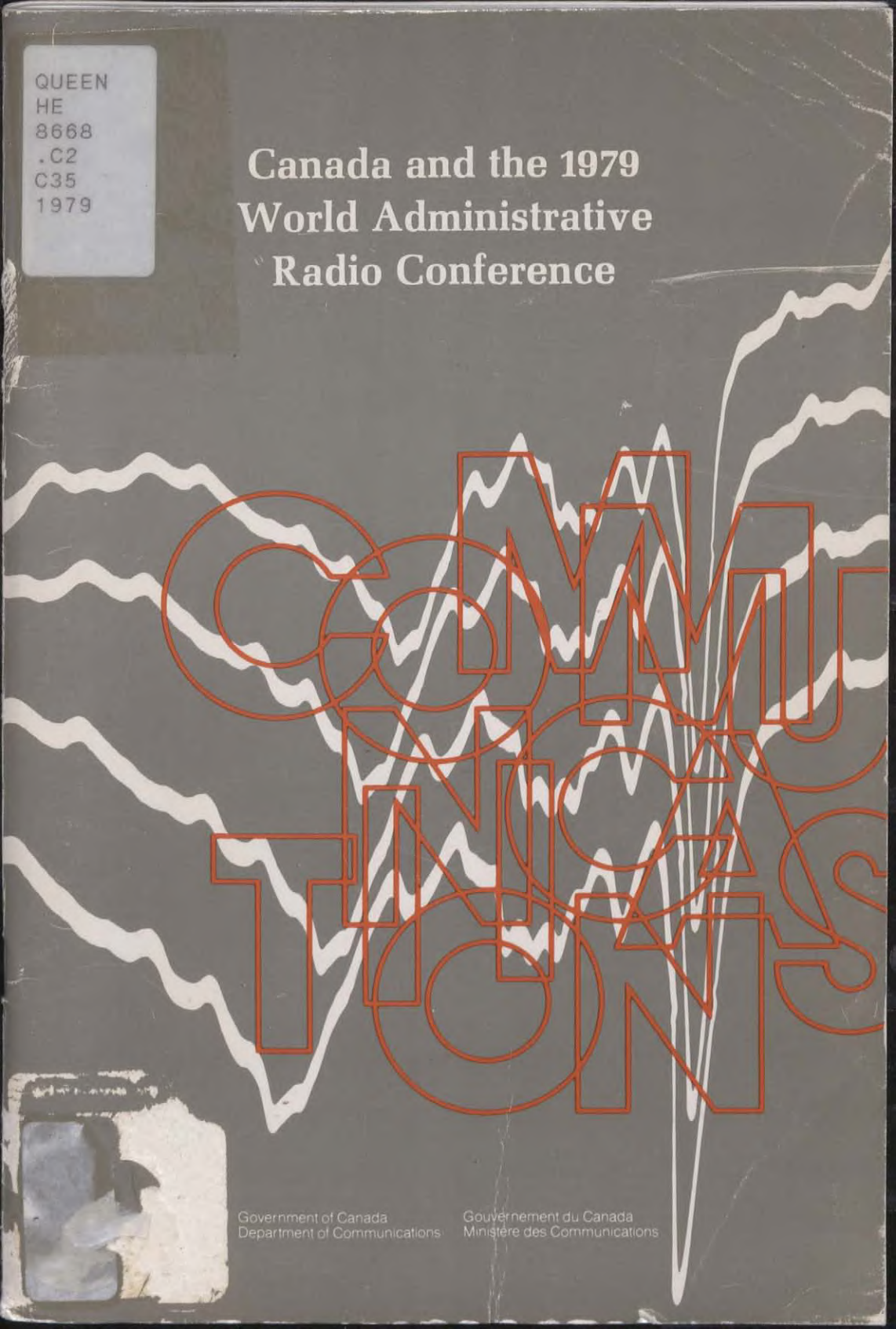
Canada and the 1979 World Administrative Radio Conference



Government of Canada
Department of Communications

Gouvernement du Canada
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Introduction

More than 1,500 delegates from 154 nations are meeting in Geneva this fall, for a ten-week conference to decide how to share an invisible resource for the rest of this century. Despite its invisibility, that resource — the radio frequency spectrum — supports much of the world's telecommunications traffic. It is as valuable as any resource we have had and, in recent years, has been subject to increasing demands. Indeed, shortages of it already exist in industrialized countries, the heaviest users of telecommunications.

