international telecommunication union

# symposium on space and radiocommunication

paris, 2 june 1969

28th international air and space show

booklet No. 4

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# symposium
# « space and radiocommunication »

organized by the

**international telecommunication union**

paris, 2 june 1969

**28th international air and space show**

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## *INTRODUCTION*

The **Symposium on Space and Radiocommunication,** organized by the International Telecommunication Union in connection with the 28th International Air and Space Show in Paris, was held on 2 June 1969.

The Symposium was sponsored by M. Yves GUÉNA, French Minister of Posts and Telecommunications, and was actually presided over by Mr. Mohamed MILI, Secretary-General of the ITU. It was opened by Mr. J. MAILLET, Commissioner-General of the International Air and Space Shows. Mr. Mili delivered the welcoming address of the ITU which was answered, on behalf of the Minister, by Mr. Marc BONNEFOUS, Principal private secretary to the Minister.

About a hundred people closely followed the talks which were given on this occasion and the ensuing discussions. The programme was divided into four parts :

1. Use of space for telecommunications :
   - Use of communication satellites at world-wide, regional and national level
   - Studies in progress
2. Radiocommunications for space activities :
   - Problems of frequency usage
   - Installation of tracking, telemetering and remote-control networks
3. Uses of space radiocommunications for meteorology, navigation, education and sound and television broadcasting
4. European programmes.

All the talks given at the symposium are reproduced below.

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## *OPENING OF THE SYMPOSIUM*

**Opening address delivered by**
**Mr. J. MAILLET, Commissioner-General**
**of the International Air and Space Shows**

I extend a special welcome to Mr. Bonnefous representing Mr. Guéna, Minister of Posts and Telecommunications, whom a most unfortunate indisposition has prevented from being here.

I should also like to greet Mr. Mili, Secretary-General of the International Telecommunication Union, Mr. John Johnson, Chairman of the Interim Communication Satellites Committee (ICSC) of INTELSAT, and Mr. Marzin Director-General of French Telecommunications.

I likewise welcome the many international organizations represented here. I will not mention them all by name — CERS/ESRO *, CECLES/ELDO **, CNES, the *Centre national d'études spatiales* — the European Broadcasting Union, several agencies of the United Nations, UNESCO, the International Civil Aviation Organization, the Inter-governmental Maritime Consultative Organization, and the World Meteorological Organization. I think it is most appropriate that this meeting, this symposium of the International Telecommunication Union, should take place within the framework of the Air and Space Show. Indeed, the subject of the symposium is, first and foremost, space and telecommunications. You will see, in the Show as a whole, a cross-cut of space activities throughout the world; that this symposium, itself placed under the space sign, should take place here is an excellent thing. But apart from this you are endeavouring, within the framework of your Union, to foster the co-operation among both official and industrial organizations. This is what we are likewise trying to do in the Air and Space Show: it comprises extensive pavilions occupied by national organizations as well as stands arranged by several hundred private undertakings showing their products. The idea is, in fact, to show that telecommunications are a necessity as far as air and space transport is concerned and that, reciprocally, the opening up of space to man will bring about a profound change in

* In French : *Organisation européenne de recherches spatiales (CERS) ;* in English : European Space Research Organisation (ESRO).

** In French : *Organisation européenne pour la mise au point et la construction de lanceurs d'engins spatiaux (CECLES) ;* in English : European Space Vehicle Launcher Development Organisation (ELDO).

procedures and possibilities of telecommunications. These ideas will, I think, find a particularly eloquent support in what we have to show you here. And then there is a common feature between your Union and this Show, that is that both are widely international. This Show is a confrontation of air and space techniques evolved throughout the world, whatever the geographical location, whatever the form of government. And I know that it is the same in your International Union. Thus it has been a good idea indeed for you to meet within our Show; I should like, in welcoming you, to thank you for the initiative you have shown and to express a wish that it may become a habit and that every other year we shall have the privilege of welcoming you again.

*(Original language : French)*

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## Welcoming address delivered by Mr. M. MILI, Secretary-General of the ITU

Your Excellency,
Ladies and Gentlemen,

While man is preparing to take his first steps on the Moon and probes made by us earthmen are soft-landing on Venus in order to lift a corner of the veil which modestly covers it, the International Telecommunication Union, which is taking part in the Air and Space Show for the first time, felt that it should organize this symposium to emphasize the exceptional importance of telecommunications in this exciting field which is opening a whole new era for mankind.

I should like to express my warm thanks to all of you who have so kindly agreed to participate in such numbers in this Symposium on Space and Radiocommunications, thus underlining the basic role of radio in any space activity, the active part played by each of the organizations you represent in the smooth development of these activities and the fundamental role of co-ordinator played by the ITU at world level in the various sectors which fall within its competence.

But before I give a brief account of ITU activity, allow me to express my great pleasure at being with you today in this beautiful city of Paris which is so dear to my heart. For, in addition to its acknowledged virtues, the city of light has a special meaning for me as Secretary-General of the ITU.

Having spent the best seven years of a man's life as a student here, I am always deeply moved to return to Paris.

But Paris is also the birthplace of the ITU. It was in the famous *Salon de l'Horloge* on the Quai d'Orsay 104 years ago, on 17 May 1865 to be precise, that the plenipotentiaries of twenty European countries signed the first international convention that was ever introduced: the International Telegraph Convention, forerunner of our present International Telecommunication Convention.

By this historic document, the twenty plenipotentiaries, for the first time in human history, created an international intergovernmental organization based on mutual understanding and co-operation among all peoples of the earth without discrimination of any kind.

At that time, of course, telecommunications consisted simply of electrical telegraphy, but the importance of the event lay not in the simple apparatus which had given rise to it but rather in the completely new world-wide spirit behind it. The fact that politicians of that time felt such a need to initiate at government level an effective instrument of international co-operation, in which all men of goodwill could join, was a revolutionary event of the greatest importance that was to have a profound and irrevocable influence on human activity in many fields.

But today, at this wonderful Air and Space Show and inaugurating this Symposium on Space and Radiocommunication with you, your Excellency, allow me to express my pleasure at finding myself among the representatives of so many organizations which regularly co-operate with the ITU and consistently take part in its various activities.

This is a most unusual feature of the universal character of the ITU, whose structure is sufficiently flexible to allow both national administrations, private operating agencies and international, scientific and industrial organizations to take part in its work, particularly in the Consultative Committees *.

In short, all those whose activities are related to telecommunications can make their contribution to the development of the work of the ITU and to its expansion in accordance wih the International Telecommunication Convention which states :

" *The purposes of the Union are :*

*a) to maintain and extend international co-operation for the improvement and rational use of telecommunications of all kinds ;*

*b) to promote the development of technical facilities and their most efficient operation with a view to improving the efficiency of telecommunication services, increasing their usefulness and making them, so far as possible, generally available to the public ;*

*c) to harmonize the actions of nations in the attainment of those common ends.*"

The ITU has thus fostered international co-operation since its inception and, since 1947, has been the United Nations specialized agency for telecommunications of all kinds. At the same time, it firmly supports every effort to strengthen co-operation at regional level, efforts which undoubtedly help to promote world-wide co-operation.

To realize its objectives, the ITU proceeds as follows :

1. it co-ordinates the efforts of all its Members in order to develop both national and international telecommunication networks, thus making available to all, the technical progress achieved by certain countries ;

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* International Radio Consultative Committee (CCIR)
International Telegraph and Telephone Consultative Committee (CCITT).

2. it plans the programmes of all countries with a view to establishing a cohesive world network;

3. it also plans the management of the frequency spectrum in order to ensure that it is used as economically as possible;

4. it prepares international regulations on telephony, telegraphy and radio and also for the judicious use of frequencies. These regulations are respected voluntarily by all countries;

5. it defines technical standards which are invaluable for the telecommunications industry;

6. finally, it establishes tariff rules based on the accurate calculation of costs.

With regard to technical standards in particular, these are defined and perfected by the International Consultative Committees of the ITU, which are familiar to many of you through your participation in the work of their Study Groups.

The Consultative Committees thus carry out scientific and technical research on propagation, information theory and new transmission techniques, such as data transmission and pulse code modulation.

The Consultative Committees also do a great deal of work in standardizing certain characteristics of the equipment used for telecommunications, work which is of great interest to those whose concerns are mainly industrial. They prepare technical data which serve as a basis for the work of the Administrative Conferences which draw up international regulations and establish the necessary plans.

Finally, the World Plan Committee and its four Regional Committees have as their main duty the co-ordination of the international telecommunication networks, which naturally include satellite links.

With regard to the difficult question of the utilization and protection of the frequency spectrum, the Convention specifies that, through its appropriate specialized organ, the IFRB *, the ITU shall:

*1)* effect an orderly recording of frequency assignments made by the different countries;

*2)* co-ordinate efforts to eliminate harmful interference between radio stations of different countries and to improve the use made of radio frequency spectrum.

The activities of the ITU are therefore extremely varied and cover all technical, regulatory, operational and tariff questions. And it is concerned both with conventional telecommunications and with space communication.

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* International Frequency Registration Board (IFRB).

But there is another reason for the Union's interest in outer space. Everyone knows that a satellite's only contact with the earth is by radio. Radio, however, whatever the propagation milieu and whatever the purpose for which it is used, comes under the authority of the ITU. Because of their constitution and mode of operation, satellites create technical problems, particularly interference problems, which by nature are world-wide and which therefore require much wider and much closer international co-operation than was ever the case in the past.

The studies and standardization which are necessary for space communication are mainly the responsibility of one of the ITU Consultative Committees, namely the International Radio Consultative Committee (CCIR), whose work is familiar to many of you. The work of the CCIR relating to outer space began in 1959 following the establishment of a Study Group for the specific purpose of investigating such problems. But other Study Groups, within the limits of their terms of reference, also are concerned with certain aspects of these questions.

As more and more practical applications are being based on the use of the geostationary orbit, the ITU considers it necessary to anticipate now the measures which should be taken in order to co-ordinate the efforts of users of this orbit in the best possible manner. Last year, therefore, the CCIR set up a Working Party to study the conditions required for the best possible use of the geostationary orbit by communication satellites.

The International Telegraph and Telephone Consultative Committee (CCITT), for its part, studies the problems posed by the integration of communication-satellite systems in the world network.

But the development of technique demands the establishment of appropriate international regulations acceptable to all. These regulations are the responsibility of the Administrative Radio Conferences which are convened for the purpose under ITU auspices. It is the task of these conferences to prepare, or rather to amend, the Radio Regulations to keep pace with the advance of technique.

Although the Radio Conference in 1959 adopted the first regulations for outer space, it was felt necessary to convene a Space Conference proper, the first of its kind, in 1963. The latter considered questions affecting satellite communication and especially the allocation of frequency bands to the space services. As space activity at that time was in the experimental stage, all necessary data were not then available and the regulations which were prepared by the Conference could not but be incomplete.

Five years after the Conference, the ITU, realizing that the world was already making practical use of satellite communication on a wide scale and in a number of fields, came to the conclusion that the deficiencies of the 1963 Regulations should be made good without delay by drawing up new, more appropriate Regulations.

With the approval of the majority of Members of the Union, the ITU Administrative Council decided at its 24th Session in Geneva last month to call a second World Administrative Conference on Space Radio-communications. This Conference will begin in Geneva on 7 June 1971 and will continue for six or seven weeks. The agenda provides, *inter alia,* for the revision of the existing Radio Regulations and the adoption of new provisions for the radio services.

This decision is of cardinal importance for the future development of space communication. Now that the ITU has made the necessary decision, it is for satellite users, present and future, and all those who are interested directly or indirectly in the subject to review their requirements and their problems and, through their competent national organizations, to take whatever action may be required to ensure that those requirements and problems are taken into consideration at the next Space Conference in 1971.

The convening of this Conference is a matter of world-wide importance. The date fixed for the meeting may seem rather far off, but it was most carefully chosen to take account of the programme of work undertaken by the CCIR, whose Plenary Assembly will be held at the beginning of 1970. The work of that Assembly will constitute a source of technical documentation which is essential if the Conference is to be fully successful.

These are the few considerations I wished to lay before you at the beginning of this Symposium. I am afraid that I have taken up too much time without being able to tell you all that I should about the ITU and its work. Confident that you will learn a great deal from the eminent lecturers you will hear on this memorable day, I hope that you will have already pardoned me.

*(Original language : French)*

**Reply by**
**Mr. M. BONNEFOUS, directeur de Cabinet,**
**French Ministry of Posts and Telecommunications,**
**on behalf of the Minister**


(ITU)

**Reply by**
**Mr. M. BONNEFOUS, directeur de Cabinet,**
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Mr. Secretary-General,
Ladies and Gentlemen,

The use of satellites as relay stations in the international telecommunication network seems to be the most profitable application of artificial earth satellites. This is borne out by the fact that as early as 1964 an international consortium, INTELSAT *, which now represents more than 60 countries, was set up to operate these satellites, that it is run as a commercial undertaking and intends to make a profit.

We are now far from the heroic early days since it was on 11 July 1962 that the French P&T Administration, through its station at Pleumeur-Bodou, for the first time in Europe received a television picture, transmitted from the United States of America *via* the *Telstar* satellite.

Satellite communications have now been operated on a commercial basis for four years and telephone users who make use of intercontinental circuits (to the United States, for example) give hardly a thought to the complexity of the means and techniques required to set up such connections.

As the international organization responsible for regulation and standardization in the field of telecommunications, the International Telecommunication Union was, of course, interested at a very early stage in the development of space communications and at the beginning of 1959 it set up a Study Group

* International Telecommunication Satellites Consortium.

◄ *From left to right : Mr. J. A. Johnson, Vice-Chairman of ICSC, INTELSAT ; Mr. M. Bonnefous, directeur de Cabinet, French Ministry of Posts and Telecommunications, representing Mr. Y. Guéna, Minister ; Mr. M. Mili, Secretary-General of the ITU.*

specializing in space techniques. The general organization of satellite communication circuits gives rise to many problems in the choice of frequency bands and the optimum use of the radio spectrum, in the siting of earth stations and in the satisfactory integration of space circuits in the over-all telecommunication network. The International Telecommunication Union was particularly well-placed to deal with all of these questions ; I believe that this is what it has done and is continuing to do in the numerous international meetings and Working Parties which have been called together or will be convened in the future. It is therefore extremely fortunate that the ITU thought of organizing a Symposium on space and radiocommunications in connection with the 28th International Air and Space Show, thus providing a most convenient forum for an exchange of views on a number of important problems affecting satellite communication.

The P&T Administration, which is responsible for handling the international telegraph, telephone and telex traffic of France, considers the use of artificial satellites as relay stations in the international telecommunication network as a particularly attractive and promising means of developing intercontinental connections in order to provide the best possible technical conditions for meeting a demand that is constantly and rapidly increasing. We do not regard this new medium as a rival but rather as a complement of those which already exist, such as radio-relay systems and submarine cables. It can already hold its own, economically speaking, with other methods of operation.

The P&T Administration is fully aware of the considerable development which space communication will undergo in the next decade. With this in mind it has decided to install a second space antenna at Pleumeur-Bodou, which will be brought into operation next autumn, and is planning to install a similar antenna in the French Antilles. With the same objective it is taking an active part in the work of the national and international organizations, particularly the ITU, which concerns itself with space communication, in order to make known its point of view, i.e. that of the operator, who has to provide users with high-quality international telecommunication circuits at the lowest cost. We can thus say that the use of outer space is helping to bring people together by enabling them to communicate with each other despite the very great distances that sometimes lie between them.

