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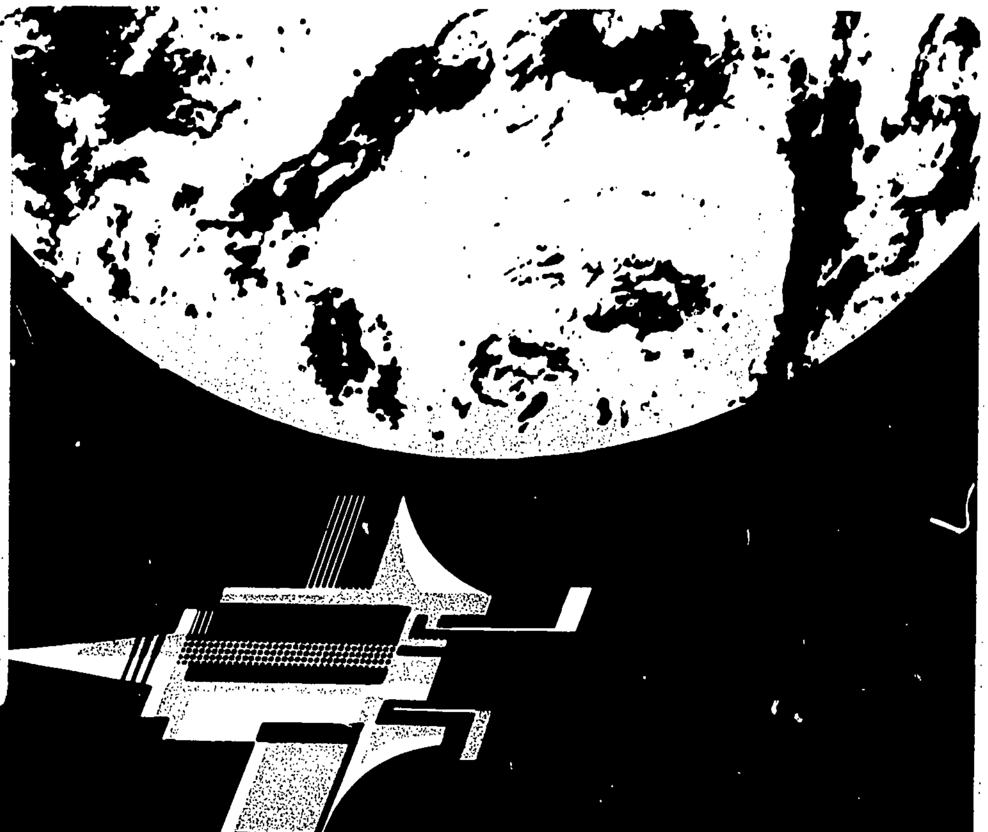
ABSTRACT

Subjects covered in this annual report of the International Telecommunication Union (ITU) include 1) action taken with regard to regulations; 2) application of international regulations; 3) telecommunication studies and standardization; 4) planning of the international telecommunication network; 5) technical cooperation activities; 6) cooperation with other international organizations concerned with space; and 7) information and documentation activities. In addition, appendixes contain the reports of individual countries on developments in space communication and relevant resolutions adopted by the United Nations at its 26th session. (RH)



booklet No. 10

Eleventh Report by the International Telecommunication Union on telecommunication and the peaceful uses of outer space

ITU

Other publications on the ITU:

- Book — From semaphore to satellite, 1793-1965 (1965)
- Booklet No. 1 — 1865-1965, a hundred years of international co-operation (1967)
- Booklet No. 2 — ITU and space radiocommunication (1968)
- Booklet No. 3 — Eighth Report by the International Telecommunication Union on telecommunication and the peaceful uses of outer space (1969)
- Booklet No. 4 — Symposium " Space and Radiocommunication ", Paris (1969)
- Booklet No. 5 — World Telecommunication Day—17 May 1969 (1969)
- Booklet No. 6 — Ninth Report by the International Telecommunication Union on telecommunication and the peaceful uses of outer space (1970)
- Booklet No. 7 — World Telecommunication Day—17 May 1970 (1971)
- Booklet No. 8 — Tenth Report by the International Telecommunication Union on telecommunication and the peaceful uses of outer space (1971)
- Booklet No. 9 — Speeches made at the inaugural meeting of the second World Administrative Radio Conference for Space Telecommunications on 7 June 1971 (1971)

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by the

international telecommunication union

on telecommunication and the peaceful uses of outer space

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Eleventh Report of the ITU on telecommunication and the peaceful uses of outer space

1. Introduction

THIS document is a report on the action taken by the International Telecommunication Union (ITU) with regard to outer space since the submission of the Tenth Report in 1971 (see the supplement to the *Telecommunication Journal*, July 1971).

It is submitted for the attention of the United Nations Committee on the Peaceful Uses of Outer Space and of the Economic and Social Council (ECOSOC) and for the information of Members of the Union.

As it was explained in earlier reports in this series, international regulations are adopted at World Administrative Conferences. Since these are intergovernmental conferences, the regulations they adopt have the force of international treaties. The international registration of frequency assignments for space telecommunications is carried out by a permanent organ of the ITU, the International Frequency Registration Board (IFRB), in accordance with Radio Regulations drawn up by the competent ITU Conferences. Technical studies relating to the use of telecommunications in outer space are conducted by two other permanent organs, the International Radio Consultative Committee (CCIR) and the International Telegraph and Telephone Consultative Committee (CCITT).

Details of the work done by the Conferences and permanent organs of the Union are given in the sections which follow.

Annex 1 contains reports by a number of Members of the Union on the progress they have made in space communications in 1971.

Annex 2 contains two resolutions of the United Nations.

2. Action taken with regard to regulations—Decisions of the World Administrative Radio Conference for Space Telecommunications (Geneva, 1971)

During 1971, the ITU's main activities with regard to outer space were carried out in the context of the World Administrative Radio Conference for Space Telecommunications. The need for such a conference had become increasingly apparent owing to advances in space radiocommunication techniques and the rapidly expanding use of these radiocommunications, calling for special attention to certain factors which could not be examined in isolation.

Some of these factors are:

- the extremely rapid development of space techniques;
- the diversification of space radiocommunications;
- the need for co-ordination between existing or planned world-wide systems and other regional or even national systems which are planned or under study;

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— the efficient use of orbits, especially the geostationary satellite orbit, and finally,

— new prospects for direct broadcasting via satellite.

The Conference, which was held in Geneva from 7 June to 17 July 1971, was attended by some 740 delegates from 100 countries (see the *Telecommunication Journal*, July, August, September, October 1971). Its work was mainly based on proposals submitted by Members of the ITU. The purpose of this World Administrative Conference was to ensure that the technical provisions and regulations governing the use of space telecommunications by all users should be based on the most recent technical achievements and that they should enable optimum use to be made of these telecommunications in forthcoming years.

Before we examine some of the decisions of the Conference, it may be useful to mention certain of the principles on which they were based: use with equality of rights of the frequency bands allocated to the space radiocommunication services, no permanent priority that might create an obstacle to the establishment of their own space systems by other countries, introduction of new co-ordination procedures with a view to more efficient use of the frequency spectrum and of the geostationary satellite orbit. In the case of broadcasting, restrictions were placed on radiation inside the territory of other countries.

From 3 February to 3 March 1971, the CCIR held a special meeting of its Study Groups concerned in order to provide the Conference with technical data based on the latest developments.

The technical preparation of the Conference was the work of the IFRB.

The agenda as adopted by the Administrative Council included the following item:

" to consider, revise and supplement as necessary, existing administrative and technical provisions of the Radio Regulations and adopt, as necessary, new provisions for radiocommunication services, in so far as they use space radio techniques, including those for manned space vehicles, and for the radio astronomy service, so as to ensure the efficient use of the spectrum ".

The following is a brief review of some of the principal changes introduced into the Radio Regulations, with special emphasis on two services to which frequency assignments were made for the first time, the broadcasting-satellite service and the earth exploration-satellite service.

Article 1 (Definitions) was partly revised; in many cases, there was a tendency to regard space radiocommunications. not as a service in the proper sense of the term, but rather as a special technique used in various services. The following definitions are to be noted:

84AP *Broadcasting-satellite service*

A radiocommunication service in which signals transmitted or retransmitted by space stations are intended for direct reception[1] by the general public.

84APA *Individual reception* (in the broadcasting-satellite service)

The reception of emissions from a space station in the broadcasting-satellite service by simple domestic installations and in particular those possessing small antennae.

84APB *Community reception* (in the broadcasting-satellite service)

The reception of emissions from a space station in the broadcasting-satellite service by receiving equipment, which in

[1] In the broadcasting-satellite service, the term " direct reception " shall encompass both individual reception and community reception.

some cases may be complex and have antennae larger than those used for individual reception, and intended for use:

- by a group of the general public at one location, or
- through a distribution system covering a limited area.

84ASA *Earth exploration-satellite service*

A radiocommunication service between earth stations and one or more space stations in which:

- information relating to the characteristics of the earth and its natural phenomena is obtained from instruments on earth satellites;
- similar information is collected from air-borne or earth-based platforms;
- such information may be distributed to earth stations within the system concerned;
- platform interrogation may be included.

Article 5, which contains the Table of Frequency Allocations to the various services, was revised, chiefly in order to cater for the development of frequency requirements.

To mention only the two services whose requirements have emerged in definite form in recent years, the broadcasting-satellite service and the earth exploration-satellite service, it will be seen that new allocations have been made to both of them.

Frequencies in the band 620-790 MHz may be assigned to television stations using frequency-modulation in the *broadcasting-satellite service*, subject to agreement between the administrations concerned and those having services which may be affected (see Resolutions Nos. Spa2-2 and Spa2-3 and Recommendation No. Spa2-10).

The band 2500-2690 MHz is allocated on a primary basis to the broadcasting-satellite service, sharing with other services (fixed and mobile). The use of this band by the broadcasting-satellite service is limited to domestic and regional systems for community reception and is subject to agreement between the administrations concerned and those having services, operating in accordance with the Frequency Table, which may be affected.

Satellite broadcasting was also allocated the band 11.7-12.2 GHz (11.7-12.5 GHz in Region 1, i.e., the Old World, excluding South-East Asia). This is an allocation on a primary basis shared with other services (fixed and mobile).

The band 22.5-23 GHz was also allocated on a primary basis to satellite broadcasting (shared with the fixed and mobile services) in Region 3 (South-East Asia and Australasia).

Frequency bands were also allocated to the *earth exploration-satellite service*. These include, in particular, the bands

1525-1535 MHz
8025-8400 MHz
21.2-22 GHz

Other bands (401-403; 460-470; 1690-1700; 2025-2120 MHz) may also be used for earth exploration-satellite applications on condition that no harmful interference is caused to stations operating in accordance with the Frequency Table.

It should be noted that frequency allocations to services other than the broadcasting-satellite and the earth exploration-satellite services were likewise considerably revised. These revisions include the allocations to meteorology, space research, the amateur service, the standard frequency and time signal services, radio astronomy and, above all, the aeronautical mobile and maritime mobile satellite services, which in the next few years will be using space techniques for radionavigation and for reliable high-quality communication requirements.

The allocations to the fixed-satellite (communication-satellite) service were also revised and new allocations were added.

Given a spectrum in which all the bands were already allocated, all these new allocations, from which most of the services have benefited, were made possible only by wider use of band sharing by several services. This could not have been done without the complex technical studies carried out in recent years, mainly by the International Radio Consultative Committee of the ITU.

Whereas the allocations made by the 1963 Conference stopped short at 40 GHz, the 1971 Conference allocated parts of the 40-275 GHz range to certain services.

The following allocations may be mentioned:

- Broadcasting-satellite service
  41-43 GHz
  84-86 GHz

- Earth exploration-satellite service
  51-52 GHz
  65-66 GHz

Article 7 (Special Rules Relating to Particular Services) provides that all technical means available shall be used to reduce, to the maximum extent practicable, the radiation of space stations in the broadcasting-satellite service over the territory of other countries unless an agreement has been previously reached with such countries.

New provisions were introduced on the station keeping of space stations and on the pointing accuracy of antennae on geostationary satellites.

Article 9, on notification and recording in the Master International Frequency Register of frequency assignments to terrestrial radiocommunication stations, was amended to take account of the changes made in the procedures for co-ordination between terrestrial and earth stations.

Article 9A, which was previously concerned with the notification and recording of frequency assignments to stations in the space service, was entirely revised and now also deals with co-ordination, although it no longer applies to stations in the broadcasting-satellite service. A procedure has now been laid down for the advance publication of information on planned satellite systems, enabling any administration which considers that unacceptable interference may be caused to its existing or planned space radiocommunication services to communicate its observations to the administration concerned.

As in the past, any frequency assignment to an earth or space station shall be notified to the IFRB:

— if the use of the frequency concerned is capable of causing harmful interference to any service of another administration; or

— if the frequency is to be used for international radiocommunication; or

— if it is desired to obtain international recognition of the use of the frequency.

The Conference introduced additional clarifications of the notification procedure with regard to transmitting or receiving frequencies of earth and space stations and the receiving frequencies of radio astronomy stations.

Thanks to the work of the CCIR, in particular, it was possible to draw up a very detailed method, based on the latest technical data, of determining the co-ordination area of an earth station, i.e., the area in which such a station may cause interference to terrestrial stations or be subject to interference from them.

In addition, CCIR studies provided the basis for a method of calculating interference between geostationary satellite networks sharing the same frequency bands.

The Conference also adopted a number of Resolutions and Recommendations. These relate to various services, but some of them are more general in scope. One such text is Resolution No. Spa2-1 relating to the use by all countries, with equal rights, of frequency bands for space radiocommunication services, which provides *inter alia* that the registration with the ITU of frequency assignments for space radiocommunication services and their use should not provide any permanent priority for any individual country or group of countries and should not create an obstacle to the establishment of space systems by other countries. This is justified by the fact that the use of the allocated frequency bands and fixed positions in the geostationary satellite orbit by individual countries or groups of countries can start at various dates depending on requirements and readiness of technical facilities of countries.

Accordingly, a country or a group of countries having registered with the ITU frequencies for their space radiocommunication services should take all practicable measures to realize the possibility of the use of new space systems by other countries or groups of countries so desiring.

Resolution No. Spa2-2 relating to the establishment of agreements and associated plans for the broadcasting-satellite service provides that stations in the broadcasting-satellite service shall be established and operated in accordance with agreements and associated plans adopted by World or Regional Administrative Conferences. The Administrative Council of the ITU is requested to examine as soon as possible the question of a World Administrative Conference, and/or Regional Administrative Conferences as required, with a view to fixing suitable dates, places and agenda. During the period before the entry into force of such agreements and associated plans the administrations and the IFRB shall apply the procedure contained in Resolution No. Spa2-3.

Recommendation No. Spa2-13 relates to the use of space radiocommunications in the event of natural disasters, epidemics, famines and similar emergencies. It recommends, in particular, that administrations, individually or in collaboration, provide for the needs of eventual relief operations in planning their space radiocommunication systems and identify for this purpose preferred radio-frequency channels and facilities which could quickly be made available for relief operations. This recommendation was brought to the attention of the United Nations, the specialized agencies and other international organizations concerned in order to ensure full co-operation in its implementation.

Recommendation No. Spa2-1 relates to the examination by World Administrative Radio Conferences of the situation with regard to occupation of the frequency spectrum in space radiocommunications. In one of the "considering" paragraphs it is stated that despite the provisions of Article 9A of the Radio Regulations and the principles adopted by the Conference, which provide for full consultation and co-ordination between administrations with a view to the optimum accommodation of all space systems, it is possible that as the use of frequencies and orbital positions increases, administrations may encounter undue difficulty in one or more frequency bands in meeting their requirements for space radiocommunication. If such a situation arises, it is recommended that the next appropriate World Administrative Radio Conference be empowered to deal with it. Moreover, the ITU Administrative Council is invited, in the same event, to include in the agenda for the next appropriate World Administrative Radio Conference specific provisions enabling it to examine all aspects of the use of the frequency band(s) concerned including, *inter alia*, the relevant frequency assignments recorded in the Master International Frequency Register and to find a solution to the problem.

Another important point to be mentioned is the request that the CCIR pursue the studies relating to space radiocommunications which it has been conducting successfully for a long time. Special attention should be paid to the studies of criteria for frequency sharing between several services, which will result in the improved efficiency of radio spectrum utilization.

These are, in broad outline, some of the results achieved by the Conference. Be it recalled that the Radio Regulations as thus revised constitute (as do the Telegraph Regulations and the Telephone Regulations) an annex to the International Telecommunication Convention drawn up by the plenipotentiaries of the Member countries of the Union and ratified (or acceded to) by these countries. Accordingly, the regulations adopted by World Administrative Conferences have the force of an international treaty. The new regulations will come into force on 1 January 1973.

3. Application of international regulations—International registration of frequency assignments to space telecommunications

3.1 Since the publication of the Tenth Report, the IFRB has continued to apply the relevant provisions of the Radio Regulations annexed to the International Telecommunication Convention, in connection with frequency assignment notices for space communications, received from administrations. The Board received 951 such notices in 1971. The relevant notification and registration procedures are defined in Article 9A of the Radio Regulations.

3.2 In accordance with the provisions of Resolution No. Spa1 adopted by the Extraordinary Administrative Radio Conference to Allocate Frequency Bands for Space Radiocommunication Purposes, Geneva, 1963, the IFRB published in 1971, in a special section of its weekly circular, information from the Administration of France containing a more detailed description of the *Symphonie* experimental communication-satellite system, which had been the subject of a summary description published in 1968.

3.3 The frequency assignment notices received and dealt with by the IFRB in 1971 mainly concerned the establishment or modification of space systems and the implementation of experimental programmes. Through its weekly circular, the IFRB regularly communicated to administrations the detailed information contained in all the notices it received, as well as the findings it reached in accordance with the provisions of Article 9A of the Radio Regulations. These notices are briefly described in the table below.

11.5

Table

country	system or programme	notices received and dealt with by the IFRB in accordance with the provisions of Article 9A of the Radio Regulations
Argentine Republic	— INTELSAT programme (*Intelsat-III*)	— earth station Balcarce (transmission, reception, tracking)
Brazil	— INTELSAT programme (*Intelsat-IV*)	— earth station Tangua (transmission, reception)
Canada	— INTELSAT programme (*Intelsat-III and Intelsat-IV*)	— earth station Mill Village (Nova Scotia) (transmission, reception, tracking)
	— national communication-satellite system (*Anik*)	— space stations *Anik-1* and *Anik-2* (transmission, reception, telemetering, tracking, telecommand)
		— earth stations Allan Park (Ontario) (transmission, reception, telemetering, tracking, telecommand and Bay Bulls (Newfoundland), Grand Beach (Manitoba), Harrietsfield (Nova Scotia), Huggett (Alberta), Lake Cowichan (British Columbia), Qu'Appelle (Saskatchewan), Rivière Rouge (Province of Quebec) (transmission, reception)
	— space research programme *Isis-2*	— space station *Isis-2* (telemetering, tracking, telecommand)
		— earth stations Ottawa (Ontario) and Resolute (North-West Territories) (telemetering, tracking, telecommand)
Chile	— INTELSAT programme (*Intelsat-IV*)	— earth station Longovilo (transmission, reception)
China	— INTELSAT programme (*Intelsat-III*)	— earth station Taipei (transmission, reception)
United States of America	— INTELSAT programme (*Intelsat-IV*)	— space stations *Intelsat-IV* (Pacific 1, Atlantic 2) (transmission, reception, tracking, telemetering)

country	system or programme	notices received and dealt with by the IFRB in accordance with the provisions of Article 9A of the Radio Regulations
United States of America *(continued)*	— INTELSAT programme *(Intelsat-III and Intelsat-IV)*	— earth station Talkeetna (Alaska) (transmission, reception, tracking, telemetering)
		— earth station Yona (Guam) (transmission, reception, tracking, telemetering)
	— United States Government communication-satellite system *(I-23)*	— earth station Guantánamo Bay (reception)
	— United States Government communication-satellite system *(Phase II)*	— space stations *USGCSS Phase II* (Atlantic, East Pacific, West Pacific, Indian Ocean) (transmission, reception, tracking, telemetering)
France	— *Symphonie* experimental communication-satellite system	— space station *Symphonie-I* (transmission, reception)
	— experimental space research programme *D2-A*	— space station *D2-A* (telemetering, telecommand)
		— earth stations Brétigny-sur-Orge and Kourou (French Guyana) (telemetering, tracking, telecommand)
	— experimental space and meteorological research programme via satellite *Eole*	— space station *CAS-A* (telemetering, tracking, telecommand)
		— earth stations installed on stratospheric balloons (telemetering)
		— earth stations Brétigny-sur-Orge and Kourou (French Guyana) (telemetering, tracking, telecommand)
	— experimental space research programme *Sret*	— space station *Sret* (telemetering)
		— earth stations Brétigny-sur-Orge and Kourou (French Guyana) (telemetering, tracking)

country	system or programme	notices received and dealt with by the IFRB in accordance with the provisions of Article 9A of the Radio Regulations
Greece	— inter-governmental communication-satellite system *(Satcom-2)*	— earth station Atalanti (reception, tracking)
India (Republic of)	— INTELSAT programme *(Intelsat-III)*	— earth station Arvi (reception)
Israel (State of)	— INTELSAT programme *(Intelsat-IV)*	— earth station Emeq Ha' ela (transmission, reception, telemetering, tracking)
Japan	— INTELSAT programme *(Intelsat-III and Intelsat-IV)*	— earth station Ibaraki (transmission, reception)
	— experimental space research programme *Shinsei*	— space station *Shinsei* (telemetering, telecommand)
Malagasy Republic	— INTELSAT programme *(Intelsat-IV)*	— earth station Arivonimamo (transmission, reception)
Nigeria (Federal Republic of)	— INTELSAT programme *(Intelsat-III)*	— earth station Lanlate (transmission, reception)
New Zealand	— INTELSAT programme *(Intelsat-III and Intelsat-IV)*	— earth station Warkworth (transmission, reception, tracking)
Federal Republic of Germany	— INTELSAT programme *(Intelsat-IV)*	— earth station Raisting (transmission, reception)
United Kingdom of Great Britain and Northern Ireland	— INTELSAT programme *(Intelsat-III)*	— earth station Hong Kong (transmission, reception, telemetering, tracking)
Senegal (Republic of)	— INTELSAT programme *(Intelsat-IV)*	— earth station Rhandoul (transmission, reception)
Singapore (Republic of)	— INTELSAT programme *(Intelsat-III)*	— earth station Sentosa Singapore (transmission, reception)
Sweden	— INTELSAT programme *(Intelsat-IV)*	— earth station Tanum (transmission, reception, telemetering, tracking)
Zaire (Republic of)	— INTELSAT programme *(Intelsat-IV)*	— earth station N'Sele (transmission, reception)

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3.4 Furthermore, the ITU has published all particulars of the earth and space stations which were recorded in the Master International Frequency Register in the " List of stations in the space service and in the radio astronomy service " prepared by the IFRB. The fourth recapitulative supplement to the second edition of that list, as well as the third edition and the first supplement thereto, were published during 1971.

3.5 Under No. 482 of the Radio Regulations, the IFRB prepared the World Administrative Radio Conference for Space Telecommunications, Geneva, June-July 1971, from the technical point of view. In particular, it contributed to the work of the " Special Joint Meeting of CCIR Study Groups to prepare technical bases for the World Administrative Radio Conference for Space Telecommunications " and examined the matters of interest to the Conference and proposals submitted by administrations.

3.6 The IFRB began to prepare a new edition of its Rules of Procedure and Technical Standards, in conformity with the relevant provisions of the Radio Regulations revised by the World Administrative Radio Conference for Space Telecommunications, Geneva, 1971, which shall come into force on 1 January 1973. This new edition will be used from 1 January 1973 to effect examinations required by the regulatory provisions relating to notices of frequency assignments in bands shared between space radiocommunication services and terrestrial radiocommunication services or between space radiocommunication services.

4. Telecommunication studies and standardization

4.1 General

Studies of telecommunication questions and work on standardization within the ITU are largely done by two of its permanent organs: the CCIR and the CCITT.

4.2 Integration of telecommunication satellites in the general network (activities of the CCITT)

4.2.1 The CCITT is studying the use of telecommunication satellites for telegraph, facsimile, telephone and data transmissions and, where necessary, the signalling associated with these various types of information. A large number of Study Groups have contributed to this work

4.2.2 Study Group XII (Telephone transmission performance and local telephone networks) considers that, for the present, the propagation time limits given in Recommendation G.114, *White Book*, Volume **III** (Recommendation P.14 in Volume **V**), as approved by the IVth Plenary Assembly (Mar del Plata, 1968) should remain unchanged. The Study Group has, however, investigated ways of improving the quality of communications with very long propagation times, especially by the use of adaptive echo cancellers.

The limits laid down in Recommendation G.114 are based on speech transmission quality; error correction in data transmission may present difficulties when propagation time is long, and the question is being studied by Special Study Group A (Data transmission), Question 1/A, point AC: Use of circuits established by means of satellite for data transmission.

4.2.3 Study Group XVI (Telephone circuits) has studied the transmission problems raised by the introduction of satellite systems providing demand-assigned telephone circuits.

Study Group XIII (Automatic and semi-automatic telephone networks) is well aware that the international routing plan may require amendment a few years hence if demand assignment of circuits becomes a common practice. A study is being made of this question and will be dealt with by the Study Group early in 1972.

4.2.4 The new signalling systems recommended for telex and telephony take the peculiarities of satellite circuits into account. In particular, a Group of Experts of Study Group XI (Telephone switching and signalling) has dealt with the question of signalling in satellite systems providing telephone circuits on demand assignment. This study has corroborated the conclusions adopted for bringing the Spade (single channel per carrier PCM multiple access demand assignment equipment) system into operation and has defined the fundamental bases for any new systems of this type which may be planned. Special attention was given to the implications for such systems of the common-channel signalling system No. 6. The conclusions of this Group of Experts have been used as guidelines for the studies to be conducted on the subject in the International Telecommunications Satellite Consortium (INTELSAT).

4.2.5 The programme of Study Group IV (Transmission maintenance of international lines, circuits, and chains of circuits) includes the maintenance of satellite circuits, which poses some new problems, particularly as the composition of such circuits is not defined in the same way as in conventional systems, which means that maintenance management and clearing of faults are much more complicated.

4.2.6 Study Group II (Telephone operation and tariffs) is studying the tariff problems raised by the use of satellite circuits for telephony.

4.3 Space radiocommunication technique (activities of the CCIR)

As was mentioned in the Tenth Report of this series, the CCIR convened a Special Joint Study Group Meeting in February 1971, in accordance with a decision taken at the XIIth Plenary Assembly, New Delhi, 1970. The report of this meeting, covering all aspects of space communication, served as a technical basis for the work of the World Administrative Radio Conference for Space Telecommunications (Geneva, June-July 1971).

Many conclusions contained in the report were incorporated in the Final Acts of the Conference. They all relate to frequency sharing, directly or indirectly. In this regard, it should be stated that the CCIR recognizes that the ultimate expansion of radiocommunications within a given frequency range is limited by the problem of sharing. This problem cannot be solved in an absolute sense, but is dealt with continuously by finding optimum solutions to specific problems, resulting in a steady increase in the efficiency of use of the radio-frequency spectrum. This fundamental problem is under active investigation in all Study Groups of the CCIR, where its importance is clearly recognized. In the Final Acts of the above Conference for Space Telecommunications, important decisions are based on the results of CCIR studies.

4.3.1 Procedure for determination of co-ordination distances

The study of co-ordination distances was first initiated by CCIR Study Group IV at its Washington meeting in 1962. The objective is to limit interference in the frequency bands shared between the communication-satellite service and terrestrial radio-relay systems. The Xth Plenary Assembly of the CCIR (Geneva, 1963) adopted a recommendation and a report which served as the technical bases for the calculation procedure established by the first Space Conference held in 1963. Studies continued in CCIR Study Groups IV and V (subsequently Study Groups 4 (Fixed services using satellites) and 5 (Propagation in non-ionized media)) as the communication-satellite service expanded, and the frequency bands in the range of 1-10 GHz allocated by the 1963 Space Conference became insufficient to cover requirements. Thus the Special Joint Meeting evolved a procedure for determining the co-ordination distance for an expanded frequency range, 1 to 40 GHz. Furthermore, it now accommodates all space services, instead of only the communication-satellite service, together with terrestrial services that share frequency bands with them. New propagation curves adopted by CCIR Study Group 5 were used, which take account, amongst other effects, of those of hydrometeors (precipitation scatter). These curves were embodied in the report of a special Interim Working Party meeting held in December 1970, and were further modified at the Special Joint Meeting; Study Group 5 is devoting a good deal of its attention to propagation aspects of the sharing problem in general.

The Special Joint Meeting further defined the concept of " interference probability ", outlined methods of limiting interference in various situations, and gave information for its calculation.

4.3.2 *Efficient use of the geostationary satellite orbit*

The investigation of the various technical factors relative to mutual interference, enumerated in paragraph 4.2 of the Tenth Report of this series, is continuing. The report adopted by the 2nd Session of the Interim Working Party set up under CCIR Resolution No. 56 was further improved on the basis of various contributions to the Special Joint Meeting. As with studies on co-ordination distance, the investigation of the efficient use of the geostationary satellite orbit, formerly restricted to communication satellites, now includes satellites for other services. It is now generally agreed that this orbit has very wide applications, especially for broadcasting satellites.

The method of calculating interference is based on the concept that the effective noise temperature of the system suffering the interference increases as the level of interference rises. It can, therefore, be applied irrespective of the modulation characteristics of these satellite networks, and irrespective of the precise frequencies used.

Studies were also made of the sharing problem between geostationary and non-geostationary satellites, as well as that relating to inter-satellite relay links.

4.3.3 *Power limits*

Studies on the limits of power radiated by satellites and by radio-relay stations were pursued in greater detail. Different values were proposed for different frequency bands.

4.3.4 *Use of frequencies higher than 10 GHz*

As the requirements for space communications increase, new frequencies must be made available. Thus, studies on propagation of radio waves beyond 10 GHz, taking into account the absorption due to oxygen and water vapour, are extremely important. At the same time new demands for digital data transmission and video telephony are imposed on the radio-relay systems, which, because of wide bandwidth requirements, require bearer frequencies higher than 10 GHz for these purposes. Thus, the sharing on these frequency bands between communication satellite and radio-relay systems will continue to be a major problem in CCIR studies.

Finally, among other matters, the World Administrative Radio Conference for Space Telecommunications has referred a most important question to the CCIR in general, and as of 1971 this matter is under study. The information sought is to enable clear definition of the terms " acceptable (or unacceptable) interference " and " harmful interference ". The enormous importance of such studies in respect to future development of all radiocommunications operating under conditions of sharing cannot be exaggerated, and it is expected that 1972 will see progress in this field within the CCIR.

5. Planning of the international telecommunication network

5.1 General

According to the International Telecommunication Convention, there shall be a World Plan Committee, and such Regional Plan Committees as may be jointly approved by the Plenary Assemblies of the International Consultative Committees. These Plan Committees shall develop a general plan for the international telecommunication network to help in planning international telecommunication services. They shall refer to the International Consultative Committees questions the study of which is of particular interest to new or developing countries and which are within the terms of reference to those Consultative Committees.

5.2 The Plan Committee for Europe established the number of satellite circuits operated by each earth station. The World Plan Committee decided that these data should appear in all the Plan Books (for Regional Plans and the World Plan).

5.3 The Plan Committee for Asia and Oceania asked the International Consultative Committees to undertake a study of the technical and economic aspects of a domestic and/or regional satellite system, while the Plan Committee for Europe and the Mediterranean Basin issued an opinion on the co-ordination and development of satellite communications.

6. Technical Co-operation activities

In 1971 the ITU was actively involved in three space projects. The continuation of the activities at Ahmedabad, India; the educational feasibility study for the Andean region in association with the United Nations Educational, Scientific and Cultural Organization (UNESCO) and a new project — a space radiocommunication system for aid following natural disasters.

6.1 Space radiocommunication system for aid following natural disasters

General Assembly resolutions have pointed to the needs for better management and co-ordination of disaster relief and it is clear that without the rapid establishment of adequate telecommunications after the disaster has struck, proper management of disaster relief is virtually impossible.

Recommendation No. Spa2-13 of the 1971 World Administrative Radio Conference for Space Telecommunications stressed that rapid and reliable telecommunications are essential for the improvement of relief operations and invited the CCIR to study standard specifications and preferred frequencies for transportable earth stations and for compatible mobile and transportable radiocommunications equipment for this purpose.

It is envisaged that the equipment would be operated by the newly-established office within the United Nations system for disaster relief matters in collaboration with the Red Cross.

6.2 Andean educational television feasibility study

In the framework of United Nations Development Programme (UNDP) Special Fund Project REG-233, UNESCO has been designated executing agency, in association with ITU, with regard to the viability study and the regional system planification for education, cultural and development purposes in South America, taking into account modern communication means, including satellite communications. In the framework of this project, ITU has recruited, as from January 1971, a system planning expert, responsible for undertaking the preliminary studies and, in particular, the tentative plan for the implementation of the project. Furthermore, this expert will assure the co-ordination of the activities undertaken in the countries concerned with this study, during 1972, by a team of three experts in broadcasting, radio-relay systems and satellite communications respectively.

6.3 Experimental satellite communication earth station, Ahmedabad, India

In June 1970, the UNDP Governing Council approved a request from the Government of India for 1 068 900 US dollars for the up-grading and equipping of the experimental satellite communication earth station, which is to participate in the India/United States educational television satellite experiment project.

The year under review saw the appointment of the Technical Co-ordinator of this ITU/UNDP project. He has been actively following the co-ordination of equipment purchases provided for in the plan of operation. To aid the co-ordinator in the highly-skilled expertise required in developing the station for transmission to the satellite, a sub-contractor was employed. Work on the direct reception receivers is progressing normally under supervision of the host administration. Also progressing normally is the associated fellowship programme.

6.4 Seminars organized by the ITU

Space telecommunications often figure on the programme of ITU seminars. Such was the case with the Lagos seminar (April 1971) on broadcasting problems and with the Mexico City seminar (September-October 1971) on problems of radio-frequency spectrum management. At the latter seminar, a member of the IFRB and two staff members of its Specialized Secretariat gave lectures on frequency usage, and in particular on space telecommunications; in the course of these lectures they also analysed the results of the World Administrative Radio Conference on Space Telecommunications, Geneva, 1971 (see *Telecommunication Journal*, January 1972).

6.5 Preparation of handbooks

CCITT Special Autonomous Working Party No. 3 (GAS 3) has prepared texts on satellite telecommunications to supplement the handbook on " Economic and technical aspects of the choice of transmission systems ".

7. Co-operation with other international organizations concerned with space

In 1971, the ITU pursued its consistent co-operation with many international organizations concerned with space matters. In particular, it took part in meetings of the United Nations Committee on the Peaceful Uses of Outer Space and its Sub-Committees and Working Group.

It also continued to take an active part in the work of the specialized agencies concerned with space telecommunications

(International Civil Aviation Organization (ICAO); Inter-Governmental Maritime Consultative Organization (IMCO), UNESCO) and of inter-governmental regional organizations (European Conference of Postal and Telecommunications Administrations (CEPT); Inter-American Telecommunications Conference (CITEL)).

8. Information and documentation activities

In application of Administrative Council Resolutions Nos. 636 and 637 concerning the spread of information on the activities and role of the ITU in space telecommunications, the General Secretariat took certain measures (summarized below) during 1971.

The theme of the Third World Telecommunication Day proposed by the Administrative Council to Members of the Union was "Space and Telecommunications". A series of photographs illustrating this theme and texts specially written for the occasion were widely distributed in the weeks preceding 17 May 1971.

TELECOM 71, the first world telecommunication exhibition, organized by the ITU, was held from 17 to 27 June. Space techniques were given a prominent place and the 70 000 visitors were able to gather information on the equipment used for these techniques. The exhibition covered a surface of 24 000 m^2 and 250 exhibitors took part (see the *Telecommunication Journal*, October 1971).