As a resource that transcends national borders, the spectrum must be apportioned among the telecommunications services. The delegates who are meeting in Geneva under United Nations auspices for the 1979 World Administrative Radio Conference (WARC '79) will be revising, for the first time in 20 years, most of the rules and regulations for sharing the spectrum. All users of the air waves, from CB mobile radio operators to radio broadcasters, have a stake in the outcome of the conference. And countries must, in the end, decide their national policies and related technical standards according to the radio regulations agreed on by all nations.

Canada is represented by a substantial delegation, many of whom have been spending long hours, some of them for the past four years, exclusively getting ready for WARC '79. While this country has only a small population per square mile, its reputation among both powerful and small member nations of the United Nations is of long standing.

Of course, like all nations big or small, struggling or wealthy, Canada comes to such a U.N. technical conference on communications with well-documented positions relating to its own special needs. The sparse population strung out over a vast area, the majority within a few miles of the United States border, the rest sprinkled over a rugged and remote terrain, make all communications (and especially radiocommunications) of particular importance to Canadians. Meeting the challenges has led to some unique and remarkable answers, going all the way back to Alexander Graham Bell a century ago. So preparing for a U.N. conference which may affect the communications — in some cases the very safety and lives — of Canadians for up to 20 years to come, of necessity has involved a great deal of effort. It has called for wholehearted cooperation among governments at all levels and radiocommunications equipment manufacturers. Its results may alter the future of industries as well as operations of major users from the British Columbia mine in the high country to the lonely bushplane flying over the tundra, from Arctic offshore oil drilling rigs to Atlantic coastal trawler fleets or icebreakers.

The World Administrative Radio Conference is sponsored by the International Telecommunication Union (ITU), a United Nations specialized agency to which 154 countries — almost all the world's nations — belong. The Union's purpose is to co-ordinate international use of telecommunications and to promote the development and operation of efficient telecommunications systems throughout the world.

The radio conferences, like all such U.N. technical plenary meetings, are complex because the many interests of all nations are involved. In preparation for the conference, most countries have been conducting research, discussing national positions, and holding talks with one another for several years. About one half of the nations represented in Geneva — mainly those from Asia and Africa — did not exist or were too new to have much influence when the last general conference took place in 1959. Smaller countries will each be sending fewer than 20 delegates to the 1979 Conference, while larger countries, like the United States, will be sending as many as 60 delegates, plus support staff. With its special interests to protect, Canada will be sending about 40. These are to negotiate with their opposite numbers mainly technical experts and essential backup people from most telecommunications services.

In Geneva the delegates will form about eight major committees, each of which will organize numerous working groups and sub-groups, to review various national proposals and reports exceeding 4,500 pages in total, published in three major languages. Members will then revise the two volumes — the more than 1,000 pages — of the International Radio Regulations. A major part of their task is to make changes in the allocation of the radio frequency spectrum, used by most forms of telecommunications.

That there will be changes to the international allocations of the spectrum is beyond doubt. The question is, what changes will take place.

The 1979 conference will also revise regulations governing the technical standards of communication systems and determine methods to be followed by member nations in the co-ordination, notification and recording of frequency assignments. These methods ensure that assignments receive both international recognition and protection from interference.

WARC 1979 will be more complex than any other since the Berlin Conference in 1906, where the first international radio regulations were laid down. The regulations must take into account the tremendous growth in telecommunications in the last 20 years when technology has shot from vacuum tube to highly complex integrated circuits, crude "clothesline" radio antennae to sophisticated satellite earth stations. The decisions must be ones we will be able to live with or adapt to for as long as 20 years. Who, even with access to all this worldwide expertise, could begin to guess where telecommunications will have reached by 1999?