*(Original language : French)*

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## *USE OF SPACE FOR TELECOMMUNICATIONS*

**Account by**
**Mr. J. A. JOHNSON, Vice-Chairman**
**of the Interim Communication Satellites Committee (ICSC)**
**of INTELSAT**

Mr. Chairman,
Ladies and Gentlemen,

In the interest of time, as I understand that this session will end not later than 11 o'clock this morning, I am going to be quite brief and informal in my remarks, and I shall stop from time to time to invite questions if any of you would like to pursue any of the points that I am bringing up.

First of all I should like to clarify my own status : I was identified earlier as the Chairman of the INTELSAT governing body, the Interim Communication Satellites Committee (ICSC), but I must advise you that as of midnight last Saturday night, my term as Chairman ceased ; I am now the Vice-Chairman, the Chairman being Mr. Nuñez, the representative of Mexico.

I should like to say just a few words about the organization itself and perhaps I can also answer any questions that you may have concerning it. As you know, INTELSAT * is the first and presently the only international organization in existence whose purpose and function is to exploit communications satellite technology on a commercial basis. As a matter of fact, it represents the first time in history that the nations of the world have co-operated from the very beginning of a new technology, to develop that technology in a practical way on a world-wide co-operative basis, rather than on a competitive basis, and I think this is a history-making venture in that sense. INTELSAT was established in 1964 when agreements were signed, originally by 12 countries consisting of the larger countries of Western Europe, Canada, Japan, Australia and the United States. The membership of INTELSAT has since been expanded during the past five years to 68 nations, 48 of these countries are directly represented on the governing body of INTELSAT which consists of 18 members. A number of those members, of course, represent several countries, the largest grouping being the Arab group which actually has a total, I believe, of 13 countries represented by Algeria. Of the 18 members of the Governing body of

* International Telecommunication Satellites Consortium.



(ITU)
◄ *Model of the Nairobi earth station.*

INTELSAT, 8 are from Western Europe. There are another 5 or 6 countries presently in the process of acceeding to the agreements with the expectation of becoming members of INTELSAT in the fairly near future. As you undoubtedly know, INTELSAT was established on the basis of interim arrangements which were intended to be in operation for approximately five years, and as directed by those interim arrangements, INTELSAT's governing body, the Interim Communication Satellites Committee (ICSC), rendered a report at the end of last year containing a variety of proposals for placing the organization on a permanent basis. Also persuant to the 1964 agreements, a Conference was called by the Government of the United States of America in Washington, in February, for the purpose of considering that report and commencing the process of negotiating the permanent arrangements for INTELSAT. A preparatory committee meeting carrying forward the work of that Conference, will also convene in Washington on 23 June and, at the present time, a resumption of the Plenipotentiary Conference is scheduled for 18 November of this year. The purpose, as I have mentioned, is to place the INTELSAT organization on a permanent or legal basis. That in itself is such a large subject, that I think it is best not for me to volunteer anything on the subject, but to leave it to questions if you wish to ask them.

Now, the programme of INTELSAT began with the *Intelsat-I* or the *Early Bird* satellite which was launched in the Spring of 1965. That venture was made possible, of course, by the previous action of the International Telecommunication Union in 1963 which Secretary-General Mili has explained to us, and I might add at this point that we in INTELSAT are looking forward with great interest and hopeful expectations to the Conference which is scheduled for 1971. The Early Bird satellite, Intelsat-I, functioned only for the North Atlantic area and in its mode of operation was very much like a submarine cable, that is, it only functioned with one earth station on the North Atlantic side and one on the European side and in that mode of operation was able to provide 240 voice circuits of capacity, about twice the capacity, I might say, of the latest operating transatlantic telephone cable.

Intelsat-I then, was superseded by the *Intelsat-II* satellites which until this year provided the satellite coverage of both the Atlantic and Pacific Ocean areas. There have been two Intelsat-II satellites in the Atlantic area, one in the Pacific area. Each of these satellites also has had a capacity of 240 two-way telephone voice circuits, but with the added advantage that they are available to any earth station or a multiplicity of earth stations in the areas which they cover, and each one of them covers slightly more than a third of the earth's surface. The Intelsat satellite, for example, at 6° West longitude, over the equator, in the Atlantic area, has had a zone of coverage reaching all the way from the eastern coast of North America and all of South

America to as far east as the Middle Eastern area just east of the Mediterranean, in fact, it could be used by an earth station in Iran. The Pacific satellite has had a zone of coverage reaching all the way from the west coast of North America to the eastern rim of the Asiatic continent including such countries as Japan, Philippines, Thailand and Australia.

The Intelsat-II satellites have recently been superseded in both the Atlantic and Pacific areas by the *Intelsat-III* series, which has five times the capacity of the Intelsat-II series or specifically, approximately 1200 voice circuits of capacity or four television channels.

A second Pacific satellite has now been successfully launched just two weeks ago, and the previous Pacific satellite is being moved now to the Indian Ocean, and according to the latest reports that I have just received from the Manager in Washington, it appears that the Indian Ocean satellite can be ready for operation about 10 July. Now, that will be the first time that the INTELSAT system has accomplished complete global coverage and the initial users of the Intelsat-III satellite in the Indian Ocean area will be earth stations in the United Kingdom, Japan and Bahrain with several others being added very shortly after that, Kuwait, Indonesia, India, East Africa and Kenya early next year, I think there will be a total by the end of next year of about 16 earth stations using the Indian Ocean satellite.

The next launch of Intelsat-III will take place probably toward the end of July and will be a second satellite for the Atlantic area, at that time there will be a total of 4800 telephone circuits of capacity available in the four operating Intelsat-III satellites, and of course the Intelsat-II satellites would still be available for use if necessary, but we would have in the Intelsat-II system alone about five or six times the total telephone circuit capacity of all of the existing transoceanic submarine cables, so I think that gives some idea of how rapidly this new technology is moving ahead. One of the great advantages of the Intelsat-III satellite is that the capacity is such that it is going to be possible, — it is possible, — to have simultaneous intercontinental television and telephone service. With both the Early Bird and Intelsat-II satellites, as you know, it has been necessary to interrupt the telephone service in order to have the television service, but this will no longer be necessary in the era of the Intelsat-III satellites.

And then I think that the biggest news of the past six months has been the placement by INTELSAT of the contract at the end of last year for the *Intelsat-IV* satellite, which is now scheduled to have its first launch sometime during the first half of 1971, a launch dated April 1971 is at least tentatively scheduled and that satellite, we hope, will have a capacity of as much as 6000 two-way telephone circuits or five times the capacity of Intelsat-III.

Now along with this larger capacity is also coming longer anticipated lifetimes in orbit so that the anticipated lifetime of 3 years for Intelsat-II has been extended to 5 years for Intelsat-III and 7 years for Intelsat-IV.

When you put the longer lifetime together with a larger capacity the result is a much lower cost per circuit year, if I may use that concept.

In practical terms I think I can illustrate it this way. In 1965 when the Early Bird Intelsat I satellite went into operation, the initial charge, just for the satellite portion of the trans-Atlantic circuit, was 32 000 dollars for each of the earth stations involved, or a total of 64 000 dollars per year.

With the Intelsat-II series, that was reduced to 20 000 for the first stage and a total of 40 000, and we anticipate on the basis of the present traffic projections that by 1975 this figure will be down to perhaps 6000 dollars for each of the stations, or 12 000 dollars for the total circuit. I think I can even say that it ought to be 5000, or a total of 10 000; which means that in the course of the first ten years of INTELSAT operation we would expect the costs of the satellite portion of the circuit to be reduced to not more than one-sixth of what they were at the beginning of that period. In view of the fact that so many other things in the economies of our countries are going up in price during this time, it is, we think, rather encouraging that, at least in this area, there is a remarkable exception to the trend in most other sectors of the economy.

Now I want to say just one more word about the development of the earth stations, because of course the satellites without earth stations would be of no practical value. At the beginning of the INTELSAT period of operation in 1965 there were just four earth stations operating, one in the United States and three here in Europe, in France, Germany and the United Kingdom. Today there are 26 earth stations operating with the INTELSAT satellites, and by the time the Intelsat-IV system commences operation at the beginning of 1971, present plans, which I think are reasonably firm, call for about 60 earth stations to be in operation in 40 countries. These earth stations will, in reality, serve more than 40 countries; they will serve about 50 countries, because in many cases, and particularly here in Western Europe, one earth station will serve more than one country. This I think is perhaps even the most striking example of the speed with which this new technology is moving on. It is particularly, I think, rewarding to those who also have been working in this field to see how many of these stations will be in the developing countries, in countries in which until recently there has been no prospect of a really first quality telecommunication circuit, because cable connections were simply too expensive for the small streams of traffic involved. I speak particularly of course of most of the African Continent, most of the Asiatic Continent, and virtually all of Latin America ; Panama and Venezuela being the only exception to this. Today, already we have earth stations operating in Latin America, in Mexico, Panama, Brazil and Chile, with earth stations due to start operating this summer in Peru and Argentina. Before the end of this year there will be an earth station in operation in Morocco, early next year in East Africa and later towards the end of next year and perhaps early the following year, in Nigeria. Earth stations are also planned in Senegal, Ivory Coast, Cameroon, Congo, Ethiopia and other countries.

In the Middle East and Asia there will be, before the end of 1970, earth stations operating in Lebanon, Saudi Arabia, Bahrain, Kuwait, Iran, India, East and West Pakistan, Malaysia, Indonesia, Hongkong, Thailand, Republic of China. I may have missed one or two, but this gives some idea of how rapidly the development is taking place in the heretofore underdeveloped countries of the world, in the field of international telecommunications.

I might say that INTELSAT at the present time is considering seriously a system — the so called demand/access system — for use for the Intelsat-IV satellites (although no decisions have yet been made), which will, we hope, make the use of the INTELSAT system even more attractive from the economic point of view for small countries having very light streams of traffic.

While that is all I would like to say by way of opening remarks, I would hope that perhaps someone in the audience might like to ask a question which would enable me to be responsive to your own interests.

Mr. Mili, could I volunteer one more point, because I think it should be particularly interesting to this audience, and that has to do with the amount of international participation in the actual building of the satellites.

Of course the Early Bird satellite was built entirely in the United States. By the time the Intelsat-III contract was placed, it was possible to have about 6 % of the value of that contract represented by sub-contracting outside of the United States, principally here in Western Europe.

In the Intelsat-IV contract that figure has risen to between 25 % and 30 % of a total contract of approximately 70 million dollars, and this involves now a total of 11 companies in 10 different countries outside of the United States, having a very important part to play not only in the production of the satellite but in the actual design. These companies, including companies throughout Western Europe, have had their own engineers working with the prime contractor (Hughes Aircraft in California) in the design phase of this satellite, so this has been a co-operative effort from the very beginning and the contract provides at a very early stage that the complete spacecraft will be assembled here in Europe. As a matter of fact, the third satellite in the Intelsat-IV series will be assembled entirely here in Europe and the second satellite will incorporate very substantial sub-assemblies produced by the European contractors, who are associated with Hughes Aircraft.

So I would like to emphasize that not only do we have an international organization here consisting of 68 countries who are providing the capital for the development of these satellites and, at the present time, 40 nations actively engaged in the building or in the planning of earth stations, but we also have a constantly expanding industrial participation now numbering a total of ten countries in addition to the United States.

*(Original language : English)*

**CHAIRMAN** *(in French) :* Thank you, Mr. Johnson, for your interesting statement. Does anyone have any questions. Yes, Sir? Would you give your name and the organization which you represent.

**A VOICE :** My name is Robinson. I am extremely interested in Mr. Johnson's very concise and at the same time detailed account of the development of INTELSAT and its future programme.

My Committee, which represents some 7000 newspapers and news agencies throughout the world held a meeting in Rome last month in which it passed a resolution applauding all that INTELSAT and its operating agency COMSAT have done to extend world telecommunications, but there is one question which I would particularly like to ask. There are many industries, I believe, as well as the press and television, which are interested in the use of satellites for multi-destination communication. Could Mr. Johnson tell me to what extent INTELSAT/COMSAT * have in fact investigated this ; are they in fact devising systems to meet this requirement ? Thank you very much.

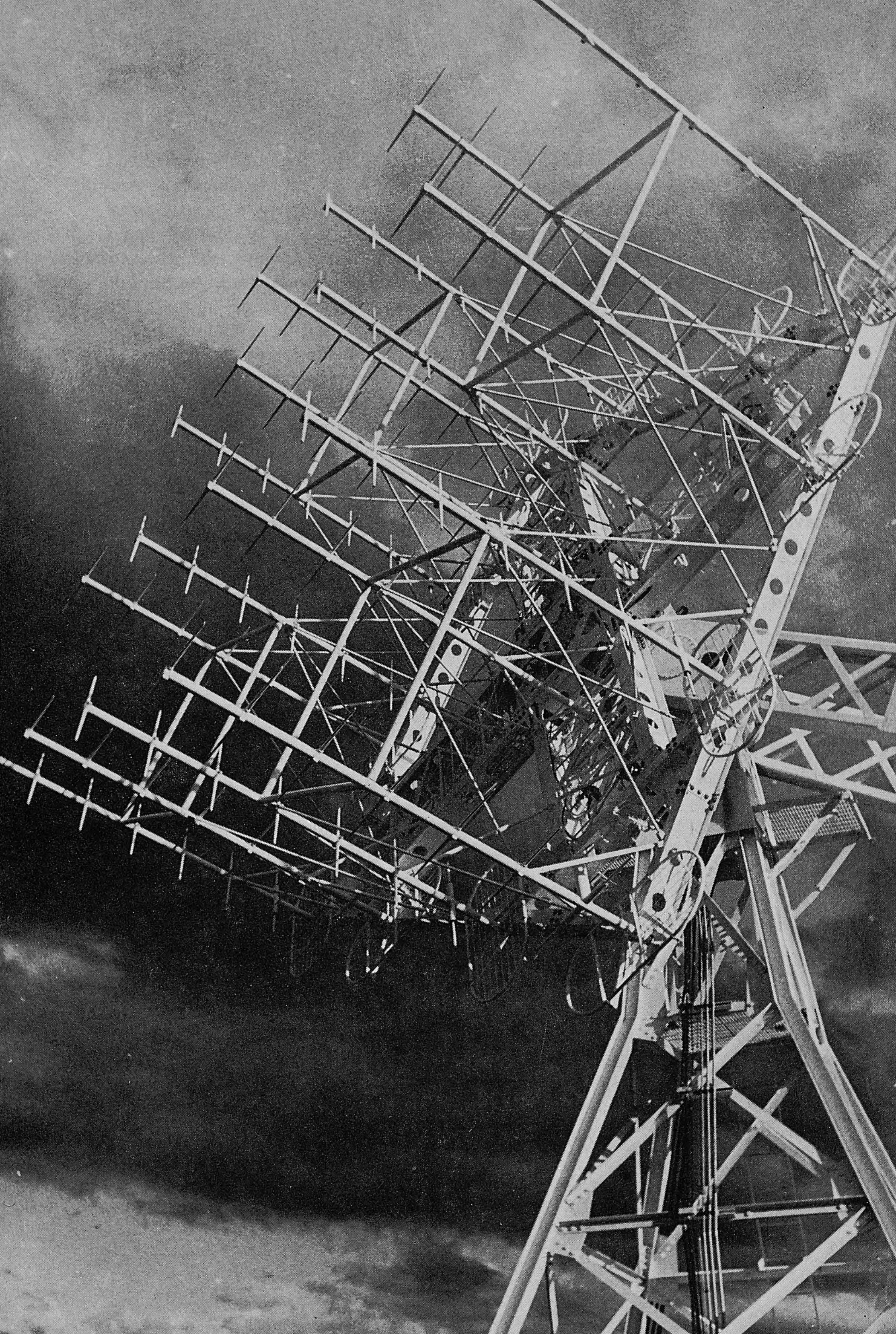
**Mr. JOHNSON :** Well, the concept of multi-destination requirements, of course, is a rather broad one. At the present time, the INTELSAT satellites of course are capable of multi-destinational use in their television usage, and this has been demonstrated, I suppose, most clearly in some of the recent uses of the satellite in connection with the *Apollo* programme. Technically, of course, the INTELSAT television usage has been between two earth stations, one at either side. But this is just a matter of the operating arrange-

* Communication Satellites Corporation.

ments that have been found to be most convenient for the countries involved. It doesn't involve any technical limitation so far as the satellites are concerned. The satellites are perfectly capable of providing for a multi-destination reception and this is done on occasions. As a matter of fact we had a little controversy in the governing body, which is not completely resolved, as to just what the charging practices should be in the case of multi-destination reception of television. So this kind of capacity will continue in the Intelsat-IV satellite. Incidentally, the Intelsat-IV satellite will be capable of having several television transmissions simultaneously. I believe that the Intelsat-III can do that, except, of course, that most of the capacity is taken up with the telephone use. This is really just a matter of the organizations on the ground, so to speak, deciding what they want, and of course, whether they are willing to pay for it. Now I am wondering whether the question possibly could have been related to what are called direct broadcast satellites rather than multi-destination transmissions to earth stations which in turn then have to use the terrestrial distribution network to get the television programme to the ultimate viewer.

