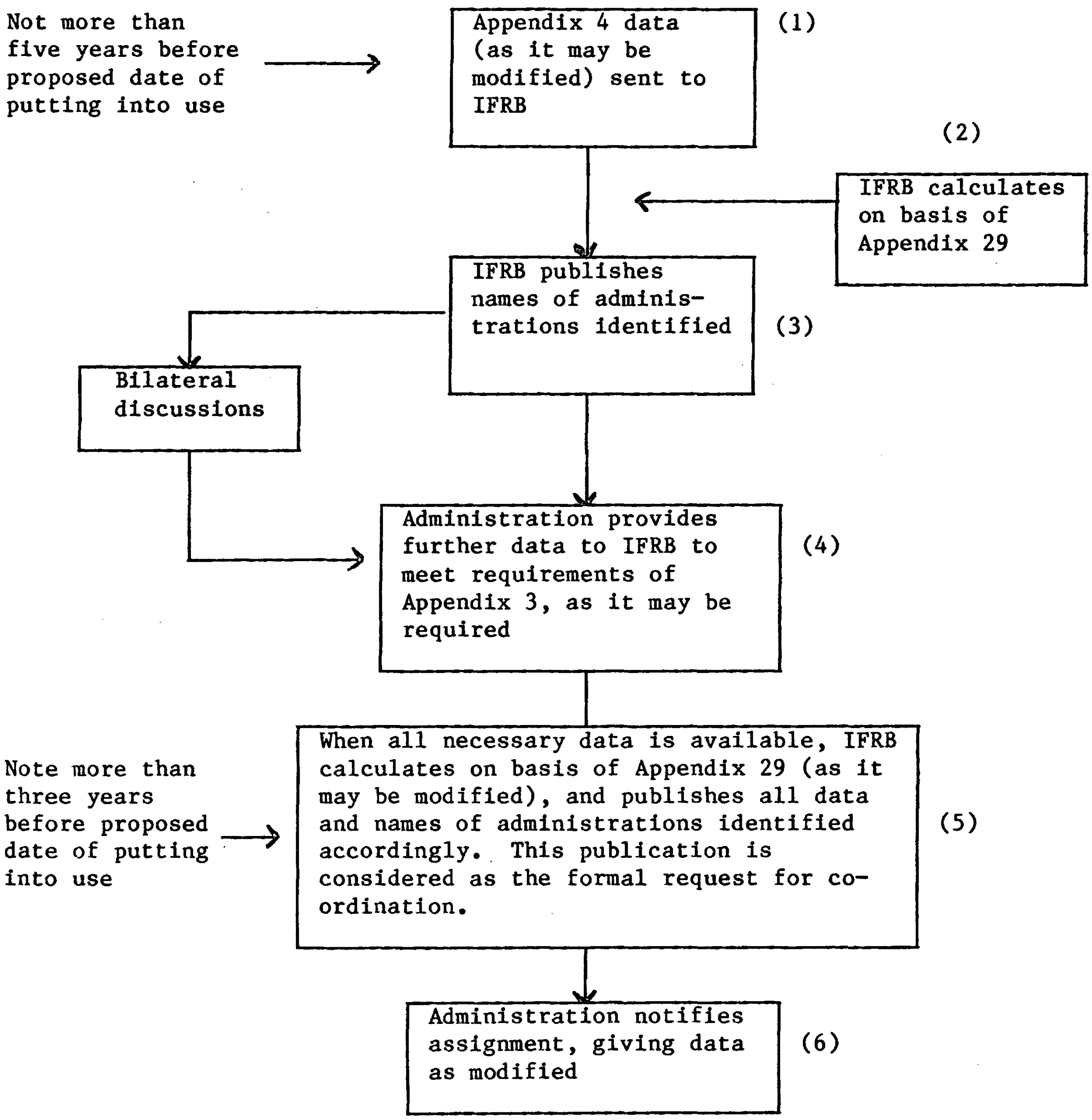
FIRST SESSION, GENEVA, AUGUST/SEPTEMBER 1985

Document DL/19-E
22 August 1985
Original: English

SUB-WORKING GROUP 5B AD HOC 2

Note by the Chairman

POSSIBLE COMBINATION OF SECTIONS I AND II OF ARTICLE 11



One way to simplify the system would consist in the following:

- Appendices 3 and 4 are merged in order to avoid duplication of information;
- only one Special Section to be published per network, this Special Section being updated as the definition of the characteristics become more precise;
- an improved Appendix 29, to be used in box (5), may permit identification of the countries affected with more precision, and so reduce the number of cases where coordination is required.

J.-L. BLANC
Chairman of Sub-Working Group 5B Ad Hoc 2

INTERNATIONAL TELECOMMUNICATION UNION

ORB-85 WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT

FIRST SESSION, GENEVA, AUGUST/SEPTEMBER 1985

Document DL/20-E
22 August 1985
Original: English

WORKING GROUP 5A

NOTE BY THE CHAIRMAN OF WORKING GROUP 5A AD HOC 1

TO THE CHAIRMAN OF WORKING GROUP 5A

The texts on planning principles from Document DT/27, those contained in Document DT/27(Add.1), and those forwarded in writing have been considered and combined where possible.

This document relates broadly to the categories of:

duration of the plan;

several geographical situations; and

provision for multi-administration networks,

but it should be recognized that some principles overlap or fall into more than one specific category.

I.R. HUTCHINGS
Chairman of Working Group 5A Ad hoc 1

DURATION OF THE PLAN

1) The planning period should cover several decades.

2) The planning should cover a period of about 10 years.

3) The planning period should coincide with the interval between successive conferences.[1]

Source of principle

1) ALG/75/3(7)

2) Several administrations

3) CLM/70/7(C2)

Note 1 - The ad hoc Group was unable to agree whether or not this text was a planning principle.

SPECIAL GEOGRAPHICAL SITUATIONS

Any planning method should take into account the relevant technical aspects of the special geographical situation of particular countries or groups of countries.

Source of principle

A/C Resolution No. 895, CLM/106(Add.2)

PROVISIONS FOR MULTI-ADMINISTRATION NETWORKS

1) Any planning method shall accommodate the particular needs of multi-administration networks.

2) Any planning method should provide the option for an administration to satisfy its requirements through participation in a multi-administration system.

3) The use of multi-administration systems should be encouraged.

4) The requirements of multi-administration satellite systems could be projected by any one administration acting on behalf of a group of named administrations as per the existing practice and arrangement.

5) Multi-administration systems should be guaranteed adequate orbit/spectrum resources for their orderly growth and development.

6) Any planning method should give priority to international and regional systems which may satisfy the requirements of several administrations.

7) Multi-administration networks should not interfere in any way with efforts to establish networks of individual administrations, especially in developing countries.

8) Future regional intergovernmental systems for the developing countries should receive the same guarantees as existing international and regional intergovernmental systems during the planning process.

Source of principle

1)	Several administrations	5)	GHA/77/2
2)	USA/5/7	6)	CTI/95/2
3)	AUS/7/6, G/18/5.11	7)	COMP/110/3
4)	IND/54/5	8)	COMP/146/3.3

INTERNATIONAL TELECOMMUNICATION UNION

ORB-85 WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT

FIRST SESSION, GENEVA, AUGUST/SEPTEMBER 1985

Document DL/21(Rev.1)-E
26 August 1985
Original: English

WORKING GROUP 4A

CHAPTER (ZZ)

SATELLITE SOUND BROADCASTING SYSTEMS FOR INDIVIDUAL RECEPTION BY PORTABLE AND AUTOMOBILE RECEIVERS

(Agenda item 4)

ZZ.1 Introduction

Satellites are one of the possible solutions for nation-wide sound broadcasting. However, current frequency allocations do not provide for the particular needs of satellite sound broadcasting serving portable receivers and receivers in automobiles. The selection of the appropriate frequency band has been the subject of various studies and experiments whose results are described in CCIR Report 955 (MOD I).

The interest of administrations, in the subject of satellite sound broadcasting at the 1979 WARC, resulted in Resolution No. 505 which resolved:

> 1. that administrations shall be encouraged to carry out experiments with a broadcasting-satellite service (sound) within the band 0.5 - 2 GHz, in appropriately placed narrow sub-bands, subject to agreement of administrations concerned. One area where such a sub-band may be placed is the band 1 429 - 1 525 MHz;
>
> 2. that the CCIR shall continue and expedite studies relating to the technical characteristics of a satellite sound-broadcasting system for individual reception by portable and automobile receivers, the feasibility of sharing with terrestrial services, and the appropriate sharing criteria;
>
> 3. that the next world administrative radio conference dealing with space radiocommunication services in general or with a specific space radiocommunication service shall be authorized to consider the results of various studies and to take appropriate decisions regarding the allocation of a suitable frequency band;
>
> 4. that the aforementioned conference shall also develop appropriate procedures for protection, and if necessary re-accommodation in other bands, of assignments to stations of terrestrial services which may be affected.

Consequently, the Administrative Council, in Resolution No. 895, decided that in order to meet the objectives of Resolution No. 505 of the WARC-79, WARC-ORB(1) was to consider the question in the light of experience gained by administrations and the results of studies in the CCIR and make appropriate Recommendations for the attention of the WARC-ORB(2).

This chapter reviews the progress of the work invited by Resolution No. 505 (resolves 1 and 2). Technical characteristics of example systems are given. Conclusions are drawn and areas for further study are defined. Recommendations are made for the attention of WARC-ORB(2), in accord with agenda item 4 and based upon the information available at the time of WARC-ORB(1).

ZZ.2 Results of studies and analysis

The CCIR in response to Resolution No. 505 of the WARC-79 has produced Report 955 concerning satellite sound broadcasting with portable receivers and receivers in automobiles. Several administrations and agencies have conducted experiments and undertaken studies to assess system feasibility within the 0.5 - 2.0 GHz band.

Annex YY gives technical information regarding sound broadcast satellite systems analyzed and studied. The following sections give the general characteristics of systems studied and discuss the major considerations pertinent to an allocation decision.

ZZ.2.1 System description

The satellite sound-broadcasting service could provide for three types of reception: portable receivers, mobile receivers such as car radios and permanently installed receivers. Such a service implies elevation and frequency-dependent link budgets. Both aspects are discussed in Annex YY of this report.

Two models have been studied. The first model uses FM with parameters compatible with terrestrial FM-broadcasting and provides monophonic reception in the case of portable and mobile receivers or stereophonic reception in the case of permanent installations where obstructions can be minimized and larger antennas can be used. The second model uses digital modulation and can provide a wider range of facilities independent of the type of reception.

Service quality and availability objectives are developed in Annex YY, § YY.2.2. Service availability has been assumed for 90% of locations. This service availability will depend on fading due to obstructions and multipath effects. Low latitudes could be served with rather moderate transmit power levels while higher latitudes would require higher levels. In both system models, it is considered that Cases A and B discussed in Annex YY, § YY.2.3 would provide satisfactory reception under all except very severe conditions.

The FM and digital models have been chosen as representative of possible methods of providing services. The selection of FM for a lower quality service does not necessarily imply that an FM system cannot provide a service quality equivalent to that from a digital system, since many other technical factors need to be taken into account.

A comparison of link budgets indicates that the digital model would require about twice the satellite transmit power of the FM model. The resulting technical requirements can be satisfied for some examples as given in Annex YY, with satellite and receiver technology available now or in the near future.

The attention of administrations is drawn to the technical factors having a bearing on costs involved in the /‾possible_7 implementation of a satellite sound broadcasting system. Examples of space-segment cost estimates can be found in Annex YY.

Technical and economic studies in the USSR have been reported since the CPM 1984 and have indicated that a satellite system could be several times more expensive than an equivalent terrestrial system. The relative cost depends on the geographical location of the service area, the shape and size of the territory, the number of programmes and other factors. Further studies into those technical factors which have a bearing on costs, are required by the CCIR.

ZZ.2.2 Frequency, bandwidth and frequency sharing considerations

Three elements of importance to making an allocation decision are the appropriate frequency for operation, the bandwidth required, and the possibilities for frequency sharing.

ZZ.2.2.1 Operating frequencies

Studies examined by ORB(1) have used frequencies in the range 0.5 - 2.0 GHz. An increase in operating frequencies would require a corresponding increase in the satellite transmit power levels which in turn will increase with latitude. A decrease in operating frequency would require an increase in the antenna diameter and would put terrestrial receivers in an environment of higher man-made noise.

ZZ.2.2.2 Bandwidth

The bandwidth required for a UHF satellite sound broadcasting service depends on the modulation method and on the extent of coverage overlap. Studies performed by EBU and ESA for almost the whole of Africa and Europe, and by Canada in Region 2, arrive at a required bandwidth of 9 to 11 MHz for providing one national sound broadcast programme per country when this is transmitted by frequency modulation. Digital modulation tends to require a somewhat larger bandwidth. The study made in Canada for Region 2 countries concluded that some 13 MHz are needed for one monophonic programme per country. These results are believed to be representative for national services.

ZZ.2.2.3 Frequency sharing considerations

Primary users of the 0.5 - 2.0 GHz band include broadcasting, mobile and fixed services. Besides that, substantial allocations are provided for aeronautical radionavigation and radiolocation services.

Sharing studies have been conducted for frequency modulation and digital modulation techniques. Frequency modulation allows very limited energy dispersal while digital modulation techniques offer a significant energy dispersal advantage. However, even the most optimistic studies for the latter modulation demonstrate that the obtainable power flux-density levels are still too high to allow frequency sharing with the broadcasting, fixed or mobile services within the service area and in large areas around it.

It can be concluded that frequency sharing will not be possible in a systematic manner. This suggests that, taking into account the existing criteria, the development of national sound broadcasting-satellite services in the frequency range 0.5 - 2.0 GHz will only be possible through the allocation of an appropriate frequency band on an exclusive basis.

ZZ.2.3 Conclusions

The studies conducted by the CCIR on the BSS (sound) in the range 0.5 - 2.0 GHz indicate that this service is feasible from the technical point of view but, due to sharing difficulties, the implementation of such a service will not be possible unless an appropriate frequency band is allocated for it on an exclusive basis.

ZZ.3 Further work

Studies performed by the CCIR and the experiments and studies undertaken by administrations have shown that accommodation of the satellite sound broadcasting service in the frequency range 0.5 - 2.0 GHz would cause considerable difficulties. Further work is needed to fully define practical system parameters that would more readily permit the implementation of such a service.

The following study areas have been identified.

ZZ.3.1 Quality of signal

The quality of received signal impacts upon overall system characteristics and sharing with other services. Different administrations may desire different quality levels. It is suggested that at least medium and high quality systems be studied, with high quality possibly being attained by the use of permanently installed receivers.

ZZ.3.2 Frequency of operation

A number of administrations indicated that they would be unable to accommodate the sound BSS in the band 0.5 - 2.0 GHz on an exclusive allocation basis. Additional study is desired to identify possible frequencies where the sound BSS might be implemented within the band 0.5 - 2.0 GHz, and using the technical parameters identified for further study. In addition, studies are requested for frequencies near the 0.5 - 2.0 GHz range where the possibilities for sharing other accommodations may be greater.

ZZ.3.3 Modulation type

Changes in modulation format may reduce the power required for sound BSS transmitters and may enhance the possibilities for sharing with other services.

ZZ.3.4 Digital systems

The technical characteristics of practicable digital systems need further determination.

ZZ.3.5 Bandwidth required

The change in modulation type or the use of other digital systems may alter the bandwidth required from the values given in the example systems discussed in this report.

ZZ.3.6 Receivers

Signal processing techniques and the possibility of use of existing receivers were identified as areas of study.

ZZ.3.7 Antenna design

Antennas with improved side-lobes and antennas to accommodate feeder links from multiple administrations to the same satellite are necessary to be studied to increase sharing possibilities.

ZZ.3.8 Feeder links

Technical characteristics of required feeder links need to be identified.

ZZ.3.9 Appropriate sharing criteria

Sharing criteria are needed to determine possibilities for sharing with all services using frequency bands in which the sound BSS might operate. In particular, studies need to be directed towards sharing on a geographical basis, that is within regions or among groups of administrations.

ZZ.3.10 Costs

Several input studies were available to determine space segment costs, total sound BSS system costs, and costs of alternative coverage by terrestrial sound broadcast systems. Additional study is needed to identify more precisely these costs for practicable systems.

ZZ.4 Recommendations

After considering sound broadcasting by satellites in the light of experience gained by administrations and the results of studies in the CCIR, ORB(1) recommends for the attention of ORB(2) the items in Resolution/Recommendation AA.

E.F. MILLER
Chairman of Working Group 4A

INTERNATIONAL TELECOMMUNICATION UNION

ORB-85 WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT

FIRST SESSION, GENEVA, AUGUST/SEPTEMBER 1985

Addendum 2 to
Document DL/21-E
24 August 1985
Original: English

WORKING GROUP 4A

ADDITIONAL TEXT FOR CHAPTER (ZZ)

SATELLITE SOUND BROADCASTING SYSTEMS FOR
INDIVIDUAL RECEPTION BY PORTABLE AND AUTOMOBILE RECEIVERS
(Agenda item 4)

Add the following text to § ZZ.2.1, at the end of the second paragraph.

"The FM and digital models have been chosen as representative of possible methods of providing services. The selection of FM for a lower quality service does not necessarily imply that an FM system cannot provide a service quality equivalent to that from a digital system, since many other technical factors need to be taken into account."

Add the following sections.

ZZ.2.2.2 Bandwidth

The bandwidth required for a UHF satellite sound broadcasting service depends on the modulation method and on the extent of coverage overlap. Studies performed by EBU and ESA for almost the whole of Africa and Europe, and by Canada in Region 2, arrive at a required bandwidth of 9 to 11 MHz for providing one national sound broadcast programme per country when this is transmitted by frequency modulation. Digital modulation tends to require a somewhat larger bandwidth. The study made in Canada for Region 2 countries concluded that some 13 MHz are needed for one monophonic programme per country. These results are believed to be representative for national services.

ZZ.2.2.3 Frequency sharing considerations

Primary users of the 500 MHz to 2 000 MHz include broadcasting, mobile and fixed services. Besides that, substantial allocations are provided for aeronautical radionavigation and radiolocation services.

Sharing studies have been conducted for frequency modulation and digital modulation techniques. Frequency modulation allows very limited energy dispersal while digital modulation techniques offer a significant energy dispersal advantage. However, even the most optimistic studies for the latter modulation demonstrate that the obtainable power flux-density levels are still too high to allow frequency sharing with the broadcasting, fixed or mobile services within the service area and in large areas around it.

It can be concluded that frequency sharing will not be possible in a systematic manner. This suggests that, taking into account the existing criteria, the development of national sound broadcasting-satellite services in the frequency range 500 MHz to 2 000 MHz will only be possible through the allocation of an appropriate frequency band on an exclusive basis.

ZZ.2.3 Conclusions

The studies conducted by the CCIR on the BSS (sound) in the range 500 - 2 000 MHz indicate that this service is feasible from the technical point of view but, due to sharing difficulties, the implementation of such a service will not be possible unless an appropriate frequency band is allocated for it on an exclusive basis.

E.F. MILLER
Chairman of Working Group 4A

INTERNATIONAL TELECOMMUNICATION UNION

ORB-85 WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT

FIRST SESSION, GENEVA, AUGUST/SEPTEMBER 1985

Addendum 1 to
Document DL/21-E
23 August 1985
Original: English

WORKING GROUP 4A

PROPOSED MODIFICATIONS TO DOCUMENT DL/21

(Item ZZ.2.1)

1. Technical and economical studies into possible satellite sound broadcasting systems in the 0.5 - 2.0 GHz band have shown that in the present time the cost of establishing such systems is much greater (5-40 times) than the cost of setting up a terrestrial VHF-FM broadcasting network providing high quality stereo reception throughout the whole of the area to be served.

The cost depends on the geographical location of the service area, the shape and size of the territory and the number of broadcast programmes.

For space stations of the 2,400 kg class, the total cost of two in-orbit space stations (one operational and the second a spare) plus one-half of an on-ground spare is estimated to be of the order of US $ 360 million.

2. Experiments in the USSR have been reported since the CPM 1984 and have indicated that a satellite system would be considerably more expensive [perhaps up to 40 times] than an equivalent terrestrial system. Such a comparison could result in different conclusions in countries with different circumstances and further studies by the CCIR are necessary.

E.F. MILLER
Chairman of Working Group 4A

INTERNATIONAL TELECOMMUNICATION UNION

ORB-85 WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT

FIRST SESSION, GENEVA, AUGUST/SEPTEMBER 1985

Document DL/21-E
23 August 1985
Original: English

WORKING GROUP 4A

CHAPTER (ZZ)

SATELLITE SOUND BROADCASTING SYSTEMS FOR INDIVIDUAL RECEPTION BY PORTABLE AND AUTOMOBILE RECEIVERS

(Agenda item 4)

ZZ.1 Introduction

Satellites are one of the possible solutions for nation-wide sound broadcasting. However, current frequency allocations do not provide for the particular needs of satellite sound broadcasting serving portable receivers and receivers in automobiles. The selection of the appropriate frequency band has been the subject of various studies and experiments whose results are described in Report 955 (MOD I).

The interest of administrations, in the subject of satellite sound broadcasting, resulted in Resolution No. 505 which resolved:

1. that administrations shall be encouraged to carry out experiments with a broadcasting-satellite service (sound) within the band 0.5 - 2 GHz, in appropriately placed narrow sub-bands, subject to agreement of administrations concerned. One area where such a sub-band may be placed is the band 1 429 - 1 525 MHz;

2. that the CCIR shall continue and expedite studies relating to the technical characteristics of a satellite sound-broadcasting system for individual reception by portable and automobile receivers, the feasibility of sharing with terrestrial services, and the appropriate sharing criteria;

3. that the next world administrative radio conference dealing with space radiocommunication services in general or with a specific space radiocommunication service shall be authorized to consider the results of various studies and to take appropriate decisions regarding the allocation of a suitable frequency band;

4. that the aforementioned conference shall also develop appropriate procedures for protection, and if necessary re-accommodation in other bands, of assignments to stations of terrestrial services which may be affected.

Consequently, the Administrative Council, in Resolution No. 895, decided that in order to meet the objectives of Resolution No. 505 of the WARC-79, WARC-ORB(1) was to consider the question in the light of experience gained by administrations and the results of studies in the CCIR and make appropriate Recommendations for the attention of the WARC-ORB(2).

This chapter reviews the progress of the work invited by Resolution No. 505 (resolves 1 and 2). Technical characteristics of example systems are given. Quality and availability objectives are discussed. The bandwidth required and the frequency sharing possibilities are discussed. Conclusions are drawn and Recommendations are made for the attention of WARC-ORB(2), in accord with Agenda item 4 and based upon the information available at the time of WARC-ORB(1).

ZZ.2 Results of studies and analysis

The CCIR in response to Resolution No. 505 of the WARC-79 has produced Report 955 concerning satellite sound broadcasting with portable receivers and receivers in automobiles. Several administrations and agencies have conducted experiments and undertaken studies to assess system feasibility within the 500 - 2 000 MHz band.

Annex YY gives technical information regarding sound broadcast satellite systems analyzed and studied. The following sections give the general characteristics of systems studied and discuss the major considerations pertinent to an allocation decision.

ZZ.2.1 System description

The satellite sound-broadcasting service could provide for three types of reception: portable receivers, mobile receivers such as car radios and permanently installed receivers. Such a service implies elevation and frequency-dependent link budgets. Both aspects are discussed in Annex YY of this report.

Two models have been studied. The first model uses FM with parameters compatible with terrestrial FM-broadcasting and provides monophonic reception in the case of portable and mobile receivers or stereophonic reception in the case of permanent installations where obstructions can be minimized and larger antennas can be used. The second model uses digital modulation and can provide a wider range of facilities independent of the type of reception.

Service quality and availability objectives are developed in Annex YY, § YY.2.2. Service availability has been assumed for 90% of locations. This service availability will depend on fading due to obstructions and multipath effects. Low latitudes could be served with rather moderate transmit power levels while higher latitudes would require higher levels. In both system models, it is considered that Cases A and B discussed in Annex YY, § YY.2.3 would provide satisfactory reception under all except very severe conditions.

A comparison of link budgets indicates that the digital model would require about twice the satellite transmit power of the FM model. The resulting technical requirements can be satisfied for some examples as given in Annex YY, with satellite and receiver technology available now or in the near future. An example of cost estimates can be found in Annex YY.

ZZ.2.2 Frequency, bandwidth and frequency sharing considerations

Three elements of importance to making an allocation decision are the appropriate frequency for operation, the bandwidth required, and the possibilities for frequency sharing.

ZZ.2.2.1 <u>Operating frequencies</u>

Studies examined by ORB(1) have used frequencies in the range 500 to 2 000 MHz. An increase in operating frequencies would require a corresponding increase in the satellite transmit power levels which in turn will increase with latitude. A decrease in operating frequency would require an increase in the antenna diameter and would put terrestrial receivers in an environment of higher man-made noise.

E.F. MILLER

Chairman of Working Group 4A

INTERNATIONAL TELECOMMUNICATION UNION

ORB-85 WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT

FIRST SESSION, GENEVA, AUGUST/SEPTEMBER 1985

Document DL/22-E
24 August 1985
Original: English

WORKING GROUP 5A

NOTE BY CHAIRMAN OF SUB-WORKING GROUP 5A-1
TO THE CHAIRMAN OF WORKING GROUP 5A

The following texts are the result of 5A Ad hoc 1 Working Group.

The work covers:

Guarantee of access and equitability (additional principles)

Accommodation of existing systems

Different planning solutions in different circumstances

Flexibility to consider different requirements and advances in technology

Usage of allotments

I.R. HUTCHINGS
Chairman of Sub-Working Group 5A-1

GUARANTEE OF ACCESS AND EQUITABILITY

1) Equitability must be based on an identified demand.

2) All planning approaches must operate equitably, i.e. without advantaging or disadvantaging any administration or group of administrations vis-a-vis any others.

3) Any plan for the use of the orbit/spectrum resource should respect the right of all peoples to create, store, process, receive and transmit information.

4) The use of the geostationary orbit should benefit all mankind.

5) When difficulties are encountered in meeting all actual requirements for access to the orbit/spectrum resource, priority should be given to accommodating the actual requirements of administrations which have not yet established a space system or which have established only a few space systems compared to their own requirements, and later than other administrations.

Source of principle

1) CAN/35/

2) G/18/5.1 (ref: 1st paragraph)

3) COMP/110/3 (5.a.2)

4) COMP/110/3 (5.a.2)

5) CMN/25/Corr.1 to Add.1 (3.1.4)

ACCOMMODATION OF EXISTING SYSTEMS

1) Existing satellite networks should be accommodated for the duration of their designed operational life.

2) Any planning approach shall aim to maintain the continued viable operation of existing space systems; in particular, changes involving economic or operational impact shall be minimized.

3) Any planning approach shall provide for continuity of established service through replacement of satellites, including those that prematurely fail.

4) Existing systems should be included as an integral part of the Plan.

5) Existing networks must not acquire permanent title to particular frequencies or orbital locations.

6) Existing systems other than international and regional systems would be taken into consideration when the Plan is prepared and would not be entered in the Plan.

7) In any plan account should be taken of the protection and continuity of services of the existing or planned systems at the time of the planning.

8) Protection should be given to existing and planned multi-administration systems that provide global communications and also be given to existing and planned regional or subregional satellite systems that cater for a number of countries.

9) Protection should be afforded until the end of the network's satellite lifetime, or until 8 August 1995, whichever comes first.

10) Existing and planned satellite systems submitted by all administrations should be placed on an equal basis in the planning process.

11) Existing systems must not be restricted without reasons that are acceptable to the administrations concerned.

12) Existing networks should have modifications of their parameters only to the extent that are necessary to enable access of a new system to the GSO/spectrum resources.

Note 1 - The following definitions of the words existing system were considered by the Group.

- Existing systems include those under active development.
- Existing systems include systems registered before planning begins.
- Existing systems are those which are coordinated, notified or in actual operation.
- Existing systems include those under coordination.
- Existing system is one which is in operation
- Existing systems include operational satellite networks and those which are notified to the IFRB for "Advanced Publication" in accordance with the present Radio Regulations at a date before 8 August 1985 but not earlier than 8 August 1980.

Note 2 - Words "system" and "network" may be used interchangeably in many of these principles.

Source of principle

1)	AUS/7/6 (vi)	7)	J/39/3(3)
2)	USA/5/7 (27.5)	8)	GHA/77/1,2
3)	USA/5/7 (27.6)	9)	IRQ/87/7
4)	URS/9/3 (C)	10)	CHN/25/1 (3.1.2)
5)	G/18/5.3	11)	D/31/4 (ref: 2nd indent)
6)	ALG/75/17	12)	B/37/11 (C)

DIFFERENT PLANNING SOLUTIONS IN DIFFERENT CIRCUMSTANCES

1) Different planning approaches should be considered for different regions and subregions, where appropriate.

2) It is essential to plan the 4/6 GHz and 11/14 GHz bands on a world-wide basis.

Source of principle

1) AUS/7/3

2) IND/54/ (2.1)

FLEXIBILITY TO CONSIDER DIFFERENT REQUIREMENTS AND ADVANCES IN TECHNOLOGY

1) Any planning approach shall provide a means to accommodate new or unforeseen requirements, or the modification of requirements of administrations while also providing for the need to minimize disruption of existing networks.

2) Any planning approach shall be able to accommodate the introduction of new technology.

3) The plan should be based on feasible, applicable and suitable technologies which are well proven and widely available in the time frame involved.

4) Any planning method should be able to accommodate a broad range of technology and operational requirements taking into account the effective use of satellite systems for applications for which they are best suited.

5) Any planning method should use uniform technical parameters and criteria as far as possible.

6) Any planning method should recognize that the most advanced technology may not be the most appropriate.

7) If the period between conferences is not excessive then the technical parameters and criteria relating to interference should be fixed for the life of the plan.

8) Any planning method should recognize that technological changes in the space and earth segments may occur at different times.

9) Any plan shall be able to accommodate future systems with diversified parameters and applications and be adaptable to the introduction of the most advanced satellite communications technology.

Note - Principles Nos. 3 and 5 under "Reservation of resources" is also relevant to this principle.

Source of principle

1)	USA/5/7 (27.3), B/37/12	5)	ARG/101/3
2)	USA/5/7 (27.9)	7)	CLM/106/57
3) 4)	IND/54/5	9)	J/39/3 (6)

USAGE OF ALLOTMENTS

1) Any country allotment not yet used by the country must be able to be used by another country, in whole or in part, under procedures which guarantee the rights of the country for which the allotment is entered in the Plan.

2) It should be possible for allotments that are not used by an allottee to be used by another administration(s) subject to mutual agreement.

3) Any planning should provide for effective technical and operational means by which affected administrations may resolve potential interference conflicts between networks on a timely and equitable basis. The means provided for such conflict resolution should recognize the use of world, regional, subregional or bilateral forums, as appropriate.

Source of principle

1) ALG/75/10

2) GHA/77/6

3) USA/5/8 (29.C)

INTERNATIONAL TELECOMMUNICATION UNION

ORB-85 WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT

FIRST SESSION, GENEVA, AUGUST/SEPTEMBER 1985

Document DL/23-E
26 August 1985
English only

SUB-WORKING GROUP 6B-2

DRAFT REPORT OF SUB-WORKING GROUP 6B-2

4. Technical characteristics for feeder-link planning

4.1 Overall performance

Assuming that there is no transponder output back-off, a 0.5 dB noise contribution of the feeder link to the overall link requires that:

$$(C/N)_u = (C/N)_{d(total)} + 10 \text{ dB} \qquad (1)$$

For down links, the WARC-BS-77 has adopted a figure of C/N equal to 14.5 dB for 99% of the worst month at the edge of the service area. The up-link C/N required is 24 dB for 99% of the worst month, to produce an overall performance of 14 dB.

Some additional factors should also be taken into account when constructing the link budget:

- although the requirements of the WARC-BS-77 are based on the C/N at the edge of the service area, it may be useful to recall that at the beam centre the C/N will be 3 dB higher;
- a margin of 1 dB for possible mispointing of the earth-station's transmitting antenna;
- a factor of about 2 dB due to the non-linear AM-PM conversion phenomena of the satellite repeater. AM-PM conversion was not taken into account in the development of the Region 2 Plan.

Taken together these factors would give $(C/N)_u$ of 30 dB.

Another factor of about 3 dB may be desirable for systems with enhanced quality.

4.2 Carrier-to-noise ratio

The minimum $(C/N)_u$ required for planning of the feeder links in Regions 1 and 3 is 24 dB. It may be desirable for some administrations to achieve a significantly higher value of C/N, however, the use of any value higher than 24 dB should not prevent the interference conditions from being met in the plan.

4.3 Co-channel carrier-to-interference protection ratio

The protection ratio to be planned for co-channel interference is 40 dB.

4.4 Adjacent channel carrier-to-interference protection ratio

Tests carried out recently in Japan showed that the adjacent-channel protection ratio in feeder links for just-perceptible interference could be reduced to 19 dB, when signals are passed through a 12 GHz TWT amplifier operating at saturation with an AM-PM conversion factor of 2^{o}/dB and then received through an SAW filter with 27 MHz bandwidth before the demodulator.

These tests were carried out using a TWT with a low value of AM-PM conversion. It is believed that the effects of adjacent-channel interference will be intensified by AM-PM conversion by the same mechanism as that reported for the intensification of noise. An additional margin of 2 dB above the 19 dB measured in laboratory tests is therefore recommended. This makes a planning limit of 21 dB for adjacent-channel interference desirable.

One administration proposed that planning should use a value of 24 dB but where this cannot be applied a value of 21 dB be used. The other administrations supported adoption of a single value of 21 dB.

4.5 Feeder link e.i.r.p.

A uniform value of e.i.r.p. for each band should be used for initial planning. For the 17/18 GHz band this should be 84 dBW and for the 14.5 to 14.8 GHz band 82 dBW.

These are initial values to be used in developing the plan. They will be adjusted, if necessary, during the plan development on a case-by-case basis to ensure that the minimum carrier-to-noise and carrier-to-interference criteria specified in the plan are met for the feeder-link systems of all administrations. Adjustments will also be made, if required to accommodate the requirements of particular administrations.

Some administrations consider that these initial planning values may not meet their requirements.

4.6 Transmitting antenna

4.6.1 Antenna diameter

For a given value of e.i.r.p. and a given relative antenna pattern, the off-axis radiation power depends on the diameter of the antenna. The larger the diameter of the antenna, the smaller is the off-axis radiation power which is a potential source of interference between adjacent orbital positions.

So for planning of feeder links it is necessary to define a minimum reference antenna diameter. For the 17/18 GHz band the value adopted is 5 m and for the 14.5 to 14.8 GHz band 6 m.

Smaller antennas of for example 2.5 m, can also be used provided there is no degradation of the interference situation. In practice this means that the e.i.r.p. might need to be reduced or the antenna diagram improved so there is no increase in the off-axis radiation power, and hence no unacceptable interference to the adjacent orbital position and other services.

For the frequency band 17.3-18.1 GHz, the minimum antenna diameter must be such that there is no significant interference between adjacent broadcasting satellites. For other frequency bands where there is sharing with other systems of the FSS, it may be necessary to use a large antenna in order to achieve a better efficiency of orbit utilization.

4.6.2 On-axis gain

The on-axis gain for the 5 m antenna at 17/18 GHz and for the 6 m antenna at 14.5 to 14.8 GHz is taken as 57 dBi.

4.6.3 Co-polar response pattern

The reference co-polar radiation pattern is given by the formula:

$G = 32 - 25 \log \phi$ (dBi) for $1^{\circ} \leqslant \phi \leqslant 48^{\circ}$

$G = -10$ (dBi) for $\phi > 48^{\circ}$

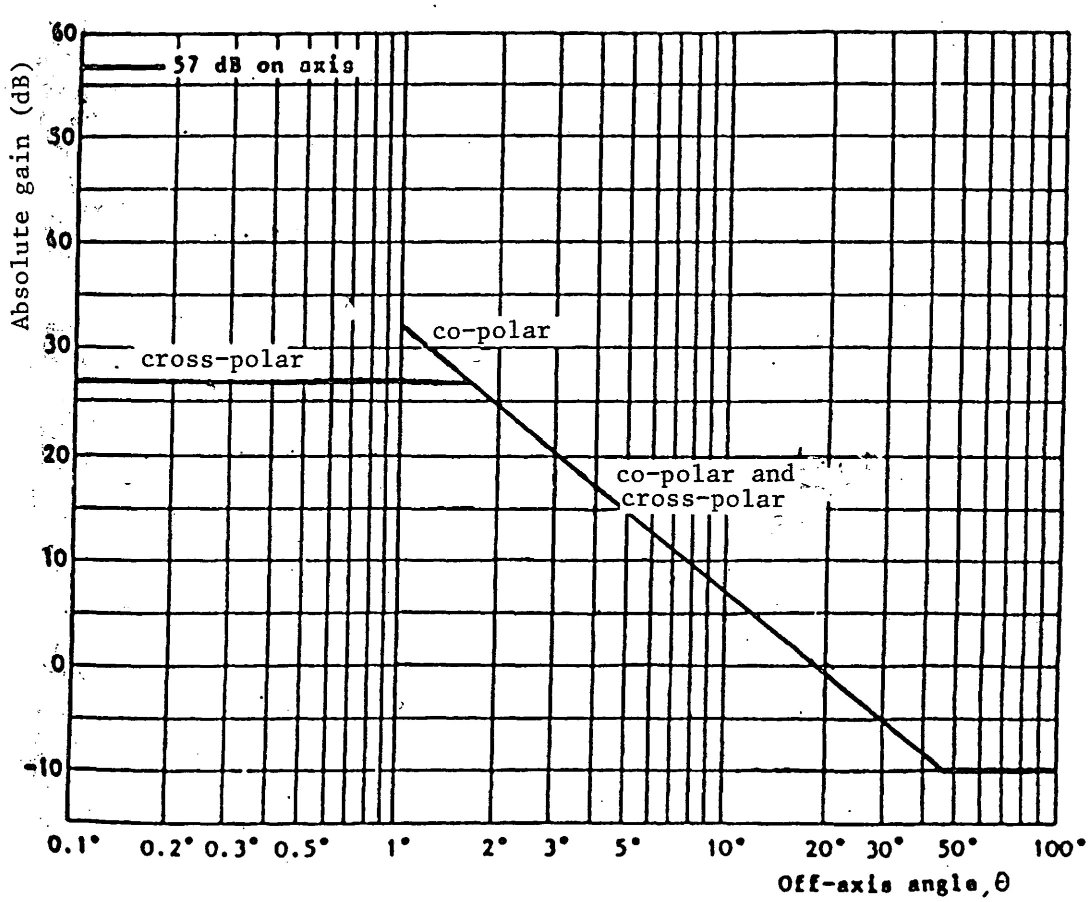


FIGURE 1

Earth station transmit antenna reference patterns

In circumstances where independent planning of orbit positions is adversely affected, the off-axis co- and cross-polar side-lobe response patterns of the earth station transmitting antenna may be limited to 29 - 25 log Θ (dBi), for values of off-axis angle, Θ, in the regions of the adjacent and next-but-one adjacent orbital positions in the plane of the geostationary orbit

4.6.4 Cross-polar response pattern

The reference cross-polar response pattern is given by the formula:

- **Cross-polar relative gain**

  $G = -30$ dB for $0 \leq \varphi \leq 1.6^\circ$

- **Cross-polar gain (dBi)**

  $G = 32 - 25 \log \varphi$ for $1.6^\circ \leq \varphi \leq 48^\circ$

- **Cross-polar gain (dBi)**

  $G = -10$ for $\varphi > 48^\circ$ (Figure 1)

In circumstances where insufficient cross-polar isolation is achieved, the off-axis cross-polar side-lobe response pattern of the earth station transmitting antenna may be limited to 24 - 25 log Θ (dBi) for $0.76^\circ \leq \Theta \leq 22.9^\circ$ and -10 (dBi) for $\Theta > 22.9^\circ$

4.7 Earth station mispointing loss

An allowance of 1 dB should be made for the loss in gain due to earth station antenna mispointing.

4.8 Satellite receiving antenna

If a common transmit/receive antenna is used, the cross-polar gain, beamwidth, pointing accuracy and the radiation pattern would be tied to the down-link antenna characteristics.

Where separate antennas are used for transmit and receive the parameters of the receiving antenna are given in the following. Separate receiving antennas offer greater flexibility in terms of independance of the feeder-link frequency, polarization and service area.

4.8.1 Cross section of receiving antenna beam

Initial planning is to be based on beams of elliptical or circular cross section. If the cross section of the receiving antenna beam is elliptical, the effective beamwidth φ_0 is a function of the angle of rotation q between the plane containing the satellite and the major axis of the beam cross-section and the plane in which the beamwidth is required.

The relationship between the maximum gain of an antenna and the half-power beamwidth can be derived from the expression.

$$Gm = 27843/ab$$

or

$$Gm(dB) = 44.44 - 10 \log a - 10 \log b$$

where:

a and b are the angles (in degrees) subtended at the satellite by the major and minor axes of the elliptical cross-section of the beam.

A minimum value of 0.6° for the half power beamwidth is adopted for planning.

