Chapter 2

The Changing Requirements, Influences, and Motivations Among Nations for Use of the Radiofrequency Spectrum

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Introduction

By any measure, the 1979 World Administrative Radio Conference (WARC-79) was a complex international event. The facts are deceptively simple. For 11 weeks in the autumn of 1979, between September 27 and December 5, the nations of the world met at Geneva as a legislative organ of the International Telecommunication Union (ITU), a specialized agency of the United Nations (U.N.). The conference produced a 984-page document–the Final Acts of WARC-79–which sets forth regulations, resolutions, and recommendations for radio communication worldwide. For most nations of the world, those Final Acts will represent a multilateral treaty and a basic source of public international law. The U.S. Senate must give its advice and consent to ratification before the United States becomes a party to the treaty.

These simple facts, however, do not begin to explain why hundreds of thousands of staff-hours, millions of dollars, and tens of millions of pages were expended in preparation for, and conduct of, this conference. They also do not explain why so many telecommunication specialists and policy makers around the world have focused on and analyzed this conference and the events surrounding it. The purpose of this report is to examine WARC-79 in a comprehensive way—describing U.S. preparations and involvement, and the impact of the conference. However, no attempt was made to examine all issues and aspects of WARC-79, but rather to focus on certain important results and analyze their consequences for the United States.

WARC-79 was held to reach global agreement concerning the international arrangements necessary for efficient and interference-free use of the radio spectrum. ITU brings nations together almost continuously at meetings and conferences necessary for coordinating the use of all telecommunications (conveying information by wire, radio, fiberoptic, etc.). WARC-79 was special because of the broad scope of its agenda, which included most of the major arrangements relating to use of the radio spectrum. These arrangements are of two major types: 1) technical and operational standards; and 2) administrative mechanisms that give member countries the right to operate particular radio stations free from harmful interference from others. Governments around the world have their own national arrangements for this, and devise necessary international arrangements through ITU. This activity is often referred to as “spectrum management.

The first function, relating to technical and operational standards, consists of establishing specifications concerning the way radio equipment should perform, the way it should be operated (particularly in emergency situations), and which portion of the spectrum should be reserved for particular kinds of radio uses. This last function is usually accomplished by defining certain kinds of radio

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"services' such as broadcasting, mobile, radiolocation, etc., and setting forth a "table of allocations" indicating which frequency bands are reserved for particular services. Both in the United States, and in ITU, much work usually surrounds the preparation of the table of allocations. Indeed, much of the work at WARC-79 was devoted to this task.

The second major management function, determining rights in operating radio stations is not always easily accomplished to everyone's satisfaction. Whether domestically or internationally, when radio channels become limited, and the possibility of stations interfering with each other on the same frequency becomes likely, some kind of administrative arrangement must be established for deciding which country has the right to operate a radio facility free from harmful interference in a given geographical area. In the domestic situation, a government agency simply devises and enforces methods of doing this. On the international level, the matter is more complicated because every nation regards itself as absolutely sovereign, unwilling to be governed by the dictates of any other nation or an international organization. As a practical matter, however, the desire to maintain interference-free radio communication has led most nations to follow arrangements fashioned at conferences of ITU.

The role of communications within a country depends on its political system, the state of economic development, access to technology, and the nature of its society. No two countries are exactly the same and the use of communication varies greatly among the countries of the world. On a broad basis, distinctions are generally made among three groups: the more highly developed industrial democracies; the varying stages of development in the East bloc countries; and the developing countries of the Third World. While these distinctions are significant, there are also many important differences within each of these broad categories.

The United States, for example, is unique in many ways. While most countries have placed the ownership and operations of telecommunication systems in government or public hands, the United States supports private ownership and commercial operations. Government ownership and operation of communication systems are reserved for those cases where commercial systems are either not available, or inappropriate, as in the case of some military operations. Even so, a large part of U.S. military communications are handled by commercial systems. The United States is dedicated to the principle of free enterprise with private and public access to the radio spectrum.