If the question is related to the so-called direct broadcast satellite, then I would have to say there is nothing in the current INTELSAT programme along that line.

*(Original language : English)*



**Account by**
**Mr. R. SUEUR, Chief Telecommunications Engineer,**
**Deputy Director-General of Telecommunications,**
**French Ministry of Posts and Telecommunications**

Mr. Chairman,
Ladies and Gentlemen,

The Secretary-General of the ITU has organized this telecommunications day in a locality that bears witness to his concern with satellite communications, and the Minister of the French Posts and Telecommunications has — by acting as President — honoured the ITU and the co-ordination and regulatory role that it has assumed for 104 years.

All of us who are interested in telecommunications know from experience how important and valuable this role is in all branches of our activity, starting with the recommendations on technical matters and quality which enable us to guide and follow up systems research, plan national and international routes and operate them, build up networks and define their technical and commercial operation, maintain them and automate operation, arrange the automatic regulation of transmission line characteristics, and all in an international context which successfully brings into play a multiple pattern of countries and languages.

Already in the recommendations on technical matters and performance the ITU plays a determining role which continues up to the study and preparation of actual medium-term plans for the development of telecommunication networks and continental, intercontinental and world plans which will serve as sound guidelines when administrations estimate their traffic and equipment.

I have made a point of stating briefly what the ITU represents for us, at a time when disputes are the fashion and preconceived ideas are questioning values which have nonetheless constantly adapted themselves to the requirements of progress.

Such is the case with the ITU.

Satellites certainly appeared at the outset to be a new medium which would renovate telecommunications radically.

In the past I have also heard that said of long-distance underground lines, carrier systems, coaxial cables, radio relay links, submarine telephone cables,



(ITU)
◄ *Telemetry antenna at Tananarive (Madagascar).*

and it is said now of electronic switching, but each new system takes its place among those already in existence and does not put them out of service.

Our responsibility for its commercial management and for making it as profitable as possible in the interest of users, obliges us to be objective in our studies and our judgment and in the economic classification of existing and future telecommunication systems.

The new factor which telecommunication satellites bring into our field, where competition between countries was mainly of a technical nature, but constructive also through the publication of ITU recommendations universally applied, is the almost total subordination of technical and commercial problems to specifically political requirements, whether national or international. This is a rather paradoxical situation, especially as commercial telecommunication authorities have to take full responsibility for their commercial and financial management of satellite systems.

We hope that all the organizations now being negotiated or set up will take this inequality of powers into consideration in their organic and operating structure and leave to the commercial telecommunication authorities the management of their own affairs in a light political context and in the best interest of users.

In our view every multinational telecommunication organization should observe the recommendations and regulations of the ITU, or pay the penalty of creating a false or embarrassing — even intolerable — situation for its own members.

We know that the ITU can adapt itself when necessary to any new situation arising from the demands of these multinational organizations by the speed of their technical and operational development, without needing to carry out identical studies on different time scales.

We also have to consider the question of order on a world scale, without which telecommunications cannot work ; in the case of satellites it is a question of regulating radio frequency usage and the positions of satellites in their orbits.

We should like to see the authority of the ITU reinforced in these two fields so that world order should not be a matter for an association of certain countries but the outcome of every country's free choice to construct or accede to the systems most valuable for routing its traffic.

This leads me to speak next of the international structure of satellite telecommunications, on the basis of the above considerations.

Satellites are essentially destined for international, continental and intercontinental use, except in the case of very large countries.

In view of the technical advance of certain countries as far as satellites are concerned, the notion of a large single technical/commercial organization, for creating the first space telecommunication network, based on this advance in technique, was inevitable.

Thanks to these countries, and principally the United States of America, we have the proof that it is possible to integrate satellites into telecommunication networks. We now have to pass to their rational use, and a re-examination of the initial principles of compulsory association which were valid at that time.

In everyday life, children mature and the parents who have brought them up have to realize it; at a certain moment the children go where their own interests lie, without forgetting — if they are honest — the interests of their family, and by making acceptable compromises they all manage to get along well together.

The children in question, who are now coming of age in space telecommunications, are the countries of Europe, but other countries and other continents will reach that age soon; the solution for world harmony is to consider the conditions, and different levels reached by the different countries. We know that INTELSAT possesses the necessary resources and France, as a partner, is convinced of its effectiveness.

An important problem for us in France, and also I believe for the rest of Europe, is that of regional telecommunication networks, in a wide sense. The problem can be split up, however, and the solutions must be primarily of an economic nature.

We have two cases:

- the first concerns the internal requirements of Europe and involves considerable telephone, telegraph, data transmission and television traffic;
- the second concerns telephone and television links at present carrying only light traffic, either within a large continent or between continents which are very close, which is the case in the African and Euro-African continents.

The question is to know whether a so-called *world system* can provide such networks by using satellites.

I shall not speak here about the legitimate desire of the continents in question to be responsible for their own solutions; respect for people's freedom is essential in this matter.

For the moment we have to determine the economic advantages of the solutions available.

With respect to the setting up of a Euro-African or intra-African network to meet traffic requirements for ten or fifteen years ahead, we have carried out a study from which it appears that it is necessary to use only the cheapest ground stations possible, i.e. stations with antennae of as small a diameter as possible, to combine telephone, telegraph and television traffic to avoid a waste of satellite positions, on the geostationary orbit, and to design a type of satellite which is suited, technically and operationally, to this kind of traffic.

This study takes into consideration the technical and commercial data available at present, and is based partly on the use of world satellites and partly on a satellite for 300 conventional carrier circuits for telephony and one television channel, with the possibility of using some of the 300 telephone circuits for *demand-assigned* traffic : it shows that the annual expenses are :

- use of an optimized system with ground antennae of 10 to 12 m in diameter, semi-steerable, with a satellite designed solely for a particular problem :
  — annual cost per circuit = 1
- use of world satellites of high circuit capacity :
  — annual cost per circuit :
    — with ground antenna 12 m in diameter = 2
    — with ground antenna 30 m in diameter = 3

Television revenues are considered as marginal.

The case of an internal network in Europe is different ; there is competition between the annual cost of links set up by the most modern and economical facilites of a terrestrial network, and those set up by satellites (once again merging television, telephone and telegraph traffic, for the same reasons as before) according to the specific requirements of the European countries and their expansion. The resulting problems are an exclusively European affair, and can and should be dealt with by Europe alone.

To return to the case of Africa, which is a developing region where telecommunication (and hence educational) satellites foster rapid development, like that produced by aircraft in transport, this continent should also decide its future in all sovereignty, especially as regards its own solutions for main traffic routes.

In the two similar cases of Europe and Africa, the use of very large intercontinental satellites, with diverse capacities, is not necessarily the best form from the viewpoint of economics and flexibility of development ; in becoming universal and gigantic, telecommunication satellites would infringe the well-tried rules of the technical hierarchy of network structure.

Let us come back to Europe.

Through its administrations or telecommunication organizations and its technical, industrial and financial potential, our continent can be full master of its problems and of its future in space telecommunications, while remaining an important partner in world plans.

Joint space programmes have already proved this — those of ELDO *, and ESRO **, and the German/Belgian/French *Symphonie* project. These three countries are demonstrating the value of such a trend and are hoping to persuade other European countries to follow suit.

What exactly is the Symphonie project ?

It is a project to construct, place in orbit and make technical and operational experiments with two flight models designed for use with the *ELDO-PAS* launcher, which is capable of putting a satellite weighing about 190 kg into geostationary orbit.

The satellite itself has two antennae with a beamwidth of 10°, and elliptical coverage of Euro-Africa and the Atlantic.

It should permit 300 20-access telephone circuits and a switchable television channel to be set up on each antenna.

Its stabilization is of the 3-axes type, calculated to within 0.5°.

It is equipped with two transponders with an output power of 13 W each, and the frequency bands are those used at present, around 4000 and 6000 GHz.

The first satellite should be placed in orbit in 1972.

The earth stations will be equipped with antennae 12 m in diameter, and the cost of the system (space and earth sectors) has been kept as low as possible as a function of the traffic to be dealt with.

The Symphonie satellites should be the first-generation experimental type

* European Space Vehicle Launcher Development Organisation.
** European Space Research Organisation.

in Europe, to be followed towards 1978-1980 by the creation of an intra-European system which will complete the expansion of the terrestrial routes.

The European Conference of Postal and Telecommunications Administrations *(CEPT *)* is now studying this system and should produce results during the current year.

As a first estimate the satellites should be used simultaneously for distributing television programmes and setting up 5000 to 10 000 telephone circuits between European countries ; the weight is estimated at about 500 kg. There will be a considerable number of earth stations for television and telephony, telegraphy and data transmission.

However, economic competition with terrestial routes, underground cables or radio-relay links will be keen ; at that time the cost of setting up ground circuits should be around 1 dollar per kilometre for routes with a very long life.

However, the over-all time taken to construct a ground network by cable or radio-relay link is much longer than that taken to set up an equivalent space system, and this consideration is important from a financial viewpoint and that of the productivity of a network and its development possibilities. This should be a third-generation system.

The second should be also on the all-European level ; il will benefit from the experience acquired with Symphonie, and, having improved it, will prepare the technology and technique for the third-generation European system, and provide the Europe-African region with a successor to Symphonie and the facilities for establishing a purely African network.

It should be understood that there is no question of organizing competition harmful to the world systems, but simply of dealing with the problems of a continent which has to harmonize its choices for expanding its telecommunication network in the best industrial, economic and operational context.

The French Posts and Telecommunications Administration, for its part, will remain an active and understanding participant in world systems, because of the international interests they represent ; it wants the regional systems to be completely integrated in the interests that are represented by the world systems.

On another level — that of the region — it will participate as a partner conscious of its interest and those of the continent.

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* *Conférence européenne des administrations des postes et télécommunications.*

The same can certainly be said of other continental countries which cannot reasonably link the future of their network to that of a very complex world network which is of a more general collective interest, and with a different development. A world-wide economic optimum cannot be attained by wishing to apply a single solution to differing problems.

This is the lesson of the experience patiently acquired through construction practices and operation of telecommunication networks.

We submit these reflections for your judgment and thank the Secretary-General of the ITU for giving us the opportunity to present them.

*(Original language : French)*

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# *RADIOCOMMUNICATIONS FOR SPACE ACTIVITIES*

**Statement by**
**Mr. Jean-François ARNAUD,**
**Centre national d'études spatiales, France**

First of all, I should like to say how glad I am to have been invited to this ITU Symposium, as we greatly needed such a meeting for two reasons :

– first, because space activities are the most recent innovation in telecommunications, and

– secondly, because the *Centre national d'études spatiales, CNES* (National Centre for Space Studies), as the French space organization, represents not only space, but also the new services required thereby. Meteorology and telecommunications have existed for a long time ; now we are also confronted with telemetering, remote control and radiolocation.

On perusing the 1959 Radio Regulations and then the Final Acts of the 1963 Conference, I cannot help feeling somewhat guilty, for these two documents clearly show that space techniques are invading the spectrum and are claiming their place in frequency allocation. Our task at the next Conference, in 1971, will be to give this place even more importance. That is why I shall now try to justify our future requirements.

**What are the space needs properly so called of satellites in telecommunications ?**

These may be divided into two categories :

– needs during launching and
– needs when the satellite is in orbit.

There are also other space uses, such as links with probe rockets and with high altitude balloons. This immediately leads us into terminological problems. Indeed, although the definitions appearing at the beginning of the Final Acts of 1963 are extremely accurate, it is possible to imagine experiments and devices which it would be difficult to classify in a given category ; for instance, I am thinking of an aircraft which has a propelled phase in the atmosphere but makes part of its flight through space. Should it be called an aeronautical mobile station or a spacecraft ? The same ambiguity arises in the case of stratospheric balloons and the first stages of launchers. There are also some difficulties in defining where space begins; should the altitude or a certain pressure level be taken as the criterion?

I shall now explain the telecommunication needs of spacecraft more specifically, with the help of examples, beginning with that of the Space Centre in French Guyana (CSG). What equipment will the Space Centre need?

At the present time, the CSG has three launching pads in operation or under construction:

– one for probe rockets,
– one for the French *Diamant* launcher,
– one for the *Europa* ELDO launcher,

and any other type of rocket proposed by a foreign applicant will be welcomed.

Any launching requires three functions to be performed:

– a radiolocation or tracking function,
– a telemetering function,
– a command function.

Radiolocation is carried out by means of radars, which are initially used for contact with the launcher at departure. The radar used is the *Adour,* operating in the 5 GHz range, which receives the echoes that bounce off the launcher. Tracking is then performed by two *Bretagne* radars, the *Cayenne* and the *Montagne des Pères,* so as to obtain the diversity necessitated by the obstacle created by the flames of the launcher. These radars operate with responders in the launcher or the capsules. Another radiolocation process is that of interference metering through the reception of signals from the launcher or the satellite, either in the 136 MHz band or in a band adjacent to 250 MHz.

The importance of remote command must not be underestimated, since it is concerned with the safety of the firing area, that is to say, with the destruction of a device which is liable to become dangerous. It operates either in the very narrow 148.25 MHz $\pm$ 15 kHz band or in the 434 and 450 MHz bands.

Another example of space telecommunications is that of the CNES station network. The tracking network, called the *Diane* network, is used for radiolocation and interference metering; it consists of two stations, one at Kourou in French Guyana and the other at Pretoria in the Republic of South Africa, operating between 136 and 138 MHz. The *Iris* telemetering and telecommand network operates at 136/138 MHz for telemetering and between 148 and

150 MHz for remote command at stations at Kourou in French Guyana, Pretoria in South Africa, Brétigny near Paris, Brazzaville in the Congo, Ouagadougou in Upper Volta, and in the Canary Islands. Finally, there is the ELDO/CECLES (European Space Vehicle Launcher Development Organisation) telemetering network, with two stations at present, one in French Guyana and a back-up station in Brazil.