4.8.2 Co-polar response pattern

The reference co-polar response pattern is given by the formula:

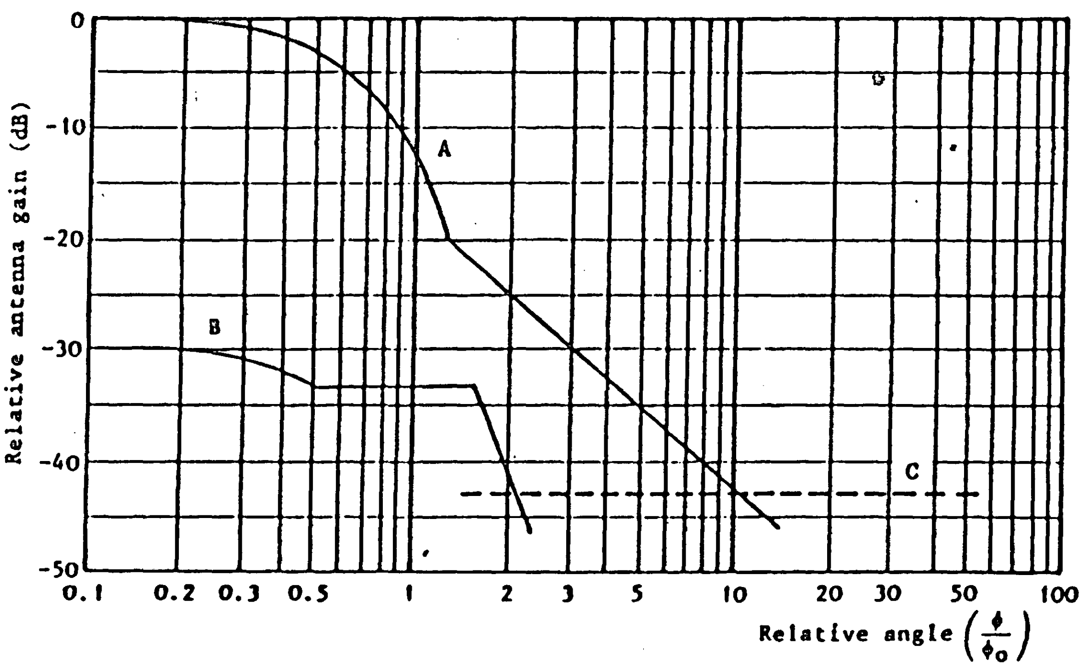
Co-polar relative gain (dB)

$$G = -12\left(\frac{\varphi}{\varphi_o}\right)^2 \text{ for } 0 \leq \frac{\varphi}{\varphi_o} < 1.30$$

$$G = -17.5 - 25 \log\left(\frac{\varphi}{\varphi_o}\right) \text{ for } \frac{\varphi}{\varphi_o} > 1.30$$

After intersection with curve C:

as curve C (see Figure 2 - curve A)



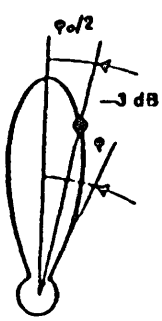


FIGURE 2

Satellite receive antenna pattern

Curve A - co-polar component (4.8.1)

Curve B - cross-polar component (4.8.2)

Curve C - minus the on-axis gain

4.8.3 Cross-polar response pattern

The reference cross-polar response pattern is given by the formula:

Cross-polar relative gain (dB)

$$G = -30 - 12\left(\frac{\varphi}{\varphi_0}\right)^2 \text{ for } 0 \leq \frac{\varphi}{\varphi_0} \leq 0.5$$

$$G = -33 \text{ for } 0.5 \leq \frac{\varphi}{\varphi_0} \leq 1.67$$

$$G = -40 - 40 \log\left(\frac{\varphi}{\varphi_0} - 1\right) \text{ for } 1.67 < \frac{\varphi}{\varphi_0}$$

After intersection with curve C:

as curve C (see Figure 2 - curve B)

4.9 Satellite receiving antenna pointing accuracy

The deviation of the receiving antenna beam from its nominal pointing direction should not exceed 0.2° in any direction. [Moreover, the angular rotation of the receiving beam about its axis should not exceed ± 1°; this latter limit is not necessary for beams of circular cross-section using circular polarization].

Should only one antenna be used for transmission and reception, the pointing accuracy for the receiving antenna is governed by, but not necessarily equal to, the transmitting antenna. Where two separate reflectors are used for transmission and reception, steering the transmitting antenna by using an automatic pointing mechanism operating by detection of a land radio-frequency beacon is possible. With this precise antenna pointing system, the receiving beam with slave control from the transmitting antenna may be stabilized to within 0.2°.

4.10 Satellite system noise temperature

The planning should be based on a satellite system noise temperature of [1 500 K].

4.11 Type of polarization

Circular polarization is assumed in planning. Linear polarization may be used at a given orbit position subject to the agreement of all the affected administrations.

4.12 Sense of polarization

In the case of uniform frequency translation the polarization sense of the feeder link should be either:

all opposite to their corresponding down-links;

or:

all the same sense as their corresponding down-links;

for each orbit position.

In the case of a non-uniform frequency translation plan it is necessary to maintain a uniform polarization/frequency arrangement at each orbit position.

Choice of the sense of circular polarization when common transmit/ receive antennas are used is influenced by the technology.

For simple elliptical beams, the opposite sense of polarization on the Earth-space and space-Earth links permits the use of a simple and economical orthomode transducer to provide isolation between transmit and receive signals.

For shaped beams employing multiple horns, the same sense of polarization permits the use of simple and economical satellite antenna configurations avoiding the complexity of a separate orthomode transducer for each feed horn in the case of the opposite sense. Isolation between transmit and receive signals is provided by filters.

It is necessary to have one choice of polarization within one orbit position. However, provided there is no interaction between feeder links to two adjacent orbital positions it does not appear to be essential to make the same choice for all orbital positions.

4.13 Automatic gain control

The plan should not take account of automatic gain control on-board satellites. Up to 15 dB of automatic gain control is permitted, subject to no increase in interference to other satellite systems.

4.14 Power control

The plan should not take account of power control. Power control is permitted [only to the extent that interference to other satellites does not increase by more than 0.5 dB relative to that calculated in the feeder link plan].

Guidelines should be developed for the use of power control based on the following information:

The allowable increase of earth-transmitter power applicable to earth-transmitting stations, without deteriorating the interference ratios in clear weather, is derived, taking into account the geographical locations of the earth stations and the feeder-link beam areas.

In line with this, Table 3 summarizes examples of probable combination of increase of transmitter power and rain attenuation for various values of cross-polar interference (XPIsat) and elevation angle.

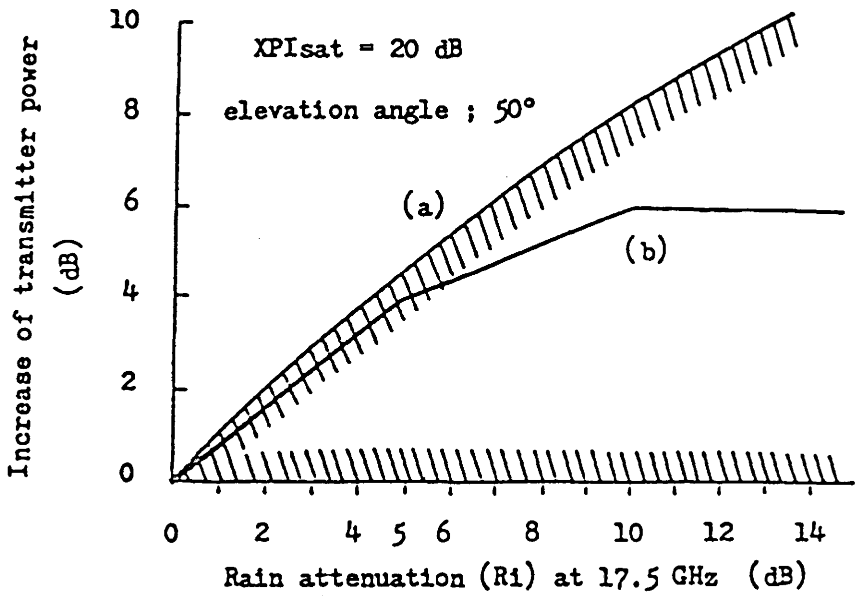


FIGURE 3

The possible increase of transmitter power for power control

Curve (a): upper limit for power control
Curve (b): an example of power control as illustrated in Table I

TABLE I

Possible increase of earth-transmitter power for power control for various values of XPIsat and satellite elevation angle

XPIsat (dB)	Satellite elevation angle (degrees)	Increase of earth-transmitter-power (dB)	
		For rain attenuation 0 dB to 5 dB	For rain attenuation 5 dB to 10 dB and more
10 to 15	0 to 10	0	0
	10 to 30	0 to 4	4 to 7
	30 to 50	0 to 4	4 to 8
	50 to 60	0 to 5	5 to 9
	60 to 90	0 to 5	5 to 10
15 to 20	0 to 10	0	0
	10 to 30	0 to 2	2 to 4
	30 to 40	0 to 3	3 to 4
	40 to 50	0 to 3	3 to 6
	50 to 60	0 to 4	4 to 8
	60 to 90	0 to 5	5 to 9
20 to 25*1	0 to 30	0	0
	30 to 40	0 to 2	2
	40 to 50	0 to 3	3 to 4
	50 to 60*1	0 to 4*1	4 to 6*1
	60 to 90	0 to 5	5 to 8
25 to 30*2	0 to 40	0	0
	40 to 50	0 to 2	2
	50 to 60	0 to 3	3
	60 to 90	0 to 5	5

*1 This case is illustrated with Curve (b) in Figure 3 as an example.

*2 These cases are identical to those given in Table I of Part II in the Final Acts of RARC-SAT-83.

4.15 Earth station location

Planning should meet the requirements of administrations, but for feeder-link earth stations located outside the down-link service area it may be necessary to employ the methods of resolving incompatibilities in planning described in 4.20.

Three cases for feeder-link service area have been identified:

i) within the down-link service area;

ii) within the national territory of an administration;

iii) within the national territory of one or more cooperating administrations serving the down-link beam of another cooperating administration.

/ In the third case, the locations of feeder-link earth stations to be used for this purpose should be specified. /

4.16 Propagation

/ To be supplied separately. /

/ 4.17 AM to PM conversion

The degradation caused by AM to PM conversion should be taken into account when calculating the C/N of the feeder link. A figure of 1.5 dB should be allowed. /

/ 4.18 Depolarization compensation

Depolarization compensation is not taken into account in planning. It is permitted only to the extent that interference to other satellites systems does not increase by more than 0.5 dB relative to that calculated in the feeder link plan. /

/ 4.19 Site diversity

The use of site diversity is not taken into account in planning. It is permitted and is considered to be an effective technique for maintaining high carrier-to-noise ratio and carrier-to-interference ratio during periods of moderate to severe rain attenuation. /

4.20 Methods of resolving incompatibilities in planning feeder links during the second session of the Conference.

Use of a common set of technical parameters for all feeder links in planning is desirable but preliminary studies by a number of administrations have indicated that there may be a difficulty in obtaining the required carrier-to-interference ratios on a small number of feeder links, particularly when certain administrations have special requirements to be met.

In order to overcome these difficulties, a certain amount of flexibility in the values of planning parameters used is proposed. Employment of one or more of the following techniques may be used, where necessary, in the planning process to attain the target values for interference protection:

4.20.1 Adjustment of the maximum level of e.i.r.p. of potential interfering feeder links or feeder links subject to excessive interference, subject to maintaining adequate carrier-to-noise and carrier-to-interference ratios on the adjusted feeder links.

4.20.2 In circumstances where independent planning of orbit positions is adversely affected, the off-axis co- and cross-polar side-lobe response patterns of the earth station transmitting antenna may be limited to 29 - 25 log Θ (dBi). For values of off-axis angle, Θ, in the regions of the adjacent and next-but-one adjacent orbital positions in the plane of the geostationary orbit.

4.20.3 In circumstances where insufficient cross-polar isolation is achieved, the off-axis cross-polar side-lobe response pattern of the earth station transmitting antenna may be limited to 24 - 25 log Θ (dBi) for $0.76^\circ \leqslant \Theta \leqslant 22.9^\circ$ and -10 (dBi) for $\Theta > 22.9^\circ$.

4.20.4 Adjustment of the feeder-link channel assignments, retaining the same translation frequency for all assignments associated with a given down-link beam.

4.20.5 Modifying the satellite receiving antenna beam pattern shape, size, and/or side-lobe response (e.g. multiple beam or shaped beam antenna), particularly when the feeder link is located outside the down-link service area.

4.20.6 Off-setting the beam-pointing direction of the satellite receiving antenna subject to maintaining the target carrier-to-noise ratio.

4.20.7 Improving the beam-pointing accuracy of the satellite receiving antenna to 0.1°.

4.20.8 Setting an upper limit of 10 dB to the rain attenuation margin included in the feeder-link power budget.

4.20.9 **Separating satellite orbit positions by $\pm 0.2^\circ$ from the nominal position and specifying the transmitting antenna pattern, for relevant earth stations in the range 0° to 1° off-axis beam angles (note that this technique may require changes to Appendix 30 and should therefore be subject to further discussion)**

[For such cases, the reference response pattern of the transmitting antenna for $0.1^\circ \leqslant \varphi \leqslant 1^\circ$ is given by the formula:

$$G = 36 - 20 \log \varphi \text{ for } 0.1^\circ \leqslant \varphi \leqslant 0.32^\circ$$

$$G = 51 - 53.2\, \varphi^2 \text{ for } 0.32^\circ \leqslant \varphi \leqslant 0.44^\circ$$

$$G = 32 - 25 \log \varphi \text{ for } 0.44^\circ \leqslant \varphi \leqslant 1^\circ.]$$

4.21 Summary table of initial technical parameters for feeder-link planning in Regions 1 and 3

(Frequency bands 17.3 - 18.1 GHz and 14.5 - 14.8 GHz)

Item	Parameter	Value	Reference
1.	Carrier-to-noise ratio	24 dB	4.2
2.	Co-channel carrier-to-interference ratio	40 dB	4.3
3.	Adjacent channel carrier-to-interference ratio	21 dB	4.4
4.	Feeder link e.i.r.p. initial planning value	17/18 GHz - 84 dBw 14 GHz - 82 dBw	4.5
5.	Transmitting antenna		4.6
a)	Diameter	17/18 GHz - 5 m 14 GHz - 6 m	4.6.1
b)	On-axis gain	57 dBi	4.6.2
c)	Co-polar response pattern	32-25 log ϕ (dBi) for $1^o \leqslant \phi \leqslant 48^o$, -10(dBi) for $\phi > 48^o$	4.6.3
d)	Cross-polar response pattern	-30 dB relative to co-polar on-axis gain, for $0^o \leqslant \phi \leqslant 1.6^o$, 32-25 log ϕ dBi for $1.6^o < \phi \leqslant 48^o$, -10(dBi) for $\phi > 48^o$	4.6.4
6.	Earth station mispointing loss	1 dB	4.7
7.	Satellite receiving antenna		4.8
a)	Cross section of beam	elliptical or circular	4.8.1
b)	Co-polar response pattern	relative gain (dB) $-12\left(\frac{\phi}{\phi_0}\right)^2$ for $0 \leqslant \frac{\phi}{\phi_0} < 1.30$ $-17.5 - 25 \log\left(\frac{\phi}{\phi_0}\right)$ for $\frac{\phi}{\phi_0} > 1.30$ After intersection with curve C: as curve C. (see Figure 2 - curve A)	4.8.2
c)	Cross-polar response pattern	relative gain (dB) $-30 - 12\left(\frac{\phi}{\phi_0}\right)^2$ for $0 \leqslant \frac{\phi}{\phi_0} \leqslant 0.5$ -33 for $0.5 \leqslant \frac{\phi}{\phi_0} \leqslant 1.67$ $-40 - 40 \log\left(\frac{\phi}{\phi_0} - 1\right)$ for $1.67 < \frac{\phi}{\phi_0}$ After intersection with curve C: as curve C. (See Figure 2 - curve B)	4.8.2
8.	Satellite receiving antenna pointing accuracy	0.2^o	4.9
9.	Satellite system noise temperature	[1500 K]	4.10

Item	Parameter	Value	Reference
10.	Type of polarization	Circular	4.11
11.	Sense of polarization	(See reference)	4.12
12.	Automatic gain control	Not taken into account	4.13
13.	Power control	Not taken into account	4.14
14.	Earth station location	(See reference)	4.15
15.	Propagation	(See reference)	4.16
16.	AM-to-PM conversion	/¯1.5 dB_7	4.17
17.	Depolarization compensation	Not taken into account	4.18
18.	Site diversity	Not taken into account	4.19

R.M. BARTON
Chairman of Sub-Working Group 6B-2

INTERNATIONAL TELECOMMUNICATION UNION

ORB-85 WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT

FIRST SESSION, GENEVA, AUGUST/SEPTEMBER 1985

Document DL/24-E
26 August 1985
Original: English

WORKING GROUP 5A

NOTE BY CHAIRMAN OF SUB-WORKING GROUP 5A-1
TO THE CHAIRMAN OF WORKING GROUP 5A

The following texts are the result of 5A Ad hoc 1 Working Group.

The work covers:

Efficiency

Provisions for multi-service and multi-band networks

Sharing of inconveniences

Others

This is the final document from the Working Group.

I.R. HUTCHINGS
Chairman of Sub-Working Group 5A-1

EFFICIENCY

1) Any planning method should ensure efficient and economical use of the geostationary orbit and the frequency bands allocated to space services;

2) Any planning approach shall, in satisfying the requirements, progressively achieve more efficient use of the GSO/spectrum resource, account being taken of the need for access and operational, technical and economical constraints.

3) Any planning method should encourage progressive improvements in satellite technology which will help increase orbit/spectrum capacity, and which are acceptable to the majority of countries.

4) Any planning method should ensure that the plan adopted meets the requirements of administrations with regard to the OSR in the most efficient way possible from the standpoint of technical, operational and economic factors and of the needs of developing countries.

5) Any planning method should ensure optimum operation of the GSO spectrum resource while permitting the development and introduction of new technical facilities which make for reduced system costs.

6) Any planning methods adopted must encourage homogeneous orbit and spectrum utilization to improve the efficiency of GSO utilization.

7) Any planning method should include only realistic requirements in any planning approach, to improve the efficiency of GSO utilization.

8) All States should cooperate in the efficient and economic use of the GO, on a regional or world-wide scale, either directly or through the United Nations and other competent international organizations.

9) Technological advances considered for the establishment of communication-satellite systems should be aimed not only at more efficient use of the OSR, but also at greater economy, especially in the Earth segment.

10) For all satellite networks whether in the plan or outside the plan, the "In-Orbit" spare satellites should utilize the same orbital positions as those of the respective primary satellites in order to avoid inefficiency and complexity in utilizing the GSO.

11) Any planning method adopted should ensure that the inactive spare satellite should be co-located with the active operational satellite.

Source of principle

1) URS/9/3(b)

2) USA/5/7(27.7), CAN/35/1

3) MLA/82/6(6.1)
SNG
THA

4) COMP/110/3(5b.8)

5) BFA/104/1

6) G/18/5.7

7) USA/5/8(d)

8) COMP/110/(a.5)

9) COMP/110/(c.3)

10) IRQ/87/13

11) MLA/82/7
SNG
THA

PROVISIONS FOR MULTI-SERVICE AND MULTI-BAND NETWORKS

1) Any planning method should be able to accommodate multi-service and/or multi-band satellite networks.

2) The requirements of multi-service and/or multi-band systems could be projected by administrations for inclusion of the appropriate elements in the development of the plan after taking into consideration the problems/difficulties, if any, in coordinating the unplanned service frequencies forming a part of such systems.

Source of principle

1) B/37/12(i)

2) IND/54/5(4.5)

SHARING OF INCONVENIENCES

1) Any planning method should ensure that existing systems will continue to be accommodated as new systems are introduced and that the burden of access will be shared among all systems over time.

2) Any adjustment of satellite networks arising from the need to accommodate unplanned requirements and/or improvements in technology should be within the resources of most countries.

3) The existing systems may also have to adjust some of their parameters, if required along with those of a new entrant. However, there is a necessity to keep these adjustments to the minimum, so that operating systems are not adversely affected. The scope and extent of such an adjustment could also be defined wherever possible.

4) Any planning method should recognize that only finite adjustments are possible to in-orbit systems over a satellite lifetime, and that the readjustment burden may be other than equitable initially.

5) If new networks or modifications cannot wait until the next Conference, the corresponding applications shall be allowed only:

- when they do not cause interference greater than that fixed for the purposes of establishing the Plan, or if the administrations affected accept the higher level of interference;

- if the rights of other administrations are not infringed.

Source of principle

1) USA/5/8(29.b)

2) MLA/82/8
SNG
THA

3) IND/54/5(4.1)

4) NZL/8/(page 7)

5) CLM/106/53

OTHERS

1) Satellites should, inter alia, be able to change orbital position and to leave the geostationary-satellite orbit as soon as they are no longer used.

2) The beam of a national satellite should so far as possible be able to cover neighbouring countries.

3) Countries should be encouraged to use less congested bands.

4) International rules must be such as to allow the use of a satellite network throughout its life without such use being modified by a change in the rules.

5) The Conference should therefore adopt a Resolution stipulating that, in designing geostationary space coverage, all available technical means should be used to reduce radiation over the territory of other countries unless those countries have expressly agreed to it, and prohibiting any intentional coverage on which there has been no consultation.

6) Any planning method should be effective and efficient with regard to operation, easy to apply and economical in its demands on the administrative and technical personnel.

7) Any planning method seeking for better ways of using GSO will necessarily require computer processing rather than manual handling.

8) Recognizing the disparity between the technical resources available to different administrations and groups of administrations, those in need of special assistance for the purposes of the coordination procedures must be assured that it will be available from the ITU consistent with the resources of the Union.

9) Any plan drawn up at the Conference shall be realistic enough to be implemented.

10) The orbit/spectrum resource is a limited natural resource and therefore subject to possible saturation.

11) A national allotment plan based on the principle of satisfying only national requirements, guaranteeing each country an orbital position and an overall bandwidth capable of satisfying all its telecommunication needs.

12) The cost of the development and application of the regulatory regime must be reasonable.

13) The planning process will cover, in relation to the geostationary orbit and the radio services utilizing it:

- the orbital positions,
- the frequency spectrum (frequency assignments and band allocations), and
- the radiocommunication services.

14) The special needs of the developing countries are explicitly taken into account in Article 33 of the Nairobi Convention [5]. It follows that all measures adopted for utilization of the OSR, in addition to being equitable, must favour solutions which help to speed up the development of these countries.

15) The GO must be used exclusively for peaceful purposes, and its planning must thus rule out any consideration contrary to those purposes.

16) Once the Plan and the corresponding technical parameters have been chosen there should be no reason for the cost of satellite systems to rise because of them for the duration of the Plan, even owing to unforeseen modifications of the introduction of unforeseen new systems. In other words, the cost would be defined when the Plan is chosen and would also be a factor in its choice.

17) The major cost of the Plan would arise from the effort required to prepare the Planning Conference. Once established, its management should require a minimum effort on the part of the ITU and the administrations.

<u>Source of principle</u>

1) ALG/75/13
2) ALG/75/6
3) KEN/20/2.1(V)
4) F/11/2
5) EQA/81
6) D/31/3
7) J/41(preface)
8) G/18/5.10
9) J/39/3(7)
10) MEX/96/28(1)
11) LBY/103/1
12) CAN/35/29
13) CLM/106/24
14) CLM/106/36
15) CLM/106/43
16) CLM/106/64
17) CLM/106/66

INTERNATIONAL TELECOMMUNICATION UNION

ORB-85 WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT

FIRST SESSION, GENEVA, AUGUST/SEPTEMBER 1985

Document DL/25-E
27 August 1985
Original: English

WORKING GROUP 4,
AD HOC 1

Working Group 4, ad hoc 1

HIGH DEFINITION TELEVISION

Reference proposals: a) HOL/23/4

b) S/33/10

c) E/34/7 (supported by Vatican City State - CVA/34(Add.1) and San Marino - SMR/149/2)

d) KEN/20

e) CAN/35/21

Reference document: Document 3 (CPM) - Annex 4, section 4.6.2.5.3

1. Introduction

High definition television (HDTV) in itself is not a separate service in the ITU context and is normally considered to be in the broadcasting-satellite service. Therefore the discussion, in part, should be centred on existing or new BSS bands which can accommodate HDTV transmissions. Of particular interest are the 12 GHz (Appendix 30 Plan) and the 22.5 - 23 GHz BSS bands.

Both of these BSS bands might have problems in accommodating HDTV. In the case of the 12 GHz band, Appendix 30 gives detailed technical criteria to be used in the implementation of assignments, which may not accommodate HDTV without modifying the Plan. As for the 23 GHz band, there is no allocation for Region 1 and even those for Regions 2 and 3 are subject to Article 14 (Footnote 877). The higher propagation losses and sharing questions will require close evaluation.

The CCIR has provided certain information on these matters as indicated in Document 3 (Annex 4, section 4.6.2.5.3). In its draft Report AC/10-11, the CCIR indicates that the 23 GHz band is technically suitable for satellite broadcasting of HDTV, in particular for smaller service areas (i.e. those which need a satellite antenna beamwidth of less than 2^{o}). System examples have been developed. Additionally, two practical factors have been identified which differentiate use of the 23 GHz band from the 12 GHz band: the higher rain attenuation and atmospheric absorption, and higher receiving antenna directivity. These factors have been investigated.

An initial estimation of the capacity is also given for the current 500 MHz of bandwidth allocated to Regions 2 and 3 at 23 GHz. Based on several assumptions, including an RF bandwidth of 60 MHz per channel, the total number of channels at each orbital location would be approximately ten using both polarizations. Finally, the 27 - 27.5 GHz band is identified as a possible candidate to be used as a feeder link band for 23 GHz HDTV transmissions.

2. Discussion of proposals

Four proposals from Region 1 administrations (HOL/23/4, E/34/7, CVA/34(Add.1) and SMR/149/2) have proposed that the second session be empowered to modify the allocation of the 22.5 - 23 GHz band in Region 1 to include BSS as already allocated in Regions 2 and 3, thus providing a world-wide allocation. However, S/33/10 proposes that other bands be studied including the 12 GHz band, and to empower the second session to modify Article 8 as necessary to put its decisions into effect.

Two proposals address future planning of 23 GHz BSS in Regions 2 and 3: KEN/20 and CAN/35/21, with the latter specifically looking to a planning conference in the 1990's.

Some proposals also addressed the associated feeder-link band (e.g. 27 - 27.5 GHz) which would be planned at the same time.

None of the proposals wanted the first session to undertake any modification of Article 8 or any planning of the BSS for HDTV at the second session.

3. Course of action

In the intersessional period, studies would have to be undertaken to examine the sharing aspects of introducing the new BSS (HDTV) into the current Region 1 allocation. Further studies to help estimate the capacity (i.e. the number of channels per administration) would be required, including consideration of the 12 GHz (Appendix 30) Plan, in addition to those referenced in Document 3. Initial concepts of system configuration and HDTV parameters would have to be refined.

The agenda for the second session would have to include consideration of Article 8 with regard to this item to permit such a modification if the second session so decides.

At the second session, a modification to Article 8 for Region 1 would have to be agreed including a review of existing BSS bands. Also, it will have to decide if any existing (or new) BSS band for HDTV is to be planned at a future conference. A review of the current Article 14 procedure (in the case of the 22.5 - 23 GHz band in Regions 2 and 3) might be undertaken. Resolutions Nos. 507 and 33 would also apply to these BSS bands. If there were to be a decision to undertake BSS (HDTV) planning, an appropriate feeder link would have to be chosen. A Resolution from ORB(2) covering these items would be forwarded to the Administrative Council.

A variation on the above would be to empower any intervening ITU conference with the responsibility of reviewing Article 8 in this regard. This would ease the workload of the second session but reduce the time for intersessional work.

R.G. AMERO
Chairman of Working Group 4, ad hoc 1

INTERNATIONAL TELECOMMUNICATION UNION

ORB-85 WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT

FIRST SESSION, GENEVA, AUGUST/SEPTEMBER 1985

Document DL/26(Rev.1)-E
27 August 1985
Original: English

WORKING GROUP 4A

DRAFT RESOLUTION/RECOMMENDATION

Satellite sound broadcasting systems for individual reception by portable and automobile receivers

The World Administrative Radio Conference on the Use of the Geostationary Orbit and the Planning of the Space Services Utilizing It (first session, Geneva 1985),

considering

1. that the World Administrative Radio Conference, Geneva 1979, adopted Resolution No. 505;

2. that satellite sound broadcasting is technically feasible;

3. that several administrations made proposals to WARC 79 concerning frequency band allocations for broadcasting-satellite service (sound) in the range 0.5 - 2 GHz;

4. that a number of administrations have expressed the view at WARC-ORB 85 that there is a future need for a broadcasting-satellite service (sound);

5. that studies of the CCIR up to now found that, due to sharing problems, the implementation of such a service will not be possible in the band 0.5 - 2 GHz unless an appropriate frequency band is allocated for it on an exclusive basis;

6. that the CCIR at its Conference Preparatory Meeting in June-July 1984 indicated that further work would be needed to define the system parameters;

is of the opinion

[a) that there will be a future need in several parts of the world for a broadcasting-satellite service (sound);]

b) that due to the existing situation it is not possible to allocate in the band 0.5 - 2 GHz an exclusive band to the broadcasting-satellite service (sound) on a world-wide basis now;

c) that an allocation to the broadcasting-satellite service (sound) can possibly only be found in the longer term;

and further considering

that at the first session of this Conference studies were not far enough advanced to make a Recommendation for any long term solution;

resolves/recommends

1. that the second session of this Conference should consider the results of the various up-to-date studies and in reviewing the situation prevailing at that time take appropriate decisions regarding the allocation of a suitable frequency band;

[2. that these studies shall include the following subjects: quality of signal, frequency of operation (0.5 - 2 GHz approximately as a guideline), modulation type, digital systems, bandwidth required, receivers, antenna designs, geographical sharing, feeder links, appropriate sharing criteria and costs;]

[2. that these studies shall be guided by the information given in Chapter ZZ.3 and its associated annex of the report of this conference;]

requests

the Administrative Council to include this Resolution/Recommendation in the agenda for the second session of the Conference which is envisaged for 1988;

invites the CCIR

to undertake studies on the indicated subjects in order to define the practical system, parameters for satellite sound broadcasting.

INTERNATIONAL TELECOMMUNICATION UNION

ORB-85 WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT

FIRST SESSION, GENEVA, AUGUST/SEPTEMBER 1985

Document DL/26-E
27 August 1985
Original: English

WORKING GROUP 4A

DRAFT RESOLUTION/RECOMMENDATION

Satellite sound broadcasting systems for individual reception by portable and automobile receivers

The World Administrative Radio Conference on the Use of the Geostationary Orbit and the Planning of the Space Services Utilizing It (first session, Geneva 1985),

considering

1. that the World Administrative Radio Conference, Geneva 1979, adopted Resolution No. 505;

2. that satellite sound broadcasting is technically feasible;

3. that several administrations made proposals to WARC 79 concerning frequency band allocations for broadcasting-satellite service (sound) in the range 0.5 - 2 GHz;

4. that a number of administrations have expressed the view now that there is a future need for a broadcasting-satellite service (sound);

5. that studies of the CCIR up to now found, that due to sharing problems, the implementation of such a service will not be possible in the band 0.5 - 2 GHz unless an appropriate frequency band is allocated for it on an exclusive basis;

6. that the CCIR at its Conference Preparatory Meeting in June-July 1984 indicated that further work would be needed to define the system parameters;

is of the opinion

a) that there will be a future need in several parts of the world for a broadcasting-satellite service (sound);

b) that due to the existing situation it is not possible to allocate in the band 0.5 - 2 GHz an exclusive band to the broadcasting-satellite service (sound) on a world-wide basis in the short term;

c) that an exclusive allocation to the broadcasting-satellite service (sound) can possibly only be found in the longer term;

further considering

that at the first session of this Conference studies were not far enough advanced to make a Recommendation for any long term solution;

<u>resolves/recommends</u>

1. that the second session of this Conference should consider the results of the various studies and in reviewing the situation prevailing then be authorized to take appropriate decisions regarding the allocation of a suitable frequency band;

2. that these studies shall include the following subjects: quality of signal, frequency of operation (0.5 - 2 GHz approximately as a guideline), modulation type, digital systems, bandwidth required, receivers, antenna designs, feeder links, appropriate sharing criteria and costs;

<u>requests</u>

the Administrative Council to include this Resolution/Recommendation in the agenda for the second session of the Conference which is envisaged for 1988;

<u>invites the CCIR</u>

to undertake studies on the indicated subjects in order to define the practical system, parameters for satellite sound broadcasting.

INTERNATIONAL TELECOMMUNICATION UNION

ORB-85 WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT

FIRST SESSION, GENEVA, AUGUST/SEPTEMBER 1985

Document DL/27(Rev.1)-E
27 August 1985
Original: English

SUB-WORKING GROUP 4B-2

DRAFT ELEMENT ON SHARING CRITERIA BETWEEN FEEDER LINKS AND OTHER SERVICES (SPACE AND TERRESTRIAL) WHICH NEED TO BE DEVELOPED DURING THE INTERSESSIONAL PERIOD

(Agenda item 3.3)

1. General

The Report of the Conference Preparatory Meeting (CPM) of the CCIR addresses the sharing criteria required between feeder links and other equal primary services in chapter 10. Further relevant material is to be found in chapter 8 of the CPM Report and additional detail in Annex 5.4 and Annex 6.

Administrations appeared to be in general agreement with the CPM Report comment on agenda item 3.3.

The relevant sections call for additional studies on many aspects of sharing. The following addresses those aspects directly relevant to intersessional studies, in the context of the frequency bands in which frequency plans for feeder links are to be developed. In this context, the criteria are those necessary for inclusion in the Radio Regulations.

2. Frequency bands

The sharing criteria are required for feeder links in the following frequency bands and sharing with the following services:

2.1 Frequency band 14.5 - 14.8 GHz

FIXED
MOBILE

2.2 Frequency band 17.7 - 18.1 GHz

FIXED
FIXED-SATELLITE (space-to-Earth)
MOBILE

3. Interference modes

The modes of interference which can occur are the following:

Mode a) Transmitting feeder-link earth station interfering with receiving terrestrial station (fixed or mobile);

Mode b) Transmitting terrestrial station (fixed or mobile) interfering with receiving feeder-link space station;

Mode c) Transmitting space station in the fixed-satellite service interfering with receiving feeder-link space station (for the 17.7 - 18.1 GHz band);

Mode d) Transmitting feeder-link earth station interfering with receiving earth station (for the 17.7 - 18.1 GHz band).

4. Sharing criteria available under various provisions of the Radio Regulations

4.1 Mode a) is covered for both frequency bands in question by Appendix 28 (Table 1). Note (5) in Table 1 states:

"The parameters associated with these columns are for feeder links to broadcasting satellites and are provisional pending further study by the CCIR: see Resolution No. 101.".

For the time being no other parameters than those in Table 1 are available.

Moreover, it should be noted that sharing criteria for bands below 15 GHz are restricted to analogue-modulated terrestrial systems, so that parameters for digital systems need to be developed.

Intersessional studies should review the values associated with these parameters.

It is noted that Appendix 28 does not cover the case of aeronautical mobile receiving stations. Since these are permitted under the Radio Regulations, intersessional studies may be needed to provide the necessary sharing criteria, and appropriate method of application.

In addition, the need for intersessional studies to take account of the occasionally simultaneous nature of relatively constant interference from the fixed-satellite service space transmitters and the short-term interference anomalously propagated from feeder-link earth stations at the limit of the coordination area determined by Appendix 28. It could be expected that there will be relatively few feeder-link earth stations on any particular frequency.

4.2 Mode b) is covered in Article 27 by RR 2503, RR 2505, RR 2508 and RR 2510 for the frequency band 14.5 - 14.8 GHz with the Footnote No. 2510.2 stating:

"The application of the limits in this frequency band is provisional (see Resolution No. 101).";

and by RR 2505, RR 2508 and RR 2511 for the frequency band 17.7 - 18.1 GHz with the Footnote No. 2511.2 (see No. 2510.1) stating:

"The equality of right to operate when a band of frequencies is allocated in different Regions to different services of the same category is established in No. 346. Therefore any limits concerning interregional interference which may appear in CCIR Recommendations should, as far as practicable, be observed by administrations."

It is, however, relevant to recall the view of the Report of the CPM on the need for pointing/e.i.r.p. restrictions. Chapter 12, section 12.6, responded to Recommendation No. 4 (COM6/4) of RARC-SAT R2 as follows:

"Recommendation No. 4 (COM6/4) requests the CCIR to study the need for limits on e.i.r.p. in the direction of the GSO to be imposed on FS transmitters in the 17.3 - 17.8 GHz band to protect BSS feeder links. Report 952 (MOD I) discusses this matter for the 17.7 - 18.1 GHz band, and concludes that with the present e.i.r.p. limit of 55 dBW in Article 27, interference situations will be rare. Further, draft new Report AB/4-9 indicates that under worst-case conditions an FS digital radio-relay transmission around 18 GHz, interfering with a feeder-link receiver, will cause a maximum degradation of 0.12 dB to the nominal received broadcasting-satellite C/N ratio in the Region 2 Plan. This assumes a feeder-link e.i.r.p. of 86 dBW but does not take into account other factors that may further reduce the effect of terrestrial interference, such as feeder-link receive antenna discrimination and power spectral density reductions due to differences in channel bandwidths. Since the effect of terrestrial interference is considered negligible, and the additional factors may further reduce the interference, it is concluded that it is unnecessary to have restrictions as to the direction of maximum radiation for terrestrial transmitters."

4.3 Mode c) - Transmitting space station in the fixed-satellite service interfering with receiving feeder-link space station

There are two situations where interference might result:

- when satellites are separated by a small orbital arc,
- when satellites are at nearly antipodal positions.

Appendix 29 contains a procedure for determination of whether coordination is required which is applicable for both situations.

Intersessional studies are needed to determine the appropriate threshold value to trigger coordination, whether it would be preferable to express it in terms of $\Delta T/T$ (as in Appendix 29) or C/I, and whether it is desirable to establish common criteria for all three Regions.

As part of the fixed-satellite service, the threshold of BSS feeder links might be expected to reflect the value in Appendix 29 of 4%. However, it could be that a more stringent value might more correctly reflect the appropriate C/I required for BSS feeder links.

On the other hand, the threshold value of $\Delta T/T$ adopted in the provisions of RARC-SAT R2 was in fact 10% for intersatellite geometric angular separations less than 10° or greater than 150°. However, coordination is not required in the latter case if the free-space power flux-density of the transmitting space station in the fixed-satellite service does not exceed a value of -123 dB(W/m^2/24 MHz) on the Earth's surface at the equatorial earth link.

4.4 Mode d) concerning the frequency band 17.7 - 18.1 GHz only which is allocated for bidirectional use; this mode is not covered by any provisions of the Radio Regulations; however, RARC-SAT R2 did develop an approach based on the use of Appendix 28 to deal with this mode. This approach was further developed at the CPM where it appears as Annex 8 to the Report. Intersessional studies may help to confirm the efficacy of the method.

Note should also be made of the possibility of occasionally simultaneous nature of the short-term interference from feeder-link earth stations at the limit of their coordination area, terrestrial fixed service transmitters at the limit of their coordination area, and the relatively constant interference from the space stations of the fixed-satellite service. Intersessional studies on the cumulative effect of the three categories of potential interferences, taking account of the time distribution of the terrestrially propagated interference, appear necessary.

It could be expected that there will be relatively few feeder-link earth stations on one frequency.

K.R.E. DUNK
Chairman of Sub-Working Group 4B-2

INTERNATIONAL TELECOMMUNICATION UNION

ORB-85 WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT

FIRST SESSION, GENEVA, AUGUST/SEPTEMBER 1985

Document DL/27-E
26 August 1985
Original: English

SUB-WORKING GROUP 4B-2

DRAFT ELEMENT ON SHARING CRITERIA BETWEEN FEEDER LINKS
AND OTHER SERVICES (SPACE AND TERRESTRIAL)
WHICH NEED TO BE DEVELOPED DURING THE INTERSESSIONAL PERIOD

(Agenda item 3.3)

1. General

The Report of the Conference Preparatory Meeting (CPM) of the CCIR addresses the sharing criteria required between feeder links and other equal primary services in chapter 10. Further relevant material is to be found in chapter 8 of the CPM Report and additional detail in Annex 5.4 and Annex 6.

Administrations appeared to be in general agreement with the CPM Report comment on agenda item 3.3.

The relevant sections call for additional studies on many aspects of sharing. The following addresses those aspects directly relevant to intersessional studies, in the context of the frequency bands in which frequency plans for feeder links are to be developed. In this context, the criteria are those necessary for inclusion in the Radio Regulations.

2. Frequency bands

The sharing criteria are required for feeder links in the following frequency bands and sharing with the following services:

2.1 Frequency band 14.5 - 14.8 GHz

FIXED
MOBILE

2.2 Frequency band 17.7 - 18.1 GHz

FIXED
FIXED-SATELLITE (space-to-Earth)
MOBILE

2bis Interregional sharing criteria will be required between feeder links operating in the 17.3 - 17.8 GHz band.

3. Interference modes

The modes of interference which can occur are the following:

Mode a) Transmitting feeder-link earth station interfering with receiving terrestrial station (fixed or mobile);

Mode b) Transmitting terrestrial station (fixed or mobile) interfering with receiving feeder-link space station;

Mode c) Transmitting space station in the fixed-satellite service interfering with receiving feeder-link space station (for the 17.7 - 18.1 GHz band);

Mode d) Transmitting feeder-link earth station interfering with receiving earth station (for the 17.7 - 18.1 GHz band).

3bis Interregional interference between feeder links involves a further mode of interference:

- Transmitting feeder-link earth station within one region interfering with a receiving feeder-link space station of another region.

4. Sharing criteria available under various provisions of the Radio Regulations

4.1 Mode a) is covered for both frequency bands in question by Appendix 28 (Table 1). Note (5) in Table 1 states:

"The parameters associated with these columns are for feeder links to broadcasting satellites and are provisional pending further study by the CCIR: see Resolution No. 101.".

/_For the time being no other parameters than those in Table 1 are available._/

Intersessional studies should review whether there is a need for the values associated with these parameters to be considered provisional.

/_It is noted that Appendix 28 does not cover the case of aeronautical mobile receiving stations. Since these are permitted under the Radio Regulations, intersessional studies may be needed to provide the necessary sharing criteria, and appropriate method of application._/

/_Text addressing the need for intersessional studies to take account of the occasionally simultaneous nature of relatively constant interference from the fixed-satellite service space transmitters and the short-term interference from feeder-link earth stations at the limit of the coordination area determined by Appendix 28._/

4.2 Mode b) is covered in Article 27 by RR 2503, RR 2505, RR 2508 and RR 2510 for the frequency band 14.5 - 14.8 GHz with the Footnote No. 2510.2 stating:

> "The application of the limits in this frequency band is provisional (see Resolution No. 101).";

and by RR 2505, RR 2508 and RR 2511 for the frequency band 17.7 - 18.1 GHz with the Footnote No. 2511.2 (see No. 2510.1) stating:

> "The equality of right to operate when a band of frequencies is allocated in different Regions to different services of the same category is established in No. 346. Therefore any limits concerning interregional interference which may appear in CCIR Recommendations should, as far as practicable, be observed by administrations."

/ Extract based on CPM Report, chapter 12, item 6, on the need for pointing/e.i.r.p. restrictions. /

/ Text covering the case of aeronautical mobile transmitting stations. /

4.3 Mode c) is covered by Appendix 29 - Case II.

4.4 Mode d) concerning the frequency band 17.7 - 18.1 GHz only which is allocated for bi-directional use; this mode is not covered by any provisions of the Radio Regulations; however, RARC-SAT R2 did develop an approach based on the use of Appendix 28 to deal with this mode.