The differences between the Western nations and the East bloc countries have been reflected in world forums like the United Nations for many years. However, the most basic change in the distribution of influence in the world has been the emergence of over a hundred developing nations since World War II. Even more significant is that these nations are increasingly organized around their common plight of underdevelopment and they have exercised increasing influence and power in international arenas where votes are cast on the basis of "one-nation, one-vote." This does not mean that there is solidarity among Third World countries on all communication and radiofrequency spectrum matters. On the contrary, there are many and varied differences among such diverse nations as India and Indonesia, Nigeria and Tanzania, or Brazil and Cuba. Nevertheless, on matters of broad principle and approaches to the use of world resources and management of the radio spectrum and the geostationary satellite orbit, the focus of world politics has shifted towards the Third World. There are many questions and issues surrounding the Third World call for redistribution of the world's resources, for technology transfer, and for changes in the way world news and other information is disseminated. The United States is dedicated to the principles of free flow of information and

freedom to express ideas.* In many countries the media are government controlled or financed and alternative sources of private capital are limited. These and other issues are encompassed under the general titles of "New World economic order" and "New World information order" now under debate in world institutions like the U.N. Educational, Scientific, and Cultural Organization (UNESCO).

*While the United States is dedicated to the principles of free flow of information and freedom to express ideas, it should be noted that both in practice and in theory these principles are not absolute. For example, information is not free; first amendment rights have restrictions, and there is no right to access to media other than the limited rights under the Fairness Doctrine's equal time provisions and right to reply to personal attacks.

Can the United States Disregard the Motivations of Other Nations?

The United States, like all other nations of the world, can ill afford to have its vital communications disrupted by interference from radio transmissions of other countries. Consequently, it must be aware of other nations' motivations for frequency utilization and cooperate within reasonable limits. There is an underlying incentive among all nations to avoid interference to their individual domestic operations; to communicate among one another using international facilities on an interference-free basis; and to cooperate generally to minimize differences in the allocation and use of frequencies. There are also many diverse interests and each country seeks to maximize its own position in the give and take of international compromise. The complexities have multiplied and efforts to cooperate and achieve a measure of uniformity among nations in their use of the radio spectrum and geostationary satellite orbit have become more difficult. This is not unexpected given the increasing reliance of both the developed and developing worlds on use of the radio spectrum and geostationary satellite orbit; the growing disparity among nations over particular needs and existing investments in various parts of the spectrum; and the philosophical differences becoming more evident with the growing influence of the Third World.

How Dependent is the United States on the Radiofrequency Spectrum Including Use of the Geostationary Satellite Orbit?

The United States and other highly developed countries like Canada, Japan, and those of Western Europe are moving from the industrial age to the information age. This means that a large and increasing share of the gross national product (GNP) of these countries arises from information-related services as opposed to agricultural and manufacturing activities. The GNP of the United States is approaching $3 trillion. Almost half of all U.S. economic activity is a result of the collection, organization, analysis, and dissemination of information and information-related services. Much of this is now handled via microwave radio relay or domestic satellites. Thus, the United States has an ever-increasing dependence on the radiofrequency spectrum and the geostationary orbit.

Since the 1940's, the United States has been the acknowledged world leader in the telecommunication field. Supporting technologies range from transistors, semiconductors, and chip technology to microproc-

essors; and from microwave and coaxial cable to satellite and fiberoptic. The productivity of the U.S. telecommunication industry has grown more than twice as fast as productivity for the U.S. economy overall since 1950. The result has been that within a single generation the communication and information industry has become one of the most productive and vital in the world. Current estimates place the market for world telecommunication, electronic, and computer equipment and services at $250 billion per year. The United States has a 45-percent share of this market that is growing at an annual rate between 10 to 15 percent. Worldwide revenues from telecommunication services alone exceeded $170 billion in 1980.

Advances in technology have revolutionized the supply of telecommunication equipment and services. The economic and social structure of the United States is tied directly to the availability of the radio spectrum and the geostationary satellite orbit to support the high growth telecommunication/information industry. U.S. defense systems, vital to our national security and that of our allies, depend on the radio spectrum and satellite orbit availability. Defense operations are making increased use of both space and terrestrial systems that use the radio spectrum and every element of the defense structure must continue to have timely and flexible access to the radio spectrum to carry out its mission for national security.

The number and variety of users and services continue to expand in an information society. The commercial, private, public, and government telecommunication users all compete for use of the radio spectrum. Other industries like transportation, entertainment, banking, trade, and the news media place increasing demands on telecommunication services. Airplanes don't fly, TV programs aren't aired, financial transactions cease, orders go undelivered, and important world events go unreported without modern communications. Growth in traditional and new telecommunication services has created new demands for spectrum/orbit availability. For example, before 1965 and the launch of the first commercial communications satellite (Early Bird) there was no demand for satellite frequencies and concerns over parking slots on the geostationary orbit were nonexistent. Today, close to 100 communication satellite systems, with several satellites each, are in operation or in the planning stage. The issues over use of the geostationary satellite orbit are growing more intense and the potential consequences are far-reaching both nationally and internationally. Four U.S. domestic satellite systems are operational and three additional systems are being planned. Some 25 U.S. commercial satellites providing a range of domestic communication services from basic telephone circuits to direct-to-home entertainment may be operating within the next 5 years. International decisions about use of the spectrum/orbit will have great bearing on the future of commercial satellite service and on U.S. military satellite systems.