New systems are now being developed every year, from teletext to telemetry, from home facsimile machines to the videophone and home computer. In North America the radio receiving population has now surpassed the human population, that is, there are 1,790 radio receiving sets for every 1,000 people. In 1954 the total number of telephones in the world was only 90 million; at the present rate of expansion, there will be 1,000 million telephones by the end of this century.

Greater inequalities exist between nations in the provision of telecommunications systems than in most other fields of industrial development. The telephone, for instance, was invented more than a century ago, but its distribution around the globe is still very uneven. There are now 358 million telephones in the world, but only 30 million of them are in Central and South America, Africa and Asia together. In parts of South America and Africa, there is less than one telephone to every two or three hundred people; in Canada there are sixty to every hundred.

Decisions about telecommunications services must be made in terms of the present and future needs of all societies. These services depend, for the most part, on the transmission of radio waves. The medium of transmission, in this case, means the electromagnetic spectrum, a vast but finite resource.

2

The Radio Frequency Spectrum

Electromagnetic radiation is a form of energy, like heat or light, which travels through space without physical connection and which carries or "transports" all radiocommunications.

The complete range of possible rates at which electromagnetic energy can be oscillated comprises the spectrum. This range of rates of oscillations, or frequencies, is vast, from almost zero cycles per second to billions of cycles per second. But only a portion of the spectrum, between a few thousand cycles per second and a few hundred billion, can be conveniently used for communication. That portion is the radio frequency spectrum.

The entire spectrum for radiocommunications falls within a range which, on the lower side, starts with ultra long waves and, on the upper side, borders on the visible, on the thermal, infrared waves. By international convention, the radio frequency spectrum has been divided into eight bands. These include all frequencies from the very low frequencies (VLF) in Band 4, to the highest frequencies, now used in Band 11 and called the extra high frequencies (EHF). The range of these frequencies is expressed in "cycles per second", or Hertz (see Appendix 1).

Electromagnetic radiation, like the world's water resources, is a renewable resource — it cannot be used up — but the amount of information it can transport is limited. The development of radiocommunications can be seen as a constant endeavour to use higher frequencies, because the higher the frequency the greater its capacity to transmit information.

Marconi's invention in 1896 involved the use of one small band of frequencies for his first wireless experiments. Today, the various frequency bands are, for international administrative purposes, allocated to an immense number of radiocommunication services. As with a traffic artery, increased use of the spectrum causes congestion. The purpose of radio regulation is to control the volume and type of traffic in each part of the spectrum.

3

The History of International Frequency Allocations

The history of the management of communication services provides a context for understanding present-day policies and programs. As early as 1848, Prussia negotiated agreements with 15 small German states to obtain rights of passage for telegraph lines to the boundaries of its own territory, and in 1849 Prussia and Austria signed the world's first international agreement regulating telegraphs, establishing priorities on the transmission of messages and laying down a scale of rates, or charges, for telegraph services. Although other European countries then sought, during the 1850s, to regulate telegraphic equipment and its use by fashioning accords among themselves, it was finally recognized that an international gathering was necessary.

On May 17, 1865, at the Paris Conference, the International Telegraph Convention was signed by 20 European states — Britain was not represented because its telegraph system had not yet been nationalized. It was the agreement signed at this conference that became the precedent for all future international regulations in the field of telecommunications. Under the Convention, the International Telegraph Union was created, which was the forerunner of the International Telecommunication Union, the world's oldest international agency. It was agreed that Morse Code would be the international system of signals, that all languages used in the member states were valid for telegraphic use, and that systems of reply-paid telegrams and multiple address telegraphs, as well as special telegraph services such as express, person-to-person and courier, would be made uniform. Also, all the major economic

centres agreed to construct direct trunk routes according to specified technical standards.