/ Text based upon Annex 8 of the CPM Report. /

K.R.E. DUNK
Chairman of Sub-Working Group 4B-2

Annex: 1

ANNEX

Draft element on sharing criteria between feeder links
and other services (space and terrestrial)
which need to be developed during the intersessional period

(Agenda item 3.3)

1. Sections 2bis and 3bis draw attention to the need for intersessional studies on the criteria to be adopted for the threshold for coordination required between feeder links in different regions intended to operate in the band 17.3 - 17.7 GHz.

2. As part of the fixed-satellite service, the threshold for BSS feeder links might be expected to reflect the value in Appendix 29 of 4%. However, it could be that a more stringent value would more correctly reflect the appropriate C/I required for BSS feeder links.

3. The threshold value of ΔT/T adopted in the provisions of RARC-SAT R2 was in fact 10%.

4. Intersessional studies are needed to determine the appropriate threshold value, and whether it would be preferable to express it in terms of ΔT/T or C/I.

INTERNATIONAL TELECOMMUNICATION UNION

ORB-85 WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT

FIRST SESSION, GENEVA, AUGUST/SEPTEMBER 1985

Document DL/28-E
27 August 1985
Original: English

WORKING GROUP 4A

ANNEX YY

(relevant to chapter ZZ)

TECHNICAL AND OPERATIONAL INFORMATION RELATING TO SATELLITE SOUND-BROADCASTING SYSTEMS FOR INDIVIDUAL RECEPTION BY PORTABLE AND AUTOMOBILE RECEIVERS

(Agenda item 4)

Annex 7 of the CPM Report is the text of this Annex.

Modify title to the title as given in this document.

Change numerical designation of Annex from 7 to YY, throughout the text.

Modify last paragraph of 7.2.2 (ZZ.2.2) to correct typographical errors.

In the case of the digital model, the quality objective at the edge of the coverage area is equivalent to a subjective quality of grade 4 on the 5 point CCIR quality scale. This will translate into an allowed bit error rate depending on the level of protection against errors, and into a required carrier-to-noise ratio depending on the channel coding used. In this case, interference is considered as additive noise and the protection ratios are set such that the noise contribution from the co-channel interference is 1 dB and each adjacent channel contributes 0.5 dB.

E.F. MILLER
Chairman of Working Group 4A

INTERNATIONAL TELECOMMUNICATION UNION

ORB-85 WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT

FIRST SESSION, GENEVA, AUGUST/SEPTEMBER 1985

Document DL/29-E
27 August 1985
Original: English

WORKING GROUP 4C

Draft element
Drafting Group 4C-5 Report

PROVISIONAL CONCLUSIONS ON HARMONIZATION

WORK PROGRAMME 2.1

Harmonization

1. Introduction

The purpose of the harmonization phase is to identify and resolve system interactions according to some agreed technical and operational criteria. This phase is particularly important when apparent conflicts are noted in the identification phase. During the harmonization phase, the agreed threshold for identifying potential interference among systems is applied, followed by a process of harmonizing any incompatibilities.

The following is a description of the technical background of the present frequency and orbit coordination procedure. Measures are described that permit effective harmonization of interfering networks which use adjacent or nearby orbital locations.

2. Present coordination procedure from a technical viewpoint

2.1 The technical basis for coordination within the FSS

The present section considers (intraservice) sharing between networks of the FSS. The FSS comprises links which are parts of fixed-satellite networks, which may include satellite-to-satellite links, and also feeder links serving satellites of other services. The interference criteria appropriate to these two broad classes of fixed-satellite link are not necessarily the same.

The regulation of interference arising from sharing between fixed-satellite networks, without degrading the performance of circuits below recommended targets, is achieved in the following way:

- a hypothetical reference circuit (HRC) or its equivalent is defined;
- a maximum level of total degradations from all sources is determined for that circuit;
- some fraction of that level of degradation is allocated to interference from all other networks of the FSS: this is called "permissible interference";

- some fraction of the total permissible interference is recommended to be the level of interference which a network should permit from any other network. This is called the "single-entry" value;

- frequency coordination is used to make sure that the single-entry limit is not exceeded, the relationship between the single-entry value and the total permissible entry having been chosen so that the aggregate of single entries will not exceed the recommended total value.

HRCs are defined for various types of circuits (analogue, digital, voice, TV) in the relevant CCIR Recommendations. For these HRCs specific allowances for the permissible interference levels have been established. To cite only one example, Recommendation 353-4 (MOD I) recommends that the noise power in any telephone channel in an FDM-FM system conforming to the HRC defined in Recommendation 352-4 shall not exceed 10 000 pWOp for more than 20% of any month. Recommendation 466-3 (MOD I) recommends that the noise level in such a circuit due to interference from other fixed-satellite networks should not exceed 2 000 pWOp under the same conditions. Exceptionally, the maximum level of permissible interference should be reduced to 1 000 pWOp for networks which had already reached the planning stage by 1978.

Considerable attention continues to be given to the question of what constitutes an acceptable level of interference. The gain of earth and space-station antennas decreases with increasing angle off the direction of maximum gain. These antenna characteristics may be the only source of isolation between networks, in which case there is an inverse relationship between the interference level and the separation angles. Thus, the greater the permissible interference between two networks serving the same or adjacent areas on the Earth's surface, the smaller can be the orbital separation between the space stations of the two networks. Similarly, the greater the permissible interference between two networks whose space stations are in approximately the same orbit location and serve different areas on the Earth's surface through narrow-beam antenna, the closer can those service areas be to each other, and the greater the number of times that the frequency band can be reused in different parts of the world.

The total interference in a network of the FSS, or other services which make use of large numbers of satellites, is due to contributions from many other networks. The question arises of how to determine all the individual entries so that their cumulative total does not materially exceed the level that the network has been designed to be capable of accommodating. The answer depends on the method used for coordinating or planning the use of the spectrum and the orbit.

The Radio Regulations, Article 13 requires the characteristics of all new or modified satellite networks to be coordinated bilaterally with all other networks if the test of need to coordinate set out in the Radio Regulations, Appendix 29, gives an affirmative result. This process of bilateral coordination allows the worst-case single-entry interference level between the subject network and each of the other networks to be constrained to a pre-determined value. The ratio between the total permissible interference level and the maximum single-entry value must be chosen so that the latter is as large as it may be without permitting the aggregate of all the single entries to exceed the former under worst-case conditions.

2.2 Interference calculations in the advanced Publication and Coordination phase of the present Radio Regulations

The interference calculations in the "advanced Publication phase" follow Appendix 29 and are based on the data about the published satellite network as contained in Appendix 4. Due to the general nature of these data, the calculated result is not very specific, although the calculations themselves tend to be laborious if they have to be done for many networks.

The calculation gives the relative increase in the equivalent noise temperature $\Delta T/T$ of the interfered with satellite network. If the $\Delta T/T$ exceeds the threshold value of 4%, then it is assumed, under the present Radio Regulations, that the permissible interference may be exceeded. Therefore the affected administration transmits its request for coordination to the administration which is responsible for the newly published network.

In some cases administrations can assess at this stage the actual interference situation by exchanging additional data. Normally, however, this assessment will be made in the "coordination phase" when the more detailed data of Appendix 3 are available. In addition to the $\Delta T/T$ values the actual interference levels caused by the carriers of the two networks can now be calculated.

It is obvious that the proper values of the $\Delta T/T$ threshold and the permissible single-entry interference values in relation to the aggregate interference values, along with the calculation methods itself are of crucial importance for the current coordination process. Possible improvements will be discussed in paragraph 3.1.5 and section 4.

3. Measures to achieve effective harmonization

For the sake of clarity these measures are subdivided into two subsets, namely individual technical elements and methods to combine those elements.

3.1 Individual technical measures

3.1.1 Flexibility in the positioning of satellites

Changes in the positions of existing satellites and in the proposed positions of new satellites are one powerful way of harmonizing different satellite networks, because it can make use of the large differences in the gain in the radiation patterns of earth station antennas. The problems of implementing changes in satellite locations, particularly for satellites which are already in service, are considered in sections ...... and .... together with Recommendations for further study.

3.1.2 Adjustment of carrier parameters

When a relatively small proportion of carriers in a network suffer excessive interference, it may be feasible to reduce that interference to the recommended level without an unacceptable loss of the satellite capacity by increasing the carrier power or, in digital systems, by using error correction. In cases where interference from terrestrial stations or from other satellite networks is likely to be small, an interference entry in excess of the recommended value may be accepted without exceeding total interference limits. Alternatively it may be feasible to reduce circuit noise or bit errors arising within the wanted network from other causes, by error correction or increase of FM deviation and carrier power, so that a higher single interference entry does not cause failure to achieve the circuit performance standards. It may be feasible to reduce substantially interference entering a network at an earth-station receiver by means of an interference canceller. This latter technique, however, requires further study, especially as to its applicability to multiple or broadband interference carriers.

3.1.3 Frequency planning to reduce spectrum overlap and inhomogeneity; spectrum segmentation

It may sometimes be found when two networks are being coordinated that the interference criteria cannot be met over the whole frequency band. If so, then it may be necessary to consider segmenting the frequency band and thereby enabling the coordination of more homogeneous bandwidth segments. Particular attention should first be given to interference from emissions with high spectral power density, such as FM television.

Carrier frequency interleaving could be one means to facilitate coordination. The extent to which closer satellite spacing and improved orbit/spectrum utilization may be achieved by interleaving the carrier frequencies of one satellite with those of a neighbouring satellite is critically dependent on the type of modulation (e.g., FM or PSK) and the multiple-access technique (e.g., single carrier or FDMA) applied to the wanted and interfering carriers. For the case of frequency-modulated FDM telephony an improvement in required carrier-to-interference ratio is obtained when interleaved carrier frequencies are used. The improvement is found to be up to about 12 dB, depending upon the modulation indices. This improvement may sometimes be reduced by the application of carrier energy dispersal to one or both of the carriers. Little improvement in satellite spacing requirements is to be obtained by interleaving digital signals.

Another approach which holds considerable promise has been designated by the term "spectrum segmentation". Spectrum segmentation is based on the fact that high spectral density carriers like TV-FM and high-capacity FDM-FM cause higher interference to carriers such as SCPC and low-capacity FDM-FM, as compared to other similar types of carriers. The use of the same frequency by high-density and low-capacity carriers in two potentially interfering networks produces inhomogeneity and leads to a relatively large intersatellite spacing requirement. Efficiency of use of the GSO could be improved if frequencies of high density and low-capacity carriers could be segregated, particularly for TV-FM and SCPC carriers.

Frequency band segmentation can be achieved by various means. One approach could be called macro-segmentation, where frequency bands are segmented into large blocks typically many transponder widths wide. In contrast to this, micro-segmentation would be based on small blocks typically the width of a transponder or less. Still another way to achieve (flexible) segmentation would be first to define the two edges of a frequency band and then place TV carriers from one edge of the band onwards and SCPC carriers from the other end onwards in reverse direction.

At this stage it is not yet possible to visualize how spectrum segmentation should be best implemented.

One item that has to be considered are the needs of international systems with their special traffic patterns. Also assumptions about the size of future network populations might be necessary before reaching any conclusions. Future studies in this area should therefore give careful consideration to each band situation to determine whether rules should have mandatory force or should have more the status of recommendations, guidelines or preferences.

In principle, spectrum segmentation clearly evolved as being highly desirable. However, intersessional studies are recommended to identify the way in which spectrum segmentation may be best achieved.

3.1.4 Improvements in satellite and earth station antenna radiation pattern

The single, most significant way of improving the efficiency of the utilization of the GSO is by improving antenna radiation patterns. Therefore, in principle, recommendations on their performance characteristics should be as stringent as necessary and practicable.

The feasibility of improving antenna radiation patterns and the economic impact of such changes are considered in section ..... together with recommendations for further study.

3.1.5 Acceptance of higher interference values

The interference to be accepted by administrations is defined in the relevant CCIR Recommendations. The impact of the growing number of satellites in the GSO on interference can be divided into two phases.

In the first phase existing satellite networks may have to accept higher interference levels than they presently have, but still within the recommended CCIR values. This is a part of the burden-sharing approach described in § 3.2.3 and Harmonization M3 mentioned in § 3.2.2.

Since the recommended CCIR values have a bearing on the number of satellites that can be accommodated, the CCIR undertakes studies in this area for the above-mentioned second phase. It is for example estimated that an increase in the permissible interference level in FDM-FM networks from 2 000 pW0p to 2 500 pW0p would allow the separation of satellites used solely in that mode to be reduced by about 20%.

There are, however, also disadvantages:

- the extent of the loss by the system operator of control of the performance of the system is substantial;

- interference takes various forms and may lead to degradations of types not simply constrainable by a bound on channel noise power; for example, impulsive interference might develop;

- the capacity of the satellites is reduced if their characteristics remain unchanged;

- the feasibility of a large measure of frequency reuse within a satellite network, which may be in itself a very powerful method of increasing the efficiency of use of orbit spectrum, is reduced by the presence of so much external interference.

In view of the potential benefits, intersessional studies on interference levels, including the relationship between single-entry value and aggregate value, are recommended. These studies should also take into account that the implementation of modified values has to be time-phased and that the relevant CCITT circuit quality objectives have to be met.

3.2 Methods to make combined use of these technical measures

3.2.1 Computer programs

The main functions of computer optimization is, ideally, to find the best satellite orbital positions, satellite beam shapes and frequency assignments. Several computer programs (e.g. Orbit II, CAP-N, SOAP) exist already which individually do not yet fulfil the overall requirements. Furthermore, the basic parameters to be used in the optimization process need defining.

The assumptions made for these computational aids depend to some degree on the studies to be carried out concerning the technical measures, described in the previous paragraphs, such as beam pattern, frequency plans and spectrum segmentation.

While it is recognized that the assumption of elliptical beams may simplify the computer calculations, it should also be kept in mind that antenna beam characteristics with a fast roll-off pattern result in better orbit utilization.

Questions concerning the proper choice of computer software are considered in section ... together with recommendations for further study.

3.2.2 Harmonization M3

One example, how to combine some of the technical measures mentioned in § 3.1 is Harmonization M3. This method, as described in the CPM Report is based on "spectrum segmentation", "relocation of satellites" and the conceptual element of "equitable interference".

3.2.3 Equitable burden-sharing related to achieving harmonization

As already discussed, the various elements which relate to harmonization may present different technical and operational problems for actual implementation. These various elements can be conceived as a "burden" to be shared between existing and new networks.

The concept of burden-sharing includes the "equitable interference" and "relocation" aspects of Harmonization M3 together with additional technical and operational factors.

The penalty of burden-sharing depends to a large extent on the stages of communication satellite development. More as a starting point for further discussion than to prejudge later decisions the following stages could be considered.

Initial Concept and Design (ICD)

A satellite system in this category has been sufficiently defined such that technical information is available to meet the data requirements of Appendix 4 to the Radio Regulations. This includes specifications of orbit location and frequency, and while the paper design may have been completed implementation has not begun.

Implementation (IM)

Typically it may take from 36 to 48 months to implement a satellite system. This includes construction of the satellite up to, but not including, actual launch. Also during this time some ground segments are designed and constructed and the system would have obtained regulatory recognition. Depending on the progress of the implementation programme there can be opportunities to make design changes to accommodate burden-sharing. Appendix 3 data on the system should be available.

Operation (OP)

At this stage the satellite system has been built, launched and is operating from a particular orbit location, with its associated earth segments. Many of the system design features are fixed, although there may be some built-in flexibility such as beam repointing, transponder gain settings, carrier frequency planning, etc.

Second generation satellite system

At the end of the useful life of a communication satellite, typically 10 years, it is likely to be replaced. At this time, there will be in place an extensive array of earth station users. Therefore, there are a number of transmission parameters which must be retained in order to preserve continued service. On the other hand, the opportunity does exist to incorporate design changes which can assist in burden-sharing. A second generation satellite thus has some of the characteristics of each of the three previous stages.

Technical and operational burdens such as satellite relocation, interference increase, earth station antenna side-lobe performance, spacecraft antenna side-lobe performance and traffic planning can be defined.

The potential value to the harmonization process could be better assessed if this concept of burden-sharing were studied in more detail to determine the extent of parameter adjustments (burdens) practicable over a period of time.

It is therefore recommended to include the concept of equitable burden-sharing in studies during the intersessional period.

4. Impact of threshold parameters used in the present coordination procedure (see § 2.2)

This section is intended to draw attention to the experience made with the present threshold parameters.

Experience has shown that in many cases the present threshold value of 4% for the $\Delta T/T$ criterion was too low. This has led to some unnecessary requests for coordination being initiated posing an additional workload on administrations and the IFRB. It is also true that the calculations are very time consuming.

Some data in Appendix 4 are probably not too relevant for determining whether a request for coordination is necessary.

In addition, as already mentioned in previous paragraphs, there may be room for the acceptability of higher interference levels.

Dependent on the outcome of Committee 5 discussions, studies concerning the technical aspects of coordination procedures would be necessary.

- Were the present procedures, as far as their basic philosophy is concerned, maintained then the following studies would be desirable from a technical point of view:

  - possibility of a higher ΔT/T threshold value, also taking into account that in future higher interference values may have to be accepted (see § 3.1.5);

  - development of simpler, though still accurate interference calculation methods.

- In recognition of the fact that the interference potential depends on the type of the respective interfering carriers, it would be conceivable to define for coordination calculation purposes, types of carriers identified by means of a standard classification. Depending on the combinations of these standard carriers more than one ΔT/T threshold value could be established. This might permit identification of the networks affected with more precision.

  It is, however, apparent that this approach would necessitate having more data available than those contained in the present Appendix 4 (see also Document 174, flowchart, Box (5)).

  For this kind of approach it would be desirable, from a technical viewpoint, to study what would be the benefit of several ΔT/T thresholds and what these values should be.

5. Summary and conclusion

The following list is a summary of individual elements of efficient harmonization considered in this section:

- flexibility in the positioning of satellites (§ 3.1.1);

- frequency planning to reduce spectrum overlap and inhomogeneity; spectrum segmentation (§ 3.1.3);

- improvement of satellite and earth station antenna radiation pattern (§ 3.1.4);

- acceptance of higher interference values (§ 3.1.5);

- computer programs (§ 3.2.1);

- Harmonization M3 (§ 3.2.2 together with 3.1.1, 3.1.3 and 3.1.5);

- equitable burden-sharing concept (§ 3.2.3).

The status of present studies on these elements indicate their usefulness, and, although not at a sufficiently advanced stage to enable firm recommendations to be made, intersessional studies are clearly warranted.

The kind of studies to be done on threshold values (ΔT/T) for coordination depends on the decisions that Committee 5 will take.

V. JANDA
Chairman of Drafting Group 4C-5

INTERNATIONAL TELECOMMUNICATION UNION

ORB-85 WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT

FIRST SESSION, GENEVA, AUGUST/SEPTEMBER 1985

Document DL/30-E
27 August 1985
Original: English

SUB-WORKING GROUP 6A2

Note by the Chairman of Sub-Working Group 6A2

The following text is proposed to be added at the end of paragraphs 4.3.1.3 and 4.3.3.3 of Article 4 of Appendix 30, before "; or":

"or having such an assignment for which its associated service area does not cover the whole of the territory of the administration, and in whose territory outside any service area of its broadcasting-satellite space station the power flux density from the broadcasting-satellite space station subject to this modification exceeds the prescribed limit as a result of the proposed modification".

J.F. BROERE
Chairman of Sub-Working Group 6A2

INTERNATIONAL TELECOMMUNICATION UNION

ORB-85 WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT

FIRST SESSION, GENEVA, AUGUST/SEPTEMBER 1985

Document DL/31-E
28 August 1985
Original: English

WORKING GROUP 4C
DRAFTING GROUP 4C-6

ELEMENT FOR ITEM 2.1 - MEANS FOR ACHIEVING EFFICIENT USE OF THE ORBIT AND SPECTRUM

THE PROBLEM OF GLOBAL COVERAGE AND NARROW SERVICE ARCS

1. Introduction

Some telecommunications satellite systems are required to cover much or the whole of the visible portion of the Earth. Such applications include major international and regional systems, and perhaps also some national systems with dispersed or wide territories or population centres.

2. Global beams

Use of global beams by satellites is at present a common means of providing such coverage. However, from the standpoint of efficient orbit/spectrum use, global beams do not usually constitute the most satisfactory solution. Problems with them include inhomegeneity relative to systems using spot beams, and very wide potential coordination areas.

Further, the "arc of mutual visibility" as reduced by other constraints in an FSS system to the "service arc" is an absolute limitation on the choice of an orbital location if service is to be provided between any two earth stations at the extremities of the service area(s) and at a nominal minimum elevation angle of 3° at the Earth's surface (see RR2550).

3. Application of intersatellite links

Due to sharing constraints, some portions of the GSO may not be suitable for satellites used to provide fixed-satellite networks in global coverage or very large coverage area systems. A possible solution is the use of direct satellite-to-satellite relays. In this manner, a satellite serving earth stations widely dispersed in longitude, and therefore having an unavoidably short service arc, can be replaced by two satellites with direct interconnections, each with a long service arc, thus introducing much greater flexibility in the choice of an orbital location. The use of inter-satellite links (ISL's), among other techniques, may facilitate coordination between global or large coverage area systems and domestic or small coverage area systems to the extent that they reduce inhomegeneity through reduced coverages and higher e.i.r.p.

The introduction of inter-satellite links, however, depends on technical and economic considerations and on the availability of a mature level of technology.

The technical feasability of the use of inter-satellite links has already been experimentally demonstrated. However, in the short to medium term, the use of ISL's to provide wide-area coverage is likely to carry a large implementation and economic penalty. As a result, the use of ISL's to reduce the need for global beams is not considered a practical option for consideration by either session of the Conference, and thus does not warrant specific study during the inter-sessional period. In the long term, ISL's may become economically attractive for some applications. Thus the continued study by the CCIR of their characteristics, advantages and penalties is warranted.

4. Conclusions

It is very desirable that global beams should be used only when strictly necessary, and with their use limited, as far as practicable, to a specified portion of the allocated band, thus facilitating spectrum harmonization. Studies and experiments should be conducted with a view to developing a more efficient system to replace this type of beam in the medium or long term.

The requirements of global and other satellite systems covering large areas, which are different from those of satellite systems covering only limited areas, must be given due consideration.

In summary, it is concluded that inter-satellite links will not offer a viable alternative to the use of global beams for at least the next 10 to 15 years for most applications. As a result, the continuing use of global beams is warranted and can be expected to continue for some considerable time, but their use should be employed to the minimum extent necessary.

G.F. JENKINSON
Chairman of Drafting Group 4C-6

INTERNATIONAL TELECOMMUNICATION UNION

ORB-85 WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT

FIRST SESSION, GENEVA, AUGUST/SEPTEMBER 1985

Document DL/32-E
28 August 1985
Original : English

STEERING COMMITTEE

Note by the Secretary General

STRUCTURE OF THE REPORT

Further to discussions in the Steering Committee, the following draft structure is suggested as a guideline for the Committees in the completion of their work.

CHAPTER 1: INTRODUCTION

CHAPTER 2: PREVAILING SITUATION FOR THE FREQUENCY BANDS ALLOCATED TO SPACE SERVICES

CHAPTER 3: DEFINITIONS

CHAPTER 4: PLANNING

4.1 Planning principles

4.2 Frequency bands and space services identified for planning

4.3 Planning method[s]

4.4 Technical parameters and criteria

4.5 Guidelines for associated regulatory procedures

CHAPTER 5: GUIDELINES FOR REGULATORY PROCEDURES FOR SPACE SERVICES AND FREQUENCY BANDS NOT IDENTIFIED FOR PLANNING

CHAPTER 6: BANDS FOR WHICH SHARING CRITERIA BETWEEN SERVICES (SPACE OR TERRESTRIAL) NEED TO BE DEVELOPED

CHAPTER 7: FEEDER LINKS FOR THE 12 GHz BROADCASTING-SATELLITE SERVICE IN REGIONS 1 AND 3

7.1 Bands for which frequency plans should be established

7.2 Planning method

7.3 Technical parameters and criteria

7.4 Intersessional activities

CHAPTER 8: BROADCASTING-SATELLITE SERVICE (SOUND) (WARC-79 RESOLUTION No. 505)

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R.E. BUTLER

Secretary-General

INTERNATIONAL TELECOMMUNICATION UNION

ORB-85 WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT

FIRST SESSION, GENEVA, AUGUST/SEPTEMBER 1985

Document DL/33-E
28 August 1985
Original: English

WORKING GROUP 5A

Note from the Chairman

DIFFERENT PLANNING SOLUTIONS IN DIFFERENT CIRCUMSTANCES

Although a worldwide planning solution would be the most suitable, the possibility of having different planning methods for different regions, frequency bands or orbital arcs may be more efficient and shall not be excluded. In this case, the planning would be done at the same World Conference.

F.S.C. PINHEIRO
Chairman of Working Group 5A

INTERNATIONAL TELECOMMUNICATION UNION

ORB-85 WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT

FIRST SESSION, GENEVA, AUGUST/SEPTEMBER 1985

Document DL/34-E
28 August 1985
Original: English

WORKING GROUP 4C

GENERALIZED PARAMETERS

Several input documents made specific reference to the need for use of generalized parameters to manage the orbit/spectrum resource. This would provide the maximum in flexibility to the users with respect to meeting their requirements while, at the same time, providing for some control of the interaction between networks. Several of these documents also contained specific proposals on particular sets of such parameters to accomplish this purpose.

Generalized parameters can be employed for several purposes:

1) to provide network design guidelines containing the elements necessary to produce a certain level of orbit utilization efficiency while retaining degrees of flexibility for the network designer;

2) to establish threshold conditions to identify the need for coordination;

3) to expedite the resolution of some problems without the need for detailed examination during the coordination process.

Particular generalized parameters have been used in the past for very specific applications, for example delta-T for the coordination threshold. Others have been studied for the purpose of improving efficiency of orbit utilization through constraints, for example, the ABCD parameters. Still others can, and have been, developed for particular application and include characteristic orbital spacing (COS), isolation and variations on the ABCD parameters.

Although there are a number of possibilities, it should be noted that all derive from the same basic interference relationships among the system characteristics. In their simplest form, each interference term is composed of the ratio of the interfering and wanted carrier e.i.r.p.s reduced by the discrimination available from earth station and spacecraft antennas and the absolute e.i.r.p. levels are not material to the level of interference. To minimize the interference the total discrimination should be maximized.

There are examples of the application of generalized parameters in existence, although not necessarily for the purpose contemplated here. They are usually contained in Recommendations of the CCIR and in Articles of the Radio Regulations. The parameters generally define one or more aspects of the interference environment which results from the simultaneous use of the same frequencies by systems of the same or different services. The particulars include power flux-density (pfd), e.i.r.p. density, and terms establishing the interference susceptibility of systems.

An important aspect in considering the use of such parameters is that associated with the objectives of 1) above. A given set of parameters can be improved or upgraded with time to permit greater orbit utilization to meet growing demand. Such improvements can be based on a specific technology effecting only one parameter, or can be more generally based on a need to establish an overall better orbit utilization which may be essential to permit accommodation of new networks in the future. Such improvements would likely carry additional constraints.

Generalized parameters specifics

1) ABCD

The study of this particular set of parameters was begun in 1977 by Interim Working Party 4/1 of the CCIR and the current status is contained in the CPM Report. Efforts to define prescribed values have not been successful primarily because of consequential constraints on systems and detailed study has been virtually abandoned in recent years.

A general observation on the ABCD parameters is they are not precise in characterizing actual interference, requiring some assumptions regarding actual individual transmission characteristics. In particular, A and C characterize the interference potential of transmissions only by the highest spectral density in a relatively narrow bandwidth while B and D reflect only the receiving system characteristics and not the specific characteristics of individual carriers. Two systems with the same ABCD parameters can therefore have widely different interference characteristics.

In addition, parameters A and B in combination will yield one value for satellite spacing while parameters C and D in combination will yield a different one unless specifically chosen to yield the same result. Both pairs are dependent upon the assumption of a particular delta-T, for the up-link for A and B and for the down-link for C and D. This provides a degree of refinement not possible with the current delta-T concept, but requires that up- and down-link contributions to interference be known.

2) Variations on ABCD

A particular variation of the ABCD parameters involves modification to the parameters B and C to reflect their impact on the environment outside of the intended coverage while maintaining A and D in the usual form. While this appears to improve on some of the perceived shortcomings of the original ABCD set, the amount of study and detailed examination necessary to confirm this has not been done. The ability to establish realistic values for B and C in this variation also relies on appropriate definition of spacecraft antenna characteristics.

A second variation presented is nearly the same as the above except that A* is dependent upon the size ot the service area, and B* and D* are not related to the single entry interference criterion, but to the aggregate interference level. This is aimed at the orbit congestion situation in which all systems are already at the aggregate limit or nearly so, and at this time the single entry has little meaning. This particular set would also require the definition of an appropriate bandwidth unit to be used that would likely be different than had been used with the original ABCD parameters.

The use in this particular situation is based on a simplified calculation of the aggregate C/I which would be used to support a planning exercise by specifying limits which take into account coverage and various reference parameters. It is also suggested that in an evolutionary environment, the values for A*, B*, C*, D* would be those actually used by existing systems and would be used to optimize the satellite locations.

As in the general ABCD case, a number of limitations exist and the possibilities for particular constraints are present for each of the variants.

3) Isolation

This concept is derived from network parameters with the intent of establishing a high level of orbit efficiency which can be expected or is needed and identifying this level of efficiency with all of the network parameters which produce this limit. The presentation is in a form which separates those elements which can be standardized easily and those which cannot. It is contended that use of this particular approach to establish these conditions will produce the best chance for achieving this efficiency.

In this regard the isolation concept is considered to yield a precise measure of actual interference between carrier pairs and can be used with knowledge of only major network design characteristics. As a result, its general use as a criteria would result in systems which are sufficiently compatible that successful coordination is likely. In this sense, isolation also provides a realistic threshold for establishing need for coordination.

There would be a need to establish the relationship between isolation and C/I for actual coordination purposes.

4) Characteristic orbit spacing (COS)

The "Characteristic orbital spacing (COS)" of a network is defined as the minimum spacing required between a hypothetical series of identical satellites serving a given service area, with the satellites assumed to be spaced equally across the visible arc.

The approach would be to select a value for COS which would in turn reflect the technical characteristics for all interference parameters collectively. Alternatively, various parameters such as C/I or antenna patterns could be selected and the useable COS so defined.

In use, the actual spacing would be the COS reduced by the satellite antenna discrimination that might be obtained. The reduction factor is particularly simple to derive when off-axis e.i.r.p. density of the Earth and the space stations (parameters A and B of ABCD) are standardized or confined to a small range.

Another aspect is the possibility for checking the aggregate interference by adding only the actual separation angles for nominal cases.

The COS is in essence, a property of a given network. It applies whether or not in practice there are more than one satellite serving a given service area and it is readily quantifiable, without necessitating the detailed consideration of technical parameters, traffic types used, interference standards, etc. Due to its quantifiable nature, it can be readily standardized, and used as a basis for equitably defining any sharing scheme for the spectrum orbit resource.

Observations

A number of interesting possibilities have been considered and the following observations are made:

1) generalized parameters can be useful in technical management of the GSO regardless of specific planning approaches while providing some degree of flexibility;

2) they can also be useful in establishing coordination thresholds and resolution of some coordination problems;

3) all of the particular approaches examined would appear to produce some constraints, although these constraints are applied to the general parameters which are made up of specific parameters. Some degree of variation is then possible for each constituent parameter;

4) an area of particular concern that was identified are those parameters that may depend upon current practice in operational systems as it is expected they will result in a wide range of values to be accommodated;

5) it is not possible at this meeting to establish how well any of the particular approaches would achieve their stated objectives and further study of each is needed in the intersessional period.

D.J. WITHERS
Chairman of Working Group 4C

INTERNATIONAL TELECOMMUNICATION UNION

ORB-85 WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT

FIRST SESSION, GENEVA, AUGUST/SEPTEMBER 1985

Document DL/35-E
28 August 1985
Original: English

SUB-WORKING GROUP 4B-2

DRAFT COMMENT ON THE IMPLICATIONS FOR COORDINATION DISTANCES OF SPECIFYING NOMINAL FEEDER-LINK EARTH STATION SITES

1. The possibility of specifying nominal BSS feeder-link earth station sites has been suggested in order to facilitate coordination with other services sharing a frequency allocation in which BSS feeder-link plans are being developed.

2. A powerful means of reducing coordination distances by such techniques as natural topographical, or artificial, shielding would appear to be cast aside if nominal sites were to be thus specified. This is because the calculation of the extent of the additional isolation achievable, perhaps 30 dB, depends upon detailed knowledge of the earth station site and its surroundings - information that can only reliably be obtained when sites are actually being surveyed during the site selection process.

3. Assuming that shielding is to be employed as a means of reducing coordination areas to the extent practicable, there is a need for intersessional studies to review the provisional nature of the site shielding values for horizon elevation angles greater than 5° implied by equation 7(a) and Figure 1 of Appendix 28.

K.R.E. DUNK
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INTERNATIONAL TELECOMMUNICATION UNION

ORB-85 WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT

FIRST SESSION, GENEVA, AUGUST/SEPTEMBER 1985

Document DL/36-E
29 August 1985
Original: English

SUB-WORKING GROUP 6A, ad hoc 1

IDENTIFICATION AND RESOLUTION OF POTENTIAL INCOMPATIBILITIES BETWEEN ASSIGNMENTS IN THE REGION 2 BSS PLAN AND FSS SPACE-TO-EARTH LINKS IN REGIONS 1 AND 3

The following information is provided as background for discussions in Sub-Working Group 6A, ad hoc 1, of potential incompatibilities between Region 2 BSS and Region 1 or 3 FSS.

The FSS networks to be considered are as follows:

Region 1 FSS network	Orbital position (°N)
Unisat 1 ATL SCPC	31
Unisat 1 Typical SCPC	31
Unisat 1 Telemetry	31
Videosat 2	37.5
Videosat 3	43.5
Intelsat IBS SCPC	40.5
Intelsat IBS SCPC	50
Intelsat IBS SCPC	53
Intelsat IBS SCPC	56
Intelsat IBS SCPC	60

The BSS assignments of the Region 2 Plan to be considered are those in the orbital arc from 31°W to 69°W with assignments in the frequency range 12.5 - 12.7 GHz since only these are potential sources of interference to the FSS satellites in question, as follows:

Region 2 BSS beam	Orbital position (°W)	Channels
B CE 312	45 ± 0.2	20-32
B CE 412	45 ± 0.2	20-32
B SU 112	45 ± 0.2	20-32
B SU 212	45 ± 0.2	20-32
ATN BEAM 1	52.8	22, 26, 30
GRLDNK 01	53.2	23, 27, 31
5 PM FRAN 3	53.2	21, 25, 29
GUF MCG 02	53.2	20, 24, 28, 32
ARG INSU 5	55.2	21, 23, 25, 27, 29, 31
ARG NORT 5	54.8	20, 22, 24, 26, 28, 30, 32
ARG SUR 05	55.2	21, 23, 25, 27, 29, 31
GRD 00059	57.2	23, 27, 31
USA EH 001	61.5 ± 0.2	20-32
B CE 311	64 ± 0.2	20-32
B CE 411	64 ± 0.2	20-32
B CE 511	64 ± 0.2	20-32
MEX 01 SUR	69.2	21, 23, 25, 27, 29, 31

Referring to the Report 809 calculations of the IFRB dated 22 August 1985, no incompatibilities appear to exist between the Region 2 assignments and the Unisat networks or the Videosat 2 network.

In the case of Videosat 3, there are potential incompatibilities on 10 out of 32 channels on each of three Brazilian beams at 45° only for the case where the Videosat 3 earth station uses the assumed 1.3 m antenna. The ratios of C/I (after correction of the space station e.i.r.p. at the edge of the service area) are:

B CE 312: 34.3 dB

B CE 412: 30.5 dB

B SU 212: 32.5 dB

Whether or not these constitute incompatibilities depends on the degree of interference protection required. If a single-entry protection ratio of 35 dB is applied, the calculated values are deficient by 0.1, 4.5 and 2.5 dB, respectively. If a "total" protection ratio of 30 dB is specified, the incompatibility nearly disappears. Finally, if either of these protection criteria are adjusted to account for the modulation index permitted by the transponder bandwidth, the incompatibility disappears altogether.

Independent of the values assumed for the protection ratio, any potential incompatibility can be reduced or eliminated by specifying linear polarization for the Videosat 3 network (as was done at the time of advance publication) and/or by using BSS satellite transmitting antennas with side-lobe performance superior to that of the reference pattern used for the Region 2 Plan.

In the case of the Intelsat IBS transmissions, the number of incompatibilities depends on the protection ratio specified for the SCPC signals. In the values of C/I calculated by the IFRB, the value of C represents the power in a single SCPC carrier (corresponding to an e.i.r.p. of 13.2 dBW) and I represents the total power of the TV/FM BSS carrier. In order to compare these C/I values with the protection ratio of about 27 dB which is appropriate when the interfering power is that appearing within the bandwidth of the SCPC signal, it is necessary to increase the calculated value of C/I by the ratio in dB of the total BSS carrier power to that fraction permitted to fall in the SCPC channel.

If the SCPC carriers are excluded from an interval of ±1 MHz about the BSS carrier frequency, the spectral density of the TV/FM carrier is such that the power in a 40 kHz bandwidth is about 22 dB below the total TV/FM power. With this adjustment, the lowest values of C/I, corresponding to the four BSS beams at 53.2°W interfering with the Intelsat IBS at 53°W, fall in the range from 14.7 to 17.1 dB.

To obtain a further improvement in C/I to meet a 27 dB protection ratio, it would appear necessary to introduce an orbital separation of between 0.5 and 1.0° between the BSS and FSS satellite.

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Chairman of Sub-Working Group 6A, ad hoc 1

INTERNATIONAL TELECOMMUNICATION UNION

ORB-85 WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT

FIRST SESSION, GENEVA, AUGUST/SEPTEMBER 1985

Document DL/37-E
29 August 1985
Original: English

WORKING GROUP 4C

THE RADIATION PATTERN OF EARTH STATION ANTENNAS

The side-lobe radiation pattern of the earth-station antenna, more particularly in the first 10° from the principal axis and in the direction of the GSO, is one of the most important factors in determining the interference between systems using geostationary satellites. A reduction in side-lobe gain levels would reduce the minimum orbital separations required between satellites and increase the efficiency of utilization of the orbit significantly.

Technical improvements are being made in the design of these antennas, reducing side-lobe gain levels. The definition by the CCIR of recommended performance targets for new antennas should lead to further improvements. In the course of time the cost of high performance antennas will fall and their use should become more general. Nevertheless the cost of earth station antennas is a major element in the economics of networks which use large numbers of small-diameter antennas, above all in dispersed territory situations. Such situations are typical of the networks of developing countries, and it is important that the opportunity remains available for antennas of well-established, mature technology with low unit cost to be used in such networks.

The following earth station antenna radiation patterns should be assumed in determining any mandatory performance criteria required for planning in the short term.

a) In frequency bands and orbital arcs which are identified as being used mainly for the networks of developing countries, the gain of the side-lobe peaks at an angle φ° from the boresight direction will not exceed:

$32 - 25 \log \varphi$ dBi (where φ is between 1° and 48°)

and

-10 dBi (where φ is greater than 48°)

if the diameter of the main reflector is greater than 100 times the wavelength. For smaller antennas, performance should be related to the diameter/wavelength ratio, D/λ, such that the gain of the side-lobe peaks will not exceed:

$52 - 10 \log D/\lambda - 25 \log \varphi$ dBi (where φ is between $\frac{100\lambda^\circ}{D}$ and 48°)

and

$10 - 10 \log D/\lambda$ dBi (where φ is greater than 48°)

b) In other frequency bands and orbital arcs, a more stringent standard should apply within the solid angle where unwanted radiation has the most serious effect on other networks.

For large antennas, performance should be assumed to be 3 dB better than the figures given for large antennas above in directions which are within 3° of the geostationary satellite orbit and 20° of the boresight direction. The performance to be assumed for small antennas needs to be determined in intersessional studies.

It is to be expected that many existing earth station antennas will not achieve the standard stated in b) above. However, it is foreseen that the mandatory performance criteria to be developed for planning purposes will allow considerable flexibility in the way in which the criteria are met, permitting such antennas to remain in service. This should be verified when the criteria are under study.

From time to time, on occasions which might be related to Plenary Assemblies of the CCIR, the side-lobe gain assumptions used for determining planning criteria should be reviewed in the light of then-current CCIR Recommendations and the cost of equipment.

D.J. WITHERS
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INTERNATIONAL TELECOMMUNICATION UNION

ORB-85 WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT

FIRST SESSION, GENEVA, AUGUST/SEPTEMBER 1985

Document DL/38
29 August 1985
Original: English

WORKING GROUP 4C

ACCOMMODATION OF SPARE SATELLITES IN ORBIT

The provisions of spare satellites in orbit reduces greatly the risk of serious loss of availability of satellite facilities due to spacecraft failures in service. Three situations commonly arise.

1. With appropriate telecommand and telemetry design, a spare satellite may be co-located with the operational satellite. In this case the spare satellite does not increase the requirements of the system for orbit or spectrum.

2. Where a common spare satellite is used to protect services via two or more operational satellites which are close together in orbit, co-location of the spare satellite with any one of the operational satellites would not be satisfactory. For example, with that arrangement it would not be feasible to transfer services to the spare satellite from one of the operational satellites with which it was not normally co-located without first moving the spare satellite away from its nominal location and preferably to the location of the failed satellite. This would involve a long period of loss of service, a significant expenditure of thruster fuel and the possibility of interference with other satellites during the transit period. A common spare would have to occupy a planned or coordinated orbit location of its own, permitting rapid point-over from a failed satellite to the spare. This practice clearly increases the total orbit/spectrum occupancy of the system without a corresponding increase in the traffic carried.

3. However, it is currently usual for a spare satellite to carry pre-emptible traffic when it is not carrying traffic displaced from a failed satellite. A spare satellite which is used in this way needs its own orbit assignment, which increases the total orbit/spectrum occupancy of the system, but it increases the total traffic carried as well.