At the same time that new services expand, the traditional uses of the spectrum like AM, FM, and TV broadcasting grow. Almost 70 percent of the national telephone network (circuit miles) is composed of radio relay systems using microwave frequencies to carry long-distance communications. Business, industrial, public, and individual usage of radiofrequencies range from taxis and CB radios to oil pipeline management, and search and rescue operations.

The Federal Government is by far the heaviest single user of the radio spectrum and the Department of Defense (DOD) uses more spectrum than any other agency. This includes early warning defense systems of ground and airborne radars, Navy fleet command and communication systems, air navigational aids, enemy detection and location devices, and modern electronic weapons that use communications as an integral part of their operations. DOD has also produced much of the new technology that has led to broader uses of the radio spectrum.

Some additional examples of Government use of the radio spectrum help illustrate the

reliance that a developed nation, like the United States, places on interference-free operation of the radio spectrum. The Federal Aviation Administration provides navigational and air traffic control service to commercial, civil, and Government aircraft representing about 35 million flights a year. The Department of Justice is *a* major user of radio for law enforcement, crime prevention, and detection activities. The National Weather Service operates weather radars, balloon stations, and meteorological satellites for forecasting land and sea weather. Without access to the radio spectrum there could be no space exploration program and the National Aeronautics and Space Administration (NASA) would have no reason to exist.

How Different From Other Countries is the United States in Its Need and Use of the Radio Spectrum?

The United States and other developed countries with sophisticated communication infrastructures focus much attention on their need to apply new technology, offer a variety of advanced services, and support military and other Government functions and services. Generally these objectives go far beyond a basic need to communicate. They involve the complexities of satisfying the competing and often conflicting requirements that come from a host of business, social, political, national, and institutional objectives.

The developing world, on the other hand, is much more preoccupied with the need to establish a basic capability, gain self-reliance and control over their own communciations, and harness the powers of communciations for educational, social, and economic development. These differences in the stage of development and basic needs are reflected in disputes over specific frequency spectrum allocations as well as disagreements over fundamental principles that govern allocation and use of this unique resource. For instance, many developing nations took a strong position at WARC-79 to allocate high frequency (HF) radio bands (HF radio) for fixed services that they need in order to develop basic domestic telephone and other services. While not reliable, HF radio is relatively inexpensive and easy to establish. The United States uses microwave frequencies domestically and has replaced most of its HF radio with more reliable satellite and submarine cable circuits for international telephone and other services. Therefore, the U.S. position at WARC-79 was to use HF radiofrequencies for international broadcasting, mobile services, and other growing services important to the United States, but not the services of comparable interest to many of the developing countries. It should be noted however, that developing countries are taking an increasing interest in international broadcasting and exercised a key role in decisions affecting this service in the HF radio bands.

A current and particularly important issue that serves to illustrate a difference in basic principle between the United States and the Third World concerns the geostationary satellite orbit. The Third World countries have expressed concern that the developed countries may proceed to launch satellites until the capacity of the orbit is used-up before the developing countries are able to use it. To protect against this eventuality, the Third World advocates a principle of distribution of orbit locations among nations under an a priori allotment approach. They believe such an approach would guarantee them future access since it would allocate orbit locations on a preplanned, negotiated basis. The

United States, on the other hand, has immediate needs and regards such an a priori allotment as wasteful and undesirable. Under the present ITU approach, the United States as well as other nations, can take account of the advances in technology and operating techniques to "engineer-in" the next satellite and fulfill requirements as necessary on an "as-needed" basis.

The differences among countries regarding the radio spectrum cover a broad range. Conflicts occur between nations no matter what the stage of development simply because nations are not uniform in their present use or future plans for this resource. Unlike most other nations, the United States places great emphasis on personal communication and private use of the spectrum (e.g., CB radios and mobile radio for private use, large number of amateur radio operators, etc.). The United States has global military commitments with diverse military spectrum requirements, a large concentration of scientific uses of spectrum including space research and radioastronomy. The United States is also a major exporter of telecommunication equipment.

