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GUGLIELMO MARCONI 1874-1937

by

Dr. C. M. MINNIS, *Secretary General, URSI*

The Commission Internationale de Télégraphie sans Fil Scientifique, which preceded URSI, was created in 1913. The intention of its members was to provide the necessary scientific basis for the rapidly growing wireless telegraph communications systems which owed their origin mainly to the pioneering work of Marconi at the end of the 19th century. There is no record of any direct contact between Marconi and URSI, but it would be inappropriate if the telecommunications Union of ICSU were not to join in celebrating the 100th Anniversary of his birth in Bologna on 25 April 1874.

The excitement engendered by a great achievement, whether it be the first ascent of Mount Everest, the launch of the first artificial Earth satellite, or the first manned landing on the Moon, tends to be forgotten once the exploit has been repeated, or once the original scientific and technological innovations have been developed and been accepted as part of everyday life. Thus it is not easy for the present generation to imagine the scientific and technological environment in which Marconi grew up, or to appreciate the impact that his earliest achievements, in particular, must have made at the beginning of this century.

When Marconi was born in 1874, Maxwell's work on the electromagnetic field had been published only nine years earlier. There was no reason to suspect that these theoretical results had any practical applications, much less that they would one day be regarded as the foundation stone for a communications system that would supersede the electric telegraph. In 1874, Hertz was still a young student and he was not to begin his experiments on electromagnetic waves until 13 years later.

At his home in the Villa Griffone near Bologna, the young Marconi showed an interest in physics and chemistry, and in the construction of mechanical models. He may have first learnt about the experiments of Hertz during the courses on electricity given by Righi in the Physics Department at the University of Bologna. Although Marconi had not succeeded in entering the University, his mother had arranged with Righi, who lived nearby, for her son to attend the electricity classes. For some time,

Righi had been interested in the generation and detection of Hertzian waves, but purely as a scientific experiment in his laboratory. Hertz died in 1894, and Righi described his work in an article which appears to have kindled the imagination of Marconi. Later that year and also in 1895, Marconi's first preoccupation was to reproduce the experiments of Hertz, as well as those of Lodge in London and Righi in Bologna. However, it was not his intention merely to repeat what had already been done by others; he was much more ambitious and forward looking, for his goal was to extend the distance between the emitting spark gap and the loop of wire that served as a receiver, and thus to develop a method for the communication of information through space, rather than along the wires of the electric telegraph.

By making improvements to the "coherer", on which Branly and Lodge had been working, Marconi succeeded in appreciably increasing the sensitivity of his receiver. Later, when the space inside the Villa Griffone became too restrictive and he began to work out of doors, he discovered, more or less by accident, that the range of his transmissions could be greatly extended by connecting one side of the Hertzian oscillator to the earth and the other to an elevated wire; a similar aerial/earth configuration was used at the receiver. By late 1895, the various improved techniques had enabled him to increase the range from the 20m achieved by Hertz to 2 km. This result seemed to him to be sufficiently promising to justify the offer he made, to the Italian Ministry of Posts and Telegraphs, of a prototype wireless telegraph system, but his offer was not accepted.

Marconi's mother was Irish and, as a boy, he had travelled with her on her visits to friends in Britain. It was thanks to her initiative that, in 1896, they returned to London and that Marconi, while still only 21, was introduced to Preece, Engineer-in-Chief of the General Post Office. It is interesting to note, in passing, that the introduction was made by A. A. Campbell Swinton, an Electrical Engineer, who was later a British delegate to the URSI General Assembly in Washington in 1927. His letter of introduction (1), dated 30 March 1896, refers to

> « a young Italian of the name of Marconi [and his] new system
> » of telegraphy without wires [which] appears to be based upon
> » the use of Hertzian waves and Oliver Lodge's coherer and
> » [with which] he appears to have got considerably beyond what
> » I believe other people have done in this line ».

Preece too must have been impressed for, within three months, Marconi was giving successful practical demonstrations of his equipment in England

and, with further improvements, he had achieved a range of 14 km by May 1897.

Marconi was well aware that electromagnetic waves, like light waves, normally travel in straight lines and that there was no accepted explanation for his success in communicating with stations which lay below the horizon. When, in 1899, he achieved ranges of about 100 km over the sea, he simply remarked that the intervening "dome of water", 160 m in height, presented no obstacle and that the waves must either have gone over it or round it, but not through it.

Even though no one had found it possible to account for the inexplicable behaviour of the waves, Marconi had sufficient faith in his own results to propose a far more ambitious project : the transmission of signals, by wireless telegraphy, across the Atlantic Ocean from England to Newfoundland. He was obviously undaunted by the fact that the dome of water would now be 200 km in height, or by the opinion, which emanated from several sources, that he was attempting the impossible. Nevertheless, the impossible was achieved during the now legendary tests in December 1901, but a quarter of a century was to elapse before the emergence of the explanation in terms of reflections of radio waves from the ionosphere. Any still lingering doubts about whether it was, in fact, possible to bridge the Atlantic with the primitive equipment used by Marconi seem to have been dispelled very recently by the estimates of the field strength made by Ratcliffe (2).