D.J. WITHERS
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INTERNATIONAL TELECOMMUNICATION UNION

ORB-85 WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT

FIRST SESSION, GENEVA, AUGUST/SEPTEMBER 1985

Document DL/39-E
29 August 1985
Original: English

WORKING GROUP 4C

MODIFIED TEXT FROM CPM REPORT § 4.6.1.3.3

In the geostationary satellite orbit there is a risk of collision with active spacecraft and blockage of beams of operational satellites due to the presence of uncontrolled man-made objects. At present, the probability of such physical interference is very low, though the number of satellites is expected to increase over time. It is advisable therefore, to urge the CCIR to develop in the intersessional period a better understanding of this physical interference process leading to:

- an identification of what is thought at present to be a theoretical problem;
- an evaluation of the risks that this phenomenon could present in the future;
- a recommendation for a solution to the problem should the study results justify further action.

The second session of WARC-ORB is invited to review the progress of these CCIR studies.

D. EDEN
Chairman of Drafting Group 4C-11

INTERNATIONAL TELECOMMUNICATION UNION

ORB-85 WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT

FIRST SESSION, GENEVA, AUGUST/SEPTEMBER 1985

Document DL/40-E
29 August 1985
Original: English

WORKING GROUP 4C

VISIBLE ARC AND SERVICE ARC

The arc of the geostationary satellite orbit within which a satellite must be located if it is to perform its mission satisfactorily is determined by the "visible arc" and the "service arc" of the network. These terms are explained in the Radio Regulations, Appendix 3.

A satellite located anywhere within the visible arc should be visible from any of the earth stations of the network at an angle of elevation not less than 10°. The visible arc will be short in certain geographical situations, and particularly if the service area is very long in the East to West direction or if it includes territory at high latitudes. For small service areas, not at high latitudes, the visible arc will be very long.

The service arc is the arc of the orbit within which the space station could provide the required service. Ideally the service arc may be as long as the visible arc in the initial stages of the definitions of a satellite network; indeed it may be larger than the visible arc if an angle of elevation of less than 10° is acceptable at earth stations. If the climate in the service area involves heavy rain, such that performance would be severely impaired at low angles of elevation, the administration responsible for the network may determine the initial service arc so that the minimum angle of elevation at earth stations is greater than 10°, particularly if frequency bands above 10 GHz are to be used. Some such limitation may also be appropriate if there are sand or dust storms in the service area; however, little is known at present about the effect of sand or dust in the atmosphere on slant path propagation.

In terrain obstruction situations, where the propagation paths between earth stations and the satellite at low angles of elevation may be blocked by mountains, it may be possible to determine the visible arc taking into account the angle of elevation of the actual horizon as seen from all of the earth stations in the network. However, this may not always be possible, since the location of some of the earth stations may not be known at the time when the characteristics of the network are initially being determined. In such a case, it may be desirable to disregard terrain obstructions when determining the visible arc, and to determine the initial service arc so that the angle of elevation at all earth stations, relative to the horizontal plane, would not restrict the possible location of earth stations unduly. In a very mountainous country a suitable value for the minimum angle of elevation might be 30°, unless the latitude of the country was too high to allow such a figure.

FLEXIBILITY OF THE NOMINAL POSITION OF A SATELLITE

The service arc for a service area which is not very large may initially be long. However, as the design and manufacture of the equipment for the network progress, in step with the determination of the nominal location of the satellite, the service arc becomes shorter. Finally, when the spacecraft has been launched and the network is in service the service arc may become quite short, perhaps only a few degrees.

There will be a few cases where the coverage requirements of a satellite will be so critical that even a small change in the satellite position would impair service to some earth stations. On the other hand, there will be many cases where the design of the satellite and the associated earth stations is such that the need to change the satellite position slightly would not present any difficulty or penalty provided such changes were required only once or twice in the lifetime of a satellite. Flexibility of this kind could prove very useful in minimizing interference between systems in congested parts of the orbit and in implementing changes found to be desirable as a result of coordination for a new planned satellite.

It has also been shown that the length of the orbital arc that is needed for a number of satellites serving different service areas depends upon the relative positions of the various satellites. It was found that the minimum length of orbital arc that would be acceptable, for stated interference conditions, varied considerably depending upon the arrangement of the satellites in the orbit. Some arrangements needed only about one-half as much space as other arrangements. It should also be noted that it is not possible to say with certainty which geographical areas would need to be covered at some time in the future from a given part of the orbit; full advantage could therefore be taken of this means of optimizing the use of the orbit only if networks were designed so that their satellites could be relocated, if necessary, within a service arc after having been put into service.

However, provision for more than quite a small amount of flexibility of orbital position may also raise substantial problems which have not been fully evaluated yet. For example:

a) the design of satellite antennas to accommodate flexibility of satellite position without loss of coverage of parts of the service area may increase the cost of the antennas. Such design may also reduce the antenna gain to a small extent, with some consequential impact on the communications capacity of the network and possibly an effect on the required separation between satellites; it may also lead to some expansion of coverage areas;

b) frequent on rapid transfer of satellites from one location to another would involve the expenditure of a significant amount of thruster fuel;

c) substantial operational problems may arise when a working satellite is being moved, particularly if it must pass close to another working satellite whilst in transit. Service will often be interrupted for considerable periods. Non-tracking earth station antennas will have to be repointed, possibly several times if the transit is long or slow, which could be costly;

d) there may be reasons why little or no significant flexibility is feasible in the nominal location of some specific satellites; for example, the visible arc may be very small or one service provided by a multi-service satellite may be planned.

Studies of these matters are in progress in CCIR. Intersessional studies are needed to provide a full evaluation of these technical, operational and economic issues, to enable WARC-ORB(2) to decide what regulatory action, if any, would be appropriate. These studies should consider two situations, firstly where the relative order of satellites in orbit remains unchanged but their relative angular separation is changed, and secondly where the order is changed.

D.J. WITHERS
Chairman of Working Group 4C

INTERNATIONAL TELECOMMUNICATION UNION
ORB-85 WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT
FIRST SESSION, GENEVA, AUGUST/SEPTEMBER 1985

Document DL/41-E
29 August 1985
Original: English

WORKING GROUP 4C

SATELLITE STATION-KEEPING

Natural forces cause three main perturbations of the orbits of geostationary satellites. Relative to an earth station the apparent effects of these perturbations are as follows:-

a) there is a long-period east-west movement due to errors in the orbital period;

b) there is a daily north-south movement, having also a small east-west component, due to orbital inclination;

c) there are daily movements with an east-west component and another component involving movement towards the Earth and away from the Earth, due to ellipticity of the orbit.

The Radio Regulations, Article 29, apply limits to east-west movements, in order to maintain efficient orbit utilization. Most satellites of the FSS in the future will be required to remain within $\pm 0.1^{\circ}$ of their nominal position in the east-west plane. Some satellites in service are already controlled to within $\pm 0.05^{\circ}$; such precise station-keeping may provide benefits to the system, including a reduction in the cost of earth stations where antenna tracking is not required if north-south station-keeping is also good.

At the present time there is no regulatory constraint on satellite movement in the north-south direction but most satellites now in operation are, in practice, controlled in the north-south direction within limits similar to the east-west tolerances. [However, the cost to systems of a regulatory constraint in terms of thruster fuel could be substantial and it might, in some circumstances, lead to a requirement for a satellite to be withdrawn from service before its planned lifetime had expired. It is not evident at present that there is a need for regulation in this matter.] [It is recognized that the cost to systems of a regulatory constraint could be substantial in terms of limiting the possible extension of satellite life. However, the impact of reduced interference potential of different north-south tolerances and the extent to which such tolerances could simplify earth station design and reduce costs should be studied in the intersessional period, with a view to establishing the right balance between the potential benefits and the operational and economic penalties that would result from regulatory constraints.]

There is also no regulatory provision for limiting the ellipticity of orbits other than the constraint on the daily east-west component of motion provided by Article 29 of the Radio Regulations. However, it is possible that the relative motion, due to orbital ellipticity, of satellites which are adjacent in orbit would impede the application of reverse band working. There has been no study of this matter in CCIR to date. Intersessional studies are required to investigate the possible need to apply regulatory constraints on orbital ellipticity in frequency bands where reverse band working is implemented.

Space operation functions for the FSS

The space operation service with its space telemetry, telecommand and tracking functions performs both crucial and routine duties for space missions. In many cases, the services performed in space operation bands are on a short-term basis (e.g., launch and positioning operations); thereafter they are routinely performed in bands other than those allocated to the space operation service (e.g., the mission bands of the satellite).

The placing on station and station-changing phases of geostationary satellites will increase in number over the next few years and their individual duration may be extended. In view of the importance of space operation during these phases, the frequency requirements must be examined with as much care as in the case of phases of normal use.

To reduce the risks of mutual interference between satellites already on station and satellites being manoeuvred, two solutions may be envisaged, one of them being to use frequencies selected from the bands allocated to the space operation service for the satellite being manoeuvred.

Another solution, which might be better from the economic standpoint and from that of optimum spectrum utilization, is to use frequencies chosen from the bands allocated to the service corresponding to the mission of each space system (FSS, MSS, BSS, etc.). In this case, however, it might be useful to designate in the mission band a narrow sub-band (for example, 0.5% of the allocated band) to be used for space operation during the placing on station and station-changing phases.

The necessity to reserve a sub-band for operational functions in launch phases and manoeuvres should be studied during the intersessional period to allow the second session to take an appropriate decision. One will take into account the current practices and the need for world-wide tracking networks.

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INTERNATIONAL TELECOMMUNICATION UNION

ORB-85 WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT

FIRST SESSION, GENEVA, AUGUST/SEPTEMBER 1985

Document DL/42(Rev.1)-E
2 September 1985
Original: English

Source: CPM Report § 4.2.10 (Annex 4), Document 18

WORKING GROUP 4C

Section 2.8

Drafting Group 4C-8

REVERSE BAND WORKING

It is feasible to use the same frequency band for up-links to one satellite and for down-links from another satellite, given suitable off-axis antenna characteristics at both satellites, a certain minimum orbital separation between the satellites and sufficient separation between the earth stations of the two networks. When combined with forward band working, RBW could provide a very significant degree of resource enhancement for the FSS. One study indicates that this enhancement might be as much as 75% if means could be found for dealing with interference to and from terrestrial services.

As a technique it is well within current technology although its implementation would add some constraint to coordination with existing systems sharing the same frequency bands. It should be noted that the use of high RBW earth station elevation angles (40° or more) would largely ameliorate these coordination constraints.

Operation of a frequency band in both directions creates several interference paths which do not arise when bands are operated unidirectionally.

A recent study by one administration has examined these new interference situations and has concluded that:

a) there will be no insuperable problems of interference with terrestrial services given a minimum satellite angle of elevation at earth stations of about 40°;

b) the separations required between earth stations using a pair of frequency bands in opposite senses will be no greater than are typically required between earth stations and radio relay stations;

c) difficulties associated with the antipodal interference path may be substantially reduced by arranging beam areas and/or satellite positions for RBW satellites such that equatorial beams are displaced by at least one half 3 dB beamwidth from the earth's limb (for a 2° beam based on satellite antenna characteristics in CCIR Report 558-2).

These restrictions would be achieved naturally in the case of regional/domestic uses, particularly in low latitude countries where relatively high rain rates and system geometry would dictate high elevation angles. Indeed, at 40^{o} RBW earth station elevation angles, the difficulties associated with antipodal interference would be entirely overcome.

From the foregoing considerations, the technique of reverse band working could offer substantial spectrum/resource enhancement for the FSS if it were carefully implemented. The problems of implementation should be the subject of intersessional studies.

These studies should be limited to national or regional systems operating in FSS frequency bands at 6/4 GHz and 14/11 GHz, and in particular the expansion bands. Consideration should be given to:

- problems that may arise from interregional differences of frequency allocations;
- the possible need for coordination modes not already covered in Appendix 29;
- the extent to which the introduction of RBW would increase the orbit/spectrum resources of the FSS;
- the most appropriate means of facilitating sharing between RBW satellite networks and terrestrial services;
- the most economically advantageous way of implementing RBW.

It would be valuable to confirm the outcome of these studies by experimentation.

D. EDEN
Chairman of Drafting Group 4C-8

INTERNATIONAL TELECOMMUNICATION UNION

ORB-85 WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT

FIRST SESSION, GENEVA, AUGUST/SEPTEMBER 1985

Document DL/42-E
29 August 1985
Original: English

Source: CPM Report § 4.2.10 (Annex 4), Document 18

WORKING GROUP 4C

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It is feasible to use the same frequency band for up-links to one satellite and for down-links from another satellite, given suitable off-axis antenna characteristics at both satellites, a certain minimum orbital separation between the satellites and sufficient separation between the earth stations of the two networks. When combined with forward band working, RBW can provide a very significant degree of resource enhancement, both for the orbit and of the radio frequency spectrum, perhaps by as much as 75%.

As a technique it is well within current technology although its implementation would add some constraint to existing systems sharing the same frequency bands. It should be noted that the use of high RBW earth station elevation angles (40 degrees or more) would largely ameliorate these constraints.

Operation of a frequency band in both directions creates several interference [modes/paths] which do not arise when bands are operated unidirectionally.

An initial study has examined the four additional interference paths which are:

a) between RBW satellites and the fixed service;

b) between adjacent FBW and RBW satellites;

c) between FBW and RBW earth stations; and lastly

d) between FBW and RBW satellites looking towards each other across the GSO, the so-called "near antipodal" case.

The study points to the following interim conclusions:

a) Although the inter-service sharing problems have not been discussed in detail in Working Group 4C, it is however important to note that the definition of minimum RBW earth station elevation angles of the order of 40 degrees is necessary in order to substantially ameliorate the interference situation with respect to the fixed service [see element from Working Group 4B].

b) For a wide range of representative satellite networks employing antenna characteristics given in CCIR Report 558-2 but with a modification to the wide angle gain from -10 dBi to -5 dBi, a 0.5 degree satellite separation would result in a multiple entry value of C/I of 42 dB or greater.

c) For the earth station to earth station path, the interference levels are more complex to analyze, however it would appear that:

   1) coordination distances for CCIR mode 1 (great circle propagation) would be less than those for terrestrial to earth station paths;

   2) provided minimum elevation angles are greater than 5 degrees, coordination distances for CCIR mode 2 (scattering from hydrometeors) would be less than those for mode 1; and

   3) the increase in total satellite noise due to the additional interference path is expected to be between 1 and 3%.

   The actual coordination distance depends on the relative relationship between earth stations and the pointing directions of their antenna and could be as small as 100 km disregarding site shielding. With site shielding, separation distances might be considerably reduced. The distances would be independent of antenna size provided that the antenna still complied with the requirements for off-beam emissions and minimum elevation angle. Higher values of minimum elevation angle result in smaller coordination distances due to less antenna coupling and the geometry providing a much smaller common scattering value.

d) Difficulties associated with the antipodal interference path may be substantially reduced by the implementation of RBW for regional or domestic uses and by arranging beam areas and/or satellite positions for RBW satellites such that equatorial beams are displaced by at least one half 3 dB beamwidth from the earth's limb (for a 2° beam based on satellite antenna characteristics in CCIR Report 558-2).

These restrictions would be achieved naturally in the case of regional/domestic uses, particularly in low latitude countries where relatively high rain rates and system geometry would dictate high elevation angles. Indeed, at 40 degrees RBW earth station elevation angles, the difficulties associated with antipodal interference would be entirely overcome.

It is worth noting that separations of RBW satellites in differing networks would be similar to those in FBW networks and improvements in antenna performance could be used in both types of network. Using the indicated 0.5 degree FBW/RBW satellite separation, it would be possible to interleave both types of network. With sufficient care in the initial orbital location, the impact on existing networks could be reduced to a level where only a few satellites may need a small orbital position adjustment. In such a situation an orbit/spectrum enhancement factor of 2 may be optimistic in practice but a factor of 1.75 could be achievable.

Earth station to earth station separation distances may be unwanted in some circumstances and through choice of paired frequency bands or sub-bands could be eliminated.

From the foregoing considerations, the technique of reverse band working could offer substantial spectrum/resource enhancement if it were carefully implemented. The problems of implementation should be the subject of intersessional studies.

These studies should be limited to the main pairs of frequency bands allocated to the FSS at 4/6 GHz and 11-12/14 GHz and should concentrate particularly on the new (WARC 1979) FSS bands.

The study should be further limited to fixed-satellite systems of a national and regional character which might be introduced during the next 10 year period.

The study should seek means of effectively isolating two communities of fixed-satellite systems from each other, i.e. those operating in the conventional directions and those operating in the same bands but in the reverse directions.

The study should also consider whether there would be any benefit from orbit sectorization and/or band segmentation for the purposes of isolating national and regional systems using reverse band working in one ITU Region from similar systems in other ITU Regions.

The study should include the following aspects:

a) any further requirements (additional to Appendix 29, Case 2) for space station - space station coordination;

b) any requirements for earth station - earth station coordination;

c) the extent to which the introduction of reverse band working would increase the effective capacity of the orbit and the main pairs of FSS bands;

d) the most economically advantageous way of introducing reverse band working into the main pairs of FSS bands;

e) the most appropriate means of reducing interference to enable adequate sharing between RBW satellite networks and the fixed service.

D. EDEN
Chairman of Drafting Group 4C-8

INTERNATIONAL TELECOMMUNICATION UNION

ORB-85 WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT

FIRST SESSION, GENEVA, AUGUST/SEPTEMBER 1985

Document DL/43-E
30 August 1985
Original: English

WORKING GROUP 4C

PRECIPITATION AND SANDSTORM SITUATIONS

Propagation effects are extremely important for planning the use of geostationary satellites for various radio services. It has been acknowledged that propagation attenuation in heavy rainfall areas imposes additional requirements on satellite system designs in the frequency bands above 10 GHz. In addition, rainfall also affects system polarization characteristics.

Normally, rain attenuation may be ignored for frequencies below about 5 GHz but constitutes a very important factor in systems above 10 GHz. The P and N rainfall zones correspond broadly to the countries at low and middle latitudes, particularly those of the tropical and equatorial areas. Stations in such areas should be designed to take due account of the effects of rain attenuation at the higher frequency bands. Furthermore, stations operating at such frequencies in territories at high latitudes may also be adversely affected by rainfall, particularly when viewing satellites from low elevation angles. Sandstorms may also be an important factor in some areas, such as deserts, in the freqeuncy bands above 10 GHz.

Snow, especially dry snow, is much less serious than heavy rain, but melting snow can cause significant attenuation. Also, snow on the antenna and feed can be more serious than heavy rain.

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INTERNATIONAL TELECOMMUNICATION UNION

ORB-85 WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT

FIRST SESSION, GENEVA, AUGUST/SEPTEMBER 1985

Document DL/44-E
30 August 1985
Original: English

WORKING GROUP 4C

PERMISSIBLE INTERFERENCE

(Note - it is proposed that this text, as approved, should be combined with the text already approved on "Harmonization" (DL/29), being inserted at the end of section 2.1).

In order to increase the number of satellites that can share the GSO, the total permissible interference noise power in any channel of an FDM/FM satellite HRC should be increased from 2000 pW0p to 2500 pW0p. The permissible single entry interference noise level, now 600 pW0p, should also be increased. However, study is required to better define the role of the single entry limit in the future, when satellite networks will tend to become interference-limited and to determine the optimum value for the single entry limit which would correspond with a total interference level of 2500 pW0p. The possible need to revise the threshold value of $\Delta T/T$ given in Appendix 29 of the Radio Regulations in consequence of any proposed increase in the single entry limit should also be studied. It will be necessary to make provision for relieving existing networks from the impact of higher interference levels. Finally, consideration should be given to the compatibility of these new FDM-FM telephony permissible interference levels with the corresponding levels for analogue FM TV recommended in CCIR Recommendation 483. These studies should be done during the intersessional period.

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INTERNATIONAL TELECOMMUNICATION UNION

ORB-85 **WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT**

FIRST SESSION, GENEVA, AUGUST/SEPTEMBER 1985

Document DL/45-E
30 August 1985
Original: English

WORKING GROUP 4C

POLARIZATION DISCRIMINATION

The use of orthogonal linear or circular polarizations permits discrimination to be obtained between two emissions in the same frequency band to and from the same satellite or different satellites at the same nominal orbital location.

The most effective way to employ polarization discrimination is by frequency reuse in the same satellite, where the greatest control of orthogonality is close to the beam axis. Polarization orthogonality between different satellites occupying the same orbit location may also be beneficial.

If the polarizations of adjacent satellites are orthogonal, it may be possible to use the polarization discrimination in the side lobes of the earth-station antennas to reduce interference between the satellite networks, and to allow satellite spacing to be reduced. The side-lobe polarization discrimination obtainable in this way will be small, but even a few decibels of discrimination would permit a significant reduction in satellite spacing. However, it would not be possible to realize this benefit in a systematic way unless and until preferred polarization characteristics have been adopted. This would need to involve a choice between linear and circular polarization and, where linear polarization is adopted, a choice of the preferred planes of polarization. There is not, at present, sufficient information to allow these choices to be made.

It is not feasible to get benefit from polarization discrimination, whether between co-located satellites or adjacent satellites, if either or both use dual polarization within their own network.

Intersessional studies should be carried out to ascertain how much benefit could be obtained from polarization discrimination between nominally co-located single-polarization satellites and also between adjacent satellites, both also having single-polarization.

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INTERNATIONAL TELECOMMUNICATION UNION

ORB-85 WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT

FIRST SESSION, GENEVA, AUGUST/SEPTEMBER 1985

Document DL/46-E
30 August 1985
Original: English

WORKING GROUP 4C

SATELLITE ANTENNA RADIATION CHARACTERISTICS AND THE POINTING ACCURACY OF SATELLITE BEAMS

An ideal satellite antenna would have the following radiation characteristics:

- the gain is uniform (or follows in a controlled way some other chosen characteristic) towards all parts of the service area, with some extension beyond the edges of the service area to allow for beam pointing errors within the constraints imposed by Article 29 of the Radio Regulations;

- this in-beam gain is maintained beyond the service area and the margin required for beam pointing errors to the extent that is necessary to provide a sufficiently wide service arc in those services where the concept of service arc is applicable;

- beyond those limits, the gain falls away rapidly with increasing angle off-axis to a low out-of-beam value and remains low in all other directions which intercept the Earth.

Satellite antennas with specially-shaped beams facilitate the suppression of undesirable spillover (transmitting) to neighbouring countries or sensitivity (receiving) to transmissions from neighbouring countries, while maintaining an effective coverage in the intended area.

The techniques of beam-shaping also provide means of controlling the distribution of gain within the beam. This feature would be of value in dispersed territory situations, where it may be desirable to distribute more gain to populous parts of the service area, and less gain to other parts of the service area where the extent of use will be small.

Shaped beams can be generated in reflector antennas by controlling the phase and amplitude distribution over the aperture according to the shape of the coverage area. The following two methods of doing this have been developed:

- shaping the surface of reflectors according to the contours of the beam coverage;

- controlling the amplitude and phase of the illumination patterns across the aperture, which are fed by the multiple horns, in order to match the contours of the beam coverage.

The former is simpler in its feed assembly composition. However, the shape of the pattern cannot be changed when the satellite is in orbit. The latter method, which is an application of the multi-beam antenna method, has an advantage in that beam-shaping capability is greater and it could be possible to reshape the beam by command from the ground.

Shaped-beam antennas offer the potential for improved side-lobe control particularly where the coverage area itself is rather large, thus improving the possibility of frequency reuse between coverage areas closer to each other.

However, it should be noted that discrimination beyond the edge of coverage is a function of satellite antenna dimensions; launch vehicle constraints may be a factor here. Also measurements made on current shaped-beam antennas show that the discriminiation achieved may be considerably less than that theoretically indicated when all directions are considered. The radiation patterns of shaped beam antennas and also elliptical beam antennas are currently under study in CCIR, with a view to recommending reference radiation patterns.

The advantages of frequency reuse may not be fully realized if the control of the satellite beam position is inadequate. Radio Regulations Article 29 requires that the beam pointing direction should be maintained within 10% of the half-power beamwidth, or 0.3° of the nominal direction, whichever is the greater.

It may be necessary to limit the gain of geostationary satellite antennas in the direction of other geostationary satellites in particular when those antennas are used in frequency bands which are allocated for both up-link and down-link operation.

For most networks, elliptical beams well-fitted to the service area, subject to a minimum beam size related to the capability of launchers to launch solid antenna reflectors, are likely to provide acceptable orbit/spectrum utilization efficiency at less cost than shaped beams. It should be assumed that their use will be general in the foreseeable future. However, shaped beams with good side-lobe suppression outside the coverage area will be advantageous in some circumstances, particularly when the service area is large and their use should be encouraged.

Inter-sessional studies are required to determine the necessary criteria for satellite beams, including:

a) reference radiation patterns for elliptical and shaped beams;

b) an appropriate minimum required beam size, as a function of frequency;

and to study whether

c) beam pointing constraints more stringent than those in Article 29 of the Radio Regulations are desirable;

d) limits need to be applied to satellite antenna side-lobe gain in the direction of neighbouring satellites in frequency bands used in both directions of transmission.

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INTERNATIONAL TELECOMMUNICATION UNION

ORB-85 WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT

FIRST SESSION, GENEVA, AUGUST/SEPTEMBER 1985

Document DL/47-E
30 August 1985

SUB-WORKING GROUP 6A AD HOC 2

Note from Chairman of Sub-Working Group 6A Ad Hoc 2

INCORPORATION OF REGION 2 FEEDER-LINK PLAN

The attached text is reproduced from the Final Acts of the Regional Administrative Conference for the Planning of the Broadcasting-Satellite Service in Region 2 (SAT-83), Geneva, 1983.

R. ZEITOUN
Chairman of Sub-Working Group 6A Ad Hoc 2

Annex: 1

PART II

Provisions and Associated Plan for the Feeder Links for the Broadcasting-Satellite Service (12.2 - 12.7 GHz) in the Frequency Band 17.3 - 17.8 GHz

ARTICLE 1

Definitions

1.1 *Region 2 feeder link Plan:* The Plan for the feeder links for the broadcasting-satellite service in the frequency band 17.3 - 17.8 GHz in Region 2 contained in this Part of the Final Acts together with any modifications resulting from the successful application of the procedure of Article 4 of this Part herein referred to as the Plan.

1.2 *Frequency assignment in conformity with the Region 2 feeder link Plan:* Any frequency assignment for a receiving space station which appears in the Plan or for which the procedure of Article 4 of this Part has been successfully applied.

ARTICLE 2

Frequency Band

2.1 The provisions of this Part apply to the feeder links in the fixed-satellite service (Earth-to-space) in the frequency band 17.3 - 17.8 GHz, for the broadcasting-satellite service in Region 2, and to other services to which this band is allocated in Region 2 so far as their relationship to the fixed-satellite service (Earth-to-space) in this band is concerned.

ARTICLE 3

Execution of the Provisions and Associated Plan

3.1 The Members of the Union in Region 2 shall adopt for their feeder link space and earth stations in the fixed-satellite service (Earth-to-space) in the frequency band referred to in this Part, the characteristics specified in the Plan.

3.2 Administrations shall not bring into use assignments to feeder link stations which are not in conformity with the Plan, except in those cases where Resolution No. 2(Sat-R2) is applicable or those cases where notification under Article 5 of this Part is appropriate.

3.3 The Plan is based on the grouping of the space stations in nominal orbital positions of +0.2° and −0.2° on both sides of the cluster of satellites and on the use of a feeder-link earth station antenna diameter of five metres.

3.3.1 An administration may use a greater antenna diameter provided that the feeder link e.i.r.p. is not greater than the Plan value. An administration may use a feeder link antenna diameter greater than five metres resulting in a greater on-axis e.i.r.p. (but a constant off-axis e.i.r.p.) provided that it obtains the agreement of administrations having assignments to space stations in the same cluster which may be affected and of any other administrations having a space station separated by less than 0.5° (see section 3.4.1 of Annex 3 to this Part).

3.3.2 Administrations may locate satellites within a cluster at any orbital position within the cluster, provided they obtain the agreement of administrations having assignments to space stations in the same cluster (see section 3.13.1 of Annex 3 to this Part).

3.4 The feeder link Plan is based on circular polarization. Administrations may use a polarization other than circular, provided it obtains the agreement of administrations having assignments to space stations in the same cluster which may be affected and of any other administration having assignments to space stations which may be affected (see section 3.8.2 of Annex 3 to this Part).

3.5 An administration is considered to be affected if the limits specified in Annex 1 to this Part are exceeded.

ARTICLE 4

Procedure for Modifications to the Region 2 Plan (17.3 - 17.8 GHz)

4.1 When an administration intends to make a modification to the Plan, i.e. either:

a) to modify the characteristics of any of its frequency assignments in the fixed-satellite service which are shown in the Plan, or for which the procedure in this Article has has been successfully applied, whether or not the station has been brought into use; *or*

b) to include in the Plan a new frequency assignment in the fixed-satellite service; *or*

c) to cancel a frequency assignment in the fixed-satellite service,

the following procedure shall be applied before any notification of the frequency assignment is made to the International Frequency Registration Board (see Article 5 of this Part and Resolution No. 2(Sat-R2)).

4.1.1 Before an administration proposes to include in the Plan under the provisions of 4.1 *b)* a new frequency assignment for reception at a space station [1] or to include in the Plan a new frequency assignment for reception at a space station whose orbital position is not designated in the Plan to this administration, all of the assignments to the service areas involved should normally have been brought into service or have been notified to the Board in accordance with Article 5 of this Part. Should this not be the case, the administration concerned shall inform the Board of the reasons thereof.

4.2 *Proposed modifications to a frequency assignment in conformity with the Plan or the inclusion in the Plan of a new frequency assignment*

4.2.1 An administration proposing a modification to the characteristics of a frequency assignment in conformity with the Plan or the inclusion of a new frequency assignment in the Plan shall seek the agreement of those administrations:

4.2.1.1 having a feeder link frequency assignment in the fixed-satellite service (Earth-to-space) in the same channel or an adjacent channel, which appears in the Plan or in respect of which modifications to the Plan have been published by the Board in accordance with the provisions of this Article; *or*

4.2.1.2 having a frequency assignment in the band 17.7 - 17.8 GHz to an earth station in the fixed-satellite service (space-to-Earth) which is recorded in the Master Register or which has been coordinated in or is being coordinated under the provisions of No. **1060** of the Radio Regulations and which is located within the coordination area of the feeder link fixed-satellite earth station;

[1] The expression "frequency assignment for reception to a space station", wherever it appears in this Article, shall be understood to refer to a frequency assignment associated with a given orbital position.

4.2.1.3 having a frequency assignment in the band 17.7 - 17.8 GHz to a terrestrial station in use or intended to be brought into use within three years of the projected date of bringing the feeder link modification into use, and which is located within the coordination area of the feeder link fixed-satellite earth station;

4.2.1.4 having an assignment in the fixed-satellite service (Earth-to-space) in Regions 1 or 3 which

a) is recorded in the Master Register; *or*

b) has been coordinated or is being coordinated or has been notified under Articles 11 and 13 of the Radio Regulations,

4.2.1.5 which are considered affected.

4.2.1.6 A frequency assignment is considered to be affected when the limits shown in Annex 1 to this Part are exceeded.

4.2.2 The agreement referred to in 4.2.1 is not required when an administration proposes to bring into use, with characteristics appearing in the Plan, a fixed earth station in the band 17.3 - 17.8 GHz or a transportable earth station in the band 17.3 - 17.7 GHz. Administrations may communicate to the Board the characteristics of such earth stations in order to include them in the Plan.

4.2.3 An administration intending to modify characteristics in the Plan shall send to the Board, not earlier than five years but preferably not later than eighteen months before the date on which the assignment is to be brought into use, the relevant information listed in Annex 2 to this Part.

4.2.3.1 Where as a result of the intended modification the limits defined in Annex 1 to this Part are not exceeded, this fact shall be indicated when submitting to the Board the information required by 4.2.3. The Board shall then publish this information in a special section of its weekly circular.

4.2.3.2 In all other cases the administration shall notify the Board of the names of the administrations whose agreement it considers should be sought in order to arrive at the agreement referred to in 4.2.1 as well as of those with which agreement has already been reached.

4.2.4 The Board shall determine on the basis of Annex 1 to this Part the administrations whose frequency assignments are considered to be affected within the meaning of 4.2.1. The Board shall include the names of those administrations with the information received under 4.2.3.2 and shall publish the complete information in a special section of its weekly circular. The Board shall immediately send the results of its calculations to the administration proposing the modification to the Plan.

4.2.5 The Board shall send a telegram to the administrations listed in the special section of the weekly circular drawing their attention to the information it contains and shall send them the results of its calculations.

4.2.6 An administration which feels that it should have been included in the list of administrations whose services are considered to be affected may, giving the technical reasons for so doing, request the Board to include its name. The Board shall study this request on the basis of Annex 1 to this Part and shall send a copy of the request with an appropriate recommendation to the administration proposing the modification to the Plan.

4.2.7 Any modification to a frequency assignment which is in conformity with the Plan or any inclusion in the Plan of a new frequency assignment which would have the effect of exceeding the limits specified in Annex 1 to this Part shall be subject to the agreement of all affected administrations.

4.2.8 The administration seeking agreement or the administration with which agreement is sought may request any additional technical information it considers necessary. The administrations shall inform the Board of such requests.

4.2.9 Comments from administrations on the information published pursuant to 4.2.4 should be sent either directly to the administration proposing the modification or through the Board. In any event the Board shall be informed that comments have been made.

4.2.10 An administration which has not notified its comments either to the administration seeking agreement or to the Board, within a period of four months following the date of the weekly circular referred to in 4.2.3.1 or 4.2.4 shall be understood to have agreed to the proposed modification. This time-limit may be extended by up to three months for an administration which has requested additional information under 4.2.8 or for an administration which has requested the assistance of the Board under 4.2.18. In the latter case the Board shall inform the administrations concerned of this request.

4.2.11 If, in seeking agreement, an administration modifies its initial proposal, it shall again apply the provisions of 4.2.3 and the consequent procedure with respect to any other administration whose services might be affected as a result of modifications to the initial proposal.

4.2.12 If no comments have been received on the expiry of the periods specified in 4.2.10, or if agreement has been reached with the administrations which have made comments and with which agreement is necessary, the administration proposing the modification may continue with the appropriate procedure in Article 5 of this Part and shall inform the Board, indicating the final characteristics of the frequency assignment together with the names of the administrations with which agreement has been reached.

4.2.13 The agreement of the administrations affected may also be obtained in accordance with this Article, for a specified period.

4.2.14 When the proposed modification to the Plan involves developing countries, administrations shall seek all practicable solutions conducive to the economical development of the broadcasting-satellite systems of these countries.

4.2.15 The Board shall publish in a special section of its weekly circular the information received under 4.2.12 together with the names of any administrations with which the provisions of this Article have been successfully applied. The frequency assignment concerned shall enjoy the same status as those appearing in the Plan and will be considered as a frequency assignment in conformity with the Plan.

4.2.16 When an administration proposing to modify the characteristics of a frequency assignment or to make a new frequency assignment receives notice of disagreement from an administration whose agreement it has sought, it should first endeavour to solve the problem by exploring all possible means of meeting its requirement. If the problem still cannot be solved by such means, the administration whose agreement has been sought should endeavour to overcome the difficulties as far as possible, and shall state the technical reasons for any disagreement if the administration seeking the agreement requests it to do so.

4.2.17 If no agreement is reached between the administrations concerned, the Board shall carry out any study that may be requested by these administrations; the Board shall inform them of the result of the study and shall make such recommendations as it may be able to offer for the solution of the problem.

4.2.18 An administration may at any stage in the procedure described, or before applying it, request the assistance of the Board, particularly in seeking the agreement of another administration.

4.2.19 The relevant provisions of Article 5 of this Part shall be applied when frequency assignments are notified to the Board.

4.3 *Cancellation of frequency assignments*

When a frequency assignment in conformity with the Plan is released, whether or not as a result of a modification, the administration concerned shall immediately so inform the Board. The Board shall publish this information in a special section of its weekly circular.

4.4 *Master copy of the Plan*

4.4.1 The Board shall maintain an up-to-date master copy of the Plan, including the overall equivalent protection margins of each assignment, taking account of the application of the procedure specified in this Article. This master copy shall contain the overall equivalent protection margins derived from the Plan as established by the Conference and those derived from all modifications to the Plan as a result of the successful completion of the modification procedure of this Article. The Board shall prepare a document listing the amendments to be made to the Plan as a result of modifications made in accordance with the procedure in this Article.

4.4.2 The Secretary-General shall be informed by the Board of modifications made to the Plan and shall publish an up-to-date version of the Plan in an appropriate form when justified by the circumstances.

ARTICLE 5

Notification, Examination and Recording in the Master Register of Frequency Assignments to Feeder Link Transmitting Earth Stations and Receiving Space Stations in the Fixed-Satellite Service in the Band Between 17.3 and 17.8 GHz in Region 2

5.1 *Notification*

5.1.1 Whenever an administration intends to bring into use a frequency assignment to a transmitting earth station or receiving space station in the fixed-satellite service in the band between 17.3 and 17.8 GHz, it shall notify this frequency assignment to the Board. For this purpose, the notifying administration shall apply the following provisions.

5.1.2 For any notification under 5.1.1, an individual notice for each frequency assignment shall be drawn up as prescribed in Annex 2 to this Part, the various sections of which specify the basic characteristics to be provided as appropriate. It is recommended that the notifying administration should also apply any other data it may consider useful.

5.1.3 Each notice must reach the Board not earlier than three years before the date on which the frequency assignment is to be brought into use. In any case, the notice must reach the Board not later than three months before that date [1].

5.1.4 Any frequency assignment the notice of which reaches the Board after the applicable period specified in 5.1.3 shall, where it is to be recorded, bear a remark in the Master Register to indicate that it is not in conformity with 5.1.3.

5.1.5 Any notice made under 5.1.1 which does not contain the characteristics specified in Annex 2 to this Part shall be returned by the Board immediately by airmail to the notifying administration with the relevant reasons.

5.1.6 Upon receipt of a complete notice, the Board shall include its particulars, with the date of receipt, in its weekly circular which shall contain the particulars of all such notices received since the publication of the previous circular.

5.1.7 The circular shall constitute the acknowledgement to the notifying administration of the receipt of a complete notice.

5.1.8 Complete notices shall be considered by the Board in order of receipt. The Board shall not postpone its finding unless it lacks sufficient data to reach a decision; moreover, the Board shall not act upon any notice which has a technical bearing on an earlier notice still under consideration by the Board until it has reached a finding with respect to such earlier notice.

5.2 *Examination and recording*

5.2.1 The Board shall examine each notice:

a) with respect to its conformity with the Convention and the relevant provisions of the Radio Regulations and Annex 1 to this Part (with the exception of those relating to conformity with the Region 2 Plan and the provisions of Resolution No. 2(Sat-R2));

b) with respect to its conformity with the Region 2 Plan;

c) with respect to its conformity with the provisions of Resolution No. 2(Sat-R2).

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[1] Where appropriate, the notifying administration shall initiate the procedure of Article 4 of this Part for modifying the Plan in sufficient time to ensure that this limit is observed.

5.2.2 Where the Board reaches a favourable finding with respect to 5.2.1 *a)* and 5.2.1 *b)*, the frequency assignment of an administration shall be recorded in the Master Register. The date of receipt of the notice by the Board shall be entered in Column 2d. In relations between administrations, all frequency assignments brought into use in conformity with the Plan and recorded in the Master Register shall be considered to have the same status irrespective of the dates entered in Column 2d for such frequency assignments.

5.2.3 Where the Board reaches a favourable finding with respect to 5.2.1 *a)* and finds that the difference between the notified characteristics and those appearing in the Plan is:

a) an earth station with reduced e.i.r.p.; *or*

b) a reduced coverage area entirely situated within the coverage area appearing in the Plan; *or*

c) different modulation characteristics [1]; *or*

d) use of an antenna diameter greater than 5 metres without increasing the on-axis e.i.r.p.;

e) a use of an antenna diameter greater than 5 metres resulting in a greater on-axis e.i.r.p. if the orbital separation with any other space station is greater than 0.5°,

the frequency assignment shall be recorded in the Master Register. The date of receipt of the notice by the Board shall be entered in Column 2d. In relations between administrations all frequency assignments brought into use in conformity with the Plan and recorded in the Master Register shall be considered to have the same status irrespective of the dates entered in Column 2d for such frequency assignments. When recording these assignments the Board shall indicate by an appropriate symbol the characteristics having a value different from that appearing in the Plan.

5.2.4 Where the Board reaches a favourable finding with respect to 5.2.1 *a)*, but an unfavourable finding with respect to 5.2.1. *b)*, it shall examine the notice with respect to its conformity with the provisions of Resolution No. 2(Sat-R2). A frequency assignment which is in conformity with the provisions of Resolution No. 2(Sat-R2) shall be recorded in the Master Register with an appropriate symbol to indicate its interim status. The date of receipt of the notice by the Board shall be entered in Column 2d. In relations between administrations all frequency assignments brought into use in conformity with the provisions of Resolution No. 2(Sat-R2) and recorded in the Master Register shall be considered to have the same status irrespective of the dates entered in Column 2d for such frequency assignments.

5.2.5 Whenever a frequency assignment is recorded in the Master Register, the finding reached by the Board shall be indicated by a symbol in Column 13a.

5.2.6 Where the Board reaches an unfavourable finding with respect to 5.2.1 *a)* or 5.2.1 *b)* and *c)*, the notice shall be returned immediately by airmail to the notifying administration with the reasons of the Board for this finding and with such suggestions as the Board may be able to offer with a view to a satisfactory solution of the problem.

5.2.7 Where the notifying administration resubmits the notice and the finding of the Board becomes favourable with respect to the appropriate parts of 5.2.1, the notice shall be treated as in 5.2.2, 5.2.3 or 5.2.4, as appropriate.

5.2.8 If the notifying administration resubmits the notice without modification and insists on its reconsideration, and if the Board's finding with respect to 5.2.1 remains unfavourable, the notice is returned to the notifying administration in accordance with 5.2.6. In this case, the notifying administration undertakes not to bring into use the frequency assignment until the condition specified in 5.2.7 is fulfilled.

5.2.9 If a frequency assignment notified in advance of bringing into use in conformity with 5.1.3 has received a favourable finding by the Board with respect to the provisions of paragraph 5.2.1, it shall be entered provisionally in the Master Register with a special symbol in the Remarks Column indicating the provisional nature of that entry.

[1] The use of other modulating signals having different characteristics (e.g. modulation with sound channels frequency-multiplexed within the bandwidth of a television channel, digital modulation of sound and television signals, or other pre-emphasis characteristics), is authorized only on condition that the use of such characteristics does not cause greater interference than that caused by the system considered in the Plan.