In all, the Convention made possible the expansion of the telegraph, as well as laying down the fundamental rules by which future international agreements regarding communication services would be sought and made. Only 20 years after the Convention — and after the inventions of Alexander Graham Bell in 1874 in Brantford, Ontario and later in the United States — member states began legislating in the field of international telephony. By the late 1880s, the first international telephone links were being built.

It was, however, the invention of systems of wireless communication that made essential more comprehensive international regulations. For example, the standardization of equipment became necessary because of the confusion caused by competing patent holders. Prince Heinrich of Prussia, returning home from a visit to the United States, was unable to send a message from aboard ship to the U.S. President because the ship's equipment was a different manufacture from that of the American reception apparatus. Soon after this incident, the Prussian government decided to hold a preliminary conference in Berlin in 1903, to prepare for a major conference in 1906.

It was at the 1906 Berlin Conference that the first international radio regulations were set down. Some standards for technical uniformity were established and, among the most significant advances, certain sections of the radio frequency spectrum were allocated by all nations to specific radio services, notably the frequencies used by ships at sea. Frequencies below 188 kHz (kilohertz) were reserved for long distance communications between coastal stations; those between 188 and 500 kHz were reserved for military use; and two wavelengths were set aside for public use in maritime services. All details of all stations — their frequencies and their hours of operation — were to be reported to the International Telegraph Office, then at Berne, and later at Geneva.

It was decided at the Berlin Conference that coastal radio stations serving ships were obliged to take in one another's messages, in particular the Morse distress signal. At the same conference, ships were encouraged both to communicate and to avoid radio interference. But the sinking of the *Titanic* in 1912 made more urgent the problem of maritime safety, for the great loss of life occurred partly because several of the ships within radio reach had no wireless and, on the ship that did, the lookout who saw the liner's distress rockets did not bother to wake the wireless operator. Thus, at the next international conference, the London Conference, scheduled to take place only three months after the tragedy, the system of maritime communications was extended. Expanded use of the spectrum for more services providing weather and storm signals at sea was legislated, as was a system of radiotelegraphs that benefitted both the shipping lines, which used

the network of coastal stations, and radiocommunications in major inland centres.

The next important advance in the management of radiocommunications was made at the Washington Conference in 1927. At this, the first truly international conference, in which representatives from 80 nations and 60 commercial firms participated, the Table of Frequency Allocations was created. Operating frequencies were then published and, under the Convention, any two nations who found that their stations had shifted channels or had begun mutual interference were obliged to submit to arbitration.

During the 1920s the uses of the spectrum multiplied — radio broadcasting had developed in many countries as a public service; transoceanic radiotelegraphy was operating on a commercial basis; and aircraft were now often equipped with radios. Careful planning and detailed research was required. By 1929 it was decided that each new type of service should be provided with a separate band of the spectrum to alleviate over-crowding in the higher frequencies.

At the Madrid Conference in 1932, the International Telecommunication Union was formed. Wire and wireless communications were seen as comprising the "media" of communication, and two separate conferences — one on telegraphs, the other on radiotelegraphy — joined together. The last general conference before the Second World War was held in Cairo in 1938, but during the War, the development of radiocommunications went on without international co-ordination. Generally, broadcasting was carried on medium and high frequency bands, and international telephony, restricted because of the war, on the high frequency band. There was, too, extensive development of the uses of the VHF, the UHF and the SHF (Super High Frequency) bands for aircraft, radio navigation and tactical communication systems.

The advance in the kinds and uses of telecommunication equipment made during and after the Second World War meant that methods for maintaining international order within the radio frequency spectrum had to be rethought. New principles for the allocation and regulation of the spectrum were established at the Atlantic City Conference in 1947, in which 600 delegates from 76 countries participated. The major innovation was that adherence to the Table of Frequency Allocations, an integral part of the Radio Regulations, became an absolute condition for registration in the Master International Frequency Register — a requirement for those countries which wished international recognition of their right to use allocated frequencies and of their right to international protection.