Marconi's early achievements, culminating in the spectacular success of the transatlantic tests in 1901, have tended to overshadow his later activities. These have not, perhaps, received the attention they deserve, but attention has been drawn to them again by Isted (3), one of Marconi's collaborators in the 1920-1930 period. It is interesting to note that, as early as 1922, Marconi had reoriented his efforts towards the development of high-frequency, rather than very low-frequency, communications; the outcome was the creation of the Marconi short-wave beam system a few years later. In 1931, he was experimenting with 600 MHz links and, by late 1932, he had set up a microwave telephone/teleprinter service, over a distance of 24 km, between the Vatican City and Castel Gandolfo.

Marconi had received advice that microwaves could not be transmitted over the horizon but, as in 1901, he ignored it and succeeded in attaining ranges of over 200 km in the Mediterranean. Although, at the time, there was no explanation for this unexpected result, he made the remark that the waves could be "refracted and contained within a space lying between

the surface of the Earth and a layer situated somewhere lower than the Heaviside layer"; this suggests that he came close to discovering the influence of the troposphere on radio waves, and the effects due to the anomalous tropospheric propagation which is frequently encountered in the Mediterranean. Isted refers also to an incident, in 1932, which may have been the first continuous-wave radar observation (on a moving steam-roller at a distance of a few hundred metres) and to a microwave marine navigation system which was successfully tested in 1934. Clearly Marconi's fertile imagination remained as active as it had been 40 years earlier. What is more important is that, even when the radio techniques he needed were non-existent and had to be developed, he did not allow such difficulties to block the way that led towards his objective.

During his lifetime, Marconi's interests extended over the fields covered by all the URSI Commissions and it is interesting to speculate whether he would have felt at ease if he had attended the early General Assemblies of URSI. Probably not, for he was more interested in the practical approach to the solution of problems than in listening to discussions and theories which, as he well knew from experience, were not always valid. This suggestion is supported by the tribute which Appleton paid to Marconi in 1938 at the Opening Session of the VI URSI Assembly in Venice (4). After referring to the fact that, in 1901, many aspects of the theory were such as to deter anyone from even attempting the transatlantic experiment, he continued

> « but Marconi, the true experimenter, did not allow himself to
> » be held up by theories. His experiments were successful and
> » the theoreticians had been confounded. Something had been
> » forgotten in their theories, or some factor had been neglected ».

In conclusion, it seems appropriate to repeat the closing remarks made by Appleton in 1938 :

> « For more than 40 years, Marconi worked as an experimenter
> » with inexhaustible energy and enthusiasm. However good his
> » results were, he never relaxed his efforts. For him it was always
> » the beginning. If a field had not been completely explored
> » and presented difficulties, he attacked these with the zeal of
> » the young experimenter starting out on his first research. He
> » remained thus to the end ».

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1. Guglielmo MARCONI (1874-1937). — *Telecomm. J.*, **41**, 236-240 (1974).
2. RATCLIFFE, J. A., Marconi : Reactions to his transatlantic radio experiment. *Electronics and Power*, **20**, 320-322 (1974).
3. ISTED, G., Marconi : A turning point in radio communication. *Ibid.*, **20**, 315-319 (1974).
4. *Proc. URSI Gen. Ass.* Vol. V, Fasc. 2, pp. 1-4 (1938).

GUGLIELMO MARCONI CENTENARY CELEBRATIONS

Florence 8-11 October 1974

The Preliminary Programme for the International Symposium on Radio Propagation in Natural Media has recently been published. Among the speakers it is appropriate that URSI should be strongly represented by several present and former members of the Board of Officers and Chairmen of Commissions :

W. J. G. Beynon
M. Boella
H. G. Booker
S. A. Bowhill
W. Dieminger
K. Rawer
J. Voge.

The attendance at the Symposium will be limited and pre-registration is advisable. Further information is available from

Prof. P. F. Checcacci,
Istituto di Ricerca sulle Onde Elettromagnetiche,
Via Panciatichi 56,
I — 50127 Firenze, Italy.

MEETING OF URSI BOARD OF OFFICERS 27, 29 MARCH 1974

The principal questions discussed by the Board at the above meeting are summarised below.

1. — XVIII GENERAL ASSEMBLY, LIMA 1975.

1.1. — It was noted that Commissions I, II, IV, V, VI and VIII had already made good progress in planning their scientific sessions and finding

speakers and that the Secretary General intended to circulate a full provisional programme and timetable to the Chairmen and Vice-Chairmen in mid-April 1974. The list of speakers will be available by the end of June and it is intended to make final adjustments to the programme at a meeting of Chairmen and Vice-Chairmen on 8 July.

1.2. — The scientific programme for Commissions III, IV and VIII was discussed with the Chairmen and Vice-Chairmen of these Commissions on 28 March and by the Board on 29 March. It was appreciated that there was a risk of serious overlap between the subjects to be discussed by these Commissions in Lima and those to be covered by the programme of the IUGG Assembly in Grenoble, a few weeks later, during which IAGA intended to organise several symposia on geophysical topics of some interest to URSI.