Under international regulations, countries need not coordinate frequency use unless there is a potential of interference with another country. In other words, those domestic radio operations that do not send signals across national boundaries that could cause interference are not of international concern. A TV broadcast station in the middle of the United States does not require coordination with any other country. However, a TV broadcast station close to the U.S.-Canadian border requires coordination because its signal crosses into Canada. This geographical proximity of two countries gives rise to many potential conflicts that require resolution. The United States and Canada and the United States and Mexico have a continuing need to coordinate use of the radio spectrum.

There is considerable flexibility in the international radio regulations for countries to use the radio spectrum independently for different services. However, there are mitigating factors, like the need to coordinate use at border areas between countries that argue for uniformity in use. This doesn't mean that the coordinating problems go away, but only that they become more manageable. Other factors like producing, selling, and operating radio equipment in different world markets provide incentives for uniform and sometimes nonuniform technical and operating standards. Certainly there must be a certain measure of uniformity or international communications could not occur between countries. Indeed, many services are global in nature requiring international agreement for spectrum allocation and protection against interference. Such services include aeronautical, maritime, and satellite services. An airplane making flights internationally must be able to navigate and communicate as it flies in different parts of the world. The International Telecommunication Satellite Organization (INTELSAT) global satellite system with 106 member countries is an example of an international common-user system that requires uniform radio spectrum allocations. Thus, the necessity to reach agreements and coordinate spectrum use among nations goes far beyond the basic need to avoid radio interference.

Why Is It Necessary To Coordinate Radiofrequency Use Internationally?

Electromagnetic radio waves behave differently depending on the particular part of the spectrum or frequency range being used. Many factors determine the behavior of particular frequencies. Whether or not interference will occur depends on many factors in

addition to the particular frequencies used. The transmitter power, type of receiver, and geographical separation between receivers, and type of terrain over which the signal travels are examples. The Earth's atmosphere has different effects on different parts of the radio spectrum. Different layers of the ionosphere reflect or absorb radio energy differently depending on the frequencies used, time of day, time of year, and period of the sunspot cycle. Frequencies lower in the spectrum tend to travel or propagate along the ground and follow the curvature of the Earth. This so-called "groundwave" becomes less important as the frequency range increases and the "skywave" or reflections from the ionosphere become more important. To achieve effective communications, one must choose frequencies from the band whose propagation characteristics are best suited for the intended use.

Using today's technology, most of the world's radio communication systems operate at frequencies between 10 kHz and 40 GHz (between 10,000 and 40 billion cycles per second). Over this range of frequencies, some 40 different radio services are internationally allocated certain segments or "bands of frequencies" within which to operate. For example, AM radio broadcast stations operate in the so-called medium frequency (MF) part of the spectrum (300 kHz to about 3 MHz) and are allocated the band 535 to 1,605 kHz. An individual AM station located in the United States is assigned a specific center frequency and a 10-kHz bandwidth by the Federal Communications Commission (FCC). Since the geographical area of coverage of an AM station is determined in part by the power of the transmitter, FCC limits the amount of power stations can use. Different classes of AM stations are authorized different power limits and thus have different coverage areas. Through such domestic regulatory decisions, FCC can increase or decrease the number of station assignments available in the United States independent of international decisions. However, international decisons bear directly on domestic issues in several ways. For example, WARC-79 decided to increase the amount of radio spectrum available for AM broadcasting by extending the frequency range to 1,705 kHz. While the United States had proposed to expand allocations to the broadcasting service, the conference results were not the same as the U.S. proposal. In any event, new AM radio receivers will need to be manufactured to receive this extended range of frequencies, and the future result will be more AM radio stations. Recently, the issue of reducing the channel spacing used by AM stations from 10- to 9-kHz spacing has been a subject of attention both within the United States and internationally. It appears that the U.S. position will be to maintain the 10-kHz channel spacing.

There are many examples to illustrate the complexities of spectrum management and policymaking regarding use of the radio spectrum. Almost any decision regarding radio spectrum and satellite orbit availability has many and varied consequences within the United States and internationally. Chapter 4 of this report discusses some of the major decisions negotiated at WARC-79 and their possible consequences for the United States.

How Is the Radiofrequency Spectrum Managed in the United States?

Government policymaking and spectrum management responsibilities are divided. Congress enacted the Communications Act of 1934, which created the FCC and gave it responsibility and authority to regulate nongovernment telecommunications. This ineludes spectrum management and the licensing of radio facilities except those operated by the Federal Government. The 1934 act gave the President responsibility and au-

thority over spectrum management matters and operation of radio facilities of the Federal Government—both civil and military. The management of Government use of the spectrum has been delegated by the President to the National Telecommunications and Information Administration (NTIA) in the Department of Commerce, aided by the Interdepartment Radio Advisory Committee (IRAC). IRAC consists of representatives of the major Government agencies making use of the spectrum and includes a liaison representative from FCC.