5.2.10 When the Board has received confirmation that the frequency assignment has been brought into use, the Board shall remove the symbol in the Master Register.

5.2.11 The date in Column 2c shall be the date of bringing into use notified by the administration concerned. It is given for information only.

5.3 *Cancellation of entries in the Master Register*

5.3.1 If an administration has not confirmed the bringing into use of a frequency assignment under 5.2.10, the Board will make inquiries of the administration not earlier than six months after the expiry of the period specified in 5.1.3. On receipt of the relevant information, the Board will either modify the date of coming into use or cancel the entry.

5.3.2 If the use of any recorded frequency assignment is permanently discontinued, the notifying administration shall so inform the Board within three months, whereupon the entry shall be removed from the Master Register.

ARTICLE 6

Preliminary Procedure Concerning Notification and Recording in the Master Register of Frequency Assignments to Terrestrial Stations in Region 2 in the Band 17.7 - 17.8 GHz, when Frequency Assignments to Feeder-Link Earth Stations for Broadcasting-Satellite Service in Conformity with the Region 2 Plan are Involved

6.1 Administrations planning to implement assignments for terrestrial stations in the 17.7 - 17.8 GHz band should evaluate the level of interference which might be caused by the closest feeder-link earth station located on the border of the territory of another administration. In cases where the entry in the Plan contains information on specific earth stations, the level of interference shall be assessed on the basis of coordination contours calculated in accordance with Appendix **28** to the Radio Regulations. Should the administration concerned find that interference may be caused by the feeder-link earth stations to its planned terrestrial station, it may request the administration responsible for the feeder-link earth station to indicate the planned actual locations of the feeder-link earth stations.

6.2 An administration which receives a request under 6.1 shall, within a period of three months, indicate the actual locations of its feeder-link earth stations and communicate them to the Board in order to update the Plan.

6.3 If, at the end of a period of three months, the administration responsible for the terrestrial station does not receive a reply, it may request the assistance of the Board.

6.4 If the administration responsible for the feeder-link earth stations does not communicate to the Board, within a period of three months, the actual locations of its feeder-link earth stations, this administration may implement its feeder-link earth station provided it does not cause harmful interference to the terrestrial station under consideration.

ARTICLE 7

Preliminary Procedure, Notification and Recording in the Master Register of Frequency Assignments to Stations in the Fixed-Satellite Service (Space-to-Earth) in Region 2 in the Band 17.7 - 17.8 GHz, when Frequency Assignments to Feeder Link for Broadcasting-Satellite Stations Appearing in the Region 2 Plan are Involved [1]

7.1 The provisions of Articles **11** and **13** and Appendix **29** of the Radio Regulations are applicable to transmitting space stations in the fixed-satellite service of Region 2 in the band 17.7 - 17.8 GHz together with the provisions of Annex 4 to this Part, except that in relationship with feeder-link stations in Region 2, the threshold value mentioned in Appendix **29** to the Radio Regulations is replaced by those given in Annex 4 to this Part.

7.2 Administrations planning to implement assignments for receiving earth stations in the 17.7 - 17.8 GHz band in the fixed-satellite service (space-to-Earth) should evaluate the level of interference that might be caused by the closest feeder-link earth station located on the border of the territory of another administration. In cases where the entry in the Plan or the Master Register contains information on specific earth stations, the level of interference shall be assessed on the basis of coordination contours calculated in accordance with Annex 4 to this Part. Should this administration find that interference may be caused by the feeder-link earth stations to its planned fixed-satellite earth station, it may request the administration responsible for the feeder-link earth station to indicate the planned actual locations of the feeder-link earth stations.

7.3 An administration which receives a request under 7.2 shall, within a period of three months, indicate the actual locations of its earth stations and communicate it to the Board in order to update the Plan.

7.4 If, at the end of the period of three months, the administration responsible for the fixed-satellite receiving earth station does not receive a reply, it may request the assistance of the Board in this matter.

7.5 If the administration responsible for the feeder-link earth stations does not communicate to the Board, within a period of three months, the actual locations of its feeder-link earth stations, this administration may implement its feeder-link earth station provided it does not cause harmful interference to the fixed-satellite earth station under consideration.

ARTICLE 8

Miscellaneous Provisions Relating to the Procedures

Section I. Studies and Recommendations

8.1.1 If it is requested by any administration, the Board, using such means at its disposal as are appropriate in the circumstances, shall conduct a study of cases of alleged contravention or non-observance of these provisions or of harmful interference.

8.1.2 The Board shall thereupon prepare and forward to the administrations concerned a report containing its findings and recommendations for the solution of the problem.

8.1.3 On receiving the Board's recommendations for the solution of the problem, an administration shall promptly acknowledge the receipt by telegram and shall subsequently indicate the action it intends to take. In cases when the Board's suggestions or recommendations are unacceptable to the administrations concerned, further efforts should be made by the Board to find an acceptable solution to the problem.

[1] See Resolution No. 7(Sat-R2).

8.1.4 In a case where, as a result of a study, the Board submits to one or more administrations suggestions or recommendations for the solution of a problem, and where no answer has been received from one or more of these administrations within a period of four months, the Board shall consider that the suggestions or recommendations concerned are unacceptable to the administrations which did not answer. If it was the requesting administration which failed to answer within this period, the Board shall close the study.

Section II. Miscellaneous Provisions

8.2.1 If it is requested by any administration, particularly by an administration of a country in need of special assistance, the Board, using such means at its disposal as are appropriate in the circumstances, shall render the following assistance:

a) computation necessary in the application of Annexes 1, 3 and 4 to this Part;

b) any other assistance of a technical nature for completion of the procedures in this Part.

8.2.2 In making a request to the Board under paragraph 8.2.1, the administration shall furnish the Board with the necessary information.

ARTICLE 10

Interference

10.1 The Members of the Union in Region 2 shall endeavour to agree on the action required to reduce harmful interference which might be caused by the application of these provisions and the associated Plan.

ARTICLE 11

Period of Validity of the Provisions and Associated Plan

11.1 The provisions and associated Plan have been prepared in order to meet the requirements for feeder links for the broadcasting-satellite service in the bands concerned for a period extending until at least 1 January 1994. [1]

11.2 In any event, the provisions and associated Plan shall remain in force until their revision by a competent administrative radio conference convened in accordance with the relevant provisions of the Convention in force.

[1] See also Resolution No. 1(Sat-R2).

ANNEX 1

Limits for Determining Whether a Service of an Administration Is Considered to be Affected by a Proposed Modification to the Plan or When It Is Necessary Under This Part of the Final Acts to Seek the Agreement of any other Administration [1, 2]

1. *Limits applicable in the band 17.3 - 17.8 GHz (of Region 2) to protect a frequency assignment to the fixed-satellite service (Earth-to-space) for feeder links to broadcasting satellites in Regions 1 and 3*

An administration of Region 1 or 3 shall be considered as being affected if the proposed use would cause, to a feeder link to broadcasting satellites in Regions 1 and 3, an increase in the noise temperature of the feeder-link space station, calculated at the feeder-link space station in accordance with the method given in Appendix **29** to the Radio Regulations (see Recommendation No. **2**(Sat-R2)).

2. *Limits applicable to protect a frequency assignment in the band 17.7 - 17.8 GHz to an earth station in the fixed-satellite service (space-to-Earth)*

An administration shall be considered as being affected if, upon application of the procedures of Section 3 of Annex 4 to this Part, that administration is included in the coordination area of the frequency assignment to a transmitting feeder-link earth station.

For this purpose, the parameters of the transmitting feeder-link earth station, as may be modified from those parameters given in Annex 3 to this Part, shall be used.

3. *Limits applicable to protect a terrestrial station in the band 17.7 - 17.8 GHz*

An administration shall be considered as being affected if, upon application of the procedures of Appendix **28** to the Radio Regulations, that administration is included in the coordination area of the frequency assignment to a transmitting feeder-link earth station.

For this purpose, the parameters of the transmitting feeder-link earth station, as may be modified from those parameters given in Annex 3 to this Part, shall be used.

4. *Limits to the change in the overall equivalent protection margin with respect to frequency assignments in conformity with the Plan*

With respect to the modification to the Plan and when it is necessary under this Part to the Final Acts to seek the agreement of any other administration, except in cases covered by Resolution No. **2**(Sat-R2), an administration shall be considered as being affected if the overall equivalent protection margin [3] corresponding to a test point of its entry in the Plan, including the cumulative effect of any previous modification to the Plan or any previous agreement, falls more than 0.25 dB below 0 dB, or, if already negative, more than 0.25 dB below the value resulting from:

- the Plan as established by this Conference; *or*
- a modification of the assignment in accordance with this Part; *or*
- a new entry in the Plan under Article 4 of this Part; *or*
- any agreement reached in accordance with this Part of the Final Acts except for Resolution No. **2**(Sat-R2).

[1] The limits specified in this Annex relate to the power flux-densities which would be obtained assuming clear sky conditions, i.e. including the effects of atmospheric absorption described in paragraph 2.1.1 of Annex 5 to Part I.

[2] See Resolution No. **9**(Sat-R2).

[3] For the definition of the overall equivalent protection margin, see paragraph 1.11 of Annex 5 to Part I.

ANNEX 2

**Basic Characteristics to be Furnished in Notices [1]
Relating to Feeder-Link Stations in the Fixed-Satellite Service
Operating in the Band 17.3 - 17.8 GHz in Region 2 [2]**

1. The following information is required in notices relating to transmitting earth stations.

1.1 Country and beam identification.

1.2 Assigned frequency or channel number.

1.3 Assigned frequency band.

1.4 Date of bringing into use.

1.5 Identity of the transmitting feeder-link station.

1.6 Geographical coordinates of a feeder-link earth station transmitting in the band 17.7 - 17.8 GHz.

1.7 Feeder-link service area for a feeder-link earth station transmitting in the band 17.3 - 17.7 GHz identified by a set of geographical coordinates of the polygon points of the feeder-link service area.

1.8 Identity of the space station with which communication is to be established.

1.9 Rain climatic zone [3].

1.10 Class of emission, necessary bandwidth and description of transmission.

1.11 Power characteristics of the transmission:

a) The following information is required for each assigned frequency:

- transmit power (dBW) supplied to the input of the antenna;
- maximum power density per Hz [dB (W/Hz)], averaged over the worst 1 MHz band, supplied to the antenna.

b) Additional information required if power control is used (see paragraph 3.10 of Annex 3 to this Part):

- mode of control;
- range, expressed in dB, above the transmit power used in *a)* above.

c) Additional information required if site diversity is used (see paragraph 3.11 of Annex 3 to this Part):

- identity of other earth station with which diversity operation is to be employed.

d) Additional information required if depolarization compensation is used (see paragraph 3.12 of Annex 3 to this Part):

- characteristics.

[1] The Board shall develop and keep up-to-date forms of notice to meet fully the statutory provisions of this Annex and related decisions of this Conference. The Board is further invited to consider the feasibility of a single notice for feeder-link earth stations operating within more than one up-link service area.

[2] Only those notices relating to frequency assignments for space stations and earth stations used for telecommand and tracking purposes associated with the Plan shall be furnished in accordance with Appendix 3 to the Radio Regulations.

[3] This information as defined in Appendix 28 to the Radio Regulations is required for frequency assignments in the band 17.7 - 17.8 GHz.

1.12 Transmitting antenna characteristics:

a) antenna diameter (metres);

b) gain of the antenna in the direction of maximum radiation referred to an isotropic radiator (dBi);

c) beamwidth in degrees between the half-power points (describe in detail if not symmetrical);

d) the measured radiation diagram of the antenna (taking as a reference the direction of maximum radiation), or the reference radiation diagram to be used for coordination;

e) type of polarization;

f) sense of polarization;

g) the horizon elevation angle in degrees and the antenna gain in the direction of the horizon for each azimuth [4] around the earth station [5];

h) altitude of the antenna above mean sea level in metres [5];

i) minimum elevation angle in degrees [5].

1.13 Modulation characteristics:

a) type of modulation;

b) pre-emphasis characteristics;

c) TV system;

d) sound-broadcasting characteristics;

e) frequency deviation:

f) composition of the baseband;

g) type of multiplexing of the video and sound signals;

h) energy dispersal characteristics (if used).

1.14 Regular hours of operation (UTC).

1.15 Coordination.

1.16 Agreements.

1.17 Other information.

1.18 Operating administration or company.

2. The following information is required in notices relating to receiving space stations:

2.1 Country and beam identification.

2.2 Orbital position (xxx.xx degrees from the Greenwich meridian).

2.3 Assigned frequency or channel number.

2.4 Assigned frequency band.

2.5 Date of bringing into use.

2.6 Identity of the space station.

2.7 Class of station.

2.8 Class of emission and necessary bandwidth of the transmission to be received.

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[4] Every five degrees, in tabular or graphical form.

[5] This information is required for frequency assignments in the band 17.7 - 17.8 GHz.

2.9 Antenna characteristics:

a) gain of the antenna in the direction of maximum radiation referred to an isotropic radiator (dBi);

b) shape of the beam (circular, elliptical or other);

c) pointing accuracy;

d) type of polarization;

e) sense of polarization;

f) for circular beams, indicate the following:

- half-power beamwidth (degrees);
- co-polar and cross-polar radiation patterns;
- nominal intersection of the antenna beam axis with the Earth;

g) for elliptical beams, indicate the following:

- co-polar and cross-polar radiation patterns;
- rotation accuracy;
- orientation;
- major axis (degrees) at the half-power beamwidth;
- minor axis (degrees) at the half-power beamwidth;
- nominal intersection of the antenna beam axis with the Earth.

h) for beams of other than circular or elliptical shape, indicate the following:

- co-polar and cross-polar gain contours plotted on a map of the Earth's surface, preferably in a radial projection from the satellite onto a plane perpendicular to the axis from the centre of the Earth to the satellite. The isotropic or absolute gain shall be indicated at each contour which corresponds to a decrease in gain of 2, 4, 6, 10 and 20 dB and thereafter at 10 dB intervals, down to a value of 0 dB relative to an isotropic radiator;

- wherever practicable, a numerical equation or table providing the necessary information to allow the gain contours to be plotted;

i) for an assignment in the band 17.7 - 17.8 GHz, the gain in the direction of those parts of the geostationary-satellite orbit which are not obstructed by the Earth. Use a diagram showing estimated gain versus orbit longitude.

2.10 Receiver system noise temperature referred to the output of the antenna.

2.11 Station-keeping accuracy.

2.12 Modulation characteristics:

a) type of modulation;

b) pre-emphasis characteristics;

c) TV system;

d) sound-broadcasting characteristics;

e) frequency deviation;

f) composition of the baseband;

g) type of multiplexing of the video and sound signals;

h) energy dispersal characteristics (if used).

2.13 Regular hours of operation (UTC).

2.14 Coordination.

2.15 Agreements.

2.16 Other information.

2.17 Operating administration or company.

2.18 Range of automatic gain control. [6]

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[6] See paragraph 3.9 of Annex 3 to this Part.

ANNEX 3

Technical Data Used in Establishing the Provisions and Associated Plan and Which Should Be Used for their Application

1. DEFINITIONS

1.1 *Feeder link*

In the Region 2 broadcasting-satellite service Plan, the term feeder link, as defined in No. **109** of the Radio Regulations, is further qualified to indicate a fixed-satellite service link in the frequency band 17.3 to 17.8 GHz from any earth station within the feeder-link service area to the associated space station in the broadcasting-satellite service.

1.2 *Feeder-link beam area*

The area delineated by the intersection of the half-power beam of the satellite receiving antenna with the surface of the Earth.

1.3 *Feeder-link service area*

The area on the surface of the Earth within the feeder-link beam area within which the administration responsible for the service has the right to locate transmitting earth stations for the purpose of providing feeder links to broadcasting-satellite space stations.

1.4 *Nominal orbital position*

The longitude of a position in the geostationary-satellite orbit associated with a frequency assignment to a space station in a space radiocommunication service. The position is given in degrees from the Greenwich meridian.

1.5 *Adjacent channel*

The RF channel in the broadcasting-satellite service frequency Plan, or in the associated feeder-link frequency Plan, which is situated immediately higher or lower in frequency with respect to the RF reference channel.

1.6 *Second adjacent channel*

The RF channel in the broadcasting-satellite service frequency Plan, or in the associated feeder-link frequency Plan, which is situated immediately beyond either of the adjacent channels.

1.7 *Overall carrier-to-interference ratio*

The overall carrier-to-interference ratio is the ratio of the wanted carrier power to the sum of all interfering RF powers in a given channel including both feeder links and down-links. The overall carrier-to-interference ratio due to interference from the given channel is calculated as the reciprocal of the sum of the reciprocals of the feeder-link carrier-to-interference ratio and the down-link carrier-to-interference ratio referred to the satellite receiver input and earth station receiver input, respectively. [1]

[1] There are a total of five overall carrier-to-interference ratios used in the analysis of the Plan, namely, co-channel, upper and lower adjacent channels, and upper and lower second adjacent channels.

1.8 *Overall co-channel protection margin*

The overall co-channel protection margin in a given channel is the difference in dB between the overall co-channel carrier-to-interference ratio and the co-channel protection ratio.

1.9 *Overall adjacent channel protection margin*

The overall adjacent channel protection margin is the difference, in dB, between the overall adjacent channel carrier-to-interference ratio and the adjacent channel protection ratio.

1.10 *Overall second adjacent channel protection margin*

The overall second adjacent channel protection margin is the difference in dB between the overall second adjacent channel carrier-to-interference ratio and the second adjacent channel protection ratio.

1.11 *Overall equivalent protection margin*

The overall equivalent protection margin M is given in dB by the expression:

$$M = -10 \log \left(\sum_{i=1}^{5} 10^{(-M_i/10)} \right) \qquad \text{(dB)}$$

where:

M_1 = overall co-channel protection margin, in dB (as defined in 1.8),

M_2, M_3 = overall adjacent channel protection margins for the upper and lower adjacent channels respectively, in dB (as defined in 1.9),

M_4, M_5 = overall second adjacent channel protection margins for the upper and lower second adjacent channels respectively, in dB (as defined in 1.10).

The adjective "equivalent" indicates that the protection margins for all interference sources from the adjacent and second adjacent channels as well as co-channel interference sources have been included.

2. RADIO PROPAGATION FACTORS

The propagation loss on an earth-space path is equal to the free space path loss plus the atmospheric absorption loss plus the rain attenuation exceeded for 1% of the worst month.

2.1 *Atmospheric absorption*

The loss due to atmospheric absorption (i.e. clear air attenuation) is given by:

$$A_a = \frac{0.0669 + 0.0091\,\rho}{\sin\theta} \qquad \text{(dB)} \quad \text{for} \quad \theta > 5°$$

where:

θ = the elevation angle (degrees);

ρ = the surface water vapour concentration, g/m^3,
with $\rho = 10\ g/m^3$ for rain climatic zones A to K
and $\rho = 20\ g/m^3$ for rain climatic zones M to P (see Figure 1).

2.2 *Rain attenuation*

For circularly polarized signals, the rain attenuation A_p exceeded for 1% of the worst month at 17.5 GHz is calculated using the method outlined in paragraph 2.1.2 of Annex 5, Part I, by substituting the relation

$$\gamma = 0.0521 \; R^{1.114} \qquad \text{(dB/km)}$$

for the one given in that paragraph.

Figure 2 presents plot of rain attenuation of circularly polarized signals exceeded for 1% of the worst month at 17.5 GHz, as a function of earth station latitude and elevation angle for each of the rain climatic zones in Region 2.

2.3 *Rain attenuation limit*

In the analysis of the Plan, a maximum rain attenuation on the feeder link of 13 dB was considered assuming that other means would be used at the implementation stage to protect for larger rain attenuation on the feeder links.

2.4 *Depolarization*

Rain and ice can cause depolarization of radio frequency signals. The level of the co-polar component relative to the depolarized component is given by the cross-polarization discrimination (XPD) ratio. For the feeder link, the XPD ratio, in dB, not exceeded for 1% of the worst month is given by:

$$XPD = 30 \log f - 40 \log (\cos \theta) - 23 \log A_p \qquad \text{(dB)} \qquad \text{for } 5° < \theta < 60°$$

where A_p (dB) is the co-polar rain attenuation exceeded for 1% of the worst month, f is the frequency in GHz and θ is the elevation angle. For values of θ greater than 60°, use $\theta = 60°$ in the previous equation.

3. BASIC TECHNICAL CHARACTERISTICS

3.1 *Translation frequency and guard bands*

The feeder-link Plan is based on the use of a single frequency translation of 5.1 GHz between the 17 GHz feeder-link channels and the 12 GHz down-link channels. Other values of the translation frequency may be used, provided that the corresponding channels have been assigned to the space station of the administration concerned.

With a single value frequency translation between the feeder-link frequency band (17.3 - 17.8 GHz) and the down-link frequency band (12.2 - 12.7 GHz), the guard bands present in the down-link Plan result in corresponding bandwidths of 12 MHz at the upper and lower feeder-link band edges. These feeder-link guard bands may be used for transmissions in the space operation service.

3.2 *Carrier-to-noise ratio*

Paragraph 3.3 of Annex 5 to Part I provides guidance for planning and the basis for the evaluation of the carrier-to-noise ratios of the feeder-link and down-link Plans.

As a guidance for planning, the reduction in quality in the down-link due to thermal noise in the feeder link is taken as equivalent to a degradation in the down-link carrier-to-noise ratio of approximately 0.5 dB for 99% of the worst month.

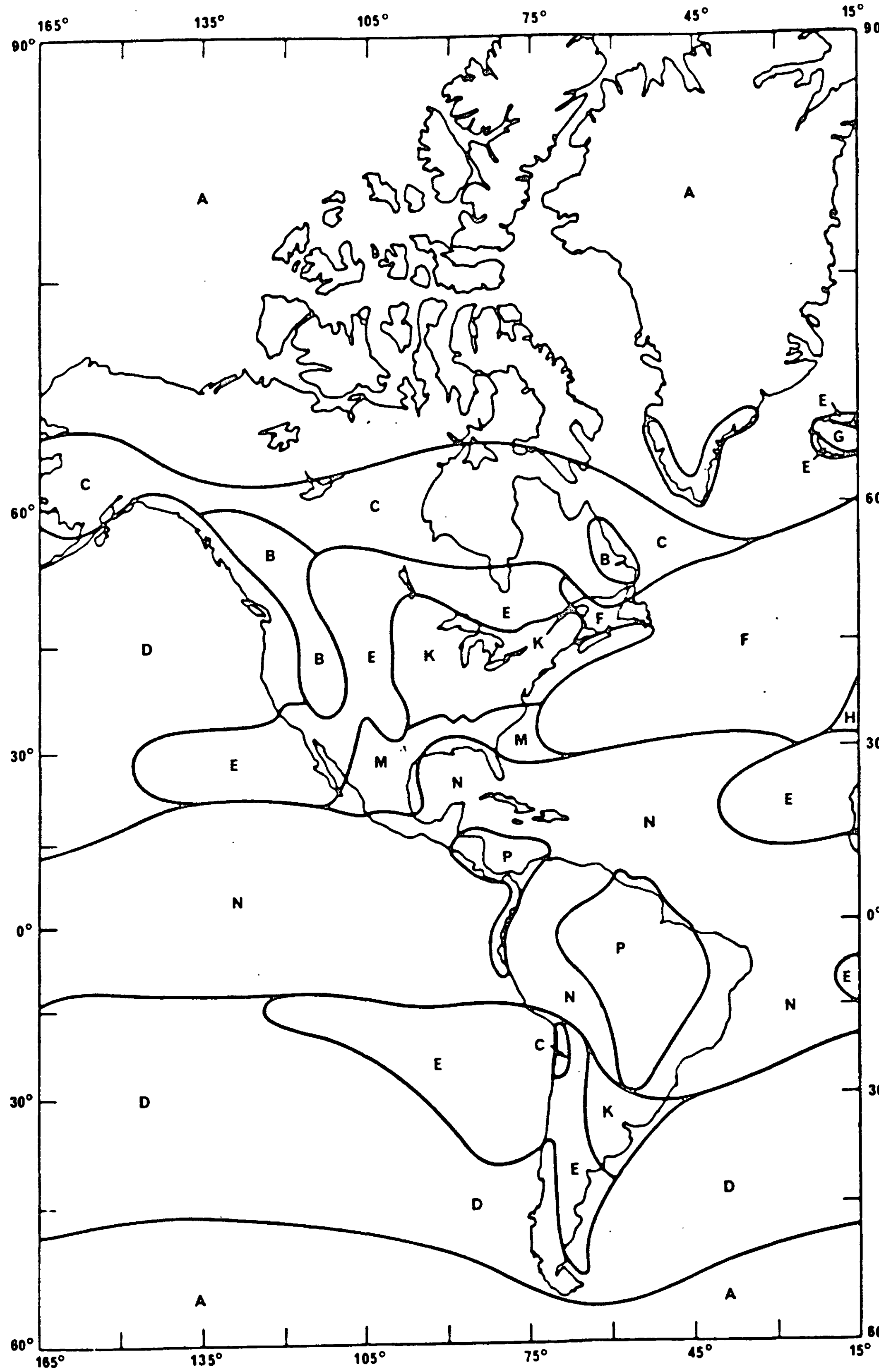
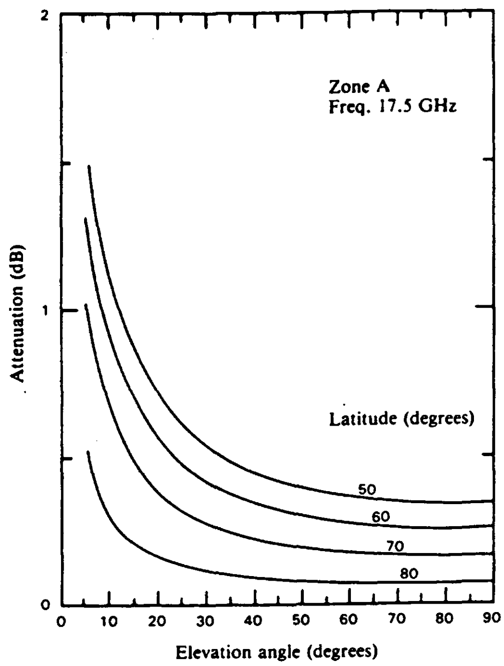
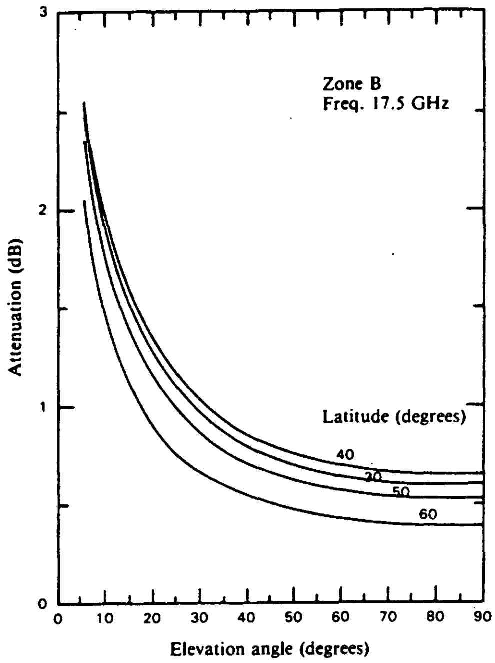


FIGURE 1

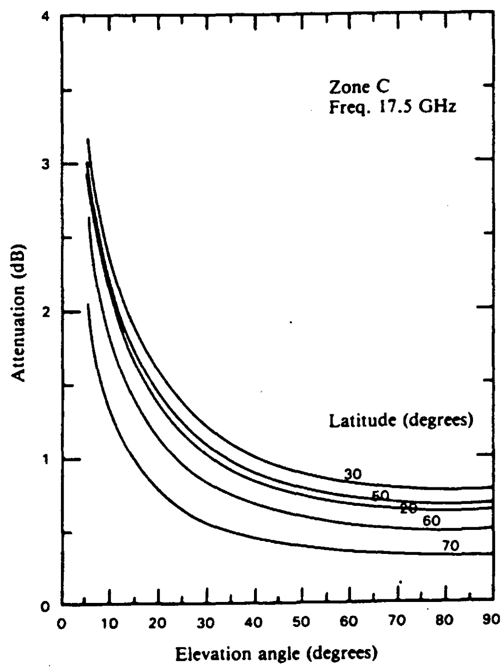
Rain climatic zones (Region 2)



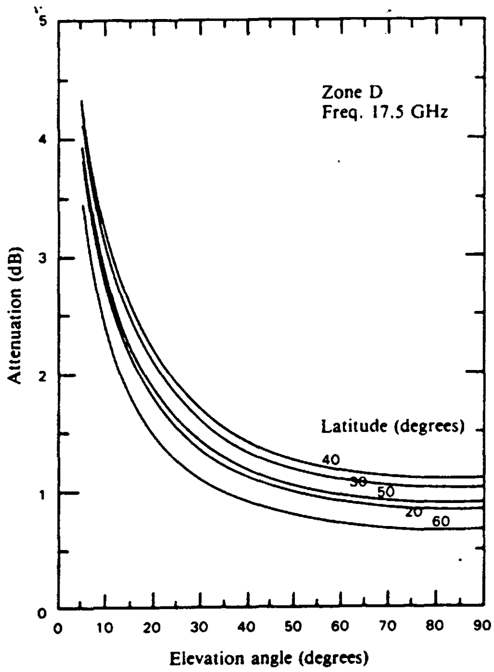
a) Rain climatic zone A



b) Rain climatic zone B



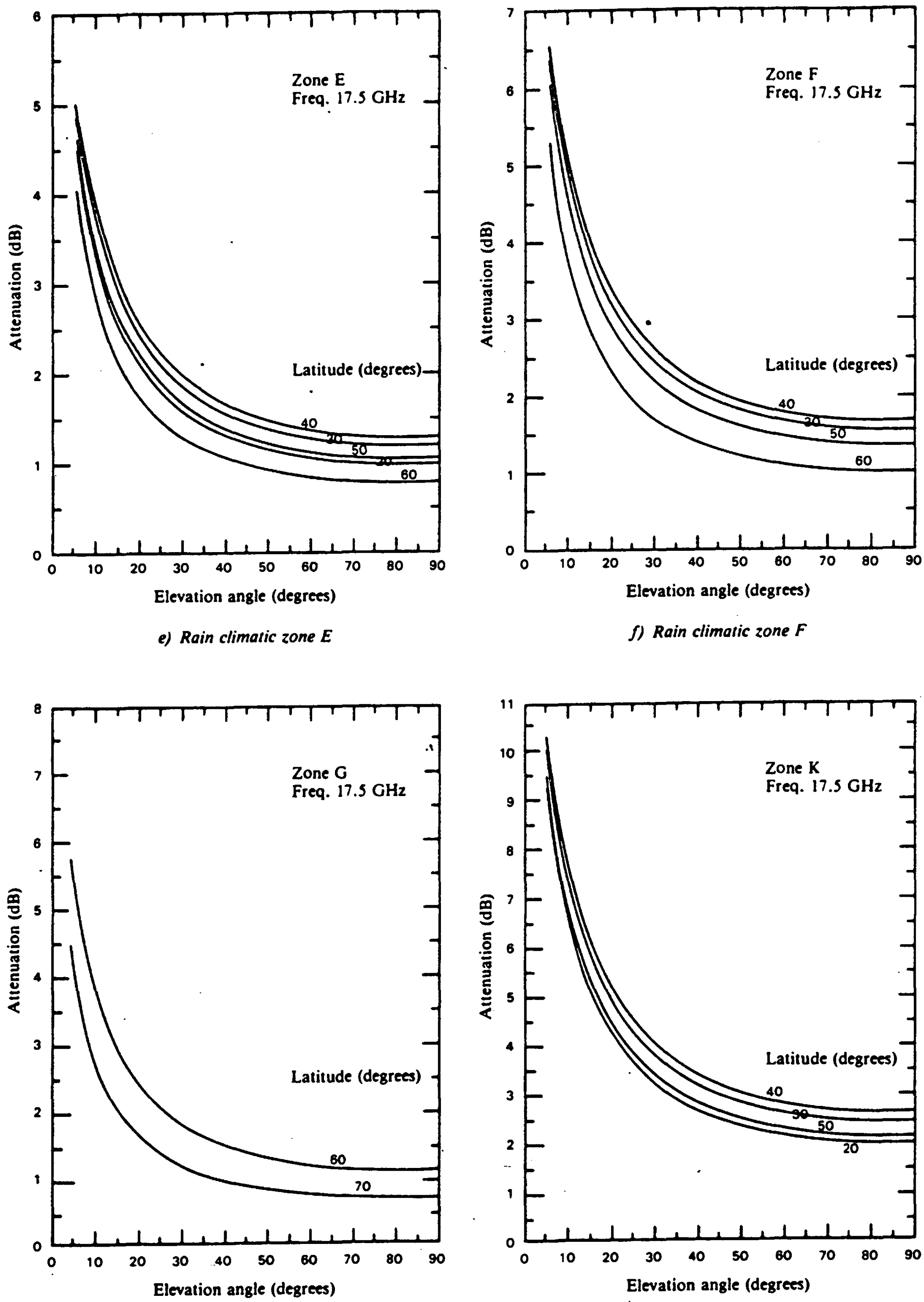
c) Rain climatic zone C



d) Rain climatic zone D

FIGURE 2

Rain attenuation values exceeded for 1% of the worst month (sea level) for Region 2 rain climatic zones



e) Rain climatic zone E

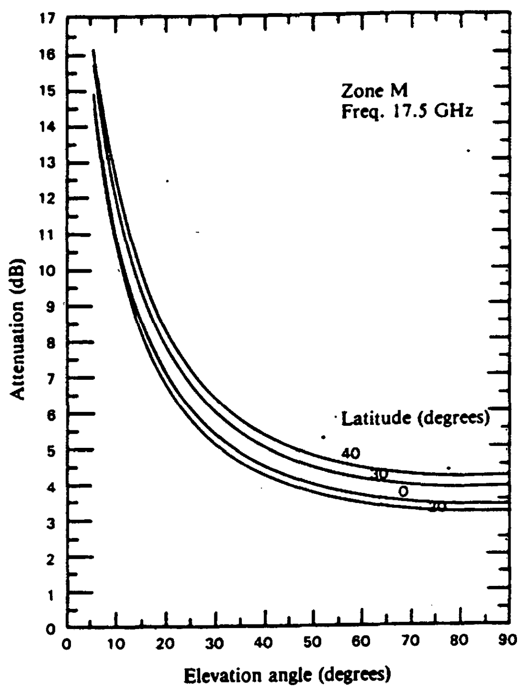
f) Rain climatic zone F

g) Rain climatic zone G

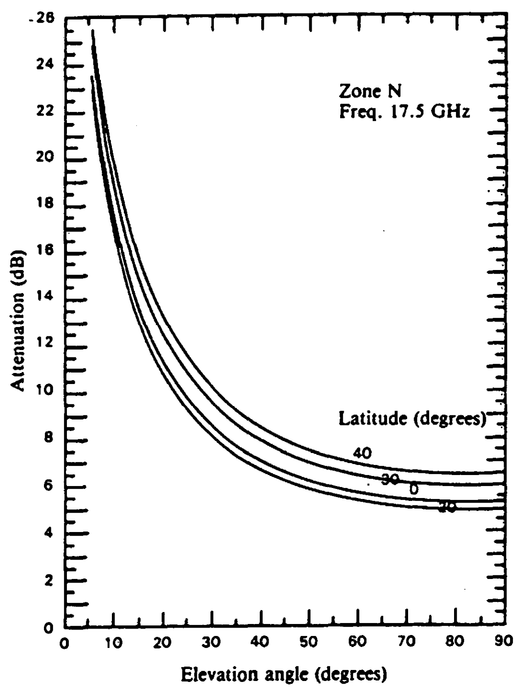
h) Rain climatic zone K

FIGURE 2 *(cont.)*

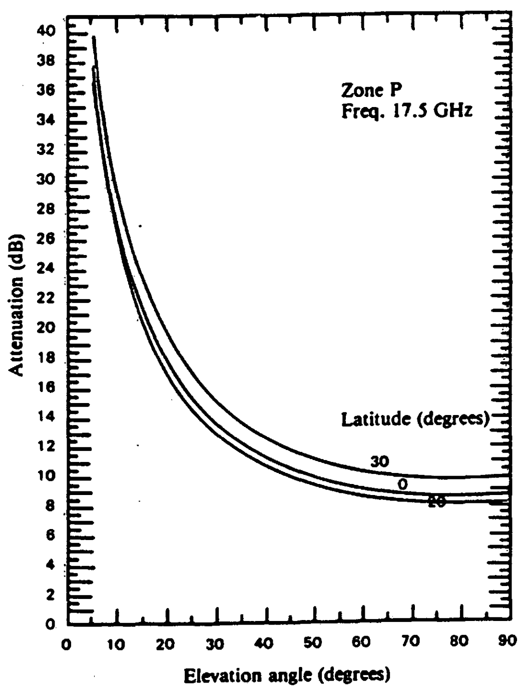
Rain attenuation values exceeded for 1% of the worst month (sea level) for Region 2 rain climatic zones



i) Rain climatic zone M



j) Rain climatic zone N



k) Rain climatic zone P

FIGURE 2 *(cont.)*

Rain attenuation values exceeded for 1% of the worst month (sea level) for Region 2 rain climatic zones

3.3 *Carrier-to-interference ratio*

Paragraph 3.4 of Annex 5 to Part I of the Final Acts provides guidance for planning for the contribution of the feeder link co-channel interference to the overall co-channel carrier-to-interference ratio. However, the feeder-link and down-link Plans are evaluated on the overall equivalent protection margin which includes the combined down-link and feeder link contributions. Definitions 1.7, 1.8, 1.9, 1.10 and 1.11 of this Annex and the protection ratios given in paragraph 3.4 of Annex 5 to Part I are used in the analysis of the Plans.

For the adjacent channels, the Plan is based on an orbital separation of 0.4° between nominally co-located satellites having cross-polarized adjacent channel assignments.

For the second adjacent channels, the Plan is based on a 10 dB improvement on the feeder-link carrier-to-interference ratio due to the satellite receive filtering.

3.4 *Transmitting antenna*

3.4.1 *Antenna diameter*

The feeder-link Plan is based on an antenna diameter of 5 metres.

The minimum antenna diameter permitted in the Plan is 2.5 metres. However, the feeder-link carrier-to-noise ratio and carrier-to-interference ratio resulting from the use of antennae with diameters smaller than 5 metres would generally be less than those calculated in the Plan.

The use of antennae larger than 5 metres, with corresponding values of on-axis e.i.r.p. higher than the planned value (indicated in paragraph 3.4.3) but without augmented off-axis e.i.r.p., is permitted if the orbital separation between the assigned orbital location of the administration and the assigned orbital location of any other administration is greater than 0.5°.

Antennae with diameters larger than 5 metres can also be implemented if the above orbital separation is less than 0.5° and if the e.i.r.p. of the desired feeder-link earth station does not exceed the planned value of e.i.r.p.

If the above orbital separation is less than 0.5° and if the e.i.r.p. of the desired feeder-link earth station exceeds the planned value, agreement between administrations is required in accordance with paragraph 3.3.1, Article 3 of this Part.

3.4.2 *Reference patterns of transmitting antennae*

The co-polar and cross-polar reference patterns of transmitting antennae used for planning in Region 2 are given in Figure 3.

3.4.3 *Antenna efficiency*

The Plan is based on an antenna efficiency of 65%. The corresponding on-axis gain for an antenna having a 5-metre diameter is 57.4 dBi at 17.55 GHz, and the corresponding value of e.i.r.p. used for planning purposes is 87.4 dBW.

3.4.4 *Pointing accuracy*

The Plan has been developed to accommodate a loss in gain due to earth station antenna mis-pointing of 1 dB. Under no circumstances shall the Plan allow for a mis-pointing angle greater than 0.1°..

3.5 *Transmit power*

The maximum transmit power delivered to the input of the antenna of the feeder-link earth station is 1,000 watts per 24 MHz television channel. This level of power can only be exceeded under certain conditions specified in paragraph 3.10 of this Annex.

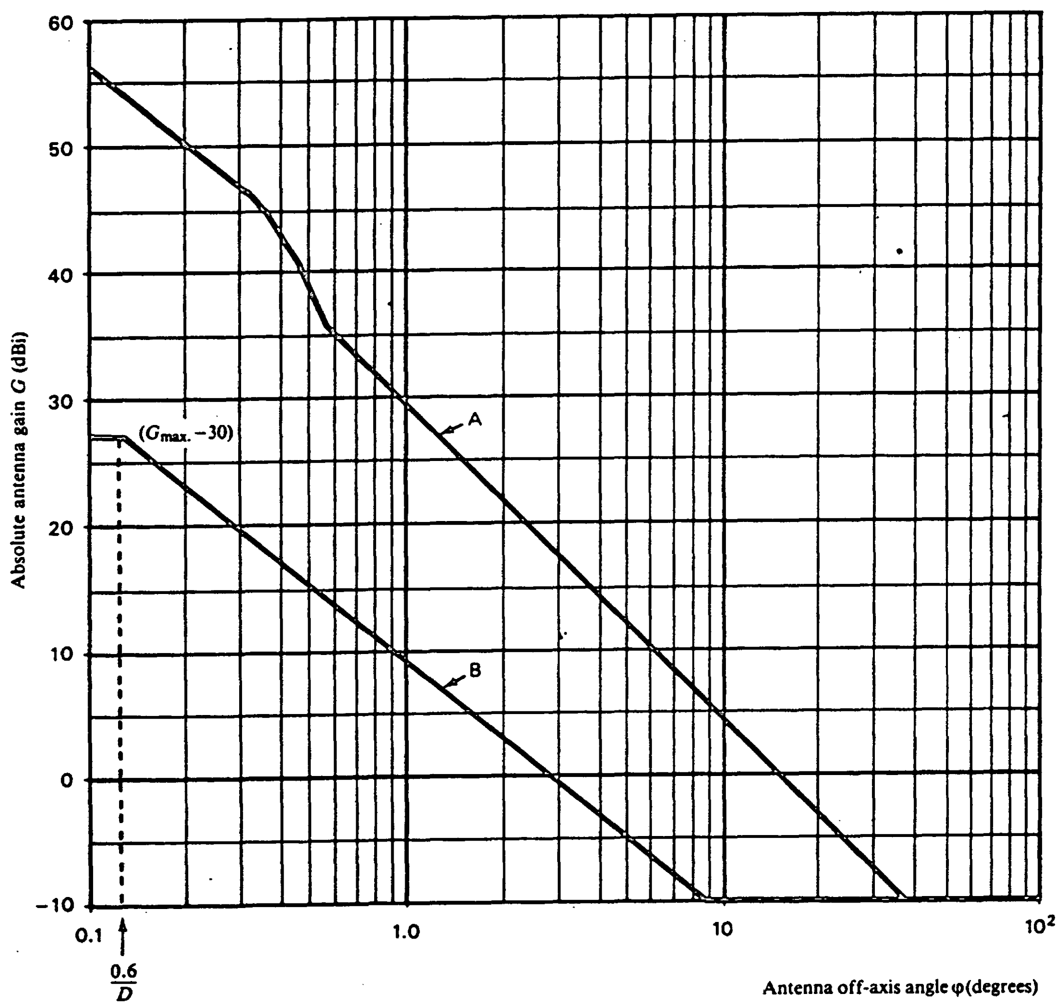


FIGURE 3

Reference patterns for co-polar and cross-polar components for transmitting antennae for Region 2

Curve A: Co-polar component (dBi)

$36 - 20 \log_{10}\varphi$	for	$0.1° \leq \varphi < 0.32°$
$51.3 - 53.2\,\varphi^2$	for	$0.32° \leq \varphi < 0.54°$
$29 - 25 \log_{10}\varphi$	for	$0.54° \leq \varphi < 36°$
-10	for	$\varphi \geq 36°$

Curve B: Cross-polar component (dBi)

$G_{max} - 30$	for	$\varphi < \left(\frac{0.6}{D}\right)^{\circ}$
$9 - 20 \log_{10}\varphi$	for	$\left(\frac{0.6}{D}\right)^{\circ} \leq \varphi < 8.7°$
-10	for	$\varphi \geq 8.7°$

where:

φ = off-axis angle referred to the main-lobe axis;

G_{max} = on-axis co-polar gain of the antenna;

D = diameter of the antenna in meters ($D \geq 2.5$).