1.3. — The Board agreed (*a*) that, as far as possible, the URSI programme should concentrate on those aspects of the ionosphere and magnetosphere which are concerned with wave phenomena and which have some relation to radiocommunications, (*b*) that purely geophysical topics, which would be discussed at the IUGG/IAGA Assembly, should be avoided. In fact, Commissions III, IV and VIII will cooperate in the organisation of three Symposia in Lima, but the subjects covered by them are not intended to correspond exactly to the fields of interest of the respective Commissions :

Symposium A	Radio waves and the ionosphere.
Symposium B	Wave physics in natural plasmas.
Symposium C	Telecommunication noise and the interference environment.

1.4. — As an experiment, it is proposed that these symposia shall be open to anyone wishing to attend and shall not be restricted to members of delegations. The President will first consult all Member Committees of URSI about the possible difficulties that this proposal could create for them.

1.5. — It was noted that the Secretary General had sent the text of the First Announcement of the Assembly to the Peruvian Committee in March 1974. It was hoped that this Announcement, with additional local information, would be circulated before the middle of 1974.

2. — RELATIONS WITH ICSU.

2.1. — ICSU has proposed a reduction in the annual grant paid to URSI, out of UNESCO Funds, from $ 11,375 to $ 7,000. The President has protested to ICSU and has asked for some clarification of the reasons for this large change. The proposal is subject to approval at the ICSU General Assembly in September 1974.

2.2. — The URSI Board considers that it has become necessary to establish contacts between ICSU and scientists in mainland China. It has asked ICSU to consider what steps can be taken, including changes in the Statutes, which would permit the Academy of Science in Peking to adhere to ICSU. The Board recommended, however, that future Chinese delegations to ICSU meetings should include scientists from Taiwan.

2.3. — The rapidly increasing cost of maintaining the activities of the Unions at the present level is a matter of general concern within ICSU. As compared with 1971, this cost (expressed in US $) will have increased by a factor of 2 in the next year or two, and of 3 by about 1980. Increases of this magnitude will create serious problems for the Academies of Science which adhere to the Unions and to ICSU. The URSI Board has recommended to ICSU that this problem be discussed, in a general way, at the ICSU Assembly in September 1974 where the Academies as well as the Unions will be represented.

3. — FUTURE URSI ASSEMBLIES.

The Committee on Future Assemblies (Chairman Dr. Waterman), which was formed in Warsaw in 1972, has received several provisional invitations for the Assemblies of 1978 and 1981. A report and recommendations will be submitted to the URSI Council in Lima in 1975.

4. — FINANCES.

Expenditure exceeded income in 1973 and, as expected, it was necessary to spend part of the General Reserve and Special Needs Funds. The Board was gratified to note that a considerable number of Member Committees had agreed to pay the Special Voluntary Contribution which was referred to in Circular letter URSI-M310 in November 1973. (*Note* : By the end of May 1974, 24 Committees had paid their annual contributions for 1974 and 10 had added the Special Contribution).

5. — URSI SECRETARIAT.

At the Board meeting in 1973, the Secretary General stated that he did not wish to be a candidate for reelection in 1975 and the Board authorised the President, Treasurer and Secretary General to enquire about potential candidates for submission to the URSI Council in 1975. Since the Board had recommended the maintenance of the URSI Secretariat in Brussels, the Member Committees in Belgium and surrounding countries were asked to suggest names of candidates. Although some names were suggested, several Committees expressed the view that it would be preferable to avoid changing the Secretary General immediately after the decisions that will be taken on internal reorganisation of the Union at the General Assembly of 1975. The Board agreed that there would be advantages in maintaining continuity in the Secretariat during the transition period 1975-1978 and asked the Secretary General whether he would be prepared to reconsider his decision and to remain in office until 1978. The Secretary General agreed to do so, if reelected, but only on a part-time basis as already recommended by the Board in 1973 (*URSI Inf. Bull.*, No. 186, p. 22).

6. — URSI BULLETIN.

The Secretary General recalled that, at the Assembly in 1972, the Finance Committee had recommended that reductions be made in the expenditure on URSI publications. During 1973, the number of pages in the *URSI Bulletin* had been reduced to approximately half the number in 1972 and this reduction would be maintained in 1974. Unfortunately, because of considerable increases in the cost of printing and circulating the Bulletin, the reduction in total cost will be less than the reduction in the number of pages.

INTERNAL REORGANISATION OF URSI

Note by Secretary General.

As required by Rec. C.1 adopted at the General Assembly in 1972, the URSI Board of Officers will submit recommendations on the internal reorganisation of URSI to the Assembly in 1975. It seems probable that the recommendations will be drafted and circulated to Member Committees after the next Board Meeting, which is to be held in December 1974.

During the past year, the internal reorganisation has been a subject for discussion and exchanges of opinion in meetings of the Board and of representatives of the Com-

missions, and also in correspondence with the Member Committees of the Union. Although it can not be said that there is complete agreement on all the questions at issue, nevertheless there appears to be a convergence of points of view on many of these and this should later make it possible to speak of a consensus of opinion.