The *Telecommunication Journal* continued to publish a monthly list of satellites launched, articles on space matters and, at regular intervals, statistics on the utilization of telecommunication satellites. The May issue (of which 10 000 copies were printed) was devoted to space, in view of the second World Administrative Radio Conference for Space Telecommunications which started on 7 June. It contained 220 pages of text and two supplements (a 146-page "List of artificial satellites launched from 1957 to 1970" and a planisphere showing the locations of earth stations used in the public satellite communication service, with a movable transparent plate for finding the coverage zone of a satellite in geostationary orbit as a function of its position above the equator).

Considerable documentation was distributed both before and during the Space Conference.

In July the "Journal" published, as a supplement, the Tenth Report by the ITU on Telecommunication and the Peaceful Uses of Outer Space and in October an analysis of the results of the Space Conference.

As in previous years, the Union's film library lent out many films dealing with space telecommunications.

Finally, the ITU produced a 72-minute colour film "TELECOM: Message to the 21st Century", part of which concerns space telecommunication.

ANNEX 1

Reports on progress made in the development of space communications

ARGENTINE REPUBLIC

Commercial services

In 1971 activities connected with space communications developed considerably in Argentina.

As will be seen from the following, the number of operating and reserve circuits increased as well as the number of communications. We can also say that the quality of the services was improved.

The commercial space services are, of course, operated by the *Empresa Nacional de Telecomunicaciones* (ENTEL) and the *Dirección Nacional de Correos y Telecomunicaciones* by means of systems installed at the Balcarce earth station at the Buenos Aires switching and international centres, both located in the Talcahuano and Cangallo building, and at the *División Operación Servicio Internacional* (DOSI) on the 5th floor of the main Post Office.

The first two centres handle international telephone, telex and television traffic and the third international telegraph traffic.

The work carried out in 1971 at each of these centres and prospects for the current year are dealt with below.

■ Balcarce earth station

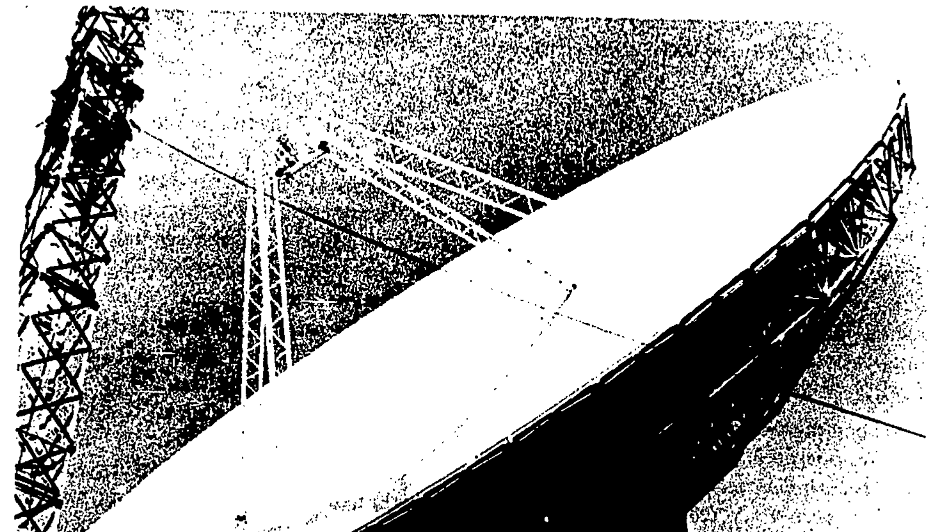
The station, which was brought into service in 1969, operated with the *Intelsat-III* communication satellite until 27 March 1971, when it started working with *Intelsat-IV*, which has almost five times the capacity of *Intelsat-III*.

A number of equipment improvements and new installations were required at the earth station to enable it to work with the new satellite and, at the same time, the work required to complete Balcarce II was continued. The position is as follows: The construction of the second antenna, with its rotating paraboloid reflector 29.75 m in diameter, has been finished and by the time this report is published, the operational tests also will more or less have been completed. The electric characteristics are similar to those of the first antenna, but a number of improvements were incorporated in the mechanical structure. Of these the following may be of interest:

— the azimuth drives (motor-reducing gear-brake system) have been installed at the first-floor level of the space inside the base, unlike the first antenna in which they were placed at basement level. The application of the forces in this position shortens that part of the vertical axis which is subject to torque so that the pointing of the assembly is more stable and more accurate;

— the floor corresponding to the ground-floor level is solid with the vertical axis and revolves with it. The transmitting equipments are mounted on this revolving platform and it was possible to dispense with rotating joints for the azimuth motion on the respective waveguides. As a result, the efficiency of the transmission system was substantially improved;

— the four final power amplifiers for the four 1.2 kW transmitters are now being installed. The travelling wave tube amplifiers have a bandwith of 500 MHz, thus obviating the need for



The Balcarce II station. The Balcarce I antenna can be seen in the background
(Telecommunication Administration, Argentina)

23.

adjustment when the carrier frequencies are changed.

The transmitters are also being equipped with four exciters (with tuning control to ensure rapid adjustment to frequency changes) and a fifth exciter for the Spade service (single channel per carrier PCM multiple access demand assignment equipment). This system offers the following advantages:

— the equipment at the earth station and the frequency spectrum used by the satellite will be substantially reduced because one carrier with 24 channels will be common to all countries and each channel may be used by all stations with the necessary equipments. Each channel will have its own sub-carrier which will be selected at random, on request, according to traffic requirements.

These equipments will be housed in the Balcarce II antenna.

The Balcarce I antenna had to be made capable of working with the *Intelsat-IV* satellite and for this purpose two exciters with tuning control and one Spade type of exciter were installed.

The equipments listed below are common to both antennae and are already installed in the equipment building:

— four modulators for telephony and one for television, similar to the original modulators;
— nine 750-70 MHz convertors for the receiving sub-system and one for television, with the required standbys;
— nine threshold extension demodulators for telephony and one for television;
— one Spade equipment initially with 12 channels and the required 750-70 MHz convertors.

Three console systems are being provided for three operating centres: antenna operation, operation and control of equipment, and video control.

A third 250 kVA generating set will be added, bringing the total power available to 750 kVA.

A switching system will be installed to permit the instantaneous transfer of communications from one antenna to the other. Transmission switching will be at 70 MHz and reception at 750 MHz.

The reliability of the Balcarce—Mar del Plata link will be improved by connecting the two points with a coaxial cable, making two complete routes between Balcarce and Buenos Aires (one normal and one alternative route).

■ Buenos Aires International Centre (CIBA — Centro Internacional Buenos Aires)

In 1971, the capacity of the telephone exchange was increased from 63 to 88 circuits. Twenty-five of the circuits are operated manually and the remainder semi-automatically, which means that an operator is required at only one terminal.

Table 1 lists the countries now interconnected with our system and shows the number of channels used in each case.

In emergencies due to failure of the earth station or of the satellite, it will be possible to bring 11 telephone circuits into operation immediately, 8 to the United States of America and 3 to Italy. The equipments are accommodated in the General Pacheco and Don Bosco transmitting and receiving exchanges.

Table 1

country	telegraphy	telephony	telex			
			carrier	telex	leased	transit
United States	ITT 1 RCA 1 WUI 1	22 1 data transm.	7	ITT 35 RCA 28 WUI 25	21 11 8	2 2 3
Italy	1	7		40		
Spain		6	1	4	2	
Chile	1	14	1	6		
Peru		3	1	3	3	
Brazil	1	12	2	14	12	1
Federal Republic of Germany	1	4	2	20	4	
France		3	1	6	6	
Venezuela		3		1 arrm via WUI	—	—
Mexico		2		3		
Canada		2		2 via USA		
Colombia		1				
United Kingdom	1	3	1	19	2	1
Switzerland		1		4 via Italy		
Austria	1			4 via Germany		
Belgium					1 via Germany	
Netherlands					4 via Germany	
Japan				4	1 via Spain	

Figure 1 gives an idea of the development of telephone traffic. It will be seen that the number of outgoing calls ranged from a minimum of 5500 in October to a maximum of 11 000 in May.

Outgoing calls in 1971 totalled 324 046 and charged minutes 2 355 154.

The capacity of the telex exchange was expanded and it is planned to equip an ESK (TWKD) exchange with 410 circuits over the next three years (see figure 2).

Table 2 shows developments in 1970 and 1971 and prospects for 1972:

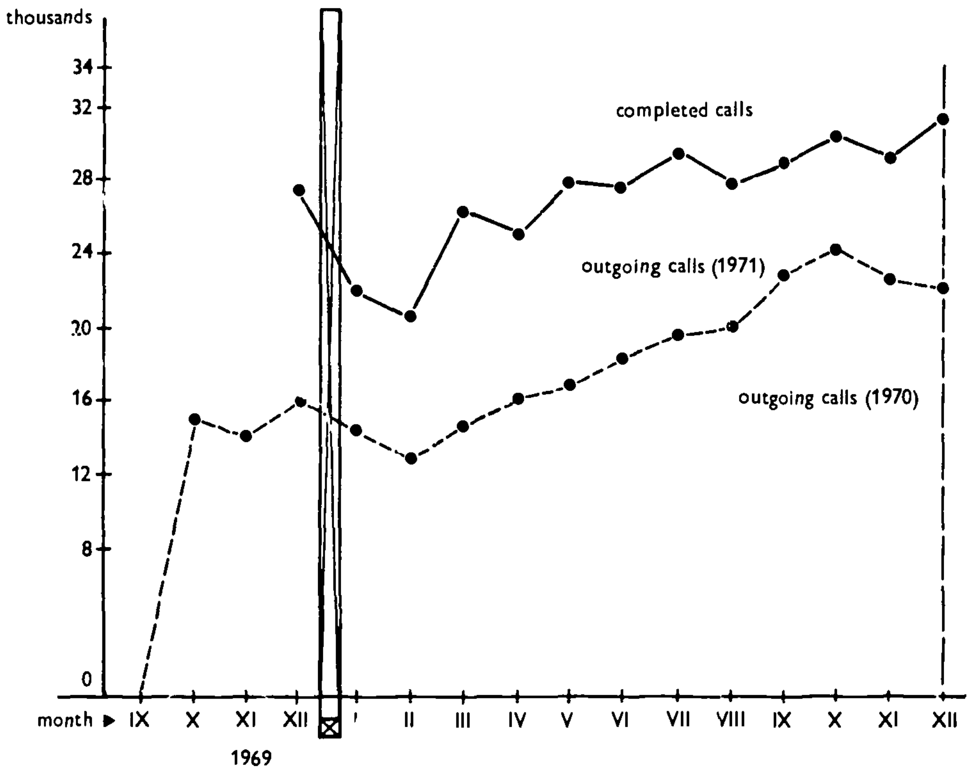


Figure 1 — International telephone traffic

Telex service exists with the following countries: Austria; Germany; Belgium and Netherlands via Germany; Brazil; Canada via RCA; Chile; Spain; United

States of America via ITT, RCA and WUI; France; Great Britain; Italy; Japan via Spain; Peru; Switzerland via Italy; Venezuela via WUI.

Operational figures for 1971 are shown in table 3.

Table 2

	1970	1971	1972
— incoming circuits	90	104	—
— two-way automatic outgoing circuits	66	76	144
— semi-automatic outgoing circuits	38	47	47

Table 3

	No. of calls	No. of charged minutes
— incoming	481 000 (approx.)	2 500 000 (approx.)
— outgoing	55[illegible] 371	2 655 809

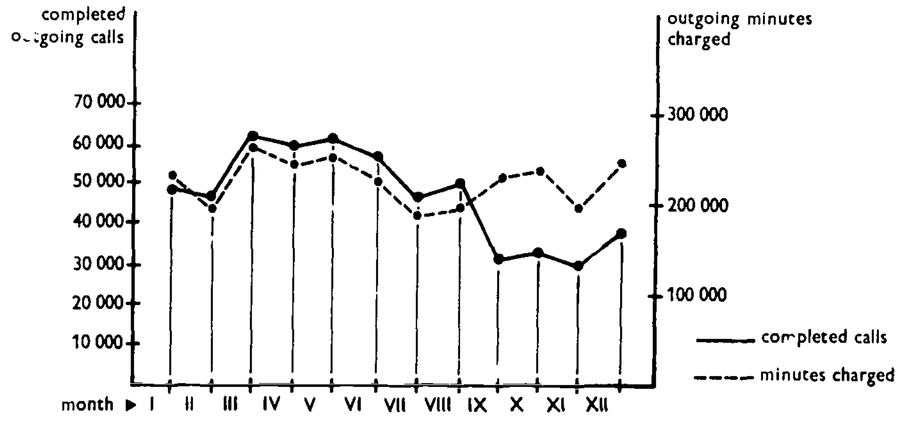


Figure 2 — Monthly figures for the telex service

■ División Operación Servicio Internacional (DOSI)

This centre handles all international telegraph traffic over nine send and receive circuits:

Buenos Aires—New York:

1 circuit with Western Union International Inc. (WUI)

1 circuit with RCA Global Communications Inc. (RCA)

1 circuit with World Communications Inc. (Worldcom)

Buenos Aires—Rome

1 circuit with *Italcable, Servizi Cablografici, Radiotelegrafici e Radioelettrici, SpA*

Buenos Aires—Rio de Janeiro

1 circuit with the *Emprêsa Brasileira de Telecomunicações* (EMBRATEL)

Buenos Aires—Hamburg

1 circuit with the Ministry of Posts and Telecommunications

Buenos Aires—London

1 circuit with the United Kingdom Post Office

Buenos Aires—Santiago

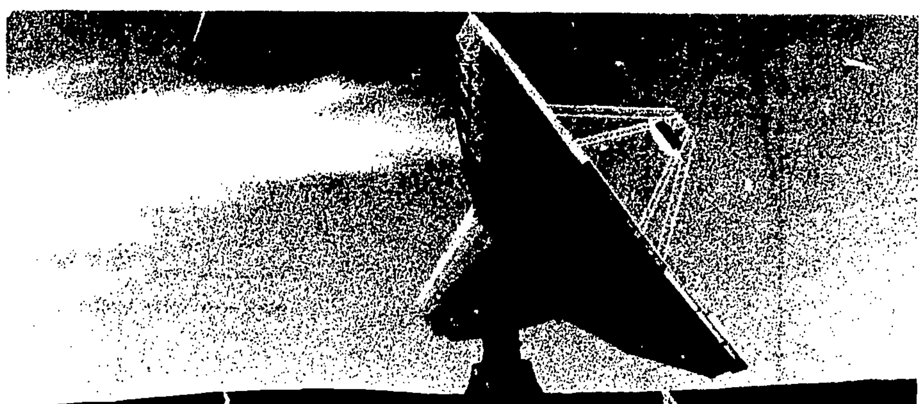
1 circuit with the *Administración Chilena* de *Telecomunicaciones*

Buenos Aires—Vienna

1 circuit with EPER Radio-Austria

Figure 3 shows the development of telegraph traffic from October 1970—when the service was nationalized—until December 1971.

Improvements in facilities are shown in figures 4, 5 and 6. Figure 4 shows the time required to collect the text of a



Antennae of the Balcarce earth station (P&T Administration, Argentina)

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telegram at a customer's home at his request. The procedure is as follows:

a) receipt of the request by telephone,

b) dispatch of messenger,

c) collection of telegram at the customer's home,

d) delivery of the telegram at the telecommunication counter.

Curve 1 shows the time from *a)* to *b)*, curve 2, the time from *a)* to *c)*, and curve 3, the time from *a)* to *d)*. It will be noted that all of these times are decreasing; in 1971, the average total time was reduced by 33%.

Figure 5 shows the time required to deliver telegrams in advance either by telephone or by telex. The average time for telephone delivery dropped from 18 to 8 min, or by 55%. Telex delivery time dropped from 12 to 7 min, or by 41%.

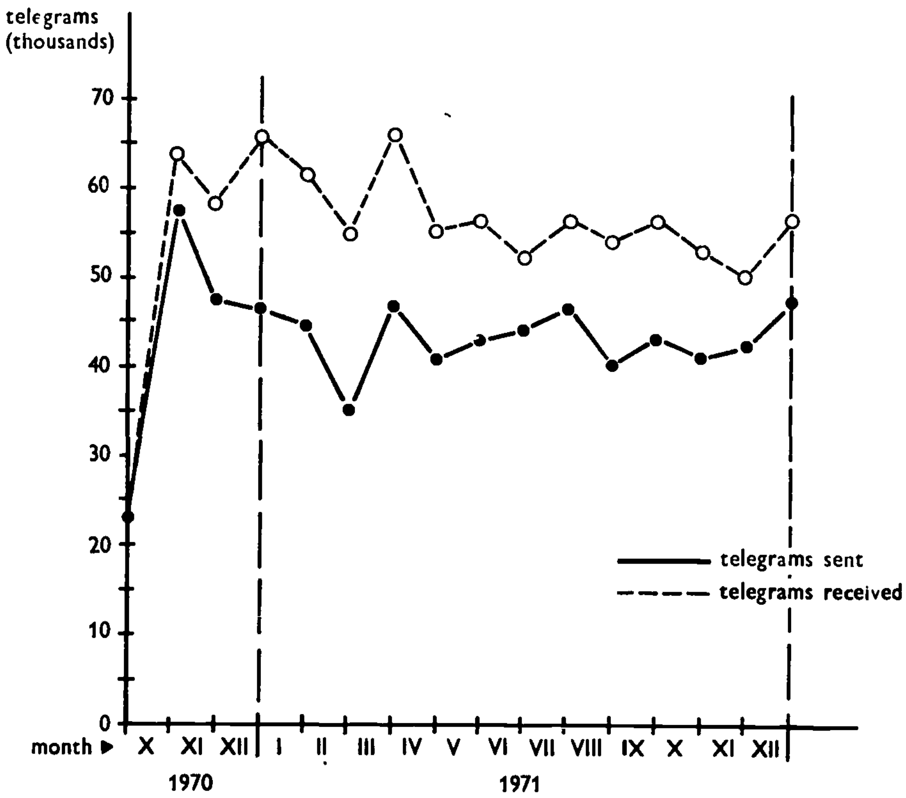


Figure 3 — International telegraph traffic via satellite

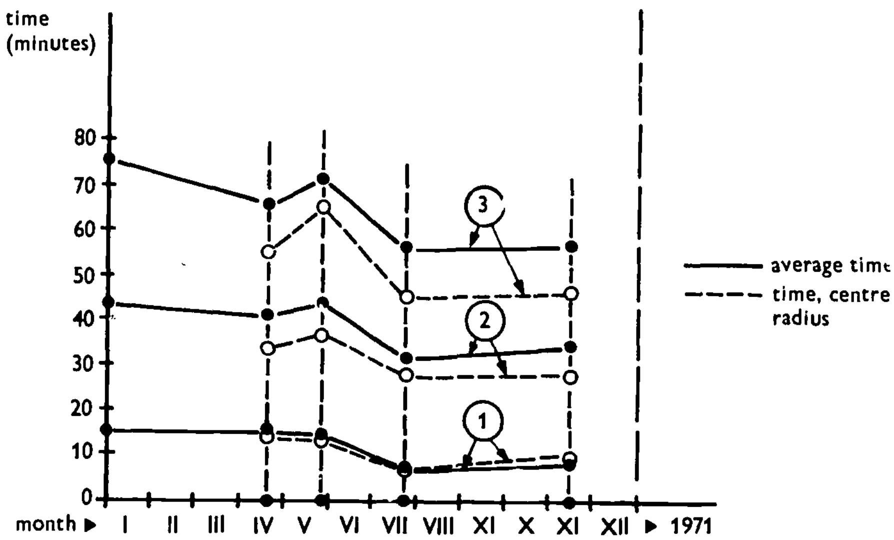


Figure 4 — Time required to collect telegrams from customer's home

1. Time elapsed between receipt of request and dispatch of messenger

2. Time elapsed between receipt of request by telephone and collection of telegram at customer's home

3. Time elapsed between receipt of request by telephone and delivery of telegram to the telecommunication counter

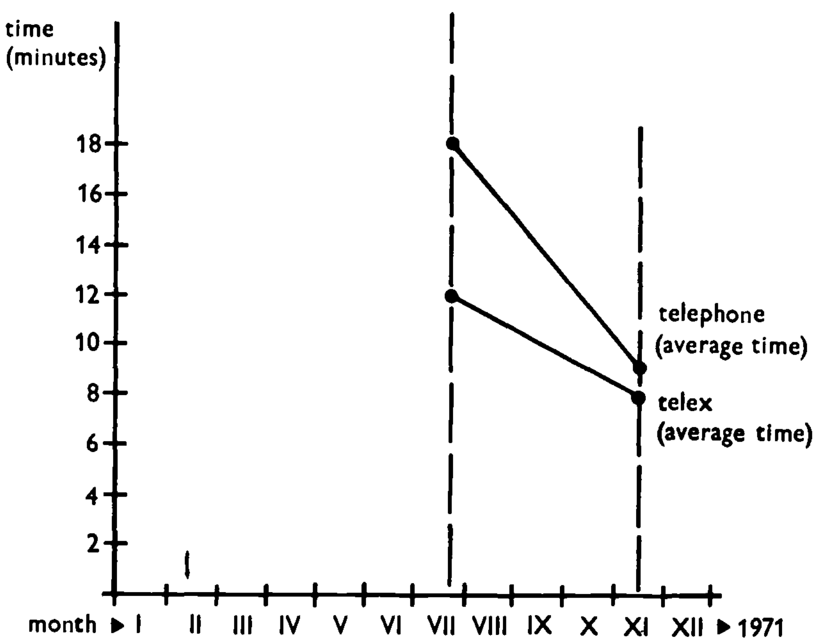


Figure 5 — Telegram advance delivery times

Figure 6 shows the time required to deliver telegrams in Buenos Aires. The average time—which is constantly diminishing—was reduced from 108 min in April to 65 min in November 1971, which represents an improvement of 39.5%.

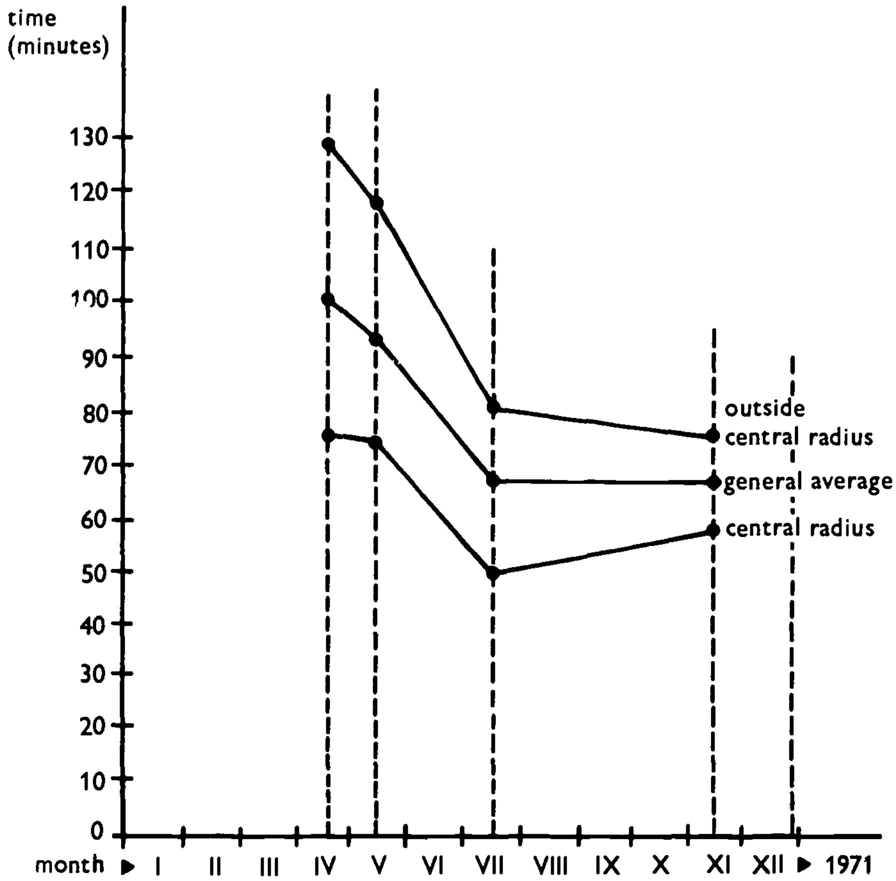


Figure 6 — Telegram delivery times, Buenos Aires

AUSTRALIA (COMMONWEALTH OF)

International satellite communications

An original signatory of the Interim INTELSAT Agreement, Australia formally acceded to the Agreements establishing Definitive Arrangements for INTELSAT when they were opened for signature on 20 August 1971. Australia continued its active participation in INTELSAT management through the representation of the Overseas Telecommunications Commission (Australia) on the Interim Communications Satellite Committee (ICSC).

Australia's use of INTELSAT satellites in Indian and Pacific Oceans through the standard earth stations located at Moree (New South Wales), Carnarvon (Western Australia) and Ceduna (South Australia) increased to a total of 169 equivalent voice-grade circuits as at 31 October 1971, compared with a total of 100 equivalent voice-grade circuits at the corresponding date in 1970. Australia is now the fifth largest user of the INTELSAT space segment.

The collocated 13 m earth station at Carnarvon provided full-time tracking, telemetry and control services for the *Intelsat-II*, *III* and *IV* satellites in 1971. Additional modifications being carried out during the year to both the 13 m and standard earth stations at Carnarvon will equip them to perform system monitoring functions for the INTELSAT network. This work, which results from a decision of the ICSC, will be completed early in 1972.

Field trials for CCITT telephone signalling system No. 6 on both satellite and cable circuits were continued during 1971. The first phase of the trials (testing of signalling) has been completed. The second phase (simulated telephone calls and test calls) conducted by Australia in conjunction with the United Kingdom, the United States, Japan and Italy, is now in progress.

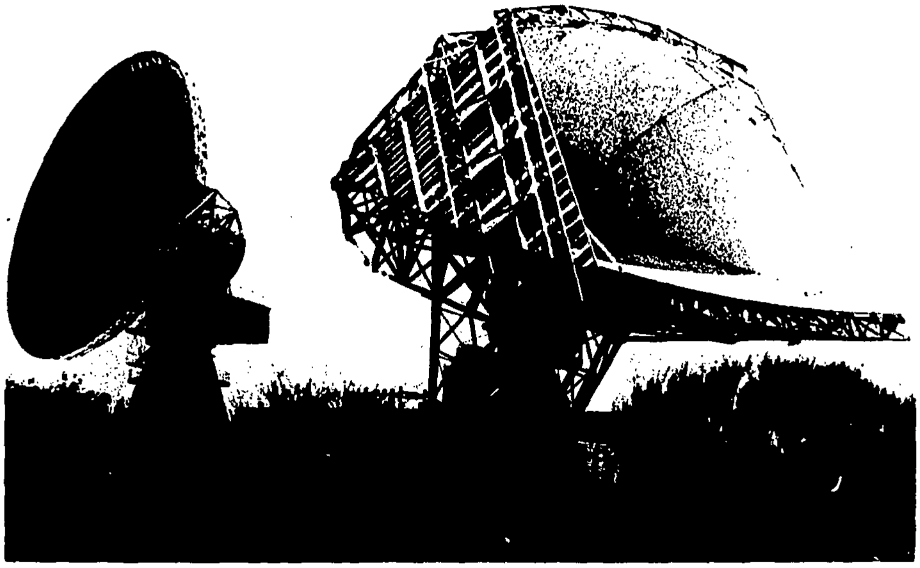
Domestic communications

The Australian Post Office has continued its studies of the feasibility and requirements for an Australian domestic satellite communications system to be integrated with the Australian national telecommunications network. An early study in 1966 showed that although a domestic satellite communications system was technically feasible and could meet the technical requirements of the Australian network, it could not compete economically at that time with conventional terrestrial microwave radio or coaxial cable systems. Progress in technological and economic factors has continued and more recent studies have shown that these improved the prospects of viability of a satellite system. Indications are that this trend will continue.

The study includes consideration of provision of facilities for the following services as part of the Australian network:

- point-to-point trunk telephony, handling large blocks of traffic over long distances — typically Sydney — Perth, Sydney — Darwin;
- multiple access trunk telephony, with smaller blocks of traffic to intermediate centres in distant areas having limited trunk access at present;
- television relay between major centres;
- television programme distribution for retransmission at established terrestrial television stations;
- a telephone subscribers' service—to individual subscribers in remote locations of the country.

A significant benefit of a satellite service which is not directly quantifiable is the improvement in reliability achievable in the long-distance trunk network when satellite links are available. A satellite system also provides the potentiality for facilities which would not otherwise be possible; in particular, the remote subscribers' telephone service. In the 1970 Report, a programme of experiments aimed at providing data for future design of such a subscribers' service was described. The results of the programme have now been published in *Australian Telecommunication Research* which is a journal of the Telecommunication Society of Australia (Box 4050, GPO, Melbourne, Victoria, Australia, 3001). The complete issue of



The Overseas Telecommunications Commission (Australia) Carnarvon installation. In the foreground is the antenna for the tracking, telemetry and control station with the huge 30 m antenna of the communications earth station to the left

(OTC)

Volume 5, No. *1*, May 1971, is devoted to these experiments.

The effect of the conclusions of the World Administrative Radio Conference for Space Telecommunications on the Australian domestic satellite proposal are also being studied, especially in relation to operating frequency bands and changed power flux density limits. In the Australian situation, the possibility of operation at frequencies above 4/6 GHz, despite increased propagation difficulties, is attractive as it minimizes co-ordination problems and sharing with heavily developed terrestrial radio-relay routes and allows earth stations to be sited close to the main traffic centres thus reducing the cost of terrestrial interconnections. The increased allowable power flux density at these frequencies, particularly at the high elevation angles of a domestic system, offers the prospects of reduced cost earth stations by taking advantage of higher satellite output powers becoming available from emerging technology.

The major propagation problem at frequencies of 10 GHz and above is created by the additional attenuation caused by rain. This attenuation will vary, *inter alia*, with meteorological conditions and there is a scarcity of data, particularly for tropical areas. Equipment is now being prepared for a programme of measurements which is planned to start in a tropical location in Australia in 1972. It will use a solar radiometer and will concentrate initially on the frequency range 10 to 15 GHz.

Meteorology

The Bureau of Meteorology has continued to operate satellite earth stations at Perth, Darwin and Melbourne to obtain data from meteorological satellites in the *Essa*, *Nimbus* and *Itos* series. These stations use steerable antennae which are remotely controlled from meteorological offices some kilometres away. A further remotely-controlled earth station will be commissioned at Brisbane early in 1972 to extend coverage to the north and east of Australia. A fixed antenna receiving system in Melbourne receives daily satellite facsimile data from the United States via the *ATS-1* synchronous satellite.

As in previous years, a temporary satellite earth station was established at Mawson to receive meteorological satellite pictures in support of Australia's Antarctic expedition in the 1971-72 summer.

Ionospheric research

Work is well advanced to establish a data acquisition station at Darwin early in 1972 to receive data from ionospheric sounding satellites. The information will be used for ionospheric research in the tropical regions by the Ionospheric Prediction Service.

Co-operation in other space projects

During 1971, co-operation in United States space projects continued.

In January and July 1971, the Carnarvon. Honeysuckle Creek and Tidbinbilla stations supported the *Apollo-14* and *15* manned lunar missions. In the latter mission. the 64 m Parkes antenna also took part to provide improved reception of lunar surface television and some essential telemetered data.

The construction of a 64 m antenna at Tidbinbilla has continued and is on schedule for operation in mid-1973.

The first British satellite launched by a British vehicle, *Prospero*, has been tracked as opportunity has arisen, by the Carnarvon and Orroral stations.

Since May 1971, the Island Lagoon station has tracked the *Mariner-9* spacecraft. It is a key station for the present Mars orbital tracking and is supported occasionally by the Tidbinbilla Deep Space Communication Complex.

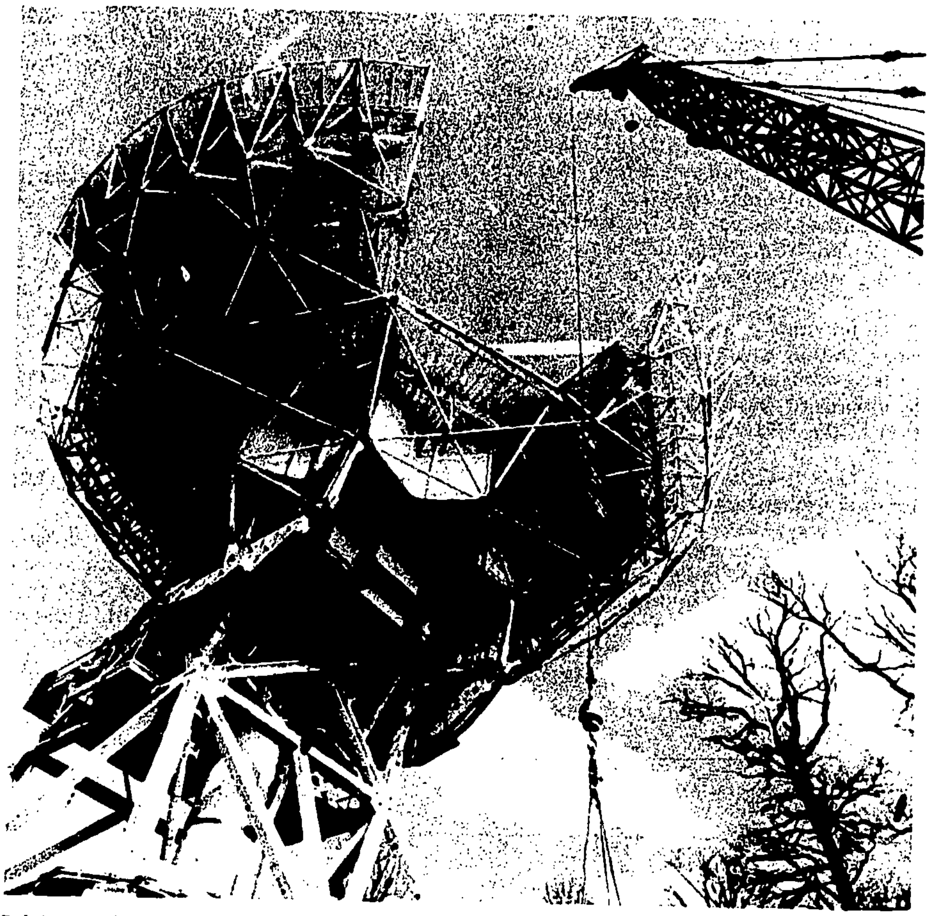
Plans to use 48 kHz (wideband) circuits for data flow between the stations and Goddard Space Flight Center have progressed and the first circuit between Goddard and the Canberra Switching Centre will be available for testing from early 1972.

BELGIUM

The Belgian Telegraph and Telephone Administration has decided to build an earth station at Lessive, for routing intercontinental traffic via the Intelsat system. Its entry into service is scheduled for the second half of 1972.

Initially, the station will have one antenna for links to the United States, Canada, Israel, and Zaire via *Intelsat-IV* over the Atlantic.

For transmission (in the 5925-6425 MHz band) it will be equipped to emit an FDM-FM carrier with 132 channels in the global beam and an FDM-FM carrier with 60 channels in the spot beam. For reception (in the 3700-4200 MHz band), it will be



Belgian earth station — mounting the antenna reflector

(RTT)

equipped to receive carriers with 252 channels from Canada, 60 channels from Israel, 432 channels from the United States and 24 channels from Zaire.

Later the station will work with the Spade system either on demand assignment or as a fixed PCM/PSK link. It will also be able to receive and transmit television programmes.

