International frequency regulation and planning

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At the origin of the regulation of radiocommunications was the problem of harmful interference, and the need to improve the safety of life at sea. As demand for spectrum grew, the need to use it more efficiently was a further incitation to regulation, which came to include frequency planning.

This article describes the development of the regulation and planning of the use of the radio frequency spectrum, with emphasis on those aspects of special relevance to broadcasting.

The adaptation of ITU structures to the changing requirements of this task is described, including the changes adopted in 1992, and the current moves to simplify the Radio Regulations.

1. Introduction

Since 1903, the management of the radio frequency spectrum and the regulation of its use has been a major function of the International Telecommunication Union (ITU).

In the matter of radio frequency spectrum management and regulation, no service can be considered in isolation. The process of allocating frequency bands is often a negotiation between the rival claims of different services. Thus no discussion of broadcasting is meaningful without placing it in the context of radiocommunications in general. That having been said, the emphasis in this article will be placed on broadcasting. For this reason, and because of the limited space available, no attempt is made to give a complete description of the development of the international radio regulations nor to cover other aspects of the work of the ITU. For that, readers are referred to the books by George Codding and Anthony Rutkowski [1][2].

Radio waves are propagated according to the laws of physics; they do not respect man-made frontiers. This property of radio waves was to oblige, both at the national and international levels, the early establishment of rules for operating radio services in order to avoid harmful interference. The radio frequency spectrum, which all radio services make use of, is a limited natural resource, which requires that it *"must be used rationally, efficiently and economically"* [3].

2. The early days of radio – the need for regulations

The first major use of radio, or wireless telegraphy as it was then known, was to provide a service which had been impossible with traditional electrical telegraphy, namely to provide communications with ships at sea.

Original language English
Manuscript received 16/12/1994

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Figure 1
Studio for the weekly Sunday Concerts established by the Deutsche Reichpost in the radio station Königswusterhausen in 1923.

As more and more ships became equipped with radio, problems soon arose. The lack of any kind of international regulation meant that every operator could do more or less as he pleased. Interference became an acute problem and the efficiency of communications was greatly reduced. This situation led to a first preliminary Radio Conference being called for 1903 in Berlin, only six years after Marconi created his *Wireless Telegraph and Signal Company* on 20 July 1897. It was attended by nine countries and led to the holding, in 1906, of the First International Radiotelegraph Conference at which a Radio Convention was drawn up, closely modelled on the Convention of the International Telegraph Union (St Petersburg, 1875). In addition, the Conference drew up the *Service Regulations* for radio which were annexed to the Convention, again following the model of the Telegraph Convention and its annexed Telegraph Regulations.

The Berlin Convention provided an international organization for the periodic revision of the Radio Convention and Regulations. This included Plenipotentiary Conferences to revise the Radio Convention and the Radio Regulations, and Administrative Conferences limited to the revision of the Radio Regulations. The conferences were to be composed of delegates of the governments of the contracting counties.

The Berlin Convention also provided for the settlement of disputes between contracting governments by a procedure of arbitration.

No separate bureau or secretariat was created for the new Radiotelegraph Union, administrative tasks being entrusted to the Bureau of the International Telegraph Union with the latter's consent.

Thus, the structure and organization for the international regulation of all kinds of telecommunications was set. This structure was able to adapt the Radio Regulations progressively, to take account of rapid growth in the use of radio and also to allow the development of new services such as broadcasting.

The special characteristics of radio required the Radio Regulations to enter into much more detail than the Telegraph Regulations. For two stations to communicate, they had to use the same frequency. And if other stations used that frequency, harmful interference could occur. Thus frequencies for communication had to be defined; rules for operating radio stations had to be adopted together with standards for the equipment to be used.

The 1906 Berlin Radio Regulations laid down frequencies (the related term of wave-length was used at that time) for public correspondence in the maritime services (1000 and 500 kHz), long-

distance communication by coast stations (188 kHz), and for military and naval stations (188 to 500 kHz). Right from the beginning the Radio Regulations recognized the importance of radio to the safety of life at sea and the distinctive distress signal • • • – – – • • • (SOS) was adopted.

The Radio Regulations were revised at London in 1912 but we shall jump ahead to the beginnings of broadcasting in the 1920s.

3. Broadcasting – a new demand for spectrum

Already by 1925 there were over 500 broadcasting stations in operation in the United States and almost every European country had a regular broadcasting service. But the existing Radio Regulations were not adequate to cope with the demands of the new service. Interference became widespread and, in Europe, the BBC invited all European broadcasting interests to meet in London in March 1925 to discuss the situation. This conference was followed by another on 3 and 4 April in Geneva at which the *Union internationale de radiophonie*, later to become the *International Broadcasting Union (UIR)*, was created with a view to bringing about a voluntary redistribution of frequencies among the European broadcasting stations [4].

However, at this time no frequency bands had yet been allocated to broadcasting by a conference of the International Radiotelegraphic Union so any redistribution made by the UIR was provisional, especially since some of the frequencies to be used were already allocated to the maritime service. A real solution to this problem could only be reached by an International Radio Conference able to regulate all radio services.

Another discovery in the 1920s which was to have important repercussions for broadcasting was the long-distance propagation of short-waves.

4. Washington D.C., 1927 – the first broadcasting allocations

The first post-World War I conference of the International Radiotelegraph Union was held in Washington D.C. in 1927, fifteen years after the previous conference. The increased number of uses to which radio had been applied since the London conference obliged the Washington Conference to widen the scope of the Convention to include *"all radio-communication stations established or operated by the contracting governments, and open to the international service of public correspondence."* The Convention was also made to include a large number of services not open to public correspondence. Finally, measures were taken to reinforce the observance of the Convention by adding the following paragraph to Article 2:

They undertake, in addition, to adopt or propose to their respective legislatures the

Table 1
Selected ITU Radio Conferences 1903–1929.

No.	Year	Dates	Place	Title	Number of participating countries	Results
	1903	04 Aug – 13 Aug	Berlin*	Preliminary Conference on Wireless Telegraphy	9	Study of international regulations for wireless telegraphy with a view to the Berlin Conference, 1906
1	1906	03 Oct – 03 Nov	Berlin	International Radiotelegraph Conference (Plenipotentiary)	30	Signature of the International Radiotelegraph Convention, the Final Protocol and the Service Regulations
2	1912	04 Jun – 05 Jul	London	International Radiotelegraph Conference (Plenipotentiary)	45	Revision of the International Radiotelegraph Convention, the Final Protocol and the Service Regulations
	1920	08 Oct – 15 Dec	Washington*	World Electrical Communications Conference	5	Preparation of the Washington Radiotelegraph Plenipotentiary Conference. This meeting involved representatives from only France, Italy, Japan, the United Kingdom and the United States
3	1927	04 Oct – 25 Nov	Washington	International Radiotelegraph Conference (Plenipotentiary)	80	Revision of the International Radiotelegraph Convention, the Final Protocol and the Service Regulations. Establishment of the first international frequency allocation table, creation of the CCIR
4	1929	04 Apr – 13 Apr	Prague	European Radiotelegraph Conference	27	Prague Plan for Broadcasting in Europe

** Strictly speaking, these were not official ITU Conferences, but intergovernmental or regional preparatory conferences.*

measures necessary to impose the observance of the provisions of the present Convention and the Regulations annexed thereto upon individual persons and private enterprises authorized to establish and operate radiocommunication stations for international service, whether or not the stations are open to public correspondence.