The remainder of this article refers to some of the questions that have been discussed since 1972. It is not intended to represent the views of any particular body or group of people, but rather to give some indication of current trends of opinion.

1. — THE RÔLE OF URSI WITHIN ICSU.

The Scientific Unions which adhere to ICSU cover practically the whole field of the exact and natural sciences. Each Union is recognised as the principal international forum for the discussion of questions relating to a particular branch of science; it is responsible also for stimulating and coordinating, on an international basis, studies in this field.

The branch of science which has always been the special concern of URSI is research on the scientific aspects of radiocommunications : that is, of the communication of information from one point to another by means of electromagnetic radiation. URSI properly deals also with certain subjects, such as information theory and circuit theory, which are of great importance in radiocommunications, but which have applications also in the wider field of telecommunications.

The present national and international telecommunications networks represent the product of many years of basic research work, with much of which URSI has been associated. It would be unrealistic, however, for URSI to become too deeply involved with the highly developed technologies which are now associated with these networks. On the other hand it seems desirable for URSI to maintain and even to develop its present relations with the International Telecommunication Union (ITU) and its technical Committees, because the contacts established in this way permit the scientists to be kept aware of current operational problems and of future requirements in telecommunications.

The desirability of maintaining contact at the international level between URSI and ITU has been mentioned above. Suggestions have been made that analogous contacts should be encouraged, at national level, between the Member Committees of URSI and the national engineering societies, in their respective countries, which are interested in telecommunications research.

2. — RELATIONS BETWEEN URSI AND OTHER UNIONS.

Developments in the use of radio waves for telecommunications were soon followed by their application, as a research tool, in other branches

of science such as astronomy, geophysics and meteorology. URSI has given much encouragement to these applications, and the use of radio waves for the acquisition of numerical data and of more general information in these sciences is now accepted practice. There is general recognition of the need to bring together, for study and interpretation, data obtained by all methods including those acquired using radio techniques.

It is appreciated that an overlap in the activities of two Unions in a given field leads to various difficulties which must be avoided, and also to an undesirable duplication and waste of effort at the international level. Thus there is a potential risk of friction between URSI and several other Unions : namely, IAU in astronomy, IUGG (IAMAP) in meteorology and IUGG (IAGA) in upper atmospheric physics.

It is not always easy to define the limit to which URSI should go when it becomes involved in a branch of science which is the principal responsibility of an other Union. It is clear that URSI, as the telecommunications Union, must maintain an interest in questions relating to the propagation of radio waves through the various ionized and non-ionized media, even though these are the concern of IUGG (IAGA and IAMAP). On the other hand, the general opinion seems to be that URSI must avoid becoming deeply involved in studies of the physics of the media themselves, and thereby risk encroaching on the territory of an other Union.

In some cases it is not possible to distinguish clearly between the rôles of the two Unions. For example, in certain magnetospheric studies the interpretation of wave phenomena requires close cooperation between scientists who are familiar with waves and plasma oscillations, and those who are concerned with the origins and characteristics of the particle population. When inter-Union cooperation of this kind is essential, the Unions must provide the mechanism which will permit appropriate contact to be made between the working scientists. Inter-Union Commissions, formally established by ICSU on the advice of the interested Unions, represent one possible type of organisation; for example, URSI and IUGG (IAMAP) have successfully cooperated in the field of radio meteorology in such an Inter-Union Commission (IUCRM). A less formal arrangement, which URSI and IUGG have agreed to try, is the Inter-Union Working Group. This is composed of a small number of scientists who are particularly interested in a given problem, but who are appointed in a personal capacity and not as representatives of the Unions which jointly sponsor the Working Group.

Within URSI, the activities of the Commissions that are concerned with telecommunications and related matters have not been restricted in any way because of the activities of those Commissions working in fields which are the concern of other Unions. If, as appears to be possible in future, URSI develops its activities in the field of telecommunications, it may become necessary to envisage some reduction in the resources that can be made available for activities in other branches of science.

3. — Commissions and Working Groups.

There appears to be general agreement that the present type of URSI Commission, consisting of Official Members appointed by the Member Committees, must be maintained. Even though the range of subjects dealt with by a Commission is often very wide, there is opposition to any appreciable increase in their number, especially from Member Committees whose delegations to General Assemblies are limited in size.

Where a Commission finds it necessary to deal with a number of topics, each of rather specialised character, there are advantages in creating Working Groups within the Commission, each with fairly well-defined terms of reference and limited objectives. If the membership is kept small, these Groups can work by correspondence and can often arrange ad hoc meetings between General Assemblies. Such Working Groups have the double advantage of ensuring that the activity of a Commission is maintained between Assemblies, and of providing a point of contact at working level between URSI and individual scientists.

4. — General Assemblies.