Note 1: In the angular range between 0.1° and 0.54°, the co-polar gain must not exceed the reference pattern.

Note 2: In the angular range between 0° and $(0.6/D)°$, the cross polar gain must not exceed the reference pattern.

Note 3: At the larger off-axis angles and for 90% of all sidelobe peaks in each of the reference angular windows, the gain must not exceed the reference patterns. The reference angular windows are 0.54° to 1°, 1° to 2°, 2° to 4°, 4° to 7°, 7° to 10°, 10° to 20°, 20° to 40°, 40° to 70°, 70° to 100°, 100° to 180°. The first reference angular window for evaluating the cross-polar component should be $(0.6/D)°$ to 1°.

3.6 *Receiving antenna*

3.6.1 *Cross-section of receiving antenna beam*

Planning has been based on beams of elliptical or circular cross-section. When the assignments are implemented, or when the Plan is modified, administrations may use non-elliptical or shaped beams.

If the cross-section of the receiving antenna beam is elliptical, the effective beamwidth φ_0 is a function of the angle of rotation q between the plane containing the satellite and the major axis of the beam cross-section and the plane in which the beamwidth is required.

The relationship between the maximum gain of an antenna and the half-power beamwidth can be derived from the expression:

$$G_m = 27\,843/ab$$

or

$$G_m(\text{dB}) = 44.44 - 10 \log_{10}a - 10 \log_{10}b$$

where:

a and b are the angles (in degrees) subtended at the satellite by the major and minor axes of the elliptical cross-section of the beam.

An antenna efficiency of 55% is assumed.

3.6.2 *Minimum beamwidth*

A minimum value of 0.6° for the half-power beamwidth of the receiving antenna has been agreed on for planning.

3.6.3 *Reference patterns*

The reference patterns for the co-polar and cross-polar components of the satellite receiving antenna used in preparing the Plan are given in Figure 4.

Where it was necessary to reduce interference, the pattern shown in Figure 5 was used; this use will be indicated in the Plan by an appropriate symbol. This pattern is derived from an antenna producing an elliptical beam with fast roll-off in the main lobe. Three curves for different values of φ_0 are shown as examples.

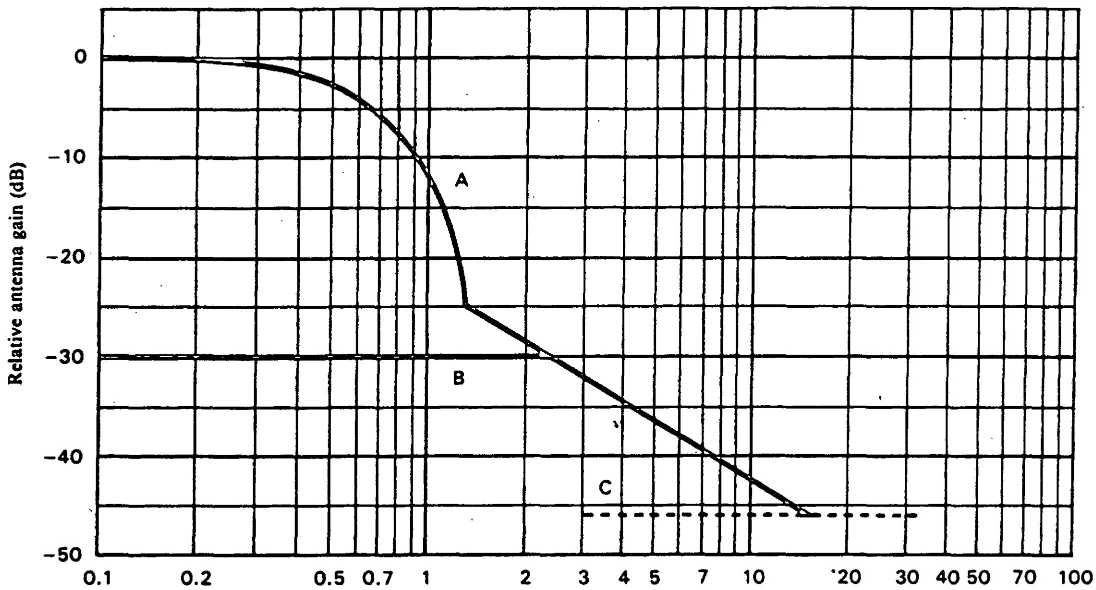


FIGURE 4

Reference patterns for co-polar and cross-polar components for satellite receiving antenna in Region 2

Curve A: Co-polar component (dB relative to main beam gain)

$-12\,(\varphi/\varphi_0)^2$ for $0 \leq (\varphi/\varphi_0) \leq 1.45$

$-(22 + 20\log_{10}(\varphi/\varphi_0))$ for $1.45 < (\varphi/\varphi_0)$

after intersection with curve C: as curve C

Curve B: Cross-polar component (dB relative to main beam gain)

-30 for $0 \leq (\varphi/\varphi_0) \leq 2.51$

after intersection with curve A: as curve A

Curve C: Minus the on-axis gain.

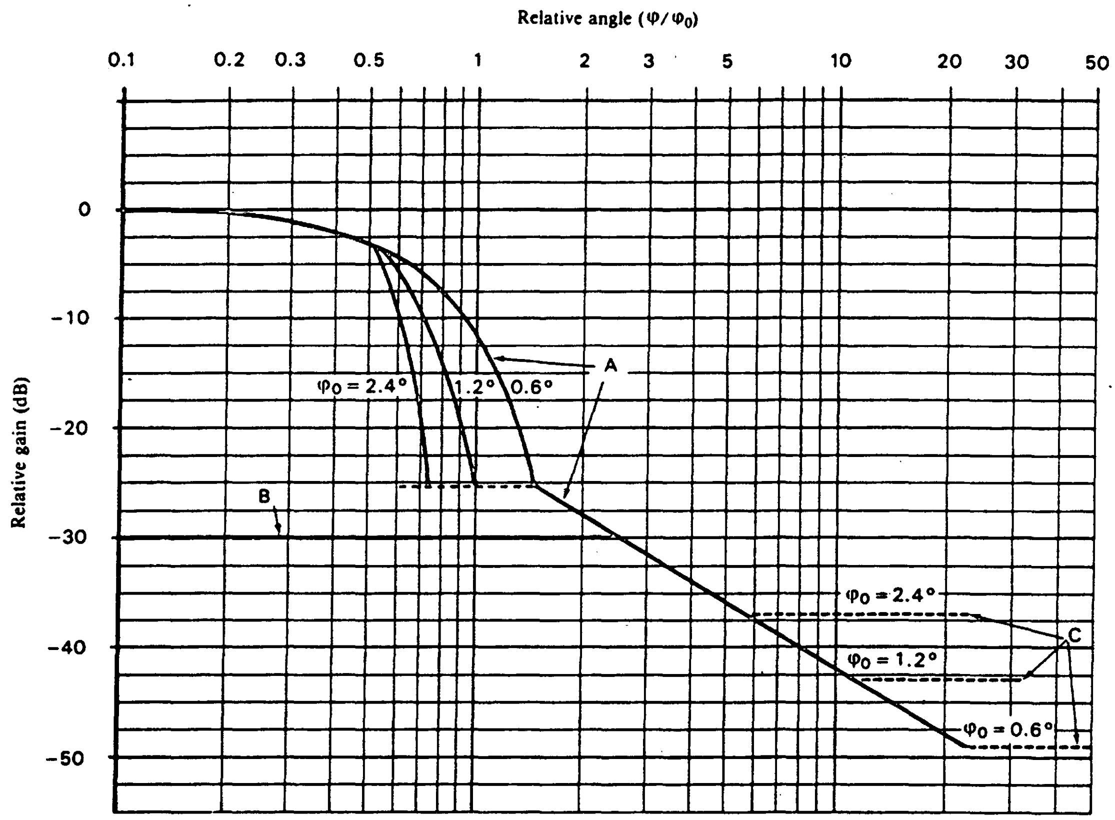


FIGURE 5

Reference patterns for co-polar and cross-polar components for satellite receiving antennae with fast roll-off in the main beam for Region 2

Curve A: Co-polar component (dB relative to main beam gain)

$-12\ (\varphi/\varphi_0)^2$ for $0 \leq \varphi/\varphi_0 \leq 0.5$

$-33.33\ \varphi_0^2 \left(\varphi/\varphi_0 - x\right)^2$ for $0.5 < \varphi/\varphi_0 \leq \frac{0.87}{\varphi_0} + x$

-25.23 for $\frac{0.87}{\varphi_0} + x < \varphi/\varphi_0 \leq 1.413$

$-\left(22 + 20 \log_{10} (\varphi/\varphi_0)\right)$ for $1.413 < \varphi/\varphi_0$

after intersection with curve C: as curve C

Curve B: Cross-polar component (dB relative to main beam gain)

-30 for $0 \leq \varphi/\varphi_0 < 2.51$

after intersection with curve A: as curve A

Curve C: Minus the on-axis gain

where:

φ = off-axis angle (degrees)

φ_0 = dimension of the minimum ellipse fitted around the feeder link service area in the direction of interest

$x = 0.5 \left(1 - \frac{0.6}{\varphi_0}\right)$

3.6.4 *Pointing accuracy*

The deviation of the receiving antenna beam from its nominal pointing direction must not exceed 0.1° in any direction. Moreover, the angular rotation of the receiving beam about its axis must not exceed ± 1°; this latter limit is not necessary for beams of circular cross-section using circular polarization.

3.7 *System noise temperature*

The Plan is based on a value of 1500 K for the satellite system noise temperature.

3.8 *Polarization*

3.8.1 In Region 2, for the purpose of planning the feeder links, circular polarization is used.

3.8.2 In the cases where there are polarization constraints, use of polarization other than circular is permitted only upon agreement of administrations that may be affected.

3.9 *Automatic gain control*

3.9.1 The Plan is based on use of automatic gain control on-board satellites to maintain a constant signal level at the satellite transponder output.

3.9.2 The dynamic range of automatic gain control is limited to 15 dB when satellites are located within 0.4 degrees of each other and operate on cross-polarized adjacent channels serving common or adjacent feeder-link service areas.

3.9.3 The 15 dB limit of automatic gain control does not apply to satellites other than those specified in paragraph 3.9.2 above.

3.10 *Power control*

The Plan has been developed without the use of power control.

The use of transmit power levels higher than those given in paragraph 3.5 is permitted only when rain attenuation exceeds 5 dB at 17 GHz. In such cases, the transmit power may be increased by the amount that the instantaneous rain attenuation exceeds 5 dB at 17 GHz up to the limit given in Table I.

TABLE I

Transmit radio frequency power (delivered to the imput of the feeder link earth station antenna) permitted in excess of 1000 watts as a function of elevation angle

Elevation angle of feeder link earth station antenna (degrees)	Transmit power permitted in excess of 1000 watts (dB)
0 to 40	0
40 to 50	2
50 to 60	3
60 to 90	5

3.11 *Site diversity*

Site diversity refers to the alternate use during rain of two or more transmitting earth stations which may be separated by sufficient distance to ensure uncorrelated rainfall conditions.

The use of site diversity is permitted and is considered to be an effective technique for maintaining high carrier-to-noise ratio and carrier-to-interference ratio during periods of moderate to severe rain attenuation. However, the Plan is not based on the use of site diversity.

3.12 *Depolarization compensation*

The Plan is developed without the use of depolarization compensation. Depolarization compensation is permitted only to the extent that interference to other satellites does not increase by more than 0.5 dB relative to that calculated in the feeder-link Plan.

3.13 *Minimum separation between satellites*

Figure 6 illustrates two adjacent clusters of satellites separated by 0.9 degree between the centres of the clusters. $A\eta$ identifies a satellite of administration η. A cluster is formed by two or more satellites separated by 0.4 degree and located at two nominal orbital positions as specified in the Plan; one position for right-hand polarized channels and the other position for left-hand polarized channels.

3.13.1 *Satellites of the same cluster*

The Plan is based on an orbital separation of 0.4 degree between satellites having cross-polarized adjacent channels (i.e. satellites located at +0.2 degree and −0.2 degree from the centre of the cluster). However, satellites within a cluster may be located at any orbital position within the cluster, requiring only the agreement of the other administrations having satellites sharing the same cluster. Such orbital positioning of satelites within a cluster is illustrated in Figure 6 by some of the satellites A5, A6 and A7.

The station-keeping tolerance of ± 0.1 degree indicated in paragraph 3.11 of Annex 5 to Part I of these Final Acts must be applied to satellites located at any position within the 0.4 degree-wide cluster.

3.13.2 *Satellites of different clusters*

In the Plan, the orbital separation between the centres of adjacent clusters of satellites is at least 0.9 degree. The value of 0.9 degree is also the minimum orbital separation to provide flexibility in the implementation of feeder links indicated in paragraph 3.4.1 of this Annex without the need for an agreement (see paragraph 3.3, Article 3 of this Part).

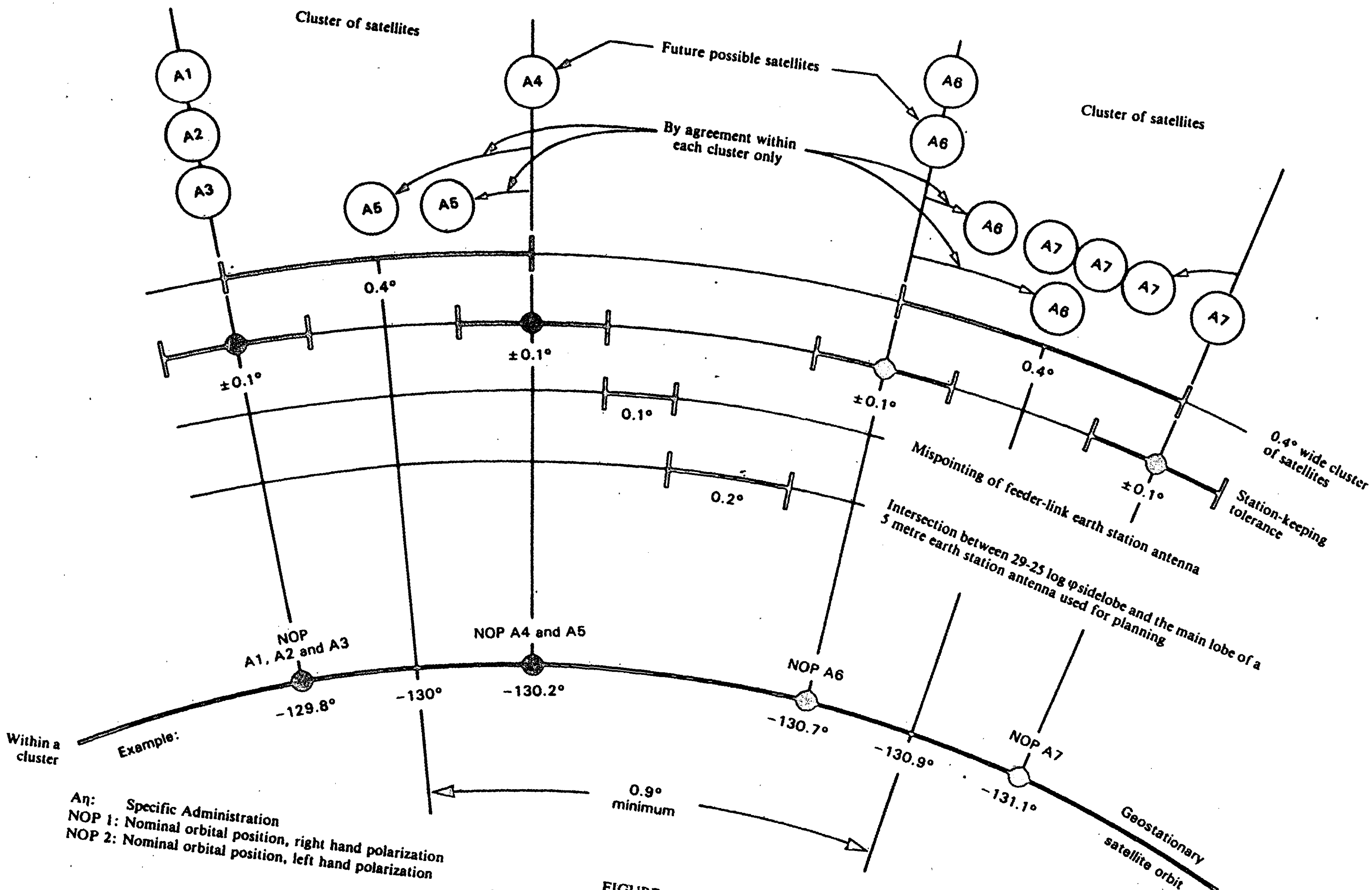


FIGURE 6

Exploded view of geostationary satellite orbit

ANNEX 4

Criteria for sharing between services

1. *Threshold values for determining when coordination is required between a transmitting space station in the fixed-satellite service and a receiving space station in the feeder-link Plan in the band 17.7 - 17.8 GHz*

With respect to paragraph 7.1, Article 7 of this Part, coordination of a transmitting space station in the fixed-satellite service with a broadcasting-satellite in the Region 2 Plan is required, for inter-satellite geocentric angular separations less than 10° or greater than 150°, when the power flux-density arriving at the receiving space station of a broadcasting-satellite feeder-link station of another administration would cause an increase in the noise temperature of the feeder-link space station which, calculated in accordance with the method given in Appendix **29** to the Radio Regulations, exceeds a threshold value of $\Delta T/T$ corresponding to 10%. The above provision does not apply when the geocentric angular separation, between a transmitting space station in the fixed-satellite service and a receiving space station in the feeder-link Plan, exceeds 150° of arc and the free-space power flux-density of the transmitting space station in the fixed-satellite service does not exceed a value of -123 dB(W/m^2/24 MHz) on the Earth's surface at the equatorial Earth limb.

2. *Threshold values for determining when coordination is required between an earth station in the fixed-satellite service (Earth-to-space) in Regions 1 and 3 and a broadcasting-satellite space station receiver in Region 2 in the band 17.7 - 17.8 GHz*

With respect to paragraph 7.1, Article 7 of this Part, an administration shall be considered as being affected by a frequency assignment in the fixed-satellite service (Earth-to-space) in Regions 1 and 3 if that assignment would result in an increase in the noise temperature of the feeder-link space station in Region 2 which, calculated in accordance with the method given in Appendix **29** to the Radio Regulations, exceeds a threshold value of $\Delta T/T$ corresponding to 10% at the feeder-link space station.

3. *Method for the determination of the coordination area around a feeder-link transmitting earth station of the Region 2 Plan with respect to receiving earth stations in the fixed-satellite service in Region 2 in the frequency band 17.7 - 17.8 GHz*

3.1 *Introduction*

In the frequency band 17.7 - 17.8 GHz, which is allocated to the fixed-satellite service, in both the Earth-to-space direction (for broadcasting-satellite service feeder links only), and the space-to-Earth direction, emissions from transmitting feeder-link earth stations may cause interference at receiving earth stations in the fixed-satellite service.

Electromagnetic coupling of an emission originating at a feeder-link earth station into a receiving earth station may occur through two propagation mechanisms or "modes":

Propagation mode (1): coupling along a great circle tropospheric interference horizon path;

Propagation mode (2): coupling through scatter from hydrometeors.

The determination of whether emissions from a feeder-link earth station may cause unacceptable interference in a receiving earth station is by means of coordination contours drawn around a feeder-link earth station on a map. When a receiving earth station is located within either or both coordination contours, i.e., within the coordination area, there is a possibility of unacceptable interference.

The procedure for the determination of the coordination area for a feeder-link earth station in relation to a receiving earth station in the fixed-satellite service is similar to that described in Appendix **28** to the Radio Regulations but differs from it in the details described below. [1]

3.2 *Determination of the coordination contour for propagation mode (1)*

The distance at which a signal of power $P_{t'}$ (in dBW) applied to the antenna terminals of a feeder-link earth station will produce a received power $P_r(p)$ at the antenna terminals of a receiving earth station, for propagation mode (1), is given by:

$$d_1 = (P_{t'} + G_{t'} + G_r - P_r(p) - A_0 - A_h)/\beta \qquad \text{(km)} \qquad (1)$$

as derived from equations (2) and (8) of Appendix **28** to the Radio Regulations,

where:

$P_{t'}$ is maximum RF power (dBW) in any 1 MHz band applied to the antenna terminals of a feeder-link earth station;

$G_{t'}$ is gain (dB) of the feeder-link earth station antenna towards the physical horizon on the azimuth to the receiving earth station;

G_r is gain (dB) of the receiving earth station antenna towards the physical horizon on the azimuth to the feeder-link earth station;

$P_r(p)$ is permissible interfering RF power (dBW) in any 1 MHz band to be exceeded for no more than p% of the time at the antenna terminals of the receiving earth station;

A_0 is a constant equal to 145.0 dB;

A_h is the sum (dB) of available site shielding at the feeder-link earth station, $A_{ht'}$, and at the receiving earth station, A_{hr}, on the respective azimuth towards the other earth station (both in dB);

β is the rate of attenuation along the interference path (dB/km), a function of the radio-climatic zone and of p as used in $P_r(p)$ above.

To determine the coordination contour for propagation mode (1) for a feeder-link earth station, equation (1) is solved for all azimuths around the earth station site (in suitable increments; e.g., every 5 degrees), and the resulting distances plotted for all azimuths on a map of suitable scale from the earth station site. The connection of the so marked distance points constitutes the coordination contour for the feeder-link earth station.

3.3 *Determination of parameters used in equation (1)*

The parameters used in equation (1) are determined as follows:

3.3.1 *Determination of $G_{t'}$ and G_r*

The determination of $G_{t'}$ follows the procedure set forth in Annex II to Appendix **28** to the Radio Regulations, using the notified feeder-link earth station antenna pattern.

For the receiving earth station, a minimum main beam elevation angle of 5° is assumed for which the reference antenna radiation diagram of paragraph 4 of Annex II to Appendix **28** to the Radio Regulations yields, in the absence of site shielding, a horizon antenna gain of $G_r = 14.5$ dB.

[1] See Resolution No. 6(Sat-R2).

3.3.2 *Determination of $A_{ht'}$ and A_{hr}*

The calculation of $A_{ht'}$ requires the determination of the horizon elevation angle θ (degrees) for all azimuths around a feeder-link earth station site. With these horizon elevation angles and the frequency of $f = 17.75$ GHz, $A_{ht'}$ is then calculated for each azimuth from equation (7a) of Appendix **28** to the Radio Regulations for $\theta > 0°$, and it should be taken = 0 dB for $\theta < 0°$.

For the fixed-satellite receiving earth station, the assumption must be made that no site shielding is available; hence, A_{hr} = 0 dB.

3.3.3 *Determination of $P_r(p)$* and *p*

The maximum permissible interfering RF power in any 1 MHz band is taken, under nominal conditions, to be limited to 15% of the total noise received at an earth station, or about 20% of the thermal noise of the receiving system. This corresponds to a value of −7 dB for the parameter J of Appendix **28** to the Radio Regulations. For percentages of time of less than 0.003%, a permissible increase in the interference by 5 dB is assumed (parameter $M(p)$ of Appendix **28** to the Radio Regulations). Considering further that the band 17.7 - 17.8 GHz is also shared with terrestrial services, the assumption is made that up to three equivalent entries of interference may be present which, however, produce their maximum interference during periods uncorrelated in time, thus allowing each to produce the maximum permissible value of interfering RF power during $p = 0.001\%$ of the time.

Therefore, according to equation (3) of Appendix **28** to the Radio Regulations:

$$P_r(p) = 10 \log (kTB) + 5 - 7 \qquad \text{(dB(W/MHz))} \qquad (2)$$

which, with

k = Boltzmann's constant,

B = 1 MHz, and

T = receiving system noise temperature, assumed to be 200 K

yields:

$P_r(p) = -147.6$ (dB(W/MHz)),

with $p = 0.001\%$ of the time.

3.3.4 *Determination of β*

The rates of attenuation for a percentage of time of 0.001%, for the three radio-climatic zones as defined in paragraph 3.1 of Appendix **28** to the Radio Regulations at 17.75 GHz, are the following:

Zone A: β_A = 0.198 dB/km

Zone B: β_B = 0.06 dB/km

Zone C: β_C = 0.074 dB/km

3.3.5 *Graphical method*

Figure 1 provides curves by means of which d_1 may be determined when only a single radio-climatic zone is involved. The three curves shown are for the three radio-climatic zones as defined in Appendix **28** to the Radio Regulations. The abscissa is given in terms of the parameter P as defined below:

$$P = P_{t'} + G_{t'} + G_r - P_r(p) - A_0 - A_h \qquad \text{(dB)}$$

3.4 *Mixed zone contours*

When the solution of equation (1) yields a distance d_1, which, on the azimuth under consideration, produces a point which lies in a different radio-climatic zone from that in which the feeder-link earth station is located, it is necessary to determine a mixed-zone coordination distance for that azimuth. Thus, if the feeder-link earth station is located in a radio-climatic zone identified by the suffix "a" and the solution of equation (1) produces a distance which ends in another radio-climatic zone, identified by the suffix "b" (a and b referring to any one of the zones A, B or C, with $a \neq b$), the coordination distance is calculated from:

$$d_1 = \frac{P - d_a\beta_a}{\beta_b} + d_a \quad \text{(km)} \tag{3}$$

where d_a is the distance (km) from the feeder-link earth station site to the boundary between the two climatic zones.

For the rare case where more than two radio-climatic zones are involved, the applicable equation would be:

$$d_1 = \frac{P - d_a\beta_a - d_b\beta_b}{\beta_c} + d_a + d_b \quad \text{(km)} \tag{4}$$

where the subscript "c" denotes the zone farthest away from the feeder-link earth station site within which the coordination distance ends.

3.5 *Determination of the coordination contour for propagation mode (2)*

In the case of scattering from hydrometeors, the high main beam e.i.r.p. from a transmitting feeder-link earth station antenna and the expected high sensitivity of a fixed-satellite service receiving earth station suggest that interference from a feeder-link earth station into a fixed-satellite earth station may be unacceptable only when either earth station can see the main beam of the other, below the maximum altitudes from which significant hydrometeor scatter reflectivity prevails.

Accordingly, to avoid such mutual visibility conditions, the rain scatter distance d_r is to be that distance at which the receiving earth station's horizon intersects the maximum expected rain scatter altitude h_s.[1]

3.5.1 *Rain scatter distance d_r*

For an assumed horizon elevation angle of zero degree at the fixed-satellite receiving earth station, d_r is given by

$$d_r = 130\sqrt{h_s} \quad \text{(km)} \tag{5}$$

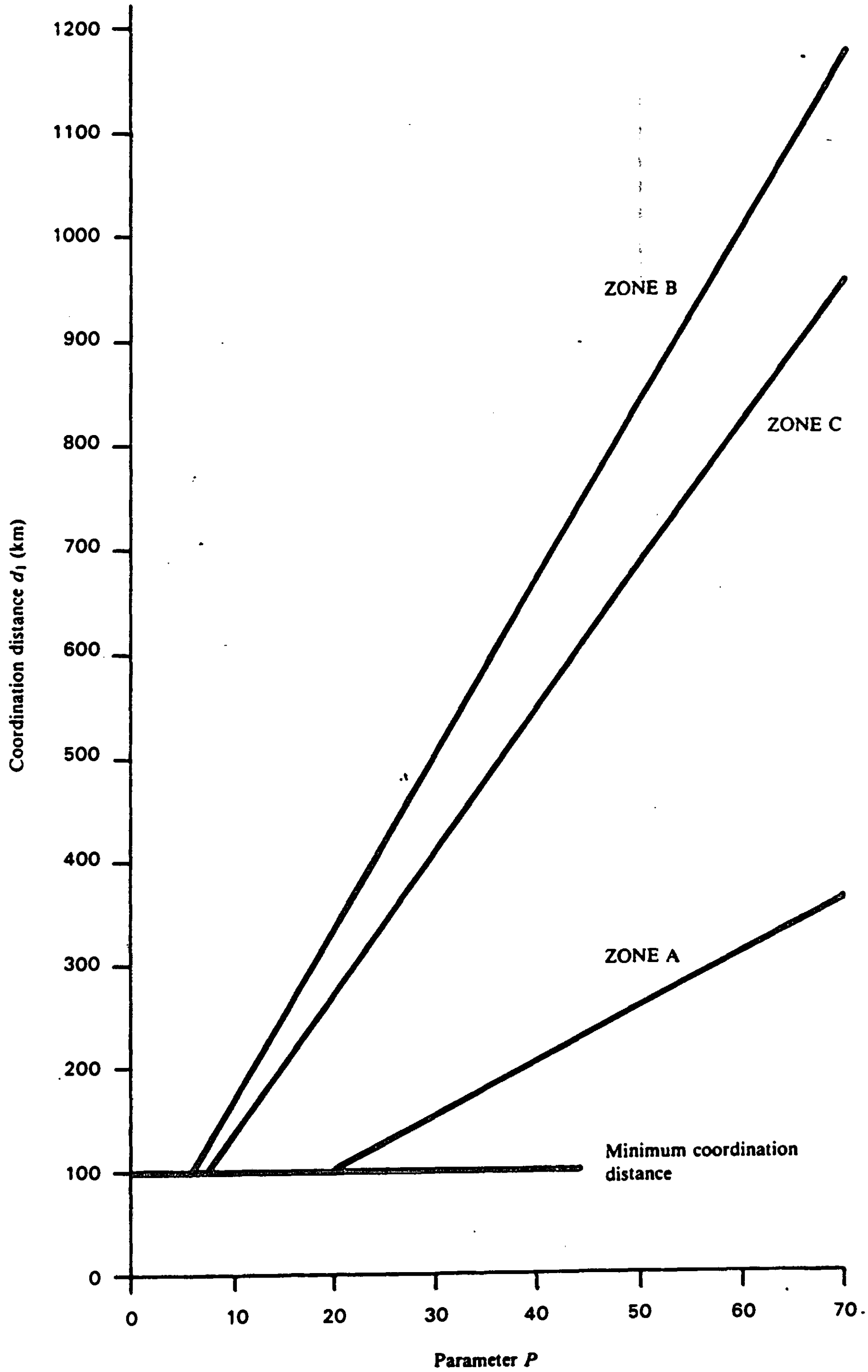
in a 4/3 earth radius reference atmosphere, with

$$h_s = 5.1 - 2.15 \log\left[1 + 10^{(\varphi - 27)/25}\right] \quad \text{(km)} \tag{6}$$

where φ is the latitude (North or South) of the feeder-link earth station site (degrees).

The rain scatter distance d_r so calculated yields the rain scatter coordination contour for the feeder-link earth station by the procedure described in paragraph 4.5 of Appendix **28** to the Radio Regulations.

[1] The maximum scatter height h_s is similar to the maximum rain height h_R of paragraph 2.1.2 of Annex 5, Part I, used in the calculation of effective path-length for the determination of rain attenuation, except that the factor "c" of paragraph 2.1.2 of Annex 5, Part I, is omitted.



$$P = P_{t'} + G_{t'} + G_r - P_r(p) - A_0 - A_h \text{ (dB)}$$

FIGURE 1

Coordination distance as a function of parameter P.
Propagation mode(1); 17.75 GHz; p = 0.001% of the time

3.5.2 *Graphical method*

Figure 2 provides a curve by means of which the rain scatter distance d_r may be read directly for a given feeder-link earth station latitude φ.

3.6 *Minimum coordination distances*

The minimum coordination distance for a feeder-link earth station shall be 100 km.

3.7 *Coordination area*

The coordination area for a feeder-link earth station is the total area contained within the combined coordination contours for propagation modes (1) and (2).

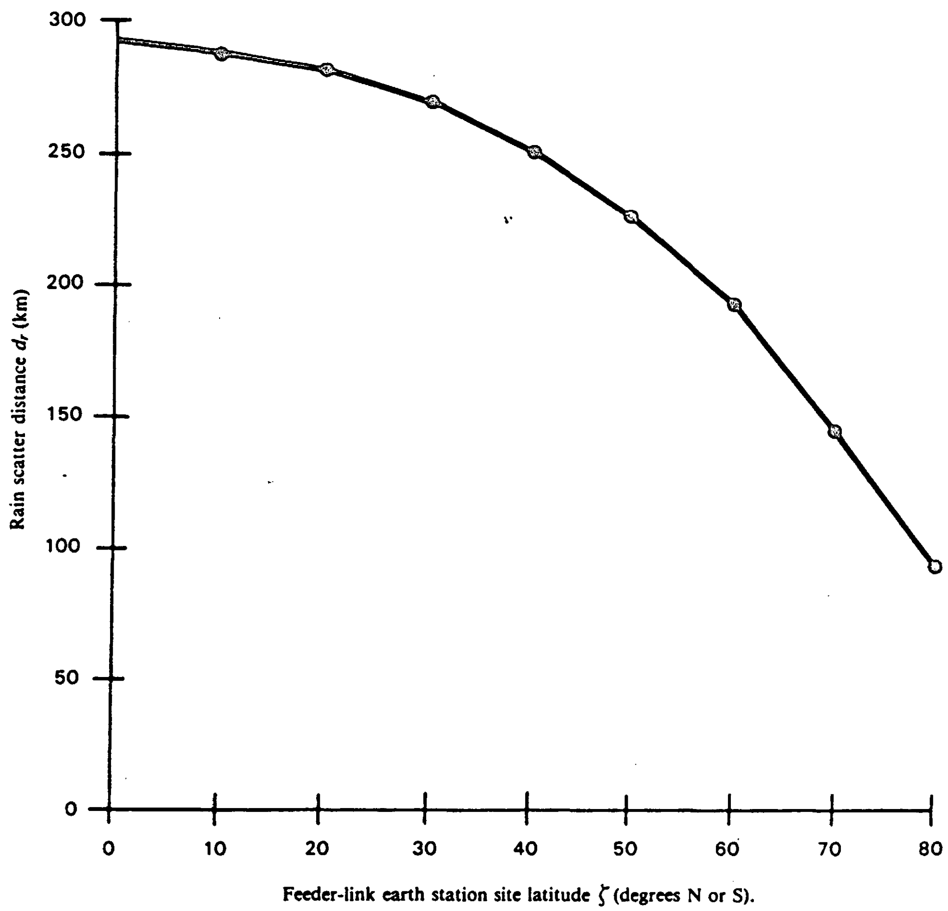


FIGURE 2

Rain scatter distance d_r as a function of feeder-link earth station site latitude ζ

INTERNATIONAL TELECOMMUNICATION UNION

ORB-85 WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT

FIRST SESSION, GENEVA, AUGUST/SEPTEMBER 1985

Document DL/48-E
31 August 1985
Original: English

WORKING GROUP 4C

Note from the Chairman of Working Group 4C

TECHNICAL INTERSESSIONAL STUDIES FOR THE FSS

Sixteen items of intersessional study have been identified in Working Group 4C and included in DL documents and are listed briefly below. The documents containing the first nine items had been agreed by 31 August and the remainder are in DL documents which are still to be discussed:

1) frequency band pairing;

2) amelioration of constraints for networks of developing countries;

3) advantages and disadvantages of orbit sectorization;

4) spectrum segmentation;

5) equitable burden sharing in harmonization;

6) various other studies on harmonization;

7) the application of generalized parameters;

8) side-lobe gain for small higher-technology earth station antennas;

9) physical interference in orbit;

10) flexibility of orbit location;

11) satellite station-keeping ellipticity [and inclination];

12) frequency band for space operations in transit;

13) reverse band working;

14) increase of single entry of permissible interference;

15) polarization discrimination;

16) criteria for satellite beams.

Some of these items could be combined to make a smaller number of coherent study areas. Working Group 4C needs to do this, defining the studies with sufficient exactness, determine whether they arise from item 2.3 or item 2.4 of the agenda of WARC-ORB(1) and present the outcome to Committee 4 for approval. A first draft proposing study areas is annexed.

D.J. WITHERS
Chairman of Working Group 4C

Annex: 1

ANNEX

Intersessional studies proposed for the FSS

a) Frequency band pairing

i) To determine the potential value of guidelines on the pairing of frequency bands.

ii) To provide, if possible, a specific list of FSS frequency band pairings which may be used as a guide for administrations to follow, to the extent possible, when designing and implementing future satellite systems.

b) Amelioration of constraints for developing countries

To find ways whereby constraints which are applied to networks may be made less severe in certain arcs of the GSO and certain frequency bands, in order to lessen the economic impact of such constraints on developing countries.

c) Orbit sectorization

To study the potential benefits and potential disadvantages of orbit sectorization, for example:

- reduction of inhomogeneity;
- constraints on choice of orbit location;
- impact on efficiency of use of orbit/spectrum.

d) Interference and harmonization

i) To consider the role of the "single entry of permissible interference" in an interference-limited situation and to determine the value of a single entry allowance in FDM/FM systems which is appropriate to a total interference entry 2500 pW0p. The possible need to revise the $\Delta T/T$ = 4% threshold in Appendix 29 of the Radio Regulations in the light of the proposed change in the single entry value should also be considered.

ii) To identify the potential benefits of spectrum segmentation and the way in which they may best be achieved.

iii) To study the concept of burden-sharing to determine the extent of parameter adjustments practicable over a period of time.

iv) To evaluate the benefits and the technical operational and economic problems arising from a requirement for flexibility of orbital position and to consider what regulatory action might be appropriate.

e) Generalized parameters

To identify and evaluate various sets of generalized parameters for planning and coordination.

f) Earth station antennas

To determine an appropriate side-lobe radiation pattern for earth station antennas for which D/λ is less than 150, to be assumed in determining generalized performance criteria for use in the first planning period in those frequency bands and orbital arcs where recognition is not given to the special needs of developing countries.

g) Physical interference in orbit

For the CCIR to develop in the intersessional period a better understanding of the physical interference process leading to:

- an identification of the relevant factors of what is thought at present to be a theoretical problem;
- an evaluation of the risks that this phenomenon could present in the future, and;
- a recommendation for a solution to the problem should the study results justify further action.

h) [Satellite station-keeping]

To study the need for and the limits to be included in a regulatory tolerance for station-keeping in the north-south direction.

i) Space operations

To study the necessity to reserve a sub-band for operational functions in launch phases and manoeuvres, taking into account the current practices and the need for world-wide tracking networks.

j) Reverse band working

To study the implementation of reverse band working in the FSS, for systems of a national and regional character in the 6/4 and 14/11-12 GHz bands, concentrating particularly on the bands newly allocated by WARC-79. The study should seek means of effectively isolating two communities of fixed-satellite systems (i.e. those operating frequency bands in conventional directions and those operating the same bands but in the reverse directions from each other). The study should also consider:

i) whether there would be any benefit from orbit sectorization and/or band segmentation for isolating networks using reverse band working in different ITU Regions from one another;

ii) whether the introduction of reverse band working will require limits to be applied to satellite antenna side-lobe gain in the direction of neighbouring satellites in frequency bands used in both directions of transmission;

iii) whether regulatory constraints would need to be applied to orbital ellipticity in frequency bands where reverse band working is implemented.

k) Polarization discrimination between networks

To study the potential benefits of polarization discrimination between single-polarization satellites which are close together in orbit, and to consider how this isolating feature can be realistically structured into the Radio Regulations.

l) Criteria for satellite beams

To determine the necessary criteria for satellite beams, including:

i) reference radiation patterns for elliptical and shaped beams;

ii) an appropriate minimum required beam size, as a function of frequency;

and to study whether

iii) beam pointing constraints more stringent than those in Article 29 of the Radio Regulations are desirable;

iv) limits need to be applied to satellite antenna side-lobe gain in the direction of neighbouring satellites in frequency bands used in both directions of transmission.

INTERNATIONAL TELECOMMUNICATION UNION

ORB-85 WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT

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Document DL/49-E
2 September 1985
Original: English

SUB-WORKING GROUP 6A-2

Note by the Chairman of Sub-Working Group 6A-2

ARTICLE 5

Proposed text changes:

5.2.10 The Board shall examine each notice:

a) with respect to its conformity with the Convention and the relevant provisions of the Radio Regulations and Annex 1 of this Appendix (with the exception of those relating to b), c) and d) below);

b) with respect to its conformity with the appropriate Regional Plan or;

c) with respect to b) above if the Board finds characteristics differing from those in the appropriate Regional Plan in respect of one or more of the following:

- use of a reduced e.i.r.p.,

- use of a reduced coverage area entirely situated within the coverage area appearing in the appropriate Regional Plan,

- use of other modulating signals having different characteristics to those given in 3.1 of Annex [6],

- use of the assignment for transmissions in the fixed-satellite service in accordance with No. 846 of the Radio Regulations,

- use of an orbital position under the conditions specified in [..... of Annex [8]], [or];

d) with respect to its conformity with the provisions of Resolution No. 2 (SAT-R2).