What are the frequency bands which the CNES hopes to obtain at the forthcoming Space Conference in June 1971 ? The 148.25 MHz ± 15 kHz band is really two narrow. We shall need a bandwidth of one to two MHz to be able to extend remote commands. At launchings, we use frequencies between 216 and 260 MHz; this may be justified in the last resort by saying that the vehicle at its propelled departure phase is really only a kind of aeronautical mobile station, and strictly speaking it may be regarded as such; but this type of use is brief, as the life of the launcher is not more than half an hour and launching pads are not so numerous as to cause much inconvenience to regulation users. Moreover this use harks back to the purely ballistic character that space vehicles had at their inception; the example has been provided by the United States, to which we are beholden for many equipment studies.

As I have already mentioned, we should also like to have a little more space for remote command in the UHF bands and especially the right to use the 434 MHz ± 250 kHz band, for it would be useful to have at least two frequencies for destruction commands, the transmission of which must be extremely reliable. The 136/138 MHz band assigned to us has also proved to be much too narrow and an extension to approximately 2290–2300 would therefore be desirable. Unfortunately, this band is reserved for deep space.

A scientific discipline which deserves a place in the space world but which necessitates world-wide co-ordination that is hard to achieve is geodesy by means of satellites. The specifications are extremely stringent, as the satellite must interrogate earth beacons on a frequency in the 2 GHz band and the earth beacon must be simple and must reply to the satellite on two harmonic frequencies, 400 and 2000 MHz for instance. World-wide allocation is desirable.

Let us now leave the subject of the frequency allocation table and turn to questions relating to regulations: the notification procedures set out in 1959 are more suited to terrestrial services. Since the beginning of the space age, experience has shown that rather more flexibility is required, that it is now difficult to establish the design for a satellite long in advance and that very often the designers are obliged to change their frequencies at the last moment.

Accordingly, on the one hand, there is a need for flexibility and for securing the available frequencies long in advance and, on the other hand, since space technology is developing very rapidly and satellites do not have the life-span of a radio relay or a transmitter, frequent renewal of equipment is to be expected. But with the constant change in technology, the former notifications cease to be appropriate. Finally, research is an important branch of space activities and research is essentially incompatible with rigorously accurate planning; this is yet another reason for our desire for greater flexibility. Our position, therefore, will be that of asking for a little more tolerance towards the space telecommunications we are establishing; to take up the analogies which Mr. Sueur drew this morning, we are fully aware of our role as the cuckoo which is about to invade the nest of the other users and we are only asking for a little indulgence towards this cuckoo.

*(Original language : French)*

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**Reply by**
**Mr. M. MILI, Secretary-General of the ITU**

I would like, as Secretary-General of the ITU, to make the following comments :

I was very glad to hear Mr. Arnaud say what he did, as he stressed a number of difficulties at present encountered in space research and in the peaceful use of space.

Space communications, as we said this morning, can in fact be divided into two categories : telecommunications which serve the satellite and those which use the satellite as a means of transmission. The word telecommunications must thus be interpreted in its widest meaning, embracing both uses.

At the beginning of his statement Mr. Arnaud mentioned the question of definitions. Definitions are indeed given both in the 1959 Regulations and in those of 1963. But since these definitions are, to a great extent, obsolete, we shall have to bring them up to date with the progress made or even introduce other definitions. None of this has escaped the notice of the ITU Administrative Council which discussed the problem at its last session. We may therefore rest assured that the Conference of 1971 will consider this particular problem. I would ask all those who find certain difficulties in the way technical words and terms are used to think seriously about this question so that the 1971 Conference may take account of any suggestions they may have to offer and adopt the most suitable definitions for space communications.

The 1971 Conference will not, of course, do everything by itself, starting from scratch. Quite on the contrary, during the two years before the Conference meets, all those who are concerned with space communications — Administrations, operating agencies and scientific and industrial organizations — should reflect upon all these problems so that they may make valuable contributions to the Conference which, in the course of six or seven weeks, will have to take all the decisions required and justify the tremendous hopes which we attach to it.

Mr. Arnaud has also said, with great frankness, that the Regulations of 1959 and 1963 can no longer be strictly applied because they are outmoded and are, if anything, a hindrance to progress. Permit me to mention in this connection that the International Radio Consultative Committee (CCIR) Study Groups to which I referred this morning and in which many telecommunication specialists take part, are now assembling all the data pertinent to the problem. The conclusions which they will reach will provide a solid preparatory basis for the Conference's work in 1971.

I think I am right in saying that several CNES — the French *Centre national d'études spatiales* — engineers are taking part in the work of the CCIR, just as are their American colleagues. This is most important and encouraging. As I stressed this morning the ITU is endowed with the original quality of being able to let all those who are interested in telecommunications participate in the work of its Study Groups. Frankly, their work is most important, perhaps at least as important as the work of the Space Conference itself. Because in order to arrive at valid conclusions, the Conference will have to base its deliberations on the work which the Study Groups perform.

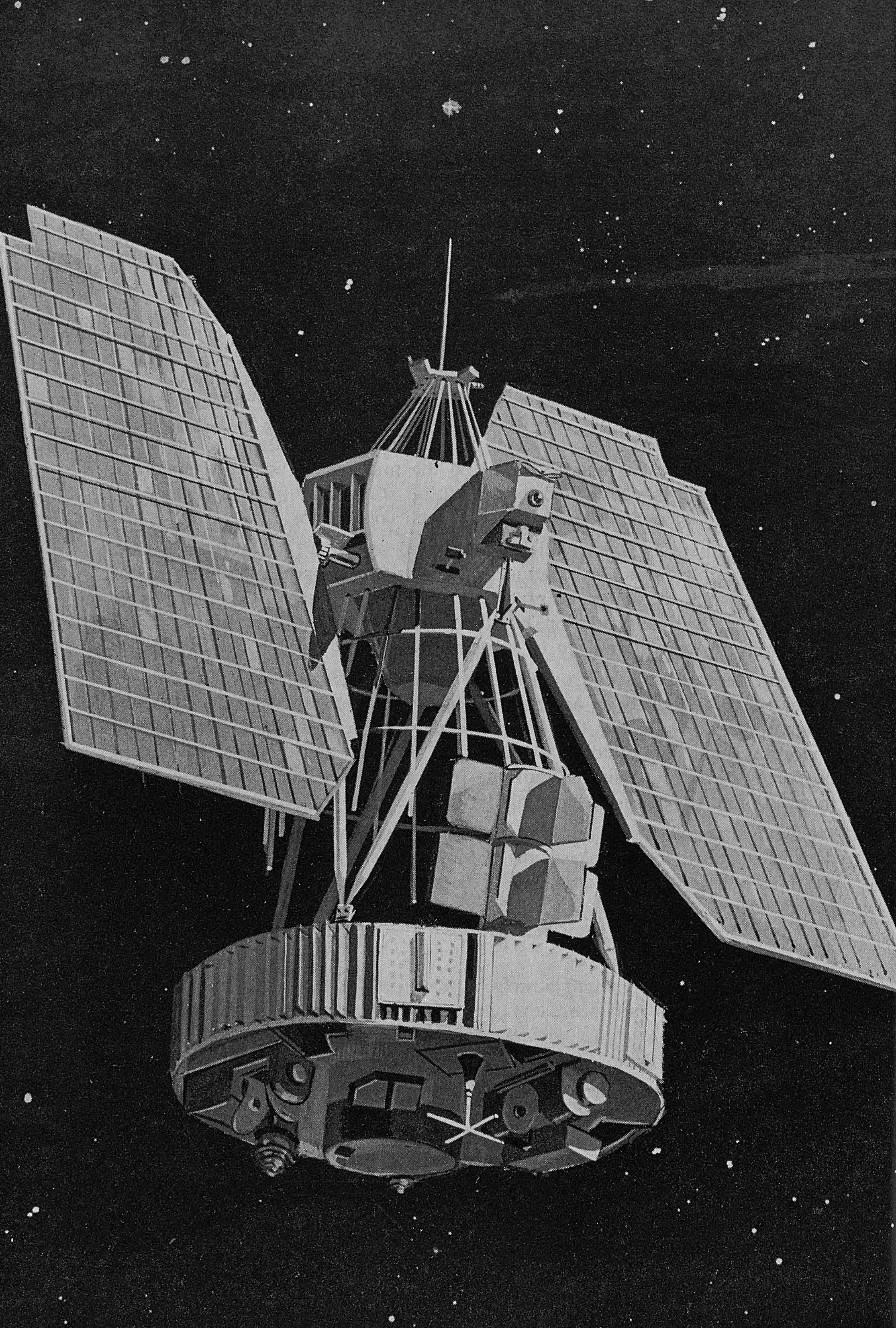
The CCIR Study Groups will hold their next group of meetings this September in order to prepare for the CCIR Plenary Assembly which will convene in January 1970. In any case, it is most important that the results of research, the difficulties encountered, and the problems which still remain to be solved, should be channelled towards those Study Groups so that they can take them into account when formulating their conclusions.

The new regulations which will be established by the 1971 Conference must make it possible for all to continue their work unhampered, whether in the field of research or in that of practical application. As Mr. Arnaud emphasized earlier, the new regulations should be sufficiently flexible. But to achieve this the problems will have to be properly formulated for the Conference.

We have several times had occasion to stress the difference between conventional telecommunications and space telecommunications. In particular, we can all see how quickly the latter are developing and we must bear this important factor in mind in anything we establish or codify. The fullest degree of flexibility desirable must be sought in order to enable space communications to progress without hindrance.

I believe that one of the aims of this Conference of 1971 is to take all the data relevant to the problem into account and to produce regulations that will be viable in future and enable all to work in full harmony with the established rules.

*(Original language : French)*



# USES OF SPACE RADIOCOMMUNICATIONS FOR METEOROLOGY, NAVIGATION, EDUCATION AND SOUND AND TELEVISION BROADCASTING

**Account by**
**Mr. H. A. BARI, Chief, Telecommunications Section,**
**Scientific and Technical Department,**
**World Meteorological Organization, WMO**

Mr. Chairman,
Ladies and Gentlemen,

During the middle of the nineteenth century, the advent of the electric telegraph and later the use of radio for communication purposes opened the possibility of quick communications permitting the real-time collection of meteorological observational data, thus permitting the development of synoptic meteorology. The important influence which communications have had in the development of synoptic meteorology and weather forecasting can therefore be recognized. Only the availability of real-time data permitted the meteorological services to issue forecasts and warnings to the public and for specialized users. The development of space radiocommunication techniques will have an even more profound impact on meteorology.

The importance of space technology for meteorology is that satellites provide an additional observing platform which, of course, can only be used if proper radio links can be established with earth stations in order to permit real-time telemetering of meteorological data. In addition to the use of satellites as an observing platform, satellites will provide new telecommunication systems for the collection, exchange and distribution of meteorological data. From the point of view of the observing system, satellites will contribute to a global observing system which would permit, on a truly worldwide basis, the possibility of observing the whole atmosphere. Up to now, this was not possible because of the large uninhabited areas and the fact that two-thirds of the globe is covered by ocean and, for these reasons, it was very difficult to obtain meteorological observations.

We feel that meteorological satellites may provide cheaper information on a global basis than radiosonde stations but we are not visualizing an exclusive satellite-based system. Our observing system will be a mixture of conventional techniques complemented by space techniques. There is no intention



(NASA)
◄ *NASA's experimental weather satellite* Nimbus-B.

of eliminating our entire observing system and replacing it by satellites but only to obtain those data which we scannot obtain otherwise.

Without going into all technical details which have been considered and are still under active consideration by the WMO, I should like to attempt to highlight the impact of space radiocommunication techniques on meteorology.

1. Space techniques will be used to telemeter observational data from meteorological satellites to earth stations. At present, low-orbiting satellites are used for mapping the earth's surface in order to identify cloud patterns and also to collect infrared radiation data. This technique is very well known to you because the United States of America and the USSR are operating meteorological satellite systems which are providing this type of data either to a data acquisition station upon interrogation or by direct broadcast to earth stations. The latter system is known as *Automatic Picture Transmission (APT)*. There are currently several hundred APT stations in the world which regularly receive this type of information. The information from the major data acquisition stations is made available to all meteorological services through the world meteorological services through the world meteorological centres Washington and Moscow. In this connection it may be worthwhile to mention that very recent experiments with the *Nimbus-3* satellite have shown that low-orbiting satellites are capable of obtaining temperature profiles using infrared soundings. The results demonstrated techniques which were completely revolutionary for meteorological observations after the radio-sondes.

   In addition to the low-orbiting satellites, tests have been made with geostationary satellites — in particular with the *ATS* satellite. These tests indicated that it is realistic to assume that, where cloud elements suitable for use as tracers exist, winds at the levels of these cloud elements can be measured to the accuracy required.

   A Global Observing System is now being planned as a part of the Global Atmospheric Research Programme (GARP). It will consist of the operational ground-based and space-based systems plus special satellites and other requirements for research purposes. This plan visualizes that geostationary satellites will, in future, give continuous cloud observations (both visible and infrared) over the tropics and part of middle latitude areas. Near polar orbiting, low altitude satellites will have sensors to determine temperature and water vapour *fields* and will provide tracking and relaying of observations from platforms; i.e., balloons, buoys, automatic land stations. On this occasion it should be mentioned that GARP can only be successfully implemented if meteorological satellites are available and will provide the initial data for further computation and numerical experiments carried out by powerful electronic computers. The use of meteorological satellites would permit, for the first time, to acquire global data for the description of the initial state of the atmosphere and would permit input into the numerical models for the prediction of the motions in the atmosphere and thus hopefully permit the preparation of weather forecasts for an extended period and improve forecasts for shorter periods. Of course, as mentioned before, reliable data links from the satellites to the ground stations for the telemetering of the observed values will be indispensable to achieve this goal.

2. Space communication techniques will also be applied in meteorology for the collection of meteorological information from remote sensors. It is expected that satellite will have the capability of interrogating remote sensors on fixed and mobile platforms. For mobile platforms, the system should also be capable of accurate radio determination and location. In this connection, it should be mentioned that it is planned to carry out tests for the collection of meteorological data using a fleet of super-pressure balloons at appropriate levels, interrogated and located by a system of orbiting satellites.

3. Thus, the importance of satellites for the collection of initial data is seen, however space communication techniques will also be used for the distribution and exchange of data between meteorological services in order to meet their data requirements. In this connection, very little will be said about the use of telecommunication satellites for the establishment of point-to-point links. It is understood that the full implementation of a global space communication system would, for the first time, permit the exchange of meteorological data at high speed between the major meteorological centres of the world. In many respects, this would improve the data exchange between centres in the northern and southern hemispheres where, up to now, this was not possible due to the lack of reliable circuits for medium and high speed data transmission.

4. Still another important application of space techniques for exclusive meteorological purposes might be the use of geostationary satellites for the distribution of processed information in alpha-numeric and pictorial form. Such geostationary satellites would permit the distribution of analysis and forecast charts prepared by world and regional centres to other meteorological centres and thus permit full participation of all nations in the advancement of meteorology. The use of geostationary satellites for the global distribution of meteorological information to meteorological centres and to users would ensure that meteorological offices all over the world, as well as users such as ships and aircrafts, can rapidly obtain weather information and warnings to satisfy their needs. In this connection, it

should be mentioned that the feasibility of such transmissions using geostationary satellites, has well been demonstrated, and appropriate technical publications in the form of planning reports have been published by the WMO Secretariat.