With few exceptions, attendance at URSI General Assemblies is restricted to the members of the delegations sent by the Member Committees of the Union. The scientific sessions organised by the Commissions would often benefit from the presence of scientists who have no association with URSI but who are interested in the subjects to be discussed. Thus there would be advantages in removing the present restrictions and permitting both delegates and unofficial observers to participate freely in the scientific sessions.

On the other hand a large increase in the number of participants would increase the administrative problems for URSI and for the host Committee. In addition, the character of the Assemblies would change and they might possibly be open to the criticisms sometimes made of the very large IAU and IUGG Assemblies.

5. — INDIVIDUAL MEMBERSHIP.

From time to time, individual scientists have expressed the view that they would like to have some direct personal association with URSI. It has been suggested that individuals should be admitted to voting membership of the Union, as in IAU, but there is little positive support for this step.

Individuals could, however, maintain personal contact with the Union by associating themselves with Working Groups created by the Commissions, and by participating in the scientific sessions at the General Assembly if it is decided to hold open Assemblies. Consideration should probably be given to these possibilities and also to the circulation of a newsletter to individuals (as in IAU) rather than the *URSI Bulletin*. Such facilities could be provided without the formal admission of individuals as voting members of the Union.

It is known that a number of Member Committees (for example in Scandinavia, F. R. Germany and the USA) hold meetings from time to time which are open to scientists who are not members of the national Committee. This practice provides another type of contact between individual scientists and URSI and appears to be worth encouraging.

THE RÔLE OF URSI IN RELATION TO THE NEEDS OF DEVELOPING COUNTRIES

Note by Secretary General :

For some time, Governments have rightly been concerned about the needs of the developing countries and about the provision of advice or material assistance to these countries. This concern is reflected in the programme and the budget of UNESCO from which ICSU receives an annual grant of about $ 250,000. UNESCO has stressed the importance of encouraging the Scientific Unions, and the various ICSU Committees, to devote part of their efforts to studies of the present needs of the developing countries.

Since the scientific activities of the Unions are usually oriented towards research rather than towards technological developments, it is not easy for the Unions to provide immediate help of the kind normally required by the developing countries. On the other hand, the technological assistance that can be made available from governmental or other sources is, in most cases, a product of basic research carried out much earlier and often with the encouragement of the ICSU Unions. This theme is developed, with special reference to URSI, in the following memorandum which was submitted to ICSU in December 1973.

1. — INTRODUCTION.

As a general rule, the ICSU Unions are concerned primarily with scientific research, much of which is fundamental in character and has no immediate application in practice. There is, however, an increasing demand that the Unions should pay more attention to the present needs of the developing countries. In making such demands, it is often forgotten that much of the work being done at any given time by the scientists associated with a Union can not be applied, at short notice, to the needs of a developing country. The time lag between the completion of a research programme, followed by the practical development of the results of the research and, finally, the application of the results in everyday life is too well known to require further comment.

It is important not to overlook the fact that much of the assistance that can be given now by UNESCO and other agencies in the solution of the problems of the developing countries has materialised only thanks to research carried out several years or even several decades earlier. For example, there is an obvious connection between the many artificial fertilisers and pesticides that are now available and chemical research (IUPAC), flood prevention, water conservation and hydrological studies (IUGG/IASH), new types of bridges and theoretical mechanics (IUTAM), telecommunications systems and basic research in radio wave propagation (URSI).

The resources of the Unions, and even of ICSU, are too small to allow them to make any substantial contribution to the provision of assistance to developing countries. On the other hand, a Union may be able to establish a contact between the representatives of a developing country with a specific problem and a scientist whose knowledge and experience may be helpful in exploring methods for solving the problem. It is clear, however, that there must be a limit to the number of scientists that can be diverted from research to technological development or to advisory duties. The results of such a shift of emphasis would often have undesirable effects at some time in the future if it were allowed to go too far.

2. — RADIOCOMMUNICATIONS.

In URSI, as in other Unions, it is difficult to point to particular very recent activities which have had direct applications to the current needs of the developing countries. On the other hand the developing countries are aware of the increasing importance of radiocommunications not

only for maintaining contact with other countries, but also for their internal systems of communications, and for national radio, and later television, networks which will be increasingly used for educational and other broadcasts. It seems important to emphasise the fact that the many types of telecommunications systems that are now in everyday use are available because of basic research work carried out over the past half century in the field of radiocommunications. As the ICSU Union responsible for the basic scientific aspects of radiocommunications, URSI has played an important rôle in providing an international forum for discussing the various interrelated facets of this branch of science and for the coordination of research programmes which often required cooperation on an international scale.

Some examples of the links between present-day radiocommunication technology and earlier research work with which URSI has been associated are outlined in the next Section.

3. — Applications of Research in Radiocommunications.

3.1. — It is not generally realised that, in the design of a communications system, there must be a proper balance between the amount of information to be transmitted in a given time, and the rate at which the system can transmit information without introducing too many errors. Present-day systems for the compression of information, so that it can be transmitted from one point to another quickly and accurately, are essential for reasons of economy and are based on developments of the theory of information and coding theory during the past few decades.

3.2. — No matter how effective the equipment may be at the transmitting and receiving terminals of a radiocommunications link, it will be useless if prior consideration has not been given to the many factors which influence the propagation of the radio waves between the two ends of the link.

3.2.1. — For many years radiocommunications networks depended mainly on the ability of the ionosphere to reflect radio waves at certain frequencies. In consequence, great efforts were made, with encouragement from URSI, to survey and catalogue the reflecting characteristics of the ionosphere and how they vary with location, time of day, season, solar activity, etc. This information is now available to radio engineers everywhere and it forms an essential basis for the radio forecasts which they

regularly use when deciding which frequency bands to use for the various radio links.

3.2.2. — The advent of microwave radio links after World War II led to a considerable reduction in the number and importance of radio systems depending on reflections from the ionosphere. Microwaves are, however, affected to a marked degree by the properties of the lower atmosphere through which they must pass. The way in which the atmosphere attenuates, scatters and refracts waves of different wavelengths is determined by the chemical composition of the atmosphere as well as by certain of its dynamical characteristics. Studies of these effects over many years have made it possible to design the modern microwave links which are making an increasingly important contribution to radiocommunications systems throughout the world.

3.2.3. — The introduction of satellite systems has revolutionised world communications within a short period of time. A satellite communications system necessarily incorporates radio links between the ground stations and the satellites themselves which act as relay stations. The radio waves must pass through the whole of the Earth's atmosphere and they may be affected by both the ionosphere and the troposphere. Although the frequencies used for these radio links are much too high to be reflected by the ionosphere, nevertheless turbulence in the ionosphere can cause scintillations in the intensity of the waves. At certain frequencies, radio waves are strongly absorbed by several constituents of the lower atmosphere and these frequencies must be avoided. Thus in designing a satellite communication system, it is necessary to take into account the influence on radio waves, at very high frequencies, of both the neutral and the ionized regions of the Earth's atmosphere. Studies of these effects have been in progress for many years.

3.3. — Antennas have always been an extremely important factor in determining the effectiveness of a radiocommunications system. They are of exceptional importance in the microwave links mentioned earlier and in satellite systems. In both cases, the radiated energy must be concentrated in the required direction so as to avoid wasting it and also so as to avoid causing interference to other systems. The antennas in everyday use at present are ultimately the products of mathematical studies of the design and operation of antennas and, obviously, of methods of conveying the energy from the transmitter to the antenna, often over considerable distances, with minimum loss. In this latter connection the development of hollow waveguides for the efficient transmission of radio waves has

led to the disappearance of two-wire transmission lines except at the lower frequencies used for radiocommunications.

3.4. — It is obvious that the equipment in a satellite which is to be used for communications must operate on the very limited amount of energy that can be collected from the solar radiation incident on it. It would be out of the question to use thermionic devices which dissipate large amounts of energy in heat. Without the many solid-state devices which have been made available in recent years, satellite communications, as we know it, would not have materialised. These devices have also completely transformed the design of large computers and of the smallest simple radio receivers. Their ready availability now is the result of much detailed work by electronic research workers interested in radiocommunications.

MOVEMENTS IN THE IONOSPHERE

From : Prof. Dr. K. Sprenger,
Zentralinstitut für solar-terrestrische Physik
der Akademie der Wissenschaften der DDR,
Observatorium für Ionosphärenforschung,
DDR — 2565 Kühlungsborn, German Democratic Republic.

To : Official Members of URSI Commission III and scientists in the field of ionospheric drift or wind.

Att. : Coordinated measurements of movements in the ionosphere (2nd circular).

Dear Colleague,

Referring to URSI Recommendation III.9 *(URSI Inf. Bull., No. 184)*. Sub-group 3.2.1. of URSI Commission III proposes the following periods in 1974 to be preferably used for coordinated simultaneous ionospheric drift or wind measurements by the various radio techniques :

1974, January 14-26 (as already appointed in my 1st circular of 12 December 1972, cited also in *URSI Inf. Bull.*, No. 186, p.16, and in *INAG Bull.*, No. 13, p. 19).

1974, April 16-May 7 (to study the behaviour of the upper atmosphere after the final warming of the stratosphere).

1974, August 7-22 (including the simultaneous recording run proposed by Dr. Roper, coordinator of the Global Radio Meteor Wind Studies Project of IAGA Commission VIII).

1974, October 23-November 14 (to study the beginning of winter conditions on tidal and planetary waves).

Additional measurements of those who wish to operate monthly are recommended to be concentrated on the weeks including the Regular World Days of the International Geophysical Calendar.

Exchange of observational results obtained during the periods mentioned above should be arranged individually between the groups concerned, but information on the material available at the individual groups should be sent to my address in order to enable me to compile this information and to circulate it to all participants in our cooperation.