5.2.11.1 Where the Board reaches a favourable finding with respect to 5.2.10 a) and 5.2.10 c), the frequency assignment shall be recorded in the Master Register.

The date of receipt of the notice by the Board shall be entered in Column 2d. In relations between administrations, all frequency assignments brought into use in conformity with the Plan and recorded in the Master Register shall be considered to have the same status irrespective of the dates entered in Column 2d for such frequency assignments. When recording these assignments, the Board shall indicate by an appropriate symbol the characteristics having a value different from that appearing in the Plan.

J.F. BROERE
Chairman of Sub-Working Group 6A-2

INTERNATIONAL TELECOMMUNICATION UNION

ORB-85 WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT

FIRST SESSION, GENEVA, AUGUST/SEPTEMBER 1985

Document DL/50-E
2 September 1985
Original: French/ English/ Spanish

SUB-WORKING GROUP 6A2

Note by the Chairman of Sub-Working Group 6A2

ARTICLE 10

The Plan for the Broadcasting-Satellite Service in the Frequency Band 12.2 - 12.7 GHz in Region 2

10.1 COLUMN HEADINGS OF THE PLAN

Col. 1. *Beam identification* (Column 1 contains the symbol designating the country or the geographical area taken from Table No. 1 of the Preface to the International Frequency List followed by the symbol designating the service area).

Col. 2. *Nominal orbital position*, in degrees and hundredths of a degree.

Col. 3. *Channel number* (see Table showing channel numbers and corresponding assigned frequencies).

Col. 4. *Boresight* geographical coordinates, in degrees and hundredths of a degree.

Col. 5. *Antenna beamwidth*. This column contains two figures corresponding to the major axis and the minor axis respectively of the elliptical cross-section half-power beam, in degrees and hundredths of a degree.

Col. 6. *Orientation of the ellipse* determined as follows: in a plane normal to the beam axis, the direction of a major axis of the ellipse is specified as the angle measured anti-clockwise from a line parallel to the equatorial plane to the major axis of the ellipse to the nearest degree.

Col. 7. *Polarization* (1 = direct, 2 = indirect)[1].

Col. 8. *E.i.r.p.* in the direction of maximum radiation, in dBW.

Col. 9. *Remarks*.

10.2 TEXT FOR SYMBOLS IN REMARKS COLUMN OF THE PLAN

1. Fast roll-off space station transmitting antenna as defined in Annex 5 (item 3.13.3) to this Part.

2. Television standard with 625 lines using greater video bandwidth and necessary bandwidth of 27 MHz.

3. This assignment will be implemented only if it does not hinder the development and subsequent introduction of a feeder-link Plan for Region 1.

4. This assignment may be utilized in the geographical area of Anguilla (AIA) (which is in the beam area).

5. Feeder-link earth stations for this assignment may also be located in the territories of Puerto Rico and the United States Virgin Islands. Such operation shall not cause more interference nor require more protection than the assignment under the Plan.

6. Feeder-link earth stations for this assignment may also be located in the States of Alaska and Hawaii. Such operation shall not cause more interference nor require more protection than the assignment under the Plan.

7. The feeder-link earth station for this assignment may also be located at the point with geographical coordinates 3°31′ West, 48°46′ North. Such operation shall not cause more interference nor require more protection than the assignment under the Plan.

[1] See Annex 5 to this Part, paragraph 3.2.

8. **Feeder-link earth stations for this assignment may also be located at the points with the following geographical coordinates:**

47°55′ West	15°47′ South	34°53′ West	08°04′ South
43°13′ West	22°55′ South	60°02′ West	03°06′ South
46°38′ West	23°33′ South	38°31′ West	12°56′ South
51°13′ West	30°02′ South	49°15′ West	16°40′ South

Such operation shall not cause more interference nor require more protection than the assignment under the Plan.

* 9/GR...: This assignment is part of a group, the number of which follows the symbol. The group consists of the beams and has the number of channels assigned to it as indicated in the Table below. Each of the assigned channels can be used by only one of the beams in the group.

Group	*Beams in the group*	*Number of channels assigned to the group*
GR1	ALS00002 HWA00002 USAPSA02	32 channels
GR2	ALS00003 HWA00003 USAPSA03	32 channels
GR3	ARGINSU4 ARGSUR04	16 channels
GR4	ARGINSU5 ARGSUR05	12 channels
GR5	BOLAND01 CLMAND01 EQACAND1 EQAGAND1 PRUAND02 VENAND03	16 channels
GR6	B SU111 B SU211	32 channels
GR7	B CE311 B CE411 B CE511	32 channels
GR8	B NO611 B NO711 B NO811	32 channels
GR9	B SU112 B SU212 B CE312 B CE412	32 channels
GR10	CAN01101 CAN01201	32 channels
GR11	CAN01202 CAN01302	32 channels
GR12	CAN01203 CAN01303 CAN01403	32 channels
GR13	CAN01304 CAN01404 CAN01504	32 channels
GR14	CAN01405 CAN01505 CAN01605	32 channels
GR15	CAN01506 CAN01606	32 channels
GR16	CHLCONT4 CHLCONT6	16 channels
GR17	CHLCONT5 PAQPAC01 CHLPAC02	16 channels
GR18	CRBBER01 CRBBLZ01 CRBJMC01 CRBBAH01 CRBECO01	16 channels
GR19	EQACOO01 EQAGOO01	16 channels
GR20	PTRVIR01 USAEHO02	32 channels
GR21	PTRVIR02 USAEHO03	32 channels
GR22	VEN02VEN VEN11VEN	4 channels

* *Note by the General Secretariat:* This new symbol for the Remarks column has been included at the request of the IFRB.

Country symbols

1. For the explanation of symbols designating countries or geographical areas in Region 2, see the Preface to the International Frequency List.

2. One additional symbol, CRB, has been created for the purposes of the present Conference only, to designate a geographical area in the Caribbean Area. The five Caribbean beams are identified as follows:

CRBBAH01, CRBBER01, CRBBLZ01, CRBEC001 and CRBJMC01

and are intended collectively to provide coverage for the following countries or geographical areas: AIA, ATG, BAH, BER, BLZ, BRB, CYM, DMA, GRD, GUY, JMC, LCA, MSR, SCN, SUR, TCA, TRD, VCT and VRG to be so used if approved by them.

TABLE SHOWING CORRESPONDENCE BETWEEN CHANNEL NUMBERS AND ASSIGNED FREQUENCIES

Channel No.	Assigned frequency (MHz)	Channel No.	Assigned frequency (MHz)
1	12224.00	17	12457.28
2	12238.58	18	12471.86
3	12253.16	19	12486.44
4	12267.74	20	12501.02
5	12282.32	21	12515.60
6	12296.90	22	12530.18
7	12311.48	23	12544.76
8	12326.06	24	12559.34
9	12340.64	25	12573.92
10	12355.22	26	12588.50
11	12369.80	27	12603.08
12	12384.38	28	12617.66
13	12398.96	29	12632.24
14	12413.54	30	12646.82
15	12428.12	31	12661.40
16	12442.70	32	12675.98

1	2	3	4		5		6	7	8	9
ALS00002	-166.20	1	-149.66	58.37	3.76	1.24	170	1	59.7	9/GR1
ALS00003	-175.20	1	-150.98	58.53	3.77	1.11	167	1	60.0	9/GR2
ARGINSU4	-94.20	1	-52.98	-59.81	3.40	0.80	19	1	59.9	9/GR3
ARGSUR04	-94.20	1	-65.04	-43.33	3.32	1.50	40	1	60.7	9/GR3
B CE311	-64.20	1	-40.60	-6.07	3.04	2.06	174	1	61.6	8 9/GR7
B CE312	-45.20	1	-40.27	-6.06	3.44	2.09	174	1	61.0	8 9/GR9
B CE411	-64.20	1	-50.97	-15.27	3.86	1.38	49	1	62.6	8 9/GR7
B CE412	-45.20	1	-50.71	-15.30	3.57	1.56	52	1	62.7	8 9/GR9
B CE511	-64.20	1	-53.10	-2.90	2.44	2.13	104	1	63.0	8 9/GR7
B NO611	-74.20	1	-59.60	-11.62	2.85	1.69	165	2	62.8	8 9/GR8
B NO711	-74.20	1	-60.70	-1.78	3.54	1.78	126	2	62.8	8 9/GR8
B NO811	-74.20	1	-68.76	-4.71	2.37	1.65	73	2	62.8	8 9/GR8
B SU111	-81.20	1	-51.12	-25.63	2.76	1.05	50	1	62.8	8 9/GR6
B SU112	-45.20	1	-50.75	-25.62	2.47	1.48	56	1	62.2	8 9/GR9
B SU211	-81.20	1	-44.51	-16.95	3.22	1.36	60	1	62.5	8 9/GR6
B SU212	-45.20	1	-44.00	-16.87	3.20	1.96	58	1	61.3	8 9/GR9
BAHIFRB1	-87.20	1	-76.06	24.16	1.81	0.80	142	1	61.6	
BERBERMU	-96.20	1	-64.77	32.32	0.80	0.80	90	2	56.8	
BERBER02	-31.00	1	-64.77	32.32	0.80	0.80	90	1	56.9	2 3
BOLAND01	-115.20	1	-65.04	-16.76	2.49	1.27	76	1	67.9	9/GR5
CAN01101	-138.20	1	-125.63	57.24	3.45	1.27	157	1	59.5	9/GR10
CAN01201	-138.20	1	-112.04	55.95	3.35	0.97	151	1	59.6	9/GR10
CAN01202	-72.70	1	-107.70	55.63	2.74	1.12	32	1	59.6	9/GR11
CAN01203	-129.20	1	-111.48	55.61	3.08	1.15	151	1	59.5	9/GR12
CAN01303	-129.20	1	-102.42	57.12	3.54	0.91	154	1	60.0	9/GR12
CAN01304	-91.20	1	-99.12	57.36	1.98	1.72	2	1	59.8	9/GR13
CAN01403	-129.20	1	-89.75	52.02	4.68	0.80	148	1	61.8	9/GR12
CAN01404	-91.20	1	-84.82	52.42	3.10	2.05	152	1	60.4	9/GR13

J.F. BROERE
Chairman

INTERNATIONAL TELECOMMUNICATION UNION

ORB-85 WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT

FIRST SESSION, GENEVA, AUGUST/SEPTEMBER 1985

Document DL/51-E
2 September 1985
Original: English

SUB-WORKING GROUP PL-A2-1

Note by the Chairman of Sub-Working Group PL-A2-1

HIGH DEFINITION TV

Option 1

To include in the Recommendation from ORB-85 concerning the draft agenda for ORB-88, the following:

"To recommend to the Administrative Council to i) consider the need to make appropriate provisions for HDTV, preferably on the basis of a world-wide allocation; and ii) make the necessary arrangements to enable this subject to be considered at either ORB-88 or the next WARC dealing with space telecommunications."

Option 2

To adopt a Recommendation on HDTV at ORB-85 and recommend that ORB-88 be empowered to consider it.

A draft Recommendation, based on S/33/10, is annexed.

M.J. BATES
Chairman of Sub-Working Group PL-A2-1

Annex: 1

ANNEX

S/33/10

DRAFT RECOMMENDATION

Relating to studies for the introduction of high definition television broadcasting via satellites

The World Administrative Radio Conference on the Use of the Geostationary-Satellite Orbit and the Planning of Space Services Utilizing It (First Session - Geneva, 1985),

considering

a) that the development of techniques for high definition television broadcasting is progressing;

b) that the frequency bands presently allocated to the broadcasting-satellite service do not provide a world-wide allocation suitable for high definition television transmissions via satellites;

c) that a world-wide allocation to the broadcasting-satellite service suitable for high definition television transmissions would be desirable;

recommends

1. that the CCIR study:

- which frequency bands would be possible and appropriate from the point of view of propagation, and
- what necessary bandwidth would be appropriate;

2. that administrations study the possibilities to suggest the allocation of a suitable frequency band, taking due account of the needs of other services;

3. that [the next world administrative radio conference dealing with space radiocommunications] shall be authorized to take appropriate decisions regarding the allocation of a suitable [world-wide] frequency band, preferably within the band 21.2 - 23.6 GHz.

INTERNATIONAL TELECOMMUNICATION UNION

ORB-85 WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT

FIRST SESSION, GENEVA, AUGUST/SEPTEMBER 1985

Document DL/52-E
4 September 1985
Original: English

WORKING GROUP 6A

Report of Sub-Working Group 6A Ad hoc 3 to Working Group 6A

ORBITAL POSITION LIMITATIONS

Sub-Working Group 6A Ad hoc 3, with the participation of several administrations as well as the IFRB, developed the Resolution found in the annex to this document.

D.I. COURT
Chairman of Sub-Working Group 6A Ad hoc 3

Annex: 1

ANNEX

[DRAFT] RESOLUTION [ ]

Relating to Orbital Position Limitations on the Broadcasting Satellite Service in Regions 1 and 2 in the band 12.2 - 12.5 GHz and on the Fixed Satellite Service (feeder link stations) in Region 2 for the Band 17.3 - 17.8 GHz

The World Administrative Radio Conference on the Use of the Geostationary-Satellite Orbit and the Planning of Space Services Utilizing It (First Session - Geneva, 1985),

considering

a) that there is currently no feeder link plan for the broadcasting satellite service of Region 1, operating in the band 11.7 - 12.5 GHz, and that in the absence of such a Plan, the usual approach to sharing cannot be applied;

b) that the RARC 1983 adopted a plan for Region 2 for the broadcasting satellite service in the band 12.2 - 12.7 GHz and their associated feeder links in the band 17.3 - 17.8 GHz;

c) that this Conference has recommended in a draft agenda for the second session the planning of the feeder links for the Regions 1 and 3 broadcasting satellite plan at WARC-ORB(2) including the band 17.3 - 18.1 GHz;

d) that there is a possibility of some interaction between the Region 2 feeder-link plan and the feeder-link plan to be developed for Regions 1 and 3 at WARC-ORB(2);

e) that there is a need to ensure that any modifications to the Regions 1 and 3 broadcasting satellite Plan and the Region 2 broadcasting satellite and feeder-link Plans will not hamper the development of the Regions 1 and 3 feeder-link Plan before its incorporation into the Radio Regulations;

resolves

1. that until the incorporation of the Region 1 and 3 feeder-link plan into the Radio Regulations any administration seeking to modify the Region 2 Plan or to introduce an interim system involving an orbital position further east than 44°W shall obtain the agreement of all administrations having orbital assignments in the Region 1 and 3 Plan within plus or minus ten degrees of the proposed orbital position;

2. that until the incorporation of the Region 1 and 3 feeder-link Plan into the Radio Regulations any administration seeking to modify the Region 1 and 3 Plan involving an orbital position further west than 28°W shall obtain the agreement of all administrations having orbital assignments in the Region 2 Plan within plus or minus ten degrees of the proposed orbital position;

3. that when the Regions 1 and 3 feeder link plan is being considered for incorporation into the Radio Regulatons at the WARC-ORB(2) it will have the same status as the Region 2 feeder link plan and the feeder-link plans shall be subject to any changes required to make them compatible.

[Note - There is a need to refer to this Resolution in the footnotes to Article 15 and Article 15A of the Radio Regulations to ensure that it has the necessary legal status and also include a reference to it in Article 7 of Appendix 30 and Article 4 of Appendix 30A.]

INTERNATIONAL TELECOMMUNICATION UNION

ORB-85 WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT

FIRST SESSION, GENEVA, AUGUST/SEPTEMBER 1985

Document DL/53-E
4 September 1985
Original: English

WORKING GROUP 6A

Note from Chairman of ad hoc Drafting Group

PROPOSED MODIFICATION TO ANNEX 3, PART 2 TO
APPENDIX /‾30A_7
(Document 213)

Add a new section as follows:

"2.5 Procedure for calculating the carrier-to-interference ratio at a space station receiver input

The calculation of the feeder-link carrier-to-interference ratio at a space station receiver input used to obtain the overall equivalent protection margin at a test point is based on the assumption that the wanted feeder-link path is rain faded corresponding to 99% of the worst month.

For the interfering feeder-link signal path clear air propagation conditions (i.e. including atmospheric absorption only) is assumed."

PROPOSED MODIFICATION OF ANNEX 1 TO APPENDIX /‾30A_7

Add footnote 4 to Document 213 as follows:

"With respect to paragraph 4 the limit specified relates to the overall equivalent protection margin calculated in accordance with /‾Section 2.5 of Annex 3_7."

R. TRENHOLM
Chairman of Ad hoc Drafting Group

INTERNATIONAL TELECOMMUNICATION UNION

ORB-85 **WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT**

FIRST SESSION, GENEVA, AUGUST/SEPTEMBER 1985

Document DL/54-E
4 September 1985
Original: English

DRAFTING GROUP 5B2

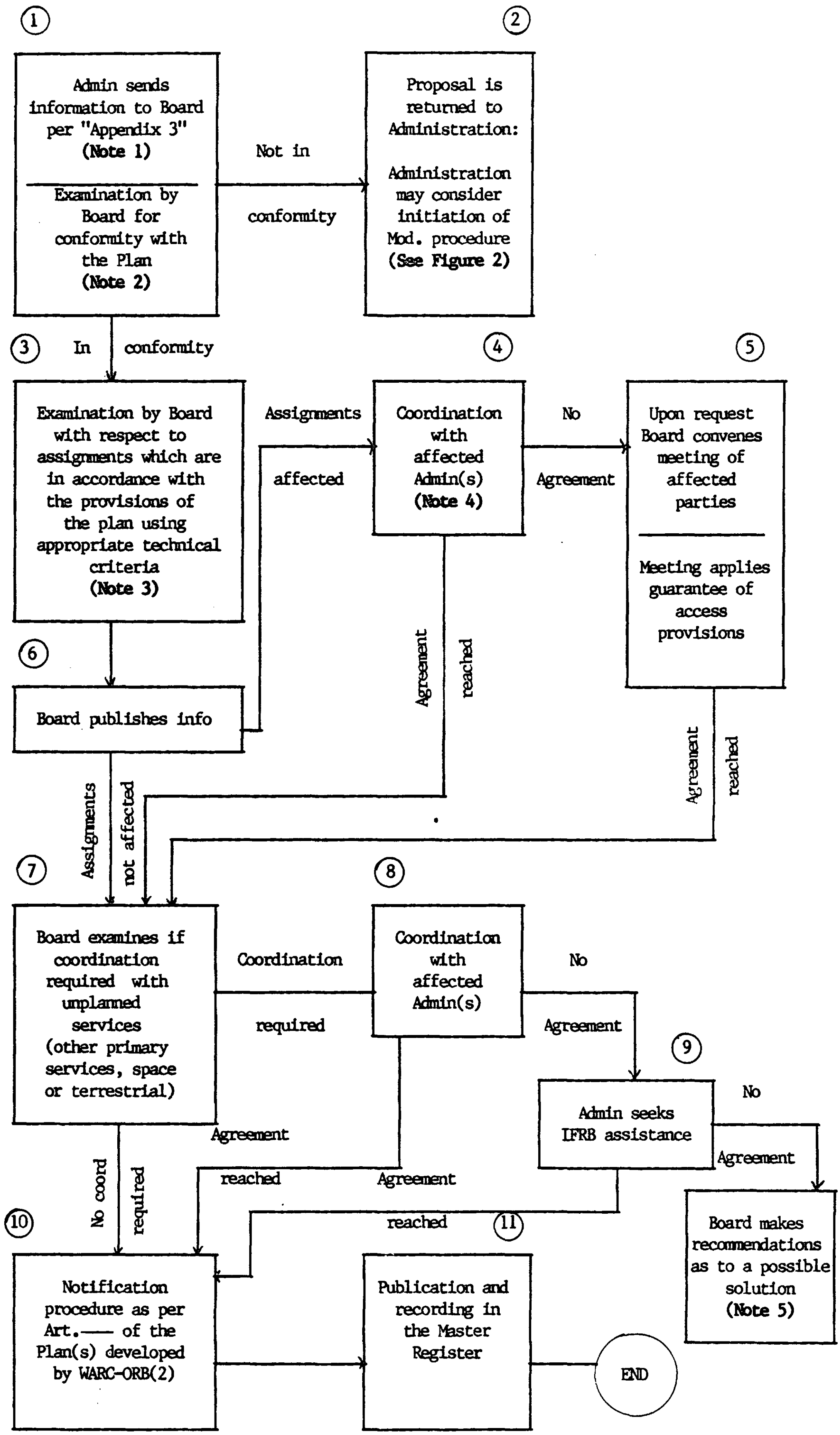
The annexed flowcharts and the associated notes reflect unanimous opinion of this informal Drafting Group in respect of procedures applicable to an allotment plan in the event that such a plan is adopted.

S.M. CHALLO
Chairman of Working Group 5B

Annex

FIGURE 1

SYSTEM IMPLEMENTATION PROCEDURE



NOTES TO FIGURE 1

Note 1: Submission of this information shall be made within (a period yet to be determined) before the date on which assignment is to be brought into use.

Note 2: The examination for conformity with the plan mentioned in box 1 should be in respect of allotments, and covers:

- orbital position in a predetermined arc (paragraphs 3 and 4 of Annex 1 to DT/70);
- service area (paragraph 1 of Annex 1 to DT/70);
- the minimum bandwidth within the band (yet to be defined) (paragraph 3 of Annex 1 to DT/70).

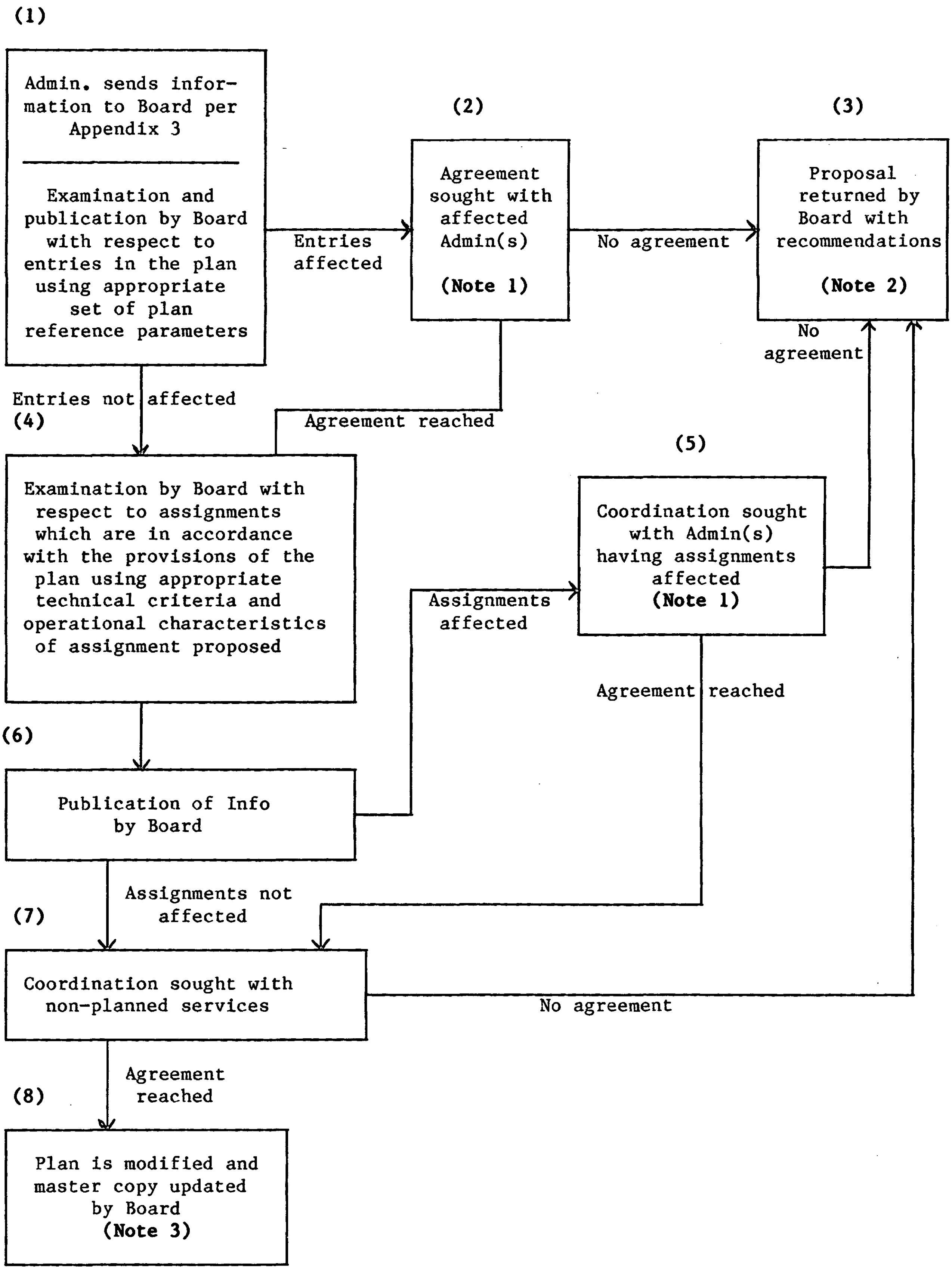
Note 3: The examination mentioned in box 3 should be in respect of assignments for which full information has been received, and covers existing systems. The status of existing systems will be determined later (paragraph 8 of Annex 1 to DT/70).

Note 4: The agreement required could be reached through bilateral discussions or at a multilateral planning meeting, as appropriate.

Note 5: The IFRB will offer assistance in the application of the modification procedure, if necessary.

Figure 2

PROCEDURE FOR MODIFICATIONS TO THE PLAN



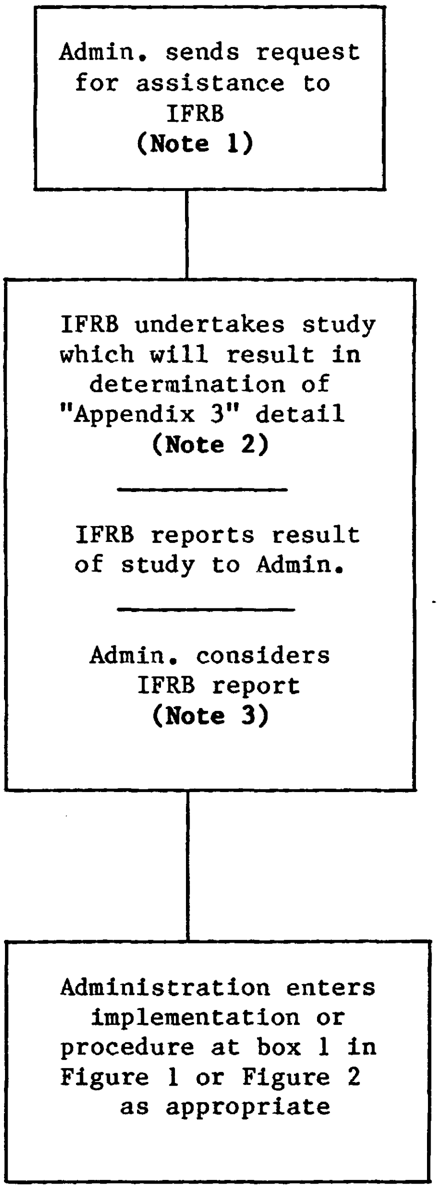
NOTES TO FIGURE 2

Note 1: The agreement required could be reached through bilateral discussions or at a multilateral planning meeting, as appropriate.

Note 2: If the requirement is for a new Member of the ITU for which there is no allotment in the plan a special effort shall be made to guarantee access for this requirement.

Note 3: When a system for which the modification procedure has been applied is to be implemented, the implementation procedure starts at box 1 in Figure 1.

Figure 3 **Requests for special assistance***



Notes to Figure 3:

Note 1: The administration should state its communication requirements in accordance with Appendix N (to be developed) which should contain sufficient detail to permit a proper assessment by the Board

Note 2: The study will take existing systems into account.

Note 3: Consultation between the IFRB and the requesting administration will take place as and when appropriate.

* This procedure may be applied on behalf of two or more administrtions wishing to establish a sub-regional system.

INTERNATIONAL TELECOMMUNICATION UNION

ORB-85 WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT

FIRST SESSION, GENEVA, AUGUST/SEPTEMBER 1985

Document DL/55-E
5 September 1985
Original : French
English
Spanish

WORKING GROUP PL-A-1

Note from the Chairman of Working Group PL-A-1

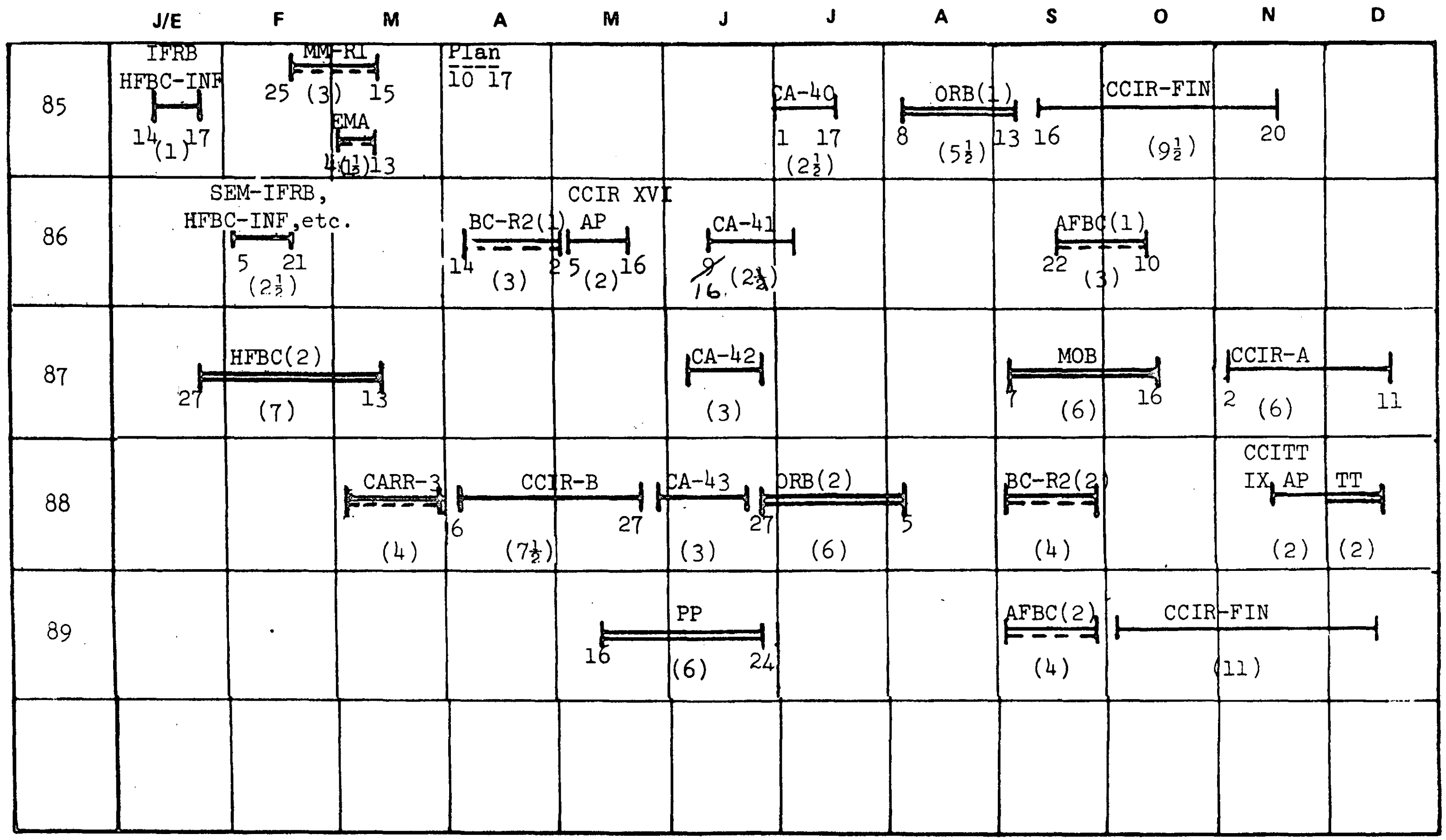
1985 - 1989 CONFERENCES AND MEETINGS TIMETABLE

R. Marchand
Chairman of Working Group PL-A-1

World Administrative Conferences and Plenipotentiary Conference

Regional Administrative Conferences

CCITT Study Group and Working Party meetings which meet throughout the year are not shown on this graph but Study Groups will not overlap with major conferences or CCIR Block A and B meetings.



1985 - 1989 Conferences and Meetings

1985 - 1989 Conferences and Meetings with key to abbreviations

1985

IFRB HFBC-INF	First Information Meeting on HFBC Intersessional Work (14-17 January 1985, for 4 days)
SEM-ORB	Preparations for the First Session of the World Administrative Radio Conference on the Use of the Geostationary-Satellite Orbit and the Planning of the Space Services Utilizing It (Regional Seminars: Buenos Aires - 18-22 March 1985 Nairobi - 24 April - 2 May 1985 Bangkok - 6-10 May 1985)
MM-R1	Regional Administrative Radio Conference for the Maritime Mobile Service and the Aeronautical Radionavigation Service in certain parts of the MF band in Region 1 (25 February - 15 March 1985, for 3 weeks)
EMA	Regional Administrative Radio Conference for the Planning of frequencies for Maritime Radiobeacons in the European Maritime Area (4 March - 13 March 1985, for 10 days)
Plan	World Plan Committee (10-17 April 1985) Washington, D.C., USA.
CA-40	40th Session, Administrative Council (Monday, 1 July - Wednesday, 17 July 1985, for 2 weeks and 3 days)
ORB(1)	First Session of the World Administrative Radio Conference on the Use of the Geostationary-Satellite Orbit and the Planning of the Space Services Utilizing It (Thursday, 8 August - Friday, 13 September 1985, for 5½ weeks)
R1	Regional Administrative Conference to abrogate and revise certain parts of the Regional Agreement and annexed Plans for the European Broadcasting Area (Stockholm, 1961) (12 August 1985, for an expected duration of two days)
AF	Regional Administrative Conference to abrogate certain parts of the Regional Agreement and annexed Plans for the African Broadcasting Area (Geneva, 1963) (12 August 1985, for an expected duration of two days)
IWP-CCIR Prep. AFBC(1)	Joint meeting (CCIR Study Groups 5, 6 and 11) to prepare technical studies for the First Session of the Regional Administrative Conference to Review and Revise the Provisions of the Final Acts of the African VHF/UHF Broadcasting Conference (Geneva, 1963)

1985 (continued)

CCIR-FIN	CCIR Final Study Group Meetings (16 September - 20 November 1985, for 9½ weeks):

SG 2	16-27.9.85	SG 9	30.9-15.10.85	SG 10	17.10-1.11.85
SG 5	16.9-2.10.85	SG 3	3-11.10.85	CMTT	21.10-5.11.85
SG 6	16-27.9.85	SG 7	10-18.10.85	SG 1	4-15.11.85
SG 4	30.9-16.10.85	SG 11	16.10-1.11.85	SG 8	4-20.11.85
				CMV	6-14.11.85

1986

SEM-IFRB	IFRB Seminar: Second Information Meeting on HFBC Intersessional Work; Meeting on National Frequency Management (Resolution No. 7 WARC-79 and Resolution No. 12 of the Plenipotentiary Conference) (5-21 February 1986, for 2½ weeks)
BC-R2(1)	First Session of the Regional Administrative Planning Conference for the Broadcasting Service in the Band 1 605 - 1 705 kHz in Region 2 (14 April - 2 May 1986, for 3 weeks)
CCIR-AP	CCIR XVIth Plenary Assembly (5 - 16 May 1986, for 2 weeks)
CA-41	41st Session, Administrative Council (9 June 1986, for 2 weeks and 3 days)
AFBC(1)	First Session of the Regional Administrative Conference to Review and Revise the Provisions of the Final Acts of the African VHF/UHF Broadcasting Conference (Geneva, 1963) (22 September - 10 October 1986, for 3 weeks)

Note: CCIR preparation for the World Administrative Radio Conference for Mobile Services, 1987 - Special meeting of Study Group 8 or a Conference Preparatory Meeting, depending upon the Conference agenda (to be held in 1986)

1987

HFBC(2)	Second Session of the World Administrative Radio Conference for the Planning of HF Bands Allocated to the Broadcasting Service (Tuesday, 27 January - Friday, 13 March 1987, for 7 weeks)
CA-42	42nd Session, Administrative Council (May-June 1987, for 3 weeks)
MOB	World Administrative Radio Conference for the Mobile Services (7 September - 16 October 1987, for 6 weeks)
CCIR-A	CCIR Interim Study Group Meetings, Series A (Monday, 2 November - Friday, 11 December 1987, for six weeks)

<u>1988</u>

CARR-3	Regional Administrative Conference to Establish Criteria for the Shared Use of the VHF and UHF Bands Allocated to Fixed Broadcasting and Mobile Services in Region 3 (first quarter of 1988, for 4 weeks)
CCIR-B	CCIR Interim Study Group Meetings, Series B (Wednesday, 6 April - Friday, 27 May 1988, for 7½ weeks)
CA-43	43rd Session, Administrative Council (May - June 1988, for 3 weeks)
ORB(2)	Second Session of the World Administrative Radio Conference on the Use of the Geostationary-Satellite Orbit and on the Planning of Space Services Utilizing It (27 June - 5 August 1988, for 6 weeks)
BC-R2(2)	Second Session of the Regional Administrative Planning Conference for the Broadcasting Service in the Band 1 605 - 1 705 kHz in Region 2 (third quarter of 1988, for 4 weeks)
CCITT-AP	CCITT IXth Plenary Assembly (November 1988, for 2 weeks)
TT	World Administrative Telegraph and Telephone Conference (beginning of December 1988, for 2 weeks) (see Resolution No. 10 of the Plenipotentiary Conference, Nairobi, 1982)

<u>1989</u>

PP	Plenipotentiary Conference (Tuesday, 16 May - 24 June 1989, for 6 weeks)
CA-44	44th Session, Administrative Council (dates to be determined, for 3 weeks)
AFBC(2)	Second Session of the Regional Administrative Conference to Review and Revise the Provisions of the Final Acts of the African VHF/UHF Broadcasting Conference (Geneva, 1963) (September 1989, for 4 weeks)
CCIR-FIN	CCIR Final Study Group Meetings (October - December 1989, for 11 weeks).

INTERNATIONAL TELECOMMUNICATION UNION

ORB-85 WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT

FIRST SESSION, GENEVA, AUGUST/SEPTEMBER 1985

Document DL/56-E
5 September 1985
Original: English

WORKING GROUP 5B

The Annex reflects the opinion of the Chairman of Working Group 5B in respect of improved procedures for application to FSS bands which are not to be subject to the allotment planning approach.

S.M. CHALLO
Chairman of Working Group 5B

Annex: 1

ANNEX

Section I

Introductory remarks

1. Improved procedures for application to FSS bands which are not to be subject to the/an allotment planning approach.

2. This document describes a method to be applied to the FSS bands which are not subject to an allotment Plan approach.

3. The principal characteristic of this method is the convening of periodic multilateral planning meetings (MPM). The overall fundamental aim of the MPM procedure is to guarantee in practice for new or modified networks to gain access to the GSO/spectrum resources while adequately protecting existing systems.

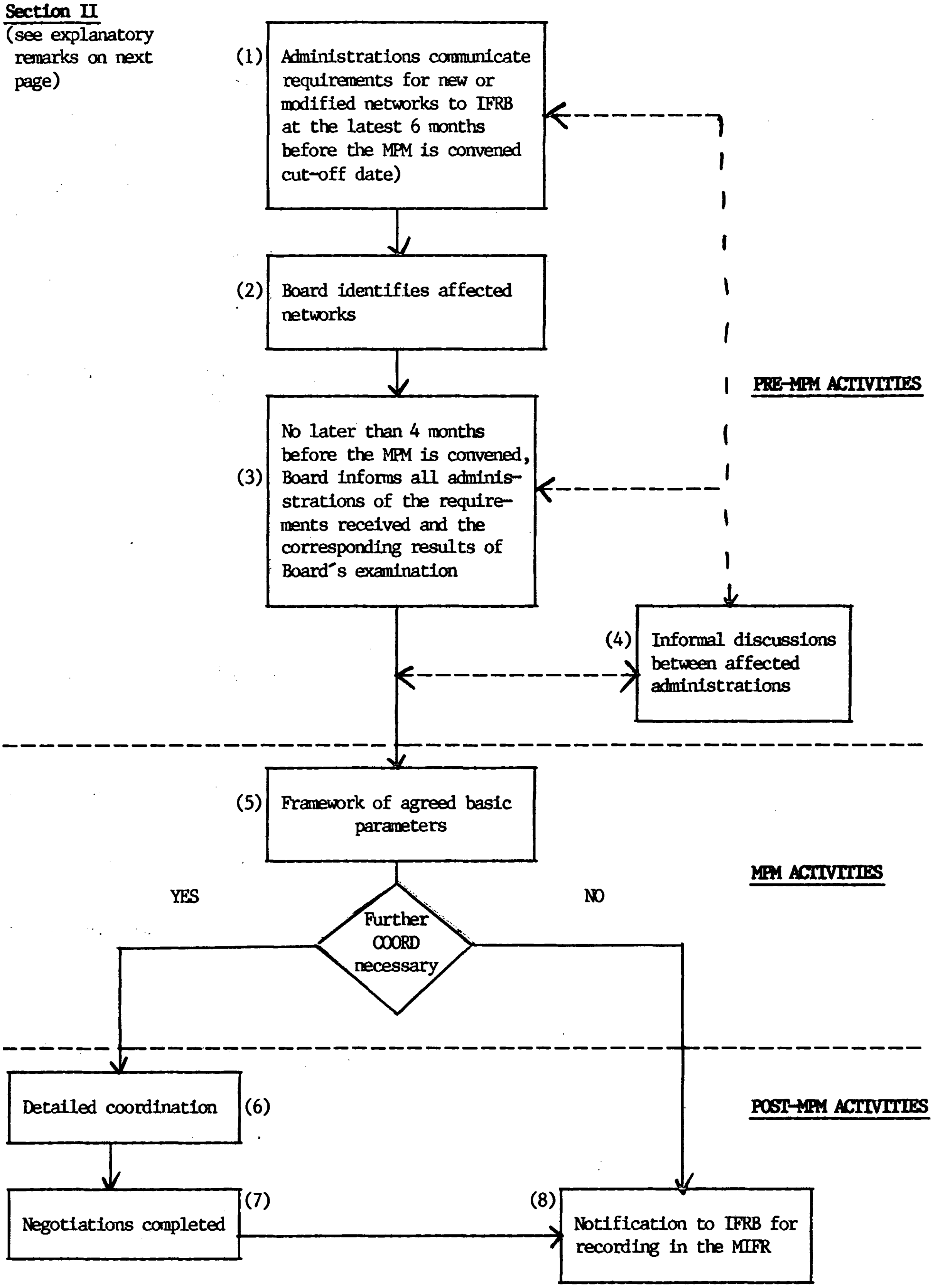
4. The MPM will be the normal process to gain access to the GSO/spectrum resources.