Washington marked a turning point in the technical provisions of the Radio Regulations. During previous conferences, the main emphasis had been on the regulation of radio traffic and on the minimum standards that allowed an efficient international system of communications. Now it became necessary to restrict the use of some of the older types of emitters, the spark sets, and to divide up more thoroughly the radio spectrum among the ever-increasing number of services using it.

The allocation of frequencies throughout the radio spectrum as then used and generally understood, from 10 to 60 000 kHz, was a major achievement of the Washington Conference. The Allocation Table included the first allocations formally agreed for broadcasting. The many conflicting claims – based on both priority of use and operational efficiency, the need to find space for the new services such as broadcasting, aeronautical communications and long-range point-to-point, often to the detriment of older services – all helped to complicate the task. Yet although the allocation table had been completed, it was still not possible to make adherence to it obligatory.

Nevertheless, in case of disagreement between Administrations regarding the interpretation or execution of the Convention or Regulations, the Washington Conference made obligatory the recourse to arbitration.

The Washington Conference made another innovation. It set up an International Technical Consultative Committee for Radioelectric Communications (CCIR) *"with the task of studying technical and related questions which concern international radiocommunications and which are submitted to it by the participating Administrations or private enterprises."* The conclusions of these studies were often used at the following radio conference, thus eliminating part of the burden of exhaustive technical studies that had been necessary during conference time [5].

Finally, the Washington Conference adopted a resolution calling on the contracting governments to examine the possibility of combining the Radiotelegraph Convention and the Telegraph Convention. The place and date of the next Radiotelegraph Conference was fixed for Madrid 1932, the same time and place as had already been chosen for the next Telegraph Conference.

5. Madrid, 1932

This article on the history of the regulatory aspects of broadcasting is not the place to enter into detail about the deliberations of the two parallel Conferences which resulted in the fusion of the Telegraph and Radiotelegraph Conventions and the creation of the International Telecommunication Union. Suffice it to say that the articles of Chapter IV of the 1932 Madrid Convention were, with very few exceptions, identical to the corresponding articles of the 1927 Radiotelegraph Convention. One major exception was Article 35 dealing with interference; its provisions were altered and expanded with a view to providing greater protection from interference for all existing services. In its new form it read:

1. *All stations, regardless of their purpose, must, so far as possible, be established and operated in such a manner as not to interfere with the radio services or communications of either the other contracting governments, or the private operating agencies recognized by these contracting governments and of other duly authorized operating agencies which carry on radiocommunication service.*

2. *Each contracting government which does not operate the radio facilities itself undertakes to require the private operating agencies recognized by it and the other operating agencies duly authorized for this purpose, to observe the provisions of paragraph 1 above.*

In the years leading up to 1932, broadcasting had become a world-wide activity of the greatest social importance. A number of countries requested the Madrid Conference to allocate additional spectrum to broadcasting in the MF band and this was backed up by a comprehensive plan prepared by the International Broadcasting Union. Requests were also made for additional spectrum for the aeronautical service, also in the MF band. Matters were further complicated by the existence of radio stations not conforming to the frequency allocation table. One reason for this was that the Soviet Union had not been invited to the Washington Conference and was bound only by the Radio Regulations of 1912. Consequently the USSR had no obligation, not even a moral one, to be bound by the Washington allocation table of 1927. Not surprisingly, interference occurred frequently. The episode illustrates clearly that in matters of radio frequency spectrum planning it is

better to leave politics at home and try to ensure that all countries are involved in the negotiations and subsequent agreement.

The difficulty was finally overcome by planning the European use of the MF and LF bands independently from the "other regions". This could be done because of the limited propagation of LF and MF waves as compared with higher frequencies. Secondly, it was decided that a European Conference on broadcasting should be held before the entry into force of the Madrid General Radio Regulations so that the available frequencies could be assigned with greater efficiency.

Other important decisions taken at Madrid were:

- to drop the clause describing the frequency allocation table as a "guide"; henceforth administrations *"undertake to assign frequencies ... in conformity with the table of distribution of frequencies"* [6];
- in order to increase technical efficiency, tables of frequency tolerances and acceptable bandwidths were drawn up for the first time;
- to lay down new rules for the registration of frequencies; in future, any country deciding to put a radio station into operation was obliged to notify the International Bureau in Bern *"before the frequency is put into service and sufficiently in advance thereof to allow administrations to take any action which they may deem necessary to insure the efficient operation of their services."*

6. The European Broadcasting Conference, 1933

An immediate consequence of the Madrid Conference was the holding of the European Broadcasting Conference at Lucerne in 1933. After two months work, the Lucerne Conference drew up and signed a European Broadcasting Convention with an annexed frequency assignment plan for all the broadcasting stations in the European area. Although the plan was a great achievement, eight of the 35 participating countries refused to sign the final documents and 19 of those that did made reservations.

7. First Inter-American Radio Conference

Another regional conference took place in La Havana in 1937 at the invitation of the Cuban government. The 16 American countries which were represented there drew up:

Table 2
Selected ITU Radio Conferences 1932–1946.

No.	Year	Dates	Place	Title	Number of participating countries	Results
5	1932	03 Sep – 09 Dec	Madrid	International Radiotelegraph Conference	68	The Telegraph Convention and the Radiotelegraph Convention were merged to form an International Telecommunication Convention with the Telegraph Regulations, the Telephone Regulations and the Radio Regulations as annexes. The International Telegraph Union became the International Telecommunication Union
6	1933	15 May – 19 Jun	Lucerne	European Radio Conference	35	Signature of the European Broadcasting Convention, adoption of the Lucerne Plan
	1934	March and August	Buenos Aires* and Rio de Janeiro*	South American Broadcasting Conference	8	Establishment of a Regional Broadcasting Union
	1937	01 Nov – 13 Dec	Havana*	Inter-American Radio Conference	16	Signature: Inter-American Radiocommunication Convention – Inter-American Radiocommunication Arrangement – North America Regional Broadcasting Convention
7	1938	01 Feb – 08 Apr	Cairo	International Radiocommunications Conference	70	Revision of the Service Regulations and the Table of Frequency Allocations
	1938	24 Nov – 08 Dec	Guatemala City*	Central American Broadcasting Conference	7	Signature of a Broadcasting Agreement
8	1939	01 Mar – 15 Apr	Montreux	European Broadcasting Conference	36	Signature of the European Broadcasting Convention and the Montreux Plan
	1946	04 Feb – 25 Feb	Washington*	North American Regional Broadcasting Conference	7	Signature of an interim Agreement extending the application of the North America Regional Broadcasting Agreement (1937)

** Strictly speaking, these were not official ITU Conferences, but intergovernmental or regional preparatory conferences.*

- the Inter-American Agreement on Radiocommunications which provided for the allocation of frequencies by services, in three different zones of the Americas;
- the North-American Regional Broadcasting Agreement which assigned frequencies in the medium-wave band among the stations of Canada, Cuba, Dominican Republic, Haiti, Mexico and the United States.