As to participation in 1973, I have obtained information from :

— Dr. E. S. Kazimirovsky, Irkutsk, USSR, confirming participation of several stations in the USSR;

— Dr. A. Spizzichino, Issy-les-Moulineaux, France, confirming participation of the radar meteor wind station of Garchy;

— Dr. B. H. Briggs, Adelaide, Australia, announcing participation by observations over the height range 70-100 km by the partial reflection spaced-receiver technique;

— Prof. B. Rachmandra Rao, Visakhapatnam, India, announcing participation by spaced receiver drift measurements and radar meteor wind observations;

— Dr. R. K. Rai, Udaipur, India, making regular ionospheric drift measurements at 2.5, 3.0 and 5.0 MHz;

— Dr. H. U. Widdel, Lindau, Federal Republic of Germany, expressing his willingness to adapt the launching times for rocket-borne wind measurements over Spain as far as possible to the proposed schedule of ionospheric drift and wind measurements;

— the observatories of Kühlungsborn and Collm in the German Democratic Republic (Prof. K. Sprenger and Dr. R. Schminder) making regular ionospheric drift measurements in the LF range.

I thank all of you who wrote to me and hope for further participation and for a good success of our joint efforts. With best wishes for a happy new year.

20 December 1973

Yours sincerely,

K. Sprenger,
Chairman, Sub-group 3.2.1 of
URSI Commission III

MICROWAVE SCATTERING AND EMISSION FROM THE EARTH

Berne, 23-26 September 1974

The Preliminary Programme for the URSI Specialist Meeting on the above subject is as follows :

September

23	am	—
	pm	Theory of scatter from rough surfaces and below
24	am	Experiments on scatter and emission from water
	pm	Theory of emission from rough surfaces and below
25	am	Experiments on scatter and emission from ice, snow and soil
	pm	Experimental techniques and equipment
26	am	Experiments on scatter and emission from vegetation
	pm	Experiments on scatter and emission from man-made surfaces and objects.

Intending participants are invited to notify the Chairman of the Local Organizing Committees :

Dr. Erwin Schanda,
Institute of Applied Physics,
University of Berne,
Sidlertrasse 5,
CH — 3012 BERNE, Switzerland.

EUROPEAN GEOPHYSICAL SOCIETY

The second Meeting of the Society will be held in Trieste, Italy, from 23-26 September 1974 following the Assembly of the European Seismological Commission. The Meeting will be open to scientists from outisde Europe. About 15 Symposia on a wide range of geophysical topics are being planned, including three dealing with magnetospheric physics :

L. Penetration of solar particles in the near-Earth environment
M. Physics of the plasmapause
N. Instabilities and wave-particle interactions in the magnetosphere.

Requests for further information should be sent to :

Prof. A. Marussi,
Istituto di Geodesia e Geofisica,
Universita degli Studi,
Trieste, Italy.

SYSTEMS ENGINEERING EDUCATION IN DEVELOPING NATIONS

The Institution of Engineers (India) is organising an International Symposium on "Systems Engineering Education in Developing Nations" in New Delhi from 4-7 November 1974. During the Symposium it is expected that an assessment will be made of the impact of systems theory and analysis in the field of education in developing nations of the world in general, and in India in particular. It is hoped that the Symposium will bring out the various ways in which Systems Engineering can modernise engineering activities so as to help engineers and planners in solving expeditiously the complex and intricate multi-disciplinary problems associated with large-scale integrated projects.

Further information can be obtained from

The Convenor,
c/o Institution of Engineers (India),
Bahadur Shah Zafar Marg,
New Delhi — 110001, India.

BEACON SATELLITES

Moscow, 25-29 November 1974

The date of the Symposium on Beacon Satellite Investigations of Ionosphere Structure, and ATS-F Data has been postponed because of the delay in the date of launch of the ATS-F satellite : now 1 June 1974. Abstracts of papers should arrive in Graz before 10 July 1974, but those dealing with data from ATS-F will be accepted up to 8 November 1974. Further information is available from :

Dr. R. Leitinger
Institut für Meteorologie und Geophysik,
Universität Graz,
Halbärthgasse 1,
A — 8010 Graz, Austria.

INTERNATIONAL DATA EXCHANGE

In December 1973, the ICSU Panel on World Data Centres published the *Third Consolidated Guide to International Data Exchange through the World Data Centres.* This volume replaces the second edition published by the Comité International de Géophysique in November 1963, and Supplements No. 1 (December 1964) and No. 2 (July 1965).

The new edition deals with various solar and geophysical data, but it does not cover data in meteorology, volcanology and geothermics; these subjects will be covered in a future supplement. Copies of the Guide are being widely circulated by the Secretary of the Panel :

Dr. E. R. Dyer,
National Academy of Sciences,
2101 Constitution Avenue, N.W.,
Washington D. C. 20418, USA.

MEMBER COMMITTEES OF URSI ; URSI COMMISSIONS

Since the publication of the complete lists in *Information Bulletin* No. 189, notification has been received of the changes and corrections listed below.

It would be appreciated if notification of further modifications could be sent to the Secretary General before mid-November 1974 for inclusion in the next full list which will appear in the December 1974 issue.

The following entries replace the corresponding ones in Bulletin No. 189.

Presidents and Secretaries of URSI Member Committees

China (Taiwan) :

President : Prof. H. C. Fang, Directorate General of Telecommunications, P. O. Box 84, Taipei, Taiwan.