Additionally, in cases where administrations have an urgent need between MPMs, simple matters of access or modifications could be dealt with between administrations. These cases shall be formalized at the next MPM.

5. The MPM approach should be a new and separate procedure to be added to the Radio Regulations.

6. A flowchart of the MPM procedure is to be found in section II.

Section II
(see explanatory remarks on next page)



Explanatory notes

Box 1

1. The data to be sent to the IFRB should enable the identification of affected networks. Furthermore, the data should be at least sufficient to enable the MPM to establish a list of basic elements guaranteeing the access. These basic elements should be decided upon by the second session. In any case, the list should include the orbital position, frequency bands and coverage areas.

2. The requirements for new or modified networks which are submitted six months prior to the MPM will be eligible for consideration at the MPM concerned. The MPM will decide how to deal with requirements received at a later date.

3. Only requirements relating to networks planned to be put into use within five years from the "date of its first accommodation" will be considered at the MPM. However, administrations may submit their requirements at an earlier date.

Box 2

The Board should identify the affected networks by using Appendix 29 as possibly improved.

Box 3

In preparing for the MPM, administrations should study the data published by the Board with a view to determining possible solutions to accommodate new networks.

Box 4

1. Administrations may at this stage initiate informal discussions with a view to speeding up the work at the MPM.

2. An administration may report the results of its discussions to the MPM.

3. The possibility of the IFRB providing assistance to administrations should be considered.

MPM activities

1. The MPM shall carry out its activities on the basis of the provisions agreed to at the second session. Some of the guidelines for these provisions are given below.

2. The MPM should be convened at regular intervals of not less than two years and not more than four years.

3. Another possibility could be that the MPM be normally convened every two years; extension of this period may be envisaged in certain circumstances, but the maximum period between two MPMs shall be four years.

4. Participation in the MPM should be open to every administration. Appropriate secretariat assistance should be provided by the ITU.

5. The administrations having submitted requirements shall be present. In the event that they are not present, their requirements will not be considered.

6. All administrations with existing systems should be present, particularly those which the IFRB has identified as being affected.

7. Notifying administrations/multi-administration networks shall ensure that decisions can be taken with regard to those networks.

8. A mechanism should be developed to enable the MPM to make decisions in the event that a notifying administration, having a system which may be affected, is not present at the MPM.

9. The technical bases for the activities of the MPM should be in conformity with the agreed planning principles and should permit the use of the most recent agreed performance and interference criteria.

10. The costs of the MPMs should come from the budget for conferences in the usual fashion.

11. To cover the situation where the accommodation of a new system is not possible without affecting networks which are already afforded protection, the MPM should have a mechanism for establishing burden-sharing criteria, and therefore this mechanism, should be adopted at the second session.

Box 5

The results of the MPM will be published by the IFRB as soon as possible after the MPM. This report shall contain a list of the new or modified networks agreed upon at the MPM. For each network it should at least contain:

- a framework of the basic elements such as orbital position, frequency bands, coverage and areas;
- general information on the interference conditions;
- any special agreements reached; and
- the resulting framework of basic elements will be protected.

Box 6

In some instances, negotiations with regard to the detailed coordination may be completed during an MPM.

Box 7

In this part of the procedure there are two possibilities. The normal situation is when the negotiations are completed without changes to the agreed basic elements. In this case, an administration may proceed with the notification to the IFRB. In some special cases, the negotiations may lead to modifications in the agreed basic elements. When these changes do not affect other networks over the limits agreed to at the MPM, the administration may proceed with the notification. The framework of agreed basic elements is correspondingly updated. If other networks are affected beyond the limits agreed upon at the MPM, the modified requirements shall be submitted to the following MPM.

Box 8

In the event that a notified network is not put into use within six months from the planned date of putting into use, the IFRB shall delete the entry from the MIFR and no longer take it into consideration when identifying affected networks (c.f. Box 2). Extension of this period is restricted to cases of "force majeur". In those cases, the next MPM shall decide on the prolongation to be granted.

INTERNATIONAL TELECOMMUNICATION UNION

ORB-85 WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT

FIRST SESSION, GENEVA, AUGUST/SEPTEMBER 1985

Document DL/57-E
6 September 1985
Original: French
English
Spanish

COMMITTEE 6

Note from Chairman of Sub-Working Group 6 Ad Hoc 3

The Resolutions and Recommendations in the annex to the present document are reproduced from the Final Acts of the Regional Administrative Conference for the Planning of the Broadcasting-Satellite Service in Region 2 (SAT-83), Geneva, 1983.

G.H. RAILTON
Chairman of Sub-Working Group 6 Ad Hoc 3

Annex

RESOLUTION No. 1(Sat-R2)

Relating to the Period Between 1 January 1984 and the Entry into Force of the Final Acts of the First Session of the World Administrative Radio Conference on the Use of the Geostationary-Satellite Orbit and the Planning of Space Services Utilizing It, Geneva, 1985 (WARC-ORB (1))

The Regional Administrative Conference for the Planning of the Broadcasting-Satellite Service in Region 2, Geneva, 1983,

considering

a) that the provisions and the associated Plans prepared by the present Conference are subject to formal adoption and incorporation into the Radio Regulations by the First Session of the World Aldministrative Radio Conference on the Use of the Geostationary-Satellite Orbit and the Planning of Space Services Utilizing It, Geneva, 1985 (WARC-ORB (1));

b) that, during the period between 1 January 1984 and the date of entry into force of the Final Acts of the WARC-ORB (1), administrations of countries in Region 2 may wish to bring into use assignments appearing in the Plan or to modify them or to bring them into use as interim systems;

c) that, in accordance with Resolution Nos. 31, 503 and 504 of the World Administrative Radio Conference, Geneva, 1979 (WARC-79) and No. 839 of the Radio Regulations, pending the entry into force of the Final Acts of WARC-ORB (1), the provisions of Resolution No. 33 of WARC-79 and Articles 11, 13 and 14 of the Radio Regulations shall apply to stations of the broadcasting-satellite and fixed-satellite services;

further considering

that there is a need for procedures to be applied by administrations of Region 2 and the IFRB during the above period;

resolves

1. that, during the period between 1 January 1984 and the date to be adopted by WARC-ORB (1) on which the provisions and the associated Plans established by the present Conference will apply to all countries of Region 2, the following procedures shall be applied:

1.1 the Board shall consider any notification of an assignment to a station of the broadcasting-satellite service in the band 12.2 - 12.7 GHz which is in conformity with the Broadcasting-Satellite Plan:

- as having been agreed to in accordance with Article 14 of the Radio Regulations by countries participating in the Conference and by other countries which have agreed to apply the provisions of this Resolution;
- as having been coordinated among the same countries in accordance with sections A and B of Resolution No. 33 of WARC-79;

1.2 the Board shall consider any notification of an assignment to a station of the fixed-satellite service in the band 17.3 - 17.8 GHz which is in conformity with the feeder links Plan as having been coordinated among the same countries in accordance with Article 11 of the Radio Regulations;

1.3 that the IFRB and administrations wishing to modify their assignments in the above Plans or to bring into use interim systems shall apply the provisions of Article 4 of Part I (except those of paragraph 4.2.9) or of Article 4 of Part II (except those of paragraph 4.2.10) or of Annex to Resolution No. 2(Sat-R2) (except those of paragraphs 6 and 9) of these Final Acts, as appropriate;

2. on the date of entry into force of the Final Acts of WARC-ORB (1), for the modifications to the Plan and on a date to be decided by the said Conference for the interim systems, the IFRB shall publish modifications to the Plans and interim uses resulting from *resolves* 1 above, in a special section of its weekly circular in order to enter them in the Plan or in the Interim List referred to in paragraphs 6 and 11 of Annex to Resolution No. 2(Sat-R2);

urges the administrations not present at this Conference

to accept that the provisions of the present Resolution be applied to them within the framework of the procedures contained in Articles 11 and 14 of the Radio Regulations and of Resolution No. 33 of WARC-79 and to so inform the IFRB as soon as practicable to this effect;

recommends the WARC-ORB (1)

to consider and adopt the draft Resolution contained in the Annex to this Resolution in order to permit the application to all countries of Region 2 of the provisions and associated Plans for the broadcasting-satellite service and for their feeder links prior to the entry into force of its Final Acts;

request the IFRB

to communicate to the administrations not participating in the Conference the provisions governing the use of the broadcasting-satellite service and the fixed-satellite service for their feeder links and the associated Plans indicating the assignments entered in the Plan on their behalf and outlining the benefit to them of accepting the application of these provisions during the period preceding the WARC-ORB (1) as indicated in the present Resolution.

ANNEX TO RESOLUTION No. 1(Sat-R2)

DRAFT RESOLUTION

Relating to the Provisional Uses of Parts I and II of the Final Acts of the Regional Administrative Conference for the Planning of the Broadcasting-Satellite Service in Region 2, Geneva, 1983

The World Administrative Radio Conference on the Use of the Geostationary-Satellite Orbit and the Planning of the Space Services Utilizing It (First Session, Geneva, 1985),

considering

a) that the present Session has decided to incorporate in the Radio Regulations the provisions and associated Plans for the broadcasting-satellite service and fixed-satellite service for feeder links in Region 2;

b) that during the period preceding the date of entry into force of the Final Acts of the present Session, administrations of countries in Region 2 may wish to bring into use assignments appearing in the Plan or to modify them or to bring them into use as interim systems;

further considering

that there is a need for procedures to be applied by the administrations of Region 2 and the IFRB during the interim period referred to above;

resolves

1. that during the period preceding the date of entry into force of the Final Acts of the present Session, administrations and the IFRB shall apply the provisions of Parts I and II of the Final Acts of the Regional Administrative Conference for the Planning of the Broadcasting-Satellite Service in Region 2, Geneva, 1983, on a provisional basis;

2. that on the date of entry into force of the Final Acts of the present Session, the IFRB shall publish modifications to the Plans introduced in application of *resolves* 1 above, in a special section of its weekly circular in order to enter them in the Plans.

RESOLUTION No. 3(Sat-R2)

Relating to the Determination and Publication of Inter-System Interference Levels Associated with the Region 2 Broadcasting-Satellite Plan and its Associated Feeder-Link Plan

The Regional Administrative Conference for the Planning of the Broadcasting-Satellite Service in Region 2, Geneva, 1983,

considering

a) that the Region 2 broadcasting-satellite Plan in Article 10 of Part I of these Final Acts specifies the frequencies, orbit positions, power levels, and beam characteristics of broadcasting-satellite service assignments;

b) that the feeder links associated with those broadcasting-satellite service assignments are similarly specified in Article 9 of Part II of these Final Acts;

c) that the technical data associated with these assignments are described in Annex 5 to Part I and Annex 3 to Part II of these Final Acts in sufficient detail to determine the individual and total interference levels between systems in the Plan;

d) that the set of computer programs used by the Conference is able to determine these interference levels;

e) that these interference levels take on a very significant role in the administration of the Plan, because the acceptability of non-standard systems and of modifications to the Plan depends on the interference levels caused by those systems;

f) that these interference levels are not explicitly a part of the Plans and their associated provisions;

g) that knowledge of these interference levels is required by administrations to develop their broadcasting-satellite systems and to determine the effect of systems of other administrations on their assignments;

resolves

1. that the IFRB provide administrations with the overall equivalent protection margins at each test point associated with the assignments of their service areas;

2. that the IFRB also identify to administrations assignments interfering with each of their assignments and related individual margins and their assignments individually causing interference to the assignments of other administrations and related individual margins [1];

3. that the IFRB shall use to that effect the technical parameters adopted by this Conference and the computer routines used at this Conference and modified to take into account the decisions of the Conference to calculate protection margins.

RESOLUTION No. 4(Sat-R2)

Relating to the Compatibility of the Plan for the Broadcasting-Satellite Service in Region 2 in the Band 12.2 - 12.7 GHz with Appendix 30 to the Radio Regulations

The Regional Administrative Conference for the Planning of the Broadcasting-Satellite Service in Region 2, Geneva, 1983,

considering

a) that it has adopted a Plan for the broadcasting-satellite service in Region 2 in the band 12.2 - 12.7 GHz;

b) that Appendix **30** to the Radio Regulations stipulates that the Region 2 Plan adopted by this Conference shall not degrade the protection afforded to the frequency assignments in the Regions 1 and 3 Plan below the limits specified in Appendix **30** to the said Regulations (see footnote to paragraph 4.3.1.2);

c) that Resolution No. **700** of the World Administrative Radio Conference, Geneva, 1979 (WARC-79) stipulates that in the drawing-up of a plan (and any associated modification procedure) for the broadcasting-satellite service in Region 2, the requirements for satisfactory future operation of the fixed-satellite service in Regions 1 and 3 shall be observed and that, if contraints on the fixed-satellite service are considered necessary to ensure that no harmful interference is caused either to the fixed-satellite or the broadcasting-satellite services involved, they should not in any case be greater than those imposed on the fixed-satellite service in Region 2 by Appendix **30** to the Radio Regulations (see *resolves* 2 of Resolution No. **700**);

d) that Resolution No. **701** of WARC-79 stipulates that planning shall take into account the pertinent provisions of Appendix **30** to the Radio Regulations, in particular those contained in Annexes 4 and 5, as well as other decisions of the above-mentioned Conference (see *resolves* 2 of Resolution No. **701**);

e) that due to the limited time available to it, this Conference could not identify the incompatibilities, if any, with broadcasting-satellite stations in Regions 1 and 3 with regard to considering *b)* above or with other services in these Regions;

f) that during the elaboration of the Region 2 broadcasting-satellite service Plan, consideration was duly given to the need for protecting the systems of Regions 1 and 3;

[1] In order to minimize costs, administrations will be provided only with individual margins at a level of less than 15 dB for down-link assignments and 25 dB for feeder-link assignments.

g) that in the cases where it was not possible exactly to meet the limits specified in Appendix 30 to the Radio Regulations, the Region 2 administrations concerned stated their intention to seek the agreement of the countries of Regions 1 and 3 which may be affected;

h) that atmospheric absorption was not taken into account by this Conference in the analysis of the Region 2 Plan;

taking note

a) that during the World Broadcasting-Satellite Administrative Radio Conference, Geneva, 1977, the power flux-densities produced at territories of Region 2 countries from space stations of Regions 1 and 3 were calculated only with respect to one test point in Region 2 (35° W, 8° S);

b) that the results of such calculations show that there are 40 beams where the value of power flux-densities at that test point exceed the limit of -138 dB(W/m^2), the worst case being one where the calculated power flux-density was -127.77 dB(W/m^2);

resolves to request the IFRB

1. to modify the computer programs used by this Conference in order to include in them the atmospheric attenuation parameters in the bands 12.2 - 12.7 GHz and 17.3 - 17.8 GHz (see Resolution No. 9(Sat-R2));

2. to communicate to each administration the details of calculations relating to its test points in the Region 2 Plan;

3. to publish a document indicating the overall equivalent protection margins to be used for the application of Article 4 of Part I;

4. to identify the countries of Regions 1 and 3 which may be affected by the assignments in the Region 2 Plan in accordance with the limits specified in Appendix 30 to the Radio Regulations;

5. to calculate, on request, and for information purposes, the power flux-density from the broadcasting-satellite space stations of Regions 1 and 3 produced at given test points in the territory of the administration(s) concerned of Region 2;

6. to communicate to administrations of Region 2 concerned and to the administrations of Regions 1 and 3 so identified the results of its calculations and to invite them to resolve the problem and to communicate to the IFRB the results of their negotiations;

7. to send at regular intervals reminders to those administrations which have not yet communicated the results of their negotiations;

8. to prepare for communication to the First Session of the World Administrative Radio Conference on the Use of the Geostationary-Satellite Orbit and the Planning of Space Services Utilizing It, Geneva, 1985 (WARC-ORB (1)) a report containing the list of cases which have been identified, together with the indication of those which have been resolved;

recommends to WARC-ORB (1)

1. to consider the results obtained by the IFRB in application of this Resolution and, where an agreement cannot be reached, to apply the following provisional procedure to the countries affected in Regions 1 and 3:

   – to enter a remark against the Region 2 assignment concerned to indicate that this assignment should be brought into use only when such agreement is reached or adequate measures are adopted to reduce the power flux-density over Regions 1 and 3 to conform to limits specified in the Radio Regulations; and

2. to instruct the IFRB to delete this remark upon being informed that agreement has been reached.

RESOLUTION No. 5(Sat-R2)

Relating to the Review of the Use of the Band 12.2 - 12.7 GHz by the Terrestrial Services in Region 2

The Regional Administrative Conference for the Planning of the Broadcasting-Satellite Service in Region 2, Geneva, 1983,

considering

a) No. **844** of the Radio Regulations;

b) that the Conference had no information relating to terrestrial services which would permit it to determine the compatibility between existing and planned terrestrial services and the broadcasting-satellite service;

resolves

1. that all administrations using or intending to use frequency assignments to terrestrial stations in the band covered by the Plan shall decide, as soon as possible, (if necessary, with the assistance of the IFRB) whether or not these assignments will affect frequency assignments in conformity with the Plan;

2. that, if it is found that existing or planned broadcasting-satellite stations having frequency assignments in conformity with the Plan may be subject to interference, administrations shall inform the IFRB of the measures they intend to take to ensure the protection of the frequency assignments concerned before the date of entry into force of the Final Acts of the First Session of the World Administrative Radio Conference on the Use of the Geostationary-Satellite Orbit and the Planning of Space Services Utilizing It, Geneva, 1985;

3. that administrations may continue to use frequency assignments which are not compatible with the Plan, provided that agreement is reached with the administrations whose broadcasting-satellite stations are affected;

4. that the administrations seeking agreement shall inform the IFRB of the terms of the agreement reached;

5. that, upon receipt of such information, the IFRB shall insert a symbol in the Remarks column of the Master Register indicating the duration specified in the agreement. The duration specified shall also be published in a special section of its weekly circular;

invites the IFRB

to assist administrations in implementing the provisions of this Resolution;

urges the administrations of Region 2

that, in addition to applying the procedure of Article 6 of Part I, of these Final Acts when planning new stations in the terrestrial services, administrations should give due consideration to their implementation in a manner which will not impose contraints on future modifications to the broadcasting-satellite systems by other administrations.

RESOLUTION No. 6(Sat-R2)

Relating to the Coordination Between Feeder-Link Earth Stations for the Broadcasting-Satellite Service and Receiving Fixed-Satellite Earth Stations in the Band 17.7 - 17.8 GHz

The Regional Administrative Conference for the Planning of the Broadcasting-Satellite Service in Region 2, Geneva, 1983,

considering

a) that the band 17.7 - 18.1 GHz is allocated to the fixed-satellite service in both the Earth-to-space (feeder links for the broadcasting-satellite service) and the space-to-Earth directions (bi-directional use);

b) that Annex 4 to Part II of these Final Acts has utilized the latest CCIR studies together with Appendix **28** to the Radio Regulations in establishing a coordination area around a feeder-link earth station;

c) that the latest CCIR propagation data were used in the preparation of Annex 3 to Part I and Annex 4 to Part II of these Final Acts;

noting

a) that Resolution No. **60** of the World Administrative Radio Conference, Geneva, 1979 (WARC-79) invited the CCIR to study the propagation data in Appendix **28** to the Radio Regulations;

b) that neither Appendix **28** nor the related CCIR texts deal with the bi-directional sharing of a frequency band by earth stations in the fixed-satellite service;

c) that only a world administrative radio conference dealing with the fixed-satellite service appears competent to add to the Radio Regulations provisions dealing with bi-directional sharing procedures for fixed-satellite service earth stations;

invites the CCIR

to study sharing between earth stations of the fixed-satellite service in those frequency bands which are allocated on a bi-directional basis;

resolves

that Annex 4 to Part II of these Final Acts should be revised accordingly whenever provisions are added to the Radio Regulations dealing with bi-directional sharing between fixed-satellite service earth stations or whenever changes are made under Resolution No. **60** of WARC-79;

requests

that the Administrative Council then place on the agendas of the competent world administrative radio conferences the revisions to Annex 4 to Part II of these Final Acts referred to in *resolves* above.

RESOLUTION No. 7(Sat-R2)

Relating to the Sharing of the Band 17.7 - 17.8 GHz Between the Space and Terrestrial Services in Region 2

The Regional Administrative Conference for the Planning of the Broadcasting-Satellite Service in Region 2, Geneva, 1983,

considering

a) that the 17.3 - 17.8 GHz band is allocated to the fixed-satellite service (Earth-to-space) for the exclusive use of feeder links to the broadcasting-satellite service;

b) that it adopted a feeder-link Plan in the band 17.3 - 17.8 GHz based on the recording in the Plan of the area in which the feeder-link earth stations may be located;

c) that the 17.7 - 17.8 GHz is also allocated on a primary basis to the fixed-satellite service (space-to-Earth) and to the terrestrial services;

d) that the equality of rights among services sharing the band 17.7 - 17.8 GHz should be reflected in the procedures adopted by this Conference;

e) that it was not possible to base the feeder-link Plan in the band 17.7 - 17.8 GHz on the exact locations of the feeder-link earth stations using characteristics given in Annex 3 to Part II of these Final Acts;

f) that administrations planning to use the terrestrial stations or the earth stations in the fixed-satellite service (space-to-Earth) should have the means to evaluate the interference that might be caused to their planned stations;

resolves to request the IFRB

1. to invite administrations to communicate the geographical coordinates of their planned feeder-link earth stations and any other technical characteristics that they may consider appropriate in the band 17.7 - 17.8 GHz;

2. to prepare a report to the First Session of the World Administrative Radio Conference on the Use of the Geostationary-Satellite Orbit and the Planning of Space Services Utilizing It, Geneva, 1985 on this matter.

RESOLUTION No. 8(Sat-R2)

Relating to the Incorporation in the Radio Regulations of the Provisions and Associated Plan for the Broadcasting-Satellite Service in the Band 12.2 - 12.7 GHz in Region 2

The Regional Administrative Conference for the Planning of the Broadcasting-Satellite Service in Region 2, Geneva, 1983,

considering

a) that the provisions and associated Plan prepared by this Conference are applicable in Region 2 subject to their adoption and their incorporation in the Radio Regulations by the First Session of the World Administrative Radio Conference on the Use of the Geostationary-Satellite Orbit and the Planning of Space Services Utilizing It, Geneva, 1985 (WARC-ORB (1));

b) that it may be useful if the provisions relating to the broadcasting-satellite service in the three Regions were contained in the same Appendix to the Radio Regulations;

c) that for lack of time, this Conference was not able to prepare a consolidated text of Appendix 30 to the Radio Regulations incorporating the provisions and associated Plan for the broadcasting-satellite service in the band 12.2 - 12.7 GHz in Region 2 in the corresponding provisions and associated Plans for the broadcasting-satellite service in the band 11.7 - 12.5 GHz in Region 1 and the band 11.7 - 12.2 GHz in Region 3;

instructs the Secretary-General

1. to prepare in the appropriate form a draft consolidated text containing the provisions and associated Plans for the broadcasting-satellite service in the band 11.7 - 12.5 GHz for Region 1 and in the band 11.7 - 12.2 GHz for Region 3 as appearing in Appendix 30 to the Radio Regulations and the provisions and associated Plan for the broadcasting-satellite service in the band 12.2 - 12.7 GHz for Region 2 as appearing in the Final Acts of this Conference;

2. to send this draft consolidated text to all administrations not later than twelve months before the opening of WARC-ORB (1), inviting them to give their comments on the text as prepared;

3. to publish as a conference document of WARC-ORB (1) at least six months before the opening of that Conference the text as prepared along with any comments on that text which may have been received from administrations.

RESOLUTION No. 9(Sat-R2)

Relating to Consideration of the Use of Atmospheric Absorption

The Regional Administrative Conference for the Planning of the Broadcasting-Satellite Service in Region 2, Geneva, 1983,

considering

a) that Annexes 1 and 4 to Appendix 30 to the Radio Regulations contain criteria for interregional coordination which are to be met assuming free space propagation attenuation;

b) that this Conference has developed interregional criteria based upon the principle of reciprocity and contained particularly in Annexes 1 and 4 to Parts I and II of the Final Acts;

c) that these Annexes specify that calculations should be based on clear sky atmospheric conditions;

d) that CCIR Report 719-1 provides information on atmospheric absorption;

and noting

a) that atmospheric absorption can provide additional interregional protection;

b) that this Conference is not competent to amend Appendix 30 to the Radio Regulations;

resolves

1. that the next world administrative radio conference competent to modify Appendix **30** to the Radio Regulations shall consider the matter of including the effects of atmospheric absorption;

2. that until then, in Annexes 1 and 4 to Parts I and II of the Final Acts of this Conference, free space propagation attenuation shall be assumed as a general rule;

3. that until then, the administrations in Regions 1 and 3 are encouraged to use atmospheric absorption on a basis of reciprocity with Region 2 countries for calculations related to interregional coordination;

requests the IFRB

to make the above suggestion to the administrations concerned and to draw their attention to the additional interregional protection than can be afforded by the consideration of atmospheric absorption.

RECOMMENDATION No. 1(Sat-R2)

Relating to the Incorporation into the Radio Regulations of the Provisions and Associated Plans for the Broadcasting-Satellite Service in the Band 12.2 - 12.7 GHz and for Associated Feeder Links in the Band 17.3 - 17.8 GHz in Region 2 and the Recording of the Assignments contained in the Plans in the Master International Frequency Register

The Regional Administrative Conference for the Planning of the Broadcasting-Satellite Service in Region 2, Geneva, 1983,

considering

a) that the provisions and associated Plans prepared by the present Conference are applicable in Region 2 subject to their adoption and their incorporation into the Radio Regulations by the First Session of the World Administrative Radio Conference on the Use of the Geostationary-Satellite Orbit and the Planning of Space Services Utilizing It, Geneva, 1985 (WARC-ORB (1));

b) that it may be useful that provisions relating to the broadcasting-satellite service in the three Regions be contained in the same Appendix to the Radio Regulations;

recommends the WARC-ORB (1)

1. to incorporate into the Radio Regulations in the appropriate form the provisions and associated Plans prepared for the broadcasting-satellite service in the band 12.2 - 12.7 GHz and for associated feeder links in the band 17.3 - 17.8 GHz in Region 2 without modifying them;

2. to instruct the IFRB to record in the Master International Frequency Register the assignments appearing in the two Plans;

3. to consider the possibility of combining the Annexes to Appendix 30 to the Radio Regulations with those to Part I of these Final Acts.

RECOMMENDATION No. 2(Sat-R2)

Relating to the Application to Regions 1 and 3 of the Limits Adopted for Region 2 with a View to the Application of Articles 11 and 13 of the Radio Regulations to the Fixed-Satellite Service in the Band 17.7 - 17.8 GHz

The Regional Administrative Conference for the Planning of the Broadcasting-Satellite Service in Region 2, Geneva, 1983,

considering

a) that it has adopted, in Article 7 of Part II of these Final Acts, provisions for the application of Articles 11 and 13 of the Radio Regulations to the fixed-satellite service in Region 2 in the band 17.7 - 17.8 GHz with limits different from those appearing in Appendix 29 to the Radio Regulations;

b) that it would simplify the coordination procedures among countries of the three Regions if the same criteria were applied in the three Regions;

recommends the First Session of the World Administrative Radio Conference on the Use of the Geostationary-Satellite Orbit and the Planning of Space Services Utilizing It, Geneva, 1985

to adopt the draft Resolution annexed to this Recommendation.

ANNEX TO RECOMMENDATION No. 2(Sat-R2)

DRAFT RESOLUTION

Relating to the Application to Regions 1 and 3 of the Limits Adopted for Region 2 with a View to the Application of Articles 11 and 13 of the Radio Regulations to the Fixed-Satellite Service in the Band 17.7 - 17.8 GHz

The World Administrative Radio Conference on the Use of the Geostationary-Satellite Orbit and the Planning of the Space Services Utilizing It (First Session, Geneva, 1985),

considering

a) that the Regional Administrative Conference for the Planning of the Broadcasting-Satellite Service in Region 2, Geneva, 1983, has adopted, in Article 7 of Part II of its Final Acts, provisions for the application of Articles 11 and 13 of the Radio Regulations to the fixed-satellite service in Region 2 in the band 17.7 - 17.8 GHz with limits different from those appearing in Appendix 29 to the Radio Regulations;

b) that it would simplify the coordination procedures among countries of the three Regions if the same criteria were applied to the three Regions;

resolves

that administrations and the IFRB shall apply to stations in the fixed-satellite service in the band 17.7 - 17.8 GHz the procedures contained in Articles 11 and 13 of the Radio Regulations and in Appendix 30 to the Radio Regulations together with those in Annex 4 to Part II of the Final Acts of the Regional Administrative Conference for the Planning of the Broadcasting-Satellite Service in Region 2, Geneva, 1983.

RECOMMENDATION No. 3(Sat-R2)

Relating to Interregional Problems of Sharing Between Region 2 Broadcasting-Satellite Service Space Stations and Certain Terrestrial Services in Region 1 East of 30° East Longitude in the Band 12.2 - 12.7 GHz

The Regional Administrative Conference for the Planning of the Broadcasting-Satellite Service in Region 2, Geneva, 1983,

considering

a) that the present Conference considered the matter of interregional sharing criteria and adopted appropriate values where possible;

b) that regarding the possibilities of sharing between the Region 2 broadcasting-satellite service and certain fixed terrestrial services in the eastern part of Region 1, the CCIR Report to the Conference included proposed power flux-density limits, identified geographical areas where these limits could not be met without the use of special techniques and recommended bilateral discussions between the administrations most directly concerned;

c) that the question could not be resolved, since not all the parties most directly affected attended this Conference;

requests the IFRB

to draw the attention of the administrations concerned in Region 1 to the above-mentioned problems of sharing with some administrations in Region 2 in the band 12.2 - 12.7 GHz;

recommends

1. that the administrations concerned initiate and continue discussions of the problems on a bilateral basis with a view to their solution;

2. that the First Session of the World Administrative Radio Conference on the Use of the Geostationary-Satellite Orbit and the Planning of Space Services Utilizing It, Geneva, 1985 (WARC-ORB (1)) take such action on the matter as may be necessary;

invites the CCIR

to continue its study of this question as a matter of urgency with a view to including appropriate conclusions in the Conference Preparatory Meeting Report to the WARC-ORB (1).

RECOMMENDATION No. 4(Sat-R2)

Relating to the Limitation of Power and the Direction of Maximum Radiation for Stations of the Fixed and Mobile Services in the Band 17.3 - 17.8 GHz

The Regional Administrative Conference for the Planning of the Broadcasting-Satellite Service in Region 2, Geneva, 1983,

considering

a) that the band 17.3 - 17.8 GHz has been used for the planning of feeder links for the broadcasting-satellite service by the present Conference;

b) that, unlike the maximum values of equivalent isotropically radiated power (e.i.r.p.) specified for frequency bands between 1 and 10 GHz (No. 2502 of the Radio Regulations) and those between 10 and 15 GHz (No. 2503 of the Radio Regulations), there are no restrictions as to the direction of maximum radiation in the frequency bands above 15 GHz;

c) that No. 2504.1 of the Radio Regulations nevertheless specifies that when the CCIR makes a Recommendation as to the need for restrictions in frequency bands specified in No. 2511 of the Radio Regulations, administrations should as far as practicable observe them;

d) that Resolution No. 101 of the World Administrative Radio Conference, Geneva, 1979 recognizes the need for study and determination, as a matter of urgency by the CCIR, of suitable criteria applicable to sharing between the fixed and mobile services and the feeder links to broadcasting satellites;

noting

a) that this Conference did not have sufficient data to adopt a definite limit of the e.i.r.p. for stations of the fixed and mobile services directed towards the geostationary-satellite orbit;

b) that this Conference can adopt regulations of this nature applicable only to countries in Region 2 but has no authority to adopt similar values applicable to countries in Regions 1 and 3;

c) that nevertheless there is a distinct possibility of stations in the fixed and mobile services in Regions 1 and 3 directing their transmissions towards that part of the geostationary-satellite orbit for which plans have been adopted by this Conference;

d) that only a competent world administrative radio conference can resolve this question on a world-wide basis;

recommends that the CCIR

continue its study on an urgent basis with a view to recommending a definite value for consideration by the First Session of the World Administrative Radio Conference on the Use of the Geostationary-Satellite Orbit and the Planning of Space Services Utilizing It, Geneva, 1985.

RECOMMENDATION No. 5(Sat-R2)

Relating to Protection Ratios Between Television Systems of Different Standards and Bandwidths

The Regional Administrative Conference for the Planning of the Broadcasting-Satellite Service in Region 2, Geneva, 1983,

considering

a) that in planning the broadcasting-satellite service and its associated feeder links, account must be taken of the protection ratios between television systems of different standards and bandwidths;

b) that technical data will be required to enable the First and Second Sessions of the World Administrative Radio Conference on the Use of the Geostationary-Satellite Orbit and the Planning of Space Services Utilizing It to revise the Radio Regulations;

c) the studies being pursued by the CCIR under the appropriate Questions and Study Programmes;

invites the CCIR

1. to continue the study of the protection ratios for television systems and, in particular, to provide further information on the protection ratios between television systems of different standards and bandwidths;

2. to submit as much information as possible on this item to the First and Second Sessions of the World Administrative Radio Conference on the Use of the Geostationary-Satellite Orbit and the Planning of Space Services Utilizing It.

RECOMMENDATION No. 6(Sat-R2)

Relating to the Need for Additional Propagation Studies in High-Rainfall Zones of Region 2

The Regional Administrative Conference for the Planning of the Broadcasting-Satellite Service in Region 2, Geneva, 1983,

considering

a) that the propagation of radio waves at frequencies above 10 GHz plays an important role in planning broadcasting-satellite services;

b) that information on rain attenuation is mostly based on propagation data from CCIR texts;

c) that the CCIR is carrying out studies on rain attenuation at frequencies above 10 GHz;

d) that there is a need for studies and propagation measurements in some parts of Region 2, particularly in rain climatic zones M, N and P, which could result in an improvement of the method for calculating rain attenuation;

taking into account

that Annex 5 to Part I and Annex 3 to Part II of these Final Acts indicate, on the basis of the relevant CCIR Recommendations, the method to be used for calculating the rain attenuation exceeded for 1% of the worst month;

invites the CCIR

to accelerate its studies on rain attenuation in tropical and equatorial zones of Region 2, including the relationship between worst month and annual distributions, and extend them, in particular, to zones with the greatest rain intensity;

recommends administrations of Region 2

1. to participate actively and collaborate in the proposed studies and to make available their observations;

2. to make use of the latest available method and data in estimating rain attenuation in setting up their broadcasting-satellite systems with a view to ensuring that satellite transmission powers are no higher than necessary for achieving effective coverage of their respective service areas at the service quality levels laid down in the Plans and their annexes, at the same time meeting the requirements of the other parameters and objectives contained in the Region 2 Plans.

RECOMMENDATION No. 7(Sat-R2)

Relating to the Interpretation of Terms "Allotment" and "Assignment"

The Regional Administrative Conference for the Planning of the Broadcasting-Satellite Service in Region 2, Geneva, 1983,

considering

that a number of difficulties have been encountered in interpreting Nos. 18 and 19 of Article 1 of the Radio Regulations concerning the terms "allotment" and "assignment" respectively, with regard to their application to plans produced by regional or world conferences;

recommends

that the First Session of the World Administrative Radio Conference on the Use of the Geostationary-Satellite Orbit and the Planning of Space Services Utilizing It, Geneva, 1985, should interpret the terms "allotment" and "assignment" clearly and unequivocally.

INTERNATIONAL TELECOMMUNICATION UNION

ORB-85 WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT

FIRST SESSION, GENEVA, AUGUST/SEPTEMBER 1985

Document DL/58-E
6 September 1985
Original: English

SUB-WORKING GROUP 6, AD HOC 3

DRAFT RESOLUTION [COM6/]

Relating to the Provisional Application for Region 2 of Resolution 2 (SAT-R2)

The World Administrative Radio Conference on the Use of the Geostationary Orbit and the Planning of the Space Services Utilizing it, First Session, Geneva, 1985

considering

a) that the 1983 Conference adopted Resolution 2 (SAT-R2) with the intention of providing the administrations of Region 2 with an orderly means of implementing the assignments in the Plan of that conference according to a phased approach and with due regard for the protection of the services of other administrations;

b) that assignments in conformity with Resolution 2 (SAT-R2) may be implemented only if they are in conformity with the Convention and with the relevant provisions of the Radio Regulations;

c) that conformity with Resolution 2 (SAT-R2) requires the agreement of all affected administrations;

d) that those affected administrations are to be determined in accordance with the limits of Annex 1 of Appendix 30,revised and Annex 1 of Appendix 30A;

e) that the discussions at this Conference has provided the IFRB with a useful opportunity to confirm its understanding of the provisions of Resolution 2 (SAT-R2);

f) that the question of the long term application of the provisions of Resolution 2 (SAT-R2) is deserving of further study;

resolves,

that the IFRB shall apply the provisions of the Annex to Resolution 2 (SAT-R2) and shall examine the notifications of the administrations of Region 2, as appropriate for conformity with that Resolution on a provisional basis until the subject is reviewed by the next competent WARC and a definitive decision is taken on the matter.

Resolves to request the Administrative Council,

to place on the agenda of WARC-ORB-(2) an item calling for the review of the long term applicability of Resolution 2 (SAT-R2).

UNION INTERNATIONALE DES TÉLÉCOMMUNICATIONS

ORB-85 CAMR SUR L'UTILISATION DE L'ORBITE DES SATELLITES GÉOSTATIONNAIRES ET LA PLANIFICATION DES SERVICES SPATIAUX UTILISANT CETTE ORBITE

PREMIÈRE SESSION GENÈVE, AOÛT/SEPTEMBRE 1985

Document DL/59-F/E/S
13 septembre 1985
Original : francais
anglais

SEANCE PLENIERE
PLENARY MEETING
SESION PLENARIA

Modifications au Document 318 proposées par le GT spécial de la Plénière

Modifications to Document 318 proposed by the Special Group of the Plenary

Modificaciones al Documento 318 propuestas por el Grupo especial de la Plenaria

ANNEXE 2 (PROJET DE RECOMMANDATION PLEN/C)

Au bas de la page 4 :

ADD reconnaît

qu'elle n'est compétente que pour la bande des fréquences comprise entre 0,5 et 2 GHz.

Page 5 :

MOD recommande 2, avant-dernière ligne:

..... en ce qui concerne les aspects du système considéré tels qu'ils figurent dans la Résolution N° 505

invite le Conseil d'administration

MOD à considérer cette Recommandation.....

invite le CCIR

MOD à engager sans dépenses supplémentaires des études comme indiqué....

ANNEX 2 (DRAFT RECOMMENDATION PLEN/C)

Bottom of Page 4 :

ADD recognizes

that it is competent only for the frequencies in the band between 0.5 and 2.0 GHz

Page 5 :

MOD recommends 2., last line :

system as outlined in Resolution 505

Page 5 (contd.)

invites the Administrative Council

MOD to consider this Recommendation in the....

invites the CCIR

MOD to undertake without additional expenditure studies as indicated...

ANEXO 2 (PROYECTO DE RECOMENDACION PLEN/C)

Al pie de la página 4:

ADD reconoce

que sólo es competente para la banda de frecuencias comprendida entre 0,5 y 2 GHz.

Página 5, recomienda 2. última línea :

MOD ..... en relación con los diversos aspectos de este sistema, tal como figuran en la Resolución 505

invita al Consejo de Administración

MOD a que examine la presente Recomendación al ...

invita al CCIR

MOD a que emprenda estudios como se indica en el recomienda 1, sin gastos suplementarios ....

The Convenor
H.A. KIEFFER

INTERNATIONAL TELECOMMUNICATION UNION

ORB-85 WARC ON THE USE OF THE GEOSTATIONARY-SATELLITE ORBIT AND THE PLANNING OF SPACE SERVICES UTILIZING IT

FIRST SESSION, GENEVA, AUGUST/SEPTEMBER 1985

Document DL/60-E
14 September 1985
Original: English

PLENARY MEETING

REPORT TO PLENARY BY THE CHAIRMAN

OF THE SPECIAL AD HOC GROUP

1. The Special Ad hoc Group met and reviewed Addendum 1 to Document 324.

2. The Group recommends to Plenary that the revised text as annexed hereto should be adopted.

3. It should be noted in the flowchart in Corr.1 to Document 324 that the following corrections are necessary:

Box 3: Amend reference to "paragraph 1 a)" to read "paragraph 4 a)"

Amend reference to "paragraph 1 d)" to read "paragraph 4 c)"

Box 12: Amend "Procedure 1 d)" to read "paragraph 4 c)".

S.M. CHALLO
Chairman of Working Group 5B

ANNEX 2

Guidelines for regulatory procedures associated with the planning method

1. This section identifies the procedures to be associated with the planning method.

2. Consideration should be given during the intersessional period and in the second session to the possibility of reducing the number of procedures and simplifying them in order to reduce the workload in the administrations and the IFRB.

3. The procedures should foresee the possibility for administrations to seek the assistance of the IFRB at the different steps of the above procedures.

4. Guidelines for regulatory procedures for the allotment Plan

a) A procedure for the modifications of the allotment Plan to be applied by the administrations intending to modify their allotments in the Plan or by new ITU Members which are candidates to an allotment in the Plan;

b) a procedure for the implementation of the Plan to be applied by administrations intending to bring into use assignments in conformity with an allotment in the Plan, i.e. to convert an allotment into assignments. This procedure was considered during the first session and is described in the flowchart presented in the attached Appendix [ ] [Corr.1 to Document 324, page 2];

c) a procedure applicable to additional FSS users in the bands covered by the allotment Plan.

5. Guidelines for improved procedures applicable to the parts of the planned band which are not covered by the allotment plan

An approach and some associated regulatory procedures are described in section 3.3.5 and Appendix [ ] [Appendix to Annex 1 of Document 324].