At the last general WARC in 1959, it was recognized that the International Telecommunication Union itself had to change its approach to administering telecommunications. Because users of the spectrum had tended to assume rights over various frequencies simply by having used them first — that is, they assumed

"squatters" rights — the Union was left to co-ordinate the separate, often conflicting, decisions of individual nations and communication services. Even during the 1920s, some wished that greater pressure be exerted on users of the spectrum — they believed, for instance, that to use the spectrum for entertainment broadcasting was frivolous, that its proper use was as a vehicle of military and administrative aims. It was decided therefore that the International Telecommunication Union, without acquiring excessive powers, should be more effective in its planning, that nations could not just nibble at parts of the spectrum, establishing their jurisdiction on a first-come, first-served basis.

The management of communication satellites — undertaken after the USSR launched Sputnik in 1957 — has since added to the complexities of allocating the spectrum. The advantages of satellites for telecommunications are great. Because the cost of satellite communication is not affected by the distance of the transmission, such services as long distance telephony, international data transmission and surveillance of weather may become relatively inexpensive; and even some mechanicial or labour-intensive services, like the postal system, may be transferred to more efficient, less costly electronic and telecommunication systems.

At several of the six specialized radio conferences, following the 1959 WARC, regulations for space communications have been negotiated. Frequencies have been set aside in each of the three regions designated by the Telecommunication Union (Region 1 — Europe and Africa, Region 2 — The Americas, Region 3 — Asia and South Pacific), to enable the operation of the different types of space services, such as direct broadcast satellites and fixed (point-to-point) satellites for telephony, meteorology and aeronautical and marine communications.

Because of new technologies, the use of the upper reaches of the spectrum has increased greatly — and in an orderly manner. Yet it is now clear that it will be necessary to make more efficient use of the radio frequency spectrum to meet future demands by the various nations. Countries are asked not to demand more of the spectrum than they can use, not to use out-of-date, wasteful equipment and to report any vacated parts of the spectrum. Priority may be given to those services which must use the spectrum, rather than to those which are able to use other means of transmission. For example, mobile services, navigation services and broadcasting services in remote areas are obliged to use radiocommunications — whether terrestrial or via satellite — while some public broadcasting services could use modern wires or cables.

4

The 1979 World Administrative Radio Conference

Canada's Policies and Planning

With the special interests of the nation foremost in mind, Canada drafted a set of proposals which were formally approved by the federal government and submitted to the ITU in February, 1979. Some of the main areas of concern covered in these formal Canadian proposals are:

- allocation of additional spectrum for mobile communications in the UHF band;
- extension of the standard AM broadcasting band to provide for additional channels covering areas in Canada not adequately served at present;
- substantial increase in the amount of shortwave spectrum employed for international broadcasting;
- additional radio spectrum for Canadian and international requirements for radiocommunications by satellites; and
- more spectrum for amateur radio service.

The preparation for Canada's participation which began in 1975 started with the formation of the Canadian Interdepartmental Committee made up of frequency management experts representing all federal government departments and agencies having an interest in radiocommunications (Communications, Transport, National Defence, External Affairs, Energy, Mines & Resources, National Research Council, Canadian Radio-television

and Telecommunications Commission, Canadian Broadcasting Corporation, Royal Canadian Mounted Police, Teleglobe and Telesat). This group undertook extensive technical studies and public consultations with the private sector and provincial governments, including public distribution of two drafts, and prepared the technical proposals for revising the International Radio Regulations. The finished book of proposals, a document 200 pages thick, has been circulated to interested parties in Canada and was sent to the ITU in Geneva. From there, copies were prepared for all countries sending delegations.

The Canadian Department of Communications, which co-ordinated the interdepartmental committee's preparatory work and the feedback from all interested sources, was most impressed by the degree of participation from the private communications sector industry in the pre-conference process. Canada (along with the United States) is one of only two countries with full and complete public consultation (there is no private sector in either telecommunications or radio broadcasting in many countries where the post and telegraph agency is a branch of government).