Secretary : Director T. I. Ho, Telecommunication Laboratories, Ministry of Communications, P. O. Box 71, Chung-Li, Taiwan.

Denmark :

President : Dr. E. Ungstrup, Danish Space Research Institute, Lundtoftevej 7, DK — 2800 Lyngby.

Germany, F.R. :

Secretary : Dr. R. Eyfrig, Fernmeldetechnisches Zentralamt, FI 33a, Postfach 800, D — 61 Darmstadt.

India :

President : Dr. A. P. Mitra, National Physical Laboratory, Hillside Road, New Delhi 120012.

New Zealand :

President : Mr. L. H. Martin, NZ Broadcasting Corporation, Bowen State Building, Bowen House, Wellington 1.

USA :

President : Dr. F. S. Johnson, University of Texas at Dallas, P. O. Box 688, Richardson, Texas 75080.

SCIENTIFIC COMMISSIONS

Commission I on Radio Measurements and Standards

China (Taiwan) : Director T. I. Ho, Telecommunication Laboratories, Ministry of Communications, P. O. Box 71, Chung-Li, Taiwan.

Commission II on Radio and Non-Ionized Media

China (Taiwan) : Mr. M. H. Wang, Directorate General of Telecommunications, P. O. Box 84, Taipei, Taiwan.

Denmark : Prof. P. Gudmandsen, Electromagnetics Institute, Technical University of Denmark, Building 348, DK — 2800 Lyngby.

Germany, F. R. : Dr. L. Fehlhaber, Fernmeldetechnisches Zentralamt, FI 31, Postfach 800, D-61 Darmstadt.

Commission III on the Ionosphere

Denmark : Dr. E. Ungstrup, Danish Space Research Institute, Lundtoftevej 7, DK — 2800 Lyngby.

New Zealand : Dr. H. E. Titheridge, Radio Research Centre, University of Auckland, Auckland.

Commission IV on the Magnetosphere

China (Taiwan) : Dr. J. N. Huang, Telecommunication Laboratories, Ministry of Communications, P.O. Box 71, Chung-Li, Taiwan.

Denmark : Dr. T. Stockflet Jørgensen, Geophysical Dept. II, Meteorological Institute, Lyngbyvej 100, DK — 2100 Copenhagen.

Germany, F. R. : Prof. Dr. H. Poeverlein, Lehrstuhl für angewandte Geophysik, Technische Hochschule, Hochschulstrasse 1, D— 61 Darmstadt.

USA : Prof. Andrew F. Nagy, Department of Electrical Engineering, University of Michigan, Ann Arbor, Michigan 48105.

Commission V on Radio Astronomy

China (Taiwan) : c/o Director T. I. Ho, Telecommunication Laboratories, Ministry of Communications, P.O. Box 71, Chung-Li, Taiwan.

Denmark : Prof. fil. Dr. A. Reiz, Astronomical Observatory, University of Copenhagen, Øster Voldgade 3, DK — 1350 Copenhagen.

Germany, F. R. : Prof. Dr. R. Wielebinski, Max-Planck-Institut für Radioastronomie, Auf dem Hügel 69, D — 53 Bonn.

Commission VI on Radio Waves and Circuits

Chairman : Prof. K. M. Siegel, KMS Industries Inc., P.O. Box 1778, 3941 Research Park Drive, Ann Arbor, Michigan 48106, USA.

China (Taiwan) : Prof. C. Hsu, Institute of Geophysics, National Central University, Chung-Li, Taiwan.

Denmark : Dr. J. Bach Andersen, Danish Engineer Academy, Dept. E, Badehusvej 1A, DK — 9000 Aalborg.

Germany, F. R. : Prof. Dr. G. Piefke, Institut für Theoretische Elektrotechnik, Technische Hochschule, Schlossgartenstrasse 8, D — 61 Darmstadt.

New Zealand : c/o Mr. G. J. Burtt, Secretary New Zealand URSI Committee, Physics and Engineering Laboratory, DSIR, Private Bag, Lower Hutt.

Commission VII on Radio Electronics

China (Taiwan) : Prof. C.-I. Chang, National Tsing-hua University, Hsinchu, Taiwan.

Denmark : Dr. Palle Jeppesen, Electromagnetics Institute, Technical University of Denmark, DK — 2800 Lyngby.

Germany, F. R. : Dr. Ing. K. Garbrecht, Siemens AG, NZL, Hofmannstrasse 51, D — 8 München 70.

COMMISSION VIII ON RADIO NOISE OF TERRESTRIAL ORIGIN

Denmark : Electronic Engineer H. G. Nissen, Danish Research Centre for Applied Electronics, Venlighedsvej 4, DK — 2970 Hørsholm.

Germany, F. R. : Prof. Dr. R. Mühleisen, Astronomisches Institut der Universität Tübingen, D — 7980 Rasthalde/Ravensburg.

USA : Mr. G. Hagn, Stanford Research Institute, SRI-Washington, 1611 North Kent Street, Rosslyn Plaza, Arlington, Virginia 22209.