Many times, the question will be put as to why meteorology will enter into the space field to such an extent. The answer to this is quite simple — Meteorology is influencing and will, in future, influence in an ever-increasing rate the economic development of the nations. It has been demonstrated that timely weather forecasts and weather advice can save considerable material losses and, on the other hand, permit meaningful planning of various operations which are — to a high degree — susceptible to the weather. Examples might be off-shore oil drilling, air operations, building industry and, last but not least, agriculture.

While I was able, in this short exposé, to briefly outline the basic philosophy of how the WMO views space radiocommunication services, this should not be regarded as a complete description but only an outline of the major points as to the importance of this field to the World Weather Watch system.

*(Original language : English)*

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**Account by**
**Mr. O. ANDERSEN, Navigation Section,**
**Inter-Governmental Maritime Consultative Organization, IMCO**

Mr. Secretary-General,
Ladies and Gentlemen,

The Inter-Governmental Maritime Consultative Organization (IMCO), which is the United Nations specialized agency dealing with maritime affairs, in particular with regard to the safety of life at sea, has, during the past years, followed with interest matters related to the use of outer-space techniques for purposes serving maritime interests, since certain of the aspects involved affect the responsibilities of the organization. The work of IMCO in this field is concentrated on the utilization of space techniques for communication and navigation and is being considered by the appropriate technical sub-committee of the organization, in co-operation with other international organizations such as the ITU and the International Civil Aviation Organization (ICAO), the latter organization having potentially similar user interests in the application of space techniques for radio communication and radio determination. IMCO, of course, also participates in the working group of the United Nations Committee on the peaceful uses of outer space.

As far as navigation is concerned the opinion expressed within IMCO is that for the time being there is no definite need to establish a satellite system for position fixing purposes exclusively. It is felt, however, that if such a system were available in the future for other requirements the navigator could also benefit from it. You will all be aware that present methods used for navigation at sea, range from dead reckoning to the more sophisticated electronic systems.

Although each of these has individual limitations due to factors such as weather, coverage and accuracy, they have all served the navigators satisfactorily, some of them are continuously improving and new ones are under development. An important advantage of a future satellite system is that it could provide a world-wide navigation capability for the merchant marine, available in all weather conditions on a 24-hour basis. If, however, a navigational satellite system were to compare favourably with other navigational systems already available and in general use, it would be essential that the ship-board equipment be of low cost and low obsolescence potential, simple to operate, requiring minimum maintenance which should not be beyond the vessel's capabilities and of a degree of reliability at least equal to that of other systems.

The application of space techniques for maritime telecommunications was among the subjects discussed at the Maritime World Administrative Radio Conference in 1967. IMCO was asked by that conference to determine operational requirements. Since then in its examination of factors involved, IMCO has noted that the technical potential is such that telecommunication by a satellite could provide a means for improving safety communications over the world ocean routes, and that successful application of space techniques for maritime operations offers the possibility of substantial communication improvements as compared with the medium and high frequency systems which are now available and in use.

At the present stage of knowledge development and experimental experience, IMCO has considered and formulated preliminary views in the belief that in future the use of satellite systems could provide substantial improvements in both communication and navigation which could not only increase safety at sea but also become of great importance with regard to efficiency and economy of shipping in general. The organization has recently formulated a tentative list of operational facilities of interest to shipping that can possibly best be met by the application of satellite techniques. Some of these facilities are sufficiently important to merit consideration for the provision of frequencies for space systems by the World Administrative Radio Conference on Space Communications which will be convened by the ITU in 1971. The operational facilities designated as important and of interest to shipping are handling of distress communications, including search and rescue control; position determination of the mobile craft in distress and of search and rescue units involved; distribution of urgency and safety messages including medical assistance; interrogation of land-based stations by mobile stations for obtaining position information; meteorological and oceanographic information or regular interrogation of mobile station by land based station for the same purposes; distribution and collection of meteorological hydrographic and oceanographic information and observations; individual meteorological and oceanographic guidance of mobile craft by land based stations; selective calling of ships by coast stations for introducing public correspondence telecommunications through terrestrial means and possibly also exchange of public correspondence in general. Other possible functions of a satellite system which are also considered desirable are automatation of the position reporting system, traffic control, including collision warning, especially in converging areas; data transmission, for example by the use of land-based computers and also television transmission for operational, medical and entertainment purposes.

When the use of satellites is considered from the financial point of view, it seems obvious that no effort should be spared to develop a space communication system with the widest possible capability for future application of a variety of specific functions required by shipping, aviation, meteorology, etc. In maritime thinking this is considered to be essential to make implementation of space techniques economically realistic and attractive. IMCO with its particular responsibility for maritime safety is at present studying the possible redesign of the maritime distress communication system, bearing in mind the advantages which a world-wide system of satellite communications might offer.

Needless to say, an integral part of these considerations is the economic viability of such a system including total cost of research and development, establishment, operation and maintenance.

It should also be interesting to see what it would mean in terms of cost for shipboard equipment, maintenance, education and training of personnel, etc. The experimental experience of satellite communications for the maritime mobile service seems to indicate the possibility of meeting certain needs with sufficient reliability. Further it is nevertheless felt that an early examination of the overall operational requirements and capabilities as well as the cost factors would be of particular importance in providing information and guide lines for the technical body of the ITU — the International Radio Consultative Committee, CCIR — which at present is studying the technical characteristics of future satellite systems for aircraft and ships.

The Inter-Governmental Maritime Consultative Organization will continue its studies on potential operational maritime requirements for the application of satellite techniques and participate in the future work of other international organizations in order to contribute within its resources to the development of the most preferable system from the viewpoint of safety, efficiency, and economy. Thank you for listening.

*(Original language : English)*

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**Account by**
**Mr. H. S. MARZUSCH,**
**International Civil Aviation Organization, ICAO**

Mr. Chairman,

This paper I am going to read will deal with the impact of space developments on civil aviation, especially as far as the International Civil Aviation Organization, ICAO, which I represent here, is concerned.

The International Civil Aviation Organization deals with a dynamic area of human endeavour, involving among others, such fields as aerodynamics, power plants and electronics. Consequently it is essential that ICAO, on a continuing basis, closely watch a wide range of technical developments and do everything possible to foster those developments which promise in one way or another to be of benefit to civil aviation.

ICAO's particular interest in space technology is a natural extension of one of the Organization's normal activities. However, prominence was given to a closer examination of space affairs when in 1965 the Assembly of ICAO, at its Fifteen Session, adopted a resolution which, among other things, directed the Council of ICAO to carry out a study of those technical aspects of space activities that affect international air navigation.

One subsequent significant event in relationship to ICAO's involvement in space techniques was a meeting on aeronautical communications matters held in Montreal in October 1966. That meeting reported that the application of space techniques could readily introduce marked improvements in the ground/aircraft communications service, especially in those parts of the world where conventional aeronautical ground stations employing high frequency and very high frequency channels would be unable to provide the required coverage and level of communications reliability at all times. One such geographical region was agreed to be the North Atlantic, likely to be followed in importance in the future by other oceanic areas and large sparsely populated land areas. A further significant potential improvement through the use of space techniques was considered to be surveillance of air traffic for control purposes where the use of conventional radar was not feasible. Again the North Atlantic was cited as a region where such an application would be of such importance that, in the opinion of many, without it, major reduction in horizontal separation between aircraft in an increasingly dense traffic pattern might well be impracticable. For both the cases of aeromobile communications and air traffic control surveillance it was agreed that the problems were not acute in 1966 but were so clearly predictable that it was most desirable that the first steps be taken without delay in the hope of having solutions available in good time.

At the time of the afore-mentioned ICAO meeting there had been no airline experience with the United States NASA Applications Technology Satellites. By 1968, this was no longer the case and ICAO therefore then decided that the time had arrived for an expansion of the scale of activity in the identification and planning of practical applications of space techniques to civil aviation. An important step in this direction was the establishment of an ICAO Panel of Experts, known as the ASTRA (Application of Space Techniques Relating to Aviation) Panel. This Panel, composed of specialists from States and International Organizations — International Telecommunication Union, ITU ; World Meteorological Organization, WMO ; International Air Transport Association, IATA — is working to identify primarily those space techniques which could be applied to meet existing and foreseen world-wide needs of civil aviation that cannot be met by non-space techniques. The Panel will also identify those applications of space techniques which offer improvements in the safety, regularity and efficiency of international air transport operations more economically than could be realized by non-space techniques. With regard to both categories of information, the Panel is expected to predict dates by which the techniques concerned are likely to be sufficiently developed for practical application, and to prepare recommendations for ICAO's technical body, the Air Navigation Commission, concerning the desirable system characteristics of each application selected. These recommendations will also deal with relative priorities and practical time scales for introduction. The Panel is also expected to indicate any related action being taken by or required of other international organizations, and any techniques towards which space research and development effort should be directed to assist in the development of practical applications for aviation, including any effort in this regard appropriate to other organizations.

### Aviation applications already recognized

While the ICAO ASTRA Panel has fairly recently been formed and has so far held only one meeting, there are several potential applications of space techniques to civil aviation than can already be identified. Three particularly important areas of application are discussed and a brief indication will be given of the special advantages which it is hoped could be realized.

### 1. Air-ground communications

Of the specialized applications of space techniques to aviation, the use of satellite relay to improve the quality and reliability of communications between aircraft and ground stations is most attractive. The technical feasibility of relaying voice and data transmissions to and from aircraft has already been demonstrated on an experimental basis. The significance of this particular application relates to the fact that for ocean and large sparsely populated areas of the world, aviation has been forced to rely on high frequency radio communications which depend on ionospheric reflection to achieve the desired coverage. Unfortunately the ionosphere does not always behave in the desired way and even when an aircraft has a number of high frequencies to select from, communications may either be impossible or so distorted as to introduce potentially dangerous situations. Hence the prospect of employing a man-made message repeater in synchronous orbit some 22 300 miles above the earth is looked forward to with eager anticipation in relationship to all types of communication in which an aircraft needs to engage.

**2. Navigation and monitoring of air traffic**

Among people not too closely associated with international civil aviation there is a fairly common but mistaken belief that aircraft crew occasionally have difficulty in knowing where they are and how to reach their destination — in other words that they are liable to get lost for want of some superior navigational aid. To the extent that a real problem does exist in position determination it might better be defined as one of " relative " navigation between two or more aircraft. Safe separation between aircraft, if based solely on each aircraft being able to follow a precise pre-planned path and report progress periodically, presents a far more demanding navigational task than merely flying to the desired destination with reasonable economy. Fortunately, in most areas of high air traffic density it is possible to provide radar surveillance so that each air traffic controller can monitor aircraft of concern to him. When this safeguard is not available, as for example over a major part of the North Atlantic Ocean, it is necessary to provide much larger protective buffers of air space around each aircraft. With the rapid growth of civil aviation there is a foreseable need to operate in such oceanic areas with appreciably reduced separation between aircraft. However, this must be done in such a way that safety standards are not derogated. The answer, as in the case of flights over developed land masses, clearly lies in providing the air traffic controllers with a surveillance capability which will permit independent monitoring on the ground of the position and progress of all aircraft. No solution to this problem using wholly non-satellite techniques that is both technically and economically acceptable to all concerned has yet been suggested. However, a number of different proposals involving the use of satellites have been made and are being evaluated. It is interesting to note that as soon as an air traffic control monitoring system is available, it requires but little expansion to retransmit positional information back to the aircraft either for comparison with the aircraft's separately derived position information, or, in certain circumstances, as the primary means of navigation.

### 3. Meteorological satellites

In this area ICAO is less concerned with the satellites themselves than it is with direct application of some of the data received from them. By this is meant that aviation has so far but few unique requirements related to meteorological satellites and the data they provide; general knowledge of the conditions of the atmosphere and its likely development are of concern to all users of meteorological information and the World Meteorological Organization is actively engaged in co-ordinating development and planning of meteorological satellite observation systems for this purpose.

Existing satellites provide cloud pictures which permit inferences regarding the location of phenomena such as jet streams, certain types of turbulence and tropical depressions. This information is used to brief pilots on the selection of optimum routes. To create pictures of similar detail and usefulness using conventional non-satellite techniques would in many cases not be possible and in others require the establishment of a world-wide network of meteorological stations of such density that, together with the necessary communications, would be of astronomical cost. It is also highly important for aviation to have accurate knowledge of winds and temperatures at all levels of flight. For certain types of operation, in particular those planned for supersonic transport aircraft, precise information on the height of cloud tops will also be needed. Future developments of meteorological satellites, possibly in association with a system of constant-level balloons, may well lead to more and better information of this type becoming available for aviation than has so far been furnished by conventional means.

I would like now to add a few words on two subjects; one is *common use of the airspace by aircraft and space vehicles,* and the other *common use of radio frequencies.*

### Common use of the airspace by aircraft and space vehicles

There have been a number of attempts in recent years to define the lower limits of outer space. It is not denied that in relationship to such matters as the limits of national sovereignty, the definition of a boundary between the atmosphere and outer space may become necessary or at least desirable. From aviation-technical and operational viewpoints, no generally acceptable simple and permanent boundary level can however be stated, and the reconciliation of common user interests related to the airspace and outer space presents therefore certain potential problems which must be watched and dealt with as and when they develop. Solutions to these problems cannot be found in segregation of the two types of activity. For example, during the periods of transit of space vehicles through the atmosphere there is a common use of the airspace by aircraft and space vehicles. Programmed ascents and descents will in general not present major difficulties although the location and extent of launching and re-entry areas and the delimitation of reserved airspace may in due course need to be the subject of co-ordinated planning. The uncontrolled penetration into the atmosphere of remnants of satellites, rockets and other space debris, generally not capable of being programmed, may present a problem in due course and developing situations will be carefully watched by ICAO. Similarly, looking into the future of air transport, the supersonic transport aircraft might be followed by the hypersonic aircraft and rocket transports. The flight path of such craft may progressively extend into what may be regarded as the lowest region of outer space and then problems of ensuring safe separation between vehicles of the two kinds in outer space could arise.

### The common use of radio frequencies

A second form of common user interest and one of more immediate importance than that dealt with in the preceding case is the planned sharing of radio frequencies for aviation and space purposes. The role of the International Telecommunication Union is here of vital importance and through the medium of its Extraordinary Administrative Radio Conference in 1963 the requirements of civil aviation related to frequencies needed for space radio communication purposes have so far been well accommodated. It is to be hoped that the next ITU Space EARC in early 1971 will experience a similar success.

### Indirect technological benefits for aviation

It is well known that research and development work undertaken primarily for space applications, particularly in the broad field of electronics, has resulted in many indirect technological benefits in non-space activities. Civil aviation has been especially fortunate in this regard and is already enjoying the application of sophisticated electronic systems of great reliability, substantially reduced bulk and weight, far sooner and more economically than would have been the case, had the demanding requirements of space activities not arisen. Apart from electronics developments, the aircraft itself has had additional benefits, for example in the use of new materials, more advanced construction techniques, and improved cabin environmental control systems.