The Havana Conference also recommended to the ITU that the frequency allocation table should be extended to 300 MHz.

8. Cairo, 1938

The first Administrative Radio Conference of the new International Telecommunication Union was held at Cairo in 1938. It extended the frequency allocation table up to 200 MHz. From the point of view of broadcasting, the main developments were the allocation of three bands for tropical broadcasting (2300-2500 kHz, 3300-3500 kHz and 4770-4965 kHz). An extra 500 kHz of spectrum was allocated to broadcasting in the HF bands and various allocations were made for European television between 40.5 and 200 MHz.

The Cairo Radio Conference extended the practice of making different uses of certain frequency bands according to region. The 7200-7300 kHz band was retained for amateur service in the Americas whilst being allocated to high frequency broadcasting in the European region. A similar practice was adopted for the frequencies above 30 MHz where, at the request of the European countries, allocations between 30 and 200 MHz were made to various services for use in the European region, whereas no allocations were made for the other regions. The Cairo Conference also insisted on higher technical standards for transmitters through improved frequency tolerance and bandwidth tables.

9. 1939-1945

In 1939 the European countries revised the European Broadcasting Convention and Broadcasting Plan but the outbreak of World War II prevented the application of the Montreux Plan. It was also to result in the indefinite postponement of the radio conference which had been scheduled for Rome in 1942.

The Bureau of the ITU, being at that time largely composed of Swiss personnel, being situated on neutral Swiss territory and being under the supervision of the Swiss government, could continue to function to a limited degree, notably collecting and publishing information and registering frequencies in the International Frequency List. Thus the Bureau was able to avoid the total eclipse of the ITU and to provide a basis for renewing its activities after the war.

The war was to result in a phenomenal development of radio techniques and applications which were to put even greater pressure on the limited radio-frequency spectrum. Two services in particular, the aeronautical and the high-frequency broadcasting services, had greatly expanded their activities to the extent that there was neither room in the allocated bands for their proper functioning nor for their planned future expansion. Furthermore, by the end of the war there was extensive use of the spectrum up to 10 000 MHz and partial use as high as 30 000 MHz. But the Cairo table had only made allocations up to 200 MHz. It was clear that the Allocation Table had to be greatly extended in order to provide for the efficient and equitable use of the higher reaches of the radio spectrum.

A further problem occurred within service bands where the ever-growing number of stations was causing frequent congestion and making it increasingly difficult for administrations to find frequency space for the operation of new stations.

After the war it was urgent to respond to this situation and, following a preliminary meeting of the "Big Five" victorious powers in Moscow in summer 1946, the United States issued an invitation through the Bern Bureau, to all members of the ITU, to attend at Atlantic City in 1947 three conferences: A Plenipotentiary Conference, an Administrative Radio Conference and an Administrative High-Frequency Broadcasting Conference. Here we shall only cover those aspects of the conferences which affected radio and more specifically broadcasting.

10. Atlantic City 1947

10.1. Creation of the IFRB

It had been realised from the early days of radio that complete information about all uses of radio frequencies would be of the greatest value, and since 1928 the Bureau of the Union in Bern had been entrusted with drawing up and keeping a Master Frequency List based on notifications made by member countries. By 1947 some 45 000 notifications of frequencies below 20 MHz had been made.

However, as a result of the tremendous growth in the use of radiocommunications for military purposes during World War II, an enormous number of stations were operating on frequencies that had never been notified to the Bureau.

In view of the resulting chaos in the use of the spectrum, and the technical progress that had been made since the preceding Radio Conference in Cairo in 1938, particularly concerning HF propagation, it was recognized that an agreed machinery for the international coordination, control or mediation of the use of radio frequencies had become essential. By the time the Atlantic City Radio Conference closed, an *International Frequency Registration Board* (IFRB) had been created and rules established for its operation. The IFRB represented a new type of administrative body for the ITU in that its functions introduced an entirely new concept into the regulation of radio.

Although the Bureau of the Union had been compiling a Master Frequency List since 1928, this work was limited to recording the frequency, the characteristics of the emission and the date of registration. The Bureau had no discretionary powers and if a frequency notified was already in use, the Bureau had no power to bring this fact to the attention of the administrations concerned nor could it suggest an alternative registration.

The Working Group at Atlantic City charged with the task of drafting the mandate of the IFRB soon

Table 3
Selected ITU Radio Conferences 1947–1959.

No.	Year	Dates	Place	Title	Number of participating countries	Results
9	1947	16 May – 02 Oct	Atlantic City	International Radio Conference	78	Signature of new Radio Regulations. Creation of the International Frequency Registration Board (IFRB)
10	1947	15 Aug – 02 Oct	Atlantic City	International HF Broadcasting Conference	68	Selection of the technical principles for establishing an HF Broadcasting Plan by the Mexico City Conference, 1948/1949
11	1948	25 Jun – 15 Sep	Copenhagen	European Broadcasting Conference	32	Signature of the European Broadcasting Convention and the Broadcasting Plan (medium- and low-frequencies), known as the Copenhagen Plan
12	1948 /49	22 Oct – 10 Apr	Mexico	International HF Broadcasting Conference	69	Signature of the Mexico City Plan and Agreement by only 50 of the participating countries
13	1949	14 Apr – 09 Jul	Washington	International Radiocommunication Conference for Region 2	23	Establishment of a frequency allocation table
	1949	14 Apr – 09 Jul	Washington*	Inter-American Radio Conference	19	Signature of the Inter-American Radiocommunication Agreement
14	1949	18 May – 17 Sep	Geneva	Administrative Radio Conference for Region 1	36	Signature of a frequency assignment plan for Region 1
15	1949	18 May – 04 Nov	Geneva	Administrative Radio Conference for Region 3	15	Publication of a frequency assignment plan for Region 3
16	1949	12 Sep – 08 Dec	Montreal	North American Regional Broadcasting Conference (NARBA)	5	Preparation of a new regional broadcasting agreement for North America
17	1950	01 Apr – 19 Aug	Florence-Rapallo	2nd International HF Broadcasting Conference	56	Failed to prepare an acceptable world HF broadcasting plan
18	1950	06 Sep – 15 Nov	Washington	North American Regional Broadcasting Conference (NARBA)	5	Signature of the North America Regional Broadcasting Agreement
19	1951	16 Aug – 03 Dec	Geneva	Extraordinary Administrative Radio Conference (EARC)	76	Adoption of the new International Frequency List, acceptance of plans for the three world Regions
20	1952	28 May – 30 Jun	Stockholm	European VHF Broadcasting Conference	31	Signature of the Regional Agreement and establishment of frequency allocation plans for sound and television broadcasting between 41 and 216 MHz
21	1959	17 Aug – 21 Dec	Geneva	Administrative Radio Conference	87	General revision of the Radio Regulations

** Strictly speaking, this was not an official ITU Conference, but an intergovernmental conference.*

realised that they were faced with a fundamental difficulty: how to give the Board fuller powers than the Bern Bureau had enjoyed, yet not unduly infringe the rights of any country to use the frequencies it deemed appropriate. The chairman of the Group considered the role of the Board as *"that of witness and nothing more"*. Yet it was obvious that the Board would have the duty of trying to avoid interference between the radio services of one country and another. The Board would also have to try to secure a more efficient and orderly use of the spectrum.