Another aspect of Canada's pre-conference participation has been the invitation of the ITU to have experts, well versed in the issues, give seminars in Nairobi (for European and African nations), Panama (North, Central and South America), and Sydney (Asia and Australasia). The object was to assist the developing countries in clarifying the issues. Since the WARC works on the basis of one nation, one vote, these developing countries must be assured that the changes proposed are not contrary to their national interests. The ITU arranged for two travel fellowships to be available to each developing nation — those in Africa were sponsored by France, in Panama by Sweden and Canada, and in Sydney by the Australian government. Over the same period, Canadian experts held consultations with many nations. including discussions in Moscow, Washington, Rome and Bogota.

The document which constitutes Canada's position on the principal issues facing WARC '79 provides the technical details of the main proposals on frequency allocation being put forward by Canada.

a) Mobile Communications and Television in the UHF Band

Canada will seek a revision of the International Table of Frequency Allocations to reflect the provision of additional spectrum for the mobile communications service that was contained in the new UHF allocation policy announced by the Minister of Communications on February 23, 1979.

b) Standard AM Broadcasting Band

The standard AM broadcasting band, providing radio service in urban Canada, can no longer supply new AM radio stations. To permit coverage of areas not adequately served at

present, Canada is proposing an extension of this band to provide additional channels.

c) Shortwave Broadcasting

This subject may be one of the major contentious issues at the conference since a number of developing countries oppose the extensive use by the developed countries of the frequencies allocated to this service.

The main features of the Canadian proposals are to increase by 50 per cent the frequency bands allocated to shortwave broadcasting, to limit the power of broadcasting transmitters, and to restrict the redundant broadcasting of the same program simultaneously on many channels in the same frequency band. By means of the improvements that would be brought about by these proposals, it is intended to respond to the criticisms of those developing countries which are stating that the only solution to the present chaos in the shortwave broadcasting bands is to convene a "special" WARC at an early date for the purpose of "planning" the shortwave broadcasting service (in ITU parlance, "planning" means the long-term allotment of frequencies to each country, often irrespective of current requirements).

One important benefit to Canada that would result from its proposed revisions related to this service, is the allocation of a new frequency band near 4 MHz which would permit more effective coverage of northern Quebec, southern Baffin Island and the James Bay area from the Radio Canada International transmitting station in Sackville, N.B.

d) Space Radiocommunications by Satellite

A major issue at the conference will be the allocation to space services of the frequency bands in the vicinity of 12 GHz, used by the new generation of advanced "fixed" (point-to-point radiocommunications) satellites like Anik C, and "direct broadcast" (direct-to-home or to small community receivers) satellites. There are some technical differences between the Canadian and U.S. proposals on allocation of additional spectrum to space services in the 12 GHz band, but it is expected these can be resolved in the course of the conference.

e) Amateur Radio Service

Some submissions made to the Interdepartmental Committee during the public consultation phase stressed the important recreational and public service aspects of the hobby of amateur (or "ham") radio. Several proposals will accordingly be made to significantly improve the regulatory provisions for this service, and Canada will be in the forefront of countries proposing additional spectrum for amateur use.

In addition, some developing countries at WARC '79 could raise non-technical issues relating to their special concerns and

what UNESCO has termed a "new world information/communications order". Although it is possible that a number of these non-technical issues could have a disruptive effect on the conference, Canadian officials hope that compromises will be found which will better reflect the requirements of the developing countries while preserving an essential element of stability in the international system.