Finally a few words regarding the

### Liaison between ICAO and other international organizations

ICAO's interests in space applications are essentially the interests of a user or a customer for the services that space techniques can offer. In this respect its interests are, if not precisely the same as, at least parallel to those of ICAO's sister organization — the Inter-Governmental Maritime Consultative Organization (IMCO). ICAO's relationships regarding space developments with some other organizations such as the International Telecommunication Union take a somewhat different form, since the ITU is not solely representing user interests in the same way as ICAO does. For example the ITU International Consultative Committee on Radio matters — the CCIR — has a Study Group which is considering among other things the desirable technical characteristics of a communication-satellite service to aircraft and ships. Additionally that group is studying the technical feasibility of using the same satellite system for navigation purposes. It is inconceivable that the CCIR task could be accomplished without a great deal of detailed knowledge of the users' requirements and a close familiarity with the manner in which each category of user conducts his business. Hence, ICAO will do everything possible to ensure that the necessary information concerning the requirements of civil aviation is made known to the ITU. ICAO considers it has a similar responsibility towards other organizations and groups that are working in parallel or to some extent overlapping fields related to space developments, notably the World Meteorological Organization, WMO, and the United Nation's own Committee on the Peaceful Uses of Outer Space.

Good co-operation and co-ordination between the many organizations and bodies interested in various aspects of space affairs is particularly important since it appears to be unproductive to attempt to define sharp boundaries of interest and responsibility without overlap. ICAO's own responsibilities for space affairs were further considered by the ICAO Assembly when it met in Buenos Aires in September 1968 for its 16th Session. A resolution then adopted by the Assembly says:

> " that ICAO is responsible for stating the positions of international civil aviation on all related outer space matters, and particularly for stating international civil aviation's requirements in respect of applications of space technology."

From what has been said it will be apparent that ICAO has now entered deeply into a phase of evaluation and planning in relationship to the application of space techniques for the benefit of international civil aviation. The possibilities already discovered are, to say the least, most encouraging. It will be possible to do certain things for aviation that were impossible with non-space techniques, and to do other things better than they can be done now. It may also be found that there are appreciable economic advantages in the application of space techniques to civil aviation with the result that air transportation, which is already vital to the economic growth of many countries and the space of the world, will be able to serve mankind even better without necessarily involving disproportionate increase in cost.

*(Original language : English)*

**Account by**
**Mr. P. NAVAUX, Director,**
**Development of Information Media Division, UNESCO**

Mr. Chairman,

I should like to thank the International Telecommunication Union for having invited UNESCO to be represented at this Symposium — a further demonstration of the constant collaboration between our two organizations which dates from long before the space-age came into being.

Since its establishment UNESCO * has been concerned with communication questions : the preamble to the Organization's Constitution states that " The States Parties . . . are agreed and determined to develop and to increase the means of communication between their peoples and to employ these means for the purposes of mutual understanding and a truer and more perfect knowledge of each other's lives ", and in Article I it is stipulated that the Organization will " collaborate in the work of advancing the mutual knowledge and understanding of peoples, through all means of mass communication ".

Clearly, therefore, UNESCO could not remain indifferent to the possibilities offered by communication satellites, first as a means of instantaneous transmission of messages between countries and continents, and it was in this field that the first particularly spectacular demonstrations took place of the role which was going to be played by these celestial bodies, conceived and built by man, in a world whose dimensions were summarily reduced : occasions of national mourning, Olympic Games, and now, approaches to the Moon . . . events in which the whole world has been able to take part. But also, and above all, because communication satellites open up new vistas in the field of education.

It might not be out of place to recall that the idea of using satellites for educational ends was first formulated in a resolution prepared by the French philosopher, the late Gaston Berger, and submitted to the UNESCO General Conference in 1960. This first UNESCO resolution on space communications, which was adopted unanimously, stressed " the obvious impossibility of eliminating mass illiteracy through the use of traditional methods alone " and went on to point out that satellites might make it possible to broadcast educational programmes over extensive territories and drew the attention of its Member States to the fact that the use of satellites for educational purposes

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* United Nations Educational, Scientific and Cultural Organization.

raised problems which could be solved only within an international framework.

This resolution served as an inspiration for a whole series of studies and experiments on the use of educational television despite the fact that this medium did not, as yet, enjoy the advantage of being broadcast by satellite.

In 1964, the General Conference of UNESCO adopted a resolution by which the Director General was invited

> " to define the principles and main lines of a long-term programme to promote the use of space communication for the free flow of information, the rapid spread of education and greater cultural exchange."

The following year UNESCO convened a first meeting of experts to advise the Secretariat on the preparation of this programme. The experts' feeling was that all action in this field should essentially be based on co-operation with other organizations, both international and regional, namely the United Nations, the International Telecommunication Union, professional broadcasting and press organizations.

They emphasized that the development of communications by satellite made it urgently necessary to conclude agreements or international conventions to regulate their use. The preparation of an international arrangement on the use of space communications is obviously much beyond the scope of UNESCO's terms of reference. It is none the less true that any arrangement of this kind would involve problems which are of paramount importance to the Organization. It was thus that the General Conference, at its last session, authorized the Director General

> " to formulate, with the help of a meeting of governmental experts, proposals concerning international arrangements and conventions to promote the use of space communication for the furtherance of UNESCO's aims, specifically in the fields of
>
> *ii)* copyright ; and
> *i)* free flow of information ;
> *iii)* the assessment of the requirements of education, science and culture with a view to the future allocation of frequencies for space communication."

The inter-governmental meeting referred to will be held in the UNESCO building next December.

Finally, the experts held the view that UNESCO could fulfill an important and useful function by sponsoring and undertaking studies on the incidence of space communication in the fields within its own sphere of competence.

And it was mainly in the field of education that, in the experts' opinion, it was particularly urgent that UNESCO should carry out studies and research. The progress made by telecommunication technique is much more rapid than that of its application to education. It is therefore quite essential for all countries to develop their system of education and simply modify both the content and the methods of their teaching.

The experts consequently proposed that a pilot project for the use of space communications for educational purposes be launched with the help of UNESCO. This project should be implemented in a part of the world sufficiently vast and populated to enable it to have the desired international impact while satisfying certain priority requirements of the region chosen. Its aim should be to experiment with the potential use of satellites, especially as an aid to education and other related activities. This project should show in a convincing way both the advantages and the possible disadvantages of using space communications for such purposes.

This recommendation began to be put into effect very quickly. In 1966, at UNESCO's request, a research team at Stanford University, United States of America, started to prepare a report on the possibilities of carrying out such a pilot project, and the following year UNESCO sent to India, at the Government's request, a mission of experts to prepare detailed plans for the execution of the project. Today, having received the report of that mission, the Indian Government is studying, through the intermediary of an inter-ministerial commission, the concrete measures which should be taken to implement the mission's recommendations and has already sent to the Special United Nations Fund for Economic Development an initial request for aid in training the specialists in educational television who would be responsible for programme production, while, under an ITU project, future space communication technicians are already being trained in Ahmedabad.

Meanwhile, other countries have approached UNESCO for advice on the use of communication satellites for educational purposes. For instance, expert missions were sent to Brazil in 1968 and to Pakistan early in 1969, and a mission will visit Ecuador, Chile, Peru and other Latin American countries in the coming months to study the possibilities of regional co-operation in this field.

These are, very briefly summarized, the reasons why UNESCO is interested in space communications and the broad lines of the programme of action which it has set itself.

For the value of modern communication media lies in the possibility of their application to education. Thanks to them, countries which do not have enough qualified teachers can have the benefit of better teaching. Those whose schools lack auxiliary teaching aids, by supplying television sets to those schools, can take advantage of the courses of high standard given in the big centres. When a special course of a specific type of teaching is required it can now be centralized and widely disseminated. The teachers can take refresher courses without having to go back to training college. Where no school exists teaching is none the less still possible, thanks to the radio. Broadcasts for rural populations can help to impart essential knowledge of health matters, agriculture or community development. In all these forms modern communications open up wider horizons to the users by showing them how people live outside their village or their country and by explaining national programmes and objectives.

In short, in the field of teaching, space communications offer solutions at a level other than that afforded by traditional means, and make it possible to rethink education in terms of new categories and place it within new dimensions.

But before we can make use of the possibilities thus placed before us, how many questions remain to be solved! To what extent do prefabricated educational messages transmitted by the great mass communication media make it possible to do away with the human element in the shape of teacher or demonstrator? How far can one extend the role of the message? At what point is an intermediary essential? To what extent can pedagogy lose in depth what it gains in breadth? So many questions which it is urgent to study far more thoroughly.

For, to quote a passage from a Wilbur Wright Memorial Lecture given by H. E. Wimperis in 1932: " The benefits to be enjoyed from any new discovery turn less upon its mechanical perfection, however splendidly satifying to the engineer, than upon the dreams and ideals of those who are able to guide its ideals and guard its use."

*(Original language : French)*

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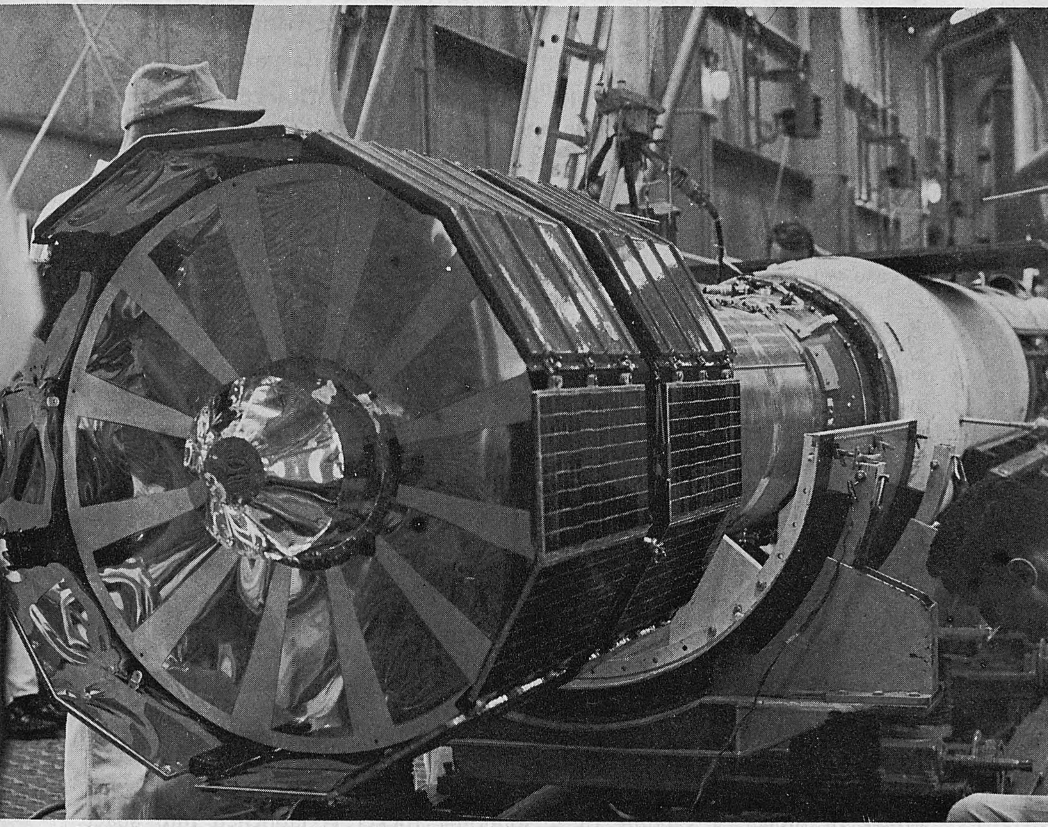

Esro-II *satellite under construction.* (ESRO)

# EUROPEAN PROGRAMMES

**Account by**
**Mr. J. B. LAGARDE, Chief of the Programme Co-ordination Group of the ESTEC *, Satellite and Sounding Rocket Department, ESRO**

Mr. Chairman,
Ladies and Gentlemen,

In case you are not well acquainted with ESRO – although that is improbable — I will begin by giving you a short outline of this organization.

The European Space Research Organisation (ESRO) was set up in 1964 on the initiative of the European Scientific Community to promote space research in Europe. Since the Bonn Conference of November 1968, its field of activity has been expanded to include preliminary studies for applied satellites, i.e. satellites that can be used for meteorological and location purposes, for prospecting and radiocommunications.

So far ESRO has the following achievements to its credit : 3 scientific satellites orbited ; about 80 sounding rockets launched ; 4 satellites at different stages of construction to be launched between autumn 1969 and winter 1972/73 ; the study of a project for an experimental European television distribution satellite in preparation for a series of operational satellites ; finally, the study of several projects for scientific satellites due to be launched in 1974/1975.

The organization comprises five separate establishments, employs a staff of about 1100 from ten different countries and operates with a budget of 250 million French francs a year.

When an object, a satellite or a sounding rocket is launched into space, the only means of communicating with it, whether on a one-way or two-way basis, is by radio. Only in isolated experiments, particularly those carried out by means of sounding rockets, is information communicated by the transmission of light or sound without the use of radio, i.e. by release of clouds of particles or by use of explosive devices. The main problems of earth-to-space radio links, as far as scientific applications are concerned, are as follows :

- Operational reliability of on-board equipment during its spatial environmental lifetime, including launching ; power radiated by the transmitters ;

* ESTEC, European Space Technology Centre.

sensitivity of the receivers and their protection from interferences; stability of the various frequencies generated (coders, transmitters) and of tuning frequencies (decoders, receivers); power consumption of, and space taken up by the various sub-assemblies.

● These difficulties are matched by the problems encountered on the ground except for the fact that the limitations on stability and equipment lifetime are less acute since adjustments can always be made and equipment replaced; there are no limitations on power consumption or space. The problems of the density of the radiated or received energy have so far been solved by the use, on board the satellites, of omnidirectional antennae, and on the ground, on the contrary, of pointing antennae which in turn gives rise to the problem of ensuring the strength and precision of the structures used.

From the very beginning ESRO has chosen for its scientific space vehicles telecommunication standards which strike a balance between consideration of performance, availability of — or the need to develop — the necessary technology in Europe, cost, and compatibility with systems already in use, particularly by NASA.

In the case of sounding rockets, the frequency band selected has so far been the 215–260 MHz band with frequency or phase modulation of the carrier by a multiplex signal made up of sub-carriers themselves frequency-modulated by information received from sensors or sampling switches: this is the conventional FM/FM system. This system operates perfectly satisfactorily so far apart from a certain amount of interference with television channels or with military transmission channels over certain firing ranges. It does not look as though the requirements of users will exceed the possibilities of the system in the immediate future and readjustments such as the replacement of certain sub-carriers by PCM channels are planned.

For the scientific satellites at present in operation, the frequency bands selected were 136–138 MHz for telemetry and 148 MHz for the command system. Where the telemetry carriers are phase modulated by a sub-carrier or directly by pulse-coded information, this is known as the PCM/PM system. The command carrier is amplitude modulated by one or more discrete frequencies selected from a series standardized by the IRIG group, which appears sequentially in accordance with a code containing one address word and one execute word. This is the command standard adopted by NASA.

