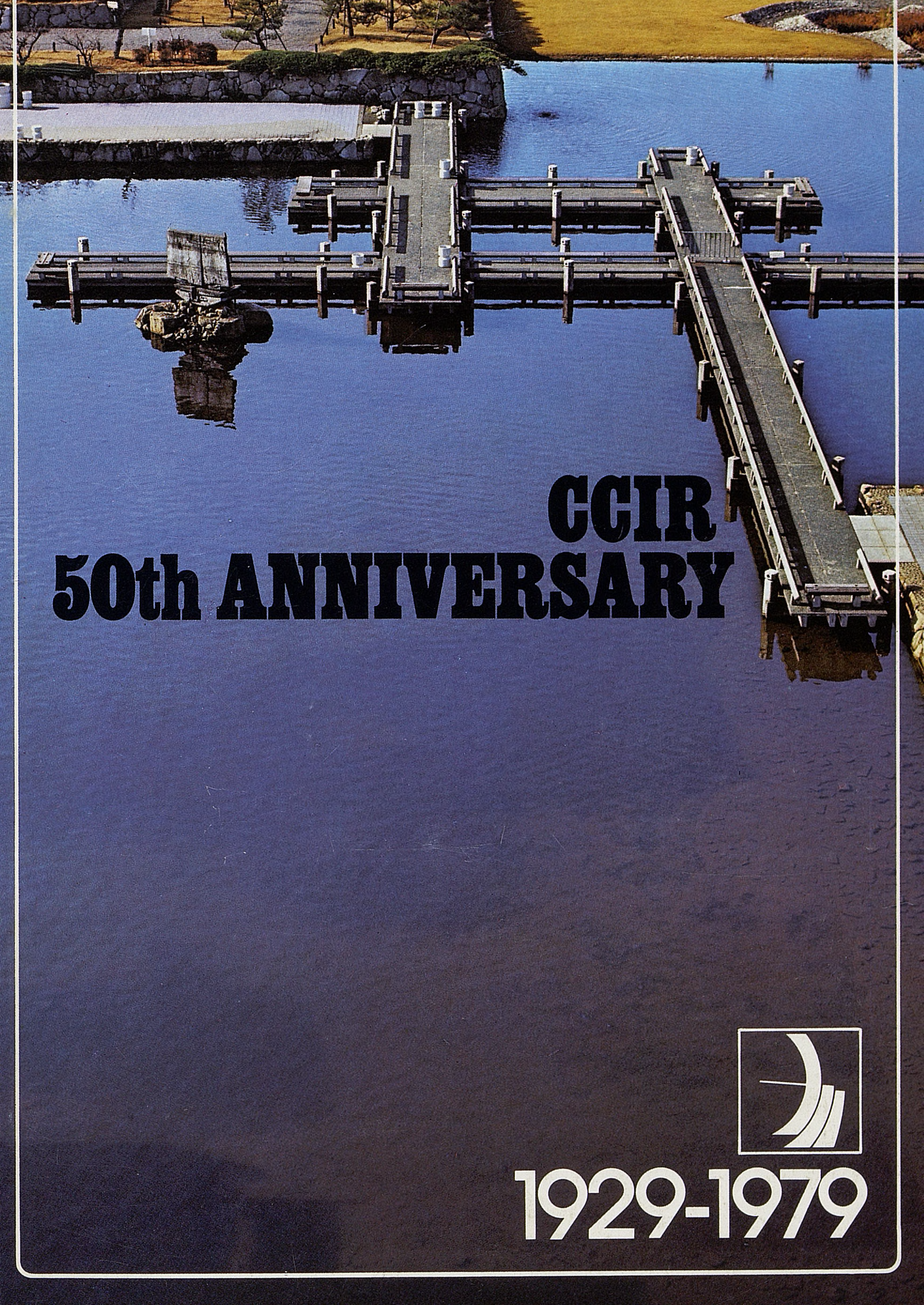


CCIR
50th ANNIVERSARY

1929-1979

$$\text{(I)}\quad \nabla \times \mathbf{E} + \frac{\partial \mathbf{B}}{\partial t} = \mathbf{O}, \qquad \text{(III)}\quad \nabla \cdot \mathbf{B} = \mathbf{O},$$

$$\text{(II)}\quad \nabla \times \mathbf{H} - \frac{\partial \mathbf{D}}{\partial t} = \mathbf{J}, \qquad \text{(IV)}\quad \nabla \cdot \mathbf{D} = \boldsymbol{\rho}.$$

J. MAXWELL

$$\mathbf{T} = \frac{2\pi \mathbf{R}}{\sqrt{g\mathbf{R}_\circ}\,\sqrt{\mathbf{R}_\circ/\mathbf{R}}}$$

J. KEPLER

Cover:
The bridge outside the Kyoto International Conference Hall, where the XIVth Plenary Assembly celebrated the 50th Anniversary of the creation of the CCIR. The bridge also symbolizes the association of ideas. Combining Maxwell's equations and Kepler's law of motion, we have radiocommunication by satellites. *(Photo provided by Mr. Shinichi Sawaragi)*

CCIR
50th ANNIVERSARY

ITU

INTERNATIONAL TELECOMMUNICATION UNION

For use of information media, not an official record

Other information publications on the ITU:

Book — From semaphore to satellite, 1793-1965 (1965)

Booklet No. 1 — 1865-1965, a undred years of international co-operation (1967)

Booklet No. 2 — ITU and space radiocommunication (1968)

Booklet No. 3 — Eighth Report by the International Telecommunication Union on telecommunication and the peaceful uses of outer space (1969)

Booklet No. 4 — Symposium "Space and Radiocommunication", Paris, 1969 (1969)

Booklet No. 5 — World Telecommunication Day Day—17 May 1969 (1969)

Booklet No. 6 — Ninth Report by the International Telecommunication Union on telecommunication and the peaceful uses of outer space (1970)

Booklet No. 7 — World Telecommunication Day—17 May 1970 (1971)

Booklet No. 8 — Tenth Report by the International Telecommunication Union on telecommunication and the peaceful uses of outer space (1971)

Booklet No. 9 — Speeches made at the inaugural meeting of the second World Administrative Radio Conference for Space Telecommunications on 7 June 1971 (1971)

Booklet No. 10 — Eleventh Report by the International Telecommunication Union on telecommunication and the peaceful uses of outer space (1972)

Booklet No. 11 — Twelfth Report by the International Telecommunication Union on telecommunication and the peaceful uses of outer space (1973)

Booklet No. 12 — Inauguration of the ITU tower (1973)

Booklet No. 13 — PANAFTEL—The Pan-African telecommunication network (1974) (1979)

Booklet No. 14 — Symposium "Space and Radiocommunication", Paris, 1973 (1974)

Booklet No. 15 — Thirteenth Report by the International Telecommunication Union on telecommunication and the peaceful uses of outer space (1974)

Booklet No. 16 — What is ITU? (1974) (1979)

Booklet No. 17 — Fourteenth Report by the International Telecommunication Union on telecommunication and the peaceful uses of outer space (1975)

Booklet No. 18 — Space radiocommunications system for aid following natural disasters (1975)

Booklet No. 19 — Fifteenth Report by the International Telecommunication Union on telecommunication and the peaceful uses of outer space (1976)

Booklet No. 20 — Centenary of the telephone

Booklet No. 21 — Sixteenth Report by the International Telecommunication Union on telecommunication and the peaceful uses of outer space (1977)

Booklet No. 22 — Telecommunication and development (1978)

Booklet No. 23 — Seventeenth Report by the International Telecommunication Union on telecommunication and the peaceful uses of outer space (1978)

Booklet No. 24 — The ITU and vocational training (1978)

Booklet No. 25 — Eighteenth Report by the International Telecommunication Union on telecommunication and the peaceful uses of outer space (1979)

Published by the International Telecommunication Union, Geneva, 1979

FOREWORD

While the creation of the CCIR was decided upon by the Washington Radio Conference, its first Plenary Assembly actually opened on 18 September 1929. The present brochure is therefore published to celebrate the 50th anniversary of this firt Plenary Assembly.

The booklet contains three articles. The first, by Mr. R. C. Kirby, Director of the CCIR, is a historical review of the work done by the CCIR. It was originally published in the June issue of the ITU Telecommunication Journal. The second, by Dr. Kenichi Miya, Managing Director of the Kokusai Denshin Denwa Co., reproduces the keynote address delivered at the Ceremony Commemorating the 50th Anniversary of the CCIR held at Kyoto on 7 June 1978.

The third article, by Dr. Y. Y. Mao, a member of the CCIR Secretariat, and introduced by Mr. Marcel Thué, Laureate of the "General Ferrié" Electronics Prize in 1968 and Chairman of the CCIR Editorial Committee since 1970, is written in a style somewhat different from that of the article by Mr. Kirby. The reader will therefore find the two articles complementary to each other, rather than the one repeating what is said in the other. With this object in mind, the author has drawn upon archive material as a source of anecdotes which he has attempted to weave into a kind of continuous narrative. An Oriental touch has been added to keep a certain balance, since the development of radiocommunications, especially in the early days, is primarily an achievement of Western civilization.

Boltzmann once said: "There is nothing more practical than a good theory." Theory and practice are like two feet in carrying research forward. One of the achievements of the CCIR, walking on both feet, has been to link up science and art by making possible intercontinent-wide colour television broadcasts and by helping to build a staircase to the heavens in space communication exploits.

M. MILI
Secretary-General of the ITU

Fifty years of the International Radio Consultative Committee (CCIR)

by Richard C. KIRBY
Director *

"*Undoubtedly, one of the most important actions of the Washington Conference in 1927 was to set up a Radio Consultative Committee. ... One of the main arguments for setting up the* Comité consultatif international technique des communications radioélectriques *was "to undertake studies and present conclusions to the next conference, thus eliminating part of the burden of exhaustive technical studies that had been necessary during conference time." Equally important was the drawing up of the first Frequency Allocation Table. ...*"

"From semaphore to satellite", 1965, A. R. Michaelis

SCARCELY forty years had passed since Heinrich Hertz had demonstrated, following James Clerk Maxwell's theoretical predictions, that high-frequency oscillations could produce electrical phenomena at a distance due to electromagnetic waves.

* *Article published in the* Telecommunication Journal *of June 1978.*

Following Marconi's and Popov's showing of the possibilities for communication, wireless telegraphy was already in world-wide use. Radio broadcasting was seven years old, and a European wavelength allocation plan had been in effect for a year. Transoceanic radiotelegraphy had begun commercially seven years earlier and transatlantic telephony had opened in January over the New York—London low-frequency circuit.

Such was the setting in which the Third International Radiotelegraph Conference, Washington, 1927, decided upon the establishment of the CCIR. The decision was far from unanimous. But when it came into effect in January 1929, immediate, active co-operation followed. The first " Plenary Assembly " * opened on 18 September 1929 at The Hague.

From 1929, the early period

The time of the CCIR's debut was an exciting one in the development of radio, a frontier period but no longer a primitive one. Indeed, the New York—London radiotelephone circuit was already using single-sideband transmission. Following propagation studies, eight new transatlantic HF radiotelephone circuits had just come into service. Many broadcasting stations were crystal-controlled and some used directional antennae. Communication frequencies as high as 150 MHz were in use experimentally. Jansky's discovery of radio emission of cosmic origin was yet two years away when General Ferrié made his visionary remarks during the First CCIR Meeting:

> " ... *Does it not lead to a broadening of our mental horizons, thanks to the waves which extend over the whole earth, reach the highest layers of the atmosphere, and according to certain theories about the delayed echoes observed in recent years, may perhaps even penetrate into interplanetary space.* "

This First Meeting (figure 1) considered definitions of power and frequency ranges; frequency measurements, monitoring and tolerances; occupied bandwidth, frequency separation, spurious emissions, fading, directivity, atmospheric noise and

* The term " Plenary Assembly " was adopted only in 1948 at Stockholm.

amateurs' licences. Of 24 technical recommendations, seven were related to the problems of frequency measurement and stability. The remainder concerned frequency allocation, limiting the power of broadcasting transmitters and the elimination of spark transmitters.

Some of the names of participants in that First Meeting are among the most famous in the history of radio and telecommunications: Ph. Le Corbeiller, T. A. M. Craven, Dr. J. H. Dellinger, H. C. A. van Duuren, T. L. Eckersley, L. Espenschied, General Ferrié, R. Goldschmidt, G. C. Gross (later Secretary-General, ITU), Professor J. Groszkowski, C. B. Joliffe, T. Nakagami, Balthasar van der Pol (later Director, CCIR), G. Valensi (later Director, CCIF). This list is by no means exhaustive, but includes many names prominent in later CCIR work or in the development of international telecommunications.

The IInd Meeting, Copenhagen, 1931, adopted 18 recommendations. A six-committee structure was set up for this and the subsequent meeting: Definitions and Standardization; Collaboration; Operation; Transmission; Organization; Drafting.

The technical recommendations included several on fixed and mobile radiotelephone services connected to the land network, specifications for technical data to be included in the International List of Frequencies, definitions of power, and terms concerning frequency control and measurement; frequency stabilization; methods for reduction of interference and of non-essential emission; reduction of occupied bandwidth. It was at this meeting that single-sideband transmission was recommended for future application, to be applied first at frequencies below 100 kHz. Studies were begun on receiver selectivity and stability, measurements of noise and speech level, and mobile telephony for trains.