Major Issues at WARC '79

Many of the 154 United Nations member countries who have been planning for WARC '79 have technical problems critical to their own needs. The causes are as divergent as diverse climates, geographical locations and economic conditions can make them. Based on information from the three regional pre-WARC sessions, three key issues among a host of more technical ones could be pivotal. Solutions or acceptable compromises to them may well prove essential to continued international radiocommunications over the next decade and beyond. These issues emerging as ones of widespread concern and far-reaching consequences are:

- **First-Come, First-Served Principle** — Up to now, in the ITU context, the "first-come, first-served" principle has governed the assignment and registration of international frequencies and has provided a necessary element of stability upon which to base important decisions on the investment in telecommunication systems. It is expected that at the conference a number of developing countries will take the position that they do not want to be deprived of access to radio frequency assignments because of late arrival to the point where they will be in a position to use more advanced technology. It is expected that the developing countries will try to force the developed countries to give up some of their acquired frequencies, and insist that frequencies be assigned on the basis of economic and social need. Such action would result in great expense and technological delays to the technologically-advanced countries.
- **The 'Region 4' Proposal** — Many of the African states have raised the idea that, in addition to the present three ITU regional groupings, there should be a Region 4 because of the unique needs of the technically less advanced countries when it comes to allocation of radio frequencies. A further refinement promoted by Kenya and some other African nations has been the suggestion that all the developing countries around the equator or within the Tropic zone should make up such a fourth region. Most of the other nations (Canada among them)

feel quite strongly that, in the interests of most efficient frequency management, the greater the degree of *commonality* from one region to another the better for all. In other words, more uniformity of services carried on each frequency band in each geographical area is the goal, and creation of a fourth region based on entrenching local service variations clearly runs counter to this objective.

- **Fixed Satellite 'Planning'** — WARC '79 is not a planning session in the conventional sense of the word, in this case 'planning' is ITU technical jargon for allocation of orbits and frequencies to particular countries rather than assignment of them by actual need as is the case at the moment. However, at the preparatory meeting in Sydney earlier in 1979, the delegation from India strongly advocated such planning of fixed (point-to-point) satellites, and was supported by a few Southeast Asian countries. Subsequently at a meeting of the Non-Aligned Countries, attended by about 25 countries at Yaoundé, Cameroon in the first week of May, a final communiqué strongly expressed the desirability of holding another WARC in the very near future to set about 'planning' the fixed satellite orbit positions and frequency bands. Many nations with sophisticated communications satellites and related hardware and software are opposed to this, because of the possibility that a detailed, inflexible plan could tie up the limited radio spectrum resources and orbital space by giving each country a reserved share, even if there is no realistic possibility that such countries will resort to satellite use.

  The concern about tying up limited spectrum, in a field where technology is changing almost out of recognition from one decade to the next, is shared by most technically-innovative nations.

- **Orbit Sovereignty** — This refers to claims which grew out of the so-called "Bogota Declaration" signed in Columbia in 1976 with the support of a number of equatorial countries. It perceives a portion of the geostationary orbit (35,787 km above the equator) as belonging to the country beneath it. While such an issue will undoubtedly crop up again in Geneva, it seems unlikely to win support since, according to 1967 U.N. Outer Space Treaty, outer space is the heritage of all mankind.

The history of some of these concerns dates from the colonial period, when telegraph and other links were first established between imperial and colonialized countries. Many developing countries have since found themselves enmeshed in telecommunications services that hark back to the days when

administrative and business links existed only between the colonial country and one of the European capitals.

A Pan-African telecommunications network is now being constructed, as is an Inter-American one; plans are being made for telephone and telegraph systems in Asia and the South Pacific — all are projects sponsored by the International Telecommunications Union, the World Bank, the United Nations Development Program and other agencies. But links across many of these regions are still inadequate, and developing countries need financial aid for training administrative and technical staff, as well as for facilities to manufacture up-to-date equipment.

In July, 1978 M. Mustapha Masmoudi, Tunisia's Secretary of State for Information, coined the expression, "the New World Information Order". It referred to the right of countries "to be informed", and also its corollary, "the right to inform". It sprang from concerns on the part of many developing countries that they were dependent on the technology and software of the developed countries. And it has sparked a debate concerning the right of developing countries to have guaranteed access to the spectrum to transmit information and the right to control information transmitted to them.