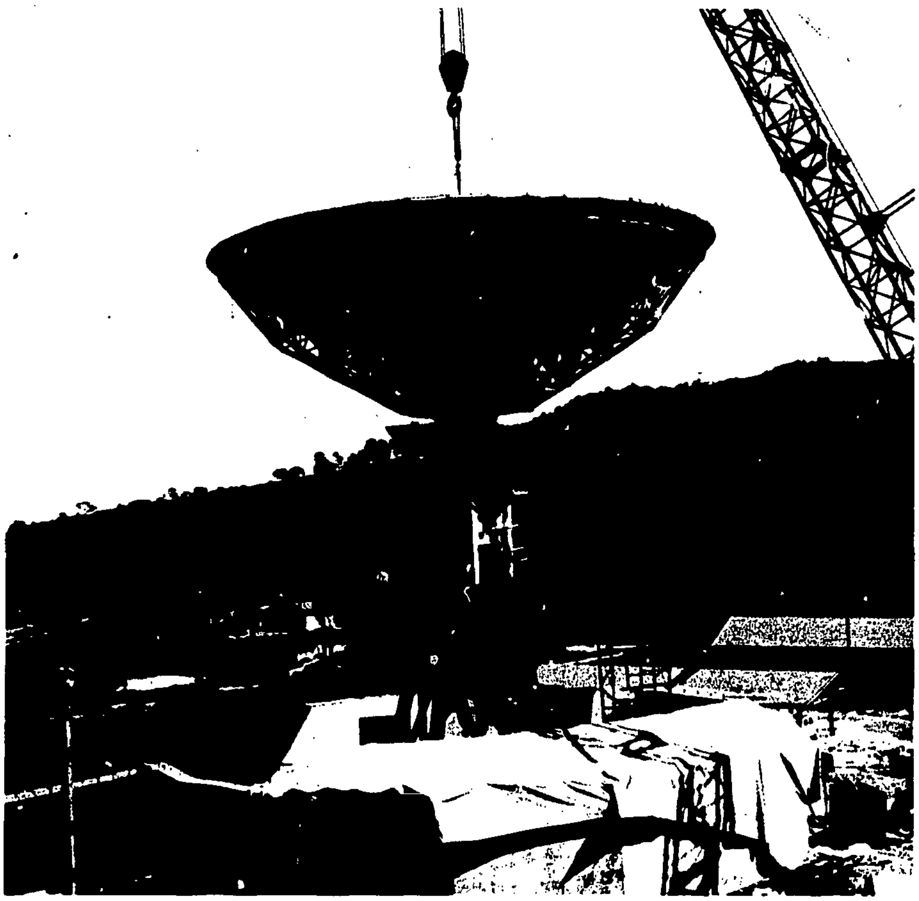
The plans of the Lessive earth station allow for future expansion to a capacity of three antennae.

BRAZIL

1. Satellite telecommunications

1.1 Utilization of facilities

Considerable progress has been achieved in Brazil's international links during 1971. A measure of this progress is the 54.9% increase in the number of satellite circuits, to 19 different countries, as shown in the table on page 38.



Installation of a 13.7 m precision radio telescope for millimetric wavelengths at Itapetinga Radio Observatory, Atibaia, São Paulo

(CRAAM)

type of circuit / date	voice	record	other	total
December 1970	60	13	0	73
December 1971	94	16	3	113

1.2 Installations

To back up this large demand of circuits, several installations have been expanded during 1971.

Most of the equipment procured for the *Intelsat-IV* operation has already arrived and is installed at the earth station.

A contract has been passed for a 3 kW TWT amplifier which is due to arrive in the near future.

An invitation for tenders was issued for Spade equipment. The Northern Electric Company (NEC) proposal is presently being evaluated.

The international switching centre is being expanded to a capacity of 370 circuits, of which 60 will be fully automatic (DDD), 240 semi-automatic and 70 for manual operation.

The number of echo suppressors was also expanded and 204 new units have been purchased. Twenty-four tone disablers have also been procured with a view to the increase in the requirement for data transmission circuits mainly of the AVD type.

The intercontinental telex exchange will be in operation in the first quarter of 1972 and the specifications for the international telegraph message switching centre have now been completed. A call for tenders will be issued shortly.

1.3 Services

The following new services have been started during 1971:

- the hot-line system which is a point-to-point transmission system for AVD use, charged for the duration of the call;
- leased, permanent voice channels for AVD use.

Another important event in 1971 was the award by the United States Communications Satellite Corporation (COMSAT) of a contract to the *Emprêsa Brasileira de Telecomunicações* (EMBRATEL) to operate two receiving terminals at 1.5 and 4 GHz for the purpose of collecting scintillation data utilizing the *ATS-5* and an INTELSAT satellite.

2. Space research

2.1 The programmes of space research are carried out by the *Instituto de Pesquisas Espaciais* (INPE), Institute of Space Research, as the main executive agency, within the orientation of the *Comissão Brasileira de Atividades Espaciais* (COBAE), the Brazilian Commission for Space Activities.

2.2 Project " Mate "

Study of the geomagnetic field. Twelve magnetometers installed as follows: one each at Fortaleza-Ceará, São José dos Campos and Baurú (São Paulo): the other nine along a line running from São José dos Campos to Marajó Island. Work done in co-operation with United States laboratories and with the *Institut für Geophysik und Meteorologie der Technischen Universität Braunschweig*, Federal Republic of Germany.

2.3 Project " Miro "

Studies of absorption of cosmic noise by the upper atmosphere, using riometers and measurement of parameters of the neutral atmosphere between heights of 30 and 90 km using a Q-switching laser radar.

2.4 Project " Tela "

Study of precipitation of charged particles in the area of the South Atlantic geomagnetic anomaly. Construction of detectors and telemetry equipment for the payloads of stratospheric balloons used in this research. Eight launchings this year.

2.5 Project " Obra "

Study of atmospheric noise caused by electrical discharges which interfere with communications in the VLF and HF bands.

2.6 Project " Safo "

Research in the upper atmosphere with the help of rocket-borne payloads, in co-operation with foreign agencies and the Brazilian Ministry of Aeronautics.

2.7 Project " Rasa "

Measurement of ionospheric electron content through Faraday and Doppler effects, also scintillation measurements of signals emitted by satellites.

2.8 Project " Rada/Sol "

Observation of solar explosions and flares by continuous photography in the H-alpha region.

2.9 Project " Sonda "

Ionospheric sounding with variable frequency sounders for studies of HF propagation.

2.10 Project " Bema "

Study of propagation of VLF electromagnetic radiation, using both terrestrial stations and sounding rockets.

2.11 Project " Lume "

Observation and analysis of luminescence in the upper atmosphere.

Variations in the photo-chemical emission lines of main constituents of the upper atmosphere are correlated with variation of ion content of the several regions of the ionosphere. A new station installed on top of the Itatiaia Mountain in 1971 in a co-operative programme with the University of Texas, at Dallas.

2.12 Project " Exametnet "

Meteorological rocket sounding seeking latitudinal knowledge of the upper atmosphere. Collaborative activity involving American countries of the northern and southern hemispheres.

2.13 Project " Mesa "

Meteorological studies based on *APT* satellite pictures of cloud cover, both in the visible and in the infrared spectrum. During 1971, twenty receiving stations built to INPE specifications were delivered by Brazilian industry.

2.14 Project " Sere "

Survey of natural resources using remote sensors in the visible, infrared and microwave regions. This programme, initiated by INPE in 1967, has resulted in the availability of trained experts for the *Radam* project of the Brazilian Government. A United Nations panel meeting was held at INPE, in December 1971, for the assessment of and possibility of adoption of these techniques by other developing countries. Fifteen countries, from Africa, Asia and Latin America, attended the two-week panel.

2.15 Project " Saci "

Utilization of the systems approach to the possible use of a Brazilian geostationary satellite to improve the capabilities of the country's educational system.

Phase A—Equipment for experimental communication with Stanford University using the *ATS-3* satellite was installed in 1971 and is undergoing tests.

Phase B—Comprehensive educational experiment in north-eastern Brazil with intended use of United States National Aeronautics and Space Administration (NASA) *ATS-F* and *G* satellites for broadcast to 500 schools (estimated 20 000 pupils). In 1971, a pilot studio was installed, production personnel trained and instructional teams formed for lay teacher training lessons. By December, seventy lessons had been taped. Low-cost parabolic reflector antennae were tested, work on 2.5 GHz converters was undertaken so that specifications could be issued to private electronics industry.

Phase C—Feasibility study on a Brazilian synchronous educational satellite as a means of providing education anywhere in Brazil. This study is intended for submission to higher authorities as a basis for their decision.

2.16 Fortaleza tracking station

At Fortaleza (Ceará), INPE operates jointly with the French *Centre national d'études spatiales* (CNES) a tracking station for spacecraft launched from Kourou, French Guiana.

3. Radioastronomy

Radioastronomy programmes are carried out by the Centre of Radio Astronomy and Astrophysics, Mackenzie University (CRAAM), São Paulo

3.1 Solar activity at microwaves

During 1971, this Centre developed regular solar radio observations, with a polarimeter at λ 4.3 cm, at Itapetinga Radio Observatory, Atibaia, São Paulo. Regular data on flux and polarization of solar activity are available to the scientific community through specialized data bulletins.

Research in this field was directed in 1971 towards the behaviour of the slowly varying solar component, the evolution of polarization with time during solar bursts, the dependence of bursts, the dependence of burst polarization on the associated active centres in the sun, and related subjects.

3.2 The new radio telescope for millimetric wavelengths

A 13.7 m precision radio telescope for millimetric wavelengths has been installed at Itapetinga Radio Observatory. This system is unique in the southern hemisphere; it has a reflector surface showing a maximum gain at 110 GHz, and pointing accuracy of about 2 millidegrees. The system is enclosed in a modern radome, and has been ordered from and developed by the Electronic Space Structure Corporation (ESSCO), Massachusetts, United States.

First tests were performed in the autumn of 1971, but the calibration work will take several months more. Initial results have been very encouraging.

Plans for 1972 call for the construction of a 50-channel spectral analyzer, and improvements on data acquisition system.

After calibrations and alignment are completed, the first research work will concentrate on circular polarization measurements of the Sun and stronger supernova remnants, interstellar water vapour, lunar occultations, spectra of quasi-stellar sources, technological research on radome behaviour under different meteorological conditions, and microwave propagation through the troposphere. Co-operative plans are scheduled with the United States National Radio Astronomy Observatory and Haystack Observatory, for very long baseline interferometry, and measurements at millimetric wavelengths.

3.3 Solar-terrestrial physics

During 1971, research was concentrated on extensive studies of VLF propagation across the geomagnetic anomaly, on riometer measurements at 30 MHz, and preparation of a programme of barium releases by rocket, the latter in co-operation with the Brazilian Air Ministry.

One part of the VLF project has developed over many years in co-operation with the Institute for Exploratory Research, Deal, New Jersey, United States, within an international effort named INT-VLF. Two tracking receivers, controlled by a cesium frequency standard having a rubidium standard as a stand-by, are operated at Itapetinga Radio Observatory. The other part was developed in co-operation with the Brazilian Air Ministry, and consists of three more tracking stations controlled by a rubidium standard, two of which will be operated at various sites in Brazil during 1972-1973, constituting the MOB-VLF project and related researches.

Research was mostly oriented in 1971 towards interpretation of an Air Force Cambridge Research Laboratories' experiment on VLF sounding, influence of VLF propagation paths on SID's effects, anomalies in propagation produced by solar protons, by X-ray fluorescent moon radiation, by cosmic ray Forbush decreases, and theoretical D region physics.

CAMEROON (FEDERAL REPUBLIC OF)

During 1971, the Federal Republic of Cameroon pursued its overall and practical study of the installation of the communication-satellite earth station at Yaoundé. The site for the station was chosen and soundings were made. The construction contract was concluded with the French *Telespace* company, which has started setting up the building site. Telecommunication equipments and other sub-assemblies have been ordered.

It is planned to bring the earth station into service early in 1973. When this space centre is in operation, technical and scientific studies in the field of space radiocommunications can be commenced.

CANADA

1. International satellite communications

1.1 Introduction

The Canadian Overseas Telecommunication Corporation (COTC) is presently involved in a major programme involving the construction of a new satellite communication earth station as well as the conversion and expansion of an existing station originally constructed in 1969.

The new station will be located on the west coast of Canada at Lake Cowichan, British Columbia, and is designed to operate via INTELSAT satellites over the Pacific to Australia and the Far East, including Japan, the Philippines, Hong Kong, New Zealand and Singapore.

The existing station located on the east coast of Canada at Mill Village, Nova Scotia, is being modified for operation to the new transmission parameters of the *Intelsat-IV* satellite, and the basic equipment capability is also being expanded to cater for the ever-increasing growth of international traffic.

1.2 Description of west coast station

1.2.1 General

Construction of the new earth station at Lake Cowichan commenced in April 1971, and it is expected that the station will enter into service by mid-1972. The site is located on Vancouver Island and will be shared with a similar, but completely independent, earth station presently under construction by Telesat Canada, a corporation entrusted with the provision of a domestic satellite system for Canada.

1.2.2 Initial capability

The COTC station will incorporate an initial capability for the transmission of three frequency-modulated multi-destination carriers with frequency adjustability to any portion of the band 5925 to 6425 MHz. The reception capability will accommodate 10 frequency-modulated carriers within the band 3700 to 4200 MHz. The station will also include facilities for transmission and reception of one television and associated sound channels adaptable to both 625/50 and 525/60 line standards. Emphasis has been placed on an overall concept which will easily allow for an expansion of this initial capability at some point in the future without the requirement for a major service interruption.

1.3 Main technical characteristics

1.3.1 Antenna

A Cassegrainian antenna system will be employed using a shaped 30.5 m parabolic reflector mounted on a wheel and track assembly. Because of the severity of Canadian winters, and deleterious effects of snow and ice on transmission, a unique antenna de-icing system will be employed. The system incorporates the use of heating elements mounted within neoprene blankets attached to the rear surface of the antenna panels and requires a peak power consumption of 500 kW. The station standby power system has therefore been designed to accommodate both the normal station load as well as the de-icing system power requirement.

1.3.2 Tracking system

The wheel and track antenna structure has a capability for continuous auto-track over the complete range of azimuth and elevation angles. Position control is derived from azimuth and elevation difference and sum signals originating from a unique integrated multi-mode feed system which will accommodate, in future, spectrum use in the transmit and receive band using polarization discrimination. The tracking signals are processed by a monopulse tracking receiver system which includes switchover facilities to a standby receiver. The monopulse receiver output interfaces with an updated static drive system. As a back-up to the auto-track system, a manual system also interfaces with the static drive and by use of a precise encoder system and position print-out information it is possible to afford precise manual operation.

1.3.3 Transmitters

A total of three transmitter chains are provided, one of which will act as standby for the other two. Each transmitter chain comprises a broadband linear modulator, double-frequency up-converter arrangement and a 3 kW air-cooled klystron of 50 MHz bandwidth. Because of the stringent level stability requirements of the satellite system, a closed loop output regulator system will be used for each transmitter. The modulators will be located in the control building and interconnected to the up-converters located in the elevated equipment room of the antenna tower by coaxial cable. The baseband feed to the modulator includes provision of energy dispersal insertion for reduction of intermodulation in the satellite by energy spreading, and to ensure that the satellite power-flux density will not exceed the limits prescribed in the ITU Regulations. In addition, to prevent over-deviation into adjacent channel allocations, a baseband overload circuit will detect excess input power and introduce attenuation as required to prevent over-deviation.

1.3.4 Receivers

The front and low noise receiver system will consist of two switchable parametric amplifiers with noise temperature of approximately 15 K. The pump generator of the amplifiers utilizes solid state design. The amplifiers will be interconnected from the antenna tower to the control building by waveguide and thence to a waveguide splitter system which will allow for branching to the individual double frequency down-converters. The down-converters will be followed by IF amplifiers, pre-detection IF filters and threshold extension demodulators designed to accommodate the range of carrier to noise temperature ratios of the *Intelsat-IV* system. The double down-conversion system provides the utmost in frequency agility since a change in frequency can be accomplished by change of local oscillator crystal only, and there is no requirement for RF filter tuning.

The receiver equipment described in the foregoing is of 100% solid state design. A standby receiver will provide automatic back-up facilities for failure of either the telephony or television receiver.

1.3.5 Monitoring facilities and display and test

A computerized system has been provided for monitoring performance parameters on a continuously sampled basis. Under normal operating conditions, the system will produce print-outs approximately once an hour; however, this interval can be manually changed to any period of time desired. When the measured value of any parameter exceeds the specified range of normal operation, an alarm identification and associated print-out will be provided indicating the source of the deviation. A total of 60 functions will initially be monitored including such parameters as receiver out-of-band noise, receive-carrier level, e.i.r.p., tracking errors, environmental parameters, etc.

All switching, control and status indications of the complete transmit and receive chains will be monitored at a centralized console area.

To facilitate line-up and trouble-shooting, built-in test loops have been provided incorporating frequency translating converters which will allow for transmit/receive test loops at baseband, IF and RF frequency.

1.3.6 Power system

A 23 kV, 3-phase transmission line provided by the local hydro authorities feeds both the COTC and Telesat stations. At the COTC station, the voltage is converted to 600 V via two separate 23 kV/600 V 500 kVA transformers. One transformer feeds a bus system restricted to communication functions and the second transformer feeds a bus used primarily for housekeeping functions. Both bus networks are interconnected by a normally open line switch that can be activated in the event of failure of one of the transformers. The communication bus feeds a rotary-inverter system equipped with batteries, which will provide a no-break facility for a 20 min power interruption. To cater for longer time breaks, a 500 kVA diesel generator system has been provided. The power distribution system has been so arranged as to allow also for use of the diesel generator for application of de-icing power to the antenna without disruption to the other loads during periods of normal commercial power service. The complete system has been equipped with the utmost in protective devices including ground fault detection, reverse power, reverse current and over-current relaying. All relaying functions feed a centralized master enunciation panel located in the main control building.

1.4 Mill Village station

The Canadian Overseas Telecommunication Corporation is currently undertaking a major modification and expansion programme at its east coast satellite communication earth station at Mill Village, Nova Scotia. Mill Village is located approximately 130 km south-west of Halifax along the coast of Nova Scotia.

The modification programme was required primarily to accommodate the new transmission parameters of the *Intelsat-IV* satellites, as well as to provide for an increased capability as required for the steady growth of trans-Atlantic traffic.

Because the *Intelsat-IV* system will provide for increased satellite system carrier levels by use of spot beam antennæ, it was calculated that the Mill Village low-noise receiver system would be driven beyond the linearity requirements of the overall system. As a result, it was found necessary to replace the tunnel diode amplifiers following the parametric amplifiers by high level, transistorized 4 GHz amplifiers. The original transmitter system included a klystron high-power amplifier for telephony carrier transmission, a similar amplifier for television and sound transmission, a high-power 8 kW TWT acting in standby for both. In order to accommodate an increase in requirements, the system has been converted to a three 8 kW TWT configuration thus allowing for the transmission of up to five telephony carriers as well as a television and sound channel.

As for the case of the new Lake Cowichan earth station, the receive system low-noise amplifier located in the antenna upper equipment room, is interconnected by waveguide to a branching arrangement located in the control room. To cater for growth, a second waveguide branching network has been added, thus effectively doubling the receiver system capability in terms of possibility of down-converter and demodulator expansion without the requirement for service interruption.

The original threshold extension demodulators which were optimized for operation with the low carrier-to-noise temperature ratios of the *Intelsat-II* system, have been modified to accept the relatively high carrier-to-noise temperature ratios associated with the *Intelsat-IV* system.

New demodulators and down-converters have also been added so that the initial capability will include reception of 14 frequency modulated telephony carriers as well as reception of one television and associated sound channel. A standby system has been provided which will allow for automatic switch-over to redundant receivers, one associated with each of the major branching networks.

Because of the decreased spacing of carrier allocations in the *Intelsat-IV* system, a development programme was initiated with Canadian industry for the provision of receiver system IF filters to meet the new stringent system requirements for bandwidth, amplitude response and group delay. The new filters have exceeded expectations, and each chain will be individually equipped with these filters designed to the individual capacity requirement. The standby receiver switching network will allow for instantaneous selection of appropriate filters upon switch-over.

In addition to the above, the Corporation is planning to participate with INTELSAT with the introduction of a demand-assigned carrier service, and a Spade system, PCM/PSK terminal will be installed in June 1972. This equipment will allow for the transmission of up to 60 single channel RF carriers, on a demand-assigned basis and will provide increased flexibility for light route communications to other earth stations, similarly equipped.

2. Domestic satellite communications

2.1 Introduction

Significant progress has been made by Telesat-Canada during 1971 towards the scheduled start of commercial operations for the Canadian domestic satellite system in January 1973. Since the major characteristics of the satellite were described in the Tenth Report, emphasis is placed this year on information relating to the associated earth stations.

2.2 Space segment

The satellite programme is proceeding satisfactorily and qualification testing of the complete spacecraft is being undertaken, following successful completion of unit and shelf assembly qualification tests. Integration of the first flight model equipment shelf with the spacecraft structure is expected to take place early in 1972. A contract with NASA for the launch of the satellite using a *Delta 1913* launch vehicle was signed in May 1971 and arrangements have been made with Hughes Aircraft Company for provision of a transportable station which will be located on an island in the Pacific Ocean. This will be used in conjunction with the tracking, telemetry and command station at Allan Park during the transfer orbit phase.

Work on the satellite control centre in Ottawa is well in hand and a contract to provide computer equipment has been awarded. Delivery and installation of computer units to the satellite control centre has been completed and deliveries of units for the tracking, telemetry and command stations are expected to be completed early in 1972. Development work on the programmes for transfer and synchronous orbit operations are well advanced and exercising of some programmes is being undertaken.

2.3 Earth segment

Bids were received in January 1971 for the construction of the earth stations required to establish the initial communication systems. By mid-1971 contracts had been signed with Canadian companies for the supply of 35 stations comprising five categories as follows:

— tracking, telemetry and control	1
— heavy route	2
— network television	6
— northern telecommunications	2
— remote television	24

The characteristics of the earth stations and their locations are outlined in table I and figure I respectively.

2.3.1 *Heavy route stations*

The heavy route stations are located at Lake Cowichan near Vancouver and at Allan Park, approximately 130 km from Toronto, where the site is shared with the tracking, telemetry and command installation. Both heavy route stations are equipped for message service and the transmission and reception of television programmes. They employ full steerable 30 m diameter wheel- and track-antennae which may be operated either in a step track or manual tracking mode.

2.3.2 *Tracking, telemetry and command*

The tracking, telemetry and command station employs an 11 m diameter antenna with a fully tracking mount which may be operated either in auto-track, programmed or manual tracking modes. It provides azimuth, elevation and range information to the satellite control computer located in Ottawa in addition to monitoring telemetry signals from, and transmitting commands to, the satellite. Provision has also been made to duplicate the telemetry and command functions of the tracking, telemetry and command station through the main communications antenna of the Allan Park heavy route station.

2.3.3 Network television

There is a total of six network television stations situated at widely separated locations across the country as shown on figure 1. These stations will be used initially for the transmission and reception of television and are equipped with antennae of 10.2 m diameter having limited steerability by means of remote manual control from within the station. Provision has been made for the addition of tracking facilities if these should be required at a later date. Possible courses of action have also been studied for the installation of message facilities at the Harrietsfield network television station in order to satisfy the traffic requirement between the east coast and Toronto which will result from the completion of the *Cantat-II* trans-Atlantic cable in 1974.

2.3.4 Remote television

The remote television stations provide television reception for 24 locations in various parts of Canada. The stations employ 7.9 m manually steerable antennae installed on a wide triangular foundation which permits locating the building directly under the rear of the dish, thus minimizing the length of the waveguide interconnection. The building is of a prefabricated fibreglass and plastic foam structure and the electronics and associated ancillary equipment are factory-installed before the building is shipped to site. In all cases where required, special precautions have been taken during preparation of the foundations to prevent thawing of the permafrost (permanently frozen terrain condition common in northern latitudes) due to loss of heat through the floor of the building.

2.3.5 Northern telecommunications

The two northern telecommunications stations located at Frobisher Bay, Baffin Island and Resolute Bay, Cornwallis Island, in the Canadian Arctic, have the same antenna facilities as the network television stations. Resolute Bay is equipped with message facilities only and communicates solely with Frobisher Bay. Frobisher Bay has both message and television receive facilities and, in addition to communicating with Resolute Bay, has a direct connection to Allan Park.

2.3.6 Thin route stations

In Canada, there are a considerable number of very small isolated communities which have virtually no communications with the community at large. The concept of the thin route station providing one to six voice circuits on individual carriers has been evolved to meet such communication requirements. Progress has been made in defining the system design and determining the optimum methods of modulation and access to the satellite for a thin route network. Two such stations are projected for service in January 1973 with a follow-on programme of 15 stations in the period 1975-1976.

2.3.7 Maintenance

The widely dispersed nature of the Canadian domestic satellite earth station network combined with inhospitable terrain and severe climatic conditions create very difficult maintenance problems. These are currently being closely studied to provide definition of overall logistic and operational requirements prior to the preparation of detailed operating procedures. The present plan is that all earth stations, except heavy route, will be unmanned and that personnel from the local community will perform simple maintenance and control functions on a routine or "as required" basis. For major maintenance, or equipment breakdown, the services of travelling maintenance crews will be available. Field repair will normally consist of restoration of service by the replacement of defective units which will then be returned to a central depot for repair and overhaul.

3. Communications technology satellite project

3.1 Introduction

The communications technology satellite (CTS) project is a joint Canada—United States programme to investigate the technology associated with high-powered communications satellites. This programme includes the launch in early 1975 of an experimental geostationary satellite with an e.i.r.p. considerably in excess of that currently available for operational satellite communications systems.

The Canadian Department of Communications will manage the project to develop the spacecraft, provide a spacecraft assembly and test facility and provide research and development support. The satellite will be built in Canada and Canadian manufacturers will design and fabricate the spacecraft sub-systems.

NASA will supply a *Thor-Delta* launch vehicle and will develop and procure a travelling wave tube (TWT) to be flown on *CTS*. This TWT will be a prototype for even higher power tubes intended for future space applications. NASA will also provide access to advanced electronic component technology and spacecraft environmental test facilities.

The principal Canadian objectives of this programme are:

a) to augment the capability of the Canadian aerospace industry, particularly in areas relating to higher-power satellites and their associated ground stations;

b) to conduct communications experiments employing high power satellites and small, low-cost ground terminals.

3.2 Major characteristics of the satellite

The *CTS* will be placed in the geostationary satellite orbit and its position will be maintained within 0.2° in both the east-west and north-south directions. It will be three-axis stabilized and its attitude with respect to the earth will be maintained to an accuracy of 0.1° in pitch and roll and 1.0° in yaw.

The satellite will receive at 14 GHz and transmit at 12 GHz; the transponder bandwidth will be approximately 85 MHz.

A 200 W TWT with an operating efficiency of 50% or better at saturation will be employed in the transponder.

The maximum e.i.r.p. of the satellite will be 59 dBW at 12 GHz.

Two SHF antennae each of 2.5° beamwidth will be used; these will be steerable on command from the ground to illuminate discrete areas of the earth's surface.

The solar power sub-system will include two extendable solar sails, each 6 m long and 1.3 m wide. The available power at beginning of life will be 1100 W.

3.3 Advanced technology and communications experiments

A number of advanced technology experiments are planned for the spacecraft. One of these is an experiment designed to evaluate liquid gallium as a power transfer medium. A second consists of a 1.78 mN thrust ion engine to be used for station-keeping. An experiment that uses an interferometer for yaw-sensing is also under consideration.

Canadian communications experiments currently planned include television broadcasting to community receive terminals, two-way voice for applications to telephony or which may be used in conjunction

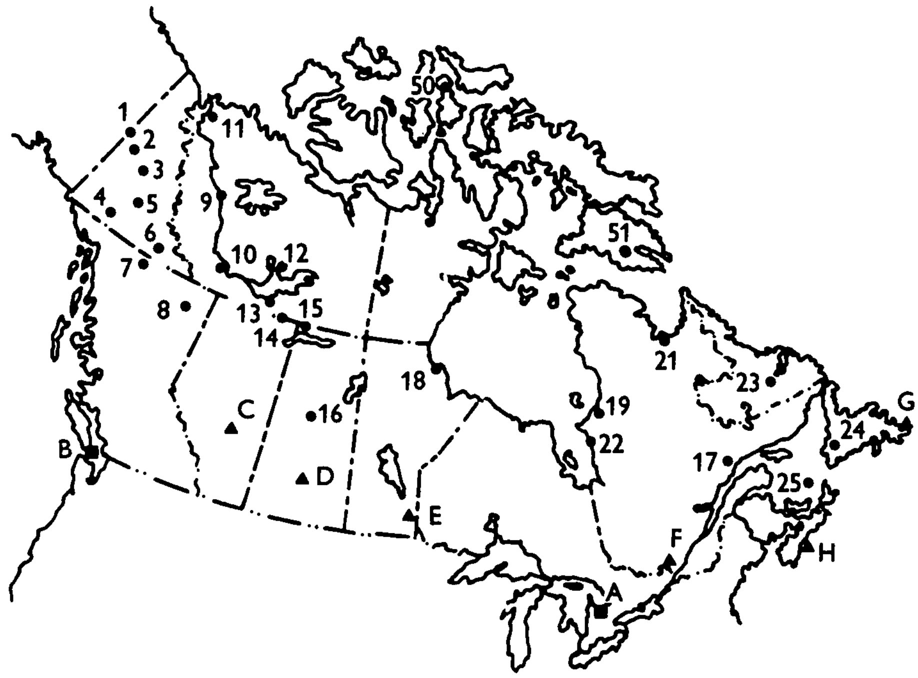


Figure 1 — Initial Telesat earth station locations

Heavy route

A. Allan Park
B. Lake Cowichan

Network television

C. Huggett
D. Qu'appelle
E. Grand Beach
F. Rivière Rouge
G. Bay Bulls
H. Harrietsfield

Northern telecommunications

50. Resolute
51. Frobisher Bay

Remote television

1. Clinton Creek
2. Dawson
3. Elsa
4. Whitehorse
5. Faro
6. Watson Lake
7. Cassiar
8. Fort Nelson
9. Norman Wells
10. Fort Simpson
11. Inuvik
12. Yellowknife
13. Pine Point
14. Fort Smith
15. Uranium City
16. La Ronge
17. Sept Iles
18. Churchill
19. Great Whale
21. Fort Chimo
22. Fort George
23. Goose Bay
24. Port-au-Port
25. Magdalen Islands

Table I

Details of initial Telesat system

	tracking, telemetry and control station	heavy route stations	network television stations	northern telecommunication stations	remote television stations
— number of stations	1	2	6	2	24
— location	Allan Park (Ontario)	Allan Park (Ontario) Lake Cowichan (British Colombia)	Bay Bulls (Newfoundland) Harrietsfield (Nova Scotia) Rivière Rouge (Quebec) Grand Beach (Manitoba) Qu'Appelle (Saskatchewan) Huggett (Alberta)	Frobisher Bay (North-West Territories) Resolute (North-West Territories)	see map
— function	tracking and ranging, telemetry, monitor, command	message; television transmit and receive [1]	television transmit and receive	all: message Frobisher: television receive	television receive

	tracking, telemetry and control station	heavy route stations	network television stations	northern telecommunication stations	remote television stations
— antenna	11 m diameter AZ-EL; auto-track or manual control	30 m diameter; wheel and track: step track or manual control	10.2 m diameter; limited steerability; manual control	same as network television stations	7.9 m diameter; limited steerability: manually adjusted
— station G/T	28 dB	37 dB	28 dB	28 dB	26 dB
— message performance	—	5625 pWpO	—	5625 pWpO Frobisher 25 000 pWpO Resolute	—
— television performance					
— video S/N	—	54 dB	54 dB	50 dB	50 dB

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— audio S/N	—	56 dB	56 dB	53 dB	53 dB
— power amplifier	3 kW klystron	message and television: 1.5 kW klystron	1.5 kW klystron	1.5 kW klystron	—
— low-noise amplifier	uncooled paramp	uncooled paramp	uncooled paramp	uncooled paramp	uncooled paramp
— standby power	supplied from heavy route station	standby diesel generator: — Allan Park: 375 kVA — Lake Cowichan: 275 kVA; — battery reserve: 15 min	standby diesel generator: 56 kVA; — battery reserve: — 2 h: Rivière Rouge; — 4 h: all others	standby diesel generator: — Frobisher 56 kVA — Resolute 2×75 kVA — battery reserve: 4 h	battery reserve: 8 h

[1] At Allan Park, the heavy route station has provision for tracking and ranging, telemetry monitoring, command and satellite e.i.r.p. monitoring. At Lake Cowichan, provision is made for the transmission of ranging signals on a separate, low-power, narrow-band carrier.

with television experiments to provide a request or interactive voice channel, the relay of television signals from a remote transportable terminal to a central receive terminal.

4. Operations, research and development

4.1 Meteorological satellite operations

The Atmospheric Environment Service of the Canadian Department of the Environment continues to receive data acquired directly from United States meteorological satellites. While this data is employed daily for meteorological purposes, it is also distributed to government, universities and other agencies for research relating to surface and environmental conditions. The Institute of Aerospace Studies of the University of Toronto utilizes the real-time satellite signals for studies relating to the development of a laser beam image recorder for the earth resources satellite programme.

Good quality transmissions are being received from the *Tos* operational spacecraft *Essa-8* and from *ATS-1* and *ATS-3*. Data was also acquired, up until midsummer, from *I-Tos-1* and *Noaa-1*. New earth stations being installed at Halifax and Vancouver for reception of APT type data are expected to be operative by late spring 1972. The data received by these two stations will be transmitted in real-time or near real-time to all major forecast centres.

4.2 Earth exploration programme

A co-operative experimental programme between the Canadian Department of Energy, Mines and Resources (EMR) and NASA is being undertaken to study the application of earth exploration satellites for the detection of environmental conditions at and near the earth's surface.

The specific objectives of this joint programme are as follows:

a) to assess the practical value of sensing features on the surface of the earth from space;

b) to compare the data acquisition capabilities of aircraft and spacecraft;

c) to determine which remote sensors are most effective for surveying the earth's surface;

d) to improve procedures for handling and processing data; and

e) to determine the requirement for an operational space-assisted system for surveying earth resources.

In order to achieve the above objectives, a Canadian centre for remote sensing has been established under the responsibility of EMR. Facilities for the handling of ground data and data retransmission are being set up. An installation located at Prince Albert, Saskatchewan, formerly used for auroral studies, has been converted to serve as the main Canadian satellite earth station receiving centre. This installation will utilize a 25.5 m diameter paraboloid which has been modified to operate at 2 GHz and has been equipped with autotrack. It is anticipated that the experimental satellite programme will commence with the launch by NASA of the earth resources technology satellite *Erts-A*, scheduled for spring 1972.

4.3 Aeronautical satellite studies

A co-operative programme undertaken by the Ministry of Transport and the Department of Communications in which satellite beacon signals were monitored at frequencies of 250 and 1550 MHz was continued in 1971. The signals are received at Ottawa (invariant geomagnetic latitude: 57°) and at Churchill, Manitoba (invariant geomagnetic latitude: 69°). This programme is providing an extensive set of ionospheric fading statistics.