*Iris,* known during construction as *Esro-II,* was launched on 17 May 1968, after a launching attempt which proved abortive owing to a fault in the third stage of the *Scout* vehicle. As most of the scientific data are digital, even the analogue measurements have first of all to be put in digital form so that at the output of the telemetry coder there is a succession of coded pulses (128 per second) which occupy only two amplitude levels (0 and 1) and recur in accordance with a specific format. This information modulates a permanently operating 200 mW VHF transmitter and is also recorded on board the satellite by an endless-tape magnetic recorder capable of storing without overlapping about 100 minutes of data, i.e. almost 700 000 pulses. This recorder can be switched by telecommand from recording to playback, which is 32 times faster and makes it possible, thanks to the use of a more powerful transmitter (1.6 W), to route the equivalent of the data of a whole orbit to the ground during the meantime in view of a station. The command system contains 36 different instructions. The telecommunication systems of Iris are still in perfect operating condition more than one year after launching except that the magnetic recorder broke down permanently after six months and three weeks in orbit. This is quite a creditable performance, however, when one thinks of the problems posed by an electromechanical assembly of this sort and when one compares its lifetime to those of the recorders on board the United States NASA satellites. The designers are also to be congratulated on the transmitters, the receiver and the coding and decoding system, whose flawless operation has caused them to be more or less forgotten.

*Aurorae,* developed as *Esro-I* and launched on 3 October 1968, has also been a success and its telecommunication equipment has performed satisfactorily, again, however, with the exception of the onboard magnetic recorder, which lasted nearly seven month. To perform its mission, which involved a study of the fine structure of the aurorae boreales, Aurorae had to be provided with a very rapid real-time transmission system since the space measurement resolution required is converted to time resolution by the speed of the satellite in orbit. A power of 200 mW is used for the continuous transmission of the 320 pulses per second of the slow format, which is also recorded on board the satellite. Playback is 32 times faster than recording, operating at the respectable rate of 10 240 pulses per second, thanks to the use of a 1.2 W transmitter. Rapid real-time transmission at 5120 pulses per second is achieved over certain stations in Scandinavia by means of the same transmitter. The command link sends out 36 instructions. As Aurorae's perigee is lower than that of Iris and good communication has to be ensured under aurora borealis conditions, its telecommunication performance, although perfectly satisfactory, has reflected the serious propagation disturbances caused by auroral phenomena even in the VHF bands, and has also revealed that the frequency allocations in this band are not being scrupulously complied with by certain countries in the southern hemisphere (desensitization of the command receiver in orbit, despite the fact that no station is supposed to transmit instructions on this frequency).

*Heos-1,* which was launched on 5 December 1968, presents a very different picture because in this case the orbit is a highly eccentric one with an apogee of 225 000 km or two-thirds of the way to the moon. The visibility of the earth stations for such an orbit is excellent as the satellite is more or less stationary in the sky for twelve hours in succession which means that no onboard recording is necessary. However, it is difficult to keep the signal-to-noise ratio within usable limits and the bandwidth has to be reduced in consequence. Only 12 pulses are transmitted per second by mean of a 6 W transmitter. The sensitivity of the command receiver is a more stringent requirement with the Iris and Aurorae and 70 instructions are needed for satellite control. Finally, a system for measuring the distance between station and satellite by means of discrete frequencies has been tried out yielding an ambiguity of 15 000 km and a maximum error of less than 100 km. Here again the assumptions made and the technology used have proved their worth : Heos-1 can be telecommanded at its apogee and over 90 % of its data can be used on the ground after being recorded by the stations in the tracking network.

As for current projects, *Esro-I/B* will be a replica of Aurorae, and *Heos-A2* will be an improved version of Heos-1 as far as telecommunications are concerned : a higher apogee (250 000 km) and a data rate of 32 pulses per second are the main constraints. *Esro-IV,* which is to be launched at the end of 1972, will still be in the small satellite class having a real-time data rate of 320 pulses per second with a faster real-time rate for certain high-resolution experiments. The *TD-1* satellite, an astronomical observatory scheduled for launching early in 1972, has more sophisticated requirements : 280 instructions are needed for orbital control, it has a real-time data rate of 1700 pulses per second transmitted by a 1 W transmitter and the two onboard magnetic recorders produce 30 600 pulses per second during playback, which means that the VHF spectrum radiated by the 5 W transmitter has a very " selfish " bandwidth requirement of 200 kHz. Other projects under study such as a geostationary scientific satellite, a double-rotation ionospheric satellite and an ultra-violet astronomical observatory, will involve carrying out experiments for which the resolution requirements will mean 4000 or 5000 pulses per second or more for the permanent real-time information so that a 1700–2300 MHz band will become inevitable.

Let us now discuss the main characteristics of the mission of the experimental communications satellite being studied by ESRO for the European Space Communications Committee. This geostationary satellite is scheduled to have two repeaters which can operate separately or simultaneously with a total passband of 140 MHz, an output power of 14 W for the European zone and 28 W for the African zone. An auxiliary repeater with a radiated power of 100 mW will duplicate the telemetry and command functions normally performed at VHF with 100 pulses per second for telemetry with two watts radiated and about 160 instructions for the command system. In this the bandwidths and signal-to-noise ratios will be determined by the quality needed for picture transmission, the distance, the performances required for energy conversion and attitude control of the sub-assemblies on board. Obviously there will be no question of omnidirectional onboard antennae and the lower limit of the usable frequency band will be 4 GHz. In addition to spectrum congestion considerations, the state of European technology in the critical areas of travelling wave tubes and the components of the attitude control system will be the determining factors when the final decision on this project is taken.

In reviewing the details of the various systems on board the *Esro* satellites in orbit, under construction or planned for the first half of the decade 1970-1980, I have tried to give you some idea of how performances and requirements are evolving.

So far, thanks to a sustained research and development effort, the European Space Research Organization and its contractors have coped successfully with the space communication demands of the Europeon scientific programme. Further development work and basic decisions on the subject of frequency bands will be needed to ensure that the future projects of ESRO can successfully take over from their predecessors.

*(Original language : French)*

**Account by**
**Mr. J. NOUAILLE, Director of**
**" Europa-II " Programme Management, ELDO**

Ladies and Gentlemen,

First of all I will briefly recall what ELDO * stands for. The aim of this organization is to produce space launchers to be made available to European States, individually or collectively, for peaceful uses. The organization, established in 1962, has as Members France, Germany, Great Britain, Belgium, the Netherlands and Italy, who were joined by Australia. All these States signed a convention for the construction of a heavy launcher, originally for the purpose of putting a heavy satellite into a low orbit. You know that this Convention, which was signed in 1962 and came into force in 1964, was subsequently the subject of much discussion and criticism and that, in particular, after making its objective the production of a heavy launcher (*Europa-I*) for low orbits, the Ministerial Conference of Member States held in 1966 expanded the Programme and redirected it towards high orbits and, more particularly, geostationary orbits (Perigee-Apogee system and *Europa-II* launcher).

The aim which ELDO assigned itself in its Convention is two-fold :

- first, a technological objective : to put European States in a position where they would not be left out of participation in a technique — launcher technique — of which no-one can tell today what its very long-term developments may be ;
- the second aim is more directly utilitarian ; it is to make it possible for European States to have their own launching capacity independent of those of the great world space Powers of today, the United States of America and the Soviet Union, and in this way to give them sufficient manoeuvering ground for them to be in a real position to negotiate when the establishment of world networks of functional satellites is discussed. This reflects the political determination of some States to preserve the utmost independence before entering into negotiations concerning complex international programmes which will have highly important consequences.

Practically speaking, you know that ELDO's present programme comprises two launchers in course of development : the first is called *Europa-I*. This is a three-stage launcher whose United Kingdom first stage is based on the use of the *Blue Streak* vehicle, its French second stage is known as *Coralie* and its German third stage called *Astris*. To this Europa-I launcher, it was

* European Space Vehicle Launcher Development Organisation.

decided at the Ministerial Conference of 1966 to add two upper stages: a perigee stage and then an apogee stage (*Europa-II* launcher). That the Europa-II launcher will be of practical value has been ensured by ELDO's decision to set up in French Guyana, within the framework of the Guyanan Space Centre of the French National Centre for Space Studies (*CNES*), an equatorial launching base which will enable the launcher to reach without difficulty the geostationary orbits which seem to be best suited for functional satellites.

### The Europa-I Programme

What are at present the possibilities and achievements of ELDO?

First of all, as part of the Europa-I Programme, you know that a number of shots have been made at the Woomera base in Australia with a view to developing the launcher. The first of these shots, made in December 1968, was, relatively speaking, a considerable success since the first stage, the second stage and the third stage all functioned correctly. Unfortunately, the course of the third stage was interrupted after a few seconds owing to a structural defect in its propergol fuel tank. This defect seems to have been brought about by some mishandling on the ground a few days earlier, the results of which had not been detected in time. We are planning a shot which we hope will place a satellite in a real orbit at the end of June; the target date at present is 30 June *.

This is a complete shot of the three-stage launcher and is the last but one to be carried out at Woomera; the final shot, which we call shot *F.9*, is due to take place in December 1969 and will conclude the programme for the development of the Europa-I launcher. I should add that this shot F.9 has another interesting feature: it was chosen by a number of States which took part in the European Conference on Satellite Communication *(CETS **)* to carry out a telecommunication experiment using responders developed in Europe. For, as you know, with each ELDO launcher we have to place what we call test satellites into orbit which, of course, are for purely technical purposes, namely:

*a)* to check that the orbit attained coincides with the calculated orbit;

*b)* to check the environmental conditions to which the satellite's instruments have been subjected;

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* This shot was made on 3 July and ended in exactly the same partial failure as the shot in December, which would seem to cast doubt on the explanation given above. An inquiry is being made before fixing the date of the next shot.

** *Conférence européenne des télécommunications par satellites.*

*c)* to check that the general functioning of the test is entirely as planned.

As we approach the end of the development, which will be shot F.9, we find that the satellite's weight and power carrying capacity is far in excess of ELDO's own needs. An offer has consequently been made to States Members of the European Conference on Satellite Communication to put " experimental payloads " in orbit for them by this means. And, in fact, five States accepted this proposal. An agreement has been signed between ELDO and these States — which are Belgium, the three Scandinavian countries and Italy — to include in our satellite F.9 a number of telecommunication responders. In fact, two responders will be carried and these are now being integrated inside our satellite. The first is an Italian responder, the second a responder of joint Belgian and Scandinavian manufacture. The responders operate in the 4000–6000 MHz band; they weigh approximately 35 kg and occupy about 30 to 40 $dm^3$ of the space available inside the satellite. The responders use the remote control and telemetric facilities already provided for in the satellite itself. They will work with existing earth stations forming part of the INTELSAT communication network, and, in particular, with the stations of Kiruna (Sweden), and Fucino (Italy), while for telemetry they will be in touch with the station of Tromsö in Norway. The power used on board the satellite for the responders is of the order of 150–200 W. The responders will operate only during the phase when they are in direct view of the stations. These periods are short since the orbit chosen for ELDO development purposes is not a geostationary orbit, but has a perigee of 400 km and apogee of 3000 km.

I think that in the future, within the framework of ELDO developments, there will be opportunities for assisting in the technological development of communication satellite techniques and from this standpoint, the trial we propose to carry out with F.9 is worthy of the greatest attention.

### Europa-II Programme

You know that, according to the directives of the Ministerial Conference of 1966, the original aim of the Europa-II development programme was to launch a relatively complex geostationary satellite, know as the *PAS* satellite, within which the ELDO Council has agreed to include a communications experiment in the 12 000–18 000 MHz band, prepared and calculated by the Italian industry and Government. This experiment was to be placed in a geostationary orbit practically at the latitude of Europe. It was to be operated by Italian stations in order to check the characteristics of telecommunication type signals when transmitted at these very high frequencies; it was not to be a real telecommunication operation since the power available on board the satellite is not enough to provide more than relatively narrow passbands. It was to be essentially an experiment in absorption and transmission. In fact, the financial difficulties in which ELDO found itself at the end of 1968, and in particular the decision of the United Kingdom Government to reduce its contribution to the organization forced us considerably to simplify the PAS satellite and to abandon this experiment which, in the meantime, has been revived as part of an Italian national programme. The same difficulties also forced us to sacrifice the apogee motor in the satellite. Nevertheless, we are going to complete this Europa-II launcher in the form in which it emerged from the ELDO crisis of 1968-1969, solved last April by the decision of France, Germany, Belgium and the Netherlands to increase their contributions so as to compensate for the British withdrawal and the Italian request for reduction of its contribution; this Europa-II launcher still offers far from negligible possibilities, since, in its present form, it can place in orbit a geostationary satellite weighing 170 to 190 kg, depending on the performance of the apogee motor which will have to be incorporated in the satellite; this figure of 170 to 190 kg is the weight of the satellite itself, the weight put into orbit corresponding to the satellite plus the empty casing of the apogee motor used to render the transfer orbit circular. This capacity of 170 to 190 kg is, as Mr. Sueur said this morning, planned with particular reference to the launching of the *Symphonie* satellite. The *Eurafrica* satellite project — of which Mr. Lagarde has just spoken and of which, I imagine, Mr. Mertens will also speak — was also planned with the performance of the ELDO launcher Europa-II in mind; this satellite is designed for the transmission of *Eurovision* programmes over the Europe-Africa complex. It could be produced and launched within an exclusively European context.

**Future programmes**

In addition to programmes planned, there are our future programmes for which two avenues are at present being explored:

- The first is a modest improvement in the performance of Europa-II by the addition to the first stage of the ELDO launcher of solid propergol boosters containing 10 to 15 tons of propergol; this would probably make it possible to increase Europa-II's present maximum capacity of 190–200 kg to 250–300 kg. No decision has so far been taken on the matter but such a launcher is certainly feasible, with relatively moderate development costs.

- The second possibility is one which marked the conclusion of our latest Ministerial Conference in April, i.e. to develop a *Europa-III* launcher, the objectives for which were fixed by that Conference at 400–700 kg in geostationary orbit. This value of 400–700 kg clearly ties up with what Mr. Sueur mentioned this morning, namely the third generation of European communication satellites (satellites of the order of 500 kg. — I cannot give more exact details). Two courses are open for Europa-III development :

- one course would be to use the Blue Streak, which is the first stage of the present Eldo launcher ; this is the most economical solution but is of course rendered politically somewhat difficult by the decision of our British colleagues to withdraw their support from the work of ELDO ;
- a second course would be to use a new first stage like the one which the French delegation proposed ; this involves using a number of motors of the *Diamant-B* launcher regrouped on a structure 3,50 m in diameter. It advocates the use of aerosine and nitrogen peroxide as propellants. This first stage, which we call *L.135* (*L.120* or *L.95* according to the circumstances — the figure corresponds to the weight of propergol —) gives a slightly better performance than that obtained with the first system, but is, of course, considerably more costly than the alternative offered by the Blue Streak whose performance up to date has been found to be extremely reliable. The choice is still open and studies are continuing.

This is how the position is at present.

I think I have managed to give you a fairly rapid sketch of what ELDO has done and can do within the framework of the European Launcher Programmes. I believe that, in the short term, let us say by 1971-1972, the capacity of 200 kg in geostationary orbit will be achieved and that the subsequent capacity, increased to 500–700 kg, will depend on the European States' willingness to continue along this path and to acquire independent launching capacity, since this type of exercise is costly, is paved with considerable technical difficulties and calls for a serious and continuous outlay of money, effort and time if one really wants to obtain results.

It remains to be seen whether enough Member States will preserve to the end their faith in this truly European enterprise.

*(Original language : French)*

**Statement by**
**Mr. H. MERTENS, Chief Engineer,**
**European Broadcasting Union, EBU**

Mr. Secretary-General,
Ladies and Gentlemen,

I should like to say first of all how happy I am to have this opportunity of giving you a brief account of the applications of space communication to television and of telling you about certain problems and plans with regard to television in the field of space communication. Television is not perhaps the most important user of communication satellites but, as I hope to be able to show you, it is undoubtedly a user whose known short-term requirements are considerable. During my report I shall speak from a specifically European point of view and I shall have frequent occasion to refer to the international system for the exchange of television programmes which is known as *Eurovision*. I don't think there is any need to explain in detail what Eurovision is: it is a system which was introduced by the European Broadcasting Union and in which the television organisations of Western Europe and North Africa regularly take part.