5

Conclusion

With such detailed preparation, Canada will be an active participant in the WARC, in an effort to ensure that the revised International Radio Regulations will allow for the continued healthy development of Canadian telecommunications systems. Indeed, the consequences of the conference will affect all telecommunications industries, spectrum users and government regulators. While it is too early to predict specific results, a few principles that will assist in formulating policy decisions can be identified:

- First, assignment of the spectrum has become sufficiently dense that the growth of future services depends upon either access to additional spectrum or to costly technology that would make more efficient use of spectrum already allocated.
- Second, only WARC '79 has the competence, within the jurisdiction of the International Telecommunication Union, to withdraw spectrum from one service and apply it to another.
- Third, the structure of WARC '79 will differ from all preceding conferences. The combined voting power of all the developing countries is much greater than that of the developed countries. The varying requirements and expectations of these developing countries in a world of accelerating technological change, will alter the traditional pattern of ITU negotiations.

Finally, many providers and users of services based on the radio frequency spectrum will find themselves having to accept compromises. But if the Canadian delegates have done their homework successfully, and if they are effective during the ten-week discussions in Geneva at WARC '79, the results, from the Canadian point of view, will be new improvements and fresh opportunities. The desired international outcome will be more efficient use of this increasingly vital but finite communications resource in ways that are more equitable for all the participating nations.

Appendices

Appendix 1

Wavelength	Frequency	Band Number	Band Designation	Metric Designation	Typical Services
10 km	30 kHz	4	VLF Very Low Frequency	Myrianetic Waves	Long range point-to-point communication (more than 1000 miles) and radionavigation (OMEGA)
1 km	300 kHz	5	LF Low Frequency	Kilometric Waves	Medium and long range point-to-point communication; navigation aids, aeronautical, Loran C
100 m	3 MHz (3,000 kHz)	6	MF Medium Frequency	Hectometric Waves	Medium range communication, AM broadcasting, aeronautical mobile, radionavigation, maritime radio telephone, Loran A, international distress, amateur
10 m	30 MHz	7	HF High Frequency	Decametric Waves	Medium and long range communication, international broadcasting, point-to-point, air-ground, ship-shore, space research, amateur, radio astronomy, General Radio Service (C.B.)
1 m	300 MHz	8	VHF Very High Frequency	Metric Waves	Short range, line-of-sight communication, over horizon scatter communication, VHF television, FM broadcasting, space tracking and telemetry, satellites, aeronautical & maritime distress, worldwide radionavigation, land mobile, amateur, radio astronomy
10 cm	3 GHz	9	UHF Ultra High Frequency	Decimetric Waves	Short range communication, microwave relay, over horizon scatter communications, UHF television, instructional television, land mobile, weather satellites, meteorological aids, space tracking and telemetry, radar, world-wide aeronautical radionavigation, amateur, radio astronomy
1 cm	30 GHz (3,000 MHz)	10	SHF Super High Frequency	Centimetric Waves	Microwave relay, deep space, space research, telemetry, communications satellites, radar, aeronautical radionavigation, meteorological aids, amateur, radio astronomy
1 mm	300 GHz	11	EHF Extremely High Frequency	Millimetric Waves	Microwave relay, space research, radar, radionavigation, amateur, radio astronomy, broadcast satellites

The vertical scale has been compressed so that each horizontal stripe represents a frequency range ten times wider than the one above.

1 hertz (Hz) — one cycle per second
1 kilohertz (kHz) — 1 000 Hz
1 megahertz (MHz) — 1 000 kHz
1 gigahertz (GHz) — 1 000 MHz

Appendix 2

List of organizations and agencies referred to in this text —

Canadian Interdepartmental Committee (CIC)
Canadian Radio-television and Telecommunications Commission (CRTC)
Canadian Telecommunications Carriers Association (CTCA)
Department of Communications (DOC)
International Frequency Registration Board (IFRB)
International Telecommunication Union (ITU)
United Nations (UN)
United Nations Development Program (UNDP)
World Administrative Radio Conference (WARC)