Investigations of the effects of multipath on the channel characteristics of a low-angle aeronautical satellite system have been carried out using a spread spectrum signal technique. A bi-phase modulated

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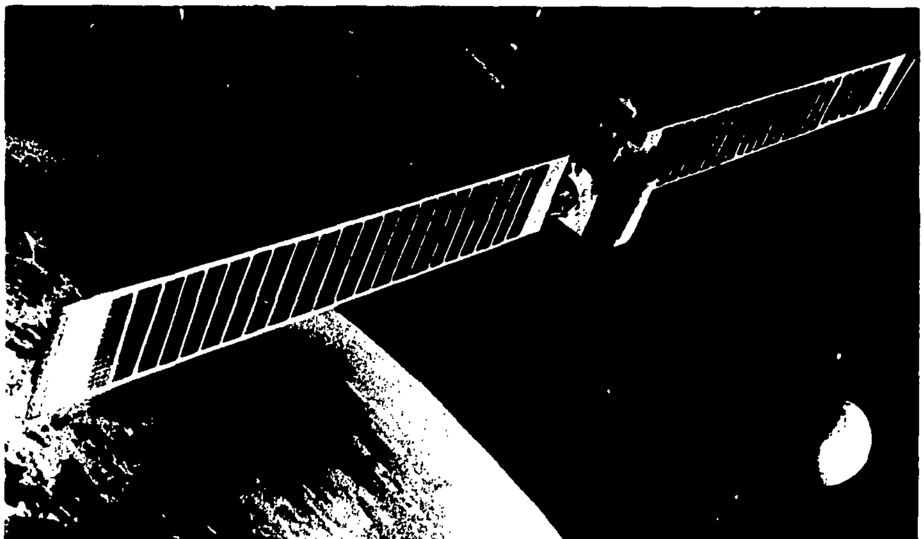
signal was transmitted through the *ATS-5* satellite and was received in an aircraft flying over the North Atlantic Ocean off the Newfoundland coast. These measurements have yielded information on time and frequency spreading characteristics of ocean-reflected signals.

The Ministry of Transport is supporting a development programme with the Communications Research Centre (CRC) to study the feasibility of an array type of antenna for use on aircraft in an aeronautical satellite system, and a prototype array has been built for testing purposes.

4.4 Low capacity communications to remote areas

A study of satellite systems for communications to small and simple ground stations serving small isolated communities and temporary installations has continued at the Communications Research Centre. Models of systems to meet Canadian traffic requirements have been devised and evaluated. Laboratory work has been carried out on various methods of speech signal processing for single-channel-per-carrier analogue FM systems. Subjective tests have confirmed improvements which can be obtained by companding and pre-emphasis of the speech signal. Work has continued on the design and laboratory implementation of a centrally-controlled system for assigning channels on demand to intermittent users to permit the sharing of satellite transponder capacity among many stations. A study has also been made of the use of a communications satellite, primarily intended for voice communications between small terminals, for the relay of data from remote unattended environmental sensing stations, such as weather stations.



Artist's conception of communications technology satellite (CTS) to be launched in 1975
(Canadian Department of Commerce)

4.5 UHF propagation studies

The Communications Research Centre has continued its investigations of the performance of satellite systems operating at frequencies near 300 MHz. This project has been active since 1967 and previous work has included measurements of ionospheric fading, time dispersion, and frequency selective fading during various ionospheric conditions, including visual aurora. Data on the behaviour of these parameters at UHF have been obtained at various Canadian locations, including Ottawa, Churchill, and Resolute Bay.

During 1971, these propagation measurements were continued. At Ottawa, nearly continuous measurements of signal fading at 250 MHz were carried out in order to establish accurate system margins. As well, simultaneous measurements of signal fading at 136, 250, and 1550 MHz were continued at both Ottawa and Churchill to obtain statistical data on the frequency dependence of signal fading amplitude. Some effort has also been directed at the measurement of sea surface and land surface multipath effects in the 300 MHz frequency range and preliminary measurements of noise levels at 300 MHz have been made in urban, suburban and rural areas.

4.6 SHF propagation studies

The Communications Research Centre also continued its programme of study of the effects of the earth's atmosphere on radiowave propagation at frequencies between about 4 and 30 GHz, particularly as these effects relate to the design of satellite communications systems.

4.6.1 Precipitation attenuation

During 1970 and 1971, the signal strength received at 15.3 GHz from the *ATS-5* satellite was measured using a 9 m antenna, providing a margin for attenuation measurements of approximately 14 dB.

The receiving antenna was also connected as a total-power radiometer, to obtain simultaneous measurements of the sky noise temperature at 15.3 GHz. Attenuations, calculated from the measured sky temperatures show very good agreement with the directly measured attenuations provided an effective medium temperature of approximately 0°C is assumed.

The spatial distribution of precipitation along the propagation path was also determined by means of an S band radar. The mean radar reflectivity at each range is used to calculate path attenuations. Generally good agreement is obtained between measured and calculated attenuations for most meteorological conditions. The effects on the calculated attenuation of radar returns from the bright band and snow aloft is under investigation.

To obtain long-term rain attenuation statistics for the calculation of margins for satellite communications systems operating at SHF, it is planned to set up radiometers at several locations across Canada characteristic of various climatic regions. It is hoped to continue these measurements continuously over a period of several years.

4.6.2 16 GHz long-range transhorizon propagation experiment

CRC continued its co-operative programme to study transhorizon propagation at a frequency of 16 GHz over a 500 km path between Boston, Massachusetts and Ottawa, Ontario. The main purpose of the experiment has been to utilize the intersection of the narrow beam antennae (approximately 0.15°) as a means for remote probing of the troposphere. However, data relevant to the problem of interference between satellite and terrestrial systems sharing the same frequencies can also be obtained from the link, and a suitable experiment has been proposed.

In the remote probing experiment, the two antennae are synchronously scanned so that the beam intersection follows a predicted path, rapidly mapping out a large volume of space. Amplitude and Doppler frequency measurements provide information on the location and motion of turbulent layers.

4.6.3 Low-angle tropospheric scintillation

When SHF signals are propagated through the troposphere, fluctuations in amplitude are caused by inhomogeneities in the refractive structure of the medium. The amplitude of the fluctuations depends on the path length in the troposphere, and hence the elevation angle of a satellite communications circuit.

Since fading statistics are important in system design, particularly in the case of satellite systems operating at high latitudes, a continuing series of measurements of low-angle fluctuations is being carried out at CRC. Receiver facilities include a fixed 9 m antenna and a transportable 1.8 m antenna. To date, fading statistics have been obtained for more than 1200 hours of observations. Although most of the data has been collected at Ottawa, limited measurements indicate that the fading amplitudes are smaller in the Arctic. The seasonal dependence is such that the fading is significantly less in winter than in summer. Investigations of the spatial coherence of the fading suggest that terminal separations in excess of about 300 m will be required if space diversity systems are to be used to overcome the fading. At the present time, experiments are being conducted at 4 and 7 GHz in an attempt to determine the frequency dependence of the fading. At a frequency of 7 GHz, fades of several decibels are typical for an elevation angle of five degrees during the summer months at Ottawa.

4.7 Upper atmosphere research

A comprehensive study of the topside ionosphere is being continued through observations made by the *Alouette-I*, *Alouette-II*, *Isis-I* and *Isis-II* satellites.

Alouette-I, launched in September 1962, now supplies about 30 minutes of ionospheric data daily.

Alouette-II, launched in November 1965, is operated from 3 to 4 hours a day.

Isis-I, launched in January 1969, is operated from about 5 to 7 hours a day.

The *Isis-II* spacecraft was launched on 31 March 1971 from the Western Test Range by NASA and is operated for about 8 hours a day. The equipment on *Isis-II* includes two optical experiments for observing aurora and airglow, as well as equipment (similar to that on *Isis-I*) which measured electron temperature and density, ion temperature, mass and number density, the spectra of soft and energetic particles, and radio emissions in the very low frequency to high frequency bands.

The intercomparison of *Isis-II* data is well under way. One brief study has confirmed the existence of the polar wind (an upward flow of protons) and has shown that the other observations (electron and ion density, composition and temperature) are consistent with the measured upward flow of protons. Also, both aurora and airglow have been observed by the optical equipments.

A study of *Isis-I* particle data has shown that the magnetospheric dayside cusp extends down to ionospheric heights and are revealed in *Isis* data by its characteristic energy spectrum.

4.8 Satellite antenna study

The National Research Council of Canada is carrying out a study in co-operation with the Communications Research Centre pertaining to antenna beam shaping and aperture synthesis. The study relates to the specialized coverage requirements of fixed satellites for single or multiple, fixed or steerable, beams of arbitrary shape. Closed form solutions have been obtained for the necessary aperture distributions on various apertures for arbitrarily specified far-field power patterns.

5. Reports from industry

5.1 Bell-Northern Research, Ottawa, is involved with several continuing space telecommunications programmes. Systems engineering studies are being pursued on questions relating to the integration of the Canadian terrestrial network and the satellite circuits that will be available upon expansion of the domestic satellite system in the years ahead. Particular emphasis is being placed on remote area communications, long-haul large capacity trunking, flexible restoral, overflow traffic handling and demand assignment. Bell-Northern Research are also investigating, on their own behalf, specific techniques including time-division multiple access for communications between major traffic centres and voice actuated carrier-single telephony channel per carrier techniques for remote areas.

Bell-Northern Research have developed a new microwave radio system to serve as back-hauls linking satellite earth stations to trunk routes or main population centres. This terrestrial system employs the latest semi-conductor technology and has been designed to operate in an area of the spectrum (6425-6590 MHz and 6770-6930 MHz) where co-ordination with space services is either not required or minimal.

5.2 As a result of a continuing development programme in earth station technology conducted by RCA Limited, Montreal, a "step-track" system has been designed which utilizes maxima seeking techniques as an alternative to the conventional auto-track system. This "step-track" system which has been adopted by Telesat for the heavy route earth stations situated at Allan Park and at Lake Cowichan (refer to section 2—Domestic satellite communications) achieves the required tracking accuracy under all environmental conditions and with significant reduction in equipment and hence improvement in reliability. Operating from one of the main communication signals, the system permits the use of a simplified servo-drive system and obviates the need for the difference mode circuitry of the feed, the tracking down-converter and the three-channel-tracking receiver.

RCA Limited have developed and tested a prototype television video-television sound multiplexer/demultiplexer that will permit two audio signals to be conveyed on one 8.5 MHz sub-carrier. In addition, the development of sum mode feed systems for 10 and 30 m antennae has been completed.

5.3 Northern Electric Company Limited, Montreal, was associated with Hughes Aircraft in the design and construction of the transponder for the *Intelsat-IV F4* satellite which was launched in January 1972. The manufacture of the electronics portions of the first flying model of the Canadian domestic satellite *Anik* is complete and test of the electronics platform was scheduled for January 1972.

CEYLON

Ceylon has taken a firm decision to establish a communications satellite earth station to operate with the Indian Ocean satellite.

Calls for tenders for this project are expected to be put out in the latter part of 1972 and the station should be in operation by September 1974.

The selection of a suitable consultant for this project is in hand.

CHINA

1. INTELSAT meetings

Two INTELSAT meetings of the Pacific and Indian Ocean regions operations representatives were held in Taipei from 24 February to 3 March 1971 with a total of 38 participants from 23 countries and territories. Important items discussed were: transition schedule for Pacific *Intelsat-IV;* restoration plan; and Spade system for Indian Ocean satellite communication.

2. International satellite communications

The Taipei earth station marked another successful operation in 1971 with an average reliability of 99.85%. By the end of 1971 54 satellite circuits were in operation.

The modification for operation with *Intelsat-IV* to be launched over the Pacific Ocean is expected to be completed in early 1972.

Preparation for building a second earth station for operation with the Indian Ocean satellite is well under way and the new station will be ready for service in the spring of 1973, as scheduled.

KOREA (REPUBLIC OF)

The Kumsan earth station was officially opened on 2 June 1970 and has been in successful operation linking directly the Seoul international exchange with Oakland, Hong Kong, Manila and Taipei.

Korea became a member of INTELSAT on 24 February 1967.

The average service reliability was 99.9% throughout the year and the overall international traffic for the Pacific region showed an increase of 150% when compared with that previously passed via high frequency radio.

By the end of 1971, 32 voice grade circuits via *Intelsat-III F4* were in commercial operation; 19 television programmes (2 transmission and 17 receiving) totalling 1934 minutes were handled via satellites during the year.

The Kumsan earth station consists of five sections under the station manager. The organization of the Kumsan earth station is as follows:

Station Manager

- 1st Operation Section
- 2nd Operation Section
- 3rd Operation Section
- Engineering Section
  antenna system, HPA, LNR, GMT, GCE, MUX, M/W, power and power back-up, special facilities
- General Affairs Section

Station description

Location: Kumsan
Choong Chung Nam Do, Korea

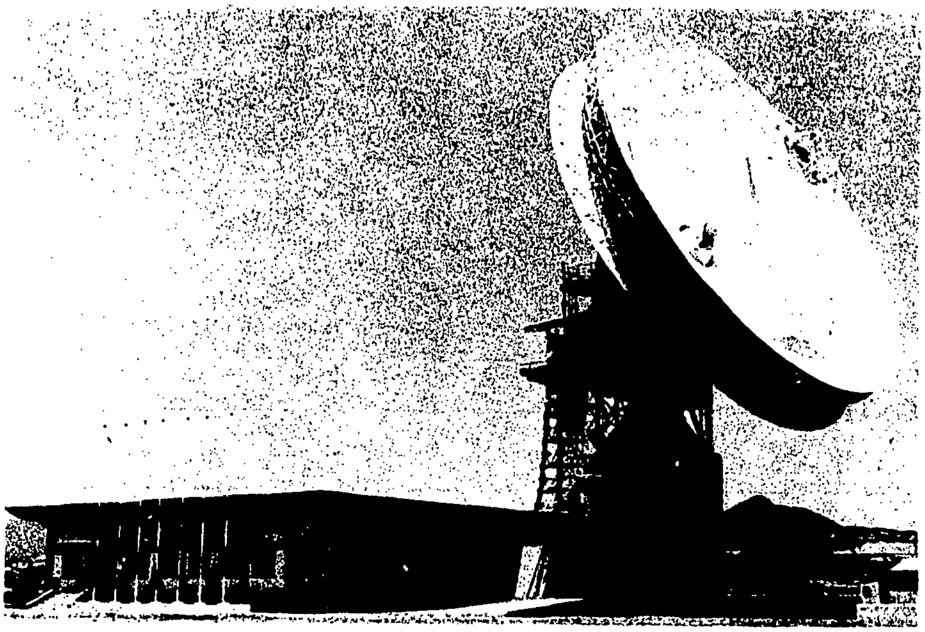
Antenna: No. 1

Antenna

- type:
  27 m Cassegrain
- sub-reflector support:
  quadruped
- mount:
  elevation over azimuth kingpost

Tracking system and feed

- prime mode:
  monopulse auto-track
- alternate:
  manual with looped-back carrier monitor
- feed system:
  five-horn monopulse



Kumsan earth station

(Ministry of Communications, Korea)

— tracking receiver:
single conversion beacon down-converter

Low-noise receiver

— type:
cryogenic four-stage parametric amplifier with an additional uncooled stage plus a tunnel diode amplifier in cascade
— cooling system:
two-stage helium refrigerator
— bandwidth:
500 MHz (1 dB)
— switching:
automatic with manual over-ride

High-power amplifier

— type:
travelling wave tubes
— bandwidth:
500 MHz
— power:
6.3 kW with NEC LD-793
— switching:
automatic with manual over-ride

GCE

— receiver type:
single conversion down-converters with phase-locked-loop threshold extension demodulators
— switching:
automatic with manual over-ride

Power

— prime:
commercial
— UPS:
electric motor driven by a commercial power source
— back-up:
diesel generator.

DENMARK, FINLAND, NORWAY AND SWEDEN

The Nordic earth station at Tanum

The Telecommunication Administrations of Denmark, Finland, Norway and Sweden have established jointly an earth station at Tanum on the west coast of Sweden. The station was brought into operation on 3 December 1971. In the first phase of operation the station will be connected to stations in the United States and Canada on pre-assigned circuits. In a later phase, the station will be connected to earth stations in South America, Africa, and the Middle East via the Spade system. The station is also fully equipped for transmission and reception of television programmes. The antenna system and the electronic equipment have been delivered by the Italian consortium, *Consorzio per Sistemi di Telecomunicazioni via Satelliti* from Milan. The buildings, power installation, and other technical equipment have been delivered by companies from the Nordic countries. The total cost for the station amounts to approximately 5 million US dollars.

In accordance with an agreement concluded between the Telecommunication Administrations of Denmark, Finland, Norway and Sweden, the station will be operated by the Swedish Administration. All important decisions concerning the earth station will be taken by a Board composed of representatives of the four above-mentioned Nordic Administrations. The operating personnel has been recruited from the Nordic countries concerned.

Tanum earth station (Sweden)

(Central Administration of Swedish Telecommunications)

Technical data for the station

Antenna

The antenna is a modified Cassegrain configuration with a diameter of 29.7 m.

The antenna, being situated in a country with very cold winters, has been supplied with a de-icing system, which will prevent any accumulation of snow or ice. The maximum heating power is 800 kW.

The measured antenna gain is 59.7 dB at 4.0 GHz and 63.3 dB at 6.0 GHz. The figure of merit (G/T) for the antenna is 41.6 dB at 4 GHz and 5° elevation.

The main reflector RMS surface error is 1 mm.

A special design feature for the antenna is that the mechanical bearings in the antenna rotating structure can be replaced in the unlikely but possible event of a bearing failure without the station being taken out of operation.

In the ground level equipment room of the antenna tower, the centre of the floor is attached to and rotates with the azimuth axis. This new " carousel " design provides space for mounting high-power transmitters and associated units which rotate with the antenna and thus eliminates the necessity for rotary joints in azimuth and reduces the length of waveguides. The fixed, or non-rotating, floor provides space for mounting additional equipment.

Receiving equipment

Cryogenically cooled parametric amplifiers are situated in an elevated equipment room, close to the antenna feed. Two cooled and two uncooled stages are used with a total gain of 40 dB.

A double conversion 750/70 MHz IF-system is used, followed by either threshold extension or conversional demodulators.

Transmitting equipment

The transmitting system is based on 1.2 kW TWT tubes which are arranged in a single-carrier-per-tube configuration. It consists of three operating transmitters: one for a telephony carrier, one for a television carrier and one for a Spade carrier. A fourth transmitter is used as a common standby for the other three. An advanced switching system gives a high degree of flexibility in the transmit system.

Power supply and continuity system

The power supply system is of the no-break type based on static inverters operating from battery supply. The batteries are charged either from the main power lines to the station or, in the case of line failure, from diesel generators at the station.

Radio link and coaxial cable system

The earth station is connected to the Swedish communication network via a radio-relay link from Tanum to Göteborg with separate links for telephony and television. A further back-up for the telephony circuits is provided by a coaxial cable connection from the earth station to Göteborg.

SPAIN

Introduction

The privileged geographical situation of Spain, between three continents, and the considerable increase in international traffic within the last five years, were at the origin of the decision to install a basic infrastructure geared to the dynamic objective of meeting short- and long-term international communication requirements.

The outcome of this decision are the multiple links—land and submarine cable, HF and microwave links and earth stations—which have provided Spain with

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direct connections to countries in all continents over the last five years.

Immediately perceiving the impact which space techniques would have on international communications, the *Compañia Telefónica Nacional de España* (CTNE) became a member of INTELSAT at the very outset. The first experimental work in this field was begun in 1963 with the mobile station at Griñón operating with non-synchronous satellites; four years later, the Maspalomas station was installed on Gran Canaria (Canary Islands); this station, equipped with two 12.6 m diameter antennae, inaugurated Spanish satellite communication traffic and extended the circuits of the NASA tracking station to the Space Flight Control Center in Houston through the INTELSAT satellites over the Atlantic.

In 1968, the Buitrago I station, located 80 km from Madrid, was brought into service and connected America to Spain with multi-destination operation; two years afterwards, the second antenna (Buitrago II) for traffic over the Indian Ocean was constructed.

The trend towards greater operational flexibility in space communication and the desire to incorporate the latest technical developments led to the inauguration in 1971 of the earth station at Agüimes (Canary Islands) and the extension and adaptation of Buitrago I for operation in accordance with *Intelsat-IV* standards.

Agüimes earth station

1. Objectives

The earth station at Agüimes was brought into service in April 1971 and is located 35 km from Las Palmas (Gran Canaria). It is intended to meet the following objectives:

■ *To supplement the Buitrago station*

In the event of a prolonged breakdown of Buitrago I (Atlantic) the new Agüimes station is capable of taking over the Buitrago I baseband and handling traffic via the Atlantic satellite.

In the event of a prolonged breakdown of Buitrago II (Indian Ocean), Buitrago I would handle Buitrago II traffic, changing over to the Indian Ocean satellite, and Agüimes would take over the Buitrago I baseband, handling the Atlantic traffic.

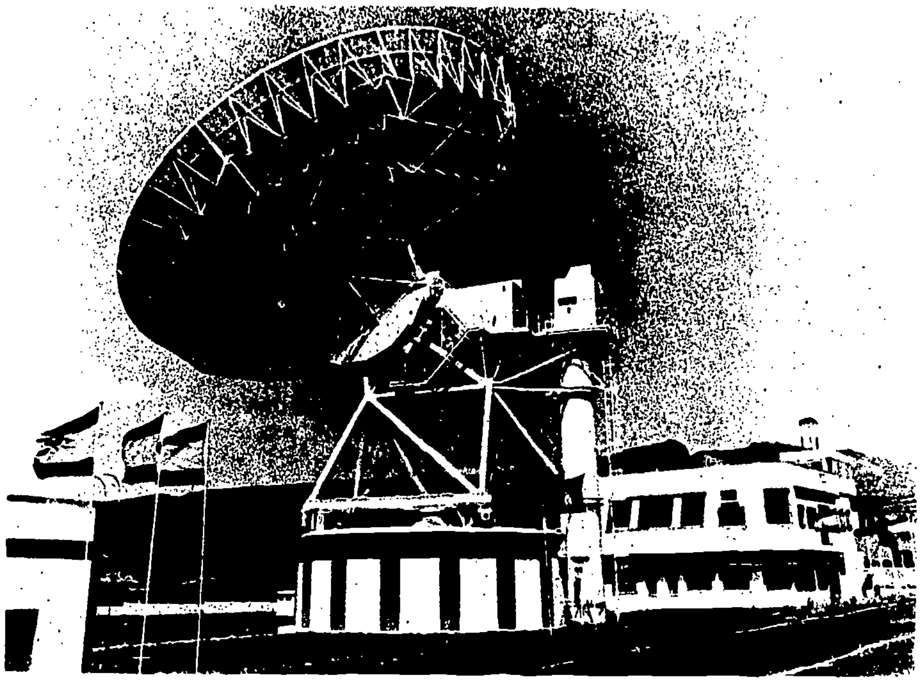
■ *For television transmission and as a carrier to the United States*

The inauguration of the Agüimes station established the first direct television transmission via satellite between the Canary Islands and the Spanish mainland. Since then there has been a daily exchange of news and educational programmes with reliable and high-quality service. CTNE's use of the space segment for television makes Spain the major user of the INTELSAT network for this type of transmission. By 31 December, 823 programmes had been exchanged between the Canaries and peninsular Spain, with a total duration of 503 h 20 min. As a permanent feature the Agüimes station transmits a carrier including NASA circuits to the United States, which was previously emitted by the now closed station of Maspalomas.

■ *As a cable back-up facility*

The strategic situation of the Canary Islands and the extensive and high-quality connections with the Spanish mainland through submarine cables *Pencan-I* (160 channels) and *Pencan-II* (1840 channels) make the Agüimes station a vital support element for the *TAT-5* cables (Spain—United States) and the proposed *Bracan* cable (Canary Islands—Brazil).

This possibility makes the Canary Islands a very attractive shore end point for future cables to Central America and West Africa.



Agüimes earth station. Antenna and building

(Dirección General de C y T, Spain)

2. Technical characteristics

2.1 Antenna

— diameter:
30 m

— gain, 4 GHz:
60.7 dB

— gain, 6 GHz:
63.3 dB

— type:
Cassegrain

— tracking system:
manual; automatic; programmed

— bandwidth:
500 MHz (1 dB)

— figure of merit (G/T):
higher than 40.7 dB/K for angle of operation

— parametric amplifier gain:
30 dB

— parametric amplifier noise temperature:
17 K

— demodulator capacity:
24-432 channels

— noise level:
8000 pWp

2.2 Reception

— range of frequencies:
3700-4200 MHz

2.3 Transmission

— range of frequencies:
5925-6425 MHz

- modulator input level:
  - message:
    —20 dBm per channel
  - vision:
    1 Vpp
- modulator output frequency:
  70 MHz
- power amplifiers:
  5
- klystron output power:
  3 kW (nominal)
- power stability:
  ±0.25 dB per day.

Extension and adaptation of Buitrago I for " Intelsat-IV " operation

1. Objectives

The need to increase satellite capacity to meet the growing demand for carriers from countries wishing to be integrated into the INTELSAT network has led to the design of a new satellite known as *Intelsat-IV*, with standards (defined in Document *ICSC-45-13E W/1/70*) which require earth station equipment to comply with stricter and stabler conditions for the more efficient use of satellite traffic capacity.

These standards, which will come into force around mid-January 1972 (phase 3 of *Intelsat-IV*), together with spot antenna transmission from the satellite, mean that earth stations must be adapted to this new space communication procedure.

In April 1971, CTNE signed a contract with a view to making the necessary extensions and adaptations of the Buitrago I station to *Intelsat-IV* and the work involved was successfully completed in September and October.

2. Characteristics

The units installed by ITT/SPC enable Buitrago I to transmit and receive the following carriers simultaneously through *Intelsat-IV* satellites:

a) monochrome or colour television carrier and associated carriers;

b) four message carriers (transmission)—with possible extension to eight;

c) Spade carrier;

d) 16 message carriers (reception).

The modifications to Buitrago I were so planned as to give a normal lifetime of 15 years and produce continuous reliability and ease of maintenance 24 hours per day.

UNITED STATES OF AMERICA

1. Satellite systems and services

1.1 Meteorological satellites

The second of the improved *Tiros* operational satellites *(Itos)* was launched late in 1970 and designated *Noaa-1*. *Noaa-1* and *Itos-1* provided world-wide stored picture data and direct read-out service via automatic picture transmission (APT) day and night—night-time data were obtained by the two channel scanning radiometer. *Essa-8* (APT) and *Essa-9* advanced vidicon camera system (AVCS)—the last satellites of the *Tos* series—continued to provide useful data throughout 1971. These two satellites sustained the operational system when failure in the *Itos* stabilization subsystem forced a temporary halt in the *Itos* service. About 500 APT stations were operated by some 60 countries to receive the APT service from the ESSA (Environmental Science Services Administration), *Itos* and NOAA (National Oceanic and Atmospheric Administration) satellites.

During 1971, the meteorological satellites provided global cloud cover observing services daily. All hurricanes and typhoons were tracked; bulletins were sent to appropriate National Weather Services giving storm position, size, and estimated strength.

ATS-I and *ATS-III*, launched in December 1966 and November 1967 respectively, continued to provide valuable data for research and operational experiments. The operational system evolving from these satellites, to be named the geostationary operational environmental satellite *(Goes)*, is now under development. The prototype is planned for launch late in 1972.

Time-lapse films from *ATS-I* and *ATS-III* pictures taken at 15 to 30 minute intervals, were used in near real time in the hurricane and severe local storms (thunderstorm and tornado) advisory services. Wind information derived from cloud motions were used daily as an input to the numerical weather prediction programme of the National Meteorological Center. Satellite pictures, picture mosaics, and specialized charts were transmitted through the *ATS-I* and *ATS-III* Wefax (weather facsimile operational experiment) systems to APT stations within range.

The satellite infrared spectrometer (SIRS) on *Nimbus-IV* provided useful data through most of 1971. Atmospheric soundings derived from the SIRS observations were used daily in the numerical weather analysis programme of the National Meteorological Center. These soundings were distributed throughout the world beginning in the latter half of 1971.

1.2 United States Government satellite communications system

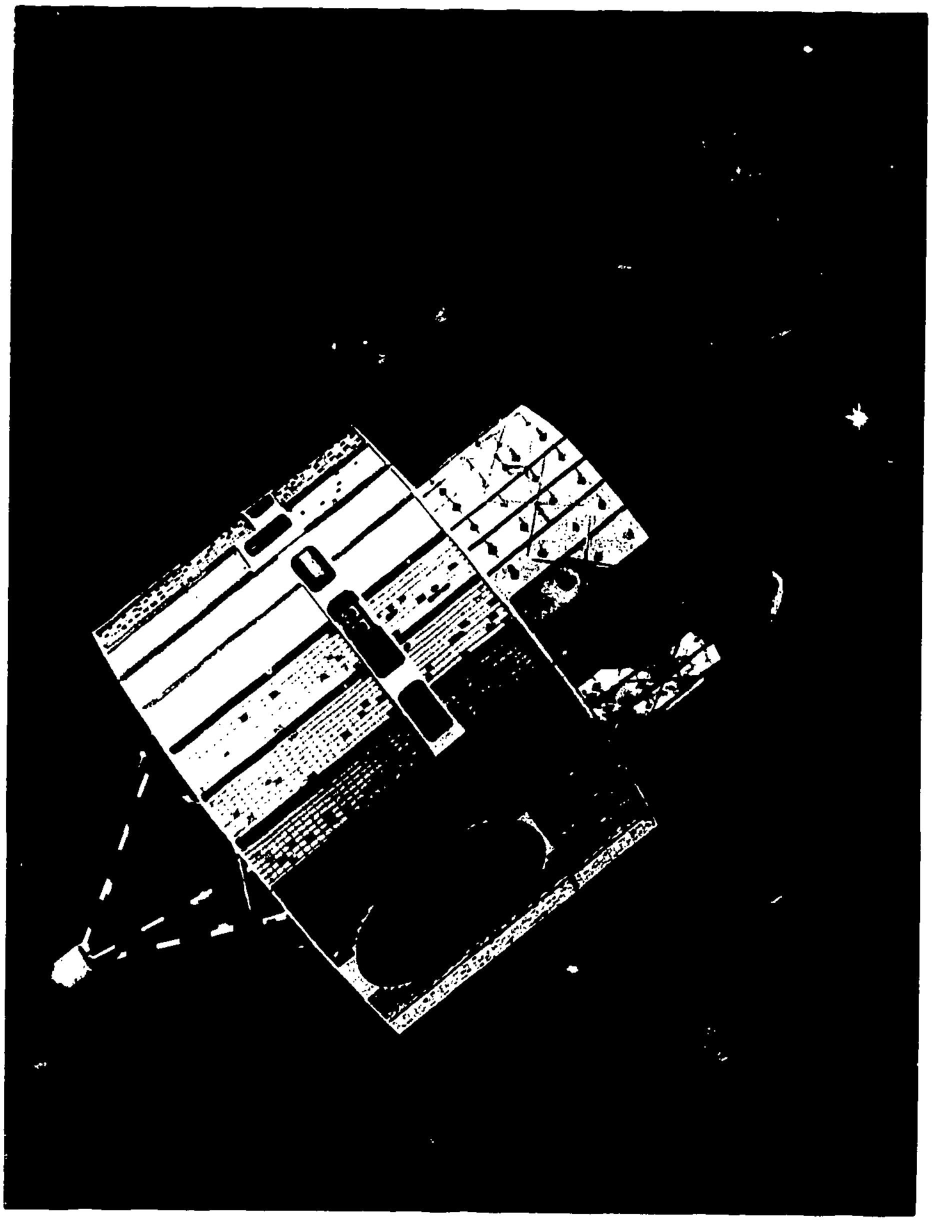
The first two synchronous, near-equatorial satellites of the second generation United States Government communications-satellite system were launched on 2 November 1971. These new satellites, which operate in the 7250-7750 and 7900-8400 MHz frequency bands, have wide-bandwidth, low-distortion communications repeaters to accommodate frequency division multiple-access and spread-spectrum multiple-access techniques for transmission of voice, digital data, and wide-band graphics. After the successful launch into orbit, some problems developed in the functioning of the satellites and efforts to resolve these problems were continuing in December 1971.

1.3 Commercial communication system

The Definitive Arrangements for INTELSAT were concluded on 21 May 1971 and were opened for signature on 20 August 1971, seven years to the date of entry into force of the Interim Agreement.

The first in the higher capacity *Intelsat-IV* series of satellites was successfully launched on 25 January 1971, by an *Atlas-Centaur* vehicle, the first use of these high-performance vehicles on INTELSAT missions. This satellite was positioned over the Atlantic Ocean area at 335.5° E and entered into service in March 1971. A second *Intelsat-IV* satellite was launched late in 1971. *Intelsat-IV* satellites are equipped with two spot beam antennae, which allow the satellite transmission to be much more concentrated over a limited geographic area. By careful pointing of these beams to high traffic catchment areas, higher capacity can be derived from the *Intelsat-IV* satellite. Each *Intelsat-IV* has global beam antennae for full coverage of the ocean basin area being served, a design life of seven years and a capacity of from 3000 to 9000 voice circuits, depending on such factors as the mix of traffic between spot and global beams and the size of the carriers.

During 1971, increases occurred in the telephony, record, and television traffic carried by the INTELSAT system. The number of full-time units (a unit is basically a two-way voice-grade link between an earth station and an *Intelsat* satellite) in service on 31 December 1970, was 4388.1; on 30 November 1971, it was 5352. The number of unit hours of temporary service for 1970 totalled 749 984; as of 30 November 1971, the number of unit hours of temporary service was 906 624.



" *SMS/Goes* " *satellite*

(Department of State, United States)

The number of television transmit hours for 1970 was 996; as of 30 November 1971, the number of television transmit hours was 1362.

Membership in INTELSAT increased from 77 at the end of 1970 to 82 as of 14 December 1971.

The number of earth stations accessing the INTELSAT system has also grown. As of 31 December 1970, there were 53 antennae at 45 earth stations in 31 countries. As of 14 December 1971, there were 63 antennae at 54 earth stations in 39 countries.

1.4 Amateur-satellite service

A new amateur satellite is being readied for launch in 1972. The prototype and flight units for the satellite, called *Amsat-Oscar B (A-O B)* are under construction by amateurs in Australia, Germany and the United States. The units under construction for the *A-O B* are a 24-channel Morse code telemetry system, a 432 to 144 MHz 10 W linear translator, a 144 to 28 MHz linear translator, a 144 to 435 MHz FM repeater, a 60-channel teletype telemetry encoder and a CODESTORE message storage device. The latter system, which can be loaded from ground stations, is designed to store emergency messages, operational information on the satellite and orbit information for repeated transmission to the ground over the satellite telemetry system. By using a combined power source of solar cells and battery, the satellite is expected to have a life span of over one year.

1.5 Mobile services

1.5.1 Aeronautical

Experimentation has continued to define the optimum system parameters and space radiocommunication techniques that will satisfy aeronautical communications and air traffic control surveillance requirements.

Experimental results from tests on the *ATS-5* satellite have confirmed theoretical estimates on absorption, scintillation propagation and airborne antenna design values. Failure in the satellite stabilization system and decreases in satellite transmitter power have hampered the collection of certain data.

1.5.2 Maritime

The World Administrative Radio Conference for Space Telecommunications allocated, on a world-wide basis, the band 406-406.1 MHz for the use and development of emergency position-indicating radio beacon (EPIRB) systems using space techniques. Following this, the United States initiated an experimental programme which is expected to provide data for the design of equipment needed to deploy an operational EPIRB system by 1976.

Studies and tests are continuing in an effort to analyze the potential for oceanic maritime communications by satellite at UHF (1535-1660 MHz) frequencies. One study has analyzed candidate tracking schemes and configurations for the postulated 10 dB ship antenna. Another study has reviewed critical sub-system design criteria for both the spacecraft and shipboard terminals. Further studies will be conducted in 1972.