In fact, the first applications of space communication to television were for establishing intercontinental point-to-point connections. There is nothing surprising about this since, in view of the large bandwidth of the signals, television had no means of transmitting pictures over very long distances before the advent of communication satellites. The first intercontinental television connection was set up in 1962, a few hours after the launching of the first *Telstar* satellite, and the first actual exchange of programmes between Europe and North America took place on 23 July 1962. Since then, the use of satellites for intercontinental television transmissions has become more and more frequent, although this development is still considerably handicapped by the charges for circuits, which are relatively high.

I should like to mention a few figures which will give some idea of the development of intercontinental television transmissions since the first Telstar satellite was launched, taking as an example the transmissions made over the North Atlantic in the America-Europe direction and relayed by one or more Members of Eurovision.

There were 12 transmissions of this type in 1962, 37 in 1963, 32 in 1964, 102 in 1965 (this jump was due to the launching of the first INTELSAT satellite, *Early Bird*), 35 transmissions in 1966, 122 in 1967 and 534 in 1968. After a brief marking-time, the trend is incontestably and rapidly upward.

It is important, however, to bear in mind the nature of the television programmes which are transmitted over long distances. In the great majority of cases these transmissions concern either important reportages, a typical example of which is obviously the Olympic Games, or news items, where the main factor for the public of televiewers is speed of transmission. Only a few days ago we witnessed events of world-wide importance during the flight of *Apollo X*, when a number of television transmissions were routed by satellites over the Atlantic and over the Pacific. It is for events of this kind that the use of satellites is most justified, for modern television demands that this type of picture be made available to televiewers throughout the world within an extremely short time and usually it is even necessary to provide these programmes live. We must therefore hope that the improvement of communication satellites and the gradual establishment of world-wide satellite communication systems will make it possible to increase these programme exchanges among all countries of the world.

Point-to-point connections, however, represent only a fairly limited, fairly marginal, aspect of the potential of satellites for television in the years to come. There are other purposes to which the characteristics of satellites lend themselves extremely well. I have in mind the problems of simultaneous distribution of television programmes to a number of receiving stations. Within this range of problems we can discern a more or less continuous development, which begins with a relatively small system involving one satellite for the distribution of a programme to a rather small number (a few dozen) of earth stations on a particular continent. We can go farther and contemplate increasing the number of receiving points. Naturally, for economic reasons, this will mean that the costs, and hence the complexity, of this earth receiving equipment must be reduced. If these installations are simple enough and numerous enough, small communities can afford to have them and it is with this type of system that we envisage solving the problems of educational television. Finally, if the receiving equipment becomes so cheap that it is within the means of the ordinary televiewer, we arrive at a direct television system in which the public receives satellite transmissions directly. The first type of system, i.e. distribution to a small number of receiving stations, has all the characteristics of a fixed service in which the satellite simply replaces a number of terrestrial radio-relay systems. In the final stage, however, when the broadcast is received directly by the public, we have a broadcasting service and, of course, the technical problems, particularly the problem of frequencies, are not the same.

I should like to consider more especially the problem of the distribution of programmes to a small number of earth stations, because this problem has already been closely studied and in Europe is capable of a short-term solution within three or five years and particularly because this system may answer a need which has been expressed by all European television authorities. It is the possibility of increasing satellite performance, with the attendant reduction in the cost of earth stations, which led the EBU to formulate what is now called the Eurovision Satellite Project.

This project consists of a system in which a geostationary satellite would partly, if not totally, replace the international radio-relay systems now used in Europe to transmit the television programmes exchanged by the various countries. Basically, therefore, it is indeed an international system in which each of the participating countries would have a transmitting and receiving station. This station would itself be connected to the national programme distribution centre, which would be responsible for fitting contributions of foreign origin into the national programmes. The system would thus be comparable in every way to no one now operated by Eurovision and, in particular, it would respect the freedom of every country and of every television service to accept or refuse the programmes transmitted by the system.

Why, then, is a satellite necessary, since in Europe we are fortunate enough to have a radio-relay system which performs its function very well? The reason is that the satellite offers a number of advantages which can be divided into three:

- First of all, operating methods would be greatly simplified. This would take rather long to explain and I shall simply point out that with a satellite, if a particular network configuration is required, it is sufficient to give an earth station the order to switch to transmission and then instruct the stations in the countries which have to receive the programme to switch to reception. It is therefore simply a matter of obtaining a certain network configuration by sending a command — and this can be done by the satellite itself — which ensures switching at the earth stations. With the present system of terrestrial circuits, to establish a network configuration we must find all the circuits required to connect the point of origin to the receiving point and then these individual circuits must be leased to the administrations which operate them. This method works satisfactorily but it does involve a rather clumsy administrative procedure which hinders the organization of many transmissions at short notice.
- Secondly, economic studies have shown that a satellite could be less expensive than renting an equivalent number of radio-relay systems. Despite the margin of uncertainty which subsists in these estimates, this argument will carry great weight when the time for decision arrives.
- The third and last advantage, perhaps the most important and certainly the most impressive, is that it will be possible to extend the geographical areas served by Eurovision. At the present time Eurovision can use very

good quality radio-relay systems covering the entire European continent and also some links which have been established between Europe and North Africa. But it is neither technically nor financially feasible to prolong this radio-relay infrastructure across the enormous stretches of the African continent. Another typical example is Iceland which, although its Television Service is a member of the EBU, one would never think of linking up with Eurovision except by a satellite. The same is true of countries in the Middle East. With a satellite, such an extension of the geographical service areas is easily obtained since all that is necessary is to arrange the radiation pattern of the antennae on board in a suitable manner. In this way any new country which is not connected to Eurovision but which lies within the area covered by the antennae could become part of the system merely by building an earth station. It was with these requirements and possibilities in view, from the start of the Eurovision Satellite Project, the EBU decided that the service area should include no only Europe but also Iceland, the countries of the Middle East and, what is extremely important, the whole African continent.

I shall now try to outline the content of the project and explain how the EBU was able to define the necessary specifications. First of all, traffic studies have shown that by the time the project will be executed, i.e. in 1975, it will be necessary to be able to transmit simultaneously two more or less continuous Eurovision programmes, one of which should be constantly accessible to Africa.

The project therefore requires a satellite, or at least part of a satellite, comprising at least two repeaters so that two television programmes can be transmitted. Each of these programmes, of course, must contain the picture (in black and white or in colour) and also the sound components normally associated with the programme, that is to say, first the sounds on the spot when the reportage or the news event is taking place and also the series of commentaries in several languages, each commentary being intended for one of the television services which relays the programme. Studies have shown that twenty channels are necessary for the commentaries for each television programme. We must also be able to transmit *via* the satellite itself the long-distance switching signals of the earth stations, for it is this device which is the real key to the simplification of operating procedures.

It was on these bases that the EBU prepared a project and defined the requirements to be met. These requirements are basically twofold :

- first we must ensure that the quality of the retransmitted programmes is adequate, and as a result of the studies it was possible to define exactly the quality level of the picture and the quality level of the sound that must be obtained ;
- secondly, the system must be such that the earth station is very cheap.

Perhaps a few words of explanation should be given on this point.

We felt that there would be no purpose in introducing a system in which the earth station was so complex and so costly that only a few rich countries would be able to afford it. The EBU project, however, has the merit that the system can be used by all countries, without exception, which are served by the satellite, and all of these countries, even the poorest, must have access to the system. It was for this reason that, particularly from the technical standpoint, our efforts were concentrated almost entirely on how to reduce the cost of the earth stations to a minimum. The estimates show that the system could be installed with earth stations equipped with antennae about 10 m in diameter and provided with fairly simple amplifying devices such as uncooled parametric amplifiers.

These, then, are the broad lines of the Eurovision Satellite Project. The project has been very thoroughly worked out and was the subject of numerous discussions with a number of organizations and institutes, but no decision has yet been reached. We in the EBU hope that a decision will be taken very soon, but for the time being there is no question of presenting the project as something that will definitely be carried through but rather as a proposal with good chances of realization.

The EBU had contacts with a number of organizations which were regarded as possible suppliers of satellites and whom the EBU approached as a potential customer. Extensive discussions were held with COMSAT * and the *Telespazio* company on the possibilities of carrying out the Eurovision mission with INTELSAT ** satellites. Contacts were pursued also with those in charge of the Franco-German *Symphonie* programme, the conception of which is relatively close to that of the EBU project, but the purpose of the Symphonie is not quite the same as Eurovision's. The most numerous contacts were with the European Conference on Satellite Communications *(CETS),* which in 1967 instructed the European Space Research Organisation (ESRO/CERS) to study the definition of a system for a European communication-satellite pilot project; it was necessary to select operations which would show an economic return within a relatively short time and the States Members of the Organization considered it essential that European technology should be brought to a sufficiently high level to carry out the project.

After lengthy study, the type of satellite finally decided upon was the one known as *CETS-C* or *Eurafrica,* which meets fully and exclusively the pur-

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* Communication Satellites Corporation.

** International Telecommunication Satellites Consortium.

poses laid down by the EBU. The system may therefore be regarded as a prototype of future Eurovision operational satellites. The Eurafrica project has now been submitted for decision to the Governments of the CETS Member States.

Whatever solution is finally adopted — CETS, INTELSAT or Symphonie, or a combination of these systems — the EBU hopes that the Eurovision programmes can be disseminated by satellite within a few years in sound technical and legal conditions and that they will be fully operational in Europe and in Africa.

In conclusion I should like to refer briefly to a particular problem regarding the project which is very much in our minds, namely, the choice of frequency bands. The frequency bands at present allocated under the Radio Regulations for satellite communications, as we have heard several times today, are mainly the 4 GHz bands (for the downward path) and the 6 GHz bands (for the upward path). There are other fairly narrow bands close to 8 GHz and there is talk of allocating frequencies above 10 GHz at the 1971 Conference. But in all these studies attention must be paid to a number of physical phenomena which in the higher frequencies cause a considerable increase in the attenuation of radio frequencies when they traverse the atmosphere. We know that this attenuation is due to oxygen and water vapour, and particularly to the presence of water in liquid form in clouds and in rain. Without suitable arrangements in the satellite (which always radiates the maximum power compatible with its characteristics), the increased attenuation at high frequencies can only be offset by improving the performance of the receiving earth station; this demands a larger antenna or an amplifier with a lower noise temperature. The seriousness of this problem in a project such as that of the EBU, where a basic requirement is lower-cost earth stations, can be illustrated by a few figures. To appreciate the significance of the following example, we must remember that the cost af an antenna varies more or less with the cube of its diameter. In a typical example, based on the characteristics of the Eurafrica satellite, we find that, all else being equal, an antenna 7 m in diameter at 4 GHz and 15 m at 12 GHz is required at the boundary of the European service area. In equatorial Africa, the antenna diameter must be about 8 m at 4 GHz and 23 m at 12 GHz, the rather substantial difference being attributable to the high rainfall in equatorial climates.

These figures are an indication of the difficulty of using frequencies above 10 GHz for communication satellites. This problem is one of the main subjects of study for the International Radio Consultative Committee (CCIR) Specialized Study Groups, which must also consider the fact that the 4 and

6 GHz bands, in principle the most suitable, are allocated to satellites on a sharing basis with the fixed and mobile services. The resultant risks of interference can only be avoided by extremely careful and difficult co-ordination studies. In this field the CCIR and the International Telecommunication Union have an important part to play in the allocation of frequencies and in defining the methods and standards which will ensure equitable and optimum use of the spectrum by all who need it.

*(Original language : French)*

## Closing speech by Mr. M. MILI, Chairman of the Symposium and Secretary-General of the ITU

Gentlemen,

We have come to the end of this Symposium on Space and Radiocommunications organized by the International Telecommunication Union under the patronage of the French Minister of Posts and Telecommunications.

I think we can rapidly drew a few conclusions :

● First of all, we have had the pleasure and good fortune to have a great number of organizations, both national and international, take part in the symposium, which is evidence of your great interest in the peaceful uses of outer space.

The lecturers you heard today come mainly from national and international organizations and I should like briefly to mention the organizations which were good enough to participate in this symposium. This morning you heard :

- Mr. Johnson, Vice-Chairman of Interim Communication Satellites Committee (ICSC), and
- Mr. Sueur, the Deputy Director-General of French Posts and Telecommunications.

This afternoon you heard representatives of the French National Centre for Space Studies *(CNES),* ELDO (European Space Vehicle Launcher Development Organisation), ESRO (European Space Research Organisation), and the European Broadcasting Union (EBU), and also representatives of four international organizations which are very interested in the development of space communication — the World Meteorological Organization (WMO), the Inter-Governmental Maritime Consultative Organization (IMCO), the UNESCO and the International Civil Aviation Organization (ICAO).

● All emphasized the great possibilities which the use of outer space offers these national and international organizations and all stressed the benefits the mankind can derive from such uses of space. Some of them, however, also mentioned the difficulties we face at present both in regulating its use and in solving the technical problems involved.

I believe that one of the purposes of this symposium organized by the ITU was to give all those who are concerned with space research or who are present or potential users of outer space the possibility of meeting and exchanging views. This is always highly instructive and beneficial. I think that all the eminent lecturers we have heard today have taught us a great deal. The ITU at least has benefited greatly. It has been most instructive for us, and I hope that it will be possible to organize similar simposia in the future.

● This is the first time that the ITU has taken part in this Air and Space Show and this morning Mr. Maillet, the Commissioner General of the Show, was kind enough to emphasize the importance of ITU participation and expressed the hope that this will merely be a beginning.

I may say that we fully share this point of view and hope that the ITU will be present at the Show in 1971. This year we did not have enough time to prepare for the symposium as well as we would have liked because it is the first time that we are attending the Air and Space Show. But we have learnt valuable lessons which, I hope, will enable us to organize ourselves better in 1971.

● Some if not all of you have drawn attention to the need for world-wide co-ordination of space activities and several speakers have stressed the importance of the part to be played by the International Telecommunication Union. Its role is indeed extremely important and this morning I tried very briefly to explain how, for one hundred years, the ITU has acted as co-ordinator of the telecommunication media which we now call conventional. Its role is the same with regard to the peaceful use of outer space. I use this term instead of space communication intentionally to emphasize the fact that all telecommunications, — whether they are of the conventional type or involve the use of satellites —, and all satellites, even when they are not communication satellites, require the use of radio, and are of concern to the ITU. The ITU will therefore do everything in its power to ensure, as in the past, the co-ordination which is so essential for the development of space communication if mankind is to derive maximum benefit from this marvellous discovery and the wonderful possibilities offered by outer space.

● I mentioned this morning that the Administrative Council of the ITU, with the approval of the majority of the Members of the Union, which now number 135, decided that the second Space Conference should open in Geneva on 7 June 1971 for a duration of six or seven weeks. I have already stressed the importance of the work done by the CCIR Study Groups. On several occasions delegates have mentioned this very important work, which will serve as the basis for the Space Conference in 1971.

We hope that all of you who are interested in space questions will contribute to the work of the CCIR so that the 1971 Conference may be as successful as we hope it will be.

These, Gentlemen, are a few conclusions. I hope that this symposium has been useful and that the next one in 1971 will be even more heavily attended.

*(Original language : French)*

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