The IIIrd Meeting, Lisbon, 1934, saw the acceptance "as a very useful guide" of quite sophisticated radio wave propagation curves prepared in large part by T. L. Eckersley. Radio wave propagation became an important part of the continuing studies of the CCIR, as the information was vital for co-ordination of international use of frequencies. New technical "opinions" included the first on standard-frequency emissions; selectivity and sensitivity of receivers; limitations of harmonic radiation and key clicks; synchronization of, and channel spacing for, broadcasting stations, as well as directional and "anti-fading" antennae. Rather comprehensive recommendations on mobile maritime operations concerned technical installations aboard ship and at coast stations, and the use of allocated frequency bands. It was decided that the question on telephony with moving trains should not be discussed further in the CCIR.

The record of the Lisbon Meeting speaks of carrying on certain CCIR traditions, " ... The symbol adopted in the preceding meetings has been kept. The flag which was displayed at The Hague and at Copenhagen now waves over the front of this building. ... " All trace of the flag seems to have been lost, as

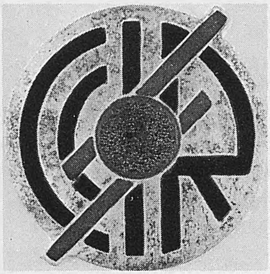


Figure 2—CCIR symbol

there is no record in the archives or stores of the ITU; G. Corbaz, retired from the ITU Secretariat, recalls the flag having been used again at Bucharest. The symbol is shown in figure 2.

The IVth Meeting, held at Bucharest in 1937, tackled the problem of the widening scope and less than systematic treatment of questions before the CCIR. The first classification of CCIR opinions was begun: I. Organizational and general matters; II. Propagation of radio waves; III. Transmitting stations; IV. Receiving stations; V. Co-ordination of different elements of communication, and VI. Standardization, measurements, etc. The new opinions included a six-language vocabulary of more than 900 terms in each language and a revised table of frequency tolerances. This meeting set the outline for contribution of radio propagation information to the forthcoming Cairo Conference—the first " interim working party " (though the term was not used), met subsequently under the chairmanship of Dr. van der Pol, and prepared the report for the Cairo Conference, which allocated the frequency spectrum up to 200 MHz and adopted the famous " Cairo curves " for wave propagation at medium frequencies. Within two years World War II had erupted, and there were to be no more CCIR meetings for a decade.

Through these early meetings certain individuals were prominent as leaders of various commissions, who were to continue their work even to the post-war period, as for example Dr. J. H. Dellinger, L. Bramel de Cléjoulx, Le Corbeiller, B. Decaux, and Messrs. Mulatier and Gross, later Secretaries-General of the ITU.

From 1947, the post-war period; and from 1959, the space era

Great strides were made in the use of radio during World War II, especially in radar and microwave communications. Frequency usage had become active up to 10 GHz and occasionally to 30 GHz. In view both of the advances of technology during the war and the need to construct new facilities in many countries after the war, it was generally felt that a review of the rationale for the future role of the ITU was in order. This took place at the Atlantic City Conference in 1947, which was at once both a Plenipotentiary Conference for revision of the International Telecommunication Convention and a Radio Conference.

Table I

CCIR Plenary Assemblies

I	1929	The Hague
II	1931	Copenhagen
III	1934	Estoril (Lisbon)
IV	1937	Bucharest
V	1948	Stockholm
VI	1951	Geneva
VII	1953	London
VIII	1956	Warsaw
IX	1959	Los Angeles
X	1963	Geneva
XI	1966	Oslo
XII	1970	New Dehli
XIII	1974	Geneva
XIV	1978	Kyoto

Among several acts of that Conference, which included setting up the International Frequency Registration Board (IFRB), the decisions were made which give the CCIR its modern terms of reference and general structure. The CCIR Specialized Secretariat was established as it was considered no longer practical for an inviting administration to organize all the activities and prepare the documentation.

■ The meetings

The first post-war meeting was the Vth Plenary Assembly, Stockholm, 1948. Dr. Balthasar van der Pol of the Netherlands, eminent mathematician and radio scientist, was elected Director; Leslie W. Hayes, United Kingdom, was elected Vice-Director. That meeting had the task of forming the first Study Groups (table II). As the work of the Study Groups was, in principle, to be conducted by correspondence, at first only isolated meetings of Study Groups were held between the Plenary Assemblies.

Technical recommendations of the 1948 meeting included: guidance on channel separation, ionospheric soundings and measurements, standard-frequency transmissions and time signals, monitoring and measurements of the frequency spectrum. Studies were begun towards television standards which would permit " interchange of programmes on the widest scale " and the " use of a receiver on transmissions differing in a minor degree ". In March/April 1950, a large group of Study Group XI technical experts visited a number of countries to evaluate *in situ* the development of black-and-white television with the purpose of trying to reach a common world-wide standard. As it proved, this was not possible, as public services having different standards were already too far in operation in a number of countries. The period of the 1950s saw feverish expansion of HF services world-wide, and the introduction of microwave radio-relay services on a large scale.

The VIth Plenary Assembly, Geneva, 1951, was notable for adoption of ground wave propagation curves and material on tropospheric propagation, and many other new recommendations on measurement and expression of field strength, power, and radiotelephony arrangements. A new Study Group on Vocabulary made its appearance.

At the VIIth Plenary Assembly, London, 1953, a series of texts on microwave radio-relay systems were developed. The " ARQ " error-correcting system for HF radiotelegraphy was introduced:

its inventor, Dr. H. C. A. van Duuren, was Chairman of Study Group III for more than twenty years. Arrangements of channels for HF independent sideband systems were recommended.

At the VIIIth Plenary Assembly, Warsaw, 1956, the Study Group structure was modified a little. Study Group XIII on Operations was replaced by a Study Group on Mobile services. It emerged that the Study Groups would have to hold interim meetings, because the Plenary Assembly could no longer cope with the detail of the technical work of the Study Groups in connection with the Plenary Assembly. Dr. Ernst Metzler of Switzerland was elected Director, upon retirement of Dr. van der Pol.

The IXth Plenary Assembly was held in Los Angeles in 1959. In the preceding twenty months, *Sputnik*, *Explorer*, *Vanguard*, and *Discoverer* satellites had been launched, and the space age in telecommunications was upon us. It was to become a major preoccupation of the CCIR for the next two decades. Study Group IV, formerly " Surface wave propagation " was renamed " Space systems " with terms of reference to study technical questions regarding systems and telecommunications with and between locations in space. The CCIR adopted its first recommendation on " selection of frequencies used in telecommunications with and between artificial Earth satellites and other space vehicles ".

The XIth Plenary Assembly was held at Oslo in the summer of 1966 and saw no marked changes in direction or structure of the CCIR. Jack W. Herbstreit, United States, was elected Director by the Assembly to succeed Leslie W. Hayes who had served as Director, *ad interim*, since the death of Dr. Metzler in 1963.

The question of international standards for colour television had been in prominence since meetings of a sub-group in 1964 and Vienna, 1965. The last great debate on the subject took place in the CCIR in Oslo. However, agreement could not be reached on a single world-wide standard. Inundation of the document process by the volume of material coming out of the Final Study Group Meetings led to the decision to separate, in the future, the Plenary Assembly from the Final Study Group Meetings.

At New Delhi in 1970, the XIIth Plenary Assembly, meeting for the first time in Asia, gave the CCIR its present-day structure, recognizing the development of satellite communication techniques in nearly all radio services. The new Study Group 1, on

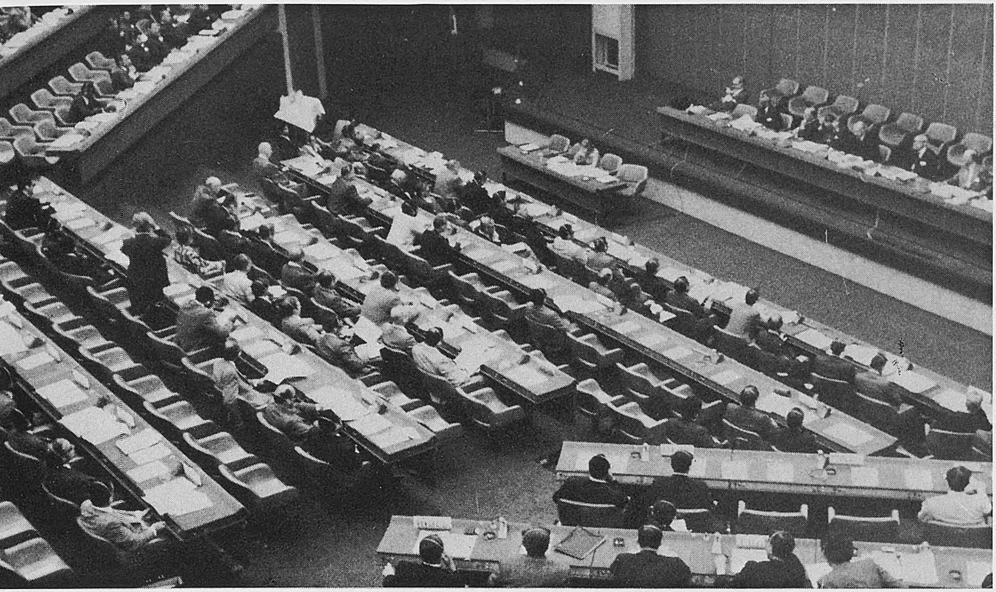
Spectrum utilization and monitoring, replaced old Study Groups I, II and VIII (see table II). A new Study Group 2 was devoted to Space research and radioastronomy.

Table II

CCIR Study Groups

Originally, as established at Stockholm, 1948	
Study Group No. I	Radio transmitters
Study Group No. II	Radio receivers
Study Group No. III	Complete radio systems employed by the different services
Study Group No. IV	Ground wave propagation
Study Group No. V	Tropospheric propagation
Study Group No. VI	Ionospheric propagation
Study Group No. VII	Radio time signals and standard frequencies
Study Group No. VIII	International monitoring
Study Group No. IX	General technical questions
Study Group No. X	Broadcasting including questions related to single sideband
Study Group No. XI	Television including questions related to single sideband
Study Group No. XII	Tropical broadcasting
Study Group No. XIII	Operation questions depending principally on technical considerations

Today, as established at New Delhi, 1970	
Study Group 1	Spectrum utilization—Monitoring
Study Group 2	Space research and radioastronomy services
Study Group 3	Fixed service at frequencies below about 30 MHz
Study Group 4	Fixed service using satellites
Study Group 5	Propagation in non-ionized media
Study Group 6	Ionospheric propagation
Study Group 7	Standard frequency and time-signal services
Study Group 8	Mobile services
Study Group 9	Fixed service using radio-relay systems
Study Group 10	Broadcasting service (sound)
Study Group 11	Broadcasting service (television)
CMTT	CCIR/CCITT Joint Study Group for television and sound transmission
CMV	CCIR/CCITT Joint Study Group for vocabulary



CCIR XIIIth Plenary Assembly (Geneva, 1974)

Over 300 delegates participated in the XIIIth Plenary Assembly (see figure 3) held in Geneva in 1974.

■ **Highlights of technical results**

There is not enough space to summarize, meeting by meeting, the results of each Plenary Assembly since 1948; these are now catalogued in 13 volumes of more than 4000 pages in each of the three working languages of the ITU. Certain highlights may be cited, though their selection surely reflects to some degree the interests and biases of the author; omissions are so numerous that an apology must be understood. In order, mention is made of contributions to radio conferences, then developments concerning terrestrial services, and finally space services.

One of the most influential aspects of CCIR activities in the recent decade has been the technical preparation for international radio conferences, recalling the CCIR's original objectives. A Special Joint Meeting of CCIR Study Groups in 1971 prepared material for the World Administrative Radio Conference for Space Telecommunications (WARC-ST), Geneva, 1971. Very substantial reports were provided for the World Maritime Administrative Radio Conference (Geneva, 1974) and the Regional LF/MF Broadcasting Conference (Regions 1 and 3), Geneva, 1975. Later a Joint Working Party prepared a report for the World Administrative Radio Conference for the planning of the Broadcasting-Satellite Service (WARC-BS), Geneva, 1977, and provided the technical bases for the successful results of that Conference. Similarly, the CCIR (Study Group 8) prepared a special report for the World Administrative Radio Conference on the Aeronautical Mobile (R) Service (Geneva, 1978).

Many operational standards or planning methods for terrestrial radio services have been given effect through the CCIR. The ARQ error-correcting system, adopted in the CCIR for direct printing radiotelegraphy, became, along with frequency-shift keying, one of the most important influences in the development of HF radiotelegraphy. In the 1960s, an analogous recommendation for HF radiotelephony introduced the *Lincompex* (linked compressor-expandor system). From the earliest times in the CCIR, technical arrangements for maritime-mobile systems world-wide have been a major activity. Ship—shore direc-printing telegraphy with its operational procedures and error-correcting systems, the standards for maritime mobile VHF equipment and, recently, digital selective calling for the international maritime mobile service, were all developed in the CCIR. For terrestrial microwave radio-relay systems, the CCIR has given the channelling arrangements and transmission standards used for international interconnection, as well as the performance criteria and methods of measurements for both analogue and digital systems. The CCIR " hypothetical reference circuit " for radio-relay systems has proved an important tool for planning purposes.

In the fields of television and sound broadcasting, standards have been promulgated for frequency modulation and stereophonic broadcasting, as well as for recording of sound and television on film and tape, for international exchange of programmes. A very comprehensive recommendation sets out the technical requirements for transmission (relay) of television programmes over long distances and provides the basis for international exchange of programmes today. Automated transmission measurements have recently been agreed, by means of insertion of special test signals in the field blanking interval. The notable inability of the CCIR to reach accord on a single world standard for colour television broadcasting, however regrettable, must be seen in retrospect to have been inevitable given the advanced state of development of, and investment in, competing standards in various countries, and the fact that the relative performance of these standards differed only in small degree. Subsequently " transcoders " have provided for international exchange of programmes, and multi-standard receivers, where necessary, have permitted viewing of programmes of neighbouring countries. However, the meeting of CCIR experts in Cannes, 1961, prepared the technical basis for the European VHF/UHF Broadcasting Conference (Stockholm 1961) constituting the first internationally accepted method for planning and co-ordination of frequency assignment for VHF/UHF sound and television broadcasting stations on a continent-wide scale.