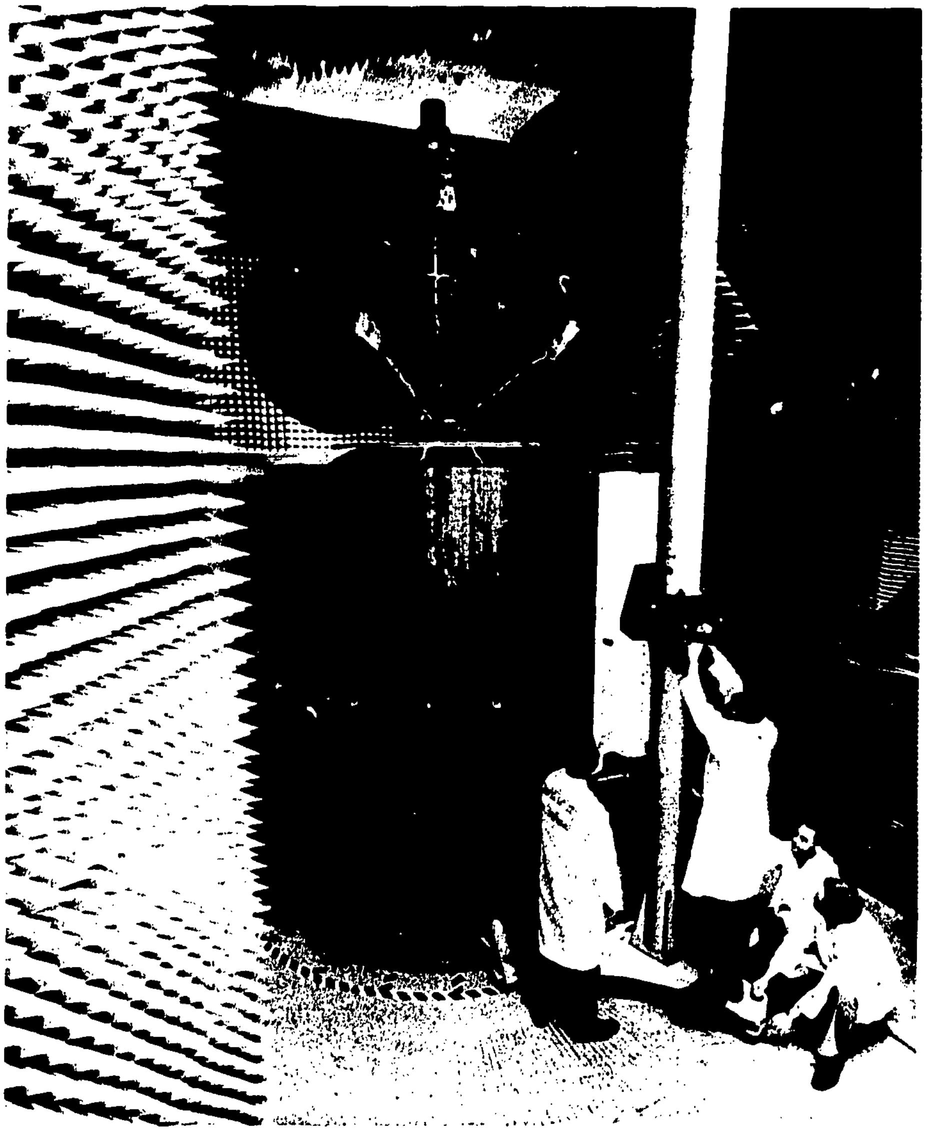
1.6 Radionavigation satellite system

The Doppler/range-rate radio navigation satellite system in the frequency bands 149.9-150.05 and 399.9-400.05 MHz, which has been operational since 1968, continues to provide navigational information in support of ship operations. Commercial equipment is available and use of the system is expanding for merchant shipping and off-shore drilling interests. Currently, there are five operational satellites in the system.

2. Research and development programmes

2.1 Applications technology satellites " ATS "

The *ATS* series of spacecraft continues to conduct experiments in meteorology, navigation, and communication satellite technologies.



Prior to launch from Cape Kennedy (Florida), COMSAT engineers extensively check the " Intel-sat-IV " spacecraft. Here COMSAT engineers check the wiring of the satellite's solar cells. These cells supply power to the satellite once it is placed in orbit

(Department of State, United States)

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The technology and experience gained in the *ATS* programme have contributed significantly to the NOAA planned operational synchronous meteorological satellite *(SMS)* system. This system may provide for the long-sought goal of two-week weather forecasts.

NASA's applications technology satellite programme is also helping to develop space technology to meet new communications requirements and is contributing to the development of techniques for air and sea navigation and air traffic control methods. Frequencies in the VHF, UHF, and SHF portions of the spectrum have been used.

2.2 Time dissemination experiments

Beginning on 1 August 1971, a time and frequency broadcast similar to *WWV* has been relayed through the applications technology satellite *ATS-3*. This satellite is geostationary, located at approximately 70° W longitude over the equator, and operates on a down-link frequency of 135.625 MHz. The broadcasts are frequency-modulated and occupy 30 kHz of bandwidth. These experimental broadcasts take place at 1700 to 1715 and 2330 to 2345 GMT Monday through Friday and are expected to continue until 1 August 1972.

Measurements are being made of the timing resolution, accuracy and reliability. Special aids for the computation of signal delays are being distributed to users. The aids include overlays of signal delay on an earth map updated monthly and a special purpose circular slide rule. Results to date have indicated the timing accuracy to be approximately 1 ms using the overlays and 25 μs using the slide rule computer. Timing resolution of 10 μs has also been experienced.

2.3 Earth resource satellites (earth exploration satellites)

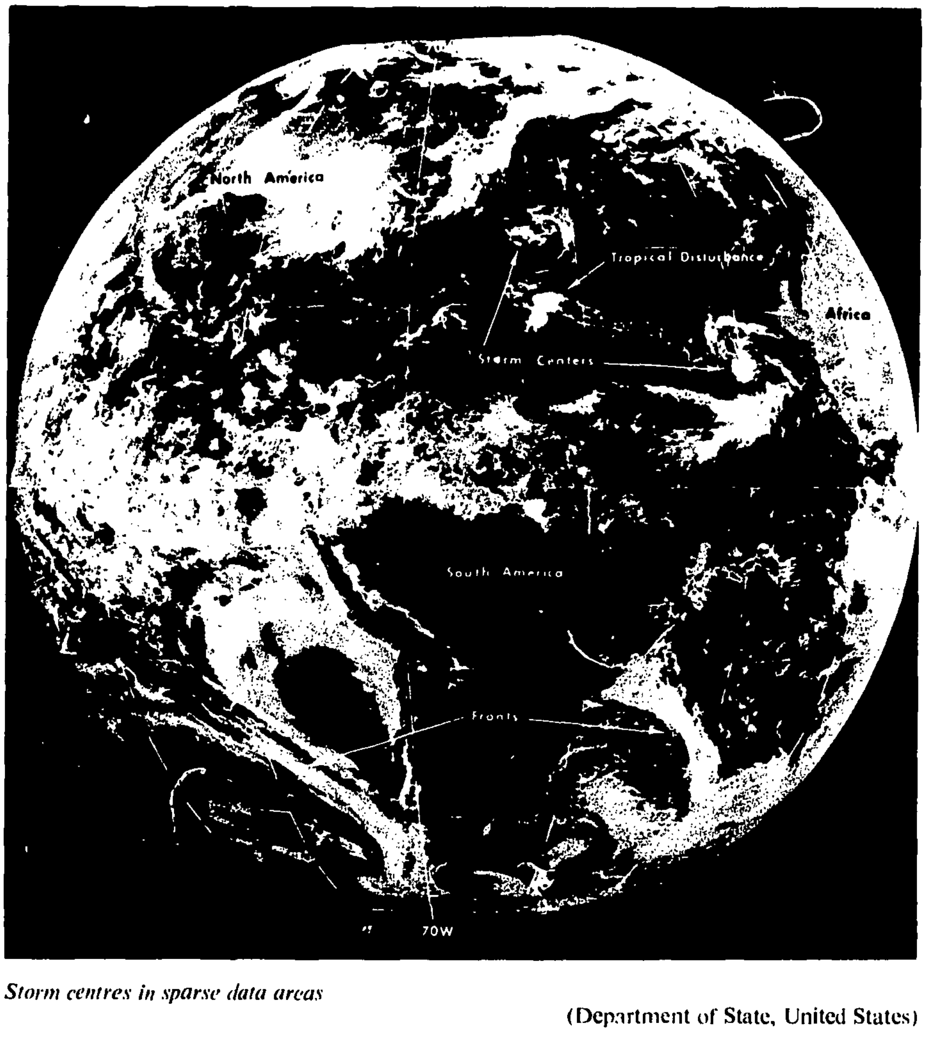
Satellites have already given us new views of our planet and its near space environment. They have indicated that the earth tends to be pear-shaped and bumpy with a bulging midriff. The satellites have verified the extent of the intense Van Allen radiation region over the earth. They have revealed that the earth's magnetic field looks like an elongated tear drop stretching at least 5.6 million kilometres outward on the earth's night side. They have reported on atmospheric particles, tiny meteoroids, and other phenomena in space near earth. For the future, an earth resources satellite programme is proposed to gather data on natural resources. Discoveries of untapped mineral wealth and fresh water, information for utilization of land for farming and forestry, assistance in telling man when and where to fish, measuring the magnitude of air and water pollution, and aid for urban planning by surveying the growth of population centres are among the results expected from the programme. Potential uses are anticipated in geography, geology, oceanography, hydrology, agriculture, forestry and cartography.

The soon-to-be-launched earth resources technology satellites *(ERTS)* will help develop and advance the technology and equipment needed for earth resources surveys from space. These satellites are expected to provide information regularly and inexpensively after initial launch. They will make repeated observations that show slow changes, will acquire data regularly from areas where other means would be difficult and expensive, and will reveal large-scale features that might be overlooked when viewed at lower altitudes.

Adequacy of the earth exploration satellite frequency bands allocated by the 1971 Space Telecommunications Conference are being tested by experiments flown in high altitude aircraft, balloons and spacecraft.

2.4 Deep space research

Some *Mariner* spacecraft have already reported on the cratered face of Mars and the peculiarly dense atmosphere and intense surface heat of Venus. These



Storm centres in sparse data areas

(Department of State, United States)

observations were made during relatively fleeting periods as the spacecraft sped by the planets. In the latter part of 1971, NASA placed a *Mariner* in orbit around Mars to gather information over different areas, take pictures and investigate surface features, atmosphere and heat balance. This mission is supported by the earth-to-space 2110 MHz band and the space-to-earth 2290 MHz band. Frequencies in these bands, as well as the 8400-8500 MHz band, will be used in the next *Mariner*.

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The deep space network continued its support of the *Pioneer* missions. Signals from these spacecraft from the far side of the sun are providing an experiment to test the validity of the Einstein theory of relativity. As the signals must pass close to the sun, the effect of that body's tremendous gravitational pull on them can be analyzed. Recent observations suggest Einstein's predictions to be in error by but a small percent.

The two new 64 m antennae, one near Madrid (Spain) and the other near Canberra (Australia) are nearing completion. These, along with the present one at Goldstone, California, will provide the capability to communicate continuously with the spacecraft probing Jupiter, Saturn and the other far planets of our solar system.

2.5 Manned space research

NASA had two very successful, manned missions to the moon during the year. *Apollo-14*, in January, with astronauts Shepard, Roosa, and Mitchell, brought back the data from many experiments, hundreds of still and movie pictures and nearly 43 kg of lunar rocks and soil. They left a number of operating experiments (*Apollo* lunar surface experiments package—Alsep-A1) on the moon supported by a telecommand link and a telemetering link to send the collected data to earth. *Apollo-15*, in July, with astronauts Scott, Warden, and Irwin, assisted in their moon explorations by a wheeled vehicle, the *Lunar Rover*, brought back even more pictures and samples. They also left an Alsep-A2 supported by a different down frequency (2119 MHz up, 2278.5 MHz down for A1 and 2278.0 MHz down for A2).

2.6 Solar radiation satellite " Solrad-10 "

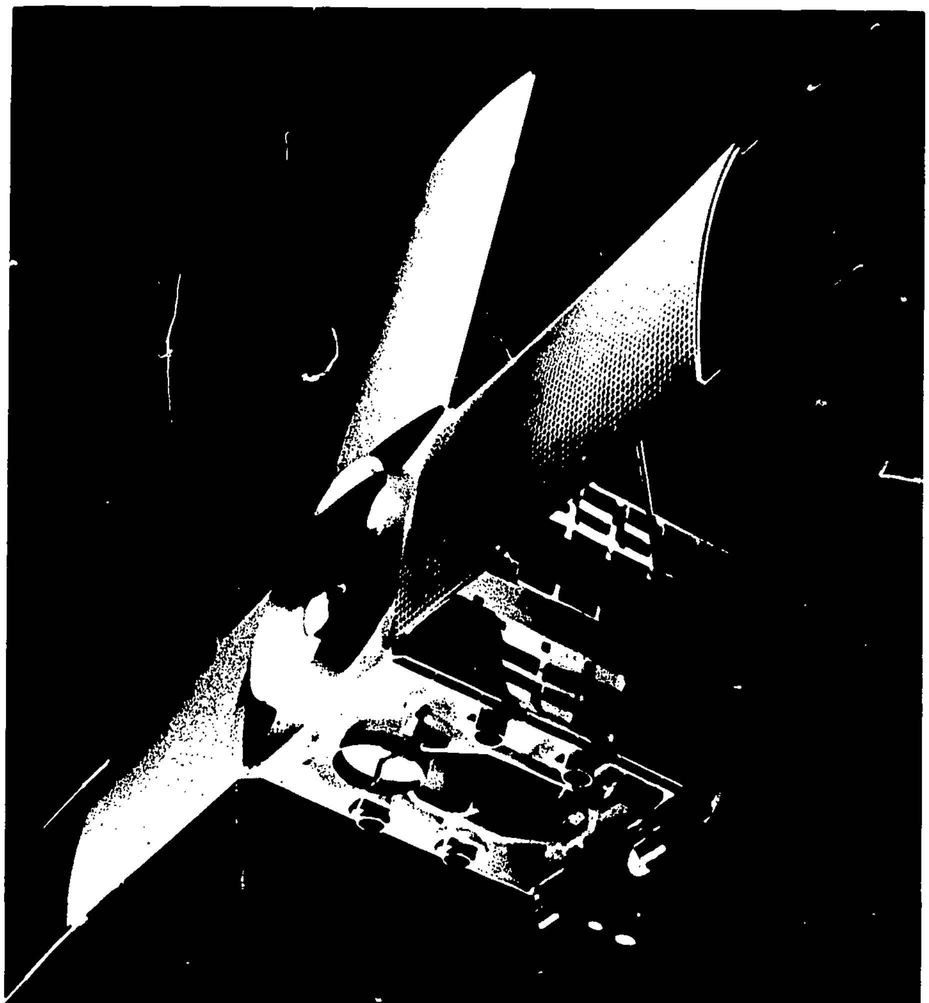
The tenth in a series of solar radiation satellites, senses and records solar X-ray emissions and, upon command, telemeters the data to an earth terminal. Solar radiation fluctuates and can be in the form of intense electromagnetic waves and nuclear particle streams. Investigations are in progress for development of earth environment disturbance forecasting techniques, utilizing *Solrad* satellite sensor data to define possible effects of solar activity emissions on the performance of VLF through EHF radio systems using or affected by the ionosphere.

2.7 TDMA techniques for space communications

Time-division multiple access (TDMA) space communications techniques have been developed for a highly efficient, flexible, and cost-effective satellite communications system. The techniques provide a truly orthogonal multiple-access system in which subscribers access the satellite sequentially in a highly synchronized time format. As a result, system efficiencies as high as 85% can be achieved. The concept provides the capability of readily mixing user terminal sizes and data rates in a common network. The time slots can be allocated and re-allocated in near real-time for effective management of the satellite resources; capability lacking in other systems.

2.8 UHF scintillation fading test

Significant results were obtained in an evaluation of ionospheric scintillation of signals from a UHF satellite to an airborne terminal operating near the equator. The test, run during September and October 1971, showed that extensive scintillation fading occurs within 10 or 15° of the magnetic equator almost every night during the equinox season. On one particular night 5 hours of continuous fading was encountered of approximately 20 dB depth on the received UHF satellite beacon signal while covering a 3600 km flight path near the magnetic equator. Fading on the ground exhibited a period of from 1 second to 1 minute. Fading while airborne



" NOAA-1 " satellite

(Department of State, United States)

exhibited a fade rate about five times as fast, i.e., a period of 1/5th second to 12 s. Often the fading was of limited duration, lasting typically 20 to 90 min a night. The fading appears to be broadband, as a check of two UHF frequencies 5 MHz apart, showed coherent fading. The SHF satellite beacon was monitored during periods of UHF fading and no noticeable SHF scintillation fading was observed. Much additional data is needed to determine the impact of this phenomenon on communications satellite system design.

2.9 Improvement of ionospheric forecasting capability

Improved ionospheric forecasting capability is being developed through the use of aerial ionospheric mapping techniques. This approach is concerned with mapping the actual electron density in the ionosphere rather than selected parameters that characterize the electron distribution. Thus, by mapping the electron density at constant atmospheric heights, the height dependence of the ionized atmosphere can be properly taken into account. Since the ionosphere is a dynamic medium with simultaneous changes in both the ionization content and the ionization height distribution, such an approach is needed first to specify and then to predict the state of the ionosphere. When the synoptic maps are obtained, they are used in conjunction with radio propagation data and the results of ray-tracing studies to determine the relationships between the maps and actual propagation conditions.

FRANCE

1. Radiocommunications in the fixed-satellite service

In 1971, the French Administration pursued and developed its activities in various contexts.

1.1 INTELSAT

As in other years since 1964, the French Administration, as a member of the INTELSAT consortium, continued to take an active part in the work of the Interim Communications Satellite Committee (ICSC) and its Sub-Committees.

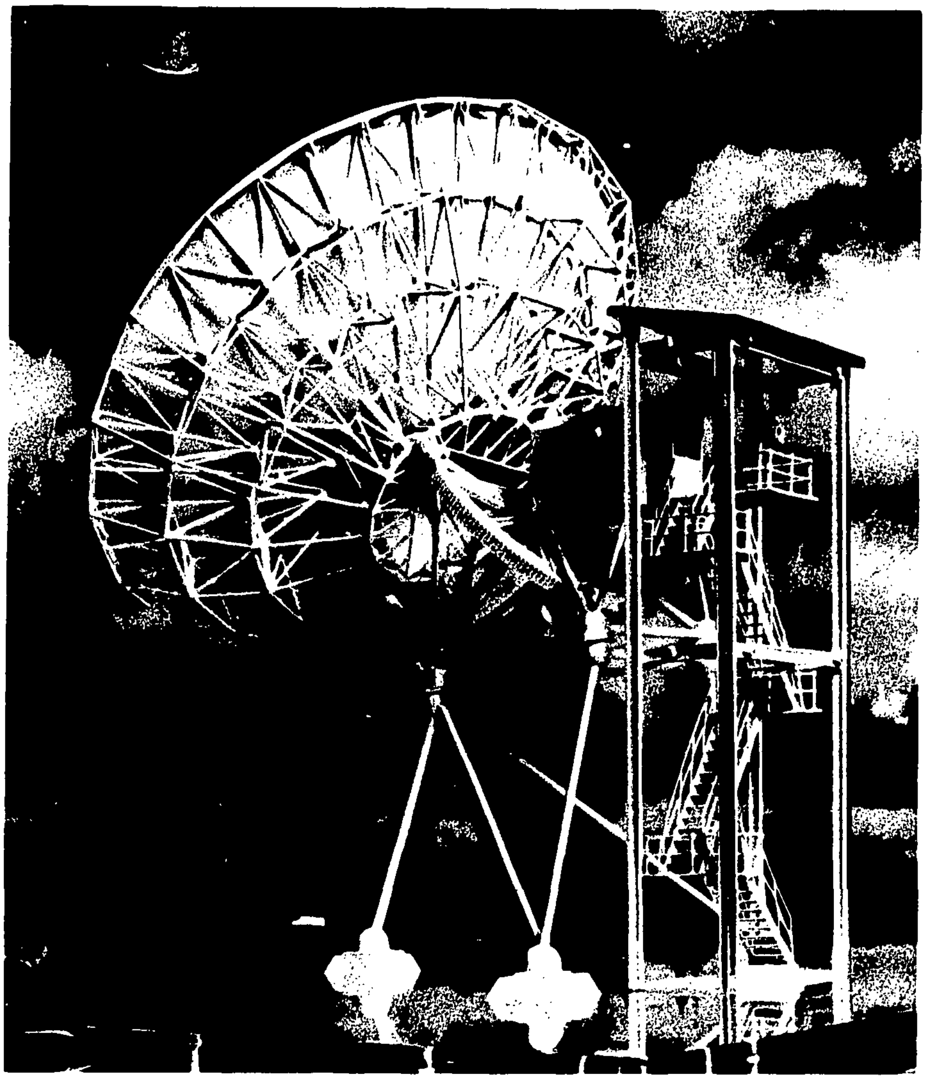
Throughout the year, the two antennae in service at the Pleumeur-Bodou satellite communication centre have continued transmission on telephone circuits and the transmission of television programmes in the Atlantic zone.

One of these antennae was used to establish links via the *Intelsat-IV* Atlantic satellite, while the other continued to work with the *Intelsat-III* satellite operating in the Atlantic area. At the end of 1971, the Pleumeur-Bodou centre was providing links with Argentina, Brazil, Canada, Iran, Jordan, Mexico, Peru, United States and Zaire for France and some other European of Middle Eastern countries.

Steps have been taken to regroup all traffic in the Atlantic area so that it can be routed by the Pleumeur-Bodou II station, which will also be fitted with Spade equipment by the beginning of 1972. The Pleumeur-Bodou I station will then be switched over to operate with the *Intelsat-III* satellite over the Indian Ocean.

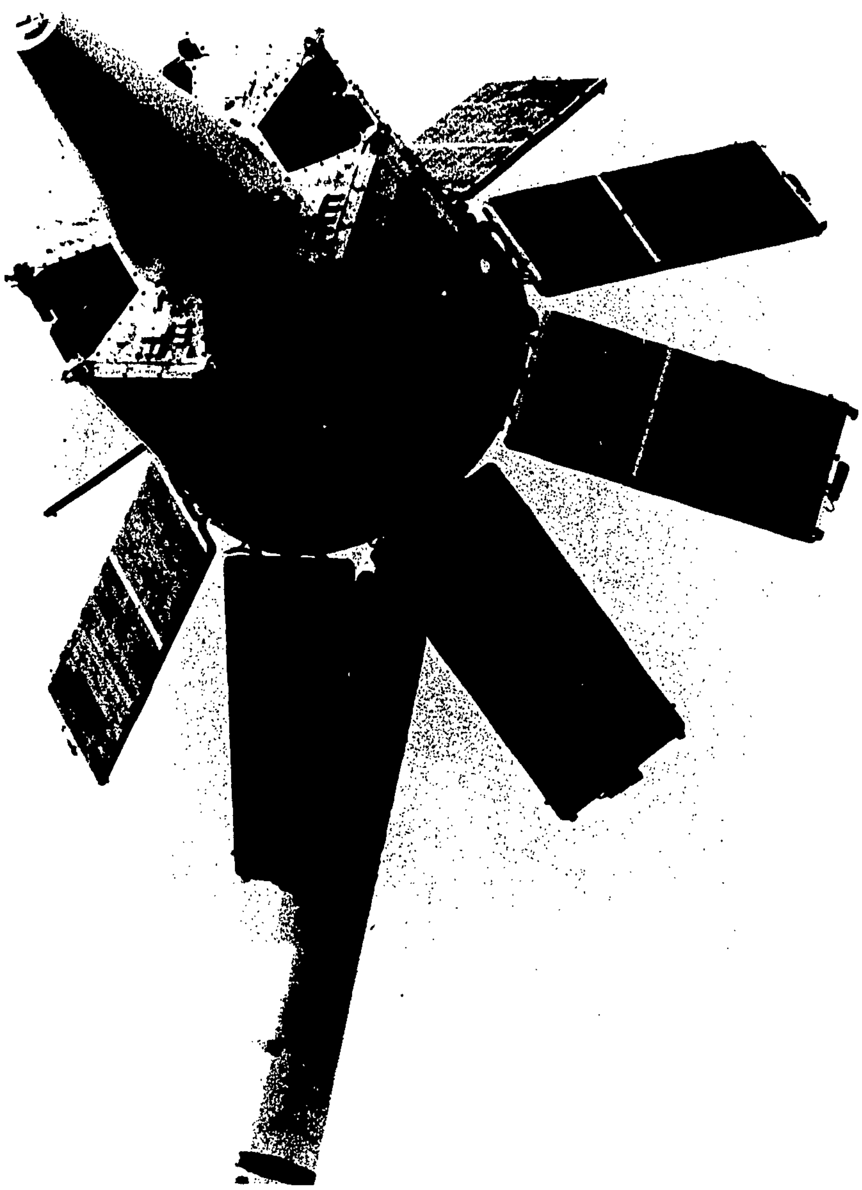
Work started on the construction of a third standard INTELSAT antenna at the Pleumeur-Bodou centre in 1971. It will become operational in mid-1973.

The construction of the standard INTELSAT station in the French West Indies (Martinique) has been completed. General trials were held at the end of 1971, with a view to bringing the station into service at the very beginning of 1972.



Model of the experimental earth station for the " Symphonie " programme now under construction at Pleumeur-Bodou

(CNES)



" Eole " meteorological satellite on antenna testing mast

(CNES)

1.2 " Molnya "

As in previous years, colour television broadcasts (*Secam* system) were relayed by the *Molnya-I* satellite between France and the USSR in 1971, using the Pleumeur-Bodou I station.

1.3 European programme

The French Administration continued to take an active part in the study of satellites for radiocommunications in the fixed service between European countries. For this purpose, the French representative has been working within the " permanent nucleus " set up by the European Conference of Posts and Telecommunications Administrations (CEPT). This nucleus of representatives of European countries conducted technical and economic studies of the projected system and collaborated closely with the European Space Research Organisation (ESRO) to which the satellite definition study was entrusted.

1.4 " Symphonie " programme

Under the Franco-German *Symphonie* agreement, the final contract for the construction of a prototype satellite and two flight models was placed in 1971. The satellites are to be delivered and acceptance-tested during 1973. The mechanical mock-up is in the process of assembly and the thermal mock-up has passed its trials. The identification model is being fabricated.

In 1971, contracts were placed for the construction of the experimental earth stations for the *Symphonie* programme. Work on the site of the station to be set up at Pleumeur-Bodou has already started.

2. Radionavigation by satellite

The French Administration has continued to participate actively in the work on the project for a satellite air navigation aid which is now being carried out within the framework of ESRO.

3. Satellite meteorology

3.1 " Péole " programme

The *Péole* satellite, which was launched on 12 December 1970, was used primarily to check the performance of the *Eole* programme's locating system, based on distance and Doppler measurements in various operating conditions. It should also be mentioned that a brief experimental sound programme relay was carried out using this satellite as repeater.

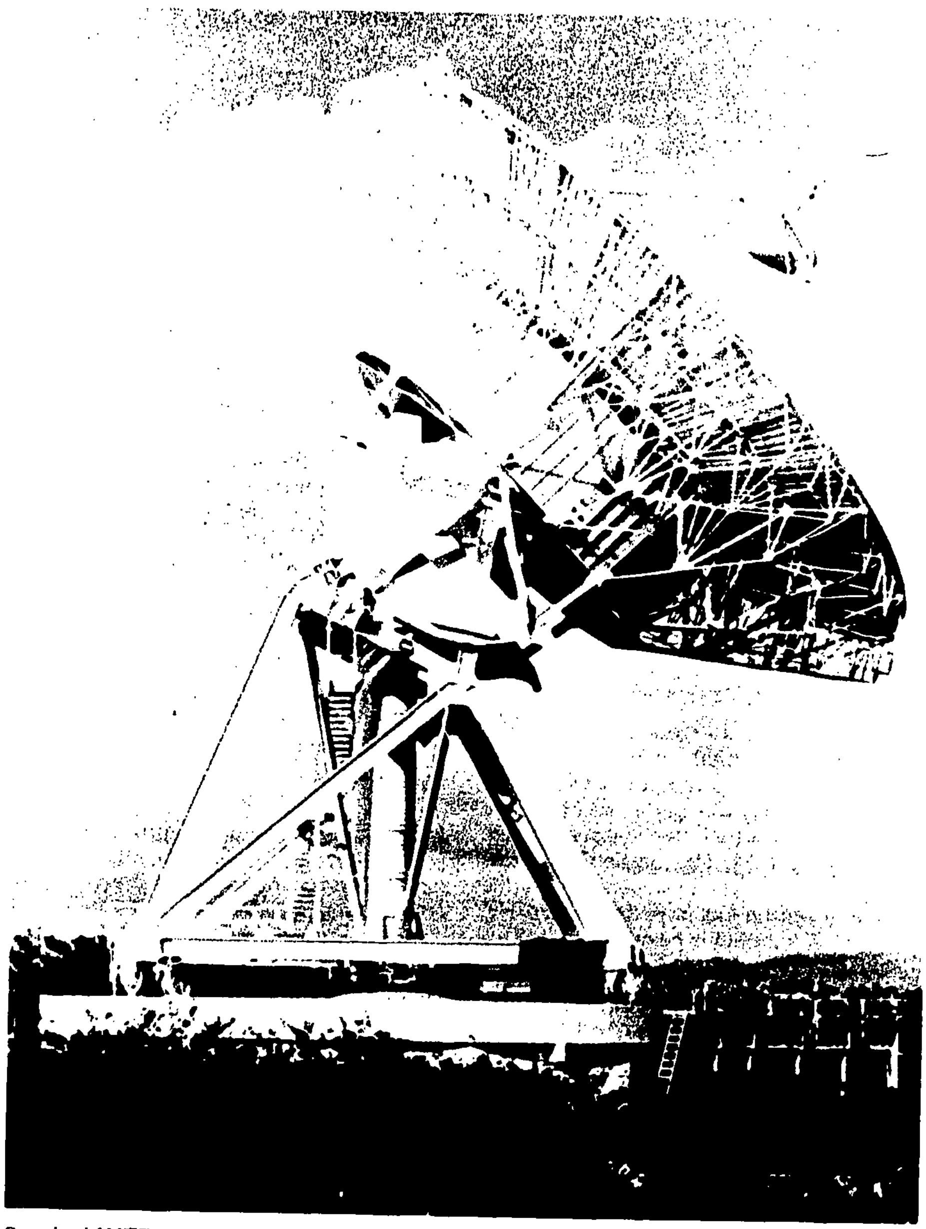
3.2 " Eole " programme

Designed for the study of the circulation of the atmosphere in the southern hemisphere, the *Eole* satellite was launched on 16 August 1971 from the American base at Wallops Island by a *Scout* launcher. At the beginning of December 1971, 479 balloons had been released from the three Argentine stations at Neuquén, Lago Fagnano and Mendoza. These balloons, interrogated and positioned by the satellite, provide information on wind behaviour. They have an average life of 6 months.

4. Earth-exploration satellite and radiocommunications in the mobile satellite service complementary " Eole " programme

In the first quarter of 1971, the *Eole* satellite was used to retrieve and re-transmit data elaborated on board merchant vessels. This experiment is a follow-up to the studies on multiple paths caused by reflections from the surface of the sea.

In 1972, after the conclusion of the main meteorological experiment carried out in conjunction with balloons, *Eole* will be used for an experiment in data collection from transponders placed on drifting buoys or in inaccessible places on the ground.



Standard INTELSAT earth station in Martinique

(Ministry of P&T, France)

5. Scientific space research

5.1 " D2 A " satellite

Launched on 15 April 1971 from the Space Centre in French Guyana, *D2 A* is the first satellite in the *D2* programme; it is also the first French satellite to be stabilized by gas jets. The scientific experiments conducted relate to the distribution of atomic hydrogen in the geocorona and in space, and solar radiation.

5.2 " D2 B " satellite

The *D2 B* satellite, now under construction, is scheduled for launching in 1974 from the Guyana Space Centre. *D2 B* will be used for three photometric experiments, one spectro-photometric experiment and a zodiacal light experiment.

6. Technical space research

6.1 " Sret " programme

The *Sret (satellites de recherches et d'études technologiques)* programme satellites are intended to try out new technologies in real conditions.

The first *Sret* satellite, to be used for experiments with thin-layer solar cells, was delivered to the USSR at the end of 1971 for launching.

6.2 Research and development

In connection with solar panels, efforts are directed towards obtaining a specific power of 60 W/kg by 1975 and have centred on thin-layer cells (CdTe and CdS) and structures.

The ionic propulsion programme aims at achieving the stabilization of 700 kg geostationary satellites by 1975. Work in 1971 was concentrated on the basic technologies: contact ionization (cesium), focussing and deflection of ion beams and neutralization.

A substantial effort has also been made in connection with solid-state hyperfrequency components for communication satellites and certain sub-assemblies for frequencies above 10 GHz (particularly on integrated parametric amplifier and 12 GHz travelling wave tubes).

Studies were also carried out on instabilities, optical components, plastic materials and the " POGO " effect (vibrations in the liquid fuel stages of launcher rockets).

7. Tracking, telemetry, telecommand

The network of stations belonging to the *Centre national d'études spatiales* (CNES) was used in 1971 for activities connected with:

- the French satellites:
  DI-A, DI-C, DI-D, Péole, D2-A, Eole
- the European satellites:
  Esro-2 and *Heos-A1*
- the American satellites:
  Essa, Nimbus, Itos-1, Noaa-1, Sasa, Syncom-3, Solrad-9, Transit, Geos-B
- the Canadian satellites:
  Alouette-1, Alouette-2, Isis-A, Isis-B
- the Italian satellite:
  San Marco-C.

GREECE

The Greek earth station Thermopylae 1, which started its service on 21 April 1970, operated very successfully throughout 1971. The initially available capacity of 60 voice grade circuits was increased in 1971 to 132 and an additional expansion to 432 will be possible when the service is transferred from the *Intelsat-III* to *Intelsat-IV* Atlantic Ocean satellite.

The necessary arrangements have already been made for the transmission, when this becomes advisable, of a second telephone carrier.

In July 1972 it is scheduled to meet the group of countries using the Spade demand assignment system over satellite circuits. The establishment of direct communications with other stations in Africa and South America will thus be possible by the use of Spade.

All contracts were approved and work is in progress for the construction and installation of a second antenna, Thermopylae 2.

The new system is planned to go into service during the third quarter of 1972 and will operate with satellites of the Indian Ocean region. It will initially provide direct communications with Australia and Japan.

Greek earth station installations and foundation of second antenna Thermopylae 2

(OTE)

INDIA (REPUBLIC OF)

1. An earth station for global communication has been established at Arvi. It was tested and put into operation through the Indian Ocean satellite *Intelsat-III F3* on 26 February 1971. It has been in regular commercial operation since then.

2. An earth station is being planned for augmenting communication facilities in the northern region of the country. This station is expected to provide facilities for participation in the NASA and the Department of Atomic Energy domestic television experiment utilizing the *ATS-F* satellite in 1974 and thereafter for commercial operation from the beginning of 1975.

3. The Indian Meteorological Department maintains five receiving stations one each at Bombay, Calcutta, Madras, New Delhi and Poona for automatic picture trans-

mission (APT) for meteorological satellites. Except for the equipment used at Bombay, all the receiving units were locally made in the Meteorological Department.

INDONESIA (REPUBLIC OF)

Progress made during the year 1971 in the development of space radiocommunications of the Djatiluhur earth station

A. Djatiluhur satellite links 1971

date	links established
1 January 1971	Yamaguchi, Goonhilly, Raisting, Ceduna, Kuantan, Buitrago
24 August 1971	Sentosa
23 October 1971	Hong Kong

B. Circuit growth 1971

i) Existing circuits at December 1970:

country	telephone	telegraph
Japan	4	1
United Kingdom	2	—
Federal Republic of Germany	1	1
Australia	2	1
Netherlands	2	—
Singapore	4	—
Malaysia	1	—
Spain	1	1
Hong Kong	3	—

1970: — total telephone circuits 20
— total telegraph circuits 4

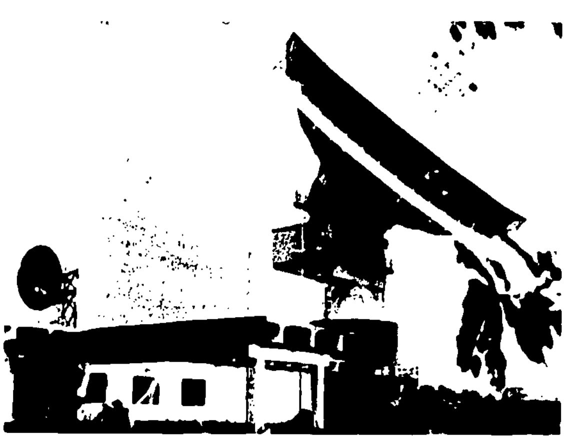
— total circuits 24

78

ii) circuits operated in 1971:

month 1971	country																	
	Japan		United Kingdom		Fed. Rep. of Germany		Australia		Netherlands		Singapore		Malaysia		Spain		Hong Kong	
	tlp	tgp	tlp	tgp	tlp	tgp	tlp	tgp	tlp	tgp	tlp	tgp	tlp	tgp	tlp	tgp	tlp	tgp
January	4	1	2	—	1	1	2	1	2	—	4	—	1	—	1	1	3	—
February	4	1	2	—	1	1	2	1	2	—	4	—	1	—	1	1	3	—
March	4	1	2	—	1	1	2	1	2	—	5	—	1	—	1	1	3	—
April	4	1	2	—	1	1	2	1	2	—	5	—	1	—	1	1	3	—
May	4	1	2	—	1	1	2	1	2	—	5	—	1	—	1	1	3	—
June	4	1	2	—	1	1	2	1	2	—	5	—	1	—	1	1	3	—
July	4	1	2	—	1	1	2	1	2	—	5	—	1	—	1	1	3	—
August	5	2	2	—	2	1	2	1	2	—	8	—	1	—	1	1	3	—
September	5	2	2	—	2	1	2	1	2	—	8	1	2	—	1	1	3	—
October	5	2	2	—	2	1	2	1	2	—	8	1	2	—	1	1	4	1
November	5	2	2	—	2	1	2	1	2	—	8	1	2	—	1	1	4	1
December	5	2	2	—	2	1	2	1	2	—	9	1	2	—	1	1	4	1

1971: — total telephone circuits	29
— total telegraph circuits	7
— total circuits	36



Earth station at Djatiluhur
(ITT)

C. Satellite service availability 1971

month	interruption time (minutes)									
	satel-lite	Yama-guchi	Hong Kong	Raist-ing	Djatil-uhur	Bui-trago	Kuan-tan	Sen-tosa	Ceduna	Goon-hilly
January	0	0		51	0	117	65	– –	9	256
February	0	1			4	0	60	–	572	35
March	0	0			1	4	14		12	21
April	0	4		0	140	21	18	–	2	97
May	0	2		14	1	25	16	—	13	265
June	0	4	—	27	17	0	12	– –	9	535
July	0	1	—	30	4	69	50	—	28	351
August	17	36		27	14	16	0	0	9	56
September	31	4	–	84	20	–	108	15	281	47
October	0	2	10	4	37		3	18	5	149
November	0	2	35	11	90	0	0	1	14	16
December	0	0	10	0	0	24	0	103	2	6
total	48	56	55	248	328	276	346	137	956	1834
Yearly availability (%)	99.991	99.989	99.958	99.943	99.937	99.936	99.933	99.932	99.816	99.696

D. Detailed cause of interruption at Djatiluhur earth station 1971

cause of interruption	interruption time (minutes)	percentage
– maintenance	145	44.21
– environment	71	21.65
– power failure	48	14.63
– tracking	35	10.67
– high-power amplifier	24	7.32
– low-noise amplifier	5	1.52

E. Video telecast 1971

date	Duration (minutes)	circuits	programme
9 March	80	New York-Jamesburg-Ibaraki-Yamaguchi-Djatiluhur-Djakarta	Clay-Frazier boxing match
26 August	82	Djakarta-Djatiluhur-Raisting-Hilversum	Queen Juliana's visit
26 August	19	id.	id.
27 August	10	id.	id.
28 August	13	id.	id.
29 August	53	Bandung-Djakarta-Djatiluhur-Raisting-Hilversum	id.
29 August	14	Djakarta Djatiluhur-Raisting-Hilversum	id.
30 August	15	id.	id.
31 August	10	id.	id.
1 September	10	id.	id.
2 September	12	id.	id.
3 September	10	id.	id.
4 September	12	id.	id.
5 September	7	id.	id.
23 October	2	Djakarta-Djatiluhur-Sentosa	Sentosa earth station opening ceremony
total	349		

F. Temporary circuits operated in 1971

date	days	circuits	application
15 February	3	Bandung-Djakarta-Djatiluhur-Yamaguchi-Fuchu air base (Japan)	Admiral McCain's visit
10 August	28	Djakarta-Djatiluhur-Raisting-Hilversum	Queen Juliana's visit
22 August	15	Bandung-Djatiluhur-Raisting-Amsterdam	Queen Juliana's visit
25 November	3	Djakarta-Djatiluhur-Yamaguchi-Fuchu air base (Japan)	Admiral McCain's visit

IRAN

The Ministry of Posts, Telegraph and Telephone of the Imperial Government of Iran made the fullest possible use of satellite communications in 1971. Up to 75% of Iran's international and intercontinental traffic was handled by the currently-operating earth station at Assadabad. A transportable earth station was also used during the month of October to carry overflow traffic on the occasion of the 2500th anniversary celebration of the foundation of the Persian empire. Iran has also implemented an expansion and modification programme for the Iranian satellite communication earth station located at Assadabad so as to meet the ever-expanding requirements for international telecommunications in Iran.

The earth station improvements encompassed the expansion of the transmit chain capability from 24 channels to a full 60 channels, while the receive capability was expanded from five to seven receive chains capable of receiving a baseband configuration of up to 420 channels.

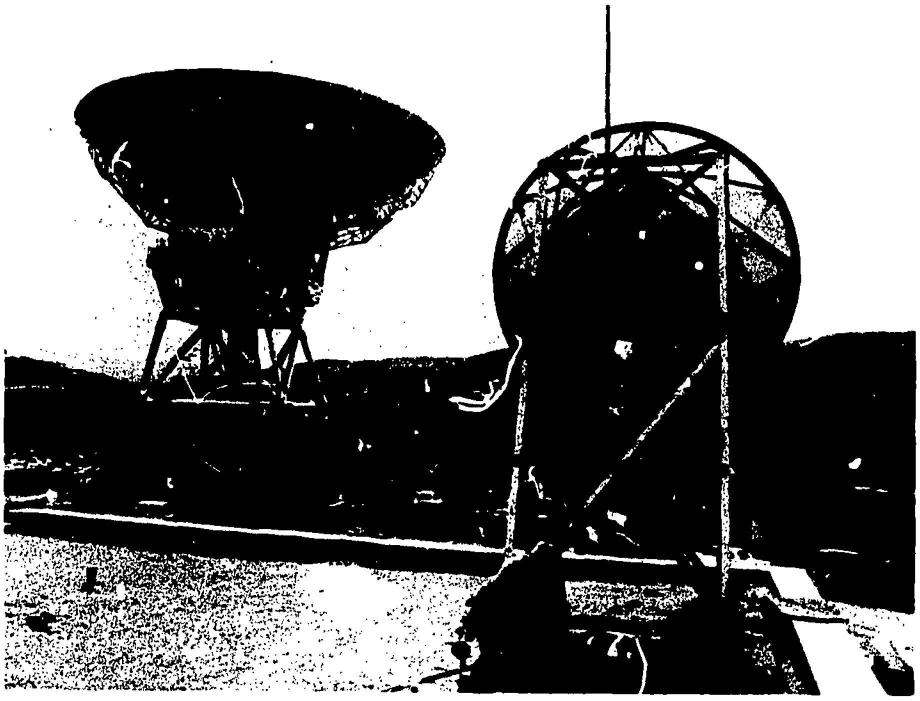
In addition, new equipment was installed to provide transmission and reception of television on a number of different frequencies simply by turning a selector switch to the desired frequency. All the new equipment added to the Assadabad earth station and the existing equipment at present being modified will meet the mandatory requirements for operation with the *Intelsat-IV* series of communications satellites. The expansion of the earth station at Assadabad has enabled Iran to have direct telephone communications with seven major countries in the Atlantic region since July 1971. An agreement has also been signed between the Ministry and the Interim Communications Satellite Committee (ICSC) to provide for the use of single-channel per carrier PCM multiple access demand assignment equipment (Spade) at the Assadabad earth station. When the Spade system becomes fully operational, Iran will be able to have direct communications on a demand basis with all countries in the Atlantic region equipped for Spade operation in addition to the seven countries with which Iran has dedicated circuits.

ISRAEL (STATE OF)

The construction of the Israeli earth station in Emeq Ha'ela, which started in November 1970, proceeded during the year 1971 at a satisfactory rate. It is expected that the station will become operational in May 1972 as specified in the contract between the Israeli Government and the contractor.

At the same time, installation of the microwave systems connecting the earth station with Tel-Aviv for message traffic on the one hand and with Jerusalem for television video and sound transmissions on the other hand has been performed by the Israeli Ministry of Communications. Additional orders were placed for equipment to enable the Emeq Ha'ela earth station to receive and transmit, in addition to black and white 625/50 and 525/60 line television signals, colour television signals both in the *PAL* (625/50) and *NTSC* (525/60) systems.

During the year 1971, work proceeded on the enlargement of the international trunk exchange to cater for the international trunk lines to be provided via the Atlantic Ocean satellite *Intelsat IV*.



Emeq Ha'ela earth station

(Ministry of Communications, Israel)

The plans were finalized for the operation of the international subscriber dialling, to be started in the year 1972/73, initially on an experimental scale.

ITALY

Facilities

A standard converter was installed at the Fucino earth station in early 1971 to convert television signals from the *NTSC* 525/60 to the *PAL* 625/50 standard and vice-versa. On the occasion of the *Apollo-15* mission in July 1971, all television programmes were converted for broadcasting on the *Eurovision* network.

Operation

Up to 30 November 1971, 203 circuits were routed through the Fucino station, divided as indicated in the table.

Table

a) Terminal circuits (total: 151)

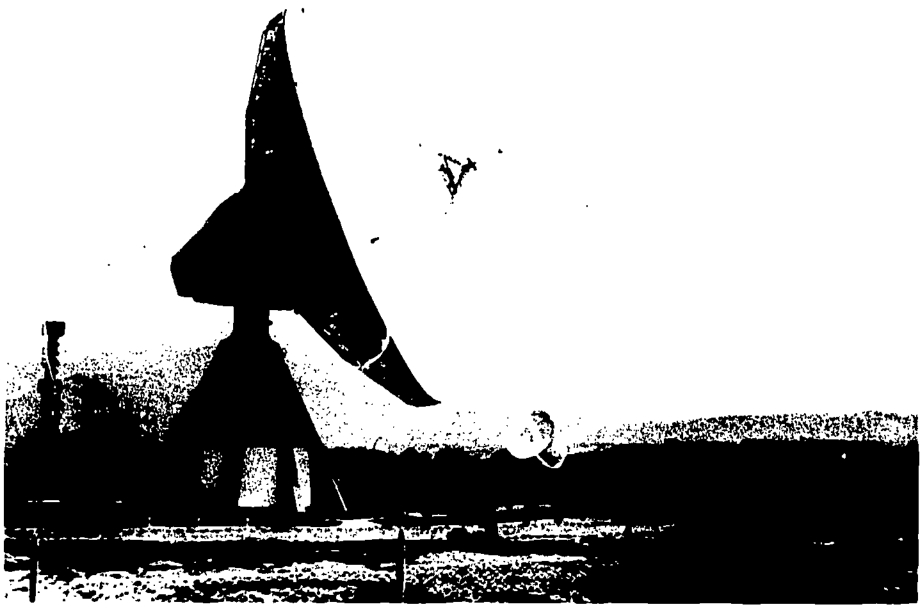
Atlantic Ocean satellite		Indian Ocean satellite	
Italy—Argentina	8	Italy—Australia	4
Italy—Brazil	10	Italy—East Africa	2
Italy—Canada	8	Italy—Japan	5
Italy—Chile	3	Italy—Kuwait	2
Italy—Mexico	7	Italy—Lebanon	1
Italy—Panama	1	Italy—Thailand	2
Italy—Peru	3	Italy—India	1
Italy—United States	75		
Italy—Uruguay	1		
Italy—Venezuela	9		
Italy—Zaire	1		
Italy—Nigeria	5		
Italy—Iran	3		
total	134	total	17

b) Transit circuits (total: 52)

Atlantic Ocean satellite		Indian Ocean satellite	
Portugal—Brazil	2	Greece—Australia	3
United Kingdom—Iran	4	France—Japan	3
United Kingdom—Jamaica	2	Switzerland—Japan	1
United Kingdom—Panama	1		
United Kingdom—Nigeria	7		
Czechoslovakia—United States	1		
Israel—United States	11		
Switzerland—United States	13		
Turkey—United States	1		
Israel—Canada	1		
total	45	total	7

From 1 January to 30 November 1971, 132 television services were routed through the Fucino earth station, for a total of 5665 minutes.

Also in 1971, the telemetry and control services for the INTELSAT satellites in orbit over the Atlantic and Indian Oceans were carried out by the Fucino station, which also took part in the control and parking operations of the first *Intelsat-IV* satellite.



The Fucino II antenna (29.56 m diameter) for communications with countries in the Indian Ocean area through an INTELSAT satellite. In the background, the Fucino I antenna (27.4 m diameter) for communications with North and South America through the INTELSAT satellite in orbit over the Atlantic Ocean. At right the antenna for telemetry and control of INTELSAT satellites

(Ministero delle Poste et delle Telecomunicazioni, Italy)

Research

Studies on the communication experiments to be made by the *Sirio* satellite have been carried out by the *Telespazio* company.

A pilot project for broadcasting of educational television programmes through the *Sirio* satellite has been completed and submitted to the Italy-Latin America Institute. Experiments in the reception of meteo photographs broadcast from the *Essa-8* satellite were also carried out at the Fucino station.

Italy also takes part in the work of the CEPT Permanent Nucleus that is carrying out a technical-economic study on a European system of satellite communications, in co-operation with ESRO.

JAMAICA

The earth station at Prospect Pen, Jamaica, constructed by Cable and Wireless Limited for Jamaica International Telecommunications Limited (JAMINTEL) commenced operations in December 1971.

JAMINTEL (the joint company formed on 1 April 1971 by the Government of Jamaica and Cable and Wireless Ltd.) operates the island's external telecommunications and the earth station operates initially via the *Intelsat-III F7* satellite over the Atlantic Ocean.

Direct circuits have been established to Barbados (via Trinidad earth station), Canada, the United Kingdom and the United States.

Direct circuits to Trinidad will be established in 1972.

JAPAN

1. Space Telecommunication Services

a) International commercial satellite communications

International commercial satellite communications from Japan continued to increase in order to be able to cope with the rapidly rising demands for international communication services.

The *Kokusai Denshin Denwa Company Limited* (KDD), the Japanese designated communications entity in INTELSAT, completed the construction of the third facility of its Ibaraki satellite communication centre in August 1971. This facility is a standard earth station intended to operate with one of the satellites belonging to the *Intelsat-IV* series, which had been scheduled to operate over the Pacific Ocean in the latter part of 1971. The equipment complies fully with the required earth station characteristics set out in Document *ICSC-45-13*. This facility also has the possibility of access to a satellite of the *Intelsat-III* series.

The specifications of the antenna and transmitter are as follows:

— antenna:
Cassegrain, fed by four reflectors and a wave guide

— size of main reflector:
29.6 m in diameter

— G/T:
41.7 dB

— transmitter:
high-power amplifiers (8 kW) equipped with travelling wave tubes commonly used for television

— maximum transmitting capacity - carrier:
1872 channels

— television transmission:
525 and 625 line systems can be used.

b) Experiments using the applications technology satellite

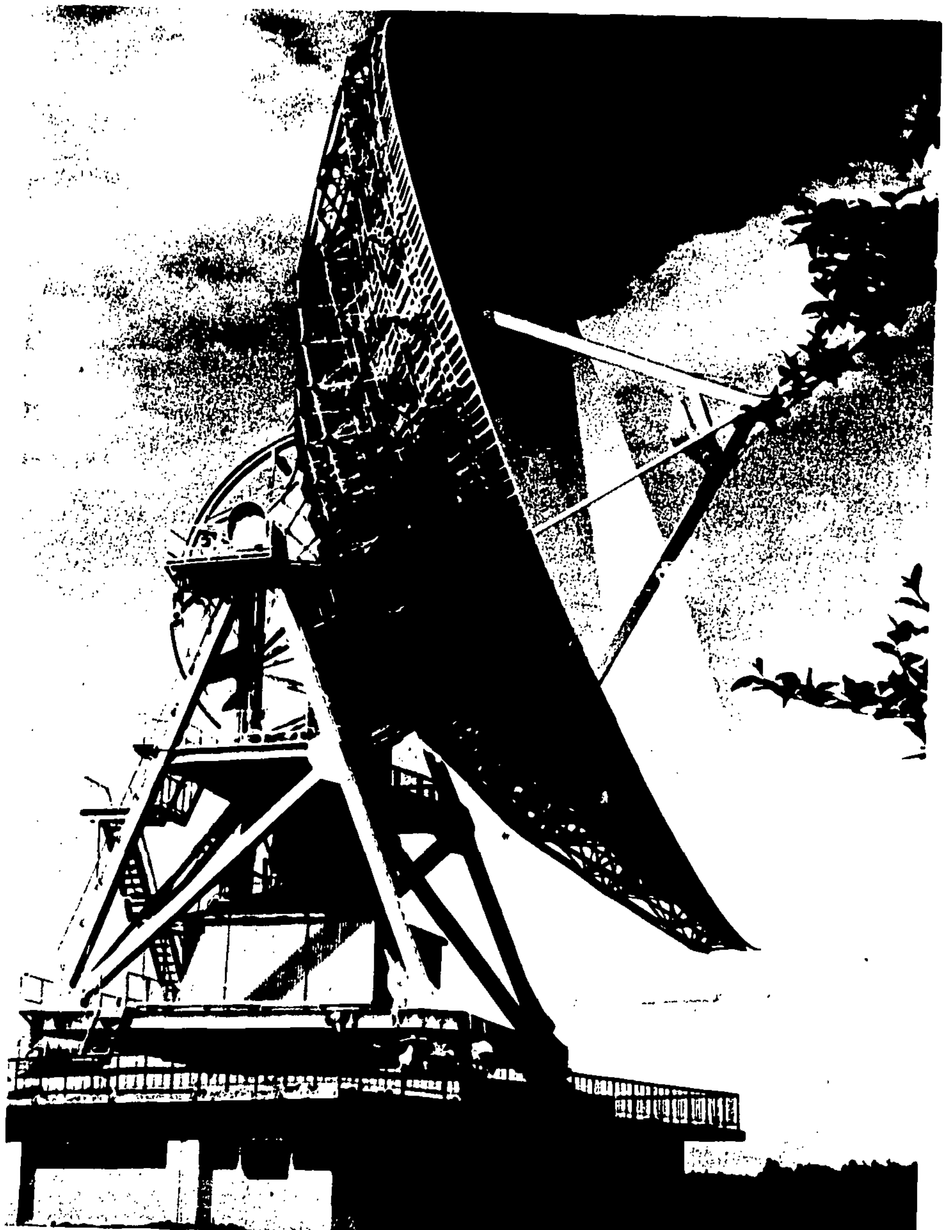
Since the applications technology satellite *ATS-1* was launched by NASA in December 1966, many experiments have been carried out by the Radio Research Laboratories, Ministry of Posts and Telecommunications, using this satellite.

In 1971, the Laboratories undertook experiments concerned with research into new systems of multi-access communication, namely the spread spectrum random access (SSRA) and random access discrete address (RADA) systems. The SSB-PM system of multi-access communication was also the subject of experiments in which NASA stations participated.

Since 1970, the Laboratories have collaborated with the Japan Meteorological Agency of the Ministry of Transport, in experiments on receiving the pictures of clouds by the spin scan cloud camera (SSCC) as well as with *Nippon Hoso Kyokai* (NHK), the Japan Broadcasting Corporation, in experiments on multiple sound channels transmitting for television.

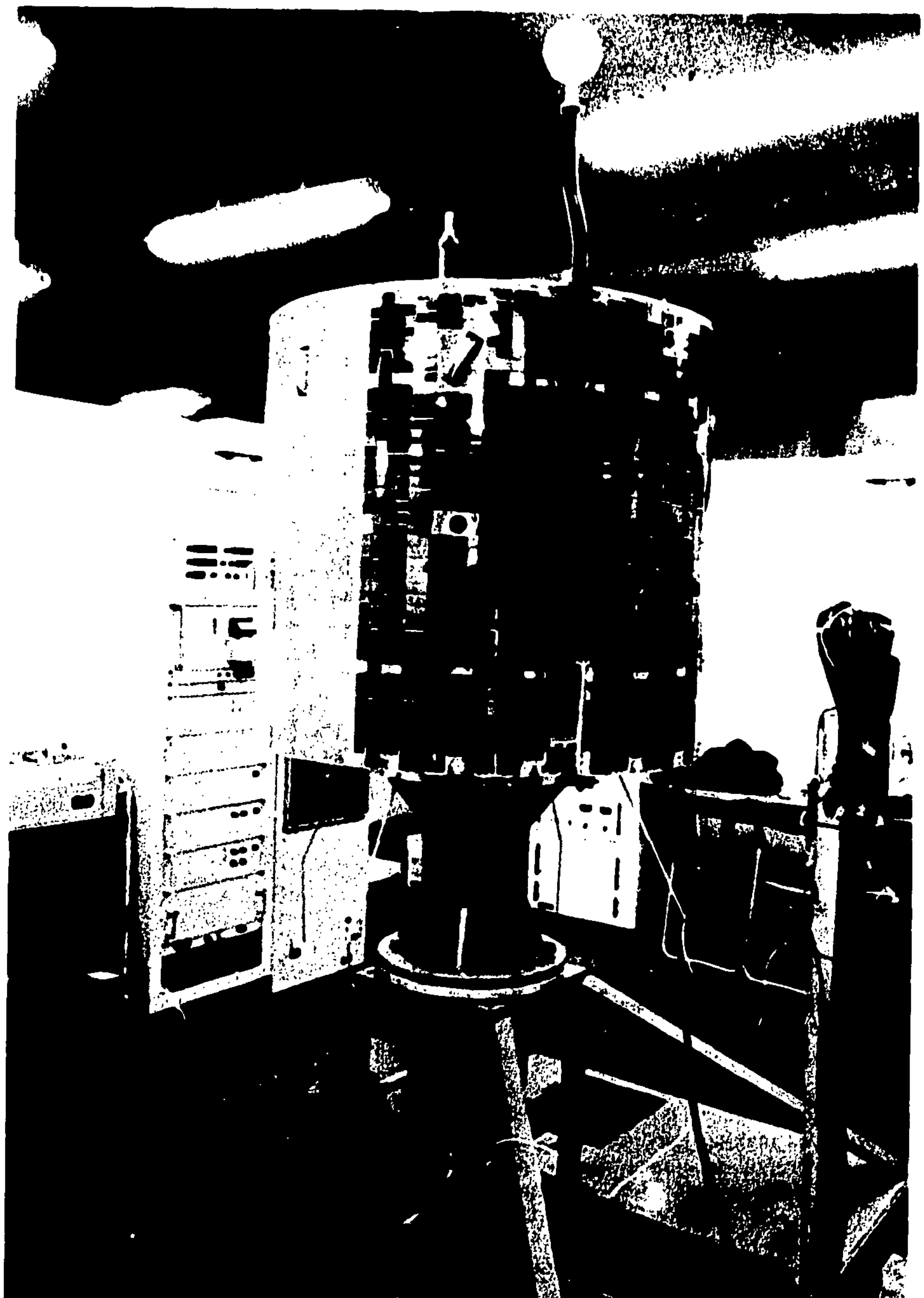
c) Terrestrial experimental facilities for domestic communication satellite

Experimental stations facilities have been constructed by the Nippon Telegraph and Telephone Public Corporation (NTT) in Yokosuka (an earth station) and in Ohkusu (a simulator of satellite), both of which are situated in Kanagawa Prefecture, in order to make research into and develop a satellite communication system for the domestic public communication services. The Corporation will begin its experiments on micro and shorter centimetric wave space communications at these stations in 1972.



The third facility of KDD's Ibaraki satellite communication centre

(Ministry of P&T, Japan)



The engineering model of "ISS" (ionosphere sounding satellite)

(Ministry of P&T, Japan)

2. Space research service

a) Success in launching experimental and scientific satellites

The Institute of Space and Aeronautical Science of the University of Tokyo launched an experimental satellite *Tansei* on 16 February 1971 and a scientific satellite *Shinsei* on 28 September 1971 from its Kagoshima Space Centre; these satellites were successfully placed into orbit around the earth. The former was internationally registered as 1971-011A and the latter as 1971-080A.

Tansei, which confirmed the launching capability of the *M-4S* type rocket, is mainly intended to acquire data on the environment and operation of the satellite. *Shinsei*, which is the first Japanese scientific satellite, is intended to observe the effect of solar radiation on HF, cosmic rays and ionospheric plasma. This satellite will be able to operate for a long period using solar cells for power supply.

b) Preparation for launching scientific satellite No. 2

The scientific satellite No. *2* is being prepared for launching in 1972 by the Institute. Its purpose will be the observation of plasma waves, plasma density, terrestrial magnetism, etc. This satellite will be launched into an elliptical orbit with a perigee of 500 km, an apogee of 3000 km, and an inclination of 30°.

3. Development of artificial satellites

a) Development of ionosphere sounding satellite

The National Space Development Agency of Japan is making good progress in the development of an ionosphere sounding satellite *(ISS)* scheduled to be launched in 1976. The engineering model was completed in March 1971 and the individual parts of it have been thoroughly tested.

The Agency has also started to assemble for tests the engineering model of the engineering test satellite *ETS-I* with the intention of launching it prior to putting *ISS* into space.

The Radio Research Laboratories, Ministry of Posts and Telecommunications, began in 1968 to construct a satellite control centre at its Kashima branch, Ibaraki Prefecture, for use in conjunction with this satellite. The parabolic antenna of 18 m in diameter, a telemetering receiver, a telecommand transmitter, etc., were completed in October 1971 in the first phase of this work.

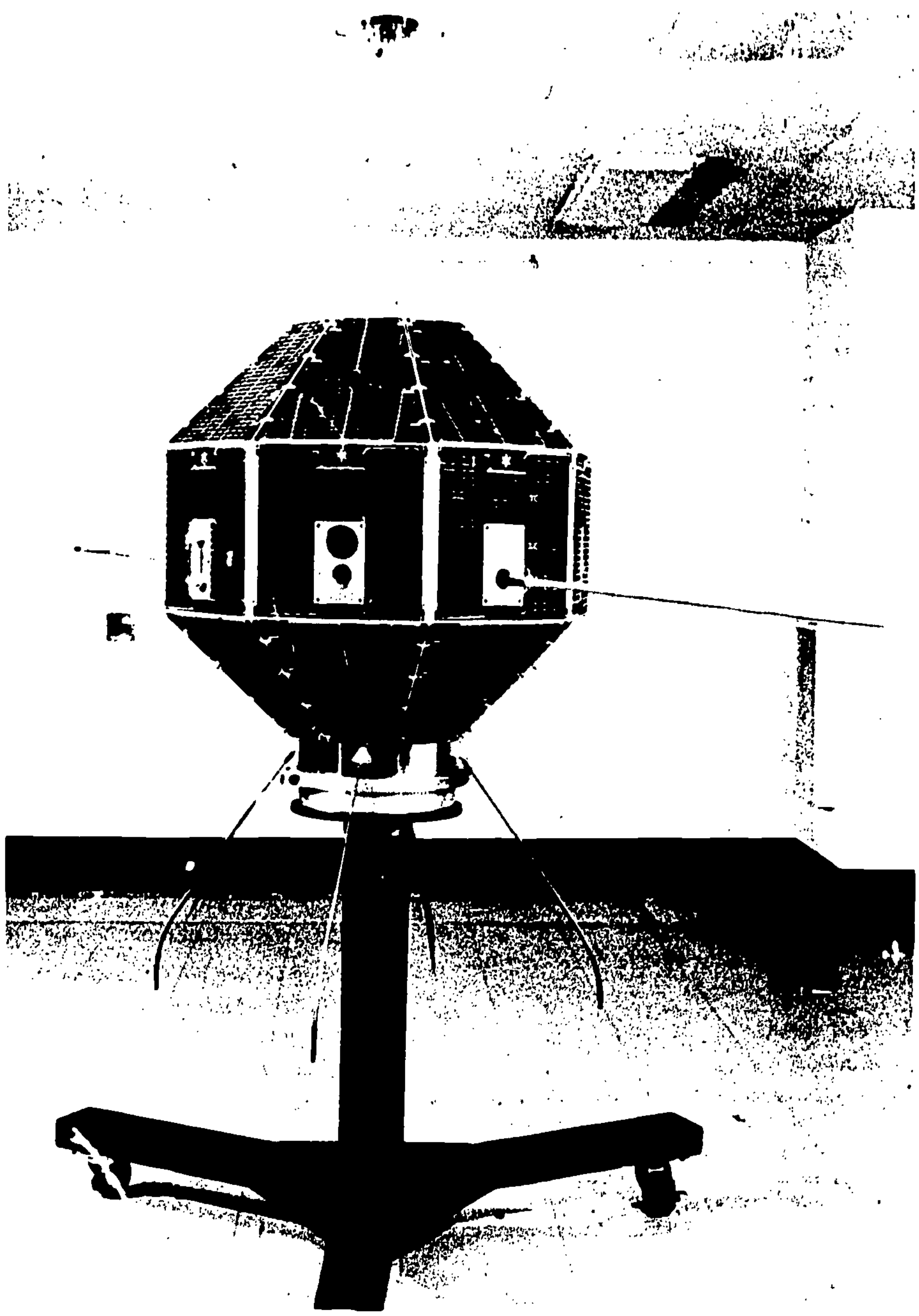
b) Development of an experimental geostationary communication satellite

An experimental geostationary communication satellite *(ECS)* is being developed in Japan for the purpose of realizing future communication satellite systems. This satellite is scheduled for launching in 1978.

The matter is the subject of deliberations in the Space Telecommunications Cooperation Council. The Council is composed of the Ministry of Posts and Telecommunications, NTT, NHK and KDD. Research work on the equipment and antennae of this satellite as well as development is being done by these four organizations according to their respective tasks.

As for the mission equipments, the trial transmitters for millimetric and shorter-centimetric waves have been produced and are being studied with a view to high capacity radiocommunication systems—a characteristic feature of space telecommunications. Bread board models of the equipments were completed and the production of the engineering models was started. A mechanical de-spin antenna is being investigated and studied for general communications.

The research and development of this equipment up to the stage of the completion of the engineering models is the responsibility of the four organizations.



" Shinsei ", the first scientific satellite launched by the University of Tokyo

(Ministry of P&T, Japan)

The task of manufacturing the satellite and launching it will belong to the National Space Development Agency.

The Agency is also studying the system engineering of the engineering test satellite *ETS-II* which is scheduled to be launched in 1977 in advance of the *ECS*. The purpose of this is to obtain a better understanding of the techniques of launching geostationary satellites, examining the operation attitude controls etc.

KENYA, UGANDA, TANZANIA (UNITED REPUBLIC OF)

Details of East African communications satellite station, end link and international transmission maintenance centre/international telephone exchange facilities

Owners and operators:

East African External Telecommunication Company Limited

Name of station:

Longonot, Rift Valley, Kenya

Location:

01° 00′ 58″ S
36° 29′ 43″ E

Commissioned:

10 August 1970

Supplier:

Marconi Company Limited

- standard design for *Intelsat-III* satellite series
- operating through the IIA satellite (*Intelsat-III F3*)

Technical details:

— *antenna:*

- Cassegrain, 30 m shaped main reflector with 2.7 m diameter sub-reflector
- fully steerable, kingpost type elevation over azimuth mount in reinforced concrete tower
- feed. static. (*Sylvania Symmtrac I*)

— *intersite connections:*

separate antenna tower and control buildings with coaxial cable transmit and waveguide receive interconnections

— *receive:*

Comtech type *401* low-noise cooled parametric amplifiers with cryogenics by Cryogenic Technology Inc. (type *350*) located in a high-level cabin above the kingpost. Parametrics are followed by low-noise TWTS intersite waveguide power dividers, down converters and threshold extension demodulators

— *transmit:*

Marconi type *P2020* low-power klystron, hybrid cooled, transmitters driven from standard Marconi baseband, modulator and upconverter equipment

— *tracking:*

Marconi standard monopulse type tracking receivers

— *space segment and end-link multiplex equipment:*

standard *Telettra* equipment

— *engineering service circuit equipment:*

- multiplex—*Marconi-Italiana*
- switching—*Marconi*

— *end-link microwave:*

2 GHz 600 channel twin path microwave standard *Fujitsu* equipment

— *television:*

not catered for

— *general:*

the station is compatible with current INTELSAT performance specifications

— *operational data:*

1. Direct communication with Australia, India, Italy, Spain and the United Kingd m
2. Circuit quantities spectively 2, 2, 2, 3 and 20
3. VFT bearers to the United Kingdom (2), Italy and Spain
4. Circuits terminate in Kenya, Uganda and Tanzania
5. The international telephone exchange, providing semi-automatic facilites to CCITT signalling system No. 5, will be ready for service in March 1972. The manufacturers are *Fujitsu Limited*
6. Current mode of operation is manuel ring-down with the international switchboards operated by EAP & T Corporation.

KUWAIT (STATE OF)

A. Communication satellite earth station facilities

1. Existing station

An earth station was established in Kuwait in October 1969, for communication via the *Intelsat-III F3* satellite located above the equator at 62° E longitude on the Indian Ocean. During 1971, this earth station was satisfactorily utilized by the Ministry of Posts, Telegraphs and Telephones, State of Kuwait, for the establishment of telecommunication circuits as well as telecasts with different countries of the world.

During 1971, the overall efficiency of the circuits derived via satellite service was kept above 99.5% throughout.

2. Future expansion

Plans have been prepared for the expansion of the existing earth station complex to provide for a second antenna for additional communication via the *Intelsat-IV* satellite, located above the Atlantic Ocean. This will enable Kuwait to open direct telecommunication services and interchange telecasts with more countries of the West and cover practically the whole of the world. It is expected to execute this plan within the next two years.

B. International telephone service

1. Existing service

The number of direct telephone circuits working with different countries in 1971 via satellites is given in table 1.

2. Future expansion

During 1972, it is expected to open new direct telephone circuits via satellites, with the following countries:

— Egypt (via Italy)
— France
— Jordan (via Lebanon)
— Syria (via Lebanon)
— Pakistan

C. International telegraph and telex service

1. Existing service

The number of voice circuits used for voice frequency telegraph with different countries via satellites in 1971 is given in table 2.

Table 1

No.	countries	number of circuits at the beginning of 1971	additional circuits established in 1971	total circuits at the end of 1971
1	Bahrain	3	3	6
2	Dubai (UAE) (via Bahrain)	1	—	1
3	India	—	1	1
4	Italy	1	—	1
5	Japan	1	—	1
6	Lebanon	—	3	3
7	Qatar (via Bahrain)	1	—	1
8	Spain	1	—	1
9	United Kingdom	3	—	3
10	United States of America (via Spain)	1	—	1
11	Federal Republic of Germany	1	—	1
	total	13	7	20

Table 2

No.	countries	number of voice circuits	number of telegraph/ telex channels
1	Bahrain	1	8
2	Italy	1	24
3	Japan	1	6
4	Lebanon	1	4
5	United Kingdom	1	14

2. Future expansion

During 1972, it is expected to open new voice circuits for voice frequency telegraph working via satellites with the following countries:

— India

— Egypt (via Italy)

— Federal Republic of Germany

— United States of America (via Italy)

D. Television service

During 1971, Kuwait received a large number of telecasts of important sports and cultural events from North America, Europe and Asia.

Such activities are expected to increase further during the future.

MEXICO

Introduction

Mexico has been interested in space communications ever since INTELSAT was set up on 20 August 1964, and on 25 August 1966 it signed the agreements making it a member of the organization.

In 1967 it acquired under contract the equipment and systems needed for an earth station. This came into service with the transmission of television pictures of the Olympic Games in Mexico in October 1968, using the *ATS-3* satellite for channelling the information.

On 13 January 1969, the earth station of Tulancingo (so-called because it is located near the town of this name) for the first time gained access to a satellite of the INTELSAT series and established telephone communication with several countries, members of the Consortium.

Since the introduction of the system, technical developments have led to improvements in equipment and in the quality of the information channelled and this, in turn, has resulted in increased services and a more efficient use of the system.

Tulancingo earth station

Operational capacity

The initial acquisition of equipment for this earth station was planned on the basis of receiving up to seven telephone carriers—two fully redundant with automatic switching and five sharing two common standby equipments. It soon became necessary to increase the number of pre-assigned receiving carriers and to use part of the standby equipment to receive three additional carriers, thus raising the total capacity to ten. This expansion lessened the reliability of the links set up, producing an immediate demand for new equipment.

The new equipment contracted for during 1971 to increase reliability in the reception of the pre assigned carriers, together with the contract for the Spade system at the end of the same year, will enable the Tulancingo station as from 1972 to meet the country's demand for telephone circuits via satellite for a reasonable period.

In addition to the telephone facilities, the Tulancingo station possesses installations for receiving one television carrier and two television sound carriers. In 1972, equipment will be added to duplicate the receiving capacity for this service.

Circuits in service

At the end of 1971, the situation with regard to satellite circuits in service (4 kHz) via the Tulancingo station was the following:

country	number of circuits
Germany (via France)	1
Argentina	2
Brazil	2
Chile	2
Colombia	2
Spain	10
France	4
England (via Spain)	2
Italy	7
Panama	3
Peru	3
Venezuela	4
total	42

One of the circuits to Italy is occupied by 24 telegraph channels of which three are directed to Tokyo (Japan), two to Berne (Switzerland) and the remaining 19 to the service with Italy.

Distribution in the baseband

The present capacity of the carrier transmitted by Tulancingo, 6281.25 MHz, is 60 channels with a bandwidth of 4 kHz. Subsequently, in phase III of the *Intelsat-IV* transition plan in the Atlantic region—i.e. in the first quarter of 1972—the capacity of the transmission carrier will be increased to 96 channels with a bandwidth of 7.5 kHz.

The channels are distributed within the carrier as indicated in the table.

Group A				
channel	frequency (kHz)	country	class	use
1	13	Italy	M1	speech
2	17	Italy	M2	speech
3	21	Italy	M3	speech
4	25	Italy	T1	telegraphy
5	29	Italy	M4	speech
6	33	Italy	M5	speech
7	37	France	M1	speech
8	41	France	M2	speech
9	45	France	M3	speech
10	49	France	M4	speech
11	53	Italy	M6	speech
12	59	Germany *	T1	telegraphy
Supergroup 1				
Group 5				
channel	frequency (kHz)	country	class	use
1	107	Peru	M1	speech
2	103	Peru	M2	speech
3	99	Colombia	M1	speech
4	95	Colombia	M2	speech
5	91			
6	87			
7	83			
8	79			
9	75	Venezuela	M1	speech
10	71	Venezuela	M2	speech
11	67	Venezuela	M3	speech
12	63	Venezuela	M4	speech

* via France

95

channel	frequency (kHz)	country	class	use
Group 4				
1	155	Spain	M1	speech
2	151	Spain	M2	speech
3	147	Spain	M3	speech
4	143	Spain	M4	speech
5	139	Spain	M7	speech
6	135	Spain	M8	speech
7	131	Spain	M9	speech
8	127	Spain	M5	speech
9	123	Spain	M6	speech
10	119	United Kingdom **	M1	speech
11	115	United Kingdom **	M1	speech
12	111	Spain	M10	speech
Group 3				
1	203	Chile	M1	speech
2	199	Chile	M2	speech
3	195	Argentina	M1	speech
4	191	Argentina	M2	speech
5	187	Panama	M1	speech
6	183			
7	179			
8	175			
9	171	Panama	M2	speech
10	167	Panama	M3	speech
11	163	Brazil	M2	speech
12	159	Brazil	M1	speech

** via Spain

Group 2 of Supergroup 1 (204-252 kHz) is assigned for future traffic witl. Germany.

Television programmes

Transmission

Few television programmes were transmitted via satellite in 1971 compared with previous years. Diagram 1 shows television transmission times since the Tulancingo earth station started operation.

Reception

There was a slight increase in the reception of television programmes in 1971, as shown in diagram 2.

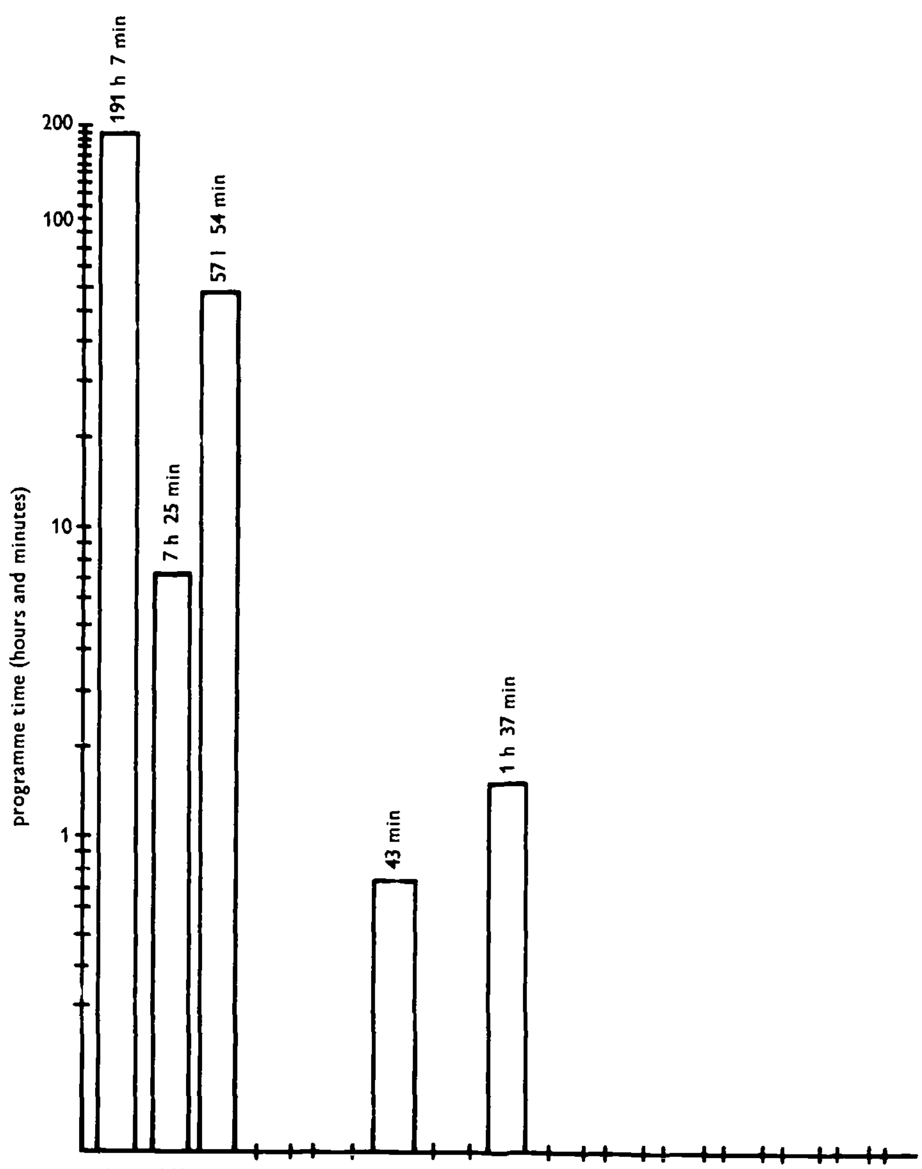


Diagram I
Television programmes—transmission time

97.

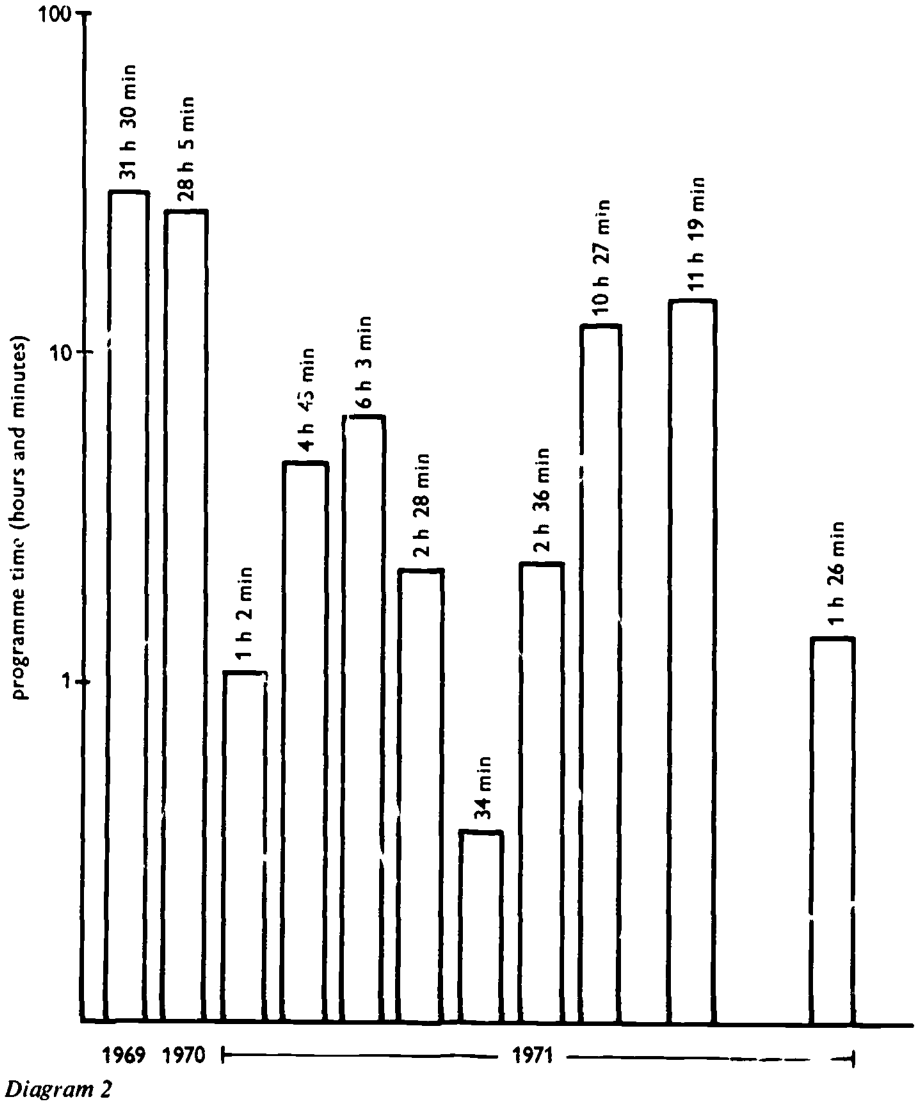


Diagram 2
Television programmes—reception time

Data transmission tests

In 1971, tests on data transmission via satellite were conducted between banking organizations in Mexico, Brazil and Italy with saitsfactory results.

Operation with the " Intelsat-IV F2 " satellite

In March, there was a changeover from operation with the *Intelsat-III F6* satellite to the *Intelsat-IV F2*, both located over the

9.8

Atlantic Ocean, according to a transition plan which involved reassignment of the carrier frequencies.

The change of satellite improved the operational angle of elevation of the Tulancingo earth station antenna from an average of 3 to almost 7 due to the more westerly siting of the new satellite.

New projects

1971 saw the beginning of a study on the technical and economic feasibility of constructing a second earth station working in the Atlantic region in 1974.

In addition, equipment was acquired by contract for the installation in the Tulancingo station of the facilities required for integration into the Spade system.

Participation in meetings and international co-operation

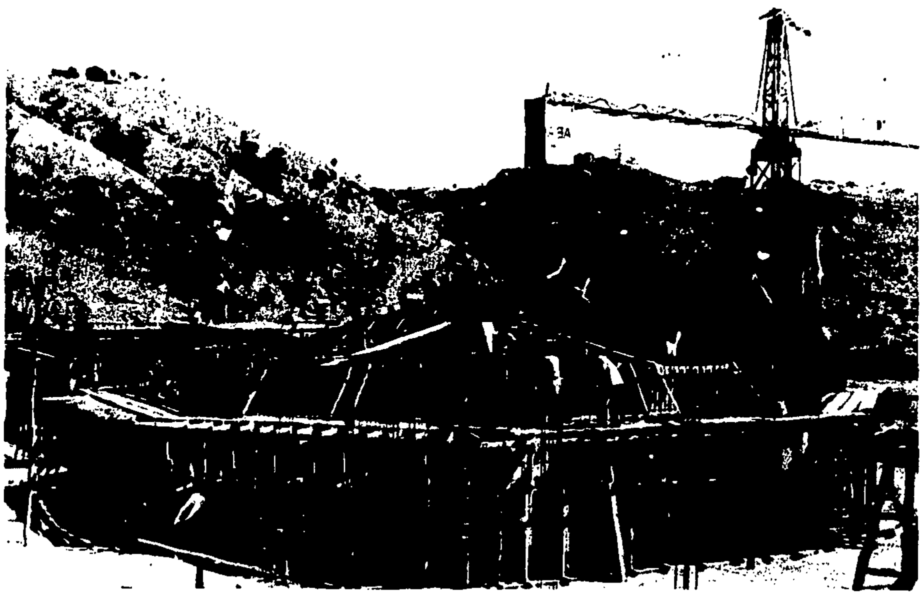
In 1971, Mexico was represented regularly at the general meetings of the ICSC and at the Plenipotentiary Conference of INTELSAT at which the Agreements establishing Definitive Arrangements for the Consortium were approved.

In June and July, Mexican representatives attended the World Administrative Radio Conference for Space Telecommunications in Geneva and meetings of the Inter-American Telecommunications Commission held in Caracas, Venezuela.

In September and October, Mexico acted as host country for the ITU seminar on frequency management which included a lecture on space communications.

Also in October, Mexico took an active part in the seminar held in Washington, DC on the operation of earth stations.

NICARAGUA



Work in progress on the NICATELSAT earth station

(Dirección General de Telecomunicaciones y Correos, Nicaragua)

The *Compañía Nicaragüense de Telecomunicaciones por Satélite* (NICATELSAT), the Nicaraguan telecommunication satellite company was set up on 5 August 1971.

On 24 September, contracts were signed with *Mitsubishi Shoji Kaisha Limited* and *Mitsui and Company Incorporated* for the construction of a communication satellite earth station some 8 km south-west of Managua. Construction work is now under way and delivery scheduled for 1 October 1972.

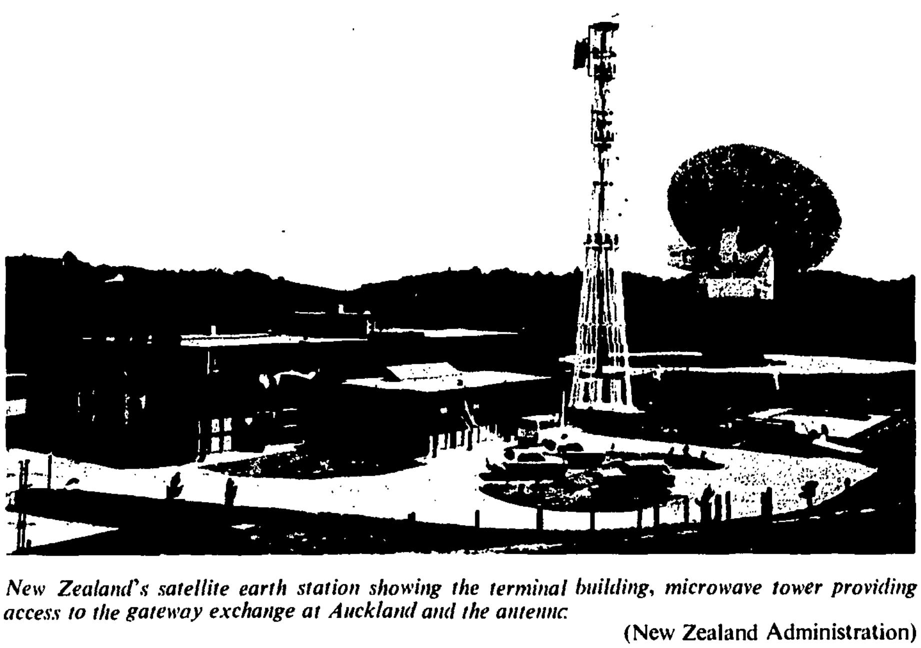
NEW ZEALAND

New Zealand's satellite earth station, sited near Warkworth, approximately 55 km north of Auckland, officially came into operation in July 1971 and has provided considerable relief on the congested *Compac* cable.

The station, which meets standard INTELSAT operational specifications, is at present working with the *Intelsat-III* satellite over the Pacific Ocean, but will later switch to an *Intelsat-IV* satellite.

Basic characteristics of the station

- opened:
  17 July 1971
- total area of land for station development:
  16.6 hectares
- number of people to maintain station:
  18
- mains power requirements:
  - initially: 250 kW;
  - ultimately: 500 kW



New Zealand's satellite earth station showing the terminal building, microwave tower providing access to the gateway exchange at Auckland and the antenna

(New Zealand Administration)

— administration and equipment building size:
1208 m²

— maximum height of antenna from ground level:
36.57 m

— diameter of dish:
30.48 m.

Station limitations

1. Antenna

a) Minimum operating angle of elevation

8°. Below this angle, an increase in noise level will occur.

b) Tracking limits

The antenna can continuously track a quasi-stationary satellite. The satellite can be tracked in azimuth ±170° on true north and in elevation 0-90° (but see 1 *a)* above).

2. Radome

Not provided.

3. Weather extremes

Can withstand 67.3 m/s (242 km/h) winds. Operates with degraded performance up to 44.8 m/s (161 km/h). Drives to stow at 53.7 m/s (193 km/h).

Available equipment

1. Transmit

One 10 MHz transmit message chain plus one spare, partially equipped.

2. Receive

Three 10 MHz receive message chains plus one spare, partially equipped.

3. Television

a) Audio

One transmit and two receive chains. The second receive chain can also be used as a contingency chain.

b) Video

One transmit, one receive.

c) Standards conversion

The station is equipped with a television standards converter which can convert television signals from 625/50 to 525/60 and vice-versa (monochrome) and from *PAL* to *NTSC* and vice-versa (colour). Conversion can be provided on transmission, reception, or transit services.

4. For contingency purposes

a) Transmit

One 10 MHz chain plus one 5 MHz chain when not used for television audio.

b) Receive

Two 20 MHz chains. The second contingency chain is shared with the television audio chain.

Note—Television and contingency services cannot be operated simultaneously.

5. Beacons

Provision has been made for beacon reception on 3934 and 3967 MHz.

6. Engineering service circuits

The message and contingency and television-audio carriers are each equipped with two voice channels and ten telegraph channels.

Additional information—future plans

A second message up chain has been provided for future use.

NETHERLANDS (KINGDOM OF THE)

Experiments with the " ATS-3 " technological satellite

In 1971 the Netherlands PTT completed a programme of VHF communication trials with shipping via the *ATS-3* satellite.

The Mojave earth station in the United States, an experimental earth station at Kootwijk in the Netherlands and two ships, the *Nieuw Amsterdam* and the *Atlantic Crown* took part in this programme, the purpose of which was to evaluate the respective advantages of various narrow-band modulations:

- frequency modulation (16 kHz bandwidth) and single-sideband modulation for telephone selective calling and facsimile transmissions;
- frequency-shift modulation (85 Hz shift) for multi-channel direct printing radiotelegraphy.

The results of these trials show that fairly accurate communications with shipping via VHF satellites, can be obtained with the three modulation systems tested.

Research on frequencies above 10 GHz

The Netherlands Administration has begun to construct an experimental earth station primarily intended for participation in the *Sirio* programme. The station will be equipped with a parabolic Cassegrain antenna, 10 m in diameter. The antenna can be steered in all directions with the aid of automatic and programmed tracking systems.

The accuracy of the main antenna surface permits working on frequencies up to 40 GHz.

PORTUGAL

Economic and technical studies are in progress with a view to the construction of three earth stations. Two of these stations are for the Portuguese Oversea Provinces (Angola and Mozambique) and the third for Lisbon; all are to work with the INTELSAT Atlantic Ocean satellite.

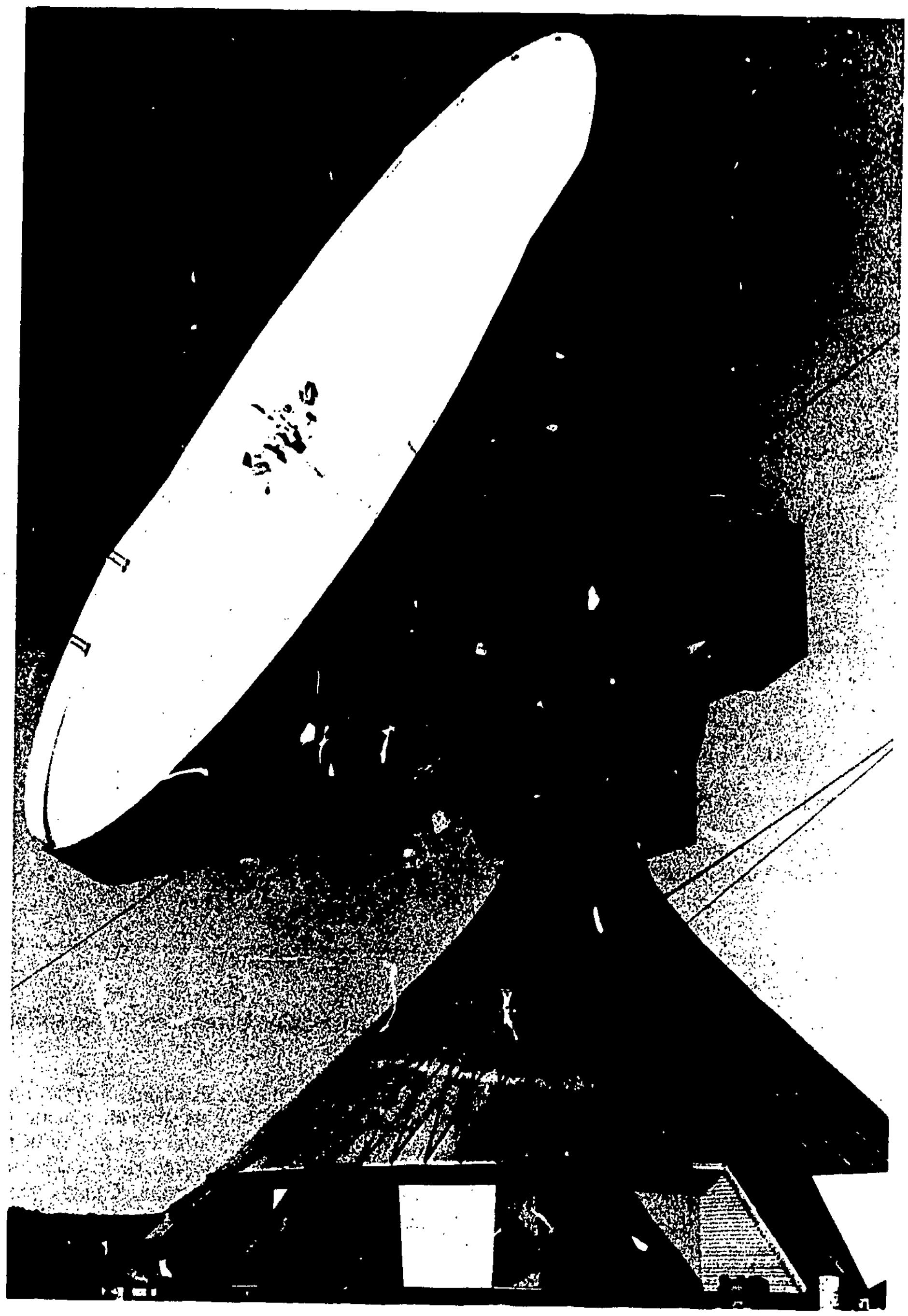
FEDERAL REPUBLIC OF GERMANY

1. Satellite telecommunication service

1.1 Satellite telecommunications via the Raisting earth station continued to expand in 1971. In the Indian Ocean region, new links were opened to Australia, Hong Kong and the Philippines; traffic with Iran was established in the Atlantic region.

The Raisting 2 antenna equipments were replaced by others conforming to the parameters of the *Intelsat-IV* satellite system. Operation will be adjusted to the new transmission parameters in the spring of 1972.

Construction of the Raisting 3 antenna, begun in mid-1970, is at such an advanced stage that mechanical and telecommunication equipment can already be installed in it. During the 1972 Olympic Games, this antenna will be used for television transmission in the Atlantic region. There will be four television channels for the Munich Games, routed through the Raisting



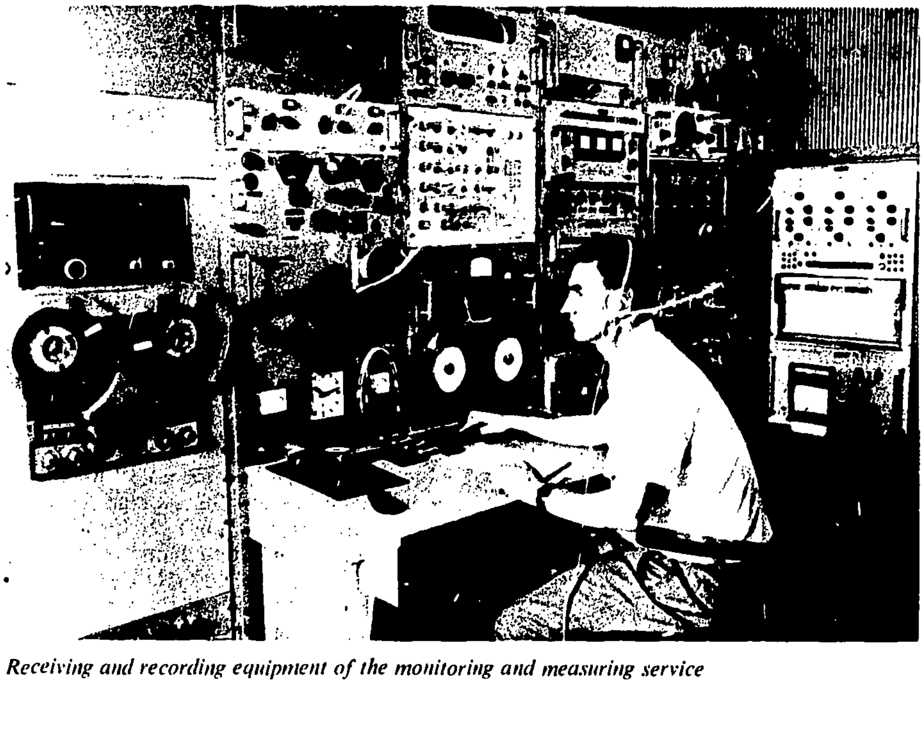
Raisting 3 antenna

(Bundesministerium für das Post- und Fernmeldewesen) antennae; after the Games, Raisting 3 will be used as a second antenna for the Atlantic region.

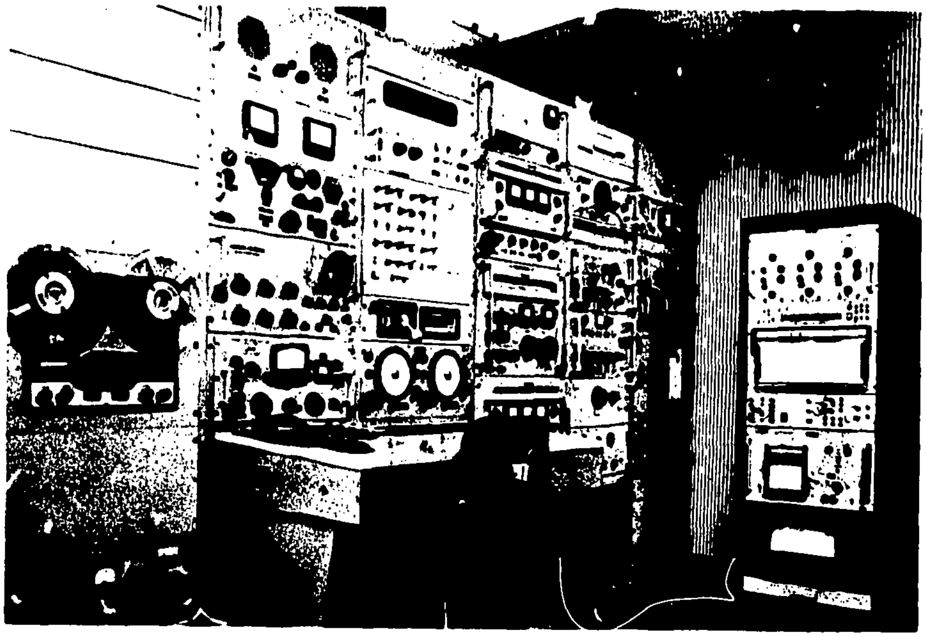
1.2 Work on the Franco-German *Symphonie* satellite project continued according to plan. On completion of the planning stage, a contract was placed for the Raisting *Symphonie* earth station. This will have a Cassegrain antenna with a figure of merit $G/T = 31.5$ dB/K for an antenna diameter of 15.5 m and a maximum e.i.r.p. of 88 dBW. The installation is to be used for an experimental Franco-German programme. The German earth station should be brought into service by early 1973.

After the project and feasibility study phases, the development of the *Symphonie* satellite was completed at the end of 1970. Tests on various preliminary models and the construction and assembly of the prototype were almost completed in 1971 and the construction of two flight models was also begun.

1.3 An experimental earth station is now being built at Leeheim in the Federal Republic of Germany for the study of propagation conditions in bands above 10 GHz. This experimental station, which will be ready in June 1972, and a transmitting station situated some distance away will initially be used to investigate precipitation scattering of microwaves, with a view to ascertaining the best bases for co-ordination of frequencies between the satellite radiocommunication service and terrestrial radio services. After the Italian



Receiving and recording equipment of the monitoring and measuring service



Other receiving and recording equipment of the monitor.ng and measuring service
(Bundesministerium für das Post- und Fernmeldewesen)

experimental satellite *Sirio* is launched, the *Deutsche Bundespost* will take part in this experimental programme through the Leeheim station.

2. Monitoring and measuring service

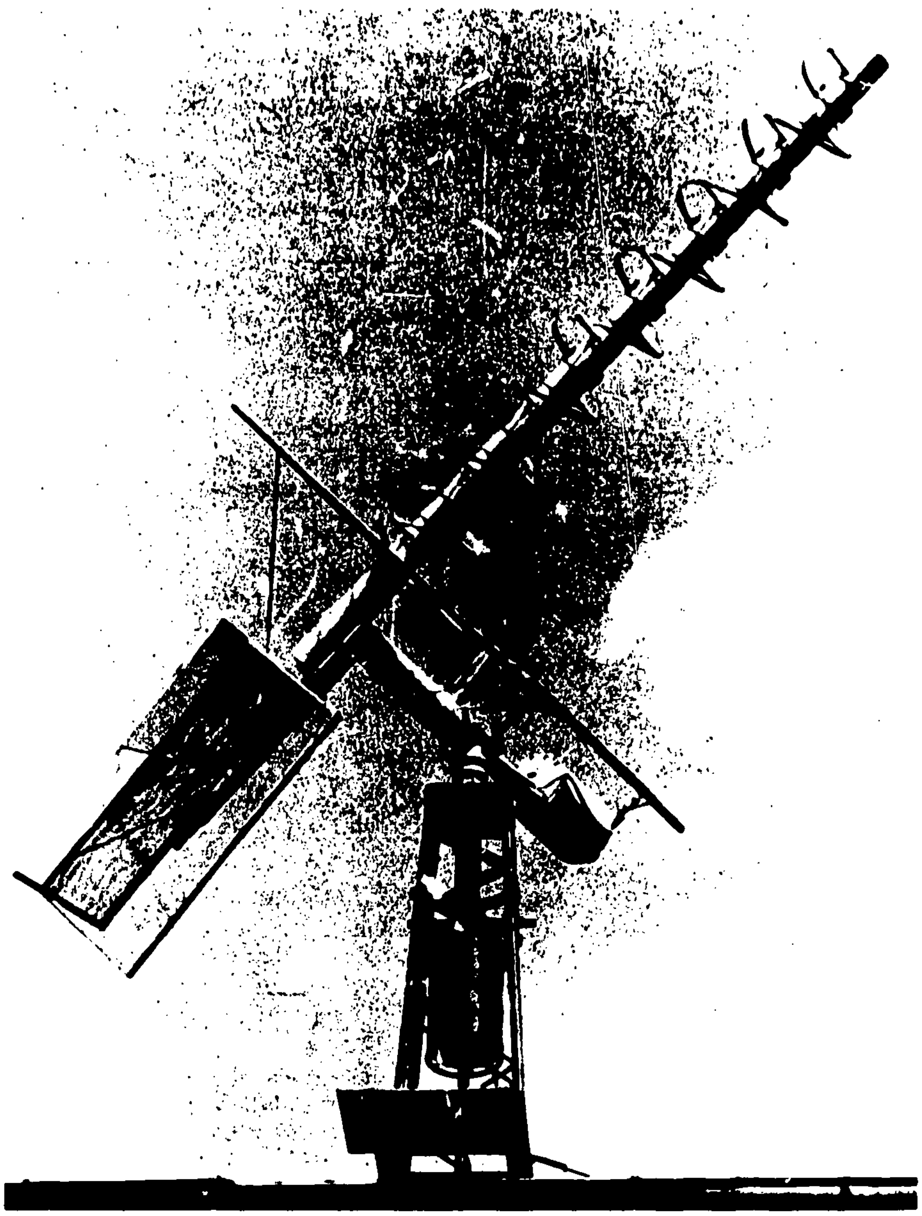
The Bundespost Monitoring and Measuring Service has an installation at Darmstadt for receiving space radio emissions between 20 MHz and 1 GHz. It is equipped for measuring field strength, frequencies and bandwidths and also for automatic monitoring of spectrum occupancy in the 80 to 470 MHz range.

A larger r..eiving installation is to be constructed which should be completed in 1975. It will cover the 135 MHz to 13 GHz range, divided into two sub-ranges, for which a common parabolic mirror antenna, 13 m in diameter, will be used.

The antenna of this installation is able to track the satellite, either automatically by the monopulse system, by programmed control, by manual steering, or by a combination of these methods. For satellite location, it is planned to have an antenna and receiver automatic station-finding system.

3. Radioastronomy service

The fully controllable radiotelescope of the *Max-Planck-Institut für Radioastronomie* was brought into service on 12 May 1971 at Effelsberg (Eifel). Its average deviation of the parabolic reflector from the parabola form is only 1 mm for a diameter of 100 m. The antenna gain at 10 GHz is 70 dB for a half-value beamwidth of the main lobe of about 1 arc minute. The antenna is commanded by a processor with a tracking accuracy of 2 arc seconds. A parametric amplifier cooled by helium gas is used as a pre-amplifier.



Antenna of the monitoring and measuring service

(Bundesministerium für das Post- und Fernmeldewesen)

4. Space research radio service

4.1 " Aeros "

The scientific mission of the *Aeros* aeronomic satellite is to study phenomena of the upper atmosphere. This is a bilateral project carried out in co-operation with NASA. The satellite is now being developed and should be launched in the autumn of 1972 by a NASA *Scout* launcher.

4.2 " Helios "

The *Helios* project, intended for solar research, is also being carried out in co-operation with NASA.

The programme comprises two probes which are to be placed in elliptical orbit round the sun at a 16-month interval from each other in 1974 and 1975. The scientific mission of these probes is to mesure solar winds, the interplanetary magnetic field, cosmic radiation, zodiacal light and cosmic dust in interplanetary space.

The launcher will be of the *Titan-III D-Centaur* type. Provisional analyses indicate that with its aid it will be possible to approach the sun to within 0.25 of an astronomical unit.

UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND, THE CHANNEL ISLANDS AND THE ISLE OF MAN

A. Satellite communications

a. Operational activities and earth station developments

1. The United Kingdom continues to participate fully in the INTELSAT Consortium and to make extensive use of its facilities. Terminals 1 and 2 at Goonhilly earth station are operating with the Indian and Atlantic Ocean region *Intelsat-III* satellites respectively. During 1971, direct satellite services were established with Nigeria, Trinidad, India, Singapore and Hong Kong. Satellite service with Iran and Nigeria was re-routed via Italy when those administrations transferred their operations to the *Intelsat-IV* satellite in late 1971.

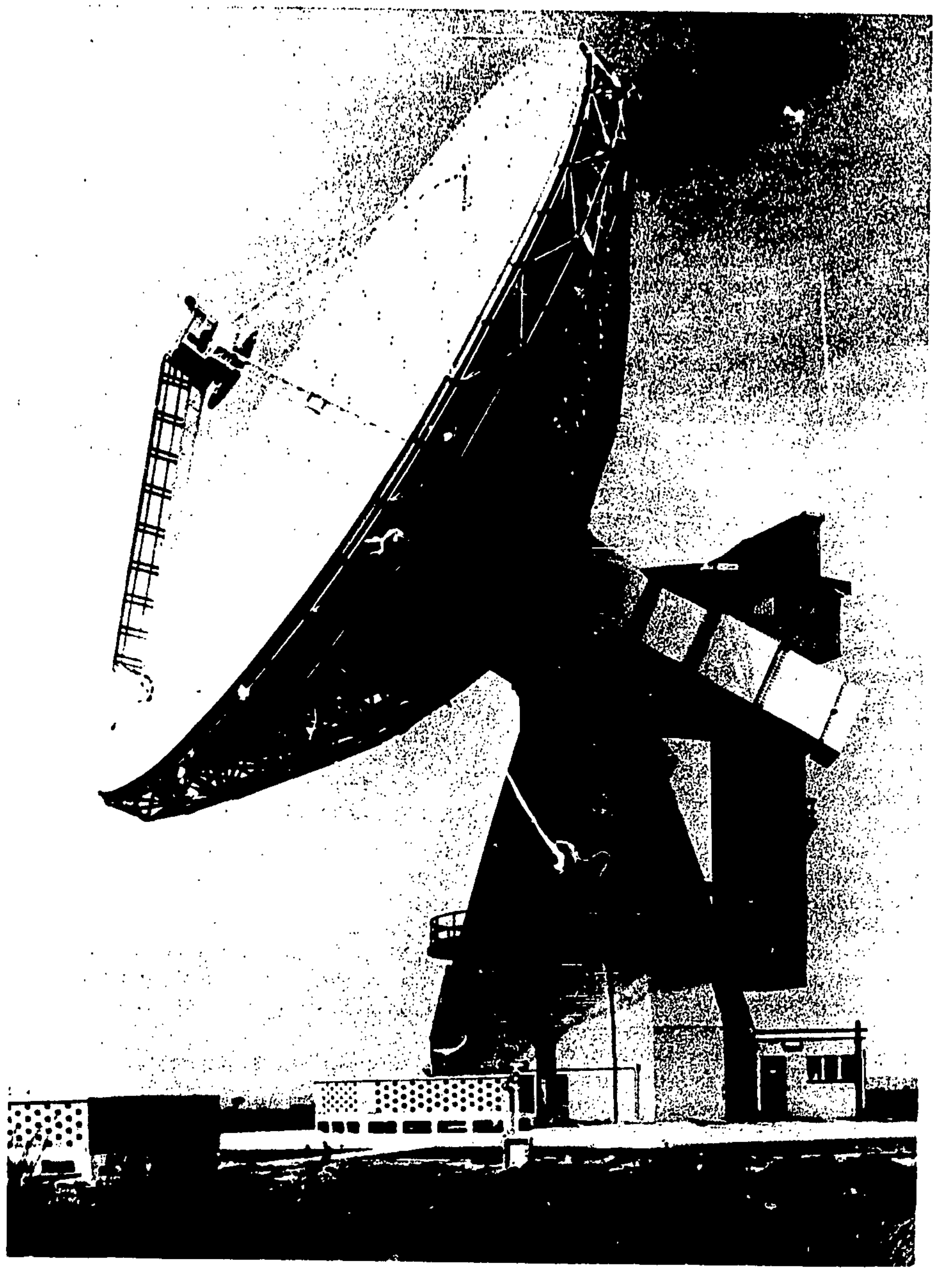
■ By September, the United Kingdom had 262 direct telephone circuits via the Atlantic and 129 circuits via the Indian Ocean satellites and the Goonhilly earth station. In addition, Goonhilly carried 72 circuits for other administrations and provided occasional television service.

2. Throughout 1971 Goonhilly continued to provide the (interim) technical and operational control centre and the associated monitoring facilities for the Indian Ocean region of the INTELSAT system.

■ Construction of the third aerial system at Goonhilly (described in the 1970 Report) is nearing the final stages and the terminal will be in service (with an Atlantic *Intelsat-IV* satellite) by mid-1972. Soon after Goonhilly 3 is brought into service, the Goonhilly 2 system will be rearranged to carry the heavy-stream transatlantic services via a second *Intelsat-IV* satellite. Spade equipment for 24 channels will be available for use in the Atlantic zone by early 1973.

■ Other innovations being introduced at Goonhilly include processor-controlled switching and signalling equipment for the engineering service circuits and a computer-controlled monitoring and data logging system.

3. Experimental and development work is being expanded. A 9 m diameter steerable aerial for experimental work has recently been installed at Goonhilly. Studies of methods of improving the efficiency and reliability of earth stations are in hand; in particular, a development contract has been placed for work on the linearization of high power travelling wave tubes and a study is being made " in-



Goonhilly aerial No. 3 during final stages of construction, April 1972

(United Kingdom Post Office)

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house " of the practicability of computer-aided control of earth stations.

4. In the Overseas Territories for whose external relations the United Kingdom is responsible, Cable and Wireless Limited is currently operating three earth stations. The Ascension Island earth station works into the Atlantic Ocean region *Intelsat-IV* satellite and is used primarily for NASA communications. The Hong Kong I earth station operates in the Pacific Ocean region *Intelsat-III* satellite zone. By the end of 1971, Hong Kong I was working circuits to Australia, Canada, Japan, New Zealand, South Korea, Thailand and the United States. The Hong Kong II earth station operates with the Indian Ocean region *Intelsat-III* satellite. The station came into service on 21 October 1971, and at the end of 1971 was working circuits to Bahrain, Germany, Indonesia, Singapore, and the United Kingdom. During 1972, it is also expected to work to India, Malaysia, Pakistan and Switzerland.

■ Hong Kong I and II earth stations each provide one unidirectional television channel. These common channels allow service with all countries working to the Pacific and Indian Ocean satellites provided their earth stations are equipped to transmit and receive television signals. Subject to the availability of facilities, each channel is available 24 hours daily, between the international television centre of Cable and Wireless in Hong Kong and the satellite, at which point the channel provided by the company connects with the channel provided by the overseas company or administration. Telecine facilities are available at both earth stations, in addition to normal services. Each is equipped for processing and monitoring 625-line 50-cycle *PAL* and 525-line 60-cycle *NTSC* television signals for either transmission or reception. One wideband audio programme channel, together with nine voice co-ordinating channels, can also be handled in either direction. Both Hong Kong I and II earth stations have been designed to withstand typhoon conditions of winds up to 338 km per hour, when their respective 27 and 29 m diameter dishes are " parked " in a horizontal position. The earth stations can also operate successfully in winds of up to 112 km per hour.

b. Propagation studies

5. During 1971, measurements were carried out at 11 and 37 GHz to evaluate the performance of the 6 m aperture steerable offset Cassegrain antenna constructed at the United Kingdom Post Office Research Department at Martlesham Heath, Suffolk. Plans for equipping this antenna for use with the *Sirio* satellite are well advanced. Development of a suitable broadband helium-cooled parametric amplifier centred on 11.6 GHz, is being carried out at Martlesham.

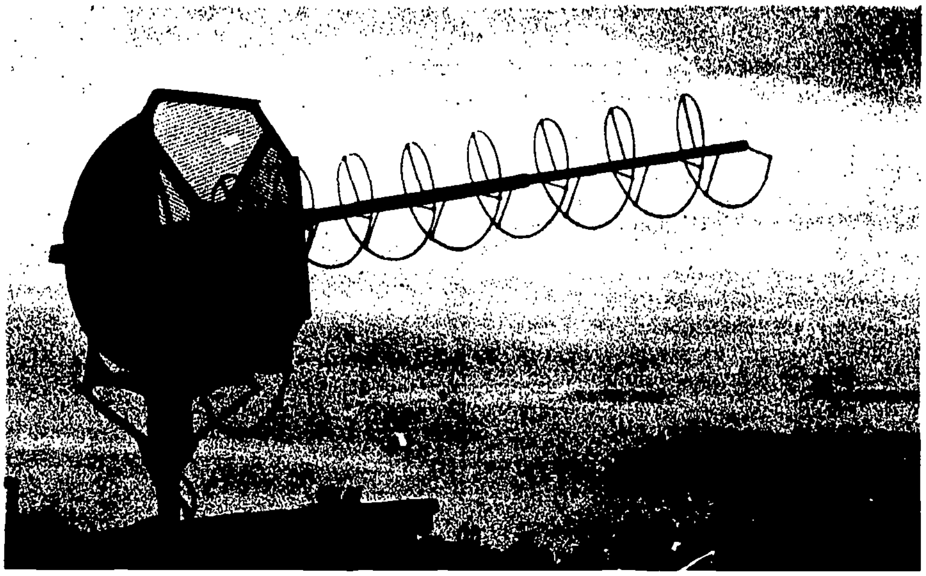
■ Measurements using a 12 GHz solar radiometer, set up to measure atmospheric attenuation for a range of elevation angles, have continued. The analyzed results of these measurements for a period of two years have been made available to the CCIR.

c. ITU Space Conference

6. The United Kingdom took an active part in the World Administrative Radio Conference for Space Telecommunications held in Geneva in June and July, and in the Special Joint Meeting of CCIR Study Groups held in February, to prepare the technical basis for the Conference.

d. ESRO applications satellite studies

7. Along with other European nations, the United Kingdom has taken part in studies of potential applications satellites within the framework of the European Space Research Organisation (ESRO). Applications for which programmes have been prepared are in the fields of aeronautical and meteorological satellites, and for a telecommunications satellite (see *e)* below).



Automatic picture transmission (APT) ground receiving equipment

The 6 m steerable aerial used for satellite propagation studies in the 10-40 GHz frequency range at the Post Office research station, Martlesham Heath (near Ipswich), Suffolk

(United Kingdom Post Office)

e. European telecommunications satellite project

8. The United Kingdom has participated in studies carried out within the framework of the European Space Conference (ESC) by representatives of the European Space Research Organisation, the European Conference of Postal and Telecommunications Administrations (CEPT) and the European Broadcasting Union (EBU). The studies have been concerned with the development of a European satellite system for telephony and television using frequencies in the 12 to 14 GHz range. Discussions are currently proceeding in ESRO Committees on the relative technical merits of possible options.

f. Consultancy services—United Kingdom Post Office and Crown Communications

9. Crown Communications, an association of the United Kingdom Post Office and Crown Agents, have recently completed their advisory services in connection with the installation of Singapore's earth station at Sentosa and assisted the Singapore Telecommunications Department in the acceptance testing and commissioning of the station.

■ Crown Communications, through the United Kingdom Post Office, is currently providing a complete consultancy service for the Zambia earth station project. Complete tender documents have been prepared and issued on a world-wide basis and tenders are now being evaluated in London.

g. United Kingdom Post Office training courses

10. The United Kingdom Post Office Engineering Training School at Leafield near Oxford continued to provide residential courses for technicians on satellite earth station principles and practice. During 1971, four courses were provided for 84 students from nine different administrations. Further courses are planned for 1972 and although the demand for seats is heavy, a few vacancies still exist.

Cloud systems received by APT

(United Kingdom Post Office)

■ The United Kingdom Government, at the July meeting of the Scientific and Technical Sub-Committee of the United Nations Committee on the Peaceful Uses of Outer Space, offered to students from developing countries a number of scholarships for the United Kingdom Post Office satellite training courses at Leafield. The United Kingdom Government will meet the subsistence and training costs of candidates while the travelling costs to and from the United Kingdom are to be met by the nominating administrations.

h. Meteorology

11. The offices in the United Kingdom and those at locations abroad equipped with suitable receiving equipment have continued to make the fullest possible use of pictorial information obtained from available meteorological satellites. In addition, the United Kingdom Government under the Voluntary Assistance Programme of the World Meteorological Organization (WMO) has provided and installed suitable equipment for receiving automatic picture transmissions from weather satellites at Addis Ababa (Ethiopia) and Amman (Jordan) during 1971. Agreements have been made to provide and install similar equipment early in 1972 at Kano (Nigeria) and Legon (Ghana). In all cases, training is given to the operators of the equipment.

■ During the latter part of 1971, only one American meteorological satellite *(Essa-8)* continued to provide an operational service, and this has daylight automatic picture transmission (APT) by vidicon cameras only. Night-time satellite observations, as well as APT, were obtained from the American *Noaa-1* (also known as *Itos-2*) satellite as long as it was in service. A number of other American meteorological satellites either ceased to provide a service or, in the case of *Noaa-2* (also known as *Itos-B*), failed to go into orbit during the year. It is thought that *Essa-8* will be the last American observational satellite to carry the daylight APT system, and any that are put into service during 1972 will provide read-out based on scanning radiometer techniques. To meet this situation action is in hand to procure suitable ground recording equipment.

B. Space research relevant to radiocommunications

12. A further satellite in the United Kingdom national programme was successfully launched on 11 December 1971. Known as *Ariel-IV*, this satellite will study the interactions between the plasma, electromagnetic waves and charged particle streams in the topside of the ionosphere. The scientific payload comprises a closely interrelated set of experiments measuring ionospheric and cosmic radio noise, electron temperature and density, VLF radiation and lightning discharge noise and low-energy proton and electron intensities.

■ In addition, through the launch of sounding rockets in its national programme and through participation in the scientific activities of ESRO and of NASA, the United Kingdom has supported various studies which have relevance to radiocommunications.

■ The radio and space research station at Slough is participating in the Italian *Sirio* project, in collaboration also with the United Kingdom Post Office, by which the propagation of millimetre radio waves between a satellite and earth will be studied. The station will be particularly interested in meteorological influences, in space-diversity reception on the ground, and in frequency dispersion in wideband transmissions. Ground equipment is being assembled in preparation for the launch, expected to be in 1973.

■ Millimetre-wave radiometer measurements of radiation from the sun have shown that in some circumstances bursts of noise are precursors of the incidence of protons from solar flares. The radiometer observations are also providing data relevant to the influence of meteorological factors, notably precipitation, on radiocommunication links.

■ Interferometer-measurements are being made on the 136 MHz transmissions from the satellite *Intelsat-II F2*. The phase fluctuations obtained so far during periods of scintillation correspond to a spread of incident energy not exceeding about 3 arc minutes.

■ In the investigation of deformations of dish aerials, it has been found convenient to use lasers as the basis of an optical technique. By this means, for example, it has been shown that the deformations of the 25 m dish aerial at Chilbolton are sufficiently small to make the aerial potentially of useful efficiency at a wavelength of 1 cm.

SWITZERLAND (CONFEDERATION OF)

Work on the project for building a Swiss earth station progressed according to plan in 1971.

THAILAND

The Government of Thailand, as the signatory to the Agreement Establishing Interim Arrangements for a Global Commercial Communication Satellite System, as well as to the Special Agreement, signed the Agreement relating to the International Telecommunication Satellite Organization "INTELSAT" and the Operating Agreement relating to the International Telecommunication Satellite Organization "INTELSAT" on 20 August 1971.

Two months before that date, Thailand participated in the World Administrative Radio Conference for Space Telecommunications held in Geneva and also in the first world telecommunication exhibition TELECOM 71.

1971 was also a year of great progress in space radiocommunication. An additional nine direct satellite circuits were brought into use for operation with Australia, Singapore and Italy. As regards live telecasts, many important events, such as the landing on the moon of *Apollo-14*, the World Champion Boxing Match, "Children of the World", etc. were televised via satellite to viewers in Thailand. There were also transmissions of news to foreign countries.

UNION OF SOVIET SOCIALIST REPUBLICS

For the operation of the long-distance radio telephone and telegraph system and for the transmission of central television programmes over the network of *Orbita* stations located in remote and inaccessible areas of the Soviet Union, *Molnya-I* communication satellites were launched on 23 July and 20 December 1971 (to supplement the report for 1970, it should be noted that a launching also took place on 25 December 1970).

New *Orbita* stations became operational in the report year bringing the total number of stations in service up to 37.

View of the "Orbita" network Novosibirsk earth station

(APN)

Work continues on the construction and planning of new stations.

The number of hours of transmission of central television programmes over the *Orbita* station network via *Molnya-I* satellites roughly doubled in the period 1968-1972.

Under the programme for the expansion of the communication system by means of satellites, a new *Molnya-II* satellite, equipped for operation in the SHF range, was launched in the Soviet Union on 24 November 1971 on a high elliptical orbit.

This new *Molnya-II* satellite is designed for the operation of the long-distance radio telephone and telegraph system in the Soviet Union and the transmission of central television programmes over the network of *Orbita* stations, which in the next few years will be modernized for operation in the SHF range and also for

N4

international co-operation in space telecommunications.

On 15 November 1971, the Intersputnik Agreement on the establishment of an international system and organization for space telecommunications was signed in Moscow. The founder members of Intersputnik are: Bulgaria, Cuba, Czechoslovakia, the German Democratic Republic, the Hungarian People's Republic, Mongolia, the People's Republic of Poland, Roumania and the USSR.

The purpose of the organization is to meet the requirements of the Member States for telephone and telegraph channels, colour and black and white television and the exchange of other types of information.

The Agreement, which is open to the signature or accession of other States, provides that the organization shall coordinate its activity with the International Telecommunication Union and co-operate with other organizations.

The instruments of ratification are deposited with the Government of the USSR.

The Intersputnik Agreement will be registered with the United Nations under Article 102 of the United Nations' Charter.

On 30 September 1971, an Agreement was signed in Washington between the Union of Soviet Socialist Republics and the United States of America on measures to improve the line of direct communication between the two countries. In order to improve the reliability of the direct line established in accordance with the memorandum signed on 20 June 1963, this Agreement provides for the establishment of two additional channels via satellites.

On the Soviet side, a channel will be provided by the *Molnya* system, while the United States Government will use the INTELSAT system. Earth stations will be built in the USSR for operation with INTELSAT satellites and in the United States for operation with *Molnya* system satellites.

ZAIRE (REPUBLIC OF)

1. The bringing into service of the earth station at N'Sele for satellite communications is the biggest telecommunications project to have been executed in the Republic of Zaire. The foundation stone for this station was laid on 30 June 1970. Twelve months later, on 29 June 1971, it was inaugurated by the President of the Republic and from that moment became operational.

It is a real achievement to have built, in a matter of 12 months, within the Presidential domain at N'Sele 65 km from Kinshasa, this vast complex consisting of an antenna 33 m in diameter, a central block housing the control units, another block for the power station, a water-pumping station as well as many other amenities such as a reception hall, a drive and so on. A site has been reserved for the installation at a later date of a second antenna directed towards the satellite *Intelsat-III*, stationed above the Indian Ocean, for communication with the Far East.

The present antenna is directed towards the *Intelsat-IV* satellite above the Atlantic.

1.1. Capacity

The capacity is adjustable and may be extended up to 300 channels or more, depending on the equipment added. At present, the station operates 24 telephone circuits of which 17 are in operation, and has a television band for transmission of *Eurovision* and *Mondovision* programmes in black-and-white and in colour.

The following international circuits are operated:

— to Brussels, via France (Pleumeur-Bodou)
— to the United States (via *Intelsat-IV*)
— to Italy (via *Intelsat-IV*).

The annexed statistics show the impact that the earth station has already had on the volume of international traffic, which has increased by 20% since June. The users welcome particularly the clarity and quality of transmission and the fact that the waiting time for a call is now shorter because there are more circuits available.

1.2 Reception

By means of its repeater 12 the station receives foreign television programmes on 525 lines/60 frames *NTSC* which are converted by the station transformer to the 625 line/50 frame standard. The programmes are transmitted by coaxial cable and then by a radio circuit to the Voice of Zaire studio (Ministry of Information) which receives them in colour on closed circuit and broadcasts them in black and white because there is no colour equipment available.

The *Apollo-15* programme and the landing on the moon of the astronauts Scott, Warden and Irwin as well as many sports events, have been received live in Kinshasa. The Olympic Games of 1972 will likewise be retransmitted live.

1.3 Telemetry

The station is also equipped with telemetric systems which are not at present in use.

1.4 Spade equipment

Spade equipment, which will be one of the first of its kind available in Africa, is to be ordered shortly. It has been chosen so as to establish direct contact between the N'Sele earth station and the other stations on the African continent. It will provide an intermittent connection with a number of countries which at present maintain a direct, permanent and very costly, link with the Republic of Zaire.

2. The second important achievement in 1971 was the automation of the telex network which, from Kinshasa, provides direct access to the international telex network.

The balance for the past year reflects a very satisfactory state of affairs. The result of the introduction into service of this extensive infrastructure will be even more striking when the terminal equipment has been installed and when the radio-relay axes are all in operation; the first of these has been in service since 1970, the second is now being installed and the third and fourth are in the course of study.

N'Sele earth station

Characteristics

— location:
04° 11′ 50.71″ S
15° 36′ 21.31″ E
— transmission frequency:
6006.25 MHz
— bandwidth:
2.5 MHz
— capacity:
60 circuits
— spot beam East transponder:
2
— number of circuits available:
24

Baseband distribution

— channels 1 to 8:
8 telephone channels
Kinshasa—Brussels

■ *Supergroup 1*ot
— channels 9 and 10:
2 telephone channels carrying voice-frequency telegraphy
Kinshasa—Brussels

■ *Group 5*
— channels 11 and 12:
2 telephone channels
Kinshasa—Paris (transit)

■ *Group A*

— channels 8-10:
2 telephone channels
Kinshasa-Paris

— channel 11:
1 telephone channel carrying voice-frequency telegraphy
Kinshasa—Paris

— channel 12:
1 channel
Kinsnasa-New York
1 channel
Kinshasa—Italy and Southern Europe.

Kinshasa—Brussels telephone traffic statistics

		Kinshasa—Brussels			Brussels—Kinshasa			totals		
1971		direct	TST	total	direct	TST	total	direct	TST	total
June *	C	2 445	672	3 117	1 386	485	1 871	3 831	1 157	4 988
	M	19 573	5 064	24 637	10 219	3 498	13 757	29 737	8 562	38 354
July *	C	3 098	1 059	4 157	1 501	642	2 143	4 599	1 701	6 300
	M	27 529	9 098	36 627	12 968	5 441	18 409	40 497	14 539	55 036
August	C	3 292	923	4 215	1 661	667	2 328	4 953	1 590	6 548
	M	30 151	8 576	38 727	14 251	6 088	20 339	44 402	14 664	59 066
September	C	3 360	1 012	4 372	2 057	693	2 750	5 417	1 705	7 121
	M	31 736	9 899	41 241	18 241	6 770	24 011	49 977	16 669	66 646
October	C	3 636	927	4 563	1 973	590	2 563	5 609	1 517	7 126
	M	35 297	9 014	44 411	16 956	5 193	22 149	52 753	14 207	66 560
November	C	3 534	1 297	4 831	1 726	617	2 343	5 260	1 914	7 174
	M	34 796	12 973	47 769	14 801	5 398	20 199	49 597	18 371	67 968
December	C	3 859	1 362	5 221	1 898	703	2 601	5 757	2 065	7 822
	M	36 352	12 747	49 099	15 062	6 191	21 253	51 414	18 938	70 352
1972										
January	C	3 427	1 267	4 694	1 745	768	2 513	5 172	2 035	7 207
	M	33 373	11 032	44 405	15 332	7 222	22 554	48 705	18 254	66 959

Source: Kinshasa Telecommunication Network C = number of calls
M = duration of calls in minutes

* For purposes of comparison, the total traffic in June and July 1970 respectively was 4 165 calls lasting 29 857 min and 3 871 calls lasting 29 998 min.

Distribution of service channels

Congo—France

— pl telephony Pleumeur-Bodou
— pl C20 teletype Pleumeur-Bodou
— pl C23 TOCC teletype
— Atlantic via Pleumeur-Bodou

France—Congo

— pl telephony Pleumeur-Bodou
— pl C20 teletype Pleumeur-Bodou
— pl C23 TOCC teletype
— Atlantic via Pleumeur-Bodou.

Note.—The telegraph circuits are all operated with a modulation speed of 50 bauds and are in conformity with the standards prescribed by CCITT Recommendat n R.35 with 60 Hz spacing betweeni wo characteristic frequencies.

The signalling current of the telephone circuits is at frequency 500/20 Hz (CCITT Recommendation Q.1).

Kinshasa—Paris telephone traffic statistics

	Kinshasa—Paris			Paris—Kinshasa			totals		
1971	direct	TST	total	direct	TST	total	direct	TST	total
June	710 5 530	261 1 905	971 7 435	367 2 820	111 913	478 3 733	1 077 8 350	372 2 818	1 449 11 168
July									2 144 16 972
August	985 8 794	587 6 223	1 572 15 017	572 5 305	223 1 739	795 7 044	1 557 14 099	810 7 962	2 367 22 061
September	1 030 9 403	681 6 909	1 719 16 312	720 5 594	241 1 830	961 7 424	1 758 14 997	922 8 739	2 680 23 736
October	991 9 773	652 6 089	1 643 15 862	625 4 982	191 1 537	816 6 519	1 616 14 755	843 7 626	2 459 22 381
November	807 6 990	661 6 013	1 468 13 003	634 5 069	180 1 515	814 6 584	1 441 12 059	841 7 528	2 281 19 587
December	948 8 344	621 5 451	1 569 13 795	658 5 071	165 1 195	823 6 266	1 606 13 415	786 6 646	2 392 20 061
1972									
January	973 8 307	622 5 351	1 595 13 658	728 5 099	199 1 556	927 6 655	1 701 13 406	821 6 907	2 522 2 031

Telecommunication statistics

services	year	9 months	
		1970	1971
Telecommunications			
1. Telephony			
● *internal traffic*			
— outgoing: number of calls	307 500	230 625	261 367
number of minutes	2 347 935	1 760 949	1 249 420
— incoming: number of calls	115 966	86 973	155 088
number of minutes	1 143 789	857 841	929 277
— total: number of calls	423 466	317 598	416 455
number of minutes	3 491 724	2 618 790	2 178 697
● *international traffic*			
— outgoing: number of calls	72 576	44 121	51 253
number of minutes	862 172	330 060	380 025
— incoming: number of calls	40 854	29 136	26 034
number of minutes	321 490	207 503	199 242
— total: number of calls	113 430	73 257	77 287
number of minutes	1 183 662	537 563	579 267
2. Telex			
● *internal traffic*			
— outgoing: number of calls	21 278	15 957	22 538
number of minutes	235 033	176 274	209 748
● *international traffic*			
— outgoing: number of calls	49 150	36 [illegible]	56 621
number of minutes	363 430	272 571	429 781
3. Telegraphy			
● *internal traffic*			
— outgoing: number of calls	1 410 734	1 058 049	1 349 546
— incoming: number of calls	1 440 562	1 080 420	1 270 278
— total: number of calls	2 851 296	2 138 469	2 619 824
● *international traffic*			
— outgoing: number of calls	108 359	71 849	94 106
— incoming: number of calls	115 159	65 655	109 093
— total: number of calls	223 518	137 504	203 199

ZAMBIA (REPUBLIC OF)

An earth station operating via the Indian Ocean satellite is planned to come into service in late 1973. Tenders are now being adjudicated and the contract may be awarded shortly.

ANNEX 2

Resolutions adopted by the United Nations

UNITED NATIONS

Resolutions adopted by the General Assembly at its Twenty-sixth Session

■ Resolution 2776 (XXVI)

2776 (XXVI)

International co-operation in ne peaceful uses of outer space

The General Assembly,

Recalling its Resolution 2733 (XXV) of 16 December 1970,

Having considered the report of the Committee on the Peaceful Uses of Outer Space[1],

Reaffirming the common interest of mankind in furthering the exploration and use of outer space for peaceful purposes,

Continuing to believe that the benefits deriving from space exploration can be extended to States at all stages of economic and scientific development if Member States conduct their space programmes in a manner designed to promote maximum international co-operation, including the widest possible exchange of information in this field,

Convinced of the need for continued international efforts to promote practical applications of space technology,

1. *Endorses* the report of the Committee on the Peaceful Uses of Outer Space;

2. *Invites* States which have not yet become parties to the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies and the Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects launched into Outer Space to give early consideration to ratifying or acceding to those agreements so that they may have the broadest possible effect;

3. *Reiterates* the importance of the goal of making satellite communications available to States on a world-wide and non discriminatory basis, as expressed in General Assembly Resolution 1721 D (XVI) of 20 December 1961;

4. *Takes note* of the agreements relating to space communications recently concluded between a number of States and of the desirability of keeping the United Nations currently informed concerning activities and developments in this field;

5. *Notes* the action taken by the International Telecommunication Union, through the World Administrative Radio Conference for Space Telecommunications held in June and July 1971, to allocate frequencies and to adopt administrative procedures for all kinds of space communications, and recommends that the Union and its specialized bodies, as well as the members of the Union, should apply these provisions with a view to promoting the use of space communications for the benefit of all countries in accordance wit' he relevant resolutions of the General Assembly;

6. *Welcomes* the progress achieved by the Committee on the Peaceful Uses of

[1] *Official Records of the General Assembly, Twenty-sixth Session*, Supplement No. *20* *(A/8420)*.

Outer Space in its efforts to encourage international programmes to promote practical applications of space technology for the benefit of all countries and commends to the attention of Member States, specialized agencies and interested United Nations bodies the programme contained in the report of the Scientific and Technical Sub-Committee of the Committee [2];

7. *Takes note with appreciation* of the valuable work carried out by the Secretary-General within the framework of the programme for promoting the application of space technology in accordance with the relevant recommendations of the Committee on the Peaceful Uses of Outer Space and resolutions of the General Assembly;

8. *Endorses* the resolution contained in paragraph 15 of the report of the Committee on the Peaceful Uses of Outer Space and recommends the continuation and development of the programme for promoting the practical applications of space technology taking into account the needs of the developing countries;

9. *Welcomes* the efforts of a number of Member States to share with other interested Member States the practical benefits that may be derived from programmes in space technology;

10. *Welcomes* the progress achieved in international co-operation among Member States in space research and exploration, including the exchange and analysis of lunar material on a broad international basis and studies of the development of compatible rendezvous and docking systems for manned spacecraft;

11. *Welcomes also* the action of a number of States and of the Food and Agriculture Organization of the United Nations in promoting international co-operation in education and training in the peaceful uses of outer space and endorses the appeal made to other States by the Committee on the Peaceful Uses of Outer Space for similar contributions to international education and training in this field;

12. *Approves* continuing sponsorship by the United Nations of the Thumba equatorial rocket launching station in India and the Celpa Mar del Plata Station in Argentina, expresses its satisfaction at the work being carried out at these ranges in relation to the use of sounding rocket facilities for international co-operation and training in the peaceful and scientific exploration of outer space, and recommends that Member States continue to give consideration to the use of these facilities for appropriate space research activities;

13. *Welcomes* the efforts of Member States to keep the Committee on the Peaceful Uses of Outer Space fully informed of their space activities and invites all Member States to do so;

14. *Notes* that, in accordance with General Assembly Resolution 1721 B (XVI) of 20 December 1961, the Secretary-General continues to maintain a public registry of objects launched into orbit or beyond on the basis of information furnished by Member States;

15. *Takes note with appreciation* of the activities of the World Meteorological Organization during the past year, as reported to the Committee on the Peaceful Uses of Outer Space [3], in particular the measures taken in implementation of General Assembly Resolution 2733 D (XXV) requesting the World Meteorological Organization to mobilize technical resources in order to discover ways and means of mitigating the harmful effects and destructive potential of tropical storms;

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[2] *A/AC.105/95*, section I.

[3] See *A/AC.105/PV.100*.

16. *Takes note* of the programmes currently being undertaken by the United Nations Educational, Scientific and Cultural Organization and the International Telecommunication Union in satellite broadcasting for the purpose of contributing to the advancement of education and training, and *draws attention* to the fact that questions relating to the legal implications of space communications are also on the agenda of the Legal Sub-Committee of the Committee on the Peaceful Uses of Outer Space, with which the two agencies should co-ordinate their activities in this field;

17. *Requests* the specialized agencies and the International Atomic Energy Agency to continue, as appropriate, to provide the Committee on the Peaceful Uses of Outer Space with progress reports on their work relating to the peaceful uses of outer space and to examine and report to the Committee on the particular problems which arise or may arise from the use of outer space in the fields within their competence and which should, in their opinion, be brought to the attention of the Committee;

18. *Endorses* the recommendations contained in paragraph 38 of the report of the Committee on the Peaceful Uses of Outer Space concerning the future work of its Legal Sub-Committee;

19. *Requests* the Committee on the Peaceful Uses of Outer Space to continue its work as set out in the present resolution and in previous resolutions of the General Assembly and to report to the Assembly at its twenty-seventh session.

Resolution 2778 (XXVI)

2778 (XXVI)

Convening of the Working Group on Remote Sensing of the Earth by Satellites

The General Assembly,

Recalling its Resolution 2733 C (XXV) of 16 December 1970 in which it requested the Scientific and Technical Sub-Committee of the Committee on the Peaceful Uses of Outer Space, as authorized by the Committee to determine at what time and in what specific frame of reference a working group on earth resources surveying, with special reference to satellites, should be convened,

Welcoming the decision of the Sub-Committee at its eighth session to establish and convene a Working Group on Remote Sensing of the Earth by Satellites [1],

Sharing the view expressed by the Committee on the Peaceful Uses of Outer Space in the report on its fourteenth session that the potential benefits from technological developments in remote sensing of the earth from space platforms could be extremely meaningful for the economic development of all countries especially the developing countries, and for the preservation of the global environment [2],

Noting that the Working Group on Remote Sensing of the Earth by Satellites had a first organizational meeting in connexion with the fourteenth session of the Committee on the Peaceful Uses of Outer Space,

Looking forward to the early initiation of the substantive work of the Working Group, keeping in mind that experiments to test the feasibility of remote sensing

[1] *A/AC.105/95*, paragraphs 15-22.

[2] *Official Records of the General Assembly, Twenty-sixth Session*, Supplement No. *20 (A/8420)*, paragraph 10.

of the earth from space platforms are scheduled to begin early in 1972,

Expressing confidence that in discharging its responsibility the Working Group would seek to promote the optimum utilization of this space application for the benefit of individual States and of the international community,

1. *Requests* Member States to submit information on their national and co-operative activities in this field, as well as comments and working papers, through the Secretary-General to the Working Group on Remote Sensing of the Earth by Satellites;

2. *Endorses* the request of the Scientific and Technical Sub-Committee that the Working Group solicit the views of appropriate United Nations bodies and specialized agencies, and other relevant international organizations;

3. *Requests* the Secretary-General to provide the Working Group with his comments on this subject and to submit working papers on matters falling within the terms of reference of the Group;

4. *Requests* the Committee on the Peaceful Uses of Outer Space and its Scientific and Technical Sub-Committee to bring about the early initiation of the Working Group's substantive work and to keep the General Assembly informed in a comprehensive fashion on the progress of its work.