The Department of State, consistent with its responsibilities for U.S. foreign policy, performs a central role in U.S. preparations for and participation at international conferences concerning the radiofrequency spectrum. The Department of State heads U.S. delegations that negotiate with foreign governments at conferences called by ITU. Other bilateral or multilateral dealings with foreign countries about spectrum management matters come under the general province of the State Department.

Congress has both general and specific oversight responsibilities for these agencies and their conduct of spectrum management. Moreover, the U.S. Senate must give advice and consent to ratification before the President can sign international agreements that bind the United States in a treaty with other nations. The Final Acts of WARC-79 will form the international radio regulations that have treaty status and thus require Senate action.

The Federal Government is responsible for, and engaged in, many activities under the broad term of spectrum management. The Government function of evaluating needs and sorting priorities for access to the radio spectrum among the many competing and often conflicting interests within the United States is a complex process. The expanding telecommunication industry adds more and more participants and, to a lesser extent, public interest and single interest groups are entering the spectrum management process.

The radio spectrum is allocated, operational rules are set, and specific frequency assignments are made by two Federal agencies—NTIA and FCC. NTIA does it for the executive branch of the Federal Government and FCC does it for the private sector and for the State and local governments. Dealings with foreign countries about the radio spectrum, including negotiation at international conferences, are the responsibility of the Government. In addition to their role as spectrum manager, the agencies of the executive branch use more radio spectrum than any other single user. They have access to almost half of the radio spectrum allocated in the United States. Most of the allocated spectrum is available to both Federal Government and private and nongovernment users on a shared basis.

How Is the Radiofrequency Spectrum Managed Internationally?

The primary world forum for international cooperation and coordination for use of telecommunications of all kinds is ITU with 155 member nations. ITU acts as the world's clearinghouse for telecommunication matters, and members of the Union undertake a treaty relationship for use of the radiofrequency spectrum as a party to the International Telecommunication Convention and to the radio regulations.

ITU is one of several specialized agencies of the U.N. However, ITU long predates the U.N. itself. ITU, which was founded in 1865, joined with the International Radiotelegraph Convention signatories in 1932 to become ITU.

ITU does not have a permanent constitution, but rather operates under the International Telecommunication Convention that is revised periodically at ITU plenipotentiary conferences. While basic to every function of the Union, the convention is relatively brief. Details delineating ITU's activities and the responsibilities of membership are spelled out in four other documents known as the administrative regulations: the telegraph regulations, the telephone regulations, the radio regulations, and the additional radio regulations–each of which enjoys treaty status in its own right (the United States is not a party to the additional radio regulations that were ultimately suppressed by WARC-79 and will pass into history on January 1, 1982). WARC-79 was convened to revise the radio regulations. Although several world and regional specialized radio conferences were held in the interim, the last conference to consider the full range of radio regulations was held in 1959.

In the world arena, ITU is the focal point for spectrum management. Its role in telecommunications, however, is much broader than spectrum matters and includes technical standards, operating practices, accounting and rate issues, as well as matters relating to wire communications. Just as ITU's influence is broader than spectrum consideration, so are international influences on spectrum issues broader than ITU. Indeed, there are no less than a dozen international organizations concerned with telecommunication/information matters and they impact directly and indirectly on the issues of spectrum management, as illustrated later in this report. Such organizations include the Universal Postal Union; the World Intellectual Property Organization; the Intergovernmental Maritime Consultative Organization; the International Civil Aviation Organization; INTELSAT: the Intergovernmental Bureau for Informatics; the Inter American Telecommunication Conference; the Organization for Economic Cooperation and Development; the North Atlantic Treaty Organization; and other groups of the U.N. family, particularly UNESCO and the U.N. Committee on the Peaceful Uses of Outer Space with its Working Group on Direct Broadcasting Satellites.

Issues Addressed in the OTA Study

The OTA study examines broad aspects of spectrum management within the United States and internationally. The present Government structure and decisionmaking processes for spectrum management are reviewed. Possible changes and improvements to existing processes are discussed and alternative policymaking mechanisms are presented in the study.

A review of the WARC-79 conference and the major decisions taken are addressed in terms of possible consequences for the United States. The present and future roles of ITU are considered with a range of alternative approaches for future U.S. participation in ITU. The study discusses alternative strategies for dealing with current and future issues that will be raised at several important conferences within the next few years.