The 1992 World Administrative Radio Conference: Issues for U.S. International Spectrum Policy

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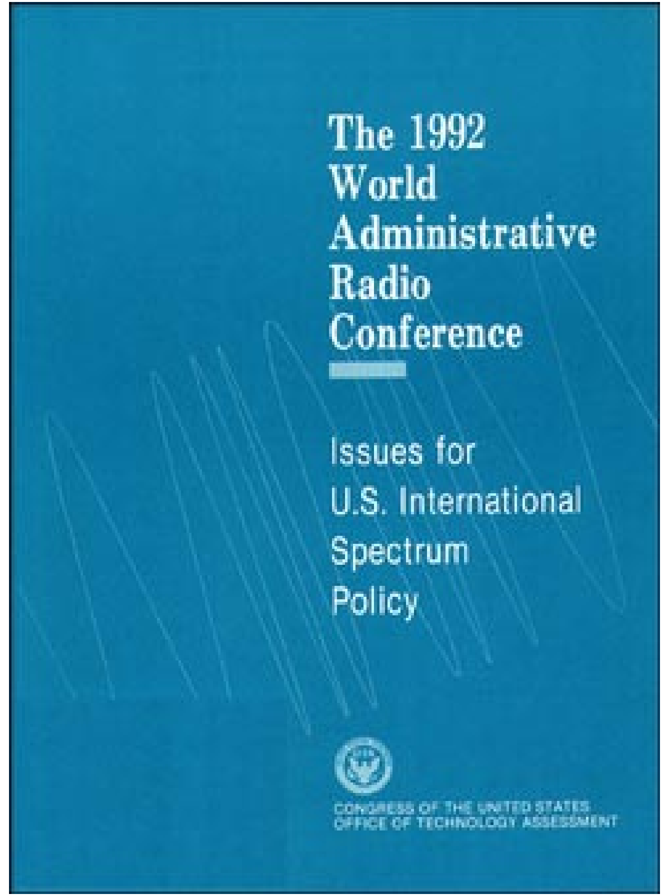

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Foreword

The radio frequency spectrum, like the ocean, the air, and space, is a common natural resource shared by the nations of the world. It is owned by no individual or government, and its use and development is not limited to or controlled by any one country or group of countries. Rather, ensuring the wise and equitable use of this vital international resource is the collective responsibility of the world community.

The radio frequency spectrum has been an integral part of domestic and international communications for more than 80 years. Radio waves make possible a wide range of communication and entertainment services, including AM and FM radio broadcasting, satellite and microwave communications, television-even baby monitors and remote garage-door openers. Today, a host of new technologies and services, such as digital audio broadcasting, high-definition television, and personal communications services, are vying with existing radio-based applications for a slice of the valuable, but crowded, radio spectrum. The World Administrative Radio Conference meeting in Spain in February 1992 (WARC-92) will attempt to reassign radio frequencies in order to take advantage of these new applications, while still accommodating the needs of existing users. The impacts of this will be felt throughout the U.S. economy and around the world. The standards and conditions set at WARC-92 will guide the development of radio-based systems and services well into the next century.

U.S. preparations for WARC-92 took place in a much different international context—political, economic, and social—than past WARCs. The geopolitical map of the world is changing rapidly with the dissolution of the Eastern bloc and the Soviet Union and the rise of Japan and the European Community as potent economic powers. The International Telecommunication Union, the body that coordinates the use and development of the radio frequency resource worldwide, is embarked on a far-reaching restructuring of its functions and processes. These changes will force the United States to adapt its international radiocommunication policy in order to retain its competitive position and traditional leadership in spectrum policymaking. However, the present fragmented domestic structure for radiocommunication policymaking may impede the development of a broad long-term vision for future radio-based technologies and services.

Because of these concerns, OTA has prepared this background paper for the House Committee on Energy and Commerce and the Senate Committee on Commerce, Science, and Transportation. OTA acknowledges the contributions of the workshop participants, who helped clarify and focus the issues. OTA also appreciates the assistance of the National Telecommunications and Information Administration, the Federal Communications Commission, and the State Department, as well as the numerous individuals in the private sector who reviewed or contributed to this document. The contents of this paper, however, are the sole responsibility of OTA.

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Introduction and Summary

The most pressing communications problem at this particular time, however, is the scarcity of radio frequencies in relation to the steadily growing demand. Increasing difficulty is being experienced in meeting the demand for frequencies domestically and even greater difficulty is encountered internationally in attempting to agree upon the allocation of available frequencies among the nations of the world.[1]

Harry S Truman, Feb. 17, 1950

Introduction

In February 1992 the International Telecommunication Union (ITU)—the organization responsible for harmonizing and regulating international telecommunication and radio services-will hold a World Administrative Radio Conference for Dealing with Frequency Allocations in Certain Parts of the Spectrum (WARC-92). WARCs are international conferences that bring together the nations of the world to coordinate radiocommunication technologies and services worldwide. WARC-92, the most wide-ranging WARC since 1979, will seek ways to designate radio frequencies for many advanced communication and entertainment services, including new mobile radio services, digital audio broadcasting, high-definition television, and new services for communication in space. The decisions made at WARC-92 will determine how and when these new services will be implemented and will influence the development of new radio technologies and applications well into the next century. The United States, as one of the world leaders in radiocommunication technology and policy, has a major stake in the outcomes of WARC-92.

The decisions made at WARC-92 will determine how and when new radio services will be implemented and will influence the development of new technologies and applications well into the next century.

In the United States the process of preparing for a WARC begins years in advance of the actual conference. Federal Government and private sector interests come together to craft the proposals the United States will present at the conference. The U.S. preparations for WARC-92 brought together many diverse interests, including broadcasters seeking to bring digital audio to listeners at home and in the car; the national security community attempting to protect frequencies used for aircraft testing; promoters of innovative mobile services provided by satellite; and a multitude of other users, e.g., amateur radio operators, police and fire departments, and the makers of microwave ovens and baby monitors. The task of sorting out and synthesizing the views of these participants is divided between the Federal Communications Commission (FCC), which examines the needs of the private sector and State and local governments, and the National Telecommunications and Information Administration (NTIA), which referees Federal Government interests. These two agencies submit their final proposals in the form of recommendations to the Department of State, which presents official U.S. proposals at WARCs and other international telecommunications meetings.

This report examines the U.S. preparations process for WARC-92, highlighting efforts to integrate the needs and concerns of various interest groups. It also reviews the forces and trends affecting the United States as it approaches WARC-92, and is intended to inform future congressional oversight of the domestic and international radiocommunication policy process.

Summary of Findings

Despite inefficiencies and problems, the domestic process of preparing proposals for international spectrum conferences works reasonably well at present. Participants in the process, in government and in the private sector, consider the

[1] Harry S Truman, quoted in Stanley D. Metzger and Bernie R. Burrus, "Radio Frequency Allocation in the Public Interest: Federal Government and Civilian Use," *Duquesne University Law Review,* vol. 4, No. 1, 1965-1966, p. 1.

process generally fair and responsive. Federal agencies have processes in place that allow them to respond relatively effectively to WARC issues and to develop coordinated positions. Final U.S. proposals for WARC-92 were developed in a timely fashion. Nevertheless, long-standing problems contribute to a process that can be overly contentious and political. Further, it is not clear that the U.S. proposals reflect the broader goals of U.S. international radiocommunication policy. More formal and rigorous government planning and high-level coordination, supported by increased staff and funds, could strengthen U.S. leadership in international radiocommunication technologies, services, and policy.

The United States is at a crucial turning point in the history of spectrum use and management. Technological, economic, and political forces are converging to radically alter the context within which domestic and international spectrum decisions and policies are made. The domestic system by which the radio spectrum is used and managed is stretched to its limits. Congested spectrum has been a recurring problem for U.S. spectrum managers for over 40 years. Demand for spectrum has continually increased, but technology has usually been able to expand the number of services and users. Today, however, the numbers of radio-based services and users are growing so quickly that the perceived scarcity of spectrum has once again become an important public policy issue. While the U.S. spectrum management system generally has worked adequately in the recent past, burgeoning demand for radio frequencies once again threatens the Federal Government's ability to promote innovation and efficiency, while at the same time accommodating existing users.[2] At the international level, WARC-92 reflects and highlights the ongoing problems of spectrum management, and represents an important opportunity for addressing the world's spectrum needs.

Because domestic problems of spectrum management do not appear to have significantly detracted from U.S. international policy in the past, it is tempting to assume that current domestic structures and processes for determining international spectrum policy will continue to serve the country well. Several trends make this assumption questionable:

More formal and rigorous government planning and high-level coordination, supported by increased staff and funds, could strengthen U.S. leadership in international radiocommunication technologies, services, and policy.

1. In the last decade, the use of radiocommunication services has expanded dramatically as technology has opened new applications. The rapid pace of technology development and increases in the use of radio services have put great stresses on the structures and processes for managing radio-based communications both domestically and internationally. Technological issues are now more complex and interwoven with economic, social, and political concerns.
2. The international scene is in a period of rapid and far-reaching transition. Old alliances are crumbling and emerging actors, such as the newly independent nations of Eastern Europe, are making international negotiations more complex than in the past. The ITU is poised to significantly restructure its organization and functioning, including the possibility that world radio conferences will be held every 2 years.[3] In this rapidly changing international environment, the United States is seeking new alliances and strengthening existing relationships. The FCC and NTIA, for example, are actively involved in efforts to strengthen the Inter-American Telecommunications Conference (CITEL), the regional telecommunications forum for the Western Hemisphere.[4]
3. The United States has no overarching policy framework or plan within which to address international radiocommunication issues, including preparations for WARCs. While there is much international expertise in the government and considerable technical expertise in

[2] U.S. Department of Commerce, National Telecommunications and Information Administration, *U.S. Spectrum Management Policy: Agenda for the Future*, NTIA Special Publication 91-23 (Washington DC: U.S. Government Printing Office, February 1991), p. 13.

[3] See the discussion of the ITU's High Level Committee (HLC) in ch. 3 and the summary of the HLC's recommendations in box 3-A.

[4] See ch. 3, box 3-B for a discussion of CITEL.

the private sector, it is not clear that this expertise is being used effectively to best realize the long-term goals of the United States. The failure to adequately address the strategic aspects of domestic and international spectrum policy in the past has contributed to international radiocommunication policy that today lacks vision and direction. In the absence of overall strategic policy planning, U.S. approaches and preparations for international conferences may not be adequate to the tasks of the future.

The implications of domestic spectrum policymaking extend beyond narrowly defined U.S. interests. Domestic and international spectrum interests are converging.[5] Until recently, policymakers approached international telecommunication policymaking and negotiation as an extension of national priorities—merely "internationalizing' domestic policy. In many cases, the focus on domestic communication issues tended to overlook the implications of those issues for international telecommunications and the interests of U.S. businesses and other communications users in the global market. Conversely, many policymakers assumed that national spectrum problems could be solved domestically-either by reallocating spectrum or increasing efficiency-without considering international pressures.

Today, international concerns are rapidly becoming part of domestic radiocommunication policymaking. There is a growing recognition among government policymakers and telecommunications analysts that many domestic spectrum problems have an inherent international dimension that must be accounted for in domestic proceedings. U.S. spectrum policy must be decided in the international context within which the radio spectrum is managed. This will require that domestic and international policies be more effectively integrated. Processes and decisions that take inadequate notice of international considerations will not be effective. The establishment of an Office of International Communications in the FCC (see ch. 4) indicates increased recognition of the importance of international concerns for domestic policy.

Successful U.S. international spectrum policymaking will require that domestic and international policies be more effectively integrated.

The lack of a unified national radiocommunication policy, including international spectrum goals, will hurt the United States' ability to negotiate and compete globally. Many of the problems in the radiocommunication policy process reflect more general failures in highlighting the importance of U.S. radiocommunication policy and pursuing integrated goals that are based on well-defined technological, economic, and social priorities. The United States has no comprehensive long-range plan or vision for the future of radiocommunications, and thus no comprehensive framework within which to make strategic spectrum policy decisions, either domestically or internationally.

This country depends on a system which emphasizes "market forces,' but which reemphasizes planning and prioritizing. This approach reflects a long held U.S. view that formal spectrum planning is not efficient and not desirable. There is a belief among some government policymakers that the government should not plan spectrum use as much as it should respond to priorities set by the private sector (and government users) through market forces. A more formal planned approach, they argue, would prejudge future radiocommunication needs and constrain technologies and services yet to be developed. One of the objectives in a market-oriented approach is to build flexibility into the system that will allow the United States to respond to the new needs and technologies of the future in a timely way. This approach, based on a diversity of interests competing before the government, may give the system the flexibility it needs to adequately meet the evolving short-term needs of both the government and the private sector, but overreliance on such market forces may threaten the effective pursuit of broader, longer-term goals and priorities. Market forces can delay introduction of new products and services and lead to inefficiencies (recall AM stereo and the battle

[5] This trend was noted by OTA in 1985. See U.S. Congress, Office of Technology Assessment, *International Cooperation and competition in Civilian Space Activities,* OTA-ISC-239 (Washington DC: U.S. Government Printing Office, July 1985).

No single government agency is responsible for planning for new radio services, and no government agency has been mandated or assumed a leadership role in domestic and international spectrum policymaking.

between VHS and Beta).[6] OTA notes that a shift to private sector decisionmaking in communication policy "has created a vacuum in the policymaking process with respect to societal decisions about communication that are not easily made by summing up individual preferences or deferring to market power. '[7] No single government agency is responsible for planning for new radio services, and no government agency has been mandated or assumed a leadership role in domestic and international spectrum policymaking.[8]

Cooperation on long-range planning or even on establishing a long-term vision for U.S. spectrum policy is almost nonexistent. While the Federal Government agencies involved in spectrum policymaking have established internal procedures for addressing specific radiocommunication issues (e.g., WARC preparations), and do cooperate on policy formulation in these areas, beyond these narrow concerns, coordination among government agencies and between the government and private sector on longer-term domestic and international spectrum issues is mostly informal. In lieu of explicit mechanisms for formulating strategic international radiocommunication policy, the process depends largely on the individuals involved and on the relationships they have formed over time. While such coordination may be effective on a day-to-day basis, the lack of long-term strategic guidance in spectrum policymaking has reduced policy planning to a reactive exercise.

In this context, WARCs are especially important because they serve as focal points for both short- and long-term spectrum planning. More importantly, they represent a critical opportunity for drawing together the interests of government and industry in developing the broader issues of international radiocommunications policy. Without WARCs, spectrum planning and policy development on an international level would likely be greatly reduced. With regularly scheduled WARCs a real possibility in the future (see ch. 3), the United States could have an important opportunity to focus ongoing attention on the "big picture" of international spectrum policy and to develop integrated long-term strategies for using spectrum resources and pursuing effective international policies.

The Radio Frequency Spectrum

General Background

The radio frequency spectrum refers to the total range of radio frequencies (3 kHz-300 GHz) that can be used for telecommunications (see figure l-l)[9] It makes possible many of today's most important communications technologies and services. Radio waves are used to transmit information and entertainment of all kinds, including television and radio programming, long-distance and cellular telephone service, safety and navigation services for aeronautical and maritime use, radar and defense communications-even the signals used by baby monitors and remote garage-door openers. Radio-based technologies and systems are increasingly being used to connect to the public telephone network, allowing users access while traveling or in rural areas without wired service. New services are being developed constantly, but the limited availability of adequate spectrum may constrain future advances in radiocommunication services.

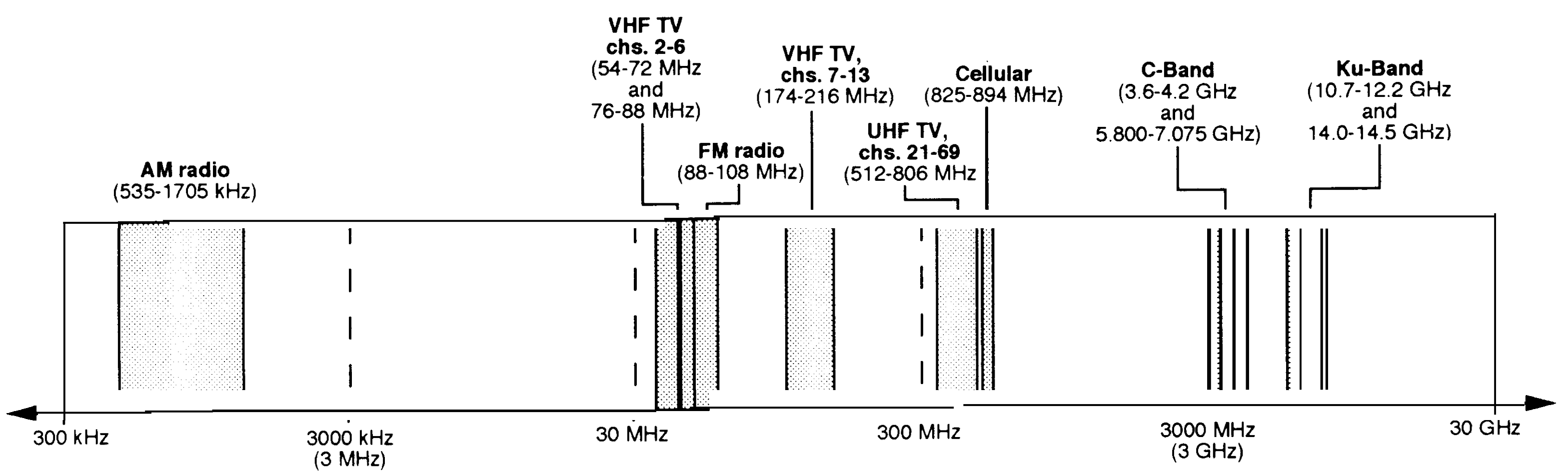
[6] Significantly, the FCC is now in the process of setting standards for future high-definition television systems, rather than let-tie market take its course.

[7] U.S. Congress, Office of Technology Assessment *Critical Connections; Communication for the Future,* OTA-CIT-407 (Washington, DC: U.S. Government Printing Office, January 1990), p. 361.

[8] NTIA's efforts to implement the recommendations of its recent report on spectrum management indicate that government policymakers are beginning to grapple with some of these issues.

[9] Radio frequencies are measured in hertz, which is a measure of the number of cycles a radio wave completes in 1 second-1 hertz (Hz) represents one cycle per second (see ch. 2). Prefixes are used to indicate numbers of hertz in multiples of 10: kHz= thousand Hz; MHz= 1 million hertz; and GHz= 1 billion hertz. The radio frequency spectrum is only one segment of the larger electromagnetic spectrum, which comprises all light and radio waves and includes audible sound, radio waves (the radio frequency spectrum), infrared light, visible light, ultraviolet light, x-rays, gamma rays, and cosmic rays.

Figure 1-1—Radio Frequency Spectrum and Selected Services



NOTE: This figure uses a logarithmic scale with dashed lines representing breaks in the scale. Shaded areas in different segments of the scale are not proportional. For example, AM radio occupies 1,170 kHz of spectrum, while cellular (which appears smaller visually) actually occupies 69,000 kHz of spectrum.

SOURCE: Office of Technology Assessment, 991.

The spectrum is divided or "allocated" into frequency 'bands' that correspond to certain ranges of frequencies and specific radiocommunication services (see table 1-l).[10] Individual radio services, such as AM and FM radio broadcasting, television, navigation, and satellite services, also use specific bands of frequencies. For example, FM radio broadcasting uses the frequencies 88-108 MHz. Within some of these radio service bands, the spectrum is further subdivided into separate "channels," which are assigned by the government to individual users. For example, 90.9 MHz in the FM radio band is assigned to radio station WETA in Washington, DC. The same charnel can also be assigned to other radio stations in distant cities, thus allowing the radio frequencies to be reused. In some frequency bands, many users and even different services, share the same segment of spectrum. Radio systems used for point-to-point and mobile communications services, for example, share many frequency bands.[11]

Radio Spectrum as Public Resource

The radio frequency spectrum has long been viewed as a vital natural and national public resource, and protecting and enhancing this limited resource has been a Federal Government function dating back to the early part of this century. In 1925, then Secretary of Commerce Herbert Hoover declared:

> The ether [sic] is a public medium, and its use must be for a public benefit. The use of a radio channel is justified only if there is public benefit. The dominant elements for consideration in the radio field is, and always will be, the great body of the listening public, millions in number, countrywide in distribution. [12]

The radiofrequency spectrum has long been viewed as a vital natural and national public resource, and protecting and enhancing this limited resource has been a Federal Government and congressional concern dating back to the early part of this century.

Congress also has a long history of seeking to ensure the development of this resource for the public good, dating back even before the creation of the FCC in 1934.[13] Concern over radio spectrum and services resurfaced in 1958, only 1 year before the 1959 general World Administrative Radio Conference:

> The development of so valuable a natural resource as the radio spectrum is a matter of paramount importance. The spectrum is a publicly owned natural resource the importance of which increases year by year as its use for varied purposes grows. It has long been apparent that the capacity of this resource is not unlimited and that its effective utilization cannot be expanded indefinitely. The interdependence of regulatory measures and technology in making possible the most effective use of the spectrum is a significant point that requires most painstaking study. The use of the spectrum requires as careful planning and administration as any other national resource.[14]

Today, spectrum policy is increasingly recognized as an important area of national telecommunications policymaking. In the last several years Congress, the executive branch, and the FCC have been studying and seeking solutions to spectrum

[10] The process of allocation refers t. the designation of a group of radio frequencies to a service or family of related services. For example, the band 88.0- 108.0 megahertz (MHz) is allocated to (FM radio) broadcasting. Assignment of frequencies refers to the granting of a right to use a specific frequency or band of frequencies to an end user or service provider. For example, the FCC has assigned 542-548 MHz (television channel 26) in Washington DC to WETA. For more in-depth discussion of the procedures of allocation and assignment, both domestic and international, see Richard Gould, Telecommunications Systems, Inc., ''Allocation of the Radio Frequency Spectrum,' contractor report prepared for the Office of Technology Assessment, Aug. 10, 1990.

[11] Sharing spectrum is accomplished in many different ways. Users can share by time (taking turns or using for specified hours of the day), by geography (users can share the same frequency if they are far enough apart so tbat signals do not interfere), or by technologies that reduce interference. Sometimes sharing is planned, as in the case of channeling arrangements, but sometimes it is not-cellular radio providers have a specific block of spectrum they must use, but individual customers use the service on demand.

[12] Quoted in Max D. Paglin (cd.), *A Legislative History of the Communications Act (New* York, NY: Oxford University Press, 1989), p. 9.

[13] For a more complete description of the early history of radio regulation leading up to the Communications Act Of 1934, see Paglin, op. cit., footnote 12.

[14] U.S. Congress, Senate Committee on Interstate and Foreign Commerce, *Commission To Investigate Utilization of Radio Frequencies Allocated to the Government, 85th* Cong., 2d sess., Report No. 1854, July 18, 1958, p. 2.

Table l-l—Radio Frequency Bands and Uses

Name	Frequency range	Examples of services
Very low frequency (VLF)	3 to 30 kHz	Marine navigation
Low frequency (LF)	30 to 300 kHz	Marine and aeronautical navigation equipment
Medium frequency (MF)	300 to 3,000 kHz	AM radio broadcast, LORAN maritime navigation, long-distance aeronautical and maritime navigation
High frequency (HF)	3 to 30 MHz	Shortwave broadcast, amateur radio, CB radio
Very high frequency (VHF)	30 to 300 MHz	Private radio land mobile services such as police, fire, and taxi dispatch; TV channels (2 through 13); FM broadcasting; cordless phones; baby monitors
Ultrahigh frequency (UHF)	300 to 3,000 MHz	UHF TV channels; cellular phones; common carrier point-to-point microwave transmission used by long-distance phone companies; satellite mobile services
Superhigh frequency (SHF)	3 to 30 GHz	Radar, point-to-point microwave, and satellite communication
Extremely high frequency (EHF)	Above 30 GHz	Satellite communications and space research

SOURCES: Harry Mileaf (cd.), *Electronics One,* revised 2d ed. (Roehelle Park, NJ: Hayden Book Co., Inc., 1976), p. 1-14; and John J. Keller, "No Vacancies," The Wall Street Journal, Nov. 9, 1990, p. R14.

concerns. In the 102d Congress, five bills relating to spectrum use and management have been introduced, the Emerging Telecommunications Technologies Act of 1991 (H.R. 531, H.R. 1407, and S. 218)[15] and the Amateur Radio Spectrum Protection Act (H.R. 73 and S. 1372). NTIA recently completed a comprehensive study of the U.S. domestic spectrum policymaking process that includes recommendations on how the system might be improved.[16] The FCC is conducting a study of spectrum use in order to identify underused portions of the spectrum for possible inclusion in a "spectrum reserve" that could be used for the development of emerging communications technologies and services.[17]

Spectrum Scarcity and Crowding

The radio frequency spectrum is a finite-but reusable—resource. It is reusable in the sense that when one person stops using a certain frequency another person can start. Using the resource does not consume it. Radio frequency spectrum is finite in that only a certain range of frequencies can be used for communication at any given level of technology. And although technological advances continue to expand the range of usable frequencies, the fundamental properties of radio waves make some radio frequencies more useful, and hence more valuable, than others. For example, the transmission characteristics of radio waves in the 1-3-GHz band (see ch. 2) make them especially valuable for many mobile and fixed services.[18]

The problem is that more and more technologies and communication services are vying for a slice of the valuable radio spectrum, and demand for spectrum is growing rapidly, both for new services, such as high-definition television (HDTV) and personal communications services (PCS) (see box 2-B), and for the expansion of existing services such as cellular telephony. The ITU has recorded as many

15 All three of these bills would require that the government make available for transfer to the private sector 200 MHz of total spectrum bandwidth. H.R. 1407, the administration's counter proposal to companion bills H.R. 531 and S. 218, also includes the requirement tbat spectrum be distributed to users through a competitive bidding process.

16 NTIA, *U.S. Spectrum Management Policy,* op. cit., footnote 2.

17 Part of the impetus for this initiative has come from developments in other countries. FCC Chairman Sikes has noted that Europe and Japan have taken steps to reserve spectrum in the 1-3-GHz band and that the United States should follow suit in order to maintain its technological and competitive edge. Speech before the Practicing Law Institute and the Federal Communications Bar Association conference, Washington DC, Dec. 6, 1990.

18 Fixed service refers t. telecommunication services more commonly known as point-to-point, microwave, or radio-relay systems. For a discussion of the technical properties of the various radio frequency bands, see Gould, op. cit., footnote 10.

new frequency assignments in the last 10 years as in the previous 80 years of radio communications.[19] In response to a recent FCC announcement that it would license 200 radio charnels to provide new mobile communications services, the Commission received almost 100,000 applications from potential providers.[20]

The result, and the most critical problem facing spectrum managers today, is a shortage of unused spectrum and serious congestion of the most valuable bands.[21] The problem is a recurring one. In the 1920s the use of radio for broadcasting in the United States exploded-interference threatened to overwhelm the industry. The problem resurfaced in the United States in the late 1950s when a report was issued on the allocation of television channels and hearings were held regarding the allocation of spectrum between government and nongovernment users.[22] Internationally, the problem dates back to the 1930s. At that time new aeronautical services had begun to compete with broadcasters and maritime users for radio spectrum.[23]

Today, the accelerated pace of technology development, coupled with a rapidly changing world environment in economics and politics, has made coordinating the use of the radio frequency spectrum increasingly complex, and has raised the issues of radiocommunication and spectrum policy to new prominence.[24] In broad terms, the problem is finding ways to expand existing services and promote new radio technologies while simultaneously accommodating existing users who have successful services and large capital investments. At the international level, WARC-92 is an important attempt to sort out these issues for many applications, including mobile services, high frequency broadcasting, and new space services (see the discussion of major WARC-92 issues below).

The problem is finding ways to expand existing services and promote new radio technologies while simultaneously accommodating existing users who have successful services and large capital investments.

Spectrum Management

Managing the use of the spectrum is an extremely complex task both because of the variety of services and technologies involved, and because radio waves easily cross geographic and political boundaries. The functions of spectrum management are twofold.[25] First, spectrum managers must try to accommodate all the various services with their differing technical characteristics and requirements. They do this by allocating bands, or blocks, of spectrum to the various services, such as broadcasting, mobile, amateur, and satellite services. Second, spectrum managers establish conditions of use for radiocommunication services in order to ensure that use is as fair and efficient as possible. Because radio waves do not respect national borders, spectrum allocation and use must be coordinated internationally as well as domestically. The most visible outcome of this function is controlling interference between users and between services. Managers also try to ensure that use of the spectrum is as efficient as possible. The international Radio Regulations that govern radiocommunications worldwide, for example, set levels on transmitter power to limit interference and

[19] Mark Lewyn and Peter Coy, "Airwave Wars," *Business Week*, July 23, 1990, p. 48.

[20] "The Scramble for Frequencies, ' *Telcom Highlights International*, vol. 13, No. 4, June 12, 1991.

[21] Some believe, however, that the spectrum "shortage" is an artificial concept—that it has been created by the processes used to allocate and assign spectrum resources. Changing the process for distributing these resources, they argue, would eliminate any scarcity. See George Gilder, "What Spectrum Shortage?" *Forbes, May 27*, 1991.

[22] U.S. Congress, Senate Committee on Interstate and Foreign Commerce, *Allocation of TV Channels: Report of the Ad Hoc Advisory Committee on Allocations, Committee* Print, *Mar. 14*, 1958; U.S. Congress, House Committee on Interstate and Foreign Commerce, *Allocation of Radio Spectrum Between Federal Government Users and Non-Federal Government Users*, Hearings June 8 and 9, 1959.

[23] For a discussion of the history of radio services and the development of the ITU, see George A. Codding, Jr. and Anthony M. Rutkowski, *The International Telecommunication Union in a Changing World* (Dedham, *MA:* Artech House, 1982).

[24] Some analysts, e.g., identified the shortage of available spectrum as the biggest hurdle facing the widespread development of personal communication networks. Charles Mason, "Wireless Technologies Draw Interest," *Telephony*, vol. 220, No. 12, Mar. 25, 1991, p. 10.

[25] For more discussion of these functions, see NTIA, *U.S. Spectrum Management Policy*, op. cit. footnote 2; U.S. Congress, office of Technology Assessment, *Radiofrequency Use and Management*, OTA-CIT-163 (Washington, DC: U.S. Government Printing Office, January 1982), pp. 25-26.

can mandate that certain technologies be used to promote efficiency, such as single-sideband broadcasting (see ch. 2).

In the United States, the agencies responsible for managing the spectrum are the FCC, an independent agency, and NTIA in the Department of Commerce. The FCC oversees the use of the spectrum by the private sector and all State and local government users, and NTIA manages the spectrum used by the Federal Government. Internationally, spectrum is allocated and regulated by the ITU through the WARCs that are held to review and revise the Radio Regulations.[26]

The problems of domestic spectrum management do not exist in isolation from the larger international context within which so much of spectrum policy is decided. Rather, domestic and international spectrum policymaking are interdependent processes-each influences the other. Domestic allocations, for example, generally conform to the international Table of Allocations and the Radio Regulations maintained by the ITU and revised at the WARCs. Those international allocations and regulations, in turn, are the product of negotiation among many countries, each pursuing its own national goals. Domestic spectrum policymaking must take careful account of the implications of international decisions if the interests of the United States are to be adequately protected.

> The more advanced our technology becomes, and the more complicated our frequency utilization, the more apparent it is that there must be complete correlation of the national and international aspects of frequency use.[27]

While these concerns are recognized by domestic spectrum policymakers, it is unclear how well domestic and international spectrum policymaking is integrated. Few attempts have been made to rationally lay out and harmonize international and domestic spectrum policy goals, and what accord does exist has occurred on a reactive, piecemeal basis rather than as a result of any long-range planning or cooperative effort. Some domestic spectrum mechanisms and activities, including WARC preparations, do take account of international parameters such as the international Table of Frequency Allocations, but these activities often concentrate on specific issues or radio services. They at-e not guided by strategic policy decisions made in a framework of long-term international spectrum goals and priorities. Longer-term domestic spectrum policymaking has largely proceeded independently of international concerns—policy is first set domestically and then extended to the international arena. The failure to aggressively link long-term international policy efforts with domestic needs could threaten U.S. technological and policymaking leadership and could undermine future success in U.S. international spectrum policymaking.

Domestic spectrum policymaking must take careful account of the implications of international decisions if the interests of the United States are to be adequately protected.

World Administrative Radio Conferences

General

The function of a WARC is fundamentally technical, but the process of spectrum allocation and management has always been both a political and technical process.[28] It is the means by which the world distributes the resources of the radio frequency spectrum. The Final Acts of WARCs have international treaty status, and must be approved and ratified by member governments. Once ratified, they

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[26]The ITU, strictly speaking, does not "manage" spectrum use on a day-today basis. Rather, it allocates spectrum bands, defines categories of services, and sets the technical and administrative rules which govern spectrum use internationally. Individual national governments usually follow these rules, but still retain final authority in deciding how their domestic spectrum resources will be used.