The CCIR's contribution to standard time and frequency has led to world-wide development of these concepts and their measurement. Coordinated Universal Time (UTC) was introduced in a CCIR recommendation, and is now in use on a world-wide scale. Standard-frequency emissions, by CCIR recommendations and reports, now have stability as high as 5 parts in 10^{13}, backed up by laboratory standards of one or two orders greater stability.

The past two decades have been notable in the CCIR for development of the technical and operational arrangements for international satellite systems. These concern, in large part, efficient use of the spectrum and the geostationary satellite orbit, as well as sharing criteria. Among the mots famous texts are those concerned with " co-ordination distances " for sharing between space and terrestrial services, and station-keeping of satellites. But many technical features of satellite services, performance criteria, measurements and operational and maintenance matters have also been developed in the CCIR. Probably the single most significant contribution was the technical preparation for the WARC-ST (1971). This conference allocated frequency bands, and established regulations and sharing arrangements up to 275 GHz.

Most important technical characteristics for broadcasting satellites, and the technical principles for their spectrum utilization in the geostationary satellite orbit, were developed in the CCIR and made available as a basis for the work of the WARC-BS (1977). Similarly, the technical and operating characteristics for maritime mobile satellite communication have been developed in the CCIR and taken full account of in the planning for the International Maritime Mobile Satellite Organization (INMARSAT) system.

Space research, as a radio service, as well as radioastronomy, have been among the most active areas of CCIR contribution in the 1970s. Modulation, antennae, and attitude control technology, have been spelled out for new services such as meteorological satellites and the Earth exploration satellites. One of the most significant contributions to radio science has been the identification, in a CCIR recommendation, of the " line frequencies " arising from natural phenomena of interest to radioastronomy and related sciences. These studies were aimed to obtain appropriate frequency allocations and protection from interference.

The CCIR studies and recommendations on space communications have been mostly carried out in parallel with the development and *well in advance of implementation* of systems. Thus these recommendations have led, rather than followed, the applications of satellites in international telecommunications.

Some of the widest-reaching contributions have been on the subject of radio wave propagation. CCIR reports and recommendations are frequently referred to in handbooks and technical publications. The recommendation of basic (solar) indices for ionospheric propagation predictions, and an atlas of predicted maximum usable frequency maps have been established for some years. The method of computing HF sky-wave field strength and transmission loss, serving as an international reference, has recently been revised and improved. A new and revised method for predicting MF and LF field strengths has also been adopted. In the realm of propagation through non-ionized media, CCIR groundwave curves from 10 kHz to 10 MHz also provide an international standard reference. Today the CCIR texts give authoritative methods for predicting propagation through the troposphere for a wide range of atmospheric, terrain, and service conditions, taking into account all the relevant modes of propagation, such as diffraction, scattering and ducting. Propagation data for calculation of " co-ordination distances " have recently been significantly improved. A rain-climatological classification of all the geographical regions of the world has been made to facilitate taking account of characteristic rainfall intensities in propagation calculations.

Finally, in its basic studies of spectrum utilization, the CCIR has proposed a new method of classification and designation of emissions which will be referred to the World Administrative Radio Conference of 1979. A " Handbook for monitoring stations " has for a number of years provided guidance to countries establishing such facilities. New mathematical models for large computers have recently been developed for examining spectrum sharing problems, but it is too early to report on their usefulness in full application.

Officers of CCIR Study Groups since 1948 are shown in table III.

Conclusions

Having reviewed, albeit in fragments, some of the history and accomplishments of the CCIR, it is tempting to think about the future. There are both technical and organizational aspects. From a technical point of view, there are many opportunities ripe for CCIR work. The question would seem to be one of priorities.

■ Technical

The vast growth of mobile radiocommunications reflects directly the need and economic significance of this service for individuals and enterprises. This includes not only telephonic and data communications, but also radio methods for acquisition of data and control of processes, in industry and transportation, even in agriculture, mining and fishing.

Already transoceanic satellite system capacities rival those of cable systems, and also provide intercontinental television relay. Domestic satellite systems are expanding rapidly in large countries and where large land networks do not already exist. Soon direct television broadcasting satellites will be in regular service. Satellites will inevitably serve international aeronautical communications, as they are already developing for the maritime service. Meteorological satellites have become indispensable in weather observing, and Earth resource satellite systems are already proving their economic importance for exploration of geology, hydrology and vegetation.

New television services, using still image and text transmission, multiplexed on regular broadcasts, are already in experimental operation and under discussion in the CCIR. " High-resolution " television seems also to be of growing interest.

There is a continuous growth of need for amplitude modulated LF and MF broadcasting channels, and the CCIR has been asked by an administrative radio conference to intensify its studies toward a suitable SSB system for AM broadcasting.

Energy transmission at microwaves, safety aspects of RF radiation, search for extraterrestrial intelligence, and new " remote sensing " applications, are all topics in which science and engineering frontiers may meet in the CCIR. Radio investigation of cosmic and interplanetary phenomena are bound to become of increasing international interest and significance.

It is clear that digital electronics is the most pervasive element of future radiocommunication technology. The enormous advantage of economics, performance, and signal processing capabilities, will propel digital technology into all radio services. There is the problem of spectrum utilization. At first, digital transmission seems to require greater spectrum occupancy than analogue transmission for comparable information channels. However, the coding and processing techniques which are now becoming economical because of large-scale integrated circuitry can be exploited for improving spectrum utilization. In principle, digital systems may be made at least as efficient users of the spectrum as their analogue predecessors. In particular, " spread spectrum " techniques, which allow superposition of a number of signals sharing the same bandwidth without mutual interference, need further study for most efficient application.

Of course, as throughout the course of development of radio, the use of higher and higher frequencies must be expected, that is well above 40 GHz now, and well above 275 GHz soon. The difficulties should not be underestimated. While the technology is very expensive, progress is being made, and hardware of reasonable cost may be expected. But the intrinsic barrier of *atmospheric*

→ *p. 21*

Table III

Chairmen and Vice-Chairmen of CCIR Study Groups 1948-1978

Introductory notes

1. Vice-Chairmen of Study Groups were designated for the first time by the VIIth Plenary Assembly of the CCIR (London, 1953), following the corresponding clauses of the International Telecommunication Convention (Buenos Aires, 1952) and subsequent Conventions.

2. Following a reorganization of CCIR Study Groups by the XIIth Plenary Assembly (New Delhi, 1970), all Study Group numbering was changed from Roman to Arabic, though the terms of reference of some Study Groups did not change. Where substantial changes in the terms of reference occurred—also prior to 1970—a dotted line appears.

Designation	Chairman	Vice-Chairman
Study Group I	Dr. E. Metzler (Switzerland) 1948-1956	Col. Lochard (France) 1953-1956
	Col. Lochard (France) 1956-1970	Prof. S. Ryzko (P. R. of Poland) 1956-1970
Study Group 1	Y. Place (France) 1970-1974	Prof. S. Ryźko (P. R. of Poland) 1970-1974
	J. T. Dixon (United States) 1974-	Prof. R. G. Struzak (P. R. of Poland) 1974-
Study Group II	P. David (France) 1948-1966	P. Abadie (France) 1953-1959 Y. Place (France) 1959-1966
	Y. Place (France) 1966-1970	N. I. Chistiakov (USSR) 1966-1970

Designation	Chairman	Vice-Chairman
Study Group 2	Prof. I. Ranzi (Italy) 1970-	J. P. Hagen (United States) 1970-
Study Group III (now 3)	Dr. H. C. A. van Duuren (Netherlands) 1948-1970 S. Aritake (Japan) 1970-1976 T. de Haas (United States) 1976-	J. Smale (United Kingdom) 1953-1956 A. Cook (United Kingdom) 1956-1959 Dr. S. Namba (Japan) 1959-1966 S. Aritake (Japan) 1966-1970 N. I. Chistiakov (USSR) 1970-1974 T. de Haas (United States) 1974-1976 Dr. H. Kaji (Japan) 1978-
Study Group IV	Prof. L. Sacco (Italy) 1948-1959	G. Millington (United Kingdom) 1953-1958
Study Group IV (now 4)	Prof. I. Ranzi (Italy) 1959-1970 W. Klein (Switzerland) 1970-	W. Klein (Switzerland) 1959-1970 E. R. Craig (Australia) 1970-
Study Group V (now 5)	Dr. R. L. Smith-Rose (United Kingdom) 1948-1970	E. W. Allen (United States) 1953-1959

Designation	Chairman	Vice-Chairman
		Dr. A. Kalinin (USSR) 1959-
	Dr. J. A. Saxton (United Kingdom) 1970-	
Study Group VI (now 6)	Dr. J. H. Dellinger (United States) 1948-1957	Dr. N. Smith (United States) 1953-1956
		Dr. D. K. Bailey (United States) 1956-1957
	Dr. D. K. Bailey (United States) 1957-	Dr. E. K. Smith (United States) 1958-1970
		C. Terzani (Italy) 1970-1974
		Miss G. Pillet (France) 1974-
Study Group VII (now 7)	B. Decaux (France) 1948-1969	Prof. M. Boella (Italy) 1953-1969
		J. T. Henderson (Canada) Sept.-Nov. 1969
	J. T. Henderson (Canada) 1969-1974	Prof. G. Becker (F. R. of Germany) 1970-1974
	Prof. G. Becker (F. R. of Germany) 1974-	J. McA. Steele (United Kingdom) 1974-
Study Group VIII	J. Ehrlich (Czechoslovakia) 1948-1949	

Designation	Chairman	Vice-Chairman
	A. Singer (Czechoslovakia) 1949-1951	
	A. H. Cannon (Australia) 1951-1954	J. Campbell (Australia) 1953-1954
	J. Campbell (Australia) 1954-1960	G. S. Turner (United States) 1954-1960
	G. S. Turner (United States) 1960-1964	M. A. Vieira (Portugal) 1962-1964
	M. A. Vieira (Portugal) 1964-1970	P. Bouchier (Belgium) 1965-1970
Study Group 8 (was XIII)	G. H. M. Gleadle (United Kingdom) 1970-1974	P. Mortensen (Norway) 1970-1972
		V. R. Y. Winkelman (Netherlands) 1972-1974
	W. H. Bellchambers (United Kingdom) 1974-	O. J. Haga (Norway) 1974-
Study Group IX (now 9)	C. F. Booth (United Kingdom) 1948-1952	
	H. Stanesby (United Kingdom) 1952-1958	G. Pedersen (Denmark) 1953-1959
	W. Bray (United Kingdom) 1958-1961	Dr. E. Dietrich (F. R. of Germany) 1959-1961

Designation	Chairman	Vice-Chairman
	Dr. E. Dietrich (F. R. of Germany) 1961-1974	J. H. H. Merriman (United Kingdom) 1962-1965 T. Kilvington (United Kingdom) 1965-1974
	J. Verrée (France) 1974-	H. Willenberg (F. R. of Germany) 1974-
Study Group X (now 10)	R. Burton (United States) 1948-1950	
	N. McNaughten (United States) 1950-1954	A. Prose Walker (United States) 1953-1954
	A. Prose Walker (United States) 1954-1974	K. Miller (United States) 1954-1959 Dr. H. Rindfleisch (F. R. of Germany) 1959-1969 C. Terzani (Italy) 1969-1970 S. S. Aiyar (India) 1970-1974
	C. Terzani (Italy) 1974-	Y. Venkataramiah (India) 1974-1976 S. N. Mitra (India) 1976-
Study Group XI (now 11)	E. Esping (Sweden) 1948-1974	G. Hansen (Belgium) 1953-1970

Designation	Chairman	Vice-Chairman
		Prof. M. I. Krivosheev (USSR) 1970-1974
	Prof. M. I. Krivosheev (USSR) 1974-	Dr. C. A. Siocos (Canada) 1974-
Study Group XII (incorporated in Study Group 10 since 1970)	S. S. Rao (India) 1948-1952	
	B. V. Baliga (India) 1952-1958	Dr. M. B. Sarwate (India) 1953-1958
	Dr. M. B. Sarwate (India) 1958-1960	A. C. Ramchandani (India) 1959-1960
	A. C. Ramchandani (India) 1960-1963	N. V. Gadadhar (India) 1960-1963
	N. V. Gadadhar (India) 1963-1966	
	V. Chaman Lal (India) 1966-1970	C. Nogbu (Ivory Coast) 1966-1970
Study Group XIII	J. D. H. van der Toorn (Netherlands) 1948-1959	J. Søberg (Norway) 1953-1959
Study Group XIII (became Study Group 8 in 1970)	G. H. M. Gleadle (United Kingdom) 1959-1970	J. Søberg (Norway) 1959-1968 P. Mortensen (Norway) 1968-1970

Study Group XIV (later CIV, now CMV)	T. Gorio (Italy) 1951-1957	R. Villeneuve (France) 1953-1957
	R. Villeneuve (France) 1957-	A. Ferrari-Toniolo (Italy) 1959-1970 B. A. Durán (Spain) 1970- M. Ducommun (Switzerland) 1974-
CMTT	Prof. Y. Angel (France) 1956-	R. H. Franklin (United Kingdom) 1956-1966 W. G. Simpson (United Kingdom) 1968-

absorption is a formidable one. Applications and systems above 40 GHz must be specifically designed for the environment.

There is a potentially significant new problem on old turf. The proliferation of "super power" (one to several megawatts) transmitters may cause, besides the cross-modulation known for decades, ionospheric modification which may in turn give rise to propagation of interference between services at frequencies as high as VHF and UHF. The CCIR needs to give its advice as unequivocally as possible.

Perhaps the most crucial problem for the future development of radio concerns utilization of the geostationary satellite orbit. As the Chairman of Study Group 4 notes in his report to the XIVth Plenary Assembly, the limited capacity of the geostationary satellite orbit will be fully used in the foreseeable future, first in the preferred frequency bands below 10 GHz. This "capacity" of the orbit results from the necessity for angular separation between satellites sharing the same frequency band, and for geographical separation of the coverage areas on the surface of the Earth. These separations (to avoid interference) depend on system configurations, including power, antenna diagrams for both satellite and earth station, modulation method, and the possible dispersal of carrier energy over a band. In principle, the greatest utilization can be obtained by sharing among homogeneous systems. But in practice system characteristics may differ. For FM systems, modulation index is of interest because, with increasing modulation index, the number of satellites which can be accommodated in a given orbital spacing increases, though capacity of an individual satellite tends to decrease. Services designed for different objectives will call for different orbital spacings; paradoxically, systems to serve small, low-capacity earth terminals require greater orbital spacing than those serving large, high-capacity earth terminals. This shows the difficulty of setting criteria for optimum use of the orbit. In some bands and regions the orbit is shared by quite different services, as between the fixed service and broadcasting satellites. A further complication is posed by multi-purpose satellites, where the operation of a single satellite must be co-ordinated in several frequency bands used by different services with quite different constraints. Here, the economy and operational advantages of multi-purpose satellites must be weighed against the complexity of co-ordination and the reduced orbital capacity.

A CCIR Working Party has been studying this problem for the fixed satellite service, and some of the principles are applicable to other services and inter-service sharing. This problem will be one of the most important to the future work of the CCIR.

■ Organizational

There is a great deal of evidence that the CCIR is an institution widely trusted by the international telecommunications community. This is a fortunate heritage of fifty years. It is all the more important to guard in the future the relevance and integrity of CCIR work.

The rate of development of new texts (table IV), including new questions, reflects an ever increasing investment by Members in CCIR work. To ensure best results in the future, however, careful attention should be given to priorities. There are so many topics to be studied and reported that resources might well be concentrated on those problems where the need and potential benefits are the greatest. A systematic review of priorities by the Study Groups, as well as by the Plenary Assembly, could be useful.

Table IV

Growth of technical studies

Plenary Assembly (year)	Questions under study *	Recommendations and reports
1929	16	21
1931	25	21
1934	35	27
1937	20	21
1948	33	35
1951	81	100
1953	111	119
1956	129	194
1959	153	236
1963	191	332
1966	241	423
1970	322	518
1974	392	633
1978	471**	774**

* Includes, after 1951, study programmes

** Estimated

There is also a real need for certain Study Groups to work more closely together on questions of mutual concern. Divergent or conflicting technical viewpoints can certainly be expected from the different expertise and interests represented in the Study Groups. The CCIR might consider better mechanisms for joint study and overall reconciliation of these topics. Similarly, there are several questions which call for closer co-operation with the International Telegraph and Telephone Consultative Committee (CCITT), expressly concerning radio links interconnected with land networks. The maritime mobile service is especially so involved at the moment. Co-operation is largely very effective where there are " Joint Study Groups " such as the CMTT and the CMBD. But in some other areas the needs for co-operative work are not fully met, perhaps reflecting similar gaps at the national level.

The CCIR might also give more direct and systematic attention to the expressed needs of the IFRB for technical recommendations to assist that organ of the ITU in its responsibilities.

Wider use of Interim Working Parties (IWPs) could help to reduce the time and documentation required in full meetings of Study Groups. IWPs, however, should have terms of reference devoted to a quite specific question, with a reporting schedule and termination date. Some IWPs have demonstrated that much of the work can be carried out effectively by correspondence.

A more systematic approach to, and a more formal status for, CCIR's technical preparation for ITU radio conferences might reduce gaps and equivocation in the results.

One important objective of the CCIR might well concern more effective dissemination of information. A prodigious quantity of authoritative technical guidance is produced. However, by its means of distribution and cost, it is easily accessible only to a relatively small corps of specialists, many of whom are involved in preparing the texts. A vigorous review of the means of publication and dissemination of CCIR material seems warranted, as well perhaps as consideration of the format. There are several varieties of content combined in the present single publication scheme. Improved publication practices could be one of the keys to greater relevance of CCIR work to developing countries.

A closing remark about the human aspects of the CCIR. It has been noted that many of the great names of radio have been participants in CCIR work. It seems that participants in CCIR work always remark about " friendship made " and " good co-operation achieved " in CCIR meetings. The more technical, less political atmosphere as compared to radio conferences undoubtedly fosters more relaxed communication among the people; real friendship emerges which not only serves to smooth later conference work, but to strengthen the development of international telecommunications.

* * *

Acknowledgement is due to the staff of the CCIR Secretariat for assistance in preparing this review, especially to R. V. Lindsey and Y. Y. Mao for historical notes, and to G. Corbaz for his summary

of the early years. I have also drawn on an article prepared by H. Pouliquen in 1966 and one by Dr. E. K. Smith and myself in 1974.

* * *

The co-operation of Mr. M. Mili, Secretary-General of the ITU, making possible this special issue of the *Telecommunication Journal* is gratefully acknowledged.

Following this article one will find first a paper by an eminent participant in the earliest meetings and work of the CCIR, on " The origins of CCIR ". This is followed by summaries of the individual Study Group activities by each of the CCIR Study Group Chairmen. In the later section is a series of articles on the state of the art and the outlook for future developments in several important radio services, authored by world-renowned experts in these fields, including space communications, radio and television broadcasting, radioastronomy, and microwave radio services. Finally, important areas of radio technology are surveyed, including radio wave propagation, modulation, digital technology, and frequency-control. The latter group of articles (which also includes an article on mobile communications) is contained in a second issue of the " Journal ", to appear in July 1978.

The CCIR is indebted to Mr. R. Fontaine, the ITU Language Division, and the editorial staff of the " Journal ", particularly Mme C. Garstin, for their considerable assistance and painstaking editorial work for this special issue.

(Original language: English)

CCIR, radio science and radiocommunications

by Dr. Kenichi Miya *

Preface

Mr. Director of the CCIR, Mr. Vice-Minister of Posts and Telecommunications, Distinguished Guests, Ladies and Gentlemen:

I am very honored to be able to speak on this glorious occasion of the fiftieth anniversary of the CCIR. I am full of gratitude, and at the same time aware of the great responsibility, for the fact that Mr. Richard C. Kirby, Director of the CCIR, and the high officials of the Ministry of Posts and Telecommunications of Japan should have chosen me to make this commemorative address today despite of the presence of many distinguished people who have contributed much to the achievements of the CCIR.

During the half-century of its existence, from the beginning of the age of shortwave communications to the present age of satellite communications, the CCIR has scored many wonderful breakthroughs as a result of its study efforts. Their effect on the development of world radiocommunications is immeasurably great.

In my years of continuing efforts in the international communications services, from the flourishing era of the shortwave radio to the present age of satellites, I have received great benefit from the CCIR. I hope that my research into ionospheric wave propagation and satellite communications may have helped in some measure to repay this debt.

Establishment of CCIR

Now, I would like to look back briefly at the long history of international communications and at the role the CCIR has fulfilled and give you some of my own impressions.

The first submarine cable for telegraphy used for international communications was that laid between England and France in 1850. After that the age of international communications by means of cable continued for approximately half a century.

Then in 1901 long-wave transatlantic communications between England and America made their appearance and the age of radiocommunications was open. And then, a quarter of a century later, that is in 1926, shortwave came into practical use for the first time in the form of the directional communication network of Great Britain and the real age of international radiocommunications began.

The CCIR was formed at exactly the time of this sudden rise of shortwave communications and has played a role of motive force in the development of radio communications.

* *Address to the XIVth Plenary Assembly, Kyoto 1978.*

Development of modern methods of telecommunications

In 1956, approximately half a century after the beginning of the radio age, a transatlantic coaxial cable was laid for telephone use. In other words, the first modern means of transmission for international communications had been realized. Then a mere nine years later the second modern means of transmission was established with the inauguration of commercial satellite communications through INTELSAT in 1965.

Satellite communications, as you know, are superior in terms of adaptability and economy because of its multiple access capability which enables simultaneous communications among many stations possible, and because of its capability of easy setting up of new circuits. Cable communications, on the other hand, have such features as interference-free due to the transmission through a closed medium, and shorter time delay compared with satellite communications.

Between these two means of transmission—radio and cable—there has long been competition in the good sense of the word, not only from the point of view of technological or economical considerations, but also from the point of view of communications policy and industrial policy.

Under present technological conditions, the economical break point between cable and satellite communications is a transmission distance of about 3000 km. In other words, we can say that cable is more economical up to 3000 km and satellite is more economical over 3000 km. However, as we all know, the two last mentioned factors—communications policy and industrial policy—are, in practice, extremely important elements in selecting cable or satellite, or deciding on their combined use.

Consequently, these two wide-band transmission systems have continued to develop while mutually competing in many ways. While preserving their advantages, they complement each other, and through their effective utilization, I believe, a highly reliable world communication system is being established.

In the meantime, the CCIR has contributed a lot to the development of the world-wide telecommunications by pushing forward with studies on mobile communications and broadcasting as well as to fixed communications as stated above.

As these modern methods of communication have developed, they have come to be jointly used in the international transmission of information. If we take a look at the example of Japan, at present, the total number of transmission circuits is approximately 3100, of which satellite circuits account for 62%, submarine cables 24% and over-horizon microwave circuits 13%. Shortwave, which enjoyed its prosperity until some ten years ago, now occupies a mere 1%.

CCIR's research into shortwave propagation

With respect to shortwave communications, which were until not too long ago the principal transmission means, I think there are several lessons which must be learned from the research into ionospheric wave propagation. That is to say, as you all know, as part of its basic studies on radiowave propagation, the CCIR first explained the relationship between the solar activities and the ionosphere and made it possible to predict the world-wide distribution of critical frequencies for vertical incidence into the ionosphere. The fact that real scientific research work was crystalized in the form of prediction, which is purely practical, should be highly evaluated.

However, I believe that the studies on another major subject, that is, the search for the average field strength of signals and the establishing the propagation curve, has taken a little too long. This study has been given particular attention since the IXth Plenary Assembly held in Los Angeles in 1959.

At that time, several methods of field strength calculation have been proposed by the United States, Japan, Soviet Union and Federal Republic of Germany. The method of the United States, developed at the Central Radio Propagation Laboratory was most comprehensive and practical. It should be noteworthy that a calculation method was originally introduced by Dr. Shogo Namba in 1932 with the concept of absorptive and reflective attenuation in the ionospheric HF propagation. Following his school, I myself proposed an improved calculation method as a Japanese method which was established based on the results of studies on the propagation mechanism of obliquely incident pulse signals.

There has been much debate over which method should be adopted and no agreement could be reached among the various countries, but recently the so-called CCIR method of field strength calculation, which is applicable to computer, has finally been established. Further, based on the method proposed by me, world-wide consensus has been achieved at last for the method of field strength calculation of Sporadic-E signal which undergoes extremely complicated behaviour in its propagation.

These two important long-pending field strength calculation methods are going to be approved as Recommendations by this Plenary Assembly. I am truly delighted that this should happen just before the World Administrative Radio Conference I have the highest respect for Dr. D. K Bailey, Chairman of Study Group 6, for his invaluable guidance and leadership.

Nevertheless, as a radiowave researcher, I feel it unfortunate that we lost the opportunity to obtain the great benefits we would have won if this sort of calculation method had been developed at the height of the shortwave age rather than now, at its wane.

Radio science and CCIR

The most predominant feature of radio communications, irrespective of their means, is the fact that they utilize the open space as transmission media which, more or less, are inevitably affected by natural phenomena. Shortwave communications are dependent on the ionosphere and terrestrial microwave communications are subject to the tropospheric phenomenon. Even space communications are affected by th the ionosphere or troposphere depending on the frequency to be used.

In such a manner, radiocommunications and radio science are closely interrelated with each other. The shortwave communications can be said to have the closest relationship with radio science, since shortwave propagation is fully dependent on the ionosphere. The weak point of shortwave communications lies in the fact that the ionosphere sometimes suffers from disturbance caused by the solar activities and the propagation condition becomes unstable.

Accordingly, investigations into the characteristics of the ionosphere and those into solar phenomena, which are the source of disturbance, had long been the principal subjects in radio science. In recent years, such studies resulted in a great development of new science, the sunearth relationship embracing the magnetosphere, as the observations by use of artificial satellites have been proceeded.

In 1935 Dr. J. H. Dellinger published his theory of sudden ionospheric disturbances (SID) occuring in a 54-day cycle in the *Physical Review*. I was much stimulated by this and became absorbed in the research. In the course of this study, in 1938, I could measure a strong solar noise appearing in the HF band in the SID period. In 1932, Mr. K. G. Jansky published a report on the observation of galactic noise. Who could have imagined such cosmic noise sources should have such a close connection with the satellite communications technology of today?

Research into ionospheric propagation is truly a profound and appealing subject for a scientist. There are an immeasurable number of interesting phenomena such as whistler, ionospheric forward scatter, ground scatter, scintillation, ionospheric storm, meteoric burst and other ionospheric anomalies.

When *Sputnik-1* was launched in October 1957, we measured the direction of arrival and Doppler shift of the satellite signals using the direct vision type direction finder which had been developed by us for shortwave propagation investigation. It was also at this period when we could directly prove the existence of HF ground scatter.

I feel that this sort of research is extremely important but that studies of the CCIR must not be diverted, in excess of search for truth, from its primary objective. There is a saying in Japan that "A hunter in pursuit of a deer sees no hills" or, in other words, a person devoting himself to one thing notices nothing else. At the same time, at an international conference it is necessary to take heed of as many viewpoints as possible, but one must not lose sight of the main issues through an excess of caution.

The frequency is a limited resource held in common by all mankind and the CCIR should concentrate its effort on studies of radio technology to use it effectively and to establish communication means with less mutual interference. I believe that fundamental scientific research should essentially be left to such bodies as the International Union of Radio Science (URSI), to carry it out.

Closing remarks

The CCIR is facing a new age of communications. Satellite technology has just been extended to the maritime mobile communications, and realization of broadcasting satellite has become a matter of practice. The scope of studies of the CCIR is expanding especially in the field of space researches. The upper frequency limit with which the CCIR is concerned was once raised from 45 to 275 GHz, and then from 275 to 3000 GHz. The CCIR is now attempting to raise the limit to the frequency of light wave.

In conclusion, I would like to take this opportunity to express my hope that the CCIR will be able to play an ever more effective role in the forefront of the development of radio-communications in the midst of this sort of transitional age.

Anecdotes dedicated to the celebration of the 50th anniversary of the CCIR

by Dr. Y. Y. Mao*

Introduction

When the members of the CCIR Editorial Committee prepare the texts for submission to the next Plenary Assembly, they have no time to ponder the prophetic words uttered by General Ferrié at the First Plenary Assembly in 1929, or even reflect on the circumstances in which the Editorial Committee was set up by the Second Plenary Assembly in 1931: this is due in part to the ever-increasing volume of material which they have to get through, which leaves them littler leisure for historical contemplation, and it is also doubtless because most of the members of the Editorial Committee—like most of those who participate in the work of the Study Groups—are by no means thorough versed in the history of the CCIR.

It is the outstanding merit of Dr. Y. Y. Mao, who is thoroughly familiar not only with the techniques currently being explored by the various Study Groups, but also with the work carried out by the CCIR since it was first established, that he has set out, in a pleasantly readable text, full of poetic imagination and studded with historical details, some of the salient facts marking the birth and existence of the CCIR up to its 50th anniversary.

It is highly desirable for all those interested in the development of radiocommunications to give some of their time to reading and meditating on Dr. Mao's summary of the history of the CCIR: they will be agreeably surprised to discover that the history of an international body devoted to technical matters may sometimes prove as gripping as an adventure story, because it is indeed a fascinating adventure—and one that arouses enthusiasm—to keep always in the forefront of progress in a technical field undergoing constant and rapid development.

The CCIR's half centenary provides us with the opportunity to look back upon the past and take stock of the progress that has been made since 1929; but it should equally encourage us to turn resolutely towards the future: like General Ferrié, who already in 1929 was a convinced and enthusiastic advocate of the conquest of space and the development of the new technique known as "astronautics", we should attempt to imagine what will be the most promising lines for the development of radiocommunications in the year 2000 and beyond—such as systems operating in the optical (visible and infrared) ranges of the spectrum (covered by CCIR Question 53/1), or even radiocommunication systems to search for extraterrestrial life (Question 17/2).

Marcel Thué, Winner of the 1968 "General Ferrié" electronics prize, and Chairman of the CCIR Editorial Committee since 1970

* *Presented to the XIVth Plenary Assembly, Kyoto 1978.*

Preface

This year, CCIR is 50 years old. However, radiocommunication had its beginnings well before 1928 so to tell the whole story we should start with the invention of radio. It is a fascinating tale in which the first character is James Clerk Maxwell (1831-1879), a Scottish physicist and gifted mathematician, who laid down a set of equations, based upon electrical phenomena observed earlier and from them predicted the existence of electromagnetic waves. In Germany, Heinrich Rudolph Hertz (1857-1894) verified them experimentally, which culminated in producing a faint discharge with a crude transmitter and a crude receiver. This discharge, however faint, not only confirmed Maxwell's predictions but also laid the foundations of radiocommunication.

That faint spark of Heinrich Rudolph Hertz has also made the impossible possible. Without radio, the idea of communication over vast distances could be described by an old Chinese saying as "An idiot relating his dream". However, Hertz and other pioneers have converted that dream to reality and it is up to this and later generations to build wisely on the foundations laid in the past. CCIR looks forward to contributing to this future development in the years to come.

Radiowaves recognize no national boundaries. More than any other human activity, regulations on an international scale on the use of radio waves are indispensable. As the problems grew more complex, the need of a consultative committee to study the technical aspect of radiocommunication was felt and, in the Washington Radio Conference held in 1927, its creation was decided upon.

It was, however, not without hitches that the birth of this important international body took place. There was much apprehension on the part of many participants. In the Technical Committee, one participant stated:

"*... Wireless technique is still in process of development. Either the committee will confine itself to assembling documentation from the various countries, in which case the International Bureau at Berne is sufficient, or it will attempt to carry out technical examinations and organizational studies, which will be a slow process in view of the complexity of the problems and the interests involved.*

"*Thus it will retard progress and practical applications since most Administrations, in view of the prestige of those comprising the committee, will consider themselves bound to request and await its prior recommendations and to take them into account.*

"*We therefore consider that the creation of a committee of this type should be deferred, at least until the next conference.*" *

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* See "*Documents de la Conférence radiotélégraphique internationale de Washington, 1927, p. 449*".

Another participant made the following retort:

"... *On the contrary, radiotelegraphy is evolving at lightning speed. Thirty years ago it did not exist, now it is already at quite an advanced stage of development.*

"*Scientists will determine the theoretical aspects and engineers will study the practical side. In the interval between international conferences (usually five years) very great progress may be made. Is it not wise, therefore, that there should be an international committee able, in between conferences, to provide for the examination of any questions that may arise, on a continuing basis? There is no need to wait for the merging of the Telegraph and Radiotelegraph Convention before setting up such a committee.*" *

In the minutes of the Convention Committee, one could read the following passage:

[One delegate had pointed out that] "*there is a reason for the hesitation noticeable among some delegates which it is perhaps better to explain quite frankly*".

[Certain delegations] "*fear that the proposed technical committee will simply promote the interests of powerful firms, which would contrive to have recommended the use of equipment and devices of their own manufacture. Before proceeding to a vote, he thought, in order to clarify the discussion, to say in public, quite categorically and without bias, what many colleagues, rightly or wrongly, think in private.*" **

As years went by, this negative attitude gradually disappeared, and nowadays nobody ever raises the slightest doubt as to the necessity of such a Consultative Committee.

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* *See "Documents de la Conférence radiotélégraphique internationale de Washington, 1927", p. 449.*

** *See the same document, p. 129.*

Going back 50 years, it was on the historic day of 18 November 1927 that the international body known as the CCIR was created by a vote of 30 in favour, 26 against, with 11 abstentions, in the 6th Plenary Session of the Washington Radio Conference.

The legal instrument for this historic event reads as follows:

ARTICLE 13bis*

An International Radio Technical Consultative Committee shall be established to study technical and related questions concerning radio communications.

Its composition, functions and operations are defined in the General Regulations annexed to the present Convention.

while the relevant texte in the General Regulations reads as follows:

ARTICLE 34**

1. The International Technical Consulting Committee on Radio Communication, established by Article 13bis of the Convention, shall be charged with the study of technical and allied questions which relate to international radio communication and which shall have been submitted to it by the participating Administrations or private enterprises. Its function shall be limited to giving advice on questions which it will have studied. It shall transmit this advice to the International Bureau, with a view to its being communicated to the Administrations and private enterprises concerned.

2. This Committee shall be formed, for each meeting, of experts of the Administrations and authorized private radio operating companies, who wish to participate in its work and who undertake to contribute, in equal parts, to the common expenses of the contemplated meeting. The personal expenses of the experts shall be borne by the Administration or private enterprise which has appointed them.

The experts of such authorized private enterprises shall participate in the work with the right to deliberate but not to vote. When, however, a country is not represented by an Administration, the experts of the authorized private enterprises of that country shall have a right, as a whole and regardless of their number, to a single vote.

3. The Administration of the Netherlands shall be charged with organizing the first meeting of the International Technical Consulting Committee on Radio Communication and with drawing up the program of work for this meeting.

* *See "Documents de la Conférence radiotélégraphique internationale de Washington, 1927", p. 789.*

** *See the same document, p. 967.*

After the turn of the century, research in the field of radiocommunication was conducted both theoretically and experimentally. Its progress was rapid and steady, very much like walking on both feet. While it was the faint spark of Hertz which set human imagination afire, to be followed by the inventions of Poulsen (arc), and Fleming (thermionic valve) which made sustained electromagnetic oscillations possible, research workers in this field are indebted to the genius of Laplace, Fourier and Bessel, mathematicians of the previous century, who, among many others, derived equations and functions which aided the rigorous analysis of electromagnetic phenomena, thus laying a solid foundation upon which further progress in radio science was to be made.

Up until now, the fundamental doctrine of "walking on both feet" was forever and everywhere evident and reflected in many achievements of the CCIR; "... scientists will determine the theoretical aspects and engineers will study the practical side", as a participant in the 1927 Radio Conference had declared.

The first Plenary Assembly of the *Comité consultatif international technique des communications radioélectriques* (at that time French was the only language of the Committee) was held in The Hague, Netherlands, in September-October 1929. At its Inaugural Meeting, General Gustave Ferrié, President of the French delegation, in reply to the welcome address by Dr. P. J. Reymer, Minister of the *Waterstaat*, made an historic speech of which the following passages are of everlasting interest:

"*Does it not in fact extend the horizon of our thought as the result of the waves, which cover the Earth, reach the highest layers of the atmosphere and perhaps penetrate interplanetary space, as certain theories of retarded echoes recently observed admit?*

"*If this distant propagation were definitely proved, for the first time a certain form of energy produced by man would have attained other bodies of the solar system and might perhaps be observed there, thus constituting the most extraordinary phenomenon of modern physics. We may justly be proud of the result of our work, which is henceforward associated with geophysics and astrophysics.*"

Less than half a century later, the CCIR, after having been immensely succcessful in studies on space communications, in a similar vein but in the opposite direction, has adopted a new question on radiocommunication requirements for systems to search for extraterrestrial life.

What a prophet was General Ferrié, in predicting the shape of things to come!

In the same inaugural speech General Ferrié pronounced:

"*... Time, a weighty word and one fuller of meaning than any other, for it reminds us of the hours that have flown and the limits of life. It has inspired as many poets as men of science. Our Corneille, in particular, in a madrigal addressed to a beautiful lady, sadly said:*

> '*All that is most beautiful*
> *Time delights to insult:*
> *He will make your roses fade*
> *As he has wrinkled my brow*'"

Strangely enough, very similar sad thoughts, also in poetic licence, were expressed, a few centuries earlier, long ago and far away, in an immortal Chinese classic, "The Dream of the Red Chamber", when the author wrote, in a scene entitled "Tai-yu buries the petals at the tomb of the flowers":

> "*Today one giggles when you bury the faded flowers*
> *Who knows who will bury you when your time is up?*"

General Ferrié continued:

"...*This precious and inexorable Time, we must measure with the greatest precision; and thus we must be infinitely grateful to the great physicist and astronomer, Huygens, who is amongst the pleiad of great men of Holland who have done honour to humanity in the realm of science.*

"*Already celebrated for his work in astronomy and physics, in particular for his wave theory of light, afterwards completed by Fresnel and by Young, Huygens in 1657 conceived the idea of keeping a pendulum in motion by giving it a new impulse at each beat by means of an apparatus called an 'anchor escapement'.*

"*Before this discovery time was not a measurable quantity. There were only water clocks, hourglasses and sundials, although certain attempts at spring clocks had been made without success. Huygens is therefore the man who has enabled us to measure time. All honour to him.*

"*We are going to set to work with zeal and confidence and, as you have recommended, sir, we shall direct all our efforts to the giving of opinions and recommendations on the questions in our programme which may improve the technique and help to develop the application of radioelectricity.*"

With no ambiguity, these concluding remarks of General Ferrié, delivered in the inauguration speech 50 years ago, are still a source of inspiration and encouragement to many participants in the CCIR today.

In another context, the time has changed. In 1927, when the creation of the CCIR was under discussion, it was the United States, France and England which opposed the idea, while Germany and Italy supported it. Half a century later, those three countries which opposed it had become ardent supporters. *

The concept of time which General Ferrié evoked in his inaugural speech is the reciprocal of frequency. "Frequency", the unit of which is now called the hertz, in honour of the pioneer of radio, is a term used every day and in practically every document of the CCIR.

The 50 years of CCIR's existence are 50 years devoted to the study of electromagnetic waves, with frequency as its primary parameter.

At this point it may be of some interest to make a general survey of the state of the radio art at that epoch, in order to better appreciate the significance of the CCIR, whose creation was described earlier:

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* *See "From Semaphore to satellite", p. 229.*

Radiocommunication was brought out from the laboratory by Marconi, Popov and others at the turn of this century. Its first use was for ships at sea, which it suited admirably. By the time of the Washington Radio Conference, aircraft began to supplement ships as means of transportation. No one, in the wildest of his dreams, can claim that without radio aircraft can operate safely and reliably, if at all.

Another use of radio, that of broadcasting, came into being in the 1920s. In 1927, the British Broadcasting Company changed its name to the British Broadcasting Corporation. The theme which served as the opening of a broadcast, whether it was news, drama, music, or simple story telling, "This is the BBC", came to assure the listener, wherever he was, of education, information or entertainment of a high cultural value. Regular French broadcasts from the Eiffel Tower began in that same year. As many as 733 broadcasting stations were in operation in the United States. These are just some of the highlights, certainly there are many other developments in this field in other countries. In any event, since 1927 science and art joined hands on an unprecedented scale: Radio Broadcasting.

On the theoretical side, the phenomenon of signal transmission through empty space must have been extremely fascinating, especially to those who had experienced it for the first time. As early as 1902, in an effort to explain the remarkable feat of Marconi in transmitting radio signals from England to Newfoundland in 1901, Kennelly and Heaviside advanced the notion of a conducting layer around the Earth. Nevertheless, emphasis at that time was on the use of ground waves, which depended upon the electrical characteristics of the Earth for their propagation.

In 1909 Arthur Sommerfeld, in a paper published in *Annalen der Physik*, investigated the effect of a finitely conducting plane upon the radiation of an oscillating dipole. It was recognized from the beginning that his solution could be interpreted as a bundle of plane waves reflected and refracted from the Earth's surface at various angles of incidence. This point of view was developed by Weyl. An interesting and useful solution of the Sommerfeld-Weyl expression was discussed by van der Pol in 1935, but that was a few years after the Washington Radio Conference, and we will come to this a little later in our story.

In all fairness, one must not discount the important contributions made by radio amateurs in the pioneer days of radio. Although as old as the art of radio itself, amateur radio did not always enjoy the prestige to which it is entitled. By 1912 there were many government and commercial stations, and hundreds of amateurs; regulation was needed, so laws, licenses, and wavelength specifications appeared. The official viewpoint towards amateurs was something like this, even in countries where their activities were not outlawed:

"Amateurs...Oh, yes...Well, stick'em on 200 metres and below, they'll never get out of their backyard with that."

It may very well be that we are indebted to radio amateurs by virtue of their lack of knowledge of researches carried out by Sommerfeld, Weyl, and many others; for if they had been aware of them, they would have neglected altogether to experiment with waves shorter than 200 m to which they were relegated, for according to the classical theory these waves could not propagate over long distances, while the zeal of amateurs was for just this. It is doubtful that they were better informed on theories advocated by Kennelly-Heaviside concerning the ionosphere either; in any case their hypothesis of the existence of the ionosphere was too fragmentary at that time. Nevertheless, these amateurs carried on their experimentation, come what may. Reports indicated that as the wavelength dropped (or frequency increased) the results were even better. In November 1923, two-way amateur transatlantic communication was accomplished on 110 m. Additional stations dropped down to 100 m and they too could easily work two-way across the Atlantic. The exodus from the 200 m region had started. The "short wave" era had begun, just four years before the founding of the CCIR.

One must not forget that radio had also been used for the fixed service, like telephony and telegraphy. Thus, five major services, namely, the fixed, maritime mobile, aeronautical mobile, broadcasting and amateurs, entered the scene to cut up as big a slice as possible of the limited radio frequency spectrum, which only from that time onwards was considered an expendable natural resource.

In 1927, the unending battle of the frequencies had started in earnest, and became more and more furious as time marched on.

Participants of the Ist Plenary Assembly of the CCIR entered the *Ridderzaal* (Hall of the Knights) for the Inaugural Meeting at The Hague, Netherlands, on the historic day of 18 September 1929 with this background of the state of the radio art in their minds.

At its Ist Plenary Assembly, the CCIR followed a work programme proposed by the Netherlands Administration. This is in contrast to the practice today, in which the Questions and Study Programmes must be approved by at least 20 Administrations or by the Plenary Assembly.

The Ist Plenary Assembly set up Committees on Organization, Standardization, Co-operation and Exploitation, dealing with 16 topics on the agenda, two of which were concerned with organization, while the others were technical. Since it was the Ist Plenary Assembly, the considerations on organization took preponderance. The Secretariat was provided by the host Administration, with the co-operation of officials from the International Bureau of the Telegraph Union, known later as the Berne Bureau.

Fifty years ago there was no International Frequency Registration Board (IFRB). Hence, many of the knotty problems now incumbent upon that body were in the domain of the CCIR. Thus, advice on the allocation of frequencies, as well as their regulation by the Berne Bureau, form the subject of early CCIR Recommendations.

Among the technical problems on the agenda were definitions of power and frequency ranges, the study of HF (6 to 30 MHz) radiation, frequency measurement, monitoring, frequency tolerances, occupied bandwith, frequency separation, spurious emissions, fading, directivity, atmospheric noise and amateurs' licenses.

A perusal of the Minutes of this Meeting shows that the technical problems which gave rise to the lengthiest discussions were those of emission stability and frequency measurement.

The Conclusions of the Meeting (50 pages) comprised 29 Recommendations (five of them organizational) and seven Questions. Recommendation No. 1, paragraph 2 of the "considerings" reads:

"... 2) that some Questions may remain unsolved 'after meetings of the CCIR...'" a phrase which suggests that many of the participants realized there were some problems for which an immediate solution was out of the question.

Of the 24 technical Recommendations, seven were related to problems of frequency measurement and stability; the others were concerned with frequency allocation, limiting the power of broadcast transmitters to 100 kW and the elimination of spark transmitters.

The IInd Plenary Assembly was held at Copenhagen in May-June 1931, at the invitation of Denmark. The list of questions on the agenda of this Second Plenary Assembly shows that some ground had already been travelled since The Haghe Plenary Assembly; particular stress was laid on co-ordination of maritime radiocommunication with the land network and on improvement of the quality of emissions. Among other subjects, mention
network and on improvement of the quality of emissions. Among other subjects, mention
may be made of links with trains in motion and the establishment of a list of symbols and a terminology.

The work was divided among six committees: in addition to the four set up at the Ist Plenary Assembly, the IInd Plenary Assembly set up a Committee on Emissions and a Drafting Committee.

The discussions reveal an interest in such new techniques as single-sideband emissions and in such new concepts as the field strength required for reception. Interest was also taken in the most general aspect of propagation and in the study of receivers.

The imminence of the Madrid Telecommunications Conference of 1932 lent special importance to this IInd Plenary Assembly. The question was raised whether the CCIR should, on the basis of Recommendations adopted at its first two Meetings, submit proposals to that conference for the amendment of the general rules.

The Final Acts of the IInd Plenary Assembly consisted of 23 new Recommendations and 14 Questions; in addition to the problems already discussed at the Conference, they refer to such subjects as the establishment of standard-frequency transmissions.

The IIIrd Plenary Assembly of the CCIR (by now called the International Radio Consultative Committee) was held at Lisbon in September-October 1934, at the invitation of Portugal. The study of different problems was again divided among six committees, with the same terms of reference as at the preceding Plenary Assembly. It is noteworthy that this Plenary Assembly began to study certain problems which are still on the agenda of the CCIR meetings, such as minimum spacing between HF broadcasting stations, single-sideband broadcasting, propagation by the reflected wave at MH and the minimum field for television reception. A thorough study was also made of the organization of the CCIR. There was still no question of a permanent secretariat. New questions were raised by Administrations and accompanied by an explanation; an Administration was chosen to centralize the handling of each question or group of related questions; the Administration which had issued the invitation for the next meeting became the co-ordinating Administration, responsible for communicating to other Administrations its plan for apportioning agenda items among the various committees, providing the secretariat for meetings and sending out invitations. The Chairman of the CCIR was appointed at the opening plenary meeting.

The Final Acts of this IIIrd Plenary Assembly of the CCIR consisted of 27 new Recommendations and 18 Questions. One of these Recommendations gave medium-wave propagation curves for day and night and diagrams for calculating the short-wave field.

The IVth Plenary Assembly of the CCIR, the last before the Second World War, was held at Bucharest in May-June 1937. It was attended by about 200 participants and the work was divided among the same committees as those set up at the two preceding Assemblies (organization, definition and standardization, co-operation, utilization, emission and drafting). Once again, great importance was attached to problems of organization. The United States delegation brought a group of translators and stenographers, at its own expense, to translate the documents issued in French (at that time, the Convention stipulated that the Acts of conferences and all the documents of the Union must be drafted in French). As at other meetings, a number of discussions were held on the terms of participation of bodies other than Administrations, such as the League of Nations, for instance.

Among the technical problems which aroused particular interest, we may cite the study of means of overcoming the shortage of frequencies for broadcasting (stabilization, synchronization) and those concerned with mobile services interference, phototelegraphy and wave classification.

The Final Acts of this IVth Plenary Assembly comprised 47 Recommendations and 20 Questions. They include, *inter alia*, a draft terminology in six languages, a Recommendation establishing the terms of co-operation with the International Special Committee on Radio Interferences (CISPR) and a list of symbols drawn up by the International Electrotechnical Commission (IEC). The questions examined practically cover the spheres of the present CCIR Study Groups with the exception of radio-relay systems and space communications.

The work of this Plenary Assembly was influenced by the proximity of the Administrative Telegraph, Telephone and Radio Conferences which, for the first time, were placed under the auspices of the new ITU as established at the Madrid Telecommunications Conference. These administrative conferences were held in Cairo the following year.

Sweden invited the CCIR to hold its Vth Plenary Assembly at Stockholm in 1942, but unfortunately the Plenary Assembly could not be held until 1948.

At that epoch, the topic which occupied the attention of the world's foremost scientists and engineers in the field of radiocommunication was undoubtedly the propagation of radio waves. As was mentioned earlier, the first solution for the field produced by a short vertical antenna at the surface of a plane earth of finite conductivity was obtained by Sommerfeld, in an article entitled "The propagation of waves in wireless telegraphy", published in the *Annalen der Physik*, Vol. 28, 1909. Little attention was paid to it, however, until it was used by R. H. Barfield, to explain ground-wave attenuation of broadcast waves in an article entitled "The attenuation of wireless waves over land", published in the *Journal of Electrical Engineering*, Vol. 66, 1928. Later analyses of the same problem made by different methods by Weyl, Sommerfeld, in 1926, Balthazar van der Pol and K. F. Niessen, and W. H. Wise differed slightly from Sommerfeld's original solution because of an error in sign in the original derivation discovered by K. A. Norton, whose paper entitled "The propagation of radio waves over a plane Earth" and published in *Nature*, Vol. 125, 1935, created a sensation. Work by Charles R. Burrows, "The surface wave in radio propagation over plane Earth", *Proc. I.R.E.*, Vol. 25, 1937, gave experimental verification that the revised analysis was correct. Other scientists, like T. L. Eckersley and G. Millington, to name only two, also made significant contributions. Their paper "Application of the phase integral method to the analysis of the diffraction and refraction of wireless waves round the Earth", in the *Philosophical Magazine*, Vol. 27, 1939, was also of very great importance.

A group of participants to the IVth Plenary Assembly of the CCIR held in Bucharest in 1937 set forth to use the accumulated knowledge available up to that time to devise internationally agreed propagation curves. These are of historic value since they were adopted by the next Administrative Radio Conference, Cairo, 1938, and became known as the "Cairo curves". These are partially valid even to this day, since the LF/MF Broadcasting Conference held in 1975, Geneva, still made use of them.

The CCIR since 1947

The Second World War brought all international efforts in radiocommunication to a complete standstill. Nevertheless, the greatest wartime development, *radar*, must be considered as a major breakthrough in the development of radiocommunication, and it had a pronounced effect on the future work of the CCIR. It opened up the centimetre-wave bands for those services in which large bandwidths are required. The techniques of visual display in radar lent themselves remarkably to further refinements in television. We will have an occasion to dwell on this subject a little later, when we come to the contributions of the CCIR on colour television.

Acting on a suggestion of the United States, the Government of the USSR invited the other "Big Five" powers, China, France, the United Kingdom and the United States, to meet with them in Moscow to prepare for the next International Telecommunication Conference. The Moscow Conference of 1946 was a preliminary conference, yet many of the modern features of the ITU, as it is known today, can be traced back to the discussions held near the Kremlin at the time. After 21 days of conference, the delegations returned to their own countries; the United States Government, after hearing the report of its delegates, issued an invitation, through the Berne Bureau, to all the Members of the ITU to attend at Atlantic City, in 1947, a Plenipotentiary Conference, together with an Administrative Radio Conference and an Administrative High Frequency Broadcasting Conference.

The summer months of 1947 could not have been easy for the 600 delegates from 76 countries who met at Atlantic City. Many of the old problems of the ITU had assumed a new and much more pressing shape in the post-war world; other difficulties, due to scientific progress in the field of telecommunications, demanded an urgent solution.

It was at this Atlantic City Conference that the important decisions were taken to create the International Frequency Registration Board and the permanent Secretariat of the International Radio Consultative Committee. The structures of these bodies were given shape. The functioning of the CCIR was thenceforth determined by its Plenary Assembly and its Specialized Secretariat.

To make good a promise made by Sweden at the IVth Plenary Assembly held in Bucharest before the war, the Swedish Administration renewed its invitation to hold the Vth Plenary Assembly in Stockholm in 1948, which was accepted. It undertook to organize not only the Plenary Assembly itself, but to do also some preparatory work and, in particular, to co-ordinate the work left outstanding from Bucharest.

This first post-war Plenary Assembly adopted 35 Recommendations and drew up a programme for the study of 33 Questions, many of which were redrafted from old ones. It also adopted a structure of 13 Study Groups, in accordance with the nature of the questions to be studied.

From then on plenary assemblies have been held regularly at intervals of about three years, giving the CCIR an organization which ensures proper continuity in the study of various questions. Although the Plenary Assembly is empowered to adopt Recommendations, the groundwork is done in the study groups. Some of the groups held meetings when the study of a subject became urgent; examples of this are the meetings of Study Group 11 (Television) in 1949 and 1950, to study monochrome television standards; the meeting of Study Group 14 held in 1954 to study radio-relay systems in its province.

Other meetings of study groups have been convened for the technical preparation of administrative conferences. In particular, there was the meeting of Study Groups 5, 6 and 11 at Stockholm in May 1952 before the European Broadcasting Conference, and the meeting of the group of experts of Study Groups 5, 10 and 11 at Cannes in February 1961, prior to the European VHF and UHF Broadcasting Conference (Stockholm, 1961).

However, most of the work is done at the plenary assemblies. At the beginning of each of them, or, since 1966, a few months beforehand, the study groups hold meetings at which they finalize technical documents. These are then submitted to the Plenary Assembly itself for approval. Thus, the working procedures and especially the final drafting of texts at each Plenary Assembly make it possible to take stock at the end of each Plenary Assembly of the texts examined by each study group and subsequently to have all the documents available, whether they be new texts or old ones retained and brought up to date. In addition to these study groups, which are the backbone of the CCIR for the study of problems submitted to it, each Plenary Assembly sets up committees to study general problems and to prepare appropriate texts when necessary. As a usual rule, Committees on Finance (changed to Budget Control since 1970), Organization and Technical Co-operation are set up.

It is practically impossible to summarize the work of the plenary assemblies since the VIth Plenary Assembly held in Geneva in 1951, as was done for the previous plenary assemblies. At each of these plenary assemblies texts were adopted on the most traditional subjects of radiocommunication (already referred to in the passage on the Ist Plenary Assembly), such as quality of emissions, propagation and properties of receivers. Yet the changes introduced into these Recommendations and Reports at each plenary assembly are the result of constant research. Also many new subjects were added to the repertoire which represent the tremendous growth in the field of activity of the CCIR. These, in fact, are mirror images of developments in radiocommunication, in every sense of the word.

Some reference must, however, be made to certain provinces in which the CCIR has played an especially important part, for example:

— auto-alarm devices on board ships;

— sound recording for international exchange of broadcasting programmes;

— radioastronomy;

— radio-relay systems;

— space communications.

The last subject has acquired increasing importance for the CCIR. We shall revert to it in connection with the study groups.

The International Telecommunication Convention

Passages of the ITU Telecommunication Convention concerning the work of the CCIR have undergone no major changes since the Atlantic City Plenipotentiary Conference. As a matter of fact, relevant passages in the new Convention (Malaga-Torremolinos, 1973) follow closely those in the Montreux Convention, 1965. They are as follows:

308 2. (1) The questions studied by each International Consultative Committee, on which it shall issue recommendations, shall be those referred to it by the Plenipotentiary Conference, by an administrative conference, by the Administrative Council, by the other Consultative Committee, or by the International Frequency Registration Board, in addition to those decided upon by the Plenary Assembly of the Consultative Committee itself, or, in the interval between its Plenary Assemblies, when requested or approved by correspondence by at least twenty Members of the Unions.

419 1. The Plenary Assemblies of the International Consultative Committees are authorized to submit to administrative conferences proposals arising directly from their recommendations or from findings on questions under their study.

Prior to 1965, however, the approval of 12 Administrations was sufficient for the adoption of a question.

The Study Groups

In the first few plenary assemblies, topics for study were treated in Committees, very much as in an Administrative Conference. Since the Vth Plenary Assembly of Stockholm 1948, Study Groups were constituted, each having its own terms of reference. Participants announce themselves through their Administrations. They fulfil their tasks in a capacity not as representatives of their countries, but by virtue of their expertise. It is in the plenary assemblies that Administrations, being sovereign, decided to accept or to reserve their positions on particular texts, which are drafted by study groups beforehand.

At the end of the Vth Plenary Assembly there were 13 study groups, while a fourteenth (Vocabulary) was set up in 1951 by the VIth Plenary Assembly. The name of this particular Study Group has undergone several changes, and now it is known as the CMV, a joint Study Group with the CCITT.

At the VIIIth Plenary Assembly held in Warsaw, in 1956, the mandate of Study Group 9 was changed so that henceforth it dealt with radio-relay systems exclusively. The following Plenary Assembly, held in Los Angeles, 1959, saw the name of Study Group 13 changed to "Mobile services", dealing with maritime mobile, aeronautical mobile and land mobile services.

But the major innovation of the CCIR study group structure is that introducing work on space systems. The launching of the first artificial satellite by the USSR heralded the dawning of the Space Era. As a matter of fact, the original objectives of this first event were quite modest and simple.

In the framework of scientific studies to be carried out during the International Geophysical Year, known as the IGY, the first artificial earth satellite, spherical in form and with a small transmitter emitting only 1 W, was to measure certain parameters in the immediate environment of the Earth. Whether by design or by fortuity, this event touched off gigantic undertakings and, in a short span of 20 years, we have witnessed spectacular successes in practically every endeavour in space.

It was during this same period that science fiction in space travel—the literature that kept young boys and girls quiet and happy, as they read it, goggle-eyed, under cover of their school desks—has become real and actual, an everyday topic, and "Superman" has become a mortal, in the form of a Gagarin or a Glenn, or any of the cosmonauts or astronauts that followed in their footsteps.

While space travel may be fascinating in itself, the success of launching a satellite or a space probe, with great reliability and precision, has also opened up new horizons—in both the literary and scientific sense of the word—for telecommunications, meteorology, navigation, and a host of other disciplines in science. Although space science is the newest to be established, its technique, in dealing with very weak signals, readily extends itself to the oldest science, practised by the ancient Chinese and Greeks—Astronomy. It is no more science fiction that space communication and radioastronomy should go hand in hand together. Besides, many objectives, in increasing our knowledge of the Universe, are quite similar. It is indeed no wonder that space systems are almost always associated with radioastronomy, and that is precisely why a Study Group 4 was needed.

Thus, at the IXth Plenary Assembly held in Los Angeles, 1959, a decision was taken to transfer the topics on ground-wave propagation to Study Group 5 and to assign Study Group 4 to space systems. The importance which the United States Government attached to that Plenary Assembly was unprecedented. General Dwight D. Eisenhower, then President of the United States, augured its future success by a personal telegram.

The terms of reference of this Study Group in its decade of existence are well known to all. They are "to study technical questions regarding systems of telecommunications with and between locations in space and radioastronomy". Neat, concise and to the point, they illustrate the ancient proverb "A word to the wise is sufficient". All those associated with the work of this Study Group certainly had experienced something of the awe and humility of those who prepared the voyages of the old wayfarers in their covered wagons—a long trip to the unknown. This same feeling must have been experienced by all the cosmonauts and astronauts, headed by Gagarin and Glenn, but on a far more gigantic scale, for their unknown, instead of being two dimensions—for wayfarers never left the earth's surface as they trekked—is in three dimensions, or even four, if one includes the dimension of time.

Speaking of the unknown, sometimes we associate it with vision. Vision is not lacking in the CCIR either. All that is necessary is to recall General Ferrié's words in the Inaugural Meeting of the Ist Plenary Assembly of the CCIR, on radio waves penetrating into interplanetary space. The formation of CCIR Study Group 4 devoted to space communication systems was like a dream come true.

From this vision to the triumphs of the space probes in enacting a performance of "One touch of Venus" or "Promenade on the Moon" with our Universe as the stage, man's ingenuity in the conquest of the unknown—outer space—has been very spectacular indeed. While astronauts and cosmonauts always occupy prominent places in the limelight, the scientists and engineers working behind the scenes, including those in charge of telecommunications, such as contributors to the work of the CCIR, rarely made their presence felt, let alone their work acknowledged, yet without them no exploits in space would have ever been possible.

The first meeting of the newly formed Study Group 4 was held in Washington in 1962. Lyndon B. Johnson, then Vice-President of the United States inaugurated it.

Living up to its expectations, this Study Group has fared well.

Another dream dear to the heart of telespectators came true as a result of the advent of space communication. With satellites as transmitting stations or relay stations in the sky, the intercontinental television network is a reality.

Efforts made in the field of television in the CCIR are not lacking either, and they date from much earlier.

Let us once again turn back the clock 50 years. In 1929 the British Broadcasting Corporation experimented with the mechanical system due to John L. Baird for regular trial transmission from its London studio. At the same epoch Zworykin demonstrated, at a meeting of the Institute of Radio Engineers, the use for picture display of cathode-ray tubes, originally invented by C. F. Braun in 1897.

This electronic display, together with electronic scanning, is the basic principle used up to the present day.

World War II interrupted the development of television, but afterwards many of the techniques developed for radar were adapted to television. The two technologies have many features in common.

The CCIR, reanimated after about one decade of inactivity, immediately took up the challenge on studies of television. In fact, it was one of the major problems tackled. The attack is on two fronts:

— improvement of the quality of service;
— standardization.

On the problem of standardization, one must recall that a major obstacle at that time was the number of systems then existing. They were identified by the number of lines in the picture frame, i.e. the 405-, 525-, 625- and 819-line systems. A note to Recommendation 29 adopted at Stockholm states:

"*It is realized that due to certain technical factors such as different power supply frequencies and different frequency allocations to television in the various regions, world-wide standardization may be delayed for a considerable time, but in view of the rapid development expected for television in the next few years urgent attention should be given to the solution of the problem on as wide a geographical basis as possible, with a view to the early formulation of agreed standards.*"

Considering this urgency and the difficulty of reaching agreement on such standards by correspondence and provisions contained in the Radio Regulations then in force, Study Group 11 convened a meeting in Zurich in the summer of 1949, which was followed by visits to the United States, France, the Netherlands and the United Kingdom to see actual demonstrations.

Upon completion of these visits Study Group 11 met in London to discuss the results. A sub-group was formed there under the chairmanship of Dr. W. Gerber (Switzerland) to establish details for the 625-line standards. The final report of the Gerber Sub-Group is of monumental importance in the annals of television development. It laid down the major technical parameters for a 625-line television system. Although at that time only a black-and-white television system was under consideration, later the colour television standards, owing to compatibility requirements, scrupulously observed the same standards for the luminance component of the colour signal.

Another remark in the report of the late Mr. Erik Esping, then Chairman of Study Group 11, is of very great significance:

"... In the opinion of the Chairman, Study Group 11 must in the future take more interest in colour television problems than has hitherto been the case..."

From that moment on, colour television had always been on the forefront of deliberations in the CCIR.

While workers in the field of colour television always made use of the principle of addition of the three primary colours, namely red, green and blue, to obtain the colour image, the principle prevalent in colour photography, the idea of compatible colour television must be attributed as a little-known fact about a well-known person, namely Georges Valensi, the Director of the former CCIF which, after its merger with the old CCIT, became the CCITT, as it is known today.

In 1938, Valensi proposed the separate transmission of luminance and chrominance, which was a new departure at that time. But even today his system still has another original aspect: the reduction, to a single parameter, of the chrominance, or rather the chromaticity.

This proposal, simple as it seems, has much more significance than meets the eye. It embodies the idea of compatibility, i.e. a colour television signal should be able to produce a monochrome image on a monochrome receiver. Conversely, a monochrome television signal should also produce a monochrome image on a colour receiver.

Henceforth "compatibility" has been the keyword in CCIR studies on colour television systems.

As a result of a decision taken at the Study Group 11 meeting held in Brussels in April 1955 and following the example set by demonstrations held in 1949, the same Administrations, namely, those of the United States, France, the Netherlands and the United Kingdom, once again invited participants to CCIR Study Group 11, to witness colour television demonstrations in their countries in the spring of 1956. The report was appended to a document submitted to the VIIIth Plenary Assembly at Warsaw by the Chairman of Study Group 11.

To the same document was appended a letter written by the late Professor Dr. Balthasar van der Pol, then Director of the CCIR, in which he made an appeal in favour of one single world standard colour television system. The following is abstracted from that letter:

"*It was agreed that the realization in certain parts of the world, and particularly in Region 1 and in some countries outside Region 1, of a common standard for these bands was still a possibility, and studies should be made.*

"*At the request of the Chairman of Study Group 11, and with the unanimous agreement of the Group, I am writing to ask Administrations to give full consideration to this possibility before taking decisions which might compromise the adoption of such a standard in the future.*"

Ten years passed. Study Group 11 reached its conclusions on this subject at its Final Meeting held in Oslo, in the summer of 1966, preceding the XIth Plenary Assembly of the CCIR.

How one reacts to these conclusions depends very much on whether one in a pessimist or an optimist. It is often said that a good means of identification between the two categories of people is to present them with a bottle of wine: a pessimist would see it half empty, while an optimist, half full.

Similarly, an optimist praised these conclusions in that from now on the world would have no more than three major colour television systems, namely, the *NTSC*, the *PAL* and the *SECAM*, while the pessimist felt that three standards, instead of one, is a catastrophe.

George Hansen, Technical Director of the European Broadcasting Union, wrote a long article in the August 1966 issue of *EBU Technical Review*, entitled "Colour television in Europe", in which he ended with the following words:

"Evidently one might try to ascribe the blame for the Oslo failure and for the several earlier failures regarding colour television, and indeed there is plenty to be said about the mistakes and missed opportunities—a bookful—but such an apportionment of responsibility could hardly now bear any useful fruit. Every country is already trying hard enough—indeed this was much too evident in Oslo—to throw the blame for the breakdown on others. Useful fruit is not in fact to be expected, since in the last analysis the responsibility must be laid on the lack of a general will to work together in Europe. Perhaps many more failures and lessons will be necessary before that will makes itself clearly felt. Perhaps we must have still more faith, courage and patience—above all, patience.

"'I shall die with the love of Europe as much as the love of France in my heart; I should sometimes like to go down on my knees to beg her not to allow herself to be divided by fratricidal jealousies, not to forget her duty, her common task, which is civilisation.'

"Whose words are these? Perhaps those of a French statesman before the creation of the Common Market? No, they are those of Ernest Renan, in the *Revue des Deux Mondes* of November 1882!

"After the Oslo Conference, we may yet ponder over these words."

However, ingenuity on the part of engineers and scientists is not lacking. In spite of the disagreement to adopt one colour television standard for the whole world, it is still possible to interconnect the three systems of different standards by means of transcoders, with only a slight loss of quality. These are becoming increasingly important in view of the possibility of global interconnections of television systems thanks to the advent of radiocommunication by satellites. The work of the CMTT, another joint Study Group with the CCITT, is further intended to meet this demande.

Heinrich Hertz saw in the Maxwell equations the existence of electromagnetic waves. Arthur C. Clarke, a British scientist, imagined from Kepler's laws of motion the superiority of geostationary satellites. In an article he published in *Wireless World* as long ago as October 1945, he pointed out that artificial earth satellites at heights of 36 000 km above the Earth's surface would rotate with the same period as the rotation of the Earth, "and if its plane coincided with that of the Earth's equator, it would revolve with the Earth and would thus be stationary above the same spot on the planet. It would remain fixed in the sky of a whole hemisphere and, unlike all other heavenly bodies, would neither rise nor set... Let us now suppose that such a station were built in this orbit. It could be provided with receiving and transmitting equipment and could act as a repeater to relay transmissions between any two points on the hemisphere beneath, using any frequency which will penetrate the ionosphere... A single station could only provide coverage for half the globe and for a world service three would be required, though more could be readily utilized."

One peculiarity of the CCIR is that is ubiquitous, or omnipresent, whenever a new problem involving radiocommunication presents itself. While the geostationary satellite orbit, a thin line traced by satellites has only a geometric existence, yet because it is used by man-made objects for radiocommunication purposes, the CCIR would not be content to leave it untouched. Of course there are more imperative reasons, as this narrative is going to unfold itself.

The studies represent not only technical progress in the disciplines of geophysics and astrophysics which General Ferrié exalted when he said "...we could then take legitimate pride in the results of our work, which would henceforth be associated with geophysics and astrophysics", at the Inaugural Meeting of the Ist Plenary Assembly held on 18 September

1929, half a century ago, but also they illustrate a mechanism by which a CCIR study group is discharging its obligations, namely, the treatment of business in an interim working party, a group of experts constituted to deal with the particular aspects of a problem.

The geostationary satellite orbit, being unique, is limited, like any other natural resource, in its service to mankind for radiocommunication purposes. Once a geostationary satellite occupies a certain position, it will exercise an influence on neighbouring satellites, in the form of interference noise. This influence depends upon many factors, the frequency being of course the major parameter. The efficient utilization of this orbit in its relation to frequency is obviously a subject for study. As a first approximation, which is also the simplest case, let us assume that all geostationary satellites systems are identical, and that all satellites, whether they belong to the same or different systems, are also the same. This constitutes what is called a homogeneous ensemble, and one can easily see that there is a minimum spacing between neighbouring satellites beyond which the interference entering into the wanted system becomes unacceptable. Assuming this spacing to be 5°, one can see that the total number of satellites in orbit, if they are to be geostationary, cannot exceed 72.

But actually things are not so simple. In the first place, one does not know what the theoretical maximum capacity of the geostationary satellite orbit is, so that it is impossible to ascribe a percentage efficiency. Secondly, the traffic demand is not evenly distributed around the Earth, since it depends upon the population pattern and other factors too numerous to mention. Thus certain segments of the orbit will be more congested than others. Thirdly, different space services, the fixed, mobile, and broadcasting, to name a few, having widely different characteristics, enter into competition since they all make use of the geostationary satellite orbit.

It was against this background that CCIR Study Group 4, at its Interim Meeting held in 1968, set up such an Interim Working Party, devoted exclusively to the study of the efficient use of the geostationary satellite orbit. In the beginning it dealt with the fixed satellite service only, but gradually many conclusions obtained by that group were adapted to other space services.

Since then seven meetings have been held by that Interim Working Party, in Ottawa, London, Melbourne, Geneva, Munich, Washington and Tokyo. Conclusions reached therein were submitted to Study Group 4, which incorporated them in regular CCIR texts.

"To govern is to foresee", says a well-known proverb. The CCIR has foreseen the shape of things to come. Its wisdom in creating the Interim Working Party, to investigate in the minutest detail the efficient use of the geostationary satellite orbit is a major contribution in preventing that "great disorders reign under heaven", an old Chinese saying concocted at a time when the Earth was thought to be the centre of the Universe, and when the geostationary satellite orbit was something unheard and undreamed of.

Space communication and colour television have been singled out for somewhat lengthy treatment on account of their impact on modern life. Science and art join hands as the CCIR walks on both feet. There are many other achievements of the CCIR Study Groups which are less widely known but their importance is in no way less significant.

The Specialized Secretariat

Since the creation of the Specialized Secretariat of the CCIR by the Atlantic City Conference, several Directors have taken office and the permanent staff members have increased from five to the present 30. In this booklet commemorating the 50th anniversary, it is only appropriate to honour the memory of its first Director, Prof. Dr. B. van der Pol, who, incidentally, was elected unanimously.

The following is taken from the Introduction to *Selected scientific papers* of B. van der Pol, by H. B. G. Casimir, one of his close friends:

"Balthasar van der Pol was a remarkable man in many different ways. He was a prominent scientist and a brilliant lecturer but he will also be remembered as a prudent diplomat and as a wise and impartial chairman of international meetings. His skill in many fields was outstanding: he was a fluent linguist and an erudite musician with a thorough knowledge of harmony and counterpoint and a very sharp sense of absolute pitch; as a stenographer he could vie with a professional... Those who knew him more closely will gratefully recollect inspiring discussions and playful debates and cherish the memory of a charming and generous host.

. . . . .

"In his earlier papers van der Pol used mathematics as a tool but later on he became more and more interested in mathematics for its own sake. He was fascinated by Heaviside's operational calculus and the theory of Laplace transformations which are indispensable tools in circuit theory; together with Bremmer he published a substantial volume on a slightly different formulation of Heaviside's method. This book contains a wealth of analytical results and perhaps it may be said that van der Pol was on the whole more interested in elegant explicit formulae than in general theorems. In later life the theory of numbers became one of his main preoccupations.

"The impact of van der Pol's work can be stated in still another way. Although the study of electromagnetic waves was originally one of the most fundamental branches of physics, radio might have remained a field of haphazard empiricism along with wild commercial ventures, but for the influence of men like van der Pol who stressed the need for a more scientific approach. Perhaps he has occasionally overemphasized formal mathematical aspects in comparison with practical applications or physical content but there can be no doubt that, by insisting on thorough analysis, by demonstrating the power of mathematical methods and by initiating many younger colleagues into his was of thinking, he has greatly contributed to raising the whole field to a higher level, thus paving the way for future developments."

Although the CCIR is primarily a technical organization, being international, it simply cannot be devoid of politics. Those of us who have gone through the devastation of the World War cannot simply forget the tension that existed when the war ended, tension arising from what is called the "cold war." Now that the cold war has given place to detente, it would be amusing to quote a speech of the remarquable van der Pol, who, having given the best part of this life to the cause of the CCIR said at his well-deserved retirement:

"*In connection with the international aspect of the CCIR work it recently struck me that the number countries in the world, or the number of Members of the ITU, is very nearly equal to the number of existing chemical elements.*

"*It also struck me that, apart from their number, there are many other analogies between the chemical elements on the one hand and the countries on the other. For instance, there are large molecules among the elements and there are small ones, just as there are large countries and small ones.*

"*Moreover, nowadays many isotopes are known which show great resemblance to the mother element. Perhaps we could compare these isotopes with the associate Members of the ITU, which often show a great similarity with their mother country.*

"*It is also well known in chemistry that there are many elements which will not combine with others, whereas there are other elements which show a great affection for each other and then they combine through single, double or triple valency bonds. Perhaps the same is true of different countries.*

"*Moreover, in chemistry and physics it often happens that an element becomes ionized when an electron suddenly leaves it and asks for asylum with another element. We read of similar cases in the daily press.*

"*Again, some elements show great stability, whereas other elements appear less stable. History has shown that some analogy might be drawn with respect to countries.*

"*Another well-known fact is that there are both natural and artificial elements and perhaps my first home country could be compared with an artificial elements because the Netherlands are well known to have been practically reclaimed from the sea. But I cannot refrain from making another analogy with respect to my second home country, Switzerland, the seat of the Union. I am sure that our Swiss friends will not objet if I compare Switzerland, i.e. Helvetia, which could be abbreviated as* He, *to* Helium, *which is a neutral and very stable 'Edelgas'.*

"*Returning to the general analogies, there are on the one hand radioactive elements which continuously show signs of internal activity and ultimately disintegrate whereas on the other hand there are elements showing a passive tranquillity. I have been told that an analogy could also be applied in this case.*

"*Of course in chemistry there are radicals and there are also conservative elements like the inert gases, and perhaps the same is true in the other field. And we should also not forget to mention the rare earths.*

"*Further, modern research studies the nuclei of these atoms which originally were considered indivisible but which modern investigation has shown to be quite complex and composite, and we study the stability and resonance of these nuclei with respect to external excitation, but I will refrain from going into too many details here. Neither will I describe* Germanium, *nor even* Polonium, *although it would be tempting to do so. I will merely close this part of my remarks with the view that in the future we may perhaps expect another Mendeleieff to systematize this complicated material.*

"*I now return to the CCIR, from whose directorship I am retiring in a few months. I know that some people consider a retirement as a catastrophe in a man's life. Let me say at once that I do* *not in the least regard my retirement as such, because, as some of you may know, I have many personal interests which I am eager to find time to pursue. I do, however, regret having to depart from so many good friends amongst the delegates of the CCIR Plenary Assembly. I am happy and proud to say that I am on very good terms with all of you and that there are several delegate whom I have known for a very long time, and whom I may call my personal friends. I admit that it is sad to depart from them after so many years of pleasant collaboration.*

"*Now that the CCIR will soon be in the hands of my old friend Dr. Metzler, I am feeling somewhat like a father whose daughter, brought up with great care and affection, is on the verge of marrying somebody she has selected and elected herself, and on which selection I, as her father, had no influence whatsoever. Under these circumstances, I might say to my future son-in-law, Dr. Metzler, that he will certainly have her affection if he treats her gently, and from the outset recognizes and tolerates some of her peculiarities, which do look worse than they really are. I might also say that she is a nice girl, worthy of his affection and that she is clever, well brought up, if I may say so, but that on rare occasions she is a bit headstrong, and he should not forget that she is all the time strongly influenced by some 90 countries, as I have described above.*

"*I, as her father, am now giving the bride away, and I do hope that there will be large offspring of recommendations, questions, study programmes, etc.*"

Looking into the future

The CCIR, whose terms of reference read: "The duties of the International Radio Consultative Committee shall be to study technical and operational questions relating specifically to radiocommunication and to issue recommendations on them", walking on both feet, will have left behind its memories of the golden anniversary before long, and it is high time to look into the crystal ball and make some projections.

Space communication, having demonstrated its superiority in many respects, will be further developed, and at an accelerated pace. The congestion of frequency bands will force upon it the use of higher and higher frequencies, for which digital techniques are the only ones feasible. Signals must traverse the Earth's atmosphere, and rain and snow will always be with us, and ways and means must be found to overcome their influence on radio propagation. One can also predict that optical frequencies will be classified as radio frequencies and that they will be used for telecommunication purposes. The CCIR will be called upon to study their use.

As certain portions of the geostationary satellite orbit will become unduly congested, inter-satellite relays will come into use to spread the occupancy of satellites in orbit more evenly. Rain and snow being absent at 36 000 km above the Earth, very high frequencies, maybe optical, can be feasible for such relays.

The Universe becomes a stage, and the sky is no longer the limit.

The CCIR, having assisted in bringing radiocommunication to the present state, strides into the future with renewed vigour and reinforced confidence; while never abandoning the doctrine of walking on both feet, it is poised to make another great leap forward, into the unknown.

One of the unknowns in undoubtedly embodied in a question adopted in September 1976, of which the main operating part reads as follows:

> "What are the most probable characteristics of radio signals which might be broadcast by extraterrestrial civilizations and the technical characteristics and requirements of a system to search for them?"

Hitherto, the study of electromagnetic phenomena is more or less restricted to interaction of electric charges and currents whose magnitudes vary with time but whose positions are fixed relative to each other and the observer. As the systems move relative to each other or to the observer, Einstein's theory of special relativity enters into play. Thus, from now on workers in radiocommunication would also have to be well versed in physics, thus demonstrating the power of prophecy of General Ferrié made at the Inaugural Meeting of the Ist Plenary Assembly 50 years ago.

Maxwell's equation and Kepler's laws of motion, totally unrelated when first developed, bind together to make space communication possible. Van der Pol once quoted the words of the English poet, Francis Thompson, in describing the power of mathematics. They are no less true here:

"All things by immortal power
Near or far,
Hiddenly
To each other linked are
That thou canst not stir a flower
Without troubling of a star"

And Lewis Carroll, in *Alice in Wonderland:*

"'*There is no use trying,'* she said: '*one can't believe impossible things.*' '*I daresay you haven't had much practice'*, said the Queen. '*When I was your age, I always did it for half-an-hour a day. Why, sometimes I've believed as many as six impossible things before breakfast.'*"

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Back: Two photographs
with a bridge of half of a century between them

Once upon a time...

1st Plenary Assembly of the C.C.I.R.,
Ridderzaal (Hall of the Knights)
18 September 1929

... Golden Anniversary

XIVth Plenary Assembly of the C.C.I.R.
(Kyoto International Conference Hall)
7 June 1978


XIVth PLENARY ASSEMBLY
OF
THE INTERNATIONAL RADIO CONSULTATIVE COMMITTEE