It was decided that the Master List of Frequencies should in future have two date columns: one entitled "Notification", the other "Registration". The first was merely to show the date of receipt of the notice of a new station using a particular frequency for a specific purpose. The second was to give a frequency assignment *"the right to international protection from harmful interference"* [7] if it complied with the relevant requirements of the Radio Regulations. This second duty, registration, gave the Board tasks of a judicial nature and made it necessary that its status and impartiality should be such as to command the willing respect of all administrations.

Ultimately it was agreed that a Board of 11 technical radio experts, nominated by their country, all of whom were to be nationals of different countries, should be elected by the Radio Conference. The members of the Board were to be chosen on the basis of equitable geographical distribution. In the Convention signed at Atlantic City in 1947, a provision was included that they should be thoroughly qualified and *"shall serve, not as representatives of their respective countries, or of a region, but as custodians of an international public trust"* [8]. They were also required to be familiar with geographic, economic and demographic conditions within the area from which they came. Such a Board, with relatively minor changes, continued to function from 1948 until March 1994 when important changes, made by the Additional Plenipotentiary Conference, Geneva 1992, entered into force.

Although the original intention had been that the IFRB would begin its functions at the same time as the Convention and the Radio Regulations were to enter into force, it soon became apparent that the Board could not function properly unless it could begin the registration of frequencies on the basis of a revised frequency list. This monumental task was undertaken by a large group of experts from the administrations, together with members of the IFRB, which was designated the Provisional Frequency Board.

10.2. The Frequency Allocation Table – new broadcasting allocations

In preparing the new frequency allocation table the greatest difficulties occurred in the band 2850 – 30 000 kHz. It was here that both the aeronautical and the high-frequency broadcasting services wished to expand. Also, the frequencies in this band had, in general, world-wide propagation characteristics. In this entire band high-frequency broadcasting gained some 35% as compared with its allocations under the Cairo Regulations. The other big winner was the aeronautical services. The losers were the fixed and amateur services.

In the lowest frequency band, from 10 kHz to 2850 kHz, allocations were made for a long-range radionavigation system, Loran, which had been established during the war. A proposal by the United States for an experimental band at 200-280 kHz was rejected since this band was already occupied by broadcasting services.

The Atlantic City Radio Conference found it necessary to make allocations up to 10 500 MHz. The Cairo Conference, it will be recalled, made allocations only up to 200 MHz. Television and FM broadcasting services received fairly generous allocations in this band. Radionavigation aids such as radar were given generous allocations. Amateur services, which had lost frequencies in the lower world-wide band, received small bands of frequencies throughout this band.

10.3. HF Broadcasting

The third Conference to be held in Atlantic City during 1947 was the International High-Frequency Broadcasting Conference. It was to be the beginning of a long story which was to terminate in failure in Rapallo on 19 August 1950. After the Atlantic City Conference ended in late September 1947, a Technical Planning Committee met in Geneva from March to June 1948 to prepare for the second International High-Frequency Broadcasting Conference in Mexico City. The Mexico City Conference lasted for six months from October 1948 to April 1949 without agreement between the major powers.

The Technical Planning Committee met again from June to December 1949 in Paris, and the third High-Frequency Broadcasting Conference met for nearly five months from April to August 1950 in

Florence and then Rapallo. After a total of almost 24 months of work, the third conference closed without succeeding in drawing up an assignment plan of any kind [9].

11. Post-War Regional Broadcasting Agreements

Meanwhile, a European Broadcasting Conference had been held in Copenhagen in 1948 to formulate a new regional broadcasting agreement and a new frequency allocation plan. This had been considered necessary, since the European Radio Convention of Montreux, 1939 had not been ratified and the Frequency Allocation Plan annexed thereto had not been applied as a result of World War II.

Thirty-two countries met in Copenhagen from 25 June until 15 September 1948, producing a Convention and Allocation Plan which was signed by 25 of the 32 delegations.

The delegations of five North American countries met from October to December 1949 in Montreal, and from September to November 1950 in Washington D.C., and drew up a new *North American Regional Broadcasting Agreement*, signed on 15 November 1950 by delegates representing the Bahama Islands and Jamaica, Canada, Cuba, the Dominican Republic, and the United States of America. The purpose of the agreement was

> *to establish fair and equitable principles governing, and to regulate, the common use of the broadcasting band in the North American Region so that each country within the region may make the most effective technical use thereof with the minimum of interference between broadcasting stations [10].*

12. The struggle to implement the new frequency planning methods

The 12-year period immediately after Atlantic City was marked by more conferences and meetings than had been seen in the ITU's 82 previous years of existence. Much of this activity involved the struggle to implement the new frequency planning arrangements introduced at Atlantic City. These new arrangements rested on the establishment of a new "planned" International Frequency List to be based on request lists submitted by all ITU members. These efforts were far from being successful because the submitted requirements greatly exceeded the available spectrum. In addition, the USSR and its allies opposed the entire approach as being a curtailment of their sovereignty.

All these problems led to the holding of an Extraordinary Administrative Radio Conference in Geneva in 1951. International tensions were high. The Korean War was in progress and the East-West Cold War had begun. Originally scheduled to last three weeks, the conference finally closed in December 1951 after four months of often acrimonious debate.

Nevertheless, the conference accepted the results obtained during the previous four years and it

Table 4
Selected ITU Radio Conferences 1960–1974.

No.	Year	Dates	Place	Title	Number of participating countries	Results
22	1960	25 Apr – 14 May	Geneva	Special (European) Regional Conference	23	Signature of the Agreement for common use by European countries of the frequency bands from 68 to 73 MHz and 76 to 87.5 MHz by the fixed and mobile services on the one hand and the broadcasting service on the other
23	1961	26 May – 22 Jun	Stockholm	European VHF/UHF Broadcasting Conference	38	Signature of the Regional Agreement and establishment of the Stockholm Plan for broadcasting in Europe (FM and television)
24	1963	29 Apr – 23 May	Geneva	African VHF/UHF Broadcasting Conference	35	Signature of the Regional Agreement and establishment of the Africa Plan (FM, television)
25	1964	12 Oct – 19 Oct	Geneva	African LF/MF Broadcasting Conference (1st Session)	52	Project for a Regional Agreement. Postponement of the Conference until 1966
26	1966	19 Sep – 08 Oct	Geneva	African LF/MF Broadcasting Conference (2nd Session)	67	Signature of the Regional Agreement and adoption of the LF/MF Broadcasting Plan for Africa
27	1974	07 Oct – 25 Oct	Geneva	Regional Administrative Conference (Regions 1 and 3) for drawing up frequency assignment plans for LF and MF broadcasting (1st session)	90	Preparation of draft frequency assignment plans and a technical report for the 2nd session

No.	Year	Dates	Place	Title	Number of participating countries	Results
28	1975	06 Oct – 22 Nov	Geneva	Regional Administrative Conference (Regions 1 and 3) for drawing up frequency assignment plans for LF and MF broadcasting (2nd session)	103	Signature of an Agreement and a frequency assignment plan
29	1977	10 Jan – 13 Feb	Geneva	World Administrative Radio Conference for the Planning of the Broadcasting-Satellite Service in Frequency Bands 11.7–12.2 GHz (Regions 2 and 3) and 11.7–12.5 GHz (Region 1)	113	Partial revision of the Radio Regulations and establishment of a Broadcasting-Satellite Plan for Regions 1 and 3
30	1979	24 Sep – 06 Dec	Geneva	World Administrative Radio Conference	150	General revision of the Radio Regulations
31	1980	10 Mar – 28 Mar	Buenos Aires	Regional Administrative MF Broadcasting Conference (Region 2), (1st session)	28	Choice of technical standards for the establishment of an MF broadcasting plan for Region 2
32	1981	09 Nov – 18 Dec	Rio de Janeiro	Regional Administrative MF Broadcasting Conference (Region 2) (2nd session)	28	Partial revision of the Radio Regulations and signature of the Regional Agreement and Plan for Region 2
33	1982	23 Aug – 17 Sep	Geneva	Regional Administrative Conference for FM Sound Broadcasting in the VHF band (Region 1 and certain countries concerned in Region 3) (1st session)	68	Preparation of a technical report for the establishment of a frequency assignment plan at the 2nd session
34	1983	13 Jun – 17 Jul	Geneva	Regional Administrative Conference for the Planning of the Broadcasting-Satellite Service in Region 2	25	Preparation of a plan (12.2 – 12.7 GHz) for the broadcasting-satellite service in Region 2
35	1984	10 Jan – 10 Feb	Geneva	World Administrative Radio Conference for the planning of HF Bands allocated to the broadcasting service (1st session)	115	Determined the technical criteria to be used for planning the HF bands allocated to the broadcasting service
36	1984	29 Oct – 07 Dec	Geneva	Regional Administrative Conference for FM Sound Broadcasting in the VHF band (Region 1 and certain countries concerned in Region 3) (2nd session)	77	Signature of a regional agreement (the Geneva Agreement, to which is annexed a plan for sound broadcasting in the band 87.5–108 MHz for over 53 000 FM stations
37	1985	12 Aug – 13 Aug	Geneva	Regional Administrative Radio Conference for the African broadcasting area	24	Revision of the Geneva 1963 Regional Agreement by way of an Amendment Protocol
38	1985	12 Aug – 13 Aug	Geneva	Regional Administrative Radio Conference for the European broadcasting area	35	Revision of the Stockholm 1961 Regional Agreement by way of an Amendment Protocol
39	1986	14 Apr – 02 May	Geneva	Regional Administrative Planning Conference for the broadcasting service in the band 1605–1705 kHz in Region 2 (1st session) – BC-R2(1)	20	Choice of the technical criteria for planning the band
40	1986	22 Sep – 10 Oct	Nairobi	Regional Administrative Radio Conference for the planning of VHF/UHF television broadcasting in the African broadcasting area and neighbouring countries (1st session) – AFBC(1)	49	Determined the technical bases to be used by the 2nd session, for establishing the frequency assignment plans for television broadcasting

Table 5: Selected ITU Radio Conferences, 1975–1986.

instructed the IFRB to develop draft plans for the high-frequency broadcasting and tropical broadcasting services amongst others.

Thus by the end of 1951, the concept of developing allotment plans had been retained [11], but the hoped-for new international frequency list consisted only of fragments. In most bands use continued on an unplanned basis.

High-frequency broadcasting remained a very contentious issue to the extent that, at the Geneva World Administrative Radio Conference in 1959 (WARC-59), the arrangements adopted for this service involved little more than requiring nations to try to coordinate broadcasting schedules amongst themselves, with the administrative assistance of the ITU. WARC-59 also took account of the advance in radio technology by extending the Table of Frequency Allocations from the Atlantic City upper limit of 10.5 GHz to 40 GHz and by defining the new satellite radiocommunication service.

During the decade from 1960 to 1969, ITU regulatory activities in the field of broadcasting were mainly confined to Africa. The African VHF/FM Broadcasting Conference met in Geneva in 1963 and produced a frequency plan for FM broadcasting stations in the African region. The following year a similar conference established the planning principles and technical criteria for medium frequency AM broadcasting in the region between 525 and 1605 kHz. Adoption of the actual plan was deferred to a second session held in autumn 1966.

In the 1970s, five Administrative Radio Conferences were held of which three were devoted to broadcasting. In 1974 the Administrative Radio Conference for the broadcasting service in the Medium Frequency Bands in Regions 1 and 3 and in the Low Frequency Bands in Region 1[1] met in a first session to adopt the planning principles to be used for these bands. The second session, which took place in autumn of the following year, drafted and adopted the new plan, based on 9 kHz channel spacing, which replaced a host of old regional agreements. The only controversial issue was the reduction in the number of low frequency broadcasting channels available to some European countries because of potential interference with some African allotments.

The Frequency Allocation Table was again extended in 1971 by the World Administrative Radio Conference for Space Telecommunications (WARC-ST). The new allocations extended from 40 GHz to 275 GHz.

An important tendency during the 1970s was to have more and more of the preparatory and technical work of conferences done by the CCIR and the IFRB. This would permit a considerable reduction in the duration of conferences with consequent cost savings.

13. Broadcasting from satellites

Although satellite broadcasting is outside the scope of this article, mention should be made of the first plan for satellite broadcasting which was drawn up by the World Administrative Conference for the planning of the Broadcasting Satellite Service (WARC-BS 77). This plan covered only Regions 1 and 3 although the conference established previsions governing the service in Region 2 pending establishment of a plan.

An interesting aspect of WARC-BS 77 was that it involved regulation and planning of a service *before* its practical exploitation began. From the purely technical point of view this was a mixed blessing. Whilst it gave operators and administrations a well-defined framework in which to plan their future services, by the time the satellites were launched and put into service technical advances had made some aspects of the plan obsolete (notably the 9° spacing of the satellites on the geostationary satellite orbit) resulting in a less than optimum use of the orbit.

There were two reasons for this haste to plan the Broadcasting Satellite Service. One was the fear of many less developed countries that, by the time they were ready to start such a service, the orbital slots they would need would be already occupied. The other reason was the desire of many countries, for reasons of national sovereignty and cultural impact, to avoid being the unwilling target of satellite broadcasting from other countries.

Many countries therefore saw the adoption of a satellite broadcasting plan as a means both of obtaining their fair share of the spectrum and orbit resources and of excluding unwanted broadcasts. Later events would show that this latter goal would often not be attained.

1. The three ITU Regions were first defined in the Atlantic City Radio Regulations (1947), Art. 5. To summarize the highly detailed definitions, **Region 1** is Europe, Africa and the Community of Independent States; **Region 2** is the Americas; **Region 3** is Asia (except for that part included in Region 1) and Australasia.

14. WARC-79

The big event of the decade came in autumn 1979 when a World Administrative Radio Conference was convened in Geneva for ten weeks to make a general revision of the Radio Regulations.

WARC-79 extended the Frequency Allocation Table from 275 GHz to 400 GHz, it revised many technical and operating standards for radio and modified the allocations in various bands to reflect the increased use of satellite communications. At the same time many footnotes were introduced into the Table to reflect different specific uses made by particular countries. The net result was to decrease the global standardization of spectrum use and complicate the application of the regulations.

Also in evidence at WARC-79 was the increasing tendency of developing countries to make maximum use of planning mechanisms for reserving radio resource rights.

15. The 1980s – decision to change to SSB working for HF broadcasting

In 1980 and 1981 were held two sessions of the Regional Administrative Medium Frequency Broadcasting Conference for Region 2. The first session was held in Buenos Aires to establish the technical criteria and the planning principles. The second session took place in Rio de Janeiro to adjust the draft plan prepared by the IFRB between the two sessions and to formally adopt the plan which replaced the North American Regional Broadcasting Agreement of 1950. A basic question was whether to adopt the 9 kHz channel spacing already accepted for the rest of the world, or to remain with the existing 10 kHz spacing in the Americas. It opted for the latter.

Two sessions of a World Administrative High-Frequency Broadcasting Conference were held in 1984 and 1987. The second session had two main objectives:

Table 6
Selected ITU Radio Conferences 1987–1993.

No.	Year	Dates	Place	Title	Number of participating countries	Results
41	1987	02 Feb – 06 Mar	Geneva	World Administrative Radio Conference for the planning of the HF bands allocated to the broadcasting service (2nd session) – HFBC(2)	116	Establishment of procedures for preparing and implementing seasonal broadcasting plans; technical standards and procedures for future single-sideband operation; revision of the Radio Regulations relating to the use of HF bands allocated exclusively to broadcasting
42	1988	29 Feb – 19 Mar	Rio de Janeiro	Regional Administrative Radio Conference to establish a plan for the broadcasting service in the band 1605–1705 kHz in Region 2 – BC-R2(2)	22	Frequency allotment plan, regulatory procedures, and technical standards for the use of the band 1605 – 1705 kHz by the broadcasting service in Region 2; regulatoryprocedures governing the use of the band 1625 – 1705 kHz by other services in Region 2
43	1989	13 Nov – 08 Dec	Geneva	Regional Administrative Conference for the planning of VHF/UHF television broadcasting in the African Broadcasting Area and neighbouring countries (2nd session – AFBC(2))	49	Completion of the revision of the 1963 Plan, notably in relation to television broadcasting Assignment Plan for television stations between 862 MHz and 960 MHz following the procedures set out in Article 12 of the Radio Regulations
44	1989	04 Dec – 05 Dec	Geneva	Regional Administrative Conference of the Members of the Union in the African Broadcasting Area to abrogate the Regional Agreement for the African Broadcasting Area (Geneva, 1963)	93	Abrogation of those parts of the 1963 Agreement relating to television which were still in force. The 1989 Plan will replace the1963 Plan with regard to television
45	1992	03 Feb – 03 Mar	Malaga-Torremolinos	World Administrative Radio Conference (WARC–92)	127	Partial revision of the frequency allocation table. New spectrum allocations for BSS (sound and HDTV), HF broadcasting and other services
46	1993	15 Nov – 19 Nov	Helsinki	World Radiocommunication Conference		First WRC following the reorganization of ITU. Established agenda for WRC-95 and WRC-97

a) to consider one or more trial seasonal plans developed on the basis of the technical criteria and planning principles adopted by the first session in 1984;

b) to adopt the procedures for the preparation and implementation of seasonal plans based on the requirements submitted by administrations.

However, the analysis of the trial plans showed that the HFBC planning system was not able to include all the 18 000 requirements submitted by the administrations. In addition, the high occurrence of frequency discontinuity within the time frame of a broadcasting service was unacceptable to the majority of delegations.

It emerged that, to ensure adequate frequency continuity and to enable the implementation of all the requirements, the HFBC planning system had to be modified and tested before it could be used in combination with a consultation procedure. The conference thus decided that the ITU, together with a group of experts from administrations (Rec. 509), should carry out modifications and tests in accordance with a programme of action, which it defined in its Resolutions 511 and 515, and that WARC-92 should examine the results.

However, it turned out that the IFRB and the administrations had great difficulty in implementing *"the improved HFBC planning system adopted by HFBC-87"*. So when WARC-92 came to consider the question, it resolved in effect that the status quo, as defined in Resolution 512, should be applied until the planning process had been completed and that a WARC should be convened as soon as possible to do this (Res. 523).

HFBC-87 also recommended an extension of the frequency spectrum allocated to HF broadcasting by a future radio conference (Rec. 511) and set in motion a major change in the future of this service by programming the generalized changeover from double side-band to single side-band emissions (Res. 517).

16. WARC-92

The World Administrative Radio Conference held in Malaga-Torremolinos (Spain) from 3 February to 3 March 1992 was the first major frequency allocation conference to be held since WARC-79. HFBC-84 and HFBC-87 and other conferences devoted to particular services were limited to planning and regulating the use of frequency bands already allocated to their respective services.

The essential problems faced by WARC-92 were the following:

- for many new services as well as existing services, the same portion of the spectrum is the most technically suited;
- any change in band allocations has financial and economic implications to be borne by the operators and users of the existing service in that band;
- stakes were high because the services under consideration involved new and fast-growing systems;
- the national interests of different countries frequently do not coincide.

Thus the challenge was to make provision for the introduction of new services without adversely affecting existing ones and to do this with a minimum of change to the Frequency Allocation Table given the financial implications such changes entail.

WARC-92 allocated to HF Broadcasting a total of 790 kHz additional spectrum of which 200 kHz below 10 MHz (the most congested part of the HF bands) and 590 kHz between 11 and 19 MHz.

The new allocations were on a worldwide basis, subject to planning, and reserved for single side-band emissions. They will become available for broadcasting on 1 April 2007. With regard to the generalized introduction of SSB and the cessation of DSB emissions in the HF broadcasting bands, which HFBC-87 scheduled tentatively for 31 December 2015, many countries wish to see this change implemented much earlier and the conference recommended the Administrative Council to place this matter on the agenda of the "next competent WARC" (Rec. 519). However, the ITU Council has given this matter no specific mention in any agenda so far although hopefully it will be discussed at WRC-97 under item 3.3 of the preliminary agenda which specifies:

> *examination of, and taking necessary decisions on, the question of the HF bands allocated to the broadcasting service in the light of developments to date and the results of studies carried out by the Radiocommunication Sector.*

An allocation exclusively for Digital Sound Broadcasting was made on a worldwide basis in the band 1452-1492 MHz. This band is to be used both for satellite-based and terrestrial Digital Sound Broadcasting. A conference is to be held not later than 1998 for planning the Broadcasting

Satellite Service (sound) and to develop procedures for coordination with the complementary terrestrial broadcasting.

A Resolution (Res. 524) was adopted to review the Broadcasting Satellite Service Plans for Regions 1 and 3. As evoked in Section 14 above, the technology has advanced since the adoption of these plans particularly in the areas of satellite antennas and receiver sensitivity. Updating the technical parameters should lead to improved spectrum and orbit efficiency. This matter has been placed on the preliminary agenda of WRC-97.

Terrestrial digital sound broadcasting will be included in the agenda of a future Regional Radio Conference for Region 1 and interested countries of Region 3 (Res. 527). Since several European countries are considering the implementation of DAB on an interim basis in the VHF bands allocated to broadcasting, the ITU's Radio Bureau was asked to study compatibility criteria including protection of the safety services using VHF bands.

17. ITU reforms and restructuring

The Changing Telecommunications Environment has been a central preoccupation of the ITU ever since the publication of a report under that title in February 1989 [12]. The members of the ITU also passed a resolution on this subject at the Plenipotentiary Conference in Nice that same year. Besides passing the resolution, the Nice Plenipotentiary also decided to set up a High-Level Committee to examine how the structure and functions of the ITU could be adapted to the changing telecommunications environment.

On the basis of 96 recommendations for reform made by the High-Level Committee [13], the Member states adopted changes in the structure and functioning of the ITU at a Plenipotentiary Conference held in Geneva in December 1992. The new structure and related working methods entered into force on 1 March 1993. We shall confine ourselves here to outlining only those of concern to radiocommunications.All ITU work in the field of radiocommunications has been consolidated into a new Radiocommunication Sector with the role of ensuring the rational, equitable, efficient and economical use of the RF spectrum and the geostationary satellite orbit.

This aim is achieved by:

- holding World and Regional Radiocommunication Conferences to address radiocommunication matters of global or regional importance;
- developing and applying Radio Regulations and Regional Agreements covering the use of the radio frequency spectrum;
- establishing ITU-R Recommendations on the technical characteristics and operational procedures for radio communication services and systems;
- coordinating efforts to eliminate harmful interference between radio stations of different countries;
- maintaining the Master International Frequency Register;
- providing tools, information and seminars to assist national radio frequency management.

The Radiocommunication Sector operates through:

- Radio Conferences and Radiocommunication Assemblies supported by Study Groups (legislative functions);
- an Advisory Group (strategic advice) and;
- a Bureau headed by a Director (administrative functions)

17.1. Radiocommunication Conferences

World Radiocommunication Conferences (WRC), held every two years, may:

- revise the Radio Regulations and any associated Frequency Assignment and Allotment Plans;
- address any radiocommunication matter of worldwide character;
- instruct the Radio Regulations Board and the Radiocommunication Bureau, and review their activities;
- determine questions for study by the radiocommunication Assembly and its Study Groups in preparation for future Radiocommunication Conferences.

The general scope of the agenda is set by a WRC four years in advance of the conference. The final agenda is set by the ITU Council, preferably two years in advance.

The first World Radiocommunication Conference under the new structure was held in Helsinki in November 1993.

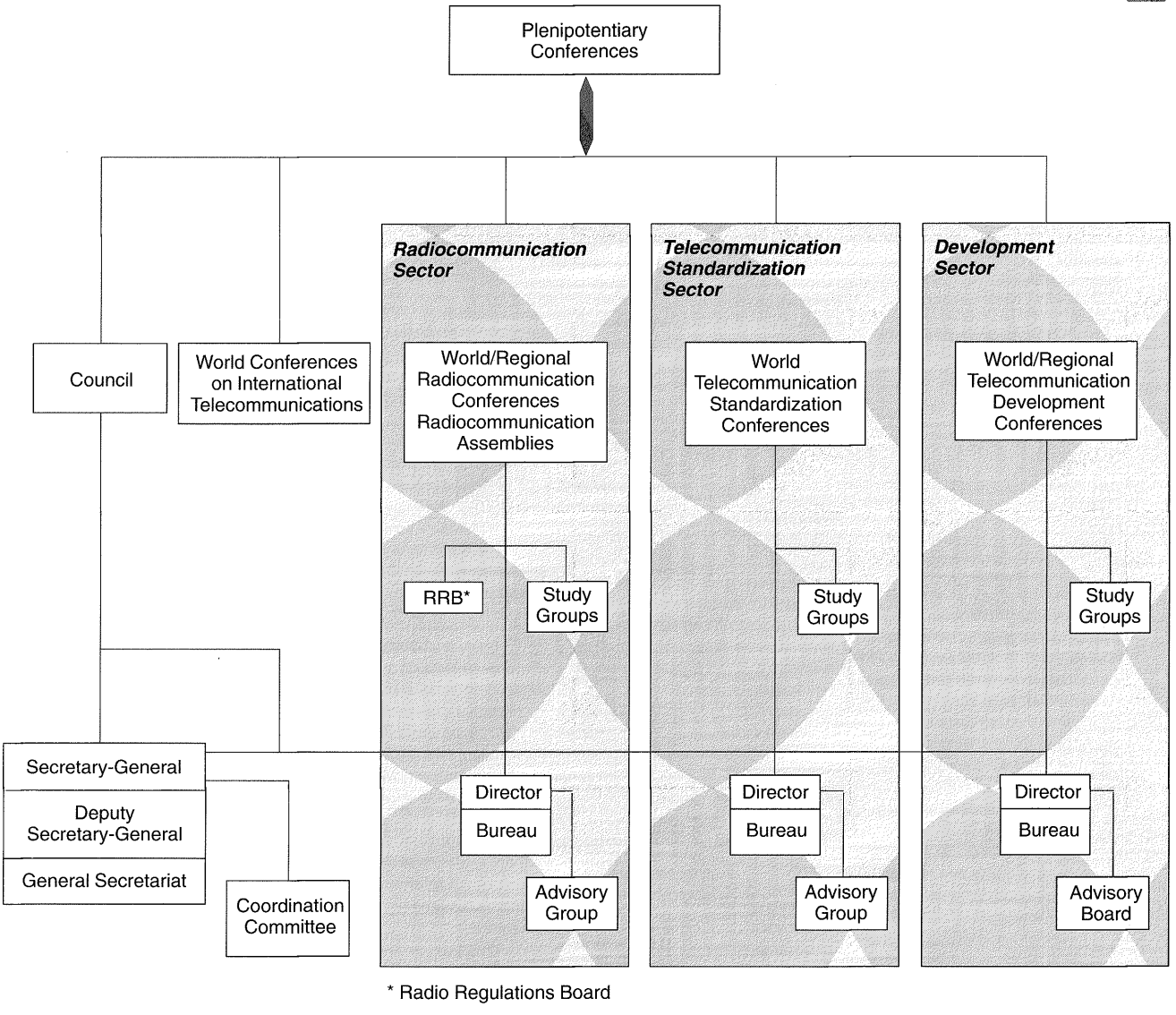

Figure 2
New structure of the ITU.

17.2. Radiocommunications Assemblies

Radiocommunications Assemblies (RAs) are responsible for the structure, programme and approval of radiocommunication studies.

The Assemblies:

- assign conference preparatory work and other questions to the Study Groups;
- respond to other requests from ITU conferences;
- suggest topics for the agenda of future WRCs;
- approve and issue ITU-R Recommendations and Questions developed by the Study Groups;
- set the work programme for Study Groups, and disband or establish Study groups according to need;
- establish procedures for approval of ITU-R Recommendations by correspondence in the interval between Assemblies.

Radiocommunication Assemblies are normally convened every two years and are associated in time and place with WRCs.

17.3. Radiocommunication Study Groups

More than 1500 specialists from telecommunications organizations throughout the world participate in the work of the Radiocommunication Study Groups which:

- prepare the technical bases for Radiocommunication Conferences;

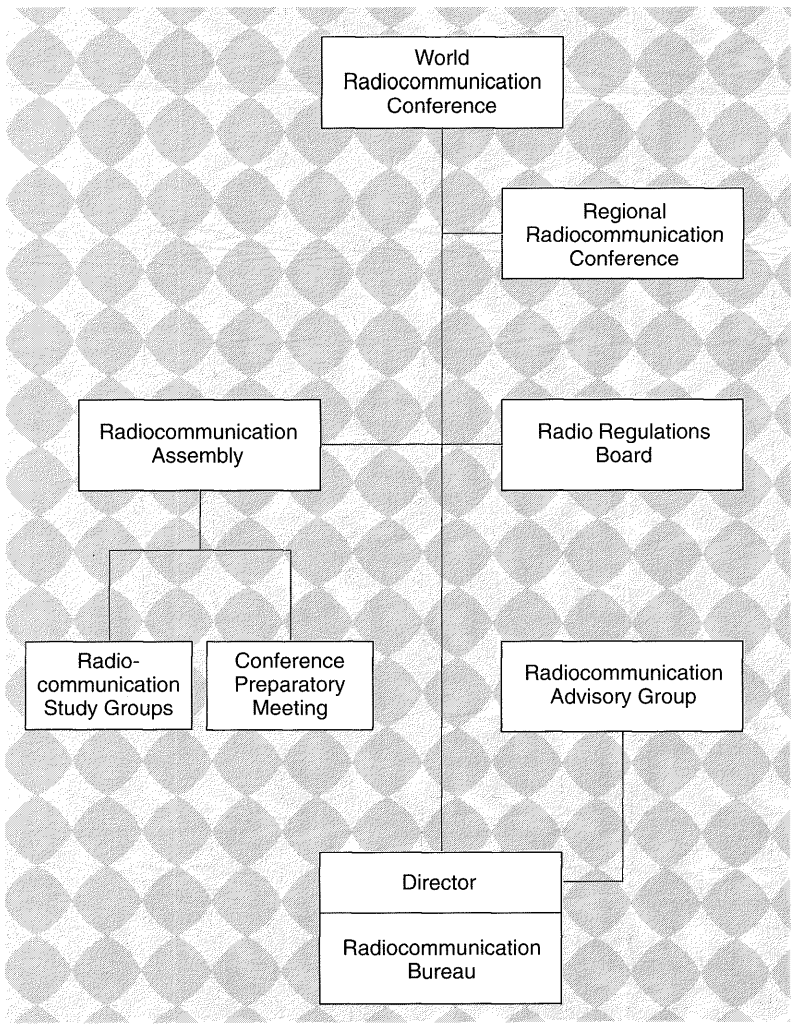

Figure 3
Structure of the Radiocommunication Sector.

- develop draft ITU-R Recommendations and compile handbooks on spectrum management and new services.

17.4. Radio Regulations Board

The nine members of the new Radio Regulations Board (RRB) are elected by the Plenipotentiary Conference. They perform their duties on a part-time basis, normally meeting up to four times a year in Geneva. The Board:

- approves the Rules of procedure used by the Radiocommunication Bureau in applying the provisions of the Radio Regulations and registering frequency assignments made by ITU Members;
- addresses matter referred by the Bureau which cannot be resolved through application of the Radio Regulations and Rules of Procedure;
- considers reports of interference investigations carried out by the Bureau at the request of one or more ITU Members and formulates recommendations;
- provides advice to Radiocommunication Conferences and Assemblies.

The first part-time 9-Member Radio Regulations Board was elected at the Kyoto Plenipotentiary Conference in September 1994 and takes up its duties on 1st January 1995[2].

17.5. Radiocommunication Advisory Group

As part of its action to improve strategic planning in the ITU, the 1992 Plenipotentiary Conference created a Radiocommunication Advisory Group (RAG) to review the priorities and strategies adopted in the Sector, to provide guidelines for the Study Groups and monitor the progress of their work, and to recommend measures to foster co-operation with other standards bodies.

17.6. Radiocommunication Bureau

The Radiocommunication Bureau (BR) is headed by an elected Director. The Bureau:

- provides administrative and technical support to Radiocommunication Conferences, Radiocommunication Assemblies and Study Groups;
- applies the provisions of the Radio Regulations and various regional agreements;
- records and registers frequency assignments and orbital characteristics of space services, and maintains the Master International Frequency Register;
- provides advice to Members on the equitable, effective and economical use of the radio frequency spectrum and the geostationary-satellite orbit, and investigates and assists in resolving cases of harmful interference;
- provides technical support and seminars on national frequency management and radiocommunications.

18. Simplifying the Radio Regulations

A far-reaching initiative adopted by the Plenipotentiary Conference (Nice) in 1989 was the creation of the *"Voluntary Group of Experts to study the allocation and improved use of the radio-*

2. During the transition period between March 1994 (entry into force of the new ITU structure) and 1st January 1995, the work of the new RRB was assured by the former members of the IFRB.

frequency spectrum and the simplification of the Radio Regulations" [14], better known as the VGE. After over four years of intensive work, the VGE's final report was submitted to the ITU Council in 1994. The report and recommendations will be discussed in detail at WRC-95 together with related proposals from administrations. If adopted, the simplified Radio Regulations should:

a) improve flexibility in using the spectrum and provide increased possibilities for sharing frequencies and bands;

b) help to avoid and eliminate harmful interference; and

c) make it easier to apply the Radio Regulations.

19. Conclusion

When we examine the development of the regulatory structure for radiocommunications we see that it consists of the resolution of a series of opposing forces which include:

- The physical laws of radio propagation which respect no man-made laws;
- The desire of countries to retain a high degree of national sovereignty;
- The need to share a limited natural resource;
- The ever-growing demands for radiocommunication services;
- The protection of existing frequency assignments;
- Ensuring equitable access to the spectrum for all countries;
- The desire of the more technically advanced countries to rapidly make use of available spectrum;
- The desire of less advanced countries to ensure that spectrum will still be available when they are ready to introduce their own services;
- The need for an optimum use of the radio spectrum by using the latest technology;
- The economic necessity for poorer countries to have an affordable service;
- The opposing interests of different radio services.

All these factors make radiocommunications one of the most difficult activities to regulate, inevitably involving a high degree of compromise. Yet regulate we must if this unique natural resource is not to be wasted.

On the national level regulation is relatively easy; there is one supreme authority. At the international level there is no supreme authority and agreement can often only be reached by a compromise after difficult negotiations. Thus, if ITU regulations and procedures have sometimes been the object of criticism this is to be expected; compromise, by definition, involves making concessions which is always done with reluctance. And, not surprisingly, the criticisms are different according to their origin. After all, if everyone were dissatisfied for the same reason, it would be easy to reach agreement on improvements.

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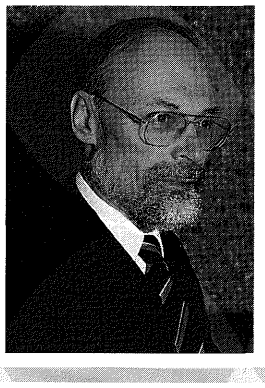
On joining the International Telecommunication Union in 1968, his work included public and press relations, and writing for the ITU Telecommunication Journal *of which he later became editor-in-chief.*

Since his retirement from the ITU in 1994, Michael Woolley has become a consultant and writer on international telecommunications.



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Courtesy of Cesky Rozhlas (Czech Radio)

The publicity bus of Czechoslovak Radio in 1935.