[27]Harold E. Fellows, testimony at hearings before a Subcommittee of the Committee on Interstate and Foreign Commerce, 011 Allocation Of Radio Spectrum Between Federal Government Users and Non-Federal Government Users, 86th Cong., 1st sess., June 8 and 9, 1959, p. 36.

[28]For a discussion of the political aspects t. ITU and WARC activities, see James G. Savage, *The Politics of International Telecommunications Regulation* (Boulder, CO: Westview Press, 1989).

are generally adhered to by all ITU members.[29] As such, they carry enormous weight in setting future international radiocommunication policy, allocations, and services. There are three types of administrative radio conferences. First, the general WARCs held by the ITU address all radio services and spectrum allocations, and can review and revise any or all of the international Radio Regulations. General WARCs were held in Atlantic City, 1947; Geneva, 1959; and Geneva, 1979. Despite the wide range of issues it will cover, WARC-92 is not a general conference since it will not examine the complete international Table of Frequency Allocations and all of the Radio Regulations.

Instead, WARC-92 is a specialized WARC. Specialized WARCs generally examine issues relating to specific frequency bands or radio services. WARC-92, for example, will examine mobile services, high frequency broadcasting, and new space services, among others. Since 1979 four specialized WARCs have been convened, covering High Frequency Broadcasting (HFBC-84/87), space services and orbital assignments for satellites (ORB-85/88), mobile services (concentrating on distress and safety services) in 1983, and mobile services (MOB-87) (see table 1-2).[30] These conferences were convened in large part to address specific issues that the 1979 general WARC could not resolve. WARC planners believed that a narrower focus on specific issues would enable the ITU members to reach decisions more easily and quickly than a broad, general WARC could allow, thus streamlining the ITU process.

Regional Administrative Radio Conferences (RARCs), which bring together the ITU member countries from a specific geographical region (see figure 1-2), sometimes address allocation issues, but are usually confined to specific issues that have particular regional importance or require regional coordination, such as television and AM/FM radio services.[31] Importantly, these conferences may not revise the Radio Regulations, but may only propose changes to be considered and confirmed at the next competent WARC. A broadcasting plan developed for Region 2 at the 1983 RARC, for example, was adopted by the 1985 specialized WARC on the Use of the Geostationary-Satellite Orbit and the Planning of Space Services Utilizing It (ORB-85).

Table 1-2—International Telecommunication Union World Conferences Since 1979

1979	General WARC (WARC-79)
1980	—
1981	—
1982	Plenipotentiary (Nairobi, Kenya)
1983	Mobile Services WARC (Distress and Safety)
1984	High Frequency Broadcasting WARC (First Session-HFBC-84)
1985	WARC on the Use of the Geostationary-Satellite Orbit and the Planning of Space Services Utilizing It (First Session-ORB-85)
1986	—
1987	High Frequency Broadcasting WARC (Second Session-HFBC-87)
	WARC for the Mobile Services (MOB-87)
1988	WARC on the Use of the Geostationary-Satell ite Orbit and the Planning of Space Services Utilizing It (Second Session-ORB-88)
1989	Plenipotentiary (Nice, France)
1990	—
1991	—
1992	WARC for Dealing With Frequency Allocations in Certain Parts of the Spectrum (WARC-92)
	Plenipotentiary (Geneva Switzerland)
1993	—
1994	Plenipotentiary (Japan)
1995	High Frequency Broadcasting WARC (proposed)
1996	—
1997	—
1998	Plenipotentiary (location undetermined)

SOURCE: Office of Technology Assessment, 1991.

The 1992 World Administrative Radio Conference

Background

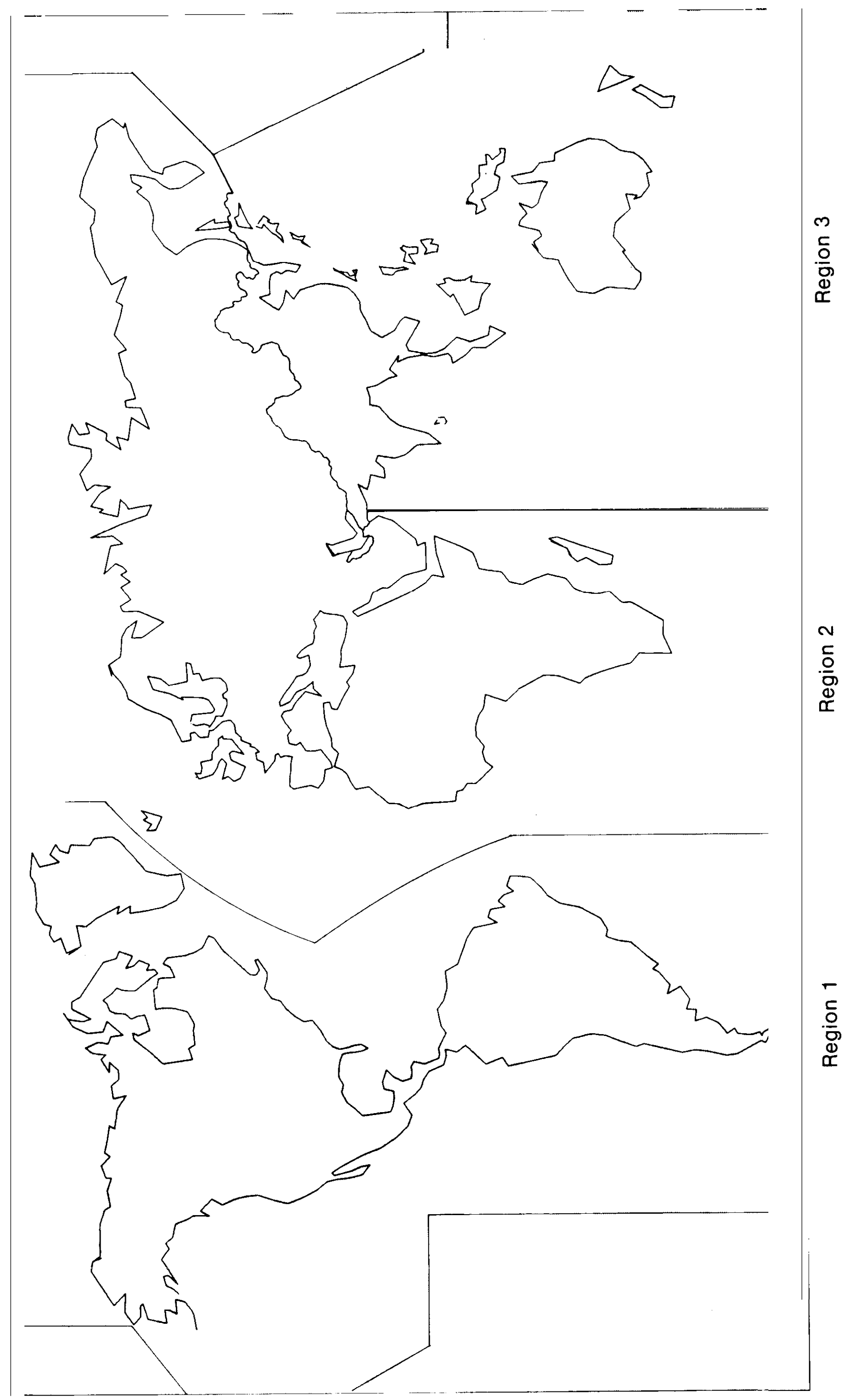
At its 1989 Plenipotentiary Conference in Nice, France, the ITU decided to hold a World Administrative Radio Conference for Dealing with Fre-

29 If a member disagrees with a specific action or the action will interfere with domestic telecommunications operations, an administration can take a “reservation” in the Final Acts stating that the country will not necessarily abide by the new regulation. A reservation permits a nation to ratify the treaty while maintaining some degree of autonomy and flexibility for its domestic policies.

30 In all, 4 WAR& (in 6 sessions) took place in the 1980s, along with 9 Regional Administrative Radio Conferences (in 12 sessions).

31 The ITU has divided the world into three regions. Region 1 consists of Africa, Europe, and the U.S.S.R. Region 2 encompasses the Americas; including Canada, Greenland, United States, Central and South America, and the Caribbean. Region 3 includes Asia, Australia, and Oceania. See figure 1-2.

Figure 1-2—International Telecommunication Union Regions of the World



SOURCE: U.S. Department of Commerce, National Telecommunications and Information Administration, *Tables of Frequency Allocations and Other Extracts From: Manual of Regulations and Procedures for Federal Radio Frequency Management*, September 1989 ed., p. 4-30.

quency Allocations in Certain Parts of the Spectrum (WARC-92). In 1990 the ITU Administrative Council prepared an official agenda of the topics to be addressed.[32] (See app. B for the full text of the WARC-92 agenda.)

In large part, WARC-92 was called to address issues unresolved at past conferences. In the 12 years since WARC-79, many specialized radio conferences took place that addressed specific areas of the spectrum and specific services, such as high frequency broadcasting and space services (see above). While these conferences often accomplished a great deal, they could not reach agreement on all issues. Consequently, many of the items on the WARC-92 agenda are based on recommendations and resolutions from previous conferences, and, as a result, the conference will address several old issues, including high-frequency broadcasting in the band 3-30 MHz, anew allocation to the broadcasting-satellite service for HDTV, preferably on a worldwide basis, somewhere in the band 12.7-23 GHz, and allocations to Mobile services, including Mobile Satellite Services in the band 500-3000 MHz.

In addition to the old items on the agenda, several new issues have been added. Prior to (and at) the 1989 Plenipotentiary Conference that scheduled the WARC, there was resistance in the United States to abroad reallocation conference. It was felt by many, especially government interests, that the United States had more to lose than gain at such a conference.[33] The United States favored a more limited conference that would deal with space services and/or mobile services. Once the initial agenda was released, however, interest in the conference grew through 1989 and 1990, especially in the private sector, which had been developing new technologies and services and saw the conference as an opportunity to get radio frequencies it needed. Lobbying by industry and the FCC's Industry Advisory Committee (see ch. 4), finally convinced the government to pursue additional agenda items. At the 1990 ITU Administrative Council meeting, the United States succeeded in having a limited number of new issues included on the agenda, such as low-Earth orbiting satellites (LEOS) and a terrestrial complement to satellite sound broadcasting (see below) .34

Although the agenda appears to be freed, and the ITU Convention states that discussion must be limited to those items on the agenda, this may not always be the case. Imprecise definitions and overlapping services encourage some governments, including the United States, to make proposals regarding items that are not explicitly part of the official agenda.[35] While these proposals are made in response to spectrum needs identified by both government and industry, some analysts are concerned that such tactics can undermine U.S. credibility abroad, and may threaten overall U.S. effectiveness at conferences.

The Context for WARC-92

In 1982, OTA published a report entitled *Radiofrequency Use and Management: Impacts from the World Administrative Radio Conference of 1979.*[36] Ten years later many of the same issues of spectrum use and management remain unresolved, and many of the same forces continue to put pressure on domestic and international spectrum policy processes. The issues and trends outlined below form the context within which WARC-92 will operate.

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[32] Proposals for conferences may originate with individual members of the ITU. More often, a Plenipotentiary Conference, or a previous Administrative Conference may adopt Resolutions or Recommendations that a conference be held within a certain time period, to address one or more specific subjects. The agenda for radio conferences is set by the ITU Administrative Council with input and agreement from member administrations, and is based on items requested by a Plenipotentiary Conference, including recommendations and resolutions from previous WARCs (see ch. 3).

[33] Department of Defense and aviation interests specifically were afraid that a general reallocation conference would take awaY some of their frequencies. The FCC did not want a broad conference because they had neither the time nor the staff resources to do the preparation work, and because initially there was little support among industry.

[34] In all, the following items proposed by the United States were put on the agenda (although not necessarily in the exact form requested): HDTV below 12.7 GHz, LEOS, terrestrial sound broadcasting between 500-3000 MHz, RDSS upgrade in Regions 1 and 3, primary MSS at 20/30 GHz, and a new space service in 27.3-30 GHz.

[35] The WARC-92 agenda, for example, only specifically addresses LEOS services *below* 1 GHz. In its final WARC-92 proposals (see app. D), however, the United States has embedded LEOS *above* 1 GHz in a proposal to allocate spectrum to the Mobile Satellite Service in the 1613.8-1626.5-MHz and 1850-1990-MHz bands. Government officials and LEOS proponents maintain that this is legitimate under existing service definitions (LEOS will provide mobile satellite services) and the WARC-92 agenda. Others believe that this violates the spirit of (and a strict reading of) the agenda, which specifies that only LEOS services in bands below 1 GHz are to be considered.

[36] Op. cit., footnote 25.

Technology (ch. 2)—Technology trends drive the WARC process. The pace of technological change is immeasurably faster than it was only 12 years ago, and rapid developments in technology have put increasing pressure on the ITU and the WARC process. The role of technology in today's crowded spectrum is twofold and often contradictory-it is both problem and solution. New technologies and services and the expanding use of old technologies and services are squeezing available spectrum allocations. On the other hand, advances in technology can free up spectrum and allow it to be used more efficiently. Innovations such as digital compression, spread spectrum, and trunking can also increase availability of radio frequencies.

International Environment (ch. 3)—But radiocommunications is not just a technology issue. The arena in which international spectrum allocation and planning takes place is also changing rapidly. Today, new players have become prominent as others have faded, and firm alliances have given way to rapidly shifting factions. The 1980s witnessed the rise of Japan as a major economic power and the industrialization of countries such as Brazil and Korea. The influence of the Soviet Union has declined dramatically as the Eastern bloc has dissolved and the U.S.S.R. itself is beset with internal turmoil. East-West and North-South confrontations have been replaced by regional divisions. Moving into the 1990s, the world is seeing the emergence of a unified Europe and a realignment of the Eastern European nations. Accompanying these changes, the historic tension between the developing and developed countries that characterized the 1970s and early 1980s has lessened. There is now a different tone to international telecommunications policymaking that is more flexible and conciliatory.

The role of technology in today's crowded spectrum is twofold and often contradictory—it is both problem and solution.

In addition to these political forces, economic pressures are also reshaping the world environment for radiocommunications. Telecommunications systems and services, including radiocommunications, are increasingly global in scope, and telecommunications is increasingly seen as an important piece of the broader context of economics, trade, and development. Competitive pressures have forced many governments to liberalize or privatize their telecommunication industries.

Telecommunications systems and services, including radiocommunications, are increasingly global in scope, and telecommunications is increasingly seen as an important piece of the broader context of economics, trade, and development.

Recognizing the importance and scope of these changes, the ITU established the High Level Committee to examine ways to improve the structure and processes of the ITU in order to more effectively respond to the challenges of advancing technology and members' development needs. In order for the United States to respond to these changes, the Federal Government, with extensive input from industry, will have to develop new ways of thinking and negotiating in order to be most effective in this new climate of change. The United States must become more adroit in setting and negotiating international spectrum policy.

Domestic Radiocommunication Policy Process (chs. 4 and 5)—The domestic process for allocating and managing spectrum is complicated. Responsibility is divided between the FCC and NTIA, with input from the private sector. International radiocommunication policymaking, including WARC-92 preparations, is also fragmented. In addition to the FCC and NTIA, the Department of State becomes involved as the official representative of the United States abroad. Some consider this diversity to be a strength, but coordination and reconciliation of various views can be difficult, and may make the process of preparing for international conferences time-consumin g and inefficient. In addition, linking the goals of WARC-92 into the overall goals of U.S. international spectum policy was not possible because no overarching framework exists to guide U.S. spectrum policy. Accountability for matching WARC proposals to long-term, strategic spectrum goals is thus almost nonexistent.

The activities of the ITU, including WARCs, offer the United States an important opportunity to advance its views on technical standards and regulations.

Why Is WARC-92 Important?

Effective U.S. participation in the activities of the ITU and the WARC process is important at several levels. Without international standards and procedures for sharing the spectrum, global radio communication and services would be impossible. Although international interference problems are not as much of a problem for the United States as other countries, the United States must nevertheless coordinate services that are worldwide, such as safety services for aeronautical and maritime services. U.S. participation in the ITU is also crucial to our international stature both politically and technically. Were the United States to pull out of or fail to ratify ITU documents, such as the Final Acts of the WARCs, on a regular basis, a poor precedent would be set that could jeopardize U.S. participation and negotiations in other international bodies. Finally, the ITU offers the United States an important opportunity to advance its views on technical standards and regulations, promoting global standards that allow U.S. firms to take advantage of economies of scale in manufacturing and the provision of services. Such input is critical in maintaining the technological and policy leadership of the United States in international radiocommunications.

WARC-92, in particular, is important to the United States for several reasons. The new services of an increasingly information-oriented and mobile society will rely heavily on radio spectrum resources, perhaps even more so than in the past. But because the most desirable parts of the spectrum are almost completely allocated and many bands are heavily used, finding room for new services is difficult. WARC-92 is the first attempt to address the requirements of the new technologies at one comprehensive meeting. While recent conferences have addressed more limited issues, WARC-92 will touch on a wide range of new (and old) radiocommunication services. The decisions reached at WARC-92 will determine which technologies and services get spectrum and how much.

The results of WARC-92 will also fundamentally affect how new services will be introduced internationally, and on what time schedule.[37] Allocations from WARC-92 will also have substantial impacts on future domestic developments and policies, because changes in the international Table of Allocations will likely be translated to the U.S. National Table of Frequency Allocations.[38] For example, the FCC now has before it several proceedings dealing with new services such as Broadcasting-Satellite Service-Sound (BSS-Sound) and PCS that could be substantially affected by WARC decisions.[39] How closely the FCC and NTIA will follow the decisions adopted at the WARC will vary by item, adhering closely to some and ignoring specifics of others. Ensuring American participation in the full range of new international communications systems will require a clear linkage of domestic spectrum policy to the international environment.

Having U.S. proposals adopted at WARC-92 is particularly important domestically for two reasons. First, because the timeframe for implementing WARC allocations and regulations is often long, sometimes 10 or 15 years, decisions made at WARC-92 will influence international and national radiocommunication policy until 2010 or beyond. Such decisions will also have important impacts on investments in radiocommunication systems, including hardware and the development of services. Decisions that do not support U.S. positions could have along-term negative impact on U.S. radiocommunication development and economic competitiveness. Second, in the past, the irregular timing of WARCs has put a premium on getting new technologies and services approved and allocated as quickly as possible. Because a schedule of future conferences has not been set, if new services do not receive any or inadequate frequencies at WARC-92, the next opportunity to address them is uncertain-this may

[37] If existing users have to be moved, the ITU will agree on a timetable for existing users to vacate the band for new services to begin operation.

[38] Adoption of the international Table of Allocations domestically is not automatic. The FCC typically initiates a rulemaking procedure after a WARC is concluded to determine how to implement changes agreed to internationally in the U.S. National Table of Frequency Allocations.

[39] The FCC has released Notices of Inquiry (NOIs) into Personal Communications Services, Gen Docket No. 90-314, released June 28, 1990, and Digital Audio Broadcasting, Gen Docket No. 90-357, adopted Aug. 1, 1990.

be the last chance to get an allocation for some services for many years. This problem is exacerbated by the long lead times required for reallocation and reaccommodation of existing service-even after frequencies have been allocated to a service, the ITU often grants existing users up to 10 or 15 years to change frequencies. However, recognizing the important and rapid changes taking place in technology and the international community, the High Level Committee of the ITU has recommended that the schedule of conferences be regularized-a conference would take place every 2 years. Such a change would lessen the uncertainty of when issues will be addressed (see ch. 3 for further discussion of the proposed changes in the ITU), and would significantly affect the timing and preparation for future WARCs. The United States has actively participated in the High Level Committee and must continue to be responsive to these possible changes.

WARC-92 thus represents both a risk and an opportunity for U.S. interests. Part of enabling U.S. companies to compete effectively depends on harmonizing international tele- and radiocommunications policies with trade policies to ensure that each reinforces the goals of the other. WARC-92 represents an important opportunity to coordinate and align frequencies to open up world (instead of domestic or regional) markets in many new services. Global coordination creates larger markets and promises lower prices, portability of services, increasing interconnection, and greater economic efficiency. If U.S. views are well articulated, supported, and presented, and the international community accepts them, benefits will flow to U.S. interests. On the other hand, lack of spectrum policy planning risks U.S. competiveness. If the U.S. fails to present well thought out and coherent proposals to the international community, it risks being left out or left behind. If other countries with less crowded airwaves and more forward-thinking policies permit new services first, their economies will be the frost to benefit from new communications services.[40]

If new services are to be accommodated, they will have to share spectrum with existing users, or the existing users will have to move.

Major Issues

The primary focus of WARC-92 will be allocating radio frequencies to new and old services.[41] These issues are complex and often interrelated. In some cases, several services compete for the same band of frequencies. The problems are not as easy as simply finding frequencies for new services, or matching a service with the most suitable frequencies. There is almost no unused spectrum below 3 GHz, so if new services are to be accommodated, they will have to share spectrum with existing users, or the existing users will have to move.[42] Reallocation decisions have technical, political, and economic consequences. Often the decisions of where to put new services and move old ones are based just as much on economic and political pressures as on purely technical requirements. Existing users with political clout may be difficult to move. Users that make extensive use of the band and have billions of dollars invested in equipment may also be difficult to move, practically and financially. The question of who pays for such reallocation is often contentious, and while the cost is not explicitly a WARC issue, it is an important consideration in the development of each government's WARC proposals.

Many problems make WARC preparations and negotiations difficult on both international and domestic levels. First, some of the technologies and services under consideration are still evolving. Final requirements for spectrum and specific standards are not yet in place, and the industries themselves are often not mature-many companies are still vying for a piece of the action. This has the effect of making coordination and compromise even more difficult-considering many different views from

[40] Mark Lewyn and Peter Coy, "Airwave Wars," *Business* Week, No. 3170, July 23, 1990, p. 49.

[41] Other matters t. be addressed by the conference include: requirements that ships-at-sea have certified radio personnel on bored, development of recommendations and resolutions for meteorological aids, and consideration of the problems of the meteorological and Barth exploration satellite services in the 401+03-MHz band. See app. B for the full WARC-92 agenda.

[42] In some cases, sharing between two competing services can be difficult or practically impossible. Sharing between high-powered radar systems and some satellite services, e.g., is very difficult.

many different companies. Second, other countries have developed systems and approaches to radiocommunications that are different from the United States. Developing countries, for example, often use the high frequency (HF) bands for domestic point-to-point communication. Developed countries, however, have largely replaced HF point-to-point links with satellite or fiber-optic telecommunications systems. They now use these bands much more heavily for international broadcasting.[43] These differences will make international agreement difficult.

In preparations for WARC-92, the most difficult allocation problems, domestically and internationally, involve the use of the L-band (roughly 1.4-1.6 GHz). Private companies, including those developing Broadcasting-Satellite Services-Sound (BSS-Sound) and Mobile Satellite Services (MSS) would like to use portions of this band because of its favorable transmission characteristics.[44] The Department of Defense, however, opposes a reallocation of the 1435-1525-MHz portion of the band for new BSS-Sound services because of existing uses.[45] The FCC, noting that the 1.5-GHz band is the band most favored by some broadcasters and other countries (notably CITEL) for BSS-Sound applications, believes that important new global services and markets may be foreclosed if the Defense Department's opposition prevents the United States from agreeing to worldwide allocations.[46] If a worldwide allocation is agreed to at WARC-92 that conflicts with the final U.S. position, the United States could decide not to abide by the specific decision. This could mean that BSS-Sound services developed in the United States would not use the same frequencies as the rest of the world—the systems would be incompatible. It would then be difficult to establish worldwide services, such as international broadcasting, using this new technology.

In preparations for WARC-92, the most difficult allocation problems, domestically and internationally, involve the use of the L-band.

Below is a summary of the allocation issues to be addressed at WARC-92, including proposed U.S. positions (see app. D for a complete summary of final U.S. WARC proposals),[47] the views of foreign administrations (where possible), and a discussion of the potentially most controversial issues to be discussed (see app. B for the full text of the agenda). The views of foreign countries outlined below are preliminary and may change before final positions are decided later this year. They should be understood as only a rough guide indicating how the various WARC agenda issues are evolving.

High Frequency Broadcasting-HF refers to frequencies in the 3-30-MHz portion of the spectrum. The band is densely packed—numerous services and users occupy the HF spectrum, including amateur radio, government-sponsored international broadcasting (Voice of America, British Broadcasting Corporation, and Radio Moscow), private religious broadcasting, and international aviation and maritime communications. Developing countries also use the HF bands for domestic point-to-point communications because of its low cost.

WARC-92 will consider expanding the bands allocated exclusively to HF broadcasting. This issue flows out of the work of the HF Broadcasting Conferences (HFBC) of 1984 and 1987.[48] For WARC-92, the United States proposes expanding the band by a total of 1325 kHz (in different blocks

43 The United States alone accounts for 10 percent of worldwide HF spectrum use. See Final Report of "Informal Working Group 1" to the Industry Advisory Committee to the FCC, IAC Document 48, Apr. 30, 1991.

44 MSS providers, however, were not able to convince government policymakers to make this a final U.S. proposal.

45 Among other uses, these bands are used by the Department of Defense and many of its contractors in the private sector for the testing Of new aircraft.

46 Because much of the data on the Federal Government's use of spectrum is classified or not easily obtained, the FCC may not have a good idea how much and how efficiently government spectrum in this area is used. This lack of adequate data makes it very difficult for the FCC to negotiate the issue.

47 In all, the United States will make approximately 50 specific proposals covering 14 different radio services. All information on final U.S. proposals comes from U.S. Department of State, *United States Proposals for the 1992 World Administrative Radio Conference for Dealing With Frequency Allocations in Certain Parts of the Spectrum,* publication 9903, July 1991.

48 The 1985/1987 HFBC WARC attempted to develop a method for planning broadcast frequency assignments on a worldwide basis. Because the broadcasting needs identified greatly exceeded the frequencies available, a workable system was never developed. As a result, the Conference recommended (Recommendation No. 511, HFBC-87) that more spectrum be allocated for HF broadcasting at a future WARC. This recommendation was included in the agenda for WARC-92.

of frequencies, see app. D)-much less than the amount recommended by the FCC's Industry Advisory Committee, which suggested 2455 kHz of additional spectrum. The 1325 kHz, or any portion approved, would be reallocated from the Fixed and Mobile services, which could continue to use the bands until the end of a transfer period.

Planning and use of the HF bands for broadcasting has been contentious for many years.[49] Two factors contribute to the problem: First, demand for HF broadcasting spectrum greatly outstrips supply. The International Frequency Registration Board's (an agency of the ITU) planning exercises conducted for the High Frequency Broadcasting WARC of 1987 (HFBC-87) indicate that more than half of all HF broadcast requirements submitted by member countries could not be adequately met, and between 25 and 35 percent of these requirements could not be accommodated at all.[50] Second, as noted above, different countries use the HF bands for different purposes. Many countries see the allocation of additional broadcast spectrum as a threat to their domestic (nonbroadcast) radiocommunications.

Preliminary negotiations indicate that this issue will be difficult for the 1992 conference (see box 3-A). Many developing countries may oppose any expansion of the broadcasting spectrum in an effort to protect their existing domestic telecommunications services and investments in equipment. In Europe, the countries that belong to the Conference of European Postal and Telecommunications Administrations (CEPT), which attempts to harmonize European telecommunications policies and is coordinating the development of European WARC proposals, have not proposed specific bands.

An additional part of the HF controversy surrounds the use of single-sideband (SSB) transmission and receivers for all new HF services (see ch. 2). SSB broadcasting requires less bandwidth to send information than most conventional radio broadcasting systems, and hence would allow more broadcasters to use the spectrum. The ITU has already

Planning and use of the HF bands for broadcasting has been contentious for many years.

mandated its use by the year 2015.[51] The United States proposes that SSB be used in all new HF frequency bands adopted at WARC-92, and that the effective date of implementation be moved up to 2007. A number of (especially developing) countries have opposed this conversion because of the large number of existing receivers and the lack of economic incentives to build the new receivers.[52]

Broadcasting-Satellite Service-Sound—BSS-Sound refers to the delivery of audio services directly to stationary and portable receivers from satellite transmitters (see figure 2-4).[53] These services, which often plan to use digital technology (digital audio broadcasting), promise to deliver radio services with compact disc quality sound to any type of receiver (home, portable, mobile) in any environment (urban, suburban, rural). Domestic service would be provided through satellites for wide area coverage and terrestrial transmitters for local services or to fill in areas where the satellite signal is weak (in tunnels, for example). International service would be provided primarily by satellite and would allow listeners to receive programming anywhere in the world. Planned systems will allow services to be tailored to local, domestic or international listeners. In the United States, several companies have applied to the FCC for authority to launch satellites and offer such services (see app. C).

BSS-Sound has been studied internationally, dating back at least 25 years. The issue of BSS-Sound was raised at WARC-79, which recommended that it be considered at a future WARC (which was later scheduled as the 1988 WARC on the Use of the Geostationary-Satellite Orbit and the Planning of Space Services Utilizing It-ORB-88). ORB-88

[49] For a full discussion of the history of HF spectrum allocation, see Savage, op. cit., footnote 28.

[50] Industry Advisory Committee, "Final Report of Informal Working Group Number 1," report submitted to the FCC, Apr. 24, 1991.

[51] International Telecommunication Union, Resolution No. 517 of The World Administrative Radio Conference for the Planning of the HF Bands Allocated Exclusively to the Broadcasting Service (Geneva, 1987).

[52] Manufacturers will not build the receivers until they can receive something, but the programmers will not broadcast in SSB until there are radios to receive the signal. Even if some manufacturers do produce these new receivers, they are likely to be very expensive until larger markets open up.

[53] BSS-Sound systems may also be complemented by terrestrial transmitters. Both satellites and terrestrial transmitters are proposed to be used either separately or in a mixed system to provide complete radio coverage.

was unable to reach agreement on possible allocations and service standards and recommended that the issue be reconsidered at a future WARC after further technical studies by the ITU's International Radio Consultative Committee (CCIR) (see ch. 3).[54] Accordingly, the Administrative Council included BSS-Sound in the 500-3000-MHz range on the WARC-92 agenda.

Debate in the United States has been intense over which bands to allocate domestically and what the U.S. international position should be. This is the only WARC agenda item that could not be reconciled between FCC and NTIA before final recommendations were transmitted to the Department of State. In initial reports, the FCC and NTIA proposed four options for BSS-Sound allocation for WARC-92.[55] BSS-Sound proponents favor the bands around 1.5 GHz (the so-called L-band), but U.S. Government interests, notably the Department of Defense and its commercial contractors, are opposed because of the existing use of the band for aircraft testing.[56] The problem with all BSS-Sound options is that sharing with other services, such as the industrial, scientific, and medical services, which includes microwave ovens, in the 2400-MHz bands is extremely difficult, and existing users are often unwilling or unable to move.[57] In its final Report, the FCC recommended the reallocation of the 1.5- and 2.3-GHz bands for BSS-Sound. NTIA proposed that the 231O-239O-MHZ band could be used. The final size and location of the bands is subject to continuing negotiation.

Internationally, there is strong interest in the concept of BSS-Sound, but sharp differences exist as to which band(s) would be most appropriate for an allocation. For example, there is little consensus internationally on the use of the 1.5-GHz band. A recent meeting of CITEL (see box 3-A) generally supported an allocation in the 1.5-GHz band, and a minority of the CEPT countries would like to use the 1.5-GHz band for BSS-Sound. However, many foreign countries seem to concur with U.S. government opposition-including many CEPT countries-who claim that there is no way to accommodate the service in the 1.5-GHz band because of tremendous demand by mobile services and existing fixed services. Other countries also seem to favor using the band for Mobile or Mobile Satellite Services. Debate on BSS-Sound at WARC-92 is expected to be difficult because all proposed bands are used by existing services.[58]

Internationally, there is strong interest in the concept of BSS-Sound, but sharp differences exist as to which band(s) would be most appropriate for an allocation.

Broadcasting-Satellite Service-High-Definition Television—HDTV was conceived more than 20 years ago, but only recently has the technology become advanced enough for commercial applications.[59] HDTV's main characteristics are high resolution (nearly twice that of conventional television) and better color, a wider screen, and compact disc quality digital sound. While HDTV systems are currently still in development, rapid advances in technology are being made that could bring HDTV to consumer markets worldwide by the mid-1990s.[60] Satellite transmission of HDTV services is only one of a number of ways to deliver such programming (others include cable, fiber optics, and terrestrial

[54] International Telecommunication Union, Resolution No. 520 of the World Administrative Radio Conference on the Use of the Geostationary-Satellite Orbit and the Planning of Space Services Utilizing It, Second Session (Geneva, 1988).

[55] 728-788 MHz; 1493-1525 MHz, 2390-2450 MHz, 2360-2410 MHz. Federal Communications Commission, "An Inquiry Relating to Preparation for the International Telecommunication Union World Administrative Radio Conference for Dealing With Frequency Allocations in Certain Parts of the Spectrum," *Supplemental Notice Of Inquiry,* Gen Docket 89-554,6 FCC Rcd 1914, p. 2.

[56] Some proponents of digital audio broadcasting, a digital transmission format that could be used to provide BSS-Sound services, have proposed that the terrestrial component of BSS-Sound would be more easily provided in existing radio broadcasting bands. They do not necessarily favor the 1.5-GHz band for this service.

[57] Another proposal for @~ audio broadcasting t. share spectrum in the UHF television band was rejected becaus the FCC anticipates that the spectrum will be needed for the transmission of advanced television (ATV) signals.

[58] The FCC notes in its Supplemental Notice of @@ that find@ a worldwide allocation for BSS may be difficult. It then raises the possibility that allocations may have to be made on a regional basis.

[59] For discussion of the historical, technical, and economic implications of HDTV, see U.S. Congress, Office of Technology Assessment, *The Big Picture: HDTV and High-Resolution Systems,* OTA-BP-CIT-64 (Washington, DC: U.S. Government Printing Office, June 1990).

[60] Japan already has a system in operation (MUSE). Ibid.

broadcasting), but proponents see HDTV as a very lucrative market for satellite services vendors. Satellite delivery of HDTV, however, depends on the availability of spectrum around the world, and many believe a worldwide allocation for HDTV is needed to further advance this service and reduce international interference problems.

A plan exists for satellite transmission of television signals directly to home receivers in the 12-GHz band. However, this band was planned primarily for direct broadcast of conventional television signals. While it appears possible to transmit some enhanced and narrow-band HDTV signals in these channels, the larger bandwidths commonly associated with full HDTV may not fit into the current planned channel bandwidths.[61] To accommodate these wider channels and any future expansion in HDTV service, HDTV allocations were considered at ORB-88, but were not agreed to. The ITU Administrative Council included this item in the agenda of WARC-92 based on Resolution 521 of ORB-88, which calls for consideration of a worldwide allocation for wide-band HDTV between 12.7 and 23.0 GHz.

The United States proposes that the existing plan in the 11.7-12.7-GHz band can serve as the basis for future HDTV services, but that additional allocations may also be necessary. The United States considered 17.3 -17.7 GHz and 24.65-25.25 GHz for these additional frequencies, and eventually the FCC and NTIA recommended the 25-GHz band.[62] The IAC generally supported the FCC positions, but expressed doubt about the necessity of expanding allocations, especially in the 17-GHz bands.[63] CEPT countries have proposed using the band 21.4-22.0 GHz on a worldwide basis for HDTV. CITEL was unable to agree on common views regarding the necessity of additional allocations given the possibilities of future technical advances in compression technology.

Several of the most important issues to be considered at WARC-92 involve the expansion of Mobile and Mobile Satellite Services.

Mobile and Mobile Satellite* Services *in 1-3 GHz -Several of the most important issues to be considered at WARC-92 involve the expansion of Mobile and Mobile Satellite Services. Recognizing the need to allocate additional frequencies to the mobile services, ITU members decided at the 1987 WARC for the Mobile Services (MOB-87) that a future conference was necessary to address these issues.[64] Consequently, the WARC-92 agenda includes four topics related to mobile and mobile satellite services: 1) increasing the allocations to these services in general; 2) allocation or designation of frequencies for public correspondence with aircraft; 3) allocation or designation of frequencies for Future Public Land Mobile Telecommunications Service; and 4) possible allocations for LEOS. Each service is discussed separately below.

Mobile Services-Although the United States is widely regarded as a leader in many areas of radiocommunications, the European countries have been aggressively developing and implementing many types of mobile communication services. In part this is because the European nations recognized early on the importance of mobile communications in an advanced information society, but more importantly because the Europeans identified these systems as a critical element in the future economic development of a unified Europe and started working out a common plan and standards for developing

[61] Rapidly advancing digital video compression capabilities could conceivably allow even the widest bandwidth HDTV signals to fit into the existing channel bandwidth constraints. There is no consensus, however, as to howmuchcompression will be practical in the short term, and some administrations remain skeptical that compression techniques will completely solve this problem. See, e.g, Organization of American States, Interamerican Telecommunications Conference, Permanent Technical Committee III, ''Report of the CITEL 1992 World Administrative Radio Conference Interim Working Group,'' Document WARC-92/62 Rev. 2, May 10, 1991.

[62] *Supplemental* NOI, op. cit., footnote 55.

[63] The basis of this position is the belief that compression technologies will be able to provide HDTV service within the existing allocations. The Industry Advisory Committee report also noted serious problems with sharing in the 17-GHz bands. Because of the lack of sharing problems in the 24.65-25.25 GHz-bands, these were endorsed by the Committee. See ' 'Final Report of Informal Working Group-Number Three,'' submitted to Industry Advisory Committee, Apr. 25, 1991.

[64] International Telecommunication Union, Resolution No. 208 of the World Administrative Radio Conference for the Mobile Services (Geneva, 1987).

such services.[65] The United States, by contrast, considers mobile services more narrowly as a matter of domestic spectrum management, not linked to development or trade, and has no comprehensive long-range plan for such services, preferring to manage and plan only in response to specific pressures. This results from a U.S. system that depends on the market to make decisions and that has many competing interests-an adversarial system that often resorts to litigation rather than negotiation. Achieving consensus and developing a unified approach is much more difficult and time-consuming in the United States than in many foreign countries.

Mobile Satellite Services-MSS encompass all types of services delivered by satellite including maritime (MMSS), aeronautical (AMSS), and land mobile (LMSS) communications. These services can be provided by either geosynchronous orbit satellites or LEOS. Because of the characteristics of radio wave propagation, the most suitable frequencies for these mobile services are below 3 GHz, and the most heavily used frequencies are in the L-band (1.5- 1.6 GHz). With the increasing demand for MSS in all parts of the world, these frequencies are becoming rapidly congested.[66]

Some of the most contentious and important issues of the WARC, both domestically and internationally, involve the MSS. The United States has proposed a generic MSS in the 1.5-1.6-GHz bands that would combine maritime, aeronautical, and land mobile services.[67] The United States has also proposed allocating frequencies in the 2.1- and 2.4-GHz bands totaling 80 MHz and the 1850- 1990-MHz band to MSS. The Industry Advisory Committee Ad-Hoc Group advising the FCC on MSS matters for WARC-92 agreed on the need for additional MSS spectrum, but could not reach consensus on the specific location or use of the additional bands. Many existing users, including public safety interests and the petroleum, railroad, and utilities, have voiced strong opposition to the use of bands below 2 GHz. There is special concern that the interests of the aeronautical and maritime distress and safety services be protected, especially from potential interference with the proposed services for public correspondence with aircraft (see below). The United States believes that such public safety concerns can be protected through footnotes allowing such services priority access to frequencies, but there is still strong aeronautical industry opposition to this view.

Discussions within CITEL established general support for additional allocations, but specific agreements on the use of the bands were limited. The CEPT countries have identified MSS allocations as the most important issue of WARC-92, and may propose up to 100 MHz of additional spectrum in the L-band as well as additional allocations above 2.5 GHz.[68] CEPT also supports the concept of a generic allocation for MSS, but only for newly allocated bands.

In addition to the above allocations, the FCC proposed to allocate 1850-1990 MHz to MSS for the use of LEOS.[69] In the final U.S. proposals, this recommendation was modified to remove explicit references to LEOS and was proposed under MSS. This change reflects a potential problem for the United States in its MSS negotiations at WARC-92. The WARC-92 agenda specifically addresses LEOS systems that would operate in frequencies *below* 1 GHz. During the course of the FCC preparations process (after the *Second Notice of Inquiry was* released), however, Motorola and Ellipsat proposed LEOS systems that would operate in frequencies

[65] Since the private sector plays a smaller role in public telecommunications systems development in Europe compared to the United States, it may be easier for the European nations to develop regional plans. For example, Global System for Mobile Communications (GSM-formerly Groupe Special Mobile) is a digital cellular standard that has been proposed to serve all Europe, replacing existing incompatible national (analog) systems. Its implementation is proceeding, although more slowly than some policymakers had anticipated.

[66] The International Radio Consultative Committee (CCIR) has studied future requirements for all MSS and has concluded that existing allocations will not be sufficient to meet estimated growth in these services. CCIR studies estimate that a total bandwidth of between 177.6 and 328.2 MHz will be required by 2010. See Organization of American States, Inter-American Telecommunications Conference, "Report of 'he CITEL 1992 World Administrative Radio Conference Interim Working Group," WARC-92/62 Rev. 2, unpublished document, May 10, 1991. Tnese figures are roughly equivalent to the IAC's estimates. See *Supplemental NOI,* op. cit., footnote 55.

[67] At the 1987 Mobile WARC, the United States did not succeed in having this view accepted. As a result, the United States took a reservation on this allocation and created a shared allocation for LMSS, MMSS, and AMSS.

[68] Comments of Eberhard George, CEPT observer, to CITEL Interim Working Group meeting, Washington DC, May 10, 1991.

[69] Federal Communications Commission, "AnInquiry Relating to Preparation for the International Telecommunication Union World Administrative Radio Conference for Dealing Witb Frequency Allocations in Certain Parts of the Spectrum,' *Report,* Gen Docket No. 89-554,6 FCC Rcd 3900 (1991).

above 1 GHz.[70] The FCC has supported these proposals, but support for the system outside the United States appears limited. At the International Radio Consultative Committee WARC-92 Conference Preparatory Meeting, for example, Motorola's Iridium proposal was extensively discussed, but LEOS systems in this band were not fully endorsed because of concerns about the ability of such systems to share spectrum with geosynchronous satellite systems.[71] Because LEO systems will be providing MSS, the United States has indicated in its final proposals that spectrum allocated to the MSS could be used for LEOS operations.

This proposal is controversial on several grounds. First, domestic MSS providers, notably the American Mobile Satellite Corporation, have argued that the FCC has taken no domestic action yet to establish the need or public interest standards for these proposed LEOS systems. They contend that bringing these proposals directly to the WARC preparations process and the WARC itself, circumvents the proper approval process. Second, because the concept of LEOS above 1 GHz is not explicitly part of the WARC agenda, some foreign governments have argued that this WARC cannot consider it. They believe that a consideration of LEOS systems above 1 GHz violates the spirit of the WARC-92 agenda. The U.S. strategy has some opponents questioning why the government is expending so much energy and risking its credibility on a proposal that has seemingly little backing internationally .72

Future Public Land Mobile Telecommunication Systems-Future Public Land Mobile Telecommunication Systems (FPLMTS) is another of the new services to be considered at WARC-92. It is within

Spectrum allocated to Future Public Land Mobile Telecommunication Systems (FPLMTS) may provide radio frequencies that could be used by future personal communications services (PCS).

this allocation (somewhere in the 1700-2300 MHz bands) that future PCS may be located.[73] Development activities are underway around the world examining voice and data applications for both personal and mobile (vehicular) uses. Studies are also underway examining the use of FPLMTS as an alternative to wire connections to provide access to public telephone networks (see ch. 2). Based on this widespread interest and the work of MOB-87,[74] the Administrative Council added FPLMTS to the WARC-92 agenda.

Allocation of additional spectrum for FPLMTS is not the critical issue. Many countries, including the United States, believe that the existing allocations for mobile services in the 1-3-GHz band are adequate. The main issue of FPLMTS centers around the designation of a common core/band of worldwide frequencies that would allow international roaming of PCS.[75] The CCIR has recommended 60 MHz for this purpose. The members of CITEL generally support the concept of FPLMTS and the need for a core band of spectrum for international roaming. The CEPT countries have indicated that they would like 200 MHz of total spectrum designated to FPLMTS, possibly in the 19OO-21OO-MHZ bands. The FCC, however, proposed no additional allocations for FPLMTS, and

[70] Specifically, the binds applied for were 16101626.5 MHZ. Ellipsat also proposed to use frequencies just below 2.5 GHz. As of July 1991, several other companies have applied at the Commission to build similar systems (see app. C).

[71] International Telecommunication Union, International Radio Consultative Committee, *CCIR REPORT: Technical and Operational Buses for the World Administrative Radio Conference 1992 (WARC-92),* March 1991, pp. 8-5,8-13,8-14.

[72] This conflict reflects the larger issue of how the world will accommodate LEOS in the international Radio Regulations and in particular frequency bands. Fundamentally, the question is: what is LEOS? Is it a separate service, or is LEOS technology merely another method for providing an existing service? Radio frequency allocations are generally made only to radio services, not technologies. Yet LEOS, which is technically just a radiocommunication technology, is being treated on the WARC-92 agenda as if it were a service. This ambiguous situation is the basis for the present controversy.

[73] Other possible PCS allocations are in the 800-900-MHz band near the cellular allocation. Many experimental licenses have been granted and applied for in this band (see app. C).

[74] International Telecommunication Union, Recommendation No. 205 of the World Administrative Radio Conference for the Mobile Services (Geneva, 1987).

[75] This would not lessen allocations t. the service in any way. Rather, it would carve out a band of spectrum that would be common to FPLMTS systems around the world. This would provide a common signaling channel worldwide that would allow users' personal equipment to access services no matter where the user is located.

believes that existing allocations have sufficient flexibility to allow any reallocation to be accomplished domestically.[76] The Commission also believes that the 60-MHz requirement identified for international roaming by the CCIR is excessive and unnecessary. Generally, this view is supported by the Industry Advisory Committee. At one point in the development of proposals, the United States agreed that a common worldwide allocation would be desirable to allow mobile roaming of PCS, but proposed 10 MHz as sufficient.[77] In the final U.S. proposals, however, this idea was dropped-the United States now believes that the designation of a frequency band for FPLMTS is premature.

Low-Earth Orbiting Satellites-LE0S systems are another method of providing MSS. Individual LEO satellites are smaller and much easier and cheaper to design, construct and launch than conventional geosynchronous satellites, and proponents envision networks of these small satellites circling the globe. LEOS services have received much attention in the United States, and several applications for LEOS systems are pending at the FCC (see app. C). Two types of LEO systems have been proposed. LEOS operating in frequencies *below* 1 GHz will provide only data applications, including position determination services for cars, trucks, ships and aircraft. In addition to these services, systems operating in frequencies *above* 1 GHz plan to provide voice services as well. Motorola's Iridium system, for example, which would use a network of 77 LEOS to provide data and voice services around the world. Although LEO satellites are relatively less expensive than geosynchronous satellites, the networks required to provide wide area coverage could be very expensive because of the large numbers of satellites required and the technical complexity of linking them all together. Iridium is expected to cost more than $3 billion. While both types of LEOS systems could be used for domestic service, larger networks of LEO satellites could also provide global coverage. For this reason, the United States persuaded the ITU Administrative Council to put LEOS (below 1 GHz) on the agenda for WARC-92. LEOS above 1 GHz were not included on the WARC-92 agenda because no systems using those frequencies had yet been proposed.[78]

Low-Earth orbiting satellite (LEOS) services have received much attention in the United States, and several applications for LEOS systems are pending at the FCC.

The United States considered several possible bands for reallocation to LEOS below 1 GHz.[79] Final U.S. proposals are for 137-138 MHz (downlink), 148-149.9 MHz (uplink), and 400.15-401 MHz (downlink). While there is relatively little interest in LEOS in other countries, many are concerned about possible interference between LEOS and existing users in the proposed bands. CITEL was not able to agree on a common LEOS proposal pending the completion of sharing studies in progress. The CEPT countries, as of May 1991, had no LEO satellite proposals.

During the course of WARC-92 preparations, the FCC also received applications for LEOS in bands *above* 1 GHz.[80] Although not explicitly included in the WARC-92 agenda, in its final proposals, the United States proposes that the band 1613.8 -1626.5 MHz be allocated to the MSS on a secondary basis to provide transmission from the satellite to receivers on Earth (the same frequencies are already allocated for transmission from Earth to satellites).

[76] Federal Communications Commission, "An Inquiry Relating to Preparation for the International Telecommunication Union World Administrative Radio Conference for Dealing With Frequency Allocations in Certain Parts of the Spectrum," *Second Notice Of Inquiry*, Gen Docket 89-554,5 FCC Rcd 6046 (1990); *Supplemental NOI*, op. cit., footnote 55.

[77] Apple Computer, Motorola, and Comsat all support at least a 1O-MHZ designation to allow international voice and data personal communications. However, the proposal is *not* included in the final U.S. proposals.

[78] Motorola and Ellipsat filed their applications well after the agenda had been finalized.

[79] The bands proposed in the FCC Notice of Inquiry process include: 137-138 and 148-149.9 MHz; 420-421 MHz and 930-931 MHz. In addition, the Industry Advisory Committee proposed 173.4-174 MHz and 400.15-401 MHz. *Second NOI*, op. cit., footnote 76; *Supplemental NOI*, op. cit., footnote 55.

[80] Motorola and Ellipsat were the initial appliants. The Iridium system would use the band 1610- 1626.5 MHz for both uplink (Earth-to-satellite) and downlink (satellite-to-Earth) transmissions, while Ellipsat would use 1610- 1626.5 as its uplink with its downlink transmissions at 2483.5-2500 MHz. Recently, more applications for such service have been filed (see app. C). For a discussion of the Iridium and Ellipsat applications and FCC proposals, see *Supplemental NOI*, op. cit., footnote 55.

This spectrum would be used in the United States for LEOS services, and responds to Iridium's proposal to use this block of spectrum for both uplink and downlink transmissions. The United States also proposes that spectrum be allocated to MSS services in 1850-1990 MHz on a shared primary basis to provide for future flexibility and expansion of MSS (specifically LEOS, although the proposals do not explicitly state this). As noted above, these proposals have generated controversy on several levels.

Other Allocation Issues—Several other allocation issues, while not receiving as much public attention as those above, pose equally great negotiating challenges for the United States, both domestically and internationally.

*Public Correspondence With Aircraft-Aeronau*tical public correspondence (APC) refers to radiocommunication services that allow airline passengers to place telephone calls while in flight. The demand for public communication with aircraft is relatively recent, having been addressed for the first time on a global basis at the 1987 Mobile WARC (MOB-87). That WARC allocated frequencies in the 1.5-1.6-GHz band for experimental terrestrial APC. Subsequent studies by the CCIR indicated the benefits of a worldwide allocation for this service, and following Recommendation 408 (MOB-87), the issue was included in the WARC-92 agenda.

Although not particularly controversial, it appears unlikely that a worldwide allocation for terrestrial APC will be accepted. In many countries, the frequencies allocated at MOB-87 are already heavily used for other services and may cause serious interference to radionavigation and radiodetermination satellite services also operating in the bands. Because of this, many countries in Regions 2 and 3, including the United States, have authorized or begun operating terrestrial APC systems in the 800-960-MHz band (a band not specifically allocated to worldwide aeronautical mobile service).[81] Consequently, the United States will not propose any additional spectrum to terrestrial APC, but will propose that bands currently used in the United States be designated for worldwide use. Most CITEL members support the U.S. proposal, but a common view has not been agreed to. The CEPT countries also do not want any additional allocations for APC in the 900-MHz band, citing extensive existing services, but will likely propose an allocation of 10 MHz of additional spectrum in the 1.7-or 1.8-GHz bands.

Radiodetermination-Satellite Service in 1.6-2.5 GHz-Radiodetermination-Satellite Service (RDSS) uses satellites to provide geographic location information to cars, trucks, aircraft, and ships at sea (see ch. 2). Several RDSS systems are operating in the United States and more are being developed. Some of these services may be offered by the proposed LEOS systems in combination with other data and messaging applications (see app. C).

RDSS was put on the WARC-92 agenda according to Resolution No. 708 of the 1987 WARC for the Mobile Services, which allocated spectrum for the service, but also called for more study of the use of RDSS and sharing between RDSS and terrestrial services in various bands. Consequently, WARC-92 will address the issues of RDSS with the intention of harmonizing regulations for its use worldwide. In this regard, the United States will propose that RDSS be upgraded to primary status in Regions 1 and 3 (to bring it in line with its status in Region 2).[82]

Fixed Satellite Service in 14.5 -14.8 GHz—The 14.5-14.8-GHz band is allocated to the Fixed Satellite Service (FSS) internationally.[83] The item was put on the WARC agenda to correct an imbalance in the number of frequencies available for sending signals to (uplink) and from (downlink) satellites. Outside the United States, the band is allocated to transmit video programming in support of the Broadcasting-Satellite Service. In the United States, however, the band is allocated exclusively for government use. Due to extensive government use of the band, the United States opposes international use of the band for commercial purposes, and opposed the inclusion of this item on the WARC agenda. U.S. representatives, however, did not prevail, and the item was included. U.S. industry has shown some support for changing the allocations

[81] In the United States, the system is fully operational and serves hundreds of aircraft. The United States uses the bands 849-851 MHz and 894-896 MHz for this system.

[82] The United States also proposes t. add MSS as a coprimary allocation in these bands. MSS and RDSS services are technically compatible, and, in fact, complement each other. They are expected to be provided by the same satellite system in many cases.

[83] Generally, Fixed Satellite Service is defined as communication between any two fried (stationary) Earth stations using a Satellite. In many applications, a satellite beams programming or information from one central point (the hub) to any number of stationary satellite receive dishes.

internationally, but the U.S. government remains opposed to any changes in the band, and will take that position into the WARC. Even if a reallocation passes, the United States will likely take a reservation on this use, denying its use in the United States.[84]

Space Operations and Research at 2 GHz—These services provide communications, data gathering, and command and control functions for space activities.[85] In the United States, for example, they support the space shuttle and the Hubble telescope. In recent years, use of these services and frequencies has intensified, making international coordination difficult. As a result, the 1988 space services WARC recommended that a future conference address the issue.[86] The United States proposes to upgrade these services to primary status.

Space Services Above 20 GHz—In addition to existing space services, WARC-92 will also consider possible allocations for new space services that would use frequencies above 20 GHz. Among the U.S. proposals for new services and allocations are: the creation of a General-Satellite Service near 20/30 GHz that would be used to provide both fixed and mobile services; an allocation for intersatellite links at 21.7-22 GHz; a primary allocation for Earth exploration satellites near 61 and 157 GHz; and a primary allocation for new space research services at 37-38 and 39.5 -40.5 GHz (for a complete summary of the U.S. proposals for new space services, see app. D).

U.S. Preparations and WARC Proceedings

Although the issues to be addressed by WARC-92 have been well known for many years, the actual preparation time for the conference has been relatively short. In the past, preparation time for WARCs has been between 3 and 5 years. The final agenda for WARC-92, however, was not adopted until mid-1990, leaving approximately only 1 year for proposals to be drafted and sent to the ITU and only 18 months before the WARC itself. This is a special problem for the United States because of the large number of constituencies involved and the extensive degree of private sector involvement. It takes a long time to make sure everyone has a fair chance to have their views heard, and then to try to work out a compromise. Nevertheless, the development of proposals was accomplished on time.

The issues to be addressed by WARC-92 have been well known for many years, but the actual preparation time for the conference has been relatively short. Nevertheless, the development of proposals was accomplished on time.

The United States began preparing for the conference in late 1989. The FCC began its proceeding (Gen Docket 89-554) into WARC positions and established the Industry Advisory Committee to provide private sector input to the formation of Commission proposals. NTIA established Ad Hoc 206 of the Interdepartment Radio Advisory Committee to provide government agency input for formulation of executive branch positions. Additional, mostly technical, work was done in U.S. national CCIR study groups. Although NTIA and the FCC developed 'their own proposals, in reality, the development of executive branch and FCC proposals was very closely coordinated. This ongoing coordination streamlines the proposal development process and ensures that final WARC positions are developed as quickly as possible.

However, the WARC-92 proposals from FCC and NTIA were not exact duplicates-one issue remained unresolved. In the U.S. final proposals, which were submitted to the ITU in late July 1991, FCC and executive branch views had not been reconciled on the recommended allocations for BSS-Sound. In cases such as this, when coordination has failed, the FCC and NTIA will continue negotiations, or the Department of State will try to negotiate a solution or establish a mechanism to resolve the dispute. If the proponents still cannot agree, a

[84] The governments of Germany, Italy, Spain, and France indicated at the 1990 ITU Administrative Council that this allocation could not be implemented in their countries.

[85] The actual frequencies allocated for these services are 2025-2110 MHz and 2200-2290 MHz.

[86] International Telecommunication Union, Recommendation 716 of the WARC on the Use of the Geostationary-Satellite Orbit and the Planning of Space Services Utilizing It, Second Session (Geneva, 1988).

mechanism' may have to be created to work out a solution.[87] One alternative is to bring the matter before the (staff of) the National Security Council, which is empowered by the President to resolve disputes of this type, although this is considered a last resort.[88] The final U.S. proposal for BSS-Sound will be submitted to the ITU in the form of a supplemental proposal before WARC-92 convenes.

Late in the summer of 1991, the Department of State, in consultation with NTIA and FCC, assembled the formal U.S. delegation that will attend the conference. Approximately 50 people serve on the delegation including representatives from FCC, NTIA, Department of State, other Federal Government agencies, and the private sector.[89] The core of the nongovernment representatives is drawn from the FCC's Industry Advisory Committee (see ch. 4). Delegations are balanced as much as possible to ensure the participation of various industry sectors as well as minority participation. The Department of State also appointed a Head of Delegation and four vice-chairs to assist him, one each from FCC, NTIA, Department of State, and the private sector. The process of finalizing the WARC-92 delegation proceeded very slowly, leading many to believe that the U.S. will not have time to adequately prepare its negotiation strategies for the WARC. As of mid-September, the delegation still had not been officially announced, although members had been notified and had begun to meet. The Head of Delegation, Jan Baran, was announced in late August.

Once the delegation was formed, WARC preparations intensified. Leadership roles within the U.S. delegation were established, and three committees (Allocation, Regulation, and Technical) were created to guide final U.S. preparations. The delegation will develop negotiating strategies and fallback positions based on U.S. needs, but also tempered by

The process of finalizing the WARC-92 delegation has proceeded very slowly, leading many to believe that the United States will not have time to adequately prepare its negotiation strategies for the WARC.

the likelihood of foreign acceptance or room for negotiation. Finally, the delegation will work out a detailed negotiating strategy that includes presentation of specific proposals and the ordering of fall-back positions.[90]

Starting sometime in August 1991, and lasting until the end of the year, the chief spokespersons (usually consisting of representatives from the Department of State, NTIA, FCC, and the private sector) of the delegation began bilateral and multilateral talks with the key foreign governments and international organizations involved in WARC-92. Until proposals for the WARC were finalized, talks were mostly informal, giving both sides the opportunity to exchange ideas, stake out initial positions, and get background for future negotiation strategies. Once national proposals have been agreed to, however, talks become more consequential as U.S. representatives try to determine how firm each nation's positions are, what backup strategies and positions the United States could develop, and how many votes the United States can count on at the conference. Negotiation becomes concentrated on selling positions as opposed to flexibly discussing them. This part of the preparations process gives U.S. representatives the opportunity to make connections with key countries, especially those in Africa and Asia, which may be unfamiliar with U.S. positions, and enables them to try to build support

87 The telecommunications Senior Interagency Group (SIG), which could have provided the basis for resolving the dispute was disbanded in the early years of the Bush administration.

88 Although it is rare for conflicts to get this far, National Security Council staff have resolved disputes in the past. During 1979 WARC preparations, Voice of America and the Department of Defense clashed over HF bands for broadcasting. Following several months of delay, the Voice of America request for additional HF frequencies was included in the final proposals.

89 At the 1979 general WARC, the United States sent 67 delegates of whom 48 (72 percent) were government representatives. The percentage of Private sector delegates is expected to be higher for WARC-92 because of the wide range of topics to be addressed.

90 The United States has consistently been criticized by industry, foreign observers, and even from within the government for the way it develops and executes conference strategy. Part of the problem is inherent in the public nature of the U.S. process. Negotiating strategies and fallback positions are meaningless if they are made public. The result has been that some fallback positions remain concealed by government representatives, even from other delegates, until the last minute. This makes the United States appear to be unyielding and bullyish, especially in the first few weeks of conferences, and can leave the United States with little room to maneuver at the conference itself. Contributing to the problem is that U.S. delegations are formed late in the preparations process. There is often too little time to develop sophisticated negotiating strategies.

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for U.S. proposals. These efforts also allow the United States to explain in detail the technologies and services being proposed, and are critical in laying the groundwork for the conference—establishing personal relationships, enhancing awareness and understanding of the technologies, and prenegotiating issues to achieve the best possible outcomes.[91]

[91]Because many developing countries do not have the extensive expertise in radiocommunications the United States has, they are still catching Up on changes and developments from the many WARCs held in the 1980s. And because their telecommunication infrastructures are less developed than tbat of the United States, they often do not need (or want) or cannot afford the latest expensive equipment. These factors create a bias to leave things as they are, and hence the United States must demonstrate the utility of these new technologies and services.

Chapter 2

Radiocommunication Technologies and Services: Problem and Solution

As the velocity of change in telecommunications technology increases, so too does the political significance of international telecommunication regulation.[1]

Introduction

In the last decade, the pace of technology development in radiocommunications has dramatically quickened. Many new radio-based technologies and services have been developed and implemented, and yet more systems and services are waiting for spectrum allocations in order to begin delivering innovative services. These new technologies and services put increasing pressure on both domestic and international spectrum management structures and practices, making the process of allocating and assigning radio frequencies more complicated at all levels. Pekka Tarjanne, Secretary General of the International Telecommunication Union (ITU), recently commented,

> This entire subject has become increasingly complex because of the dramatically increased use of digital transmission, signal processing, and dynamic spectrum management techniques that both blur the distinctions between the old notions of radio services, and afford remarkable new opportunities for a more intensive use of the spectrum.[2]

These technology pressures are one of the most significant forces driving the 1992 World Administrative Radio Conference (WARC-92) and the changes envisioned for the ITU.

The relationship of technology/services and spectrum requirements, and the impact of new technologies and services on spectrum management is actually twofold. On one hand, new technologies make innovative services possible, increasing the demand for radio frequencies and contributing to spectrum congestion and 'crowding. For example, the advent of relatively low-power, limited-range transmitters, combined with new frequency reuse techniques and small portable phones, created the now-booming market for cellular telephony. In addition, existing services are also demanding more spectrum. The demand for high frequency broadcasting spectrum, for example, consistently exceeds the amount allocated for such services. On the other hand, new technologies can help ease spectrum congestion by enabling more efficient use of the spectrum, and by squeezing more users into existing bands. Digital compression and mixing techniques, for example, allow more information (charnels) to be transmitted.

Spectrum Basics[3]

Radio Waves

Radio waves are the basic unit of wireless communication.[4] By varying the characteristics of a radio wave—frequency, amplitude, or phase-these waves can be made to communicate information of many types, including audio, video, and data (see box 2-A). Radio waves that carry information are called radio signals, and the process of encoding intelligence onto a radio wave so that it can be transmitted over the air is called modulation.[5] In the process of modulation, the information or message to be transmitted-a human voice, recorded music, or a television signal-is impressed onto (modulates) a' 'carrier' radio wave that is then transmitted over the air. When a radio signal is received, the information is converted back into its original form (demodulated) by a receiver and output as sound, images, or data.

1James G. Savage, *The Politics of International Telecommunications Regulation* (Boulder, CO: Westview Press, 1989), P. 11.

2Pekka Tarjanne, "An Unusual Event," *Telecommunications Journal, vol. 58, No. HI,* March 1991, p. 123.

3Much of the material in this section comes from Richard Gould, ''Allocation of the Radio Frequency Spectrum," contractor report prepared fOr the Office of Technology Assessment Aug. 10, 1990.

4Although the term ''radio'' is most commonly associated with commercial radio broadcasting services (AM and FM radio), the term also properly encompasses the entire range of wireless communications technologies and services, including television microwave, radar, shortwave radio, mobile, and satellite communications.

5Two of the most familiar modulation techniques are amplitude modulation (AM) and frequency modulation (FM).

Box 2-A—Basic Definitions of Radiocommunication Terms

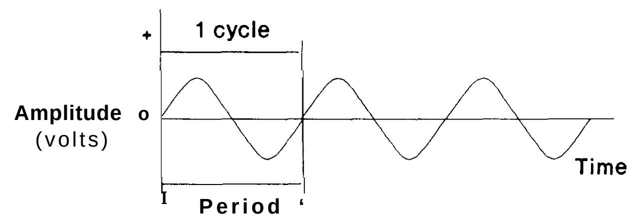
Radio communication depends on a number of basic characteristics and processes.

Amplitude: A measure of the value of a radio wave, measured in volts (see figure 2-A-l).

Analog: In analog radiocommunication, the message or information to be transmitted is impressed onto (modulates) a radio carrier wave, causing some property of the carrier-the amplitude, frequency, or phase-to vary in proportion to the information being sent. Amplitude modulation (AM) and frequency modulation (FM) are two common formats for analog transmission. In order to send analog signals, such as voice and video, over digital transmission media, such as fiber optics or digital radio, they must first be converted into a digital format. See modulation, digital.

Bandwidth: The process of modulating (see below) a radio wave to transmit information produces a radio signal, but also generates additional frequencies called ‘sidebands” on either side of the carrier (see figure 2-A-2). The total width of frequencies, including the sidebands, occupied by a radio signal is its bandwidth. In practical terms, however, the bandwidth of a signal refers to the amount of spectrum needed to transmit a signal without excessive loss or distortion. It is measured in hertz. In figure 2-A-2, the bandwidth of the signal is 4 kHz. The bandwidth of a radio signal is determined by the amount of information in the signal being sent. More complex signals contain more information, and hence require wider bandwidths. An AM radio broadcasting signal, for example, takes 10 kHz, while an FM stereo signal requires 200 kHz, and a color television signal takes up 6 MHz. The bandwidth required by a television channel is 600 times greater than that of an AM radio channel.

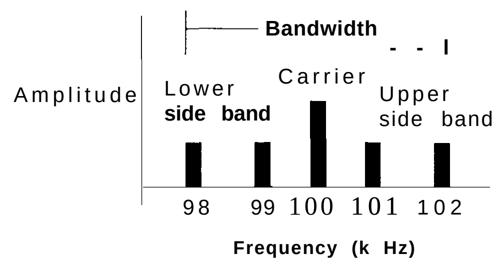
Figure 2-A-l—Basic Radio Wave



Each cycle of a pure radio wave is identical to every other cycle.

SOURCE: Office of Technology Assessment, based on Harry Mileaf (cd.), *Electronics One,* revised 2d ed. (Rochelle Park, NJ: Hayden Book Co., 1976) p. 1-10.

Figure 2-A-2-Side-Band Frequencies and Bandwidth



NOTE: This figure represents a 100-kHz earner wave modulated by 1- and 2-kHz frequencies.

SOURCE: Harry Mileaf (cd.), *Electronics One,* revised 2d ed. (Rochelle Park, NJ: Hayden Book Co., 1976), p. 1-31.

Radio waves are distinguished from each other by their frequency or their wavelength (see box 2-A). Frequency represents the number of cycles a radio wave completes in 1 second, and is the most common description of a radiocommunication signal. The international unit of frequency measurement is the hertz (Hz), which represents 1 cycle per second.[6] Radio signals can also be identified by their wavelength. Signals with long wavelengths have lower frequencies, while those at higher frequencies have shorter wavelengths. Commercial AM radio signals, for example, consist of very long waves (approximately 100 to 300 meters), that may complete a million cycles per second (1 megahertz (MHz)). Microwave signals, on the other hand, are very short (as little as 0.3 centimeters) and may complete hundreds of billions of cycles per second (100 gigahertz (GHz)). The relative nature of radio wavelengths is the origin of terms such as “short wave, ’ which was given to radio frequencies around

[6] Multiples of the hertz are indicated by prefixes (see box 2-A): “kilo” for one thousand, “mega” for one million, and ‘giga” for one billion. Thus, a million hertz-a million cycles per second—is expressed as one megahertz (abbreviated “MHz”).

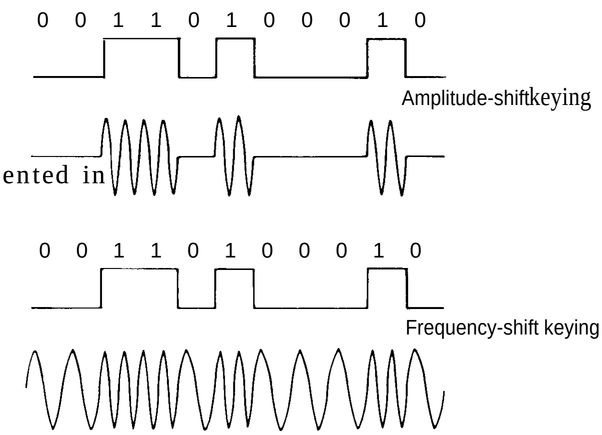
Carrier: A radio wave that is used to transmit information. Information to be sent is impressed onto the carrier, which then carries the signal to its destination. At the receiver the carrier is filtered out, allowing the original message to be recovered.

Digital: Digital transmission formats can be used to transmit images and voice as well as data. For continuously varying signals such as voice or images, an analog/digital converter changes the analog signal into discrete numbers (represented in binary form by O's and l's). These binary digits, or bits, can then be sent as a series of "on" /"off' pulses or can be modulated onto a carrier wave by varying the phase, frequency, or amplitude according to whether the signal is a "l" or a "O." Data is sent in a similar fashion although it does not have to be converted into digital form first. (See figure 2-A-3,)

Frequency: The number of cycles a radio wave completes in 1 second (see figure 2-A-4). Frequency is measured in hertz (1 cycle per second equals 1 hertz). Radio frequencies are described as multiples of hertz: kHz, kilohertz: thousand cycles per second; MHz, megahertz: million cycles per second; GHz, gigahertz: billion cycles per second.

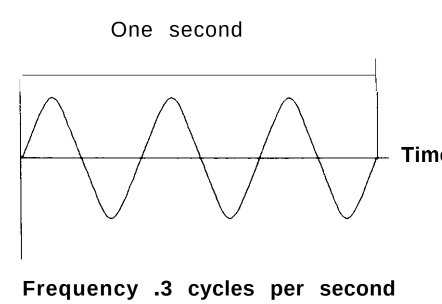
The frequency of a radio wave is the inverse/reciprocal of its period. For example, if a wave had a period of 0.1 seconds, its frequency would be 10 hertz.

Figure 2-A-3-Techniques for Modulating an Analog Carrier To Send information in a Digital Format



SOURCE: U.S. Congress, Office of Technology Assessment, *The Big Picture: HDTV & High-Resolution Systems,* OTA-BP-CIT-64 (Washington, DC: U.S. Government Printing Office, June 1990), figure 3-3, p. 41.

Figure 2-A-4-Frequency of a Continuous Wave



SOURCE: Harry Mileaf (cd.), *Electronics One,* revised 2d ed. (Rochelle Park, NJ: Hayden Book Co., 1976), p. 1-10.

(continued on next page)

2.8 MHz in the 1920s because the wavelengths in that frequency range were shorter than the wavelengths that had previously been used.

The radio spectrum is divided into "bands" that correspond to various groups of radio frequencies. These bands are identified by their frequencies or wavelengths (as above), or by descriptive terms that have been adopted over time. Several types of descriptive names have been attached to various portions of the spectrum (see figure 2-l). One method denotes relative position in the spectrum: very low frequency (VLF), high frequency (HF), very high frequency (VHF), superhigh frequency (SHF), etc. Another method derives from usage developed in World War II to keep secret the actual frequencies employed by radar and other electronic devices: L-band, S-band, and K-band.[7] The ITU classifies frequencies according to band numbers—Band 1, Band 2, etc. Frequency bands are also

[7] These letter designations are not precise measures of frequency because the band limits are defined differently by different segments of the electronics and telecommunications industries.

Box 2-A—Basic Definitions of Radiocommunication Terms-Continued

Modulation: The process of encoding information onto a radio wave by varying one of its basic Characteristics-am plitude, frequency, or phase-in relation to an input signal such as speech, data, music, or television The input signal, which contains the information to be transmitted, is called the modulating or baseband signal. The radio wave that carries the information is called the carrier wave. The radio wave that results from the combination of these two waves is called a modulated carrier. Two of the most common types of modulation are amplitude **modulation (AM) and frequency modulation (FM) (see figure** 2-A-5).

Period: The length of time it takes a radio wave to complete one full cycle (see figure 2-A-l). The inverse of the period is a radio wave's frequency.

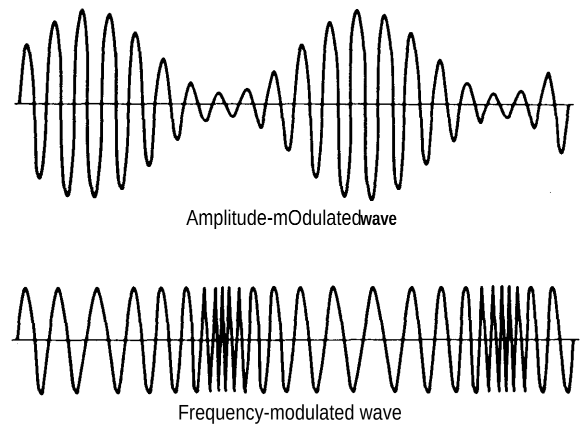
Phase: A measure of the shift in position of a radio wave in relation to time (see figure 2-A-6). Phase is often measured in degrees.

Spectrum: Each radio signal is actually made up of a number of different radio waves at different frequencies. The spectrum of a radio signal refers to the range of frequencies it contains. In **figure 2-A-2,** the spectrum of the signal extends from 98 to 102 kHz. The width of the spectrum is called the bandwidth of the signal More broadly, the radio frequency spectrum consists of all the radio frequencies that are used for radio communications.

Wavelength: The distance between successive peaks of a continuous radio wave.

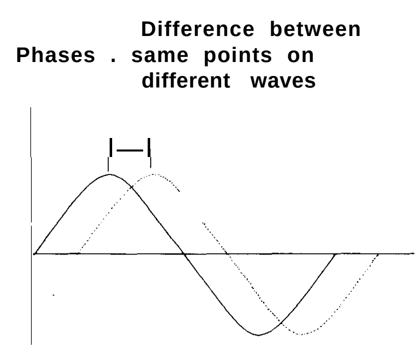
SOURCES: Harry Mileaf (ed.), Electronics One, revised 2d ed. (RochellePark, NJ: Hayden Book Co.,Inc., 1976); U.S. Congress Office of Technology Assessment, *The Big Picture: HDTV & High-Resolution Systems,* OTA-BP-CIT-64 (Washington, DC: Us. Government Printing Office, 1990); William Stallings, *Data and Computer* Communications (New York, NY: MacMillan Publishing CO., 1985).

Figure 2-A-5--Amplitude and Frequency Modulation



SOURCE: U.S. Congress, Office of Technology Assessment, The *Big Future: HDTV & High-Resolution Systems,* OTA-BP-CIT-64 (Washington, DC: U.S. Government Printing Office, June 1990), figure 3-1, p. 41.

Figure 2-A-6-Phase of a Continuous Wave



SOURCE: Harry Mileaf (cd.), *Electronics One,* revised 2d ed. (Rochelle Park, NJ: Hayden Book Co., 1976), p. 1-10.

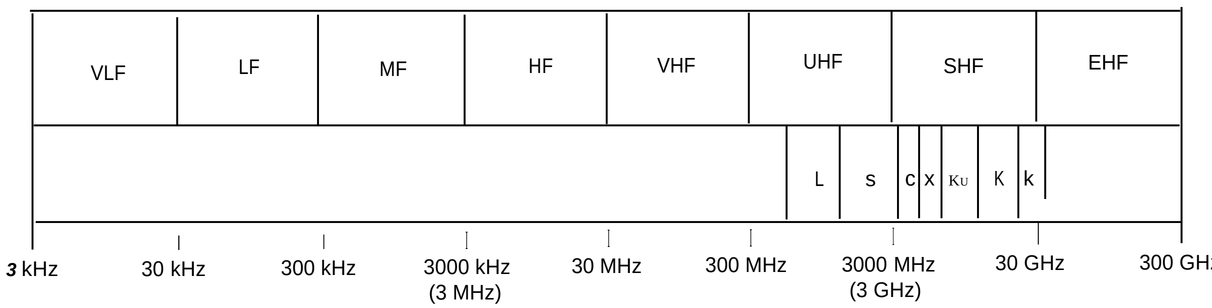
known by the services which use them-the AM radio broadcast band, for example, occupies the range (band) of frequencies 535-1605 kHz.

Transmission Characteristics

Several factors affect the transmission of radio signals, and at different frequencies, some factors will affect radiocommunication more than others. Attenuation refers to the weakening of a radio signal as it passes through the atmosphere. All radio signals are attenuated as they pass through rain or any kind of water in the air (clouds, snow, sleet), but radio signals at higher frequencies will be attenuated more than those at lower frequencies. For instance, the attenuation of a radio signal passing through a rain storm will be 10 times as great if the frequency of the signal is doubled from 5 GHz to 10 GHz. This makes radiocommunication, especially over long distances, extremely difficult in the upper (above 10 GHz) frequencies.

Radio waves are also bent and/or reflected as they pass through the atmosphere. Because of changes in

Figure 2-l—Frequency Band Designations



SOURCE: **Office of Technology Assessment, 1991, based on Richard G. Gould, "Allocation of the Radio Frequency Spectrum," OTA contractor report, Aug. 10, 1990.**

the density of the atmosphere with height, radio signals bend as they pass from one atmospheric layer to the next. This bending is called refraction (see figure 2-2). In addition to refraction, if atmospheric conditions are right, radio waves are also reflected by the ionosphere, the top layer of the Earth's atmosphere. Ionospheric reflection enables some radio signals to travel thousands of miles, and accounts for the long-distance communication that is possible in the frequency range between about 3 and 30 MHz (the HF band-see below).

Although refraction and reflection are conceptually distinct, and refraction can occur without reflection, it is possible to think of reflection as an extreme case of refraction in the ionosphere.[8] The amount of refraction, or bending, experienced by a radio signal is related to its frequency. Lower frequencies bend (are refracted) easily and are readily reflected back to Earth. Higher frequency signals experience less refraction than those at lower frequencies, and at progressively higher frequencies, there will be less and less bending. At a certain frequency, atmospheric conditions will be such that there is so little refraction that the signal will not be reflected back to Earth. The point at which this occurs is called the maximum usable frequency (MUF), and is generally in the range of 10-15 MHz, although it can be as high as 30 or 40 MHz or as low as 6 MHz, depending on time of day, season, and atmospheric conditions. Below the MUF, radio signals can be used for long-distance communication by reflecting the signal off the ionosphere. Above the MUF, the signal travels straight through the atmosphere and into space.

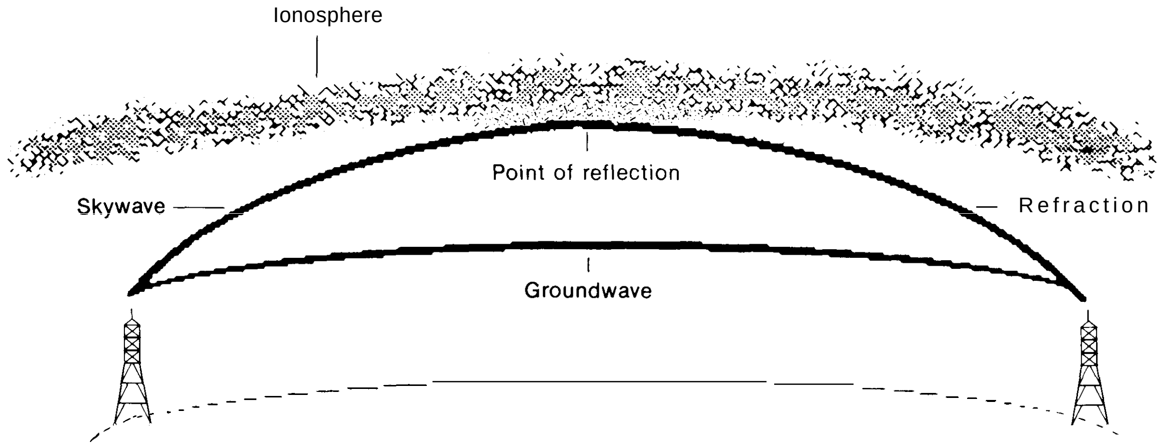
At higher frequencies, above the MUF, radio signals travel in almost straight lines from the transmitter to receiver, a transmission characteristic referred to as "line-of-sight."[9] Line-of-sight conditions affect radiocommunication above the MUF, but especially affect frequencies above 1 GHz. The distance a line-of-sight signal can travel is usually limited to the horizon or a little beyond. However, because the Earth is curved, the transmission distance will also be limited depending on the height of the transmitting antenna-the higher the antenna, the farther the signal can travel. For example, if the transmitting antenna is mounted on top of a mountain or a tall tower, the line-of-sight distance will be greater. Satellites, in simple terms, extend line-of-sight to the maximum distance (see figure 2-3). Line-of-sight transmission requires that there be no obstacles between the transmitter and receiver—anything standing between the transmitter and receiver, e.g., a building or mountain will block the signal.

Atmospheric conditions have substantial impacts on line-of-sight radiocommunications. Differences in atmospheric temperature or the amount of water vapor in the air, for example, can cause radio signals to travel far beyond the "normal" line-of-sight

[8] All radio waves are bent as they pass from a region of the atmosphere having a certain number of free electrons to a region with a different number of electrons. During the day, energy from the Sun splits the molecules of the gasses far above the surface of the Earth (in the troposphere and the ionosphere), producing many free electrons and creating layers of ionized particles. A radio wave from Earth entering one of these layers will be refracted, and if there are enough free electrons, the bending will be so great that the signal will be reflected back to Earth

[9] It is important to note that refraction does not cease to affect radio waves above the MUF. Even at frequencies in the VHF and UHF bands, radio waves bend slightly as they move through the atmosphere.

Figure 2-2—Radio Wave Transmission



SOURCE: Office of Technology Assessment, 1991.

distance. This condition is called ducting or superrefraction. At such times, signals travel for many miles beyond the horizon as though the Earth were flat. This condition is much more common over large bodies of water than over land. Atmospheric conditions can also bend the signal away from the Earth, shortening the practical transmission distance. The occurrence of these rare conditions complicates radio system design and spectrum management. For line-of-sight systems, too large a radius cannot be assumed for the service area because of the possibility that "subrefraction" or "negative' refraction may keep the signal from reaching the periphery of the service area. On the other hand, the same frequency cannot be used again many miles beyond the horizon because of the possibility that superrefraction may carry an interfering signal far beyond its accustomed limits. One of the basic functions of international spectrum management is to prevent or reduce such interference.

Characteristics of Radio Frequency Bands

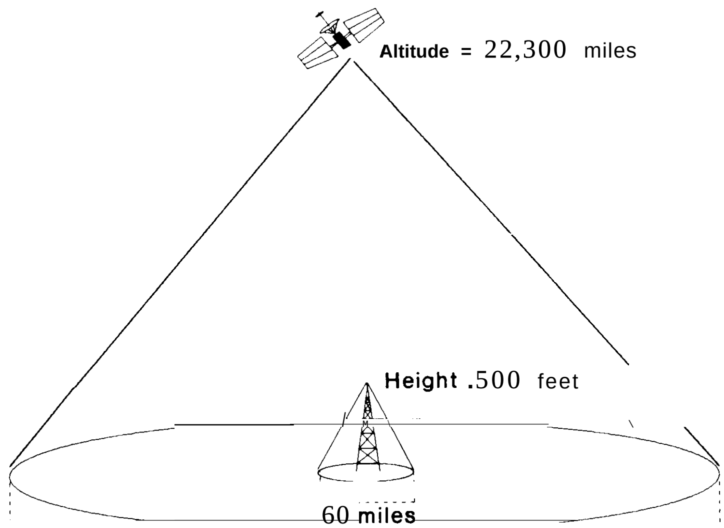
The physical properties of radio waves, combined with the various transmission characteristics discussed above, determine how far and where radio signals can travel, and make different radio frequencies better suited to certain kinds of communications services. The following is a brief description of the various radio bands, some of their uses, and the factors affecting transmission of radio signals in them.

Very Low, Low, and Medium Frequencies: 3 to 3000 kHz

In this portion of the spectrum, encompassing the bands denoted as VLF, low frequency (LF), and medium frequency (MF), radio signals are transmitted in the form of "groundwaves' that travel along the surface of the Earth, following its curvature. Groundwaves lose much of their energy to the Earth as they travel along its surface, and high power is required for long-distance communication throughout this portion of the spectrum. Groundwaves travel farther over water than over land.

At the lower end of this region, transmissions are used for low data rate communications with submarines and for navigation. The maritime mobile service, for example, has allocations in this band for communication with ships at sea. Conventional AM radio broadcasting stations also operate in a part of this band, at MF, typically between 540 and 1605 kHz. Attenuation during daylight hours limits the range of these AM stations, but at night, when attenuation is lower, AM radio signals can travel very long distances, sometimes even hundreds of miles. To prevent interference at these times to distant radio stations using the same frequency, some stations may be required to reduce the power of transmissions in the direction of those distant stations.

Figure 2-3-Terrestrial and Satellite Transmission Ranges



NOTE: This figure is not drawn to scale.

SOURCE: Office of Technology Assessment, 1991, based on Richard G. Gould, "Allocation of the Radio Frequency Spectrum," OTA contractor report, Aug. 10, 1990.

High Frequencies: 3 to 30 MHz

In this frequency range, denoted as HF, propagation of a "skywave" supplements the groundwave (see figure 2-2). While the groundwave dies out at about 100 miles, the skywave can be bent back to Earth from layers of ionized particles in the atmosphere (the ionosphere). When the signal returns to Earth, it may be reflected again, back toward the ionized layers to be returned to Earth a second time. The signal can make several 'bounces' as it travels around the Earth. It is this reflection that makes long-distance communication possible. However, there are occasional-and largely unpredictable— disturbances of the ionosphere, including sunspots, that interfere with HF communications. Overall, the reliability of HF communications is low, and the quality is often poor.

The HF 'shortwave' bands are used primarily by amateur radio operators, governmental agencies for international broadcasting (Voice of America, Radio Moscow), citizens' band radio users, religious broadcasters, and for international aviation and maritime communications. Overseas telephone links using HF radio have, for the most part, been replaced by satellites, and Inmarsat satellites have taken over a major portion of the maritime communications previously provided by HF systems. Likewise, future aeronautical mobile-satellite service (AMSS) systems may also supplement or replace the HF channels now used by airplanes when they are out of range of the VHF stations they communicate with when over or near land.

While little use is made of HF radio systems for domestic communications in industrialized countries like the United States, developing countries still find HF cost-effective for some of their domestic radiocommunication needs. This has led to a conflict over allocating the HF band internationally: the developed world wants to use the band for international broadcasting and long-distance mobile communication, while the developing countries want to retain it for their domestic point-to-point systems.

Very High, Ultrahigh, and Superhigh Frequencies: 30 MHz to 30 GHz

The groundwave, which permits communication beyond the horizon at lower frequencies (VLF, LF, MF), dies out after a short distance in this frequency range. Moreover, the skywave--which is reflected from the ionospheric layers at lower frequencies—tends to pass through the atmosphere at these higher frequencies. Communication in this band is thus limited to little more than line-of-sight distances. For short transmitting antennas, the maximum distance a radio signal can travel may be no more than 25 miles, but this distance can be increased by raising the height of the antenna.

This limitation can also bean advantage: the same frequencies can be reused by stations beyond the normal transmission range. Unfortunately, the distances that these line-of-sight signals can sometimes travel can be quite large, especially if the path is over water. At times, atmospheric conditions may establish a‘ ‘duct” over a large body of water (see above). As it travels down the length of the duct a signal will be reflected back and forth between the water and the top of the duct, which can be hundreds of feet above the Earth's surface. These trapped signals can travel hundreds of miles. To minimize interference from a ducted signal, stations on the same frequency must be spaced far apart. This requirement limits the frequency reuse that can be achieved.

This part of the spectrum is used by many important communication and entertainment services, including television broadcast signals, FM radio, and land mobile communications. These frequencies are also used by the radiolocation service for long-range radars (1350 MHz to about 2900 MHz), aircraft landing radar (around 9000 MHz), and for point-to-point radio relay systems (various bands between 2000 and 8000 MHz). In recent years, communication satellites have made increasing use of frequencies in this band.[10]

The portion of this band between approximately 1 and 10 GHz is particularly valuable. It is bounded by increasing cosmic and other background noise at its lower end, and by precipitation attenuation at its upper end, but in between, communications can be carried out very well. Today, because of its favorable transmission characteristics, the 1-3 GHz band is especially sought after for mobile communications, including personal communication services (PCS), and for new broadcasting technologies such as digital audio broadcasting (DAB).

Above 10 GHz

At 10 GHz and above, radio transmissions become increasingly difficult. Greater attenuation of the radio signal takes place because of rain, snow, fog, clouds, and other forms of water in the signal's path. Nevertheless, crowding in the bands below 10 GHz is forcing development of the region above 10 GHz. One desirable feature of the frequencies above 10 GHz, beside the fact that they are relatively unused, is the extremely wide bandwidths that are available. The 3-30 MHz, HF band, for example, is 27 MHz wide. That is enough bandwidth for about 9,000 voice charnels (at 3 kHz each). However, the frequency range 3-30 GHz is 27,000 MHz wide. That bandwidth could accommodate about 9 million voice channels.

Technologies and Services Create Congestion

The radio frequency spectrum has been more or less crowded almost since its first use for communication—technology (and the regulations and procedures to support it) must continually advance to enable the supply of spectrum to meet demand. Today, however, as the number of users and applications booms and more of the usable communication spectrum is filled, congestion has once again become a serious problem. Virtually all of the radio frequencies below 3 GHz are allocated and in use, and innovative technologies such as PCS, DAB, and air-to-ground communications systems must compete with existing services and technologies for a crucial slice of the spectrum pie. Spectrum managers are faced with a classic battle of old versus new—trying to accommodate existing technologies while simultaneously promoting innovation and technological advancement.

In the early days of radiocommunication, there were fewer services compared to today, and relatively few users. Nevertheless, the spectrum was still congested. The range of frequencies that could be

[10] Satellites operating in the C-band, e.g., use frequencies around 4 and 6 GHz, and are heavily used for transmitting television programming to cable television operators. Ku-band satellites, which generally operate at frequencies around 12 and 14 GHz, are increasingly being used for private communication networks and the delivery of entertainment programming.

used was limited by available technology, and equipment capabilities-transmitter power, antenna gain, receiver sensitivity-and, most important, by the cost of the equipment itself.[11] The government and commercial broadcasting concerns quickly filled the airwaves. As technology advanced, the range of frequencies that could be used for communication expanded, but the number of users and applications grew as well. And as increasing numbers of users began taking advantage of new services, the amount of unused spectrum shrank.

Over the past two decades, many new radiocommunication technologies have been developed, leading to the introduction and rapid dissemination of many innovative radio-based services. Satellites became a staple of long-distance communication in the 1970s and 1980s; in the 1980s first citizens' band radios and then cellular telephones put two-way radios in many of America's cars, trucks, and boats; and today, baby monitors, cordless phones, and garage-door openers are in many of America's homes. **All** of these technologies, and the services and industries they generated, depend on radio frequencies for their operation. The use of almost all these wireless systems and services will continue to increase as people come to depend on them more and more. The use of mobile radio communications systems, for example, has exploded in the last decade, and today there are over 10 million two-way radios being used by industry, transportation, and public safety (police and fire) organizations. This dramatic growth in the use of existing radiocommunication technologies, exacerbated by the rapid development of new radio-based technologies, has led to increasing crowding and congestion in many of the most valuable frequency bands.

Reallocating spectrum is difficult because the spectrum is finite-almost any allocation that is made to a new service (or for the expansion of an existing service) will have to be taken away from an existing service. The process is never easy—reallocation of spectrum is based on social and political factors as well as on technical and economic considerations. At the international level, the process of reallocation takes place at the WARCs, and WARC-92 is faced with resolving the competing demands of existing service providers who want to protect their spectrum or even expand it, and a variety of new services that are demanding access to spectrum. This is the technological context facing the United States as it approaches WARC-92. This section will examine some of the old and new technologies vying for spectrum both domestically and internationally.

Broadcasting

The demand for AM, FM, and TV broadcasting stations has been increasing, particularly in major market areas. Prospective operators of these stations see a need for more specialization in programming (narrowcasting) and for improved signal quality (e.g., high definition television (HDTV) for television stations and digital modulation for compact disc quality radio broadcasting). HF broadcasters such as the Voice of America and many religious groups also are making increasing use of radio broadcasting to reach audiences overseas (see ch. 1).

HDTV, which promises picture and sound quality far superior to today's television, has been in development for many years, but only recently have definitive steps been taken to promote its widespread adoption around the world.[12] Originally, an allocation was made for ITU Region 2 (the Americas) in the 12.2-12.7 GHz band to the broadcasting-satellite service (BSS) that would allow satellites to deliver conventional television programming directly to home receivers.[13] Since a plan was developed for this service in 1983, however, HDTV has developed rapidly, and HDTV proponents are now seeking to use the BSS allocations for this new kind of television, preferably in the same frequency band all over the world (see ch. 1). Experimental or quasi-operational HDTV service is currently being planned or implemented in Japan, the United Kingdom, France, and Germany.

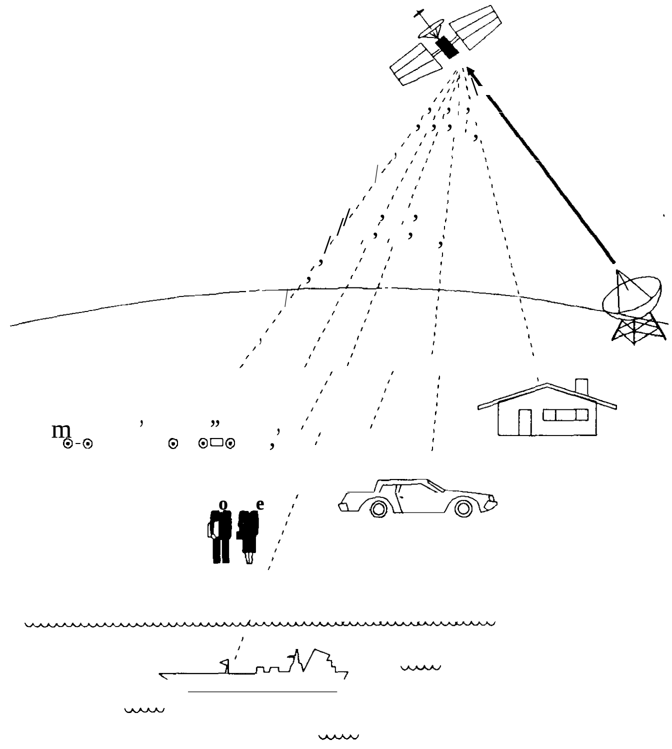
11 When transmitters cost thousands of dollars, radio was used primarily for those commercial and governmental applications that could Justify the expense. Now, however, cellular mobile telephones are available for under $100, and remote garage-door openers, wireless microphones, and cordless telephones are within the budgets of millions of individuals and families.

12 See U.S. Congress, Office of Technology Assessment *The Big Picture: HDTV & High-Resolution Systems*, OTA-BP-CIT-64 (Washington, DC: U.S. Government Printing Office, June 1990).

13 The satellite transmission of programming directly to homes is also known as direct broadcast satellite service, or DBS. There are no DBS systems operating in the United States, although several are planned (see app. C). Only a few DBS systems are operating in other countries.

Another technology that is being aggressively developed is BSS-Sound.[14] BSS-Sound, while not yet in operation, will use satellites (supplemented in some cases by terrestrial transmitters) to deliver high-quality audio services directly to home and car radio receivers throughout the country (see figure 2-4). Such services will not be compatible with existing analog radio receivers, and will require consumers to buy new radios. Some operators plan to offer BSS-Sound services in conjunction with other mobile services such as paging and location services, and several companies have filed applications at the Federal Communications Commission (FCC) to provide such service. However, as of early July 1991, only one experimental application had been granted (see app. C). The primary hurdle to introduction of such services both domestically and internationally is a lack of agreement on the radio frequencies to be used (see ch. 1).

Figure 2-4--Broadcasting-Satellite Service-Sound



SOURCE: Office of Technology Assessment, 1991.

Mobile Services

Mobile communications is one of the fastest growing segments of telecommunications services. In the past 10 years, there has been a phenomenal growth of personalized radio services for general-purpose communications: cellular mobile telephone, specialized business mobile telephone services, local and nationwide paging, and the newest personal telephone services just on the horizon, PCS. Estimated yearly growth rates for mobile services are as high as 25 percent and up to 80 percent for cellular services worldwide, and demand shows little signs of slacking.[15] Nearly 15 percent of the telephone lines installed in this decade are expected to be wireless.[16] Mobile services delivered by satellite, including data transfer, voice services and position determination for individuals, cars, trucks, ships, and aircraft, are also experiencing rapid growth. WARC-92 will address increasing the allocations for both Mobile and Mobile Satellite Services.

Cellular

Since its inauguration in 1983, cellular telephone service has grown at an explosive rate (see figure 2-5), and is predicted to serve over 20 million subscribers by the year 2000.[17] Today, cellular service is available in all major urban areas of the country, and rural cellular licensing is in progress. In recent years, many cellular systems, especially in urban areas, have become increasingly congested—calls often cannot be completed because the system is overcapacity. The cellular industry has developed a number of innovative solutions to address this problem. Cell sizes have shrunk, allowing frequencies to be reused more often and more users to be served. Recently, the industry has begun moving toward the next generation of cellular systems using

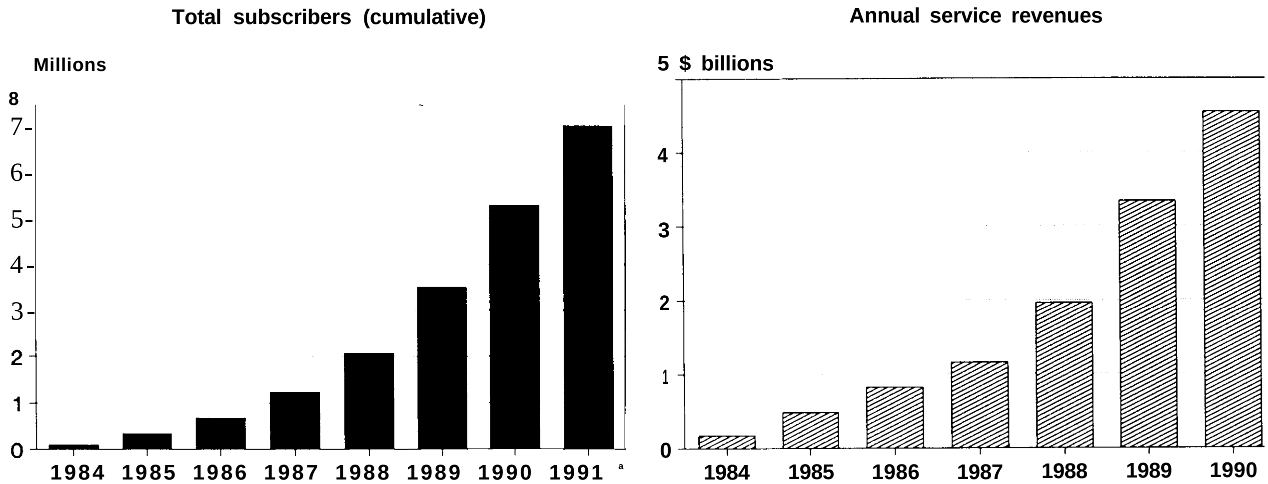
[14] The term digital audio broadcasting (DAB) is often used in the United States in place of BSS-Sound, reflecting continuing U.S. concern for terrestrial broadcasting systems and operators.

[15] Pekka Tarjanne, op. cit., footnote 2, p. 123. One conference brochure touts a 530-percent expansion of mobile communications markets (cellular, personal communication networks, cordless, mobile radio, and paging) by the year 2000.

[16] Pekka Tarjanne, "Simpler Radio Regulations?" editorial in *Telecommunications Journal,* vol. 58, No, II, February 1991, p. 65.

[17] John Keller, "Cellular Phones Dial Digital for Growth," *Wall Street Journal,* May 5, 1990, p. B1.

Figure 2-5-Growth in Cellular Phone Service, 1984-91



aThe 1991 subscriber figure is an estimate.

SOURCES: U.S. Department of Commerce. International Trade Administration. 1991 *U.S. Industrial Outlook* (Washington, DC: U.S. Government Printing Office, January 1991); and U.S. Department of Commerce, unpublished data, 1991.

digital technology. Digital compression technology, which can pack more phone calls into a given portion of spectrum, promises to increase cellular system capacity from 6 to 20 times (see below). Such advances will take time to implement, however, and some urban cellular systems may remain congested for many years.

In addition to traditional cellular voice applications, new data services are being developed. GTE Mobilnet, for example, is planning a field trial of a cellular packet data system (using existing cellular equipment) that could give rise to new services and expand the market potential for cellular networks.[18] The system could be used for credit card verification, remote monitoring of vending machines, and connecting field service personnel to customer's records stored in a remote computer.

Personal Communications Services

PCS is emerging as an umbrella term encompassing a wide range of personal communications systems and applications now being developed.[19] Basically, PCS is wireless phone service that lets users communicate wherever they are-walking outside; in a car, ship, or plane; or even at work. PCS systems are usually considered terrestrially based, but satellite-delivered systems are also being developed. The use of small, lightweight and (eventually) inexpensive handsets is one common factor of all these systems.

PCS takes many different forms. The most basic type of PCS service is often called Telepoint. Telepoint allows users with portable phones to make calls (but not receive them) as long as they are close enough (within approximately 100 yards) to the Telepoint receiver that is connected to the public telephone network. Most advanced are the full-featured two-way voice and data services commonly known as Personal Communications Networks (PCN) (see box 2-B). PCNs will operate similarly to cellular telephone systems, but will use many more, much smaller cells (called microcells) that allow more people to use the system and enable smaller, more portable phones. These types of networks, which are being developed by telephone companies, cable television companies, and small telecommunications companies, allow users to place and receive phone calls or even exchange data with remote computers—all with radio technology that frees them from a wire connection. Eventually, users may also be able to send and receive video signals.

Many companies have begun PCS trials around the country, but none are operational yet (see app.

[18] "GTE Mobilnet Announces a Field Trial of a Cellular Packet-Data Network," *Telcom Highlights International*, vol. 13, No. 3, Jan. 16, 1991, p. 5.

[19] The February 1991 issue of *IEEE Communications* Magazine is devoted to personal communications and contains articles on technology, regulatory, and service issues. *IEEE Communications Magazine*, vol. 29, No. 2, February 1991.

Box 2-B—Future Phone? The PCN Is a Wireless To Watch

Pity the mail handlers at the Federal Communications Commission. When the agency asked for ideas last year on how to promote and regulate new wireless phone services, more than 3,000 pages of comments poured in from everywhere from Silicon Valley to Sweden. The intense interest reflected the huge potential of new wireless technologies, especially one called the personal communications network (PCN). Impulse Telecommunications Corp., a Dallas-based market researcher, estimates that by the year 2000, PCNs will bring in $2.78 billion annually-about what cellular phone systems bring in today.

Even though PCNs are at the experimental stage, proponents say they could eventually render the wired local phone monopolies passe. At minimum, they'll be one of many forces acting to loosen the grip of local phone companies on their customers. But before they take on the establishment, the upstart PCN systems must overcome technical, financial, and regulatory hurdles.

As envisioned by their proponents, PCNs would have light, inexpensive handsets that would communicate via low-power antennas. Subscribers would be able to make and receive calls while traveling, as they can with cellular phone systems, but at a lower price. Eventually, so many people would use PCNs that most calls would never have to travel over the wires of the local phone company.

Cable Assist. That's a costly vision. To carry as much traffic as their business plans call for, PCN startups may need to erect a dozen antennas to cover the same area that a cellular system now serves with one. That means an enormous up-front investment. Indeed, companies experimenting with PCNs are already seeking ways to hold down expenses-perhaps by piggybacking on cable TV networks or creating networks only in certain areas, such as within large office buildings.

Finding a market niche for PCNs will be a challenge, too. Cellular is already well entrenched. And a cordless phone service known as CT-2 does some of what PCNs promise, but at a substantially lower cost. Already used in England, CT-2 lets customers make-but not receive-calls while in the vicinity of special transmitters.

And regulation is yet another hurdle. The FCC hasn't decided how-or whether-to make room on the precious airwaves for a service that overlaps existing ones. To ease its way with the commission, New York-based Millicom Inc. is testing a PCN setup in Houston and Orlando that works on part of the spectrum already used by microwave communications.

Even PCN entrepreneurs concede that they have a long struggle ahead. "It's not a shoo-in, and we're going to have to learn things about it," says Millicom CEO J. Shelby Bryan. Still, even if they don't match the cellular-phone revolution, PCNs are likely to be one more factor in the demise of the local phone monopolies.

SOURCE: Reprinted from the Mar. 25, 1991 issue of *Business Week* by special permission.

C). Great Britain has experimented extensively with the more limited second-generation cordless telephone (CT2) and Telepoint systems. WARC-92 will address the issue of finding spectrum dedicated to PCS as part of discussions on Future Public Land Mobile Telecommunication Systems (see ch. 1).

Paging

The use of radio paging has also increased markedly in the last decade. From 6.5 million customers in 1987, paging services are expected to be used by 15 million customers by 1995.[20] Like many telecommunications applications, paging started out as a local service (for repair people, technicians, doctors), but now serves customers from all segments of the business community, including executives and sales personnel. In recent years, pagers have also gained popularity with illegal-drug dealers, who use them to keep in contact with their buyers.

Paging systems primarily use terrestrial radio signals to reach local subscribers, but several companies have developed national terrestrially based paging systems and still others plan to use satellites to deliver national paging. Paging companies would like to offer their services in foreign countries ("international roaming"), but equipment incompatibility is a limiting factor. Many different frequencies are used in other countries, and none of the larger developed countries use the same frequencies for their national paging service as those used in the United States. This means that a U.S. traveler

[20] U.S. Department of Commerce, National Telecommunications and Information Administration, "Telecom 2000: Charting the Course for a New Century," NTIA Special Publication 88-21 (Washington, DC: U.S. Government Printing Office, October 1988), p. 286.

cannot be served by his or her pager in a foreign country. New frequencies are being sought to permit paging anywhere in the world using the same paging unit.

Specialized Mobile Radio

Specialized Mobile Radio (SMR) services were created by the FCC in 1974 to provide land mobile communications on a commercial basis to businesses, government agencies, and individuals.[21] SMRs operate in two bands (around 800 and 900 MHz), and provide dispatch services and service similar to cellular telephony .22 Construction companies with many trucks at different job sites or limosine services are typical SMR users. Since the first service began operation in 1977, SMR service has grown to over 7,000 SMR systems serving over 1 million users. The annual growth rate for 800-MHz SMRs has been about 15 percent, but the growth rate of the newly introduced 900-MHz SMRs between 1988 and 1990 was over 240 percent. The FCC expects the growth rate for SMR services to remain in double digits for some years.

Radiodetermination-Satellite Service

The Radiodetermination-Satellite Service (RDSS) uses satellites to provide location information (primarily for vehicles, ships at sea and airplanes) and the transmission of brief data messages. RDSS systems, using new allocations around 1600 MHz for uplinks to the satellite, and around 2500 MHz for downlinks, are expected to be widely used by the transportation industry, among others, for locating vehicles and also will serve vital safety and rescue functions by helping to locate lost hikers, boats, and downed airplanes. Currently, the future of dedicated RDSS systems is in doubt with the recent bankruptcy filling of Geostar Corp., a leading proponent of RDSS. Some claim that RDSS will not survive as a service by itself, and that RDSS spectrum and services should be considered as part of a more generic Mobile Satellite Service (MSS) that would provide voice and data services in addition to RDSS.[23] Several companies, including those developing low-Earth orbiting satellite (LEOS) systems, plan to offer RDSS services bundled with more advanced messaging services (see app. C).[24]

Aeronautical Services

Another relatively new mobile radiocommunication service is air-to-ground telephone service for airline passengers. The FCC has expanded the number of service providers in the nascent field of phone service from airplanes (none transmits to airplanes yet). Currently, six providers are licensed to provide service from airplanes, up from only one a year ago.[25] Data services for airplanes are also being developed and implemented. COMSAT and ARINC, for example, have begun offering satellite-based low-speed data services to airlines with eventual services expected to include voice, electronic messaging, fax, and computer file transmissions.

Mobile Satellite Service

The increase in terrestrial mobile communication services is mirrored in space. Several developments have recently widened the provision of MSS. A portion of the spectrum previously set aside for aeronautical mobile-satellite service (AMSS) was recently reallocated by the ITU to land mobile-satellite service (LMSS). In the United States, the FCC approved a domestic mobile-satellite system which is scheduled for operation in the mid- 1990s.[26] Proponents of mobile-satellite services are already requesting that more spectrum be allocated for such systems, and WARC-92 will address how and where to provide more spectrum for future expansion of MSS (see ch. 1).

In the United States, interest is also growing in LEOS systems (see ch. 1). In contrast to the more

21For a description of SMRs, their history, and their regulations, see Doron Fertig, "Specialized Mobile Radio," background PaPer, Federal Communications Commission, Private Radio Bureau, Land Mobile and Microwave Division, Policy and Plarming Branch, March 1991.

22SMRs are generally smaller, less complex, and less costly to construct and maintain than cellular systems.

23"TRW, Loral/Qualcomm Venture," *Telecommunications Reports,* vol. 57, No. 24, June 17, 1991, p. 28.

24Qualcomm, Inc. already operates an extensive (16,000 terminals) two-way messaging service, and Orbital Communications Corp. and Starsys, Inc. plan to use LEOS to provide similar services (see below). Daniel Marcus, "Messaging Market Evolves," *Space News,* vol. 2, No. 24, July 8-14, 1991.

25The six are: Airfone, Inc., the first company t. receive an experimental license from the FCC; Clairtel Communications Group; Mobile Telecommunications Technologies Corp.; American Skycell Corp.; Jet Tel; and the In-Flight Phone Corp.

26The future of this system, t. be operated by the American Mobile Satellite Consortium (AMSC), was in doubt after a court struck down key portions of the FCC's ruling requiring a consortium approach. The FCC subsequently has issued a tentative decision reaffinning AMSC'S status as the U.S. MSS licensee. AMSC is proceeding with its plans.

common 'conventional" satellites, which circle the Earth in a geosynchronous orbit 22,300 miles above the equator, LEOS systems will use a network of smaller, lighter, and cheaper satellites to maintain constant contact with users on the ground.[27] Nine companies have applied with the FCC to offer LEOS services, basically divided into two groups-those planning to operate at frequencies below 1 GHz and those planning to operate above 1 GHz (see app. C). The frost LEOS systems proposed to the FCC plan to use frequencies below 1 GHz to deliver data services. Of this original group, none has been granted an operational license, but Orbcomm and VITA have received experimental licenses.[28] The other group of applications, including Motorola's Iridium system, propose systems that would use frequencies in the L-band (1.5- 1.6 GHz). They plan to offer both voice and data services. None of these applications has yet been acted on.

Part 15 Devices

Part 15 of the FCC Rules regulate radio-operated devices that, in theory, use such low power that they will not cause interference to other services and systems in the same band, and therefore do not need to be licensed. However, the number and variety of these devices has increased sharply in recent years, bringing about interference between the devices themselves, and between them and other services. Part 15 devices include: cordless telephones, wireless or cordless microphones (for stage performers, and for baby monitors), garage-door openers, control and security alarm devices (for fire, and intrusion detection), automatic vehicle identification systems (e.g., at toll plazas), auditory assistance devices (headsets used by hearing impaired patrons in theaters), and devices that permit the simultaneous viewing of a VCR on several TV sets throughout a house.

Part 15 devices operate under the restrictions that they must not cause interference to other users, nor claim protection from interference. However, the consumers who buy these devices are often unaware of their tenuous regulatory status. Not unreasonably, consumers think that the devices they have bought should perform their advertised function throughout their useful lifetime.

Point-to-Point Microwave Radio Relay Systems

The general growth in telephone usage, data communications, and information services and in the distribution of video materials such as TV programming and teleconferencing has brought about a commensurate increase in the need for long-distance, wideband, point-to-point systems for transmitting this information. Even though some of this demand has been absorbed by communications satellites and by the use of coaxial and fiber-optic cable systems, the number, extent, and capacity of terrestrial microwave systems have been growing. As the lower bands have become congested, particularly in and around major metropolitan areas, higher frequencies have been employed around 11 GHz, and 18-23 GHz. Some systems in the higher bands are designed for relatively short distances, with close spacing of the relay stations. These relays are small and self-contained, and can be mounted on existing telephone poles.

Radio in the Local Loop

A larger trend that may have an impact on the demand for radiocommunication services is the opening of portions of the public telephone network to competition.[29] Bypass of the public network 's increasing as large companies build their own networks or subscribe to private fiber networks and satellite teleports. Cable companies have begun to examine how their existing wire networks can carry telephone calls as well as video entertainment. Radio technologies, including microwave, cellular, and eventually microcell/PCN and satellite communications systems are increasingly seen as viable alternatives to the traditional wireline network—either replacing it completely or serving as an alternative way to connect to the public telephone network. These technologies provide potential competitors to the phone companies a way to build a

[27] While the individual satellites used in LEOS systems may be inexpensive compared to traditional geosynchronous satellites, this does not mean that the LEOS systems are any less expensive. Since they require many more (anywhere from 24 to 77 in current plans) satellites to cover the Earth, initial system costs still remain high. Motorola's Iridium, e.g., is expected to cost well over $2 billion.

[28] Andrew Jenks, "Flurry of Low Earth Orbit Filings Flood the FCC," *Washington Technology,* vol. 6, No. 6, June 131991.

[29] For a recent discussion of the technologies and politics of bypass and competition in the local loop, see Gary Slutsker, "Divestiture Revisited," *Forbes, Mar. 18, 1991,* pp. 118-124; Peter Coy and Mark Lewyn, "The Baby Bells Learn a Nasty New Word: Competition," *Business Week, Mar. 25, 1991,* pp. 96-101.

competing network and service without the major expense and time (and without having to acquire rights of way) for laying cable.

Many companies are now experimenting with wireless alternatives to the "last mile' or local loop connection of the phone companies, including the phone companies themselves. Several cable companies are investigating using their existing cable networks to supply PCN services (see app. C). There are several examples of how wireless local telephone service can be provided.[30] Cellular/PCS systems could supplement the existing wire network, but some advocates believe that with enough subscribers these systems could actually become a second phone system separate from the wire system. The second way in which radio technologies are coming into the local loop are through a new generation of digital radio services designed to bring local telephone service to rural areas not economically served by wire technologies. The primary advantage of such systems is their ability to bring 'plain old' and eventually advanced voice and data services to rural customers without the heavy expense of laying (copper or fiber optic) cable.[31] Such systems are currently serving more than 15,000 customers, with estimates that up to 900,000 more remote subscribers could be served.[32]

For the same reasons radio technology is attractive to rural applications in the United States, it also being deployed in developing countries and in countries with underdeveloped telecommunication infrastructures, such as Eastern Europe. The German Ministry of Posts and Telecommunications, for example, is considering radio technologies such as CT2 and PCN in order to improve telecommunications services in former East German states.[33]

Satellite Services[34]

Another fast growing telecommunication service vitally dependent on spectrum is the rapidly growing field of satellite communications. Satellite communication systems are used for a variety of purposes including delivering entertainment programming, transmitting long-distance telephone calls, and facilitating data transmission. For example, private users as well as government agencies are making increasing use of private satellite networks based on very small aperture terminals (VSATs). The decrease in size, cost, and ease of installation has made satellite receivers attractive to users with minimal communications requirements. Customer premises Earth stations are frequently located on the roof of a company headquarters or a warehouse. These stations are most commonly used for data communications, but can easily accommodate voice and video applications as well.

Networks of these satellite terminals allow businesses to communicate directly with hundreds or thousands of individual locations. Currently, an estimated 20,000 VSATs are operating in the United States, and estimates project use to increase severalfold by 2000.[35] Chevron, for example, has begun building a private network connecting approximately 4,000 service stations and corporate sites, primarily for interactive data, but also with some video services.[36] The FCC typically grants blanket licenses to hundreds or even thousands of VSATs at a time.[37]

Two of the most rapidly increasing uses of satellites are for videoconferencing and education. Interactive videoconferencing has increased dramatically in recent years as standards have been established and technology has improved the quality

[30] For a more detailed description of how radio technologies are being used to deliver local telephone service in rural areas, see U.S. Congress, Office of Technology Assessment *Rural America at the Crossroads: Networking for the Future,* OTA-TCT-471 (Washington DC: U.S. Government Printing office, April 1991), pp. 71-74.

[31] The average cost of providing access to rural customers can run as high as $10,000, while the average cost of digital radio is $3,000. Ibid., P. 73.

[32] Ibid.

[33] Local wireless access will be tested later this year with CT2 in order to get subscribers connected to the public network as quickly and cheaply as possible. In the future, PCN may either function as an alternative to the public network or as a supplement to it, as cellular. "Wireless Technology for Eastern GermanY," Telecommunications, International Edition, vol. 25, No. 4, April 1991, pp. 15-16.

[34] The services described in this section represent only one small portion of all the satellite-based systems. Other services, such as mobile satellite, are described elsewhere in this chapter depending on what type of service they deliver.

[35] "VSAT NOTES," *Telcom Highlights International,* vol. 13, No. 13, Mar. 27, 1991, P. 14.

[36] 'Hughes Installing Hybrid VSAT Network for Chevron Corp., " *Telcom Highlights International,* vol. 13, No. 1, Jan. 2, 1991, p. 16.

[37] Scientific Atlanta, e.g., was granted a license for 2,500 VSATs, while GTE Spacenet was granted a license for 101. "Actions of Interest at the FCC," *Telcom Highlights International,* vol. 12, No. 50, Dec. 12, 1990, p. 15.

of the transmission while simultaneously lowering the cost. During the recent war in the Persian Gulf, for example, videoconferencing increased dramatically as U.S. businesses restricted travel abroad. The educational use of satellites, distance education, has also increased dramatically in the last 5 years.[38] In most education uses, satellites are used to transmit a live, one-way video image of the teacher to subscribing schools around the country. Students at the schools can respond to the teacher in real-time through the use of telephones ("800" numbers) or computers. Such systems have proven to be a highly effective way to bring educational resources to isolated students.

During the 1980s, C-band satellites, operating in the 6/4-GHz bands, were the most commonly used satellites for commercial, education, and entertainment applications. However, the anticipated growth in smaller Earth stations has led to launching of many higher-power, Ku-band satellites for U.S. domestic service. The next frontier for satellite services is at 20 and 30 GHz, the Ka-band. This shift up in frequency is occurring not because the higher frequency bands are attractive technically (in fact, they are extremely sensitive to rain attenuation), but because lower frequency bands are at or near capacity. Italy and Japan have launched experimental Ka-band satellites, and the National Aeronautics and Space Administration's (NASA) Advanced Communications Technology Satellite (ACTS), expected to be launched in 1993, will operate in this band. Norris Satellite has filed an application for a commercial Ka-band system.

Other Specialized Services

Many other specialized radio services are being developed, some of which are already operating:

Stolen Vehicle Recovery Systems

Stolen Vehicle Recovery Systems (SVRS) are proliferating. Ire-jack, a service intended to aid in the radiolocation of stolen vehicles, is one example. A radio receiver/transmitter is mounted in an unobtrusive location on vehicles. If a vehicle so equipped is stolen, the owner calls the police and a coded transmission is broadcast which turns on the transmitter in that vehicle. Radio direction finders can then be used to home in on the stolen vehicle. Implementation of this new service required the reallocation of only one 25-kHz wide radio channel, but even that small "loss" of spectrum was strenuously opposed by many government agencies having large and growing mobile radio requirements. In addition to the original Ire-jack system, many other companies have entered the vehicle location and tracking market, including Teletrac, which plans to expand its services to 100 metropolitan areas in the next several years.[39]

Interactive Video Data Service

Interactive Video Data Service (IVDS) uses radio signals to allow television viewers with special home transmitters to interact with all forms of commercial, educational, and entertainment programming delivered by broadcast, cable, or direct broadcast satellite technologies.[40] Users are able to shop or bank from home, respond to polls, and receive information through their television sets. The system has been tested and is currently the subject of an FCC Notice of Proposed Rulemaking.[41]

Wireless Business Telephone

Wireless business telephone systems are being developed which provide the same features and capabilities of existing (wire-based) business telephone systems. These systems utilize digital radio signaling and intelligent transmission management techniques to eliminate many of the quality, noise and fading problems of cordless and cellular telephones. At the same time, they provide complete coverage anywhere within a building.[42]

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38 For a complete discussion of distance learning, see U.S. Congress, Office of Technology Assessment *Linking for Learning: A New Course for Education, OTA-SET-430* (Washington, DC: U.S. Government Printing Office, November 1989).

39 "Teletrac Launches Fleet Locator Service," *Telcom Highlights International, vol. 13, No. 3,* Jan. 16, 1991, p. 16.

40 "FCC Proposes Interactive Video Data Service in the 218-218.5 -Band," *Telcom Highlights International*, vol. 13, No. 3, Jan. 16, 1991, p. 18; "FCC Proposes Spectrum Allocation for New TV-Based 'Interactive Video Data Service,'" *Telecommunications Reports,* vol. 57, No. 2, Jan. 14, 1991, p. 10,

41 Gen Docket No. 91-2, Notice *of proposed Rule Making* "Amendment of Parts (),1,2 and 95 Of the Commission Rules to Provide for Interactive Video Data Services," 6 FCC Rcd 1368 (1991).

42 "New Wireless Business Telephone Market To Reach $2.1 Billion," *Telcom Highlights International,* vol. 13, No. 6, Feb. 6, 1991, p. 5.

Wireless Data Applications

One of the "hottest" new wireless services involves the use of radiocommunications for data transmission. Many types of wireless data systems are being developed using infrared signals, spread spectrum (see below) signals below 1 GHz, and microwave signals.[43] Wireless data applications include both wireless local area networks (LANs) such as those marketed and proposed by Motorola and Apple, and wide-area data services such as Ardis (Motorola/IBM), Coverageplus (Motorola), Mobitex (Ericsson), and VISA's proposed radio-based authorization system for credit cards.[44] Ram Mobile Data has begun operating a digital mobile data service in several cities in the SMR band.[45] NEC has also introduced a wireless portable computer that combines the functions of a standard personal computer with cellular communications capabilities.[&]

Technology Solutions to Spectrum Crowding

Many solutions have been proposed to alleviate spectrum congestion. Some of these are technological, some economic, some legislative, and some administrative. The earliest technological advancements involved the development of inexpensive and widely available microprocessors, which allow radio signals to be easily manipulated. Recently, advances in digital technology have reduced required channel bandwidths, increased charnel capacities, and made it easier to combine and configure radiocommunications systems to make them more efficient.

Most of the technological solutions to spectrum crowding focus on opening up more of the spectrum-expanding the range of usable (higher) frequencies and making spectrum use more efficient. Improved efficiency generally means that more users can share the same spectrum bands and that different services can coexist using the same frequencies.[47] Certain technological solutions that have increased the efficiency of spectrum were developed specifically to solve a congestion or interference problem. Others, however, were developed to create new radiocommunication services, but did so in a way that made more efficient use of spectrum than the conventional systems they replaced or supplemented. This section will describe some of the technological solutions that may help ease spectrum crowding.[48]

Use of Higher Frequencies

As the lower frequency bands have become increasingly crowded, engineers have begun to develop technologies that would use higher, less crowded frequencies.[49] The use of higher frequencies does not mean that more efficient use is now being made of the spectrum-it is simply an escape to less crowded territory. As was the case in extending terrestrial frontiers, taming the wilderness is difficult and expensive. In addition to the cost of developing new devices that will operate at the higher frequencies, transmission problems typically worsen at higher frequencies. Some of those problems, such as increased attenuation due to rain, appear to be surmountable only by brute force-by increasing transmitter power. In satellite systems,

43For further discussion of wireless LANs, see Christopher Hallinan, "Cableless LANs: The Network of the Future?" *Telecommunications, International* Edition, vol. 25, No. 6, June 1991.

44Ira Brodsky, "Wireless Data Networks and the Mobile Workforce, "Telecommunications, North American Edition, vol. 24, No. 12, December 1990; "VISA, Digital Radio Networks Have Pact To Roll Out 'Radio Wave Authorization Services,' " *Telecommunications Reports,* vol. 57, No. 7, Feb. 18, 1991, p. 36.

45' 'Ram Mobile Data Rolls Out Digital packet-switched Mobile Data Service in 10 Markets,'' *Telecommunications Reports,* vol. 57, No. 7, Feb. 18, 1991, p. 34.

46' 'Japan's NEC Corp. Unveils Its Wireless Notebook PC,' *Wall Street Journal,* Mar. 28, 1991, p. B1.

47Efficiency is not easily defined. While efficiency is often touted as a goal in and of itself, it is rarely pursued for its own sake, Rather, it is mOre properly conceived of as a means to an end—a way to extend or expand the use or availability of a resource, in this case spectrum. The ultimate goal of efficiency in this view of spectrum use, therefore, is not just being efficient, but permitting as many users and services to share the spectrum as possible. Other definitions of efficiency emphasize the social use of the resource—is one television channel or 600 AM radio stations or 1,500 telephone calls most efficient? If all use the same amount of spectrum, some type of social utility or market value approach may be used to define which is more efficient.

48For a discussion of the range of solutions t. spectrum crowding, see U.S. Department of Commerce, National Telecommunication and Information Administration, *U.S. Spectrum Management Policy: Agenda for the Future, NTIA* Special Publication 91-23 (Washington, DC: U.S. Government Printing Office, February 1991), p. 13; and Richard Gould, op. cit., footnote 3. See also Margaret E. Kriz, ' 'Supervising Scarcity,' *The National Journal,* July 7, 1990, and George Gilder, "What Spectrum Shortage?" *Forbes,* May 27, 1991, for a broader discussion of the issues involved in domestic spectrum allocation and management.

@Fo, a recent discussion of the Upwind expansion of usable radio frequencies, see Edmund L. Andrews, "Seeking To Use More Of the Radio Spectrum," New *York Times,* Sept. 11, 1991, p. D7.

power must be increased at both the original transmission (uplink) site on Earth and on the satellite itself. Increased satellite power greatly increases costs.

Trunked Mobile Systems

In conventional (nontrunked) mobile radio systems, one or more users are assigned to the same charnel. If that channel is busy, the user must wait until the channel is free. This process is unnecessarily time-consuming to the user, and delays the handling of messages. Not infrequently, the same channel is assigned to different companies, some of which may even be competitors in the same field (e.g., taxi companies, pizza delivery services, cement suppliers). Such disparate users have no business incentive to accommodate the needs of others seeking use of the charnel. Moreover, all the information being sent on the charnel can be heard by all its users, including potential competitors. Trunking can increase the amount of traffic that can be handled by specialized mobile telephone systems while protecting the privacy of the user.

Trunked systems use many communication channels to serve a much larger number of users. A user seeking access to the system initiates a request for a communications charnel by lifting a microphone or handset (or pressing a button). The system automatically searches for an open pair of frequencies (one each for incoming and outgoing signals) and assigns it to the user. When the connection is ready both stations are signaled, and both the mobile unit and the base station are automatically tuned to the selected frequencies. Busy signals are sent if no channels are available, or if the base station is otherwise occupied. Requests for a specific base station can be stacked up and handled in order of receipt. In trunked systems, users do not 'inadvertently hear any other conversations. Scrambling or channel-hopping schemes can be built in to the system controller to increase the level of privacy.

Establishment of trunked systems has been somewhat easier for nongovernment users than for government agencies. The majority of SMR systems, for example, are trunked systems. A group of companies, or an individual entrepreneur, can establish a trunked system for common use based on its economic appeal: namely, better communications at lower cost than in separate, individual channel systems. However, it has been difficult for the government to use trunked systems since agencies generally do not like to share systems with each other.

Reuse of Frequencies in Mobile Cellular Radio Systems

Mobile cellular radio is an example of a technology that was developed to provide a new service, but that also makes more efficient use of spectrum than previously existing mobile systems. In cellular systems, a mobile user is switched automatically from one base station to another as the vehicle moves from one part of a city to another, or travels from city to city. This "cellular' feature, designed to provide geographic continuity of service, results in a significant reuse of frequencies, and the amount of frequency reuse can be increased as traffic in the system increases.

In order to visualize how a cellular system maximizes frequency reuse, imagine a large metropolitan area covered, at frost, by one base station with power high enough to cover the whole area. In that situation, the frequencies are used only once throughout that area. As the traffic volume within the service area grows, the one base station can no longer accommodate all users and is replaced by several, lower-power stations. While the same frequencies cannot be used by adjacent transmitters (i.e., by transmitters in adjoining cells), they can be reused two cells away. Within a geographic area encompassing many cells, the same frequencies might be used three or four times. Shrinking cell sizes and lower transmitter powers, however, are not a permanent solution. Growth will continue, and there are limits on how small a cell can be and how low power can go while still maintaining adequate quality. Eventually, new methods must be found to accommodate steadily increasing numbers of users.

Digital Compression

The trend toward digital processing and transmission in all forms of radiocommunication has significant potential to increase channel capacity and service quality and options. Ironically, converting and transmitting analog signals in a digital transmission format requires larger bandwidths than transmitting the analog signals in their original form. The benefits of digital radiocommunications come in its ability to compress and combine signals. Digital compression works by removing redundant or unnecessary information from the signal. In audio transmission, for example, sound frequencies that the human ear cannot hear are often removed. This allows less information to be sent, requires less bandwidth, and allows more channels (conversations, broadcasts) to be transmitted.

Applications using digital compression techniques are spreading rapidly in many radiocommunication services. In cellular telephony, for example, digital signal processing (DSP) promises improved quality and capacity eight times as great as existing analog cellular systems.[50] COMSAT has developed technology that digitizes, compresses, and combines up to three separate TV signals for transmission on a single satellite transponder.[51] Other technology is under development that will combine up to 16 video signals on a single charnel.

Combined with compression, digital transmission techniques also allow radio signals to be sent more efficiently. Time Division Multiple Access (TDMA) and Code Division Multiple Access (CDMA) are digital coding schemes that allow more charnels to be packed into any given bandwidth than analog technology could ever allow.[52] TDMA divides each conversation or data stream into discrete chunks and sends them at specified times coordinated with a receiver that then reassembles the chunks of data into the whole conversation. CDMA techniques assign each transmission a unique identification code that allows the receiver to pick out the desired signal from among many simultaneous signals. All signals share the same range of frequencies. CDMA is used in many spread spectrum applications (see below). The primary application of such techniques is in mobile communications such as cellular and PCS, where their impressive capacities promise to alleviate at least some of the near-term capacity shortages now being experienced in cellular systems around the country. TDMA, for example, is expected to increase current capacity by 3 to 5 times, while CDMA proponents claim that CDMA will boost capacity 10 "to 20 times.[53] Which technique will dominate is unclear. TDMA appears to be further developed than CDMA, and has already been endorsed by the Cellular Telecommunications Industry Association for use in second generation cordless systems. CDMA, on the other hand, maybe more spectrum efficient than TDMA, but will require new, and potentially expensive, transmission and receiving equipment. Many companies, however, are testing CDMA and some have announced plans to build CDMA systems.

Improved Transmission Techniques

Satellite Antennas

Advanced satellite antennas permit the use of smaller, less expensive Earth stations by making more efficient use of available satellite power. Such antennas direct the signal toward, and concentrate it in, areas where the intended users are located. Systems with such antennas, called spot beams, also make more efficient use of spectrum than those with large, circular beams which waste satellite power by transmitting beyond the limits of the desired service area. The reduction of signal levels outside the service area permits the same frequencies to be reused by other systems serving nearby areas, in the same way that cellular technology operates. Motorola's Iridium and NASA's ACTS satellite systems both plan to use spot beam techniques.

Spread Spectrum

Spread spectrum is a modulation technique first developed to hide military communications amid natural noise. More recently, spread spectrum has been used to permit low-level signals to share spectrum with other services. As the name implies, the original modulating signal is spread over a wide range of frequencies (bandwidth) for transmission. The spreading over the wider band of frequencies is done according to a pattern that is also known by the receiver. The receiver reconstructs the incoming signal using the same pattern as the one used for spreading it. Interference from conventional signals, or other spread spectrum signals using a different spreading pattern, appear as noise to spread spectrum signals, and can be faltered out.

There are several types of spread spectrum systems. One type, known as direct-sequence spread spectrum, divides a radio signal's energy over a wide range of frequencies so that a little part of the signal

[50] Steve Cox and Bob Fine, "DSP May Spell Relief for Urban Cellular Congestion" *Telephony*, vol. 220, No. 9, Mar. 4, 1991, *p.* 18.

[51] "Compression News From COMSAT," Satellite *Communications*, vol. 15, No. 1, January 1991, p. 9.

[52] For a discussion of CDMA and TDMA, see Donald L. Schilling, Raymond L. Pickholtz, and Laurence B. Milstein, "Spread Spectrum Goes Commercial," *IEEE Spectrum*, vol. 27, No. 8, August 1990.

[53] Charles Mason, "Motorola, PacTel To Test CDMA," *Telephony, vol. 220, No.* 17, Apr. *29*, 1991.

appears on each frequency in the band. Frequency-hopping spread spectrum techniques spread a signal out over many frequencies by hopping from frequency to frequency in a sequence synchronized with the receiver. One frequency is not dedicated to one user, and all frequencies can be used more efficiently. Satellite CD Radio, for example, has proposed a digital frequency-hopping scheme for its BSS-Sound system that hops frequencies every 2,000th of a second and is thus better able to resist the fading of a particular frequency, resulting in improved quality.[54]

Frequency modulation or FM, is a crude form of spread spectrum. Terrestrial radio relay systems and satellite transponders compensate for their limited transmitter power by using FM, which spreads the signal over a much wider bandwidth. Thus, bandwidth can be "traded' for some of the power that would otherwise be required to send a usable signal from space to Earth. The price for this reduced power requirement is much less efficient use of spectrum. A TV signal that can be broadcast from a local station using only 6 MHz requires some 36 MHz when carried by satellite.

Because of spread spectrum's ability to coexist or overlay other types of radiocommunications signals, it is being aggressively developed as a way for many users to share spectrum. But while the spread spectrum technique permits many low power signals to share a band, each of the spread spectrum signals adds to the background noise level of the other signals in the band—including any other spread spectrum signals, lowering the signal-to-noise ratio of them all. As more signals are added, the noise will eventually become too great for good communications. New adaptations of spread spectrum techniques, including advanced forms of CDMA may help solve some of these problems.[55]

Single Sideband Transmission

In single sideband transmission (SSB), only one set of the sidebands (see figure 2-A-2) that makeup a radio signal is transmitted.[56] This is possible because all of the intelligence in a radio signal (e.g., music, video, speech) is contained and duplicated in both upper and lower sidebands. Eliminating one of the sidebands has no effect on the information being sent, and receivers can still reconstruct an accurate signal.

There are several advantages in SSB transmission, most importantly, the fact that SSB reduces by half the bandwidth required to send a signal, thereby allowing more signals to be sent or to reduce the interference between signals. Another advantage of SSB is its reduced susceptibility to noise and other forms of interference since there are fewer frequencies for noise to invade. The disadvantage of SSB is that it requires more sophisticated (and hence, more expensive) transmitters and receivers. Today's HF broadcast receivers will not work with SSB transmissions, and replacement will be necessary.[57] One of the U.S. positions for WARC-92 involves the expanded use of reduced carrier SSB transmission for HF broadcasting.

Alternatives and Competitors to Radio Systems

The remarkable advances in radio technology have been paralleled by equally remarkable advances in wire-based systems and devices.[58] In many cases, these technologies can provide an alternative to radio-based systems, thus relieving some of the pressure on crowded spectrum resources. The use of fiber optics for long-distance telephone service is one example. The majority of long-distance telephone calls used to be carried by microwave radio links and satellites. However, with the development of fiber-optic transmission technologies in the 1980s,

[54] *Satellite* communications, Op. cit., footnote 51, pp. 9-10.

[55] Synchronous CDMA, e.g., is being developed for use in future personal communications systems. Jack Taylor, Cylink, personal communication, Mar. 14, 1991.

[56] For a discussion of sidebands and single sideband transmission, see Harry Mileaf (cd.), *Electronics One* (Rochelle Park, NJ: Hayden Book Co., 1976).

[57] Currently, full-carrier double-sideband is used in the HF broadcasting bands. This is a major barrier, especially for developing countries, where the cost of radio receiver replacement becomes an issue. Broadcasters do not want SSB until listeners have receivers, but no one will manufacture or buy receivers until there is something to listen to. To address this problem, the United States submitted a proposal to the Inter-American Telecommunications Conference (CITEL) Interim Working Group for the WARC, "encouraging the manufacture, in developing CITEL countries, of inexpensive, HF-broadcast receivers compatible with the three classes of emission potentially involved in the conversion of HF broadcasting from the full-carrier double-sideband (DSB) presently in use, to reduced-carrier single-sideband (SSB)." Input document WARC-92/19 for CITEL PTC III 1992 WARC Interim Working Group.

[58] Wire-based is used here to refer to any of the so-called wireline media, including: twisted copper wire pairs, coaxial cable, digital T-1 lines, or fiber optics.

many long-distance telephone providers began to build extensive fiber-optic networks to take advantage of the huge capacity and high quality of optical transmission. Today, most domestic long-distance telephone service is routed over fiber-optic lines, leaving satellites and microwave to carry data and video services.[59]

Another alternative to radio transmission, primarily for the delivery of video programming to the home, is cable television. Broadband cables for cable television now pass 85 percent of homes in the United States, and cable penetration is above 60 percent. Most cable service is now transmitted over coaxial cables, but in new installations the trend is to use fiber optics. Such systems could supplant some radio-based systems to bring communications to homes and businesses at freed, and more or less permanent, locations. Such a shift would release spectrum to those services, such as broadcasting to mobile and portable receivers and the mobile services in general, that have no practical alternatives to radiocommunication.

In the long run, the division of communications services and resources between wired and radio services may need to be revisited. Many analysts believe that communication services now using radio spectrum could be easily (and in some cases better) supplied through wire media.[60] Radiocommunication systems would be used for applications or services not possible or practical with wired systems, such as mobile applications. If applications were switched from radiocommunication to wire delivery, a large amount of spectrum could potentially be freed for other (mobile) uses.

Barriers to such a fundamental reordering of the communications infrastructure in this country are formidable. Entrenched users will fight to keep their spectrum resources. The question of who would finance such a changeover is also difficult. In the case of long-distance providers, adequate market incentives existed to make the switch. Unfortunately, that may not be the case for all alternatives and incentives may have to be put in place to encourage users to move. Long-term U.S. telecommunications policy should examine the consequences of this shift in communication resources in order to maximize the efficient use of the spectrum. Consistent with these themes, the National Telecommunications and Information Administration (NTIA) makes the following recommendations:

> NTIA and the FCC should develop policies on the use of non-radio technologies as part of a coordinated program to foster spectrum efficiency, when consistent with other public policies. NTIA and the FCC should also develop additional regulatory or economic incentives for the use of alternative technologies in congested areas.[61]

Summary

Recent developments in radiocommunications technology have put increasing pressure on spectrum management structures and processes, but also offer opportunities for using spectrum resources more efficiently-allowing more users to have access to them. Structures, procedures, and philosophies that were adequate for dealing with technology developments in the past maybe inadequate to meet future planning and allocation needs. The rapid pace of technological development requires nations to adopt a flexible approach to wireless communication and spectrum management. Hardened approaches protected by entrenched interests, both within the government and the private sector, international and domestic, must give way to structures and processes that encourage innovation and flexibly combine the interests of all users.

[59] However, as illustrated by many of the distance learning projects being built around the country, fiberoptic is also being extensively used for private videoconferencing applications. See OTA, *Linking for Learning,* op. cit., footnote 38.

[60] See the discussion and comments in NTIA, *U.S. Spectrum Management Policy,* op. cit., footnote 48, p. 156.

[61] NTIA, *U.S. Spectrum Management Policy,* op. cit., footnote 48, p. 157.

The International Context for Spectrum Policy

> Telecommunication has acquired strategic importance. With globalization and increasing information intensity of economic activity, the importance of telecommunication now transcends the established organizations responsible for providing basic services. It now reaches all fields of economic and social endeavor.[1]

Introduction

Since the 1979 World Administrative Radio Conference **(WARC),** the world economic and political scene has changed dramatically. The 1980s witnessed the rise of Japan as a major economic power and the industrialization of countries such as Brazil and Korea. The influence of the Soviet Union has declined dramatically as the Eastern bloc has dissolved and the U.S.S.R. itself is beset with internal turmoil. Moving into the 1990s, the world is seeing the emergence of a unified Europe and a realignment of the Eastern European nations. Accompanying these changes, the historic tension between the developing and developed countries that characterized the 1970s and early 1980s has lessened. There is now a more flexible and conciliatory tone to international telecommunications policymaking.

The larger shifts in economic and political power in the world have altered the context within which international telecommunication issues are addressed. Rapidly advancing technology is linking more systems in networks that are increasingly regional and global. Competitive pressures have forced many governments to liberalize or privatize their telecommunication industries. In the past, the main telecommunication (radiocommunication) actors were well-known, and alliances were stable. Today, new players have become prominent as others have faded, and firm alliances have given way to rapidly shifting factions. East-West and North-South confrontations have been replaced by regional divisions. Recognizing these changes, the International Telecommunication Union (ITU) established a High Level Committee to examine ways to improve the structure and processes of the ITU to more effectively respond to the challenges of changing technology and members' development needs. This is the environment within which the United States must negotiate new international radio allocations at WARC-92—a world in which the actors are more numerous, their views more diverse, and relations more complex. This chapter examines the present structure of the ITU, discusses the proposed changes in the ITU, and identifies some of the larger trends that are altering the world's telecommunications policy order.

International Spectrum Administration: The ITU

Description

The International Telecommunication Union was formed in 1932 through the merger of the International Telegraph Union and the members of the International Radiotelegraph Convention. It is the principal international organization responsible for allocating and regulating the use of the radio frequency spectrum on an international basis. The ITU provides a forum for the development of global standards and procedures aimed at assuring compatibility of telecommunications facilities and services. It also acts to reduce interference between nations and among services in order to maintain harmony in the international use of the radio frequency spectrum and the provision of wireless communications services. The ITU sets equipment and systems operating standards, coordinates and disseminates information required for the planning and operation of telecommunication services, and promotes the development of global telecommunication systems and services.[2]

Since 1947, the ITU has been a United Nation's specialized agency, and is governed according to an International Convention, which is periodically

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[1] International Telecommunication Union, ''The Changing Telecommunication Environment,' Report of the Advisory Group on Telecommunication Policy, February 1989, p. 33.

[2] For a discussion of the history, structure and functions of the ITU, see George A. Codding, Jr. and Anthony M. Rutkowski, *The International Telecommunication Union in a Changing World* (Dedham, *MA:* Artech House, Inc., 1982); and James G. Savage, ***The Politics of International Telecommunications Regulation*** (Boulder, CO: Westview Press, 1989).

reviewed and revised at Plenipotentiary Conferences.[3] The ITU currently has 164 member countries, and operates according to a one-nation, one-vote process.[4]

Although the mission of the **ITU** is primarily technical, because of the voting process and the fact that the ITU is the principal international forum for allocating the world's radiocommunication resources, the activities of the Union are also strongly affected by economic and political concerns. In some cases, clashes in the ITU are based on different philosophies of public policy as much as on technical considerations. For example, one of the consistent battles fought in the ITU over the past decade centers on the necessity and desirability of planning the radio frequency bands. This issue has traditionally divided the developing and developed countries. Developing countries favor a priori planning to ensure that, as they develop more advanced radiocommunication technologies and services, spectrum resources will be available. This can mean that bands of frequencies are reserved for future use and development. Developed countries, however, favor a continuation of the ITU's traditional system of "first-come, first-served," which allows them to develop and use frequencies as needed. Developed countries believe that planning leads to inefficient use of frequencies as some lie unused. Developing countries maintain that planning is necessary in order to guarantee them access to spectrum they may need in the future.

Over the past 20 years the Plenipotentiary and Administrative Radio Conferences of the ITU have been characterized as increasingly "politicized."[5] In the last several years, however, this trend seems to have been interrupted. As a result of new economic realities and shifting geopolitical alliances, the overt politics and polemics of past ITU meetings have subsided—political concerns have been pushed aside by the increasingly vexing economic problems facing many countries.[6] Unfortunately, there is no way to judge how long-lasting this trend may be. It maybe that the world is only in a transition period that will eventually give way to some of the old politicking (albeit in different forms from different countries), as new alliances solidify. For the near future, it is possible that the shifting nature of radiocommunication alliances could contribute to more cooperation as actors search out new partners. This break in overt hostilities presents the United States with a unique window of opportunity to establish new relationships, develop new policy partnerships, and make significant gains at WARC-92.

Structure of ITU Spectrum Activities

The ITU pursues its mission of allocating, regulating, and managing the spectrum resource through a number of different bodies (see figure 3-l). The structure for spectrum activities within the ITU consists of five different parts:[7]

Plenipotentiary Conference

The Plenipotentiary Conference is the supreme governing body of the ITU, and has ultimate control over the direction and work of the Union. This power derives from the plenipotentiary's position as the only ITU body able to review and revise the International Telecommunication Convention, the document that established the ITU and sets out its basic functions and regulations. The Plenipotentiary Conferences, which are held on a somewhat irregular basis, bring together high-level representatives of member governments to elect the major officers of the ITU (including the Administrative Council),[8] establish the future schedule of WARCs, and recommend items to be included on WARC agendas (as recommended by previous WARCs). The last Plenipotentiary (Nice, France) was held in 1989. Future

[3] Changes in the International Convention are approved in the form of a treaty among ITU members. The last such revision Of the Convention occured at the 1989 Plenipotentiary Conference in Nice, France. The Nice Plenipotentiary proposed to divide the Convention into two separate pieces. The first part, called the Constitution would contain the organizational setup, functions, and mandates of the ITU, and would not be subject to change at each Plenipotentiary unless enough members agreed. The second part, still called the Convention, would define the operational principles the ITU would follow in pursuing the mandates defined in the Constitution. This document could be changed by a majority vote at the Plenipotentiary. The decisions of the Nice Plenipotentiary have not yet entered into force, and the governing document of the ITU is still the Nairobi Convention from 1982.

[4] Recently reduced from 166 due to the consolidation of the Yemens and the reunification of East and West Germany.

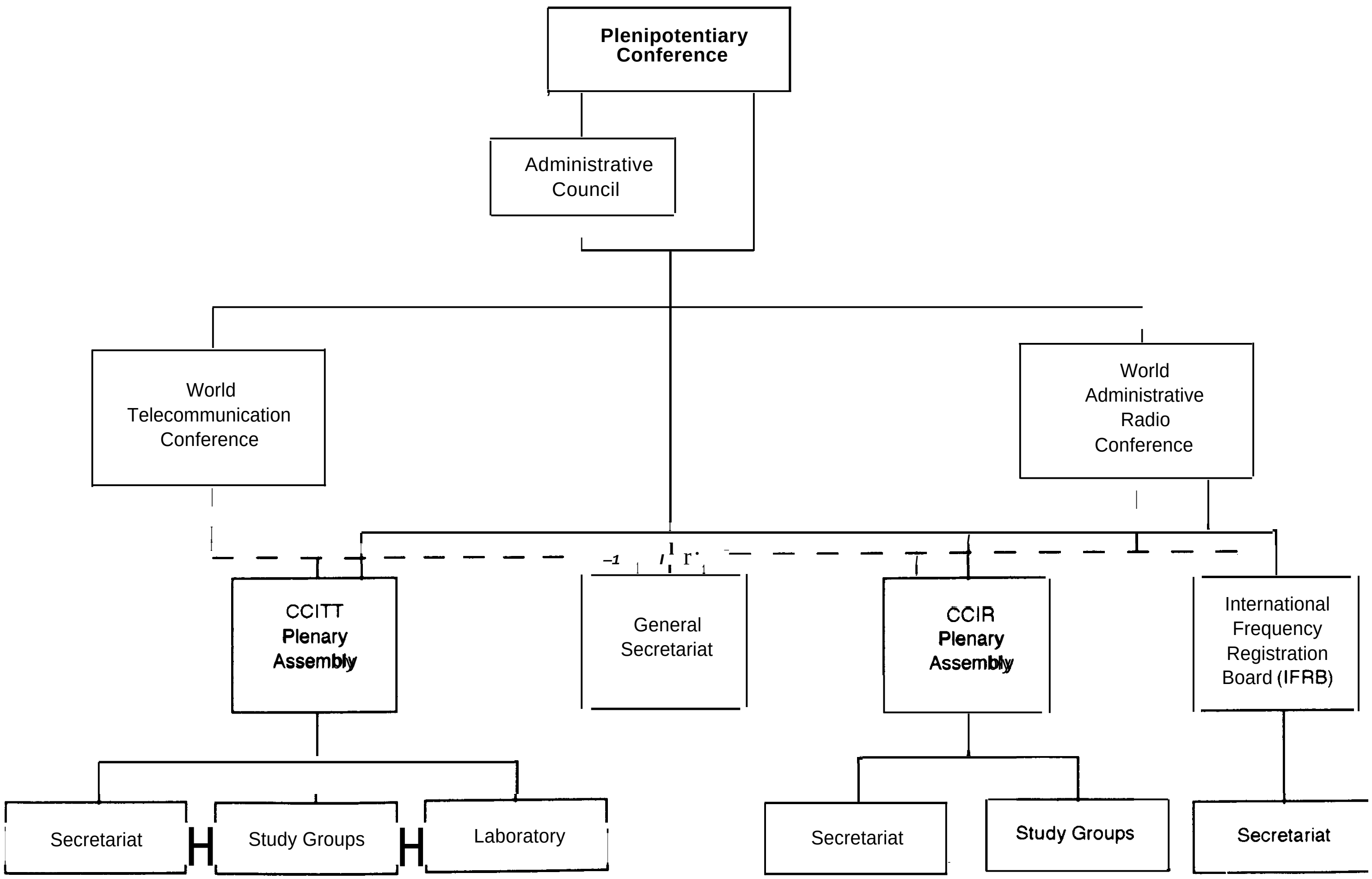
[5] For a discussion of this period of time and the implications of "politicization," see Savage, op. cit., footnote 2, pp. 52-55.

[6] It may also be that the highly technical nature and limited scope of recent conferences has stifled more visible political concerns and rhetoric.

[7] The material in this section is based on Codding and Rutkowski and Savage, Op. Cit., footnote 2.

[8] The Secretary-General, Deputy Secretary-General, five IFRB members, and the Directors of the CCIR and CCITT (and soon the Director of the Bureau for Telecommunications Development-BDT).

Figure 3-l-Current Structure of the International Telecommunication Union



KEY: CCITT=International Telegraph and Telephone Consultative Committee; CCIR-International Radio Consultative Committee

SOURCE: Richard G. Gould, "Allocation of the Radio Frequency Spectrum," OTA contractor report, Aug. 10, 1990, p. 40.

plenipotentiaries are scheduled for December 1992 (a special plenipotentiary to consider the changes proposed by the High Level Committee, see below) in Geneva and 1994 in Japan. Because of the enormous importance of the Plenipotentiary Conferences to the functioning of the ITU, they are generally the most political and polemical of the ITU's bodies.

Administrative Council

The Administrative Council of the ITU consists of 42 members and serves as the governing body of the ITU between Plenipotentiary Conferences? It meets annually to implement the decisions of the plenipotentiaries, oversee the ITU's annual budget, complete other tasks as directed by the Plenipotentiary Conferences, and set the agendas for future WARCs in consultation with the members of the ITU. In this role, the Administrative Council has substantial influence on the nature of the topics the ITU will consider through the WARC process. The United States has been a member of the Council since its inception.

World Administrative Radio Conferences

These conferences bring together radiocommunications engineers and policy experts from ITU member nations who prepare for years to make proposals on radio technologies and services that will guide world development of radiocommunications. The WARCs are the primary instrument of the ITU through which changes to the International Table of Allocations are made and by which the Radio Regulations are revised (see ch. 1).[10] WARCs provide an opportunity to make broad changes in the ways the spectrum is used. Thus, a WARC really represents the beginning of the actual work of the ITU-frequency allocations are made to different radio services, and regulations are set to encourage the most efficient and interference-free use of the spectrum. The more technical of these activities, including frequency planning, establishing technical standards and regulations for use, and developing assignment and coordination procedures, are continued after the WARC in the ongoing work of the International Radio Consultative Committee (CCIR) (see below).

International Frequency Registration Board

The International Frequency Registration Board (IFRB) is a five-member board responsible for recording, registering, publishing, and assessing the legality of every radio frequency used in the spectrum. The IFRB also advises individual countries on technical matters and does larger technical studies recommended by the WARCs. Since the 1979 WARC, the work of the IFRB has shifted in focus from high frequency issues to a broader range of topics, including satellite communications, where the Board has conducted planning exercises for the geostationary orbit.

The influx of developing countries in the ITU over the past 20 years has had a substantial impact on the IFRB. Developing countries have come to rely on the Board for technical advice and for development assistance in planning their domestic telecommunication systems. This shift in the IFRB's role reflects the larger shift of the ITU into more development-related activities. The developing countries have come to see the IFRB as an important ally in the ITU to counter the technical dominance the developed countries enjoy in the CCR.

Almost since its inception, the IFRB has been criticized, primarily by the developed countries, for being political, too closed, and too interpretive in its activities. Many criticisms center on the (actions of) board members themselves, more than on their mandated role. There is concern about the quality of the members elected to this technical board-some are viewed as highly expert, but some are not. In addition, board members have become increasingly uncooperative with each other over time, sometimes replacing cooperative decisionmaking with (political) squabbling. Some representatives of the developed countries believe that the IFRB has outlived its usefulness. Developing countries, while still committed to the IFRB, have recently become disillusioned by the loss of some key advocates who were voted off the Board. These concerns on the part of both developed and developing countries have led to recommendations for a substantial reworking of the Board's role and structure (see below).

[9]Forty-three countries are technically part of the Council, but the merging of East and West Germany ended separate East German participation.
[10]The ITU also holds infrequent World Administrative Telecommunication Conferences (formerly World Administrative Telegraph-Telephone Conferences—WATTCs), which address wire-based telecommunication technologies. The last such conference was held in 1988.

International Radio Consultative Committee

The CCIR, originally established in 1927, studies technical questions related to radiocommunications and recommends global standards of use for all types of radio systems and equipment.[11] The CCIR is directed in its work by a Plenary Assembly that meets approximately ever-y 4 years-the last being held in 1990.[12] The substantive, technical work of the CCIR is conducted in small study groups and working parties, which meet often between the Plenaries. There are currently 10 study groups covering a wide range of topics. Most of the participants in the CCIR study groups for the United States are members of the private sector. They have the extensive technical expertise the government often has in only short supply. Government policymakers in the Federal Communications Commission (FCC), the National Telecommunications and Information Administration (NTIA) and the Department of State closely follow the activities of the CCIR and a limited number of government representatives participate actively in CCIR meetings and deliberations.

Participation in CCIR activities is open to all members of the ITU and to nongovernment agencies and companies that have been approved by their respective governments.[13] Private sector participation depends on what business the company is involved in. Recognized Private Operating Agencies (RPOAs) are private-sector telecommunication service providers such as AT&T and COMSAT. Scientific or Industrial Organizations (SI0s), which design or manufacture telecommunications equipment or study telecommunications issues, such as Rockwell and Hughes Aircraft, also participate quite extensively in the substantive work of the CCIR. The increasing numbers of telecommunications companies around the world may lead to increased involvement and important new roles for private companies in the ITU (see below).

In addition to its general technical work, the CCIR also develops the technical bases for Administrative Radio Conferences. Before every WARC, the CCIR holds a joint meeting of all the study groups involved in preparations for the conference. The objective of this meeting, called a Joint Interim Working Party (JIWP), is to prepare a technical report for the guidance of the countries whose delegates will participate in the conference. The extensive preparatory mechanism for WARC-92 is shown in figure 3-2. Each study group concerned with WARC-92 issues first met in Interim Working Parties (IWPs) and in JIWPs of several related study groups. In March 1991 an overall JIWP was held bringing together IWPs and JIWPs that met previously. The product of this meeting was a voluminous report containing all the technical advice to the conference concerning suitable frequencies for the services to which allocations may be made, sharing and interference criteria and other technical conclusions and recommendations relating to use of the orbit and spectrum by those services.[14]

Because of the essentially technical nature of its work, the CCIR has generally been seen as less political than the WARCs or the Plenipotentiary Conferences.[15] However, CCIR proceedings and, especially, the JIWP before the WARCs have gained in importance in recent years as governments have realized the importance of the technical underpinnings to the WARC. The JIWP meetings have evolved beyond merely technical meetings and are now widely regarded as "mini-WARCs," that provide countries an important opportunity to exchange ideas, float trial proposals, and do some initial discussion and negotiation in preparation for the WARC itself. The result is that CCIR activities and the work of the study groups has become

[11] The International Telegraph and Telephone Consultative Committee (CCITT) studies technical issues relating to wire-based communications, including such topics as standardization computer communications, and fiber optics.

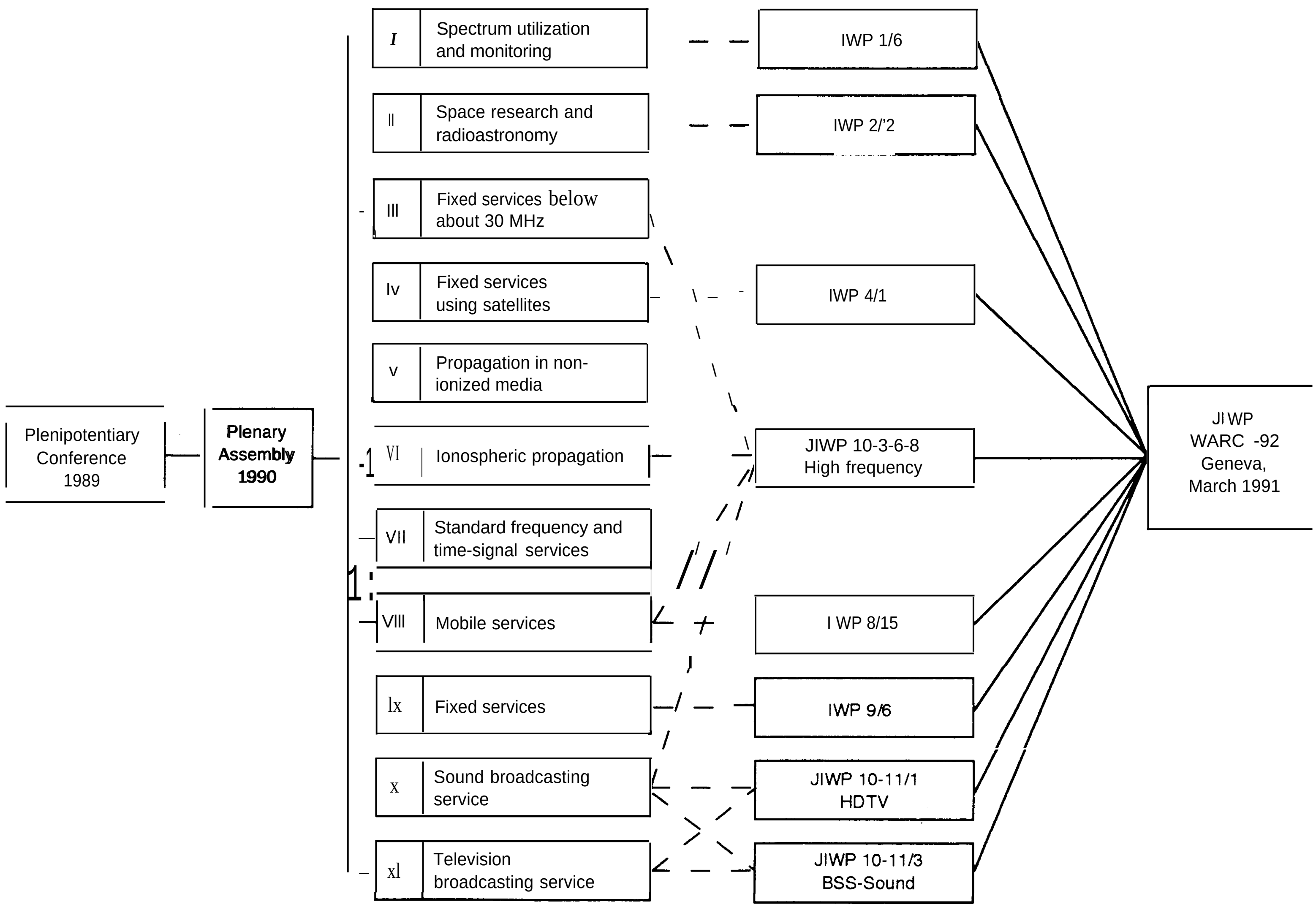
[12] Questions for CCIR study may also be proposed by the Plenipotentiary or World Administrative Radio Conferences, the Administrative Council, the CcIT"I', or the IFRB.

[13] Participation in most other activities of the ITU is restricted to member countries and their delegates only; private sector companies cannot be members of the ITU. Representatives of the private sector, however, may become members of CCIR and CCITT if they have been appointed as an official delegate by their government.

[14] International Telecommunication Union, *CCIR REPORT: Technical and Operational Bases for the World Administrative Radio conference* 1992 *(WARC-92)* (Geneva: March 1991).

[15] Most participants in the work of the CCIR study groups are technical staff, not high-level government officials. In the United States, for example, most CCIR participants come from private industry, with only limited participation and direction by the Federal Government. This is in part a function of the shortage of technical staff in the government, and also due to industry recognition that the study groups provide a good way to introduce proposals for new technologies and refine technical ideas and systems.

Figure 3-2—International Radio Consultative Committee (CCIR) Study Groups Preparing for WARC-92



KEY: BSS-Sound=broadcasting satellite service-sound; HDTV=high-definition television; IWP=Interim Working Party; JIWP=Joint Interim Working Party.

SOURCE: Office of Technology Assessment, 1991, based on Richard G. Gould, "Allocation of the Radio Frequency Spectrum," OTA contractor report, Aug. 10, 1990, p. 41,54.

increasingly "politicized," especially at meetings such as the JIWP.

CCIR activities have become more important in recent years due to the tremendous growth of telecommunications in general and the rapid development of new radio technologies. Because of this growth, and increasing workloads, the work of the CCIR (and the International Telegraph and Telephone Consultative Committee (CCITT)) has slowed, prompting calls for reform (see below). The ITU's High Level Committee has proposed changes in the structure and functioning of the ITU that would combine the functions of the CCIR's Plenary Sessions with the more general activities of the administrative conferences. Despite such criticisms, however, the work of the CCIR is praised for its businesslike approach and high quality.

The CCJR has been dominated by the developed countries for many years, due to their substantial expertise, personnel, and financial resources. Historically, the developing countries have played a minor role in the work of the CCIR study groups due to a shortage of qualified personnel and a lack of funds for preparation activities and travel to the meetings. Smaller countries face a number of unique problems participating in the CCIR and the ITU in general. First, governments in smaller or developing countries often change rapidly. Telecommunication staffs are often changed just as quickly. This prevents many countries from developing the base of expertise and international contacts that would enable them to participate effectively in international meetings. Second, developing country telecommunications staffs are often small, consisting of between one and six people. In this country, there are hundreds of people in government and industry working on WARC preparations. At conferences, the problem becomes more severe, because one delegate cannot cover all the various meetings and drafting/working groups his or her country has an interest in. Finally, smaller countries often do not have the funds to adequately prepare their delegates. They do not have sufficient travel money to send their delegates to all the meetings that would help them understand and prepare for the WARC. Lack of funds also prevents many countries from beginning their preparations until the last minute, when it is too late. It is reported that some delegates get to the WARC before they even see other countries' proposals. The industrialized countries, by contrast, begin preparing for WARCs years in advance.

Importance

The work of the ITU in spectrum management and effective U.S. participation in it is important for several reasons. Most broadly, the work of the ITU extends beyond radiocommunication services and encompasses virtually all aspects of international telecommunications. The agreements reached at the ITU form the basis for most of the world's use of radio services and contributes to an industry vital to economic, political and social interests.

Effective U.S. participation in the ITU is crucial for several reasons. Without international standards and procedures for sharing the spectrum, global radio communication and services would be impossible. Although international interference problems are not as much of a problem for the United States as for other countries, the United States must nevertheless coordinate services that are worldwide, such as safety services for aeronautical and maritime services.

> Leaving these matters to bilateral negotiations or regional associations is unlikely to produce satisfactory solutions given the large number of countries involved and the growing significance of global telecommunication networks.[16]

Participation in the ITU is also crucial to the international political and technical stature of the United States. Were the United States to pull out of or fail to ratify ITU documents on a regular basis, a poor precedent would be set that could jeopardize U.S. participation and negotiations in other international bodies. Finally, the ITU offers the United States an important opportunity to advance U.S. views on technical standards and regulations, promoting global standards that allow U.S. firms to take advantage of economies of scale in manufacturing and the provision of services. Such input is critical in maintainingg the technological and policy leadership of the United States in international radiocommunications.

Activities Outside the ITU

In addition to the international spectrum activities conducted under the aegis of the ITU, nations also engage in bilateral and multilateral discussions and

16 "The Changing Telecommunication Environment," op. cit., footnote 1, p. 11.

negotiations. Often these discussions involve neighboring countries trying to resolve specific interference problems. Bilateral discussions can also form the basis of more regional planning as in the case of the United States, Canada, and Mexico, which have agreements in many broadcasting areas. Multilateral negotiation takes place under the auspices of regional organizations such as the Conference of European Postal and Telecommunications (CEPT) administrations or the Inter-American Telecommunications Conference (CITEL), and in many international organizations with specific concerns, such as the International Civil Aviation Organization. Some advocate a more ongoing and more formal process or mechanism that would allow the United States to develop and coordinate U.S. positions with regard to these other organizations and countries.[17]

Changes in the ITU

> The more intensified globalization of telecommunication networks, including increasing complexity of telecommunication technology and a growing diversity of actors in the telecommunication field, has created additional pressures. There are now more pressing demands on ITU for accelerated handling of information and closer coordination of the activities of members. With increasing network interdependence, more effective harmonization of actions is necessary to ensure optimal connectivity and operability of networks and services. These changes in the international telecommunication environment call for an urgent review of the role and activities of ITU, if it is to fulfill its historic mandate of facilitating global telecommunication development.[18]

Recognizing the pressing nature of these changes and the importance of aggressively meeting new challenges, and to keep up with the rapid pace of radiocommunication technology development, the ITU has embarked on a broad and vital revision of its structure and processes. There was special concern that the work of the ITU was becoming increasingly bogged down and ineffective, and that if changes were not made, ITU member countries could begin bypassing the ITU in international standards and coordination activities. overall, there was a desire to make the workings of the ITU more businesslike, more regular, and less subject to political and emotional whims. The proposed changes in the ITU (if accepted) will substantially alter the way international spectrum policy is decided, and will have important consequential impacts on how the United States pursues its international spectrum policies. While many of the changes discussed below will not directly affect the proceedings of WARC-92, they will have important, if still uncertain, impacts on future radiocommunication conferences.

High Level Committee (HLC)

Background—Responding to the increasing complexity of the international telecommunications environment, the 1989 Plenipotentiary Conference (Nice) decided that:

> a High Level Committee (H.L.C.) should be established to recommend, on the basis of an in-depth review of the structure and functioning of the Union, measures to enable the ITU to respond effectively to the challenges of the changing telecommunication environment.[19]

Accordingly, the Administrative Council at an Extraordinary Session in November 1989 established the HLC to examine current ITU structure and conferences and recommend changes to improve the functioning and efficiency of the organization and its activities in light of rapid telecommunications changes.[20]

Membership in the HLC consisted of representatives from 21 countries elected in 1989 by the Administrative Council. Each elected country then designated individual representatives. The U.S. representative to the HLC was Ambassador Gerald Helman, Senior Advisor to the Under Secretary of State for Political Affairs, who was assisted by staff from the Department of State's Bureaus of International Communications and Information Policy and International Organization Affairs, FCC, and NTIA.

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[17] Hans J. Weiss and Raymond B. Crowell, "Comments of Communication Satellite Corporation," presented before the National Telecommunications and Information Administration in the matter of a Comprehensive Policy Review of the Use and Management of the Radio Frequency Spectrum, Washington DC, Feb. 27, 1990.

[18] "The Changing Telecommunication Environment" Op. Cit., footnote 1, p. 2.

[19] Final Report of the ~@ Level Committee (H.L.C.) to Review the Structure and Functioning of the International Telecommunication Union, "Tomorrow' sITU: The Challenges of Change,' Document 145-E (Geneva: International Telecommunication Union, April 1991), pp. 12-15. (Hereafter: HLC Final Report).

[20] Administrative Council Resolution No. 990 defined the tasks of the group and selected 21 member states to send representatives.

Box 3-A-Summary of Changes Proposed by the High Level Committee (HLC)

1. The world of telecommunications is undergoing **rapid change in technology, in the creative and** worldwide application of that technology, and in its immensely varied commercial applications. The information and telecommunications revolution+-almost a cliche in the hands of writers and analysts-is a daily practical reality in the work of the ITU. The ITU remains unique and irreplaceable as an intergovermental organization, both in its leading role in the global information economy and society and in the manner in which it addresses the needs of developing countries and engages the private sector in its work as part of the wider ITU family.
2. Our [HLC] Recommendations aim to help the ITU to meet the challenges of change and to continue to play its leading role in world telecommunications. Our principal recommendations areas follows.
3. The ITU should not seek to broaden or change its overall mandate, but should play a stronger and more catalytic role in stimulating and coordinating cooperation between the increasing number of bodies concerned with telecommunications. It should also recognize the growth of regional bodies and develop with them relationships which retain the ITU's primary role but allow for necessary, complementary activities.
4. The supreme body should remain the Plenipotentiary Conference, meeting every four years. It should be supported by the Administrative Council, to be renamed ITU Council, playing a broader and more strategic role.
5. The substantive work of the ITU should be organized in three Sectors: Development, Standardization and Radioconmmunication. The Standardization Sector should include the current work of the International Telegraph and Telephone Consultative Committee (CCITT) and some standardization work currently done by the International Radio Consultative Committee CCIR). The Radiocommunication Sector should include most of the current CCIR work and that of the International Frequency Registration Board (IFRB) and its specialized secretariat. The division of responsibilities between the Standardization and Radiocommunication Sectors will be kept under review and adjusted when necessary to meet changing needs and to ensure efficiency. The Development Sector should encompass the current work of the Telecommunications Development Bureau (BDT). The distinct functions originally envisaged for the Center for TelecommunicationsDevelopment should be integrated into the BDT
6. The current full-time five-member IFRB should be replaced by a part-time nine-member Radio Regulations Board.
7. For each Sector, the supreme body should be aWorld Conference, supported by Study/Working Groups. World Conferences should be held between Plenipotentiary Conferences, in a regular cycle, to promote more effective planning.
8. For each Sector, elected Directors should head Bureaus at ITU headquarters. They should also chair Advisory bodies which, according to the needs of the Sector, should review its strategies, priorities and activities and help ensure coordination of work and adaptation between conferences to changing needs and circumstances.

(continued on next page)

The private sector also had input to the process through the CCIR and CCITT National Committees.

Changes—The changes recommended by the HLC could have a profound impact on the structure and functioning of the ITU, including the WARCs, although the timing of such changes is uncertain. And while the changes proposed by the HLC will have no direct impact on WARC-92, the potential ramifications of the changes for future conferences are significant, and add another element of change that U.S. spectrum policymakers must address (see box 3-A for a summary of proposed changes) .21 The HLC has recommended that the ITU be restructured into three equal sectors: Development, Standardization, and Radiocommunication (see figure 3-3). Each sector would be governed by its own conference and headed by an elected director. The technical work of the sectors would be conducted in study groups.

The new Radiocommunication Sector would combine the work of the CCIR and the IFRB, which would be changed to a part-time 9-member board.

[21] The HLC Final Report considers many issues affecting the future of the ITU. This section will concentrate only on those changes with a direct impact on radiocommunications and the spectrum management process. For a complete discussion of the changes proposed by the HLC, see HLC Final Report, op. cit., footnote 19.

Box 3-A—Summary of Changes Proposed by the High Level Committee (HLC)-Continued

9. **Each Sector should have** its own budget, with all costs and revenues clearly identified, to ensure that all costs are assigned to the appropriate "end user" Sector.

10. The Secretary-General is the chief officer of the Union, with a key role in strategic planning, management and coordination. This role should be strengthened. He should be supported by a new Strategic Policy and Planning Unit, reporting to him but serving the needs of all Sectors. He is also encouraged to set up a Business Advisory Forum through which he can conduct a dialogue with business leaders.

11. At the same time, and supported by improved management systems, he should delegate responsibility to Directors for the management of their budgets and staff, within agreed parameters. The Coordination Committee should play a stronger collegial role in conducting and managing activities.

12. Specific improvements should be made in the internal management of ITUheadquarters, in the fields of finance, personnel and information systems. The primary aims are to: improve strategic planning and provide more effective financial, personnel and information management; promote, within this improved framework, delegation of responsibility, greater cooperation between staff and greater exercise of initiative; and, importantly, enable the staff more fully to realize their potential within a well managed organization.

13. Our [HCL] Recommendations seek to encourage greater participation by all those who have important interests in ITU activities. The ITU is an intergovernmental organization and Members are States represented by Administrations. But it exists to meet a wide range of interests: to facilitate provision of services to end users by operators, service providers and equipment manufacturers; and to assure effective use of theradio-frequency spectrum by all users. Non-Member participants also make a great contribution to its work Their even greater participation should be encouraged.

14. Our [HCL] Recommendations will increase some costs, but also lead to savings. With effective implementation, changes in the culture of the organization and the goodwill and support of the staff, we believe that the cumulative impact will have a positive effect on the finances of the ITU and will enhance performance. We have no doubt that the quality and dedication of all who work in the Union will ensure that the ITU does respond to the challenges of change.

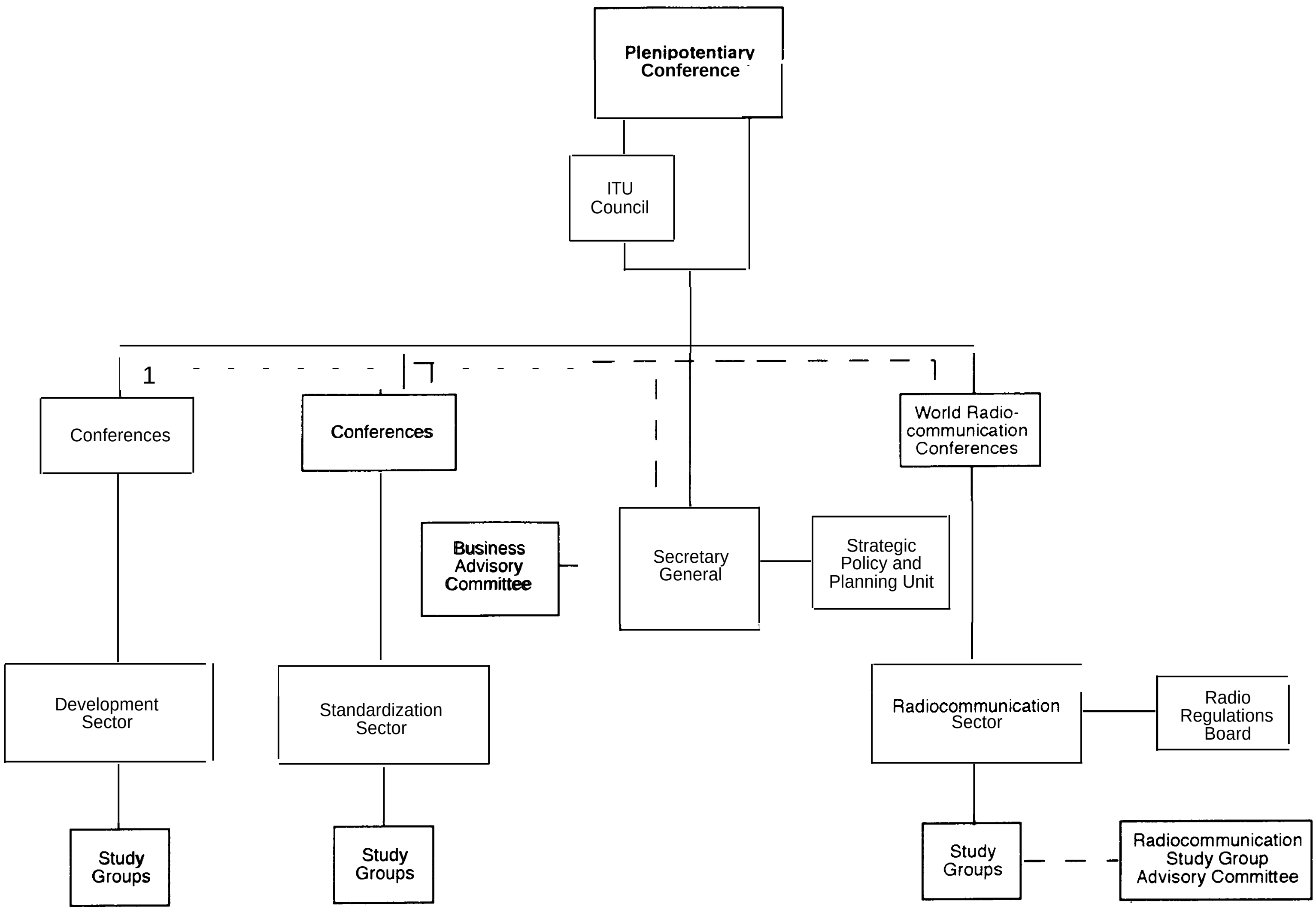
15. Our [HLC] proposals for implementing our Recommendations are in Chapter VII. It is vital that the ITU not lose momentum in taking action on this report and in implementing its recommendations. Any delay will weaken the ITU's capacity to respond to the rapidly changing telecommunication environment.

SOURCE: Final Report of the High Level Committee (_H.L.C.) to Review the Structure and Functioning of the International Telecommunication Union "'Tomorrow's ITU: The Challenges of Change," Document 145-E (Geneva: International Telecommunication Union, April 1991).

The radio activities of the ITU would be directed by World Radiocommunication Conferences, which would combine the work of the CCIR Plenary Assemblies and the WARCs. The Committee also recommended that the new conferences should include a coremittee open to nongovernmental bodies in order to increase the amount and quality of RPOA, SI0, and other interested organizations' participation. The current work of the CCIR study groups would continue, but some work related to standards would be transferred to the Standardization Sector, and a Radiocommunication Study Group Advisory Committee would be established to guide the work of the groups.

In addition to structural changes, the HLC has recommended a regular schedule of Plenipotentiary Conferences and administrative conferences for each of the new sectors. Meetings of World Radiocommunication Conferences would take place every 2 years. This regular schedule of world radio conferences may have several effects. First, a regular schedule should make it easier for countries to plan for conferences in terms of budgets and personnel, and gives the United States an opportunity to formalize and institutionalize WARC preparation processes, both in the government and industry. Private sector involvement in WARC preparation activities could become more integrated and continuous. Rather than the uncertain budget demands of irregular WARCs, including salaries, temporary staff, and wildly fluctuating travel demands, a regular cycle allows administrations (and the private sector) to get into a rhythm that promotes more efficient and rational planning for the WARCs. Personnel requirements could also be rationalized

Figure 3-3—International Telecommunication Union Structure: Changes Recommended by the High Level Committee



SOURCE: Office of Technology Assessment, 1991.

because a regular schedule would allow managers to apportion time and hire staff according to needs. This should serve more broadly to regularize the domestic preparation process itself and presents an opportunity for the United States to build a core group of international staff with continuing responsibility for WARC preparations. Such changes could potentially enhance the efficiency of the U.S. preparation process and improve U.S. effectiveness at international conferences.

The HLC recommended a number of ways to increase the formal and active participation of members of the private sector in the work of the ITU. As countries have liberalized and privatized their telecommunications industries, more new companies have come into existence. They are playing an increasingly important role in the ITU process, especially through the work of CCITT/CCIR study groups. The HLC recognized this greater role and has recommended that the Administrative Council begin a review of the participation of nonmember representatives. It also recommended that intergovernmental satellite organizations be given greater status and access to ITU meetings and that a Business Advisory Forum be created to advise the Secretary-General on private sector interests and concerns.

Impacts—The impact of these changes on the functioning of the ITU and its work in spectrum management has yet to be felt. The timeline on which these changes will take place if adopted is still unclear, but changes are likely to be phased in over a period of years. Some alterations, such as those to the IFRB, will require the approval of a Plenipotentiary Conference, while others may require only Administrative Council or Secretary-General approval. Still other changes reflect and reinforce improvements that have been underway for several years, especially in the CCIR./CCIlT The final impacts of the proposed changes (which are passed and which are not) will depend on where the decisions are made, what changes are finally approved, and how long it takes to implement them.

The major effect of regular radio conferences is to make the ITU WARC process more orderly and predictable, yet flexible. The future schedule of conferences is now uncertain. Hence, great importance has been attached to WARC-92, since no one knows when the next opportunity to address current issues will be. With future radio conferences occurring every 2 years, and planning for conferences going on almost continuously, it should be easier and faster for each country and the ITU overall to address rapidly changing technological issues. These changes could also make it easier to schedule issues to allow for longer, more thorough consideration and preparation time if needed—since the time to the next conference would not be so long and would be known. This would have the effect of lessening the uncertainty associated with today's conferences because unresolved issues could be more easily scheduled for upcoming conferences. It is uncertain whether regular world radio conferences will be broad, taking up a variety of topics every 2 years, or more specialized, dealing with specific topics. It seems likely, however, that future WARCs will deal with a more limited set of issues, even if they are not completely specialized.

The benefits of regular conferences do not come without costs, however, and will not solve all the problems with ITU spectrum allocation and management procedures. The main disadvantage is that regular conferences will require additional finding on the part of the private sector and government. Instead of sporadic preparation, the preparation process will become continuous, requiring the commitment of additional staff and funding resources. The increased resource requirements also represent a strong barrier to developing countries, who have limited personnel available for WARC activities and are already short on funds. Regularizing the conference schedule will probably not improve developing country participation in WARC activities.

Overall, the changes proposed by the HLC may prove to be far-reaching, but not dramatic. Many of the recommended changes reinforce and legitimize changes that were already underway or had previously been proposed. The work of the CCIR study groups, for example, may not be affected much beyond the streamliningalready put into place. In any case, changes in the structure and functioning of the ITU will require changes in the ways in which the United States prepares for future conferences. Regular conferences may require the establishment of permanent offices to handle conference preparatory activities. The greater involvement of the private sector in the activities of the ITU should greatly benefit the United States with its already extensive industry involvement, but closer coordination between government and industry may be necessary to coherently promote U.S. radiocommunication policies abroad. These shifts offer both challenges and opportunities that must be planned for if the United States is to continue to be effective in world radiocommunication policy.

Voluntary Group of Experts

In addition to (complementary with) the work of the HLC, the ITU has also begun a study of the Radio Regulations that govern the use of the radio frequency spectrum internationally. This study is being conducted by a Voluntary Group of Experts (VGE) in an effort to simplify the Radio Regulations and improve use of the spectrum worldwide. The VGE was established by the 1990 Administrative Council based on the recommendation of the 1989 Plenipotentiary Conference (Resolution PL-B/3). Membership is open to all member countries. At the first meeting of the VGE, which took place in late January 1991, experts from 22 countries and four international organizations participated. The VGE plans to complete its work by mid-1993. A WARC will then be needed to implement its recommendations since they directly concern the Radio Regulations.

The VGE is pursuing several objectives. Simplification of the international Radio Regulations is its primary goal. Over the years, as successive conferences have added to and modified the Radio Regulations, complaints have been raised that the regulations are too complex, very time-consuming, administratively burdensome, and not able to keep pace with the rapid changes in technology.[22] There are over 700 footnotes in the international Table of Allocations that make specific modifications to the allocations to accommodate specific country or service requirements. Many of these are now considered obsolete. By simplifying the Radio Regulations, the VGE hopes to increase the flexibility of spectrum use and management. This is a much broader and long-term task that will affect how spectrum is allocated at WARCs.

To accomplish its objectives, the VGE has divided its work into three tasks: Task 1 considers the allocation process, including definitions of radio services, alternative approaches to spectrum allocation, and the use of footnotes in allocation tables. Task 2 addresses the problems of frequency assignment, including procedures for coordinating and recording assignments and preventing interference. Task 3 encompasses operational and administrative provisions. Since most of the work of the VGE is highly technical, the CCIR established Task Group 1/1 to provide the VGE with expert support.[23] The United States has representatives on both the VGE and Task Group 1/1.

Because VGE's work began only recently, its possible impacts on the functioning of the ITU and its effects on the spectrum allocation and management process are unclear. The work of the VGE is closely tied to that of the HLC and is, in part, dependent on the implementation of proposed HLC changes. If these changes are not approved or implemented, the work of the VGE may be undermined.

The fact that the work of the VGE is so technical may have limited its appeal to high-level policymakers in the United States. Little attention is being paid to the work of the VGE outside of those actually involved. It may also be that HLC activities have overshadowed the work of the VGE (which was established after the HLC) and diverted the attention of top policymakers. Reportedly, there was initially little high-level thought or planning being given to the work of the VGE, and no concrete goals have yet been established for the U.S. representatives to the VGE to follow. A private sector task force under the national CCIR's Strategic Planning Committee provides advice to the U.S. VGE representative on possible U.S. objectives in the VGE.

CCIR

Much of the impetus for change in the ITU originally came from the international consultative committees. Several years ago both the CCIR and CCITT were having increasing difficulty keeping up with the rapid pace of technological change. Technical issues must be quickly and effectively decided if the ITU is to maintain its leadership role in international telecommunications, and ITU officials feared that, if the ITU could not act quickly enough in setting standards and rules of operation, member countries and the private sector would resort to institutions outside the ITU, including the emerging regional standards organizations, to get things done.

[22] G.C. Brooks, "Possible Evolution of the International Regulation of the Space Services," *Telecommunications Journal*, vol. 58, No. II, February 1991, p. 88.

[23] The membership of the VGE overlaps with lhsk Group 1/1 as well as with the HLC.

It was felt that this could hurt the development of global networks and services.

In an effort to speed up their processes and improve their responsiveness, first the CCITT and then the CCIR adopted reforms to improve their work and streamline their processes. CCIR's Resolution 24, adopted in 1990, was designed to accelerate the approval of recommendations on radio standards by streamlining the work of the study groups and adopting faster working procedures. These changes have taken place independently of the HLC study and are being folded into the HLC proposals. Many of them are already being implemented.

CCIR has convened a new Study Group 12 to examine ways to accommodate the growing demand for mobile services and spectrum. In the long-term, if the study group proves successful in its mission, the way is opened to consider whether a much broader array of spectrum management issues, normally dealt with at Administrative Radio Conferences, might be handled by more dynamic Consultative Committee mechanisms.[24] In the absence of possible changes to ITU structure and procedures (discussed below), this shift to the CCIR groups could benefit the United States in that the CCIR activities have long been dominated by United States and developed country contributions. A strengthening and streamlining of the CCIR process/procedures could translate into a stronger U.S. presence in the ITU generally, and represents an opportunity for the United States to both push technology advancements more rapidly and lay the groundwork for U.S. proposals at future WARCs.

Under the changes proposed by the HLC, the work of the CCIR would be subsumed under the Radiocommunication Sector and the CCIR as an separate body would be eliminated.[25] The work of the CCIR study groups, however, would continue largely intact. Many of the administrative functions of the CCIR would be merged with the WARCs into World Radiocommunication Conferences.

Development

With the rising numbers and political power of the developing countries, development—specifically telecommunications facilities and systems development—has become an increasingly important concern of the ITU. Over the last decade, the ITU has made telecommunication development and technical assistance to developing countries a more integral part of its mission. In 1985, for example, the ITU established the Center for Telecommunications Development, and in 1989 the Nice Plenipotentiary created a new Bureau for Telecommunications Development. The trend continues in the HLC proposal to create a separate Development Sector equal in status with the Standardization and Radiocommunication Sectors.

The issue of development, and the potential broadening of the mandate and activities of the ITU indicates a major shift in the purpose of the ITU and could have a major impact on international telecommunications policymaking. Although its direct impacts on spectrum policymaking are unclear (since the changes have not yet been implemented), two scenarios appear possible. First, the increasing concentration on development activities and the high status of the Development Sector may result in a shifting of resources away from radiocommunication activities.[26] Given the concurrent regularization of the WARC schedule, it will be important for the United States to monitor the situation very closely to ensure that the important activities of the WARCs and the (CCIR) study groups are not given short shrift. Second, a focus on development may affect the work programs the study groups undertake-moving them away from allocation, sharing, and standards work and toward more operational or design issues.

Major Trends Shaping International Telecommunication Policymaking

As the world moves toward a society and economy based on information and knowledge, telecommunications, including the new radio-based technologies, will assume an increasingly important role in all aspects of life.

[24] Pekka Tarjanne, "An Unusual Event," *Telecommunications Journal,* vol. 58, No. III, March 1991, p. 123.

[25] Most CCIR functions will continue under the Radiocommunication Sector, but some activities dealing with radio and public network interface standards will be transferred to the Standards Sector.

[26] Comments of COMSAT before NTIA, op. cit., footnote 17.

> Historically there has been a tendency to view telecommunication as a service by itself. Consideration of telecommunication as a facilitator of economic development, as a source of global competitive advantage, as a provider of social and welfare benefits, as a contribution to reducing regional disparities, and as a provider of information for the general elevation of the population, have not been dominant considerations in the formulation of national telecommunication policies. However, for the future, with information and knowledge becoming strategic resources, and telecommunication becoming the primary means determining their availability, a policy framework for making telecommunication a truly universal resource will need to emerge. With more people engaged in the service economy in post-industrial societies, including certain sections of developing countries, telecommunication matters are becoming increasingly important for national, economic and social policy in all countries.[27]

Broad changes in the economic, social, and political landscape will shape the future of radiocommunications policymaking.[28] These changes will substantially affect the arena for international radiocommunication policy, and present U.S. policymakers with a number of important challenges that must be forcefully and coherently addressed if the United States is to continue to play a leading role in international spectrum policymaking. The following sections summarize some of the most important trends shaping the international telecommunication environment.

Pace of Technological Change

The pace of technology development in radio-based services has accelerated dramatically in recent years (see ch. 2). This acceleration, coupled with increasing congestion in many parts of the radio frequency spectrum, has put substantial pressure on both domestic and international radiocommunication policy processes. Spectrum managers are struggling to accommodate increasing demands for frequencies for new services and the expansion of existing services, while at the same time ensuring minimal interference and enhanced efficiency. Current structures and processes are increasingly unable to keep up with the rapid pace. The inclusion of many completely new services on the agenda for WARC-92 is evidence of the rapid pace of technology development, and the ITU's efforts to respond.

These pressures put a premium on rapid and flexible approaches to spectrum policy, and present a challenge and an opportunity to make aggressive changes to policy structures and processes. Policymakers must respond rapidly and flexibly in order to take maximum advantage of technology advances. In the United States, NTIA recently completed a comprehensive report on U.S. spectrum management policy, and the FCC has initiated several proceedings on new services and is studying the creation of a spectrum reserve for new technologies. Internationally, the ITU is in the midst of efforts to streamline its processes and adapt its structure to better address emerging telecommunications needs (see above). If conferences were scheduled every 2 years, technology developments would be rapidly addressed and planning for future conferences could flexibily adapt to members' concerns and priorities in a more timely manner. For the United States to adequately respond to the accelerated development of new technology, adequate resources must be part of a coherent plan that links domestic and international spectrum policy goals.

Globalization

Telecommunication and radiocommunication systems are interconnecting on a larger and larger scale, giving rise to telecommunication networks and services that are increasingly global in scope. New international satellite systems are being planned and the connection of continents with fiber optic cables continues. Services are becoming increasingly internationalized as new information, computer, and communication services merge and extend their reach to all countries of the world. At WARC-92, for example, the main issue in future public land mobile services (see ch. 1) is how and in what band to establish a common core of frequencies that users can access from any location on Earth. Major new services, such as Broadcasting-Satellite Service-Sound and personal communication services (PCS)

[27] "The Changing Telecommunications Environment," op. cit., footnote 1, p. 3.

[28] In its Final Report t. the ITU, the High Level Committee identified six major trends affecting the international telecommunication environment. They include: globalization, pace of technological change, information economy and society, rising importance of regional organizations, the development gap, and new players and alliances. See HLC Final Report, op. cit., footnote 19; these ideas are also reflected in Government of Canada, Department of Communications, Telecommunications Policy Branch, Spectrum and Orbit Policy Directorate, "Towards a Spectrum Policy Framework for the Twenty-First Century," Discussion Paper, September 1990.

are being developed not only for domestic use, but with global markets in mind.

As a result of the worldwide expansion of technologies and services, telecommunications markets and competition in those markets are becoming increasingly global.

> Telecommunication has become increasingly important to industry in most countries as a basis for improving on organization's internal efficiency in expanding global markets. For many firms in both manufacturing and service sectors, it also has become a tool to enhance competitiveness by providing instant communication and information exchange among the many different locations of translational corporations around the world, and between major fins, their suppliers, their customers, and other intitites that together makeup a firm's network of business relations.[29]

Because of the large potential markets for international services such as satellite broadcasting and mobile satellite services, the spectrum is increasingly being viewed as a strategic resource for the future development of radio services and products for the consumer.[30]

Tempering this trend is the reality that negotiating agreements on international standards and allocations is becoming increasingly difficult. As the number of manufacturers and vendors increases and users become more sophisticated, positions diverge. International consensus is often undermined by numerous exceptions to the Radio Regulations. At the same time, for services that have clear worldwide applications and effects, such as safety and distress services, opinion is still strong that worldwide allocations and protections are desirable.

For U.S. spectrum policy, globalization means comprehensive planning and management of domestic requirements in the context of policy changes taking place at the international level.

> The expansion of telecommunication networks and services has pushed many issues of national policy to the international level. Global information and communication networks require much more than compatible technical standards. A higher degree of compatible telecommunication policies and regulations is needed in respect of service offerings, tariff structures and other matters. . . there is no longer a clear demarcation between many national and international networks.[31]

This trend makes the effective functioning of the ITU, as the primary international body for addressing telecommunication matters, critical, and effective U.S. participation in the process even more important.

Rising Importance of Regionalism

At the same time that telecommunication systems and services are becoming increasingly global, regional networks, services, and organizations are becoming more widespread. The ITU notes that:

> Telecommunication systems are becoming translational, and subregional in many areas of the world. Pan-European, Andean, Central American, African, South Pacific Islands, Nordic systems, are all at various stages of design and development. Physical networks are interconnected regionally; services are crossing borders; tariffs are being coordinated; regional standards institutes and organizations are being established; and the planning of regional satellite systems continues. All geographical areas have one or more regional telecommunication bodies, with differing mandates and missions but collectively addressing operations, planning, financing, training, and policy .32

The rise of regional cooperation and coordination has been driven by several converging trends. Advances and proliferation of many new technologies have given regions a variety of ways to address telecommunications needs, and what technologies a region chooses depends on what types of systems and services the countries want to develop and how. As users become more sophisticated, technical choices will further diversify, creating more regional and subregional networks. The creation and interconnection of such networks requires regional arrangements for fostering harmony and cooperation between telecommunication operating entities and for improving administrative and technical services across regions.[33] Economic and political forces are also leading countries with common interests to join

[29] "The Changing Telecommunication Environment," op. cit., footnote 1, p. 11.

[30] Government of Canada, Discussion Paper, op. cit., footnote 28, p.10.

[31] "The Changing Telecommunication Environment," op. cit., footnote 1, pp. 11, 29.

[32] Ibid., p. 18.

[33] 1bid., p. 31.

forces as they seek to integrate efforts on many policy fronts in order to expand their economies and better compete in world markets.[34]

These pressures have resulted in many different forms of regional cooperation and collaboration, including the formation of free trade zones (United States, Canada, and possibly Mexico) and common markets (European Community (EC)). They have also led to the establishment or strengthening of different regional organizations such as the Pan African Telecommunication Union, Asia Pacific Telecommunity, and the Arab Telecommunication Union.

The foremost example of the rise of regionalism is the EC.[35] In international telecommunications negotiations, the countries of Europe have taken bold steps to coordinate their policies and the presentation of positions. CEPT, established in 1959, currently consists of31 European telecommunications administrations. It synchronizes individual national telecommunications positions into an integrated regional telecommunications policy. In 1988 the European Telecommunications Standards Institute was spun out of CEPT in order to harmonize and strengthen the standards-setting process in Europe.[36] The power of the European countries in international forums such as the ITU has increased as their political and economic ties have become closer, and could increase further with the proposed merger of the EC countries and the countries comprising the European Free Trade Association.[37] This merger would create a trade zone encompassing 19 countries and more than 350 million people, significantly larger than the U.S. market.

In addition to the new regional arrangements and organizations, existing regional bodies are also showing a resurgence. They are being modified and substantially strengthened to adapt to the new world environment. These organizations will require effective organization and adequate resources to meet increasing demands.[38] Policymakers at NTIA and the FCC, for example, are mounting strong efforts to invigorate the Inter-American Telecommunications Conference (CITEL), the regional telecommunications organization of the Western Hemisphere, to bring increased coordination to Western Hemisphere policymaking and as a partial counter to the strength of the CEPT voting bloc (see box 3-B). The private sector, which sees CITEL as a potentially effective forum for addressing regional telecommunications issues and has recently begun to recognize the potential of Latin American and Caribbean markets, has been actively involved in these efforts. As a result, CITEL preparations for WARC-92 have been an important focus for both government and private sector interests (see box 3-C).

Increases in regional power and coordination will have significant impacts on the ways in which world telecommunications policy is decided—impacts that could be either positive or negative. On the negative side, regionalism could increase and strengthen bloc voting within the ITU-with negative impacts on U.S. interests. U.S. negotiators, for example, have noted increased difficulty at recent WARCs (and at recent meetings of the CCITT) negotiating with individual European countries. There is concern that tight European coordination and a corresponding increase in bloc voting will lead to a strengthening of the European positions and a diminishing of U.S. interests and power.

The rise of regional organizations and voting blocs could also lessen the importance of international bodies such as the ITU and the work of the CCITT and CCIR. Some analysts have expressed concern that participation and resources devoted to new regional activities will detract from the resources, time, and commitment devoted to the ITU, and more global concerns.[39] For example, many believe that regional standards organizations could be the driving force in world standards-setting activities, superseding the ITU. Regional standards

34 Comments of COMSAT before NTIA, op. Cit., footnote 17, p. 14.

35 European Community currently has 12 members: Belgium, Denmark, France, Germany, Great Britain, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, and Spain.

36 Significantly, approximately one-half of the new members joining the European Telecommunications Standards Institute in the first half of 1991 were wireless communication companies. Similar regionat standards-setting bodies also exist in North America (T-1) and Japan (the Telecommunication Technical Council-TTC). For a broader discussion of the issues of standards-setting, see forthcoming OTA study on International Standards.

37 EFTA members include: Austria, Finland, Iceland, Liechtenstein, Norway, Sweden, and Switzerland. See Patrick Oster, "Treaty Maps Out a Unified Europe," *The Washington Post*, June 16, 1991, p. H1.

38 "The Changing Telecommunication Environment" Op. cit., footnote 1, p. 40.

39 See the comments of COMSAT before NTIA in the matter of its comprehensive spectrum review, op. cit., footnote 17.

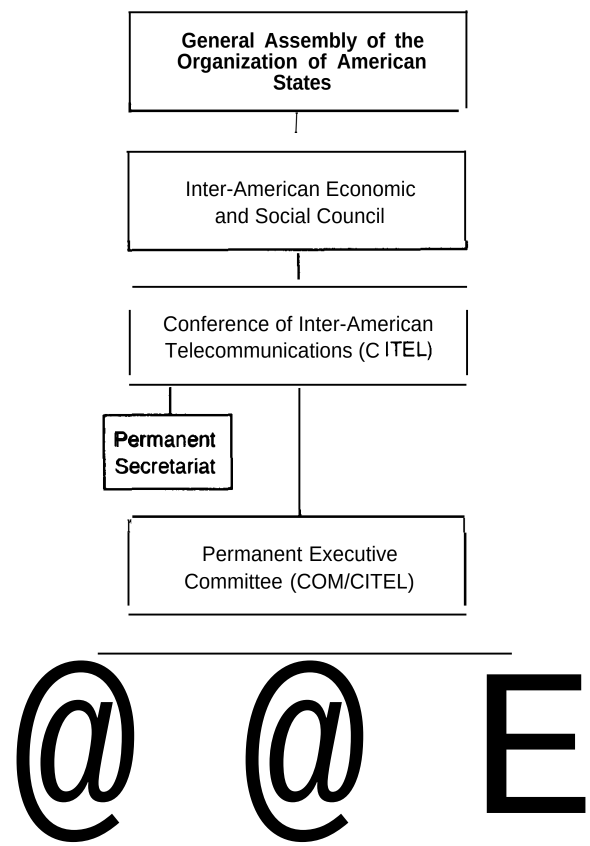
Box 3-B—Inter-American Telecommunications Conference-CITEL

The Inter-American Telecommunications Conference (CITEL), established in 1963, is a Specialized Conference of the Organization of American States (OAS).[1] CITEL'S primary mission is to promote the development and coordination of telecommunication policies and systems in the Americas by conducting studies of technologies, standards, and legal issues; convening meetings to address these issues; and maintaining contact with other regional telecommunication organizations and the ITU.. In the last several years, one of CITEL's primary functions has been to serve as a regional forum for the development of members' positions for WARC-92. Thirty-four countries in South, Central, and North America and the Caribbean are members.[2]

CITEL is not a separate institution within the OAS-it has no permanent staff, officers or a headquarters. Rather, CITEL is an ongoing series of conferences that meet periodically (the next conference, CITEL-VI, is scheduled for the fall of 1991) to establish priorities and direct the work of CITEL's four permanent committees. The Permanent Executive Committee (COM/CITEL), which serves as the executive organ of the Conference, deals primarily with administrative matters. Three Permanent Technical Committees (PTC) are concerned with substantive technical issues (see figure 3-B-l). PTC-I addresses matters involving public telecommunications systems, PTC-II addresses broadcasting issues, and PTC-III is concerned with radiocommunication issues other than broadcasting. The work of COM/CITEL and the PTCs is supported and overseen by a Permanent Secretary, a position that is, ironically, not permanent.

Historically, CITEL has played a minor role in the region's telecommunication activities, reflecting the low priority traditionally given telecommunications by the countries of the OAS.[3] CITEL budgets have been underfunded (generally less than $100,000 per year), and the lack of domestic funds has substantially

Figure 3-B-l—Organization of the Conference of Inter-American Telecommunications Within the Organization of American States



KEY: PTC-Permanent technical committee

SOURCE: U.S. Department of Commerce, National Telecommunications and Information Administration, Frequency Management Advisory Council, United *States* Preparations *for the 1991 Inter-American Telecommunication Conference (CITEL)* (Washington, DC: Apr. 1, 1991), p. 6.

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[1] The material in this section is based on U.S. Department of Commerce, National Telecommunications and Information Administration, "United States Preparations for the 1991 Inter-American Telecommunications Conference (CITEL)," Report of the Frequency Management Advisory Subcommittee, April 1991. In addition to background information on CITEL, the report contains specific recommendations on improving the effectiveness of CITEL and U.S. positions regarding CITEL activities. For more extensive discussion of the history and efforts to restructure CITEL, see Brian Segal, "Report on the Importance of CITEL and Options for Restructuring,' Report prepared for the Fourth Conference of CITEL, March 1983; and John J. O'Neill, Jr., "Commentary on Report on the Importance of CITEL and Options for Restructuring," unpublished document, March/April, 1984.

[2] CITEL member states: Antigua and Barbuda, Argentina, the Bahamas, Barbados, Belize, Bolivia, Brazil, Canada, Chile, Colombia, Costa Rica, Dominica, Dominican Republic, Ecuador, El Salvador, Grenada, Guatemala, Guyana, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, St. Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Suriname, Trinidad and Tobago, United States, Uruguay, and Venezuela.

[3] Historically, the benefits of telecommunications for economic development have not been well understood or appreciated. Consequently, it has been difficult to convince OAS/CITEL members that telecommunications activities are important enough to warrant significant funding. The current interest in CITEL activities via-a-via WARC-92 indicate that these attitudes may be changing. See O'Neill, op. cit., footnote 1.

reduced the ability of member countries to participate in the work of CITEL. As a result, CITEL does not have the status and importance necessary to achieve its stated goals, and is generally viewed as lacking substance and ineffective. This view has translated broadly into a lack of commitment from member states, and a consequent reluctance to provide additional funding. An additional problem identified by U.S. delegates to international conferences is that some Latin American delegations lack continuity. Changes in governments and telecommunications ministries bring new delegates to the conferences that have never attended before. This has made it very hard to develop lasting relationships with some governments. Consequently, until recently, CITEL has attracted little attention from U.S. policymakers and the private sector.[4]

Changes implemented in the past 5 years may make CITEL more effective. Driven by the changes in world politics and a newly competitive world telecommunications environment, CITEL is seeking to broaden its activities and is encouraging greater private sector participation. Mandates and agendas of the PTCs have been expanded to include more items of regional interest and of interest to the private sector. Steps have also been taken to improve work processes that would allow the PTCs to become more effective and responsive to the needs of CITEL's members. More such changes may result from the sixth quadrennial meeting of CITEL (VI-CITEL) to be held later in 1991. That meeting will examine the performance of CITEL, identify ways to improve its performance and give member states an opportunity to reassess their participation and support of CITEL.

Efforts to make CITEL a more effective organization have gathered substantial momentum in the last year. There is a growing feeling among U.S. and foreign government representatives and the private sector that CITEL should play a more significant role in coordinating regional telecommunication activities. A new spirit of compromise has been noted by delegates from several countries, including the United States. Developing countries also view CITEL as a valuable source of technical support in developing their own WARC proposals. When no national position has been developed, many countries may use CITEL views as (the basis for) their own national positions.

In the last several years, CITEL has received increased attention from some United States international spectrum policymakers and the private sector. They increasingly view it as an important, but underutilized, underfunded and underpowered resource for regional coordination and in the WARC preparation and negotiation process. For example, CITEL is playing an active role in WARC preparations for 1992 through an Interim Working Group of Permanent Technical Committee III (PTC-III), which is attempting to form common CITEL views which would then be carried into the WARC (see box 3-C).

Several factors have contributed to the renewed interest of government policymakers. First, the growth and strengthening of regional voting blocks within the ITU, in particular the European countries, has led the United States to look for new alliances.[5] Beginning in the late 1980s, the Europeans, through the Conference of European Postal and Telecommunications administrations (CEPT), began to formulate strong regional positions that were strictly adhered to at international conferences. This type of unity has made it increasingly difficult for the United States to promulgate its views in a forum such as the ITU with its one-nation, one-vote system. Consequently, to improve its position and in order to offset developing country blocs and the increasing power and solidity of the European countries, the United States is attempting to build regional support through the CITEL conferences and by advancing common CITEL views that will hopefully reflect United States interests. Implanting United States interests in the larger context of common CITEL views will provide added support for U.S. positions and may improve bargaining positions and chances of success at the WARC. U.S. Policymakers, however, must remain flexible in these negotiations in order to build support for a wide range of common views. Strong preliminary work at CITEL before WMC-92 should enhance the U.S. leadership role at the Conference. Developing countries also see CITEL as a reaction/counter to the increasing power of the European countries, and view it as a valuable

[4] For example, only half the member countries sent delegations to the most recent meetings of PTC-III (Ottawa, September 1990) and the Interim Working Group preparing for WARC-92 (Mexico City, January 1991 and Washington DC, May 1991). This may reflect a lack of commitment or merely a lack of travel funds. However, for CITEL meetings, this was a good turnout.

[5] The European Community (EC) and CEPT are not equivalent. CEPT was formed in 1959 to specifically represent the interests of the European post, telegraph, and telephone administrations (PTTs). It now represents the interests of 31 European telecommunications administrations. The EC is more broadly focused. Telecommunications policy in the EC has evolved, at least in part, in reaction to the narrow, traditional views of the PTTs and CEPT, but recently, EC telecommunications policy has begun to reflect the broader goals of the EC itself-to promote unity and integration among European nations. CEPT has come under attack in recent years for its closed system, and has taken steps to reform, such as spinning off its standards activities. However, it still wields considerable influence in international radiocommunications activities.

(continued on next page)

Box 3-B—Inter-American Telecommunications Conference-CITEL-Continued

opportunity to prenegotiate some of the WARC issues. This type of interaction is seen as very valuable in allowing developing country governments to prepare more effectively for the WARC. Second, CITEL offers a way to coordinate telecommunication policy on a regional basis, apart from any international concerns. There is increasing recognition among the countries of CITEL that technologies are increasingly crossing national boundaries and that domestic policies alone will not guarantee development. In this sense, its aims mirror (and extend) the theme of regional cooperation evident in the Enterprise for the Americas initiative, the Canadian Free Trade Pact and the possible Mexican Free Trade Agreement.

Traditionally, private sector participation in CITEL has been limited, perhaps because of CITEL's general ineffectiveness. The private sector is not allowed to participate directly in most activities, and industry interest in CITEL's activities has been minimal.[6] Efforts are now under way to increase industry participation in PTC-II and PTC-III There is some support in the U.S. private sector for strengthening CITEL. Industry believes that a mom effective forum is needed to focus attention on the practical and technical issues facing telecommunications providers in the region, including standards. Telecommunication vendors and service providers have also begun to recognize the potential and the importance of Latin American telecommunications markets. A series of conferences such as CITEL provides an opportunity for United States companies to make contacts in potentially lucrative Latin American markets where they have historically been overshadowed by European competitors. The extensive participation by industry in the recent PTC-III WARC Interim Working Group meeting held in Washington, DC in May 1991 demonstrates the extensive interest that the private sector has in CITEL and its member states.

Although there is much support for strengthening the role of CITEL in regional telecommunications activities and WARC preparations, some policymakers remain skeptical. It remains to be seen whether potential changes will occur, whether members' commitment to CITEL can be sustained, and how successful CITEL's activities in standards-setting and WARC preparations will be. Changes in attitude and the commitment of a small number of dedicated policymakers to make CITEL a more effective organization may not be enough. The future success of CITEL will depend on continued and high-level commitment by member governments, increased private sector participation and a proven record of success in accomplishing substantive work— including agreement on major spectrum issues. The primary challenge for CITEL is to attract the funding from the OAS necessary to improve its effectiveness.

The results of government and private sector efforts to enhance the role of CITEL and the strength of common views that might emerge will not be seen until the WARC concludes. Even if the common views forged at CITEL do not endure, or regional cooperation falters, efforts to raise the level of CITEL will likely continue. Improving the level of CITEL's work is a long-term process-it is too soon to expect spectacular results.

[6] The only way for the private sector to participate is through membership on U.S. delegations to CITEL meetings. In 1987, CITEL adopted a resolution encouraging mom direct private sector participation in the activities of PTC-I. This experiment has been generally considered a success, and there is increasing pressure to open up PTC-II and -III. However, there is as yet no formal mechanism for direct private sector participation in PTC activities.

organizations could coordinate their efforts and institute procedures to avoid duplication of work within the CCIR and CCITT. Most substantive work would be done in regional bodies, and then merely confirmed at ITU conferences. On the other hand, regional organizations and conferences could serve as important precursors to the international conferences—a way to sample ideas, build support, and prenegotiate some conference issues.[40] Many regional associations are attempting to facilitate coordination and harmonization across regions as a stepping stone to global coordination and harmonization through the ITU.[41] These efforts could make the ITU more efficient in developing global standards.

[40] In commenting on regionalism in the standards-setting proeess, COMSAT notes that: "the joint meeting of the T-l, ETSI, and TTC organizations. . . was an important first meeting to explore mutual cooperation among these regional bodies, and to discuss ways to enhance the effectiveness of the CCITT in its global standards role," ibid., p. 15.

[41] "The Changing Telecommunication Environment, op. cit., footnote 1, p. 6.

Box 3-C-CITEL Preparations for WARC-92

At its August 1989 meeting, Permanent Technical Committee III (PTC-III) of the Inter-American Telecommunications Conference (CITEL) established an Interim Working Group (IWG) to work out common regional views CITEL member countries could then use in developing their own WARC proposals. This was the first time that formal common positions had been attempted by CITEL members. After the agenda for the WARC was finalized in June 1990, PTC-III devised a work schedule for the IWG, and countries agreed to develop papers on WARC agenda issues for consideration by the Group.

The IWG met twice. At Mexico City in January 1991, 13 countries attended, and considered approximately 60 input papers and 40 technical documents. Before the formal meetings of the Group, a seminar on WARC-92 issues was held to provide in-depth information to the delegates. The results of the meeting were generally viewed positively by representatives from both foreign countries and the United States. The delegates agreed to common CITEL views on a number of WARC agenda items, and produced a first draft of a comprehensive report covering the most important WARC-92 issues.

The IWG met for the second, and final, time in Washington, DC in May 1991. Representatives from 16 countries, three international organimations, and an observer from the Conference of European Postal and Telecommunications Administrations (CEPT) attended. Approximately 90 new input papers were considered by the delegates and more than 20 papers were presented by members of the private sector at a technical symposium held during the week of the meetings. Foreshadowing future debates, a large number of the papers concerned Broadcasting-Satellite Service-Sound and Mobile Satellite Services, including low-Earth orbiting satellites. The first draft of the group's report was substantially revised and contained common CITEL views on several items. Many of the most important issues, however, could not be agreed to, including specific allocations for high frequency radio broadcasting, Broadcasting-Satellite Service-Sound, high-definition television, some Mobile Satellite Services, and Future Public Land Mobile Telecommunication Systems. Delegates were generally pleased with the outcome of the meeting, although some voiced disappointment that more common views were not agreed upon. The report will now be sent to the chairman of PTC-III and all the CITEL governments for use in preparing their own proposals for WARC-92.

SOURCE: Organization of American States, Interamerican Telecommunications Conference, Permanent Technical Committee III, "Report of the CITEL 1992 World Administrative Radio Conference Interim Working Group," Document WARC-92/62 Rev. 2, May 10,1991.

Liberalization and Privatization

As the trend toward increasing global competition intensifies, both developing and developed countries are searching for ways to be competitive. Traditional models of telecommunication operation, regulation, and policy development are increasingly being challenged.[42]

> There is a widespread concern with national telecommunication monopolies that they may be unable to provide the increasing diversity of communication services necessary to meet the expanding variety of communication needs and demands . . . . Many countries, both developed and developing, are now in the process of redefining their national telecommunication policies and regulatory mechanisms.[43]

Post, Telephone and Telegraphs (PTTs), the institutions that historically have controlled telecommunications services in many countries, are being restructured so that monopolistic privileges are replaced by a more competitive environment. Many countries have privatized (sold shares in), or will soon privatize, their government-owned PTTs—taking control out of the hands of government and replacing it with more private sector control. Since Britain privatized British Telecom in 1984, six countries have privatized their telecommunications systems (Japan, New Zealand, Malaysia, Argentina, Mexico, Chile) and several more are about to do so (Hungary, Singapore, Uruguay, South Korea, possibly Germany and Czechoslovakia). France has chosen an alternative to privatization, namely strong state intervention to encourage the adoption of new technologies and services. In 1991 France separated its telephone service (France Telecom) from the Ministry of Posts and Telecommunications (but did

[42] Ibid., p. 8.
[43] Ibid., p. 11.

not privatize it) so that it could become more competitive internationally.

In addition, many countries have liberalized their telecommunications markets and networks, allowing new equipment vendors and service providers to provide goods and services in addition to the traditional service provider (usually a PTT or equivalent).[44] Many countries, for example, are trying to encourage the development of private networks of all sorts. Because of the advances in radiocommunications technologies, and the lack of a highly developed public communications infrastructure, wireless communications is playing a very important part in this expansion of services.

The major effect of liberalization and privatization on the activities of the ITU is to increase the number of actors on the world stage and raise the level of private sector participation in international spectrum policy processes. Privatization of national industries may also have the effect of making those industries increasingly responsive to world trends, and more involved in international policymaking. Newly privatized companies have strong incentives to become actively involved in international policymaking to protect their interests and ensure that they can be competitive and efficient. This new activism may make them important players in international spectrum issues. The ITU and CITEL, for example, were once primarily intergovernment organizations. In recent years, however, with the rise of liberalized companies, the increasingly global scope of corporations and networks, and the plethora of new communications vendors, the private sector has been aggressively pursuing a more active role in the international policy process, including radiocommunications. Industry representatives want more of a say in international telecommunication policymaking and would like to see forums such as the ITU and CITEL serve as a common meeting ground for addressing government and nongovernment interests.

The ultimate extent and importance of these trends is uncertain, and the implications for U.S. policymaking are still unclear. Some believe that the effects of liberalization and privatization may be overstated. Even in countries that have been liberalized or had their industries privatized, governments often still retain strong control over the industry. These new companies and competitors do not have enough clout to significantly influence policy yet. In the future, however, as their power and prestige builds, they may become more influential both internally and internationally. They will add to the rapidly increasing and complex array of radiocommunications players discussed below.

Telecommunications and Economics

In international fora of all types, telecommunication issues are increasingly being linked to economic policy. Radiocommunications in particular is increasingly being recognized as an important force in its own right, as a major market and source of trade dollars. Sales of telecommunication products and services have increased dramatically over the last decade. Shipments of radio communications equipment are estimated at more than $55 billion annually and revenues from broadcasting and cellular services are estimated to exceed $30 billion annually.[45] As the globalization of society continues, the size and importance of these markets will increase dramatically. However, there are indications that the preeminent position of the United States may be slipping in a global environment marked by increasing competition in telecommunications markets. Between 1981 and 1987, the U.S. trade balance in telecommunications equipment went from a $817-million surplus to a $2.6-billion deficit.[46]

The trade implications of domestic and international telecommunications policy decisions, and the fact that telecommunications underlies a substantial portion of U.S. trade are becoming apparent. World markets for televisions, radios, and cellular phones are all large and all depend on spectrum. Spectrum decisions made internationally will critically affect how these markets develop and to what extent the U.S. can take advantage of them. Stakes are likely to be even higher in the future as the world moves toward an information economy, as radiocommunications systems become increasingly global, and as trade opportunities open abroad in response to liberalization and privatization.

44 "The Changing Telecommunication Environment," Op. cit., footnote 1, p. 50.

45 U.S. Department of Commerce, National Telecommunications and Information Administration, *U.S. Spectrum Management Policy: Agenda for the Future*, NTIA Special Publication 91-23 (Washington DC: U.S. Government Printing Office, February 1991), p. 13.

46 U.S. Department of Commerce, National Telecommunications and Information Administration, *NTIA Telecom 2000*, NTIA Special Publication 88-21 (Washington, DC: U.S. Government Printing Office, October 1988), p. 41.

Telecommunications products and services are also increasingly recognized as a crucial component in maintaining economic competitiveness. Telecommunication serves industry in most countries as a basis for improving efficiency in global markets, and as a tool to enhance competitiveness by allowing instant communication among the many different locations of worldwide corporations, and between major firms, their suppliers, and their customers.

The connection between radiocommuncations in particular and competition is evident in the push to establish high-definition television systems and standards in both the United States and Europe in an attempt to head off Japanese hegemony in this potentially huge market for products and services. Many countries have recognized the link between radiocommunications and development and have begun to establish priorities and formulated policies in order to rapidly develop new radiocommunication technologies. Great Britain, for example, has taken the lead in PCS, by clearing frequencies in its television spectrum. Japan has tried to clear room for digital cellular. There has been a strong push to establish Standards for many new types of services including PCS, digital cellular, and next-generation mobile systems. Centralized administrations and policymaking (and a less diverse telecommunications industry) allow such decisions to be made quickly, an important advantage in light of the rapid pace of technology development. In the United States there is no national vision or plan, and no consensus on priorities for communication technologies and services.

Historically, the United States has wielded considerable influence in the international radiocommunication policy arena because the United States has been the world's largest market for advanced telecommunications products and services. The United States was able to make technical and economic decisions and force others to follow its lead. Today, the situation is shifting. With the rise of a consolidated Europe and the increasing regionalism among other areas of the world, notably the Pacific Rim, the United States soon will no longer be the largest telecommunications equipment and service market. In addition, the United States is a rapidly maturing market-many companies see larger growth opportunities in the developing countries, which have not yet reached U.S. levels of technological sophistication and saturation.

The result is that the United States is in danger of losing its market-based power and with it, some of the enormous influence this country has enjoyed in international radiocommunication policymaking. The Europeans, for example, have shown an increasing unwillingness to follow the U.S. lead in international spectrum policy. This is yet another reason why WARC-92 is so important. The new technologies and services to be considered at the WARC offer the United States an important opportunity to solid@ or even expand its leadership in many radiocommunication areas. Without the new services made available by the new radio-based technologies, the U.S. position as market leader could slip further, siphoning off business and innovation to countries with more flexible radiocommunication environments.

New *Players and Alliances*

International geopolitics are substantially different today than only a few years ago. The international radiocommunication policy environment of 1992 is characterized by a much more diverse array of participants, and new sets of allies. The forces of globalism, regionalism, and the new players created by the forces of privatization have created a situation in which alliances have shifted and many new actors have come to the fore.

Part of the problem facing the United States as it tries to influence international spectrum policy is that different nations use telecommunications in different ways and have different communications needs. Most nations do not use radiocommunications as extensively as the United States, and are not as advanced in their use of radiocommunications. It is easier for them to find room for and develop new technologies. Also, many countries cannot afford the latest technologies. Even if they see the benefits, it may be many years before such new technologies are actually introduced. These are but some of the dynamics operating as the United States tries to negotiate internationally for spectrum so that it may improve domestic services.

The conflicting needs of many countries have important implications for how countries develop positions for the WARC. Developed countries are making greater use of the spectrum resource as new technologies are developed and old services expand. Developing countries increasingly see telecommunications in general, and radiocommunications in particular, as a vital component in their economic and social development. Individual domestic considerations are translated to the international level as spectrum managers and policymakers see spectrum allocation not only in the narrow technical terms of spectrum use, but also as part of the globalization of economics, trade, and international services.[47] W~C-92 is perceived as an important opportunity to open up new services not only domestically, but also internationally.

The wealth of new players and relationships represents both a major challenge and an important opportunity for the United States as it seeks to expand its telecommunications manufacturing and services industries and move into new markets. These pressures put increased impetus on the United States to be flexible and cooperative at WARC-92.

European Community and CEPT-As noted above, the European countries have formed strong regional telecommunication organizations, most notably CEPT. The 31 CEPT countries[48] have coordinated their WARC proposals, and are expected to have common positions that will be strictly adhered to by member countries at the conference. Such developments are likely to substantially strengthen the role of the European countries in WARC-92, and will make the process of preparing U.S. negotiating strategies more difficult.

The growing power of the European bloc will force a major reconsideration of who U.S. allies actually are for each issue. Many traditional European allies have banded together in a voting bloc that has grown increasingly stronger over time. Attendees at past conferences report that it is becoming increasingly difficult (and in many cases, impossible) to deal with individual countries in the "usual' manner. This loss of flexibility not only makes it harder for the United States to negotiate for support among individual countries, but also poses a serious threat in terms of the number of votes the EC and CEPT can now command. This is forcing the United States to look beyond its traditional allies and to forge new alliances with others. A strong, unified Europe has also led to strong interest in the United States to enhance the power and effectiveness of CITEL as a possible counter to expanding European power.

Developing Countries-The United States has already begun to reach out to the developing countries in the Western Hemisphere through the CITEL conferences, but government representatives also plan extensive trips to Africa and Asia to establish ties and build support in preparation for WARC-92. The United States may find that it has more in common with the developing countries than originally believed because of the nature of the technologies taking center stage at WARC-92. Many of the technologies to be discussed are new technologies that represent breakthroughs in ways to provide inexpensive and reliable data, voice, and in some cases, video, services. These types of wireless services, which do not depend on an extensive or developed infrastructure to work, may enable the developing countries to "leapfrog" generations of services, and obtain advanced services earlier than previously thought possible. It also provides an opportunity for the developing countries to improve their telecommunications infrastructure and services without building extensive (and expensive) terrestrial wireline systems.

The United States may have already found some new allies, especially among the countries of Africa. At the 1990 Administrative Council meeting, where the United States succeeded in adding many items it wanted to the WARC-92 agenda, the United States was largely supported by the Africans as well as many developing countries. The EC countries, on the other hand, may have lost some support, possibly due to the strength and inflexibility of their common positions. This state of affairs, however, may not carry over to the WARC itself, thus making it even more important for the United States to strengthen these ties in the months before the conference. Several trips are planned by U.S. government representatives to Africa and Asia to accomplish this goal.

The increased emphasis on courting (and counting) the developing countries, however, will not be easy and will come at increased cost. Specifically, more money will be needed for travel for U.S. representatives to make the contacts, establish the relationships, and do the initial negotiating that could help obtain positive outcomes at the 1992 conference. There are now more countries to talk to,

[47] The increasing importance of spectrum in economic considerations is also seen at the regional level in the increased emphasis put On the activities of regional bodies such as CITEL.

[48] With the expected addition of Albania later in 1991, there will be 32.

requiring travel farther a field than previously. Trips are being consolidated, but only so much can be accomplished on one trip. A lack of funds may mean that some important countries or issues do not get addressed.

Decline of the U.S.S.R. and the Realignment of Eastern Europe—Another substantial change from past WARCs is the much reduced influence and significance of the Soviet Union. The Soviets, long a major player in international radiocommunication circles, have lost much of their power and prestige. This will be the first WARC without them as a major force. Two primary trends have contributed to this loss of influence. First, the internal turmoil in the U.S.S.R. itself has made it difficult for the Soviets to prepare for WARC-92. They are expected to offer few changes in the allocations. Second, the disintegration of the Eastern bloc and the loss of Soviet control over its votes could radically change voting patterns, and will likely lead to a substantial loss of political (voting) power for the Soviet Union in the one-nation, one-vote forum of the ITU. The disintegration of the Eastern bloc has also added uncertainty in world telecommunications bodies regarding what role the newly freed Eastern European nations will play in international radiocommunications policymaking. These nations are shifting their alliances, particularly toward Western Europe, and many of them may join CEPT, adding to its voting power. However, the effects of their participation in WARC-92 are still uncertain.

Summary and Implications

Changes in the world telecommunication environment pose significant challenges for U.S. domestic and international spectrum policymaking and to the process of preparing for world radio conferences. Changing alliances, new geopolitical and economic realities, and the proposed changes in the structure and functions of the International Telecommunication Union will require the United States to reevaluate the preparation process for international conferences, and consider domestic spectrum policy in the larger context of international radiocommunication issues. Domestic spectrum policy will have to strategically link U.S. and international spectrum concerns.

Unless the United States responds quickly and effectively to these forces, it may find itself unable to successfully negotiate the challenges these changes present. U.S. approaches to international spectrum policymaking will have to flexibly adaptor domestic structures and processes for addressing international spectrum concerns may become outdated and less effective. The Federal Government, collaborating with the private sector, must develop new strategies for policymaking and negotiation to meet the demands of this new climate of change. Government spectrum policymakers recognize these challenges, but there is little consensus on what long-term strategies and goals the United States should pursue. The fragmented nature of the U.S. policy process hinders the development of unified policy and makes timely reaction to change difficult.

It remains to be seen how effective and successful the United States will be at WARC-92, but the current state of flux in world affairs presents the United States with a unique opportunity to influence the structures and procedures the world uses to set spectrum policy. In the longer term, for the United States to be most effective, the country must continue to take an active role in ITU activities and in future WARCs. Responding to the many changes taking place in the world will require flexibility and a commitment to well thought-out and carefully defined goals. Without such goals and a common vision on how the United States would like to see the ITU evolve, U.S. policy will continue to react to change rather than aggressively shaping it. Given rapid shifts in both technology and the international environment, without clear agreed-upon goals there is no way to ensure that the best interests of the United States will be met.

Chapter 4

Domestic Preparations Process for WARC-92

Introduction

The United States is influential in international spectrum circles through its leadership in radio technologies and services and its status as one of the largest telecommunications markets in the world. Decisions made regarding spectrum allocations and radio-based services in the United States have substantial impact on world radiocommunication policies and an important influence on spectrum management in other countries. The process by which domestic spectrum policies are set, and the way the United States prepares for international conferences, directly impacts international policymaking.

Unlike most countries, the United States has no central authority that is responsible for domestic or international spectrum policymaking and management. The Communications Act of 1934 divided spectrum management responsibility between the Federal Communications Commission (FCC), an independent agency, and the President.[1] In 1978, Executive Order 12,046 transferred the President's authority to the Secretary of Commerce and created an Assistant Secretary for Communications and Information, who is also the Administrator of the National Telecommunications and Information Administration (NTIA).[2] Today, domestic spectrum management and policymaking responsibility is shared by the FCC and NTIA. NTIA manages all Federal Government use of the spectrum and also serves as the President's adviser on telecommunications matters. The FCC regulates and manages all commercial and private sector use of the spectrum as well as State and local government use. In international spectrum negotiations and conferences, the State Department exercises primary authority as the President's representative in foreign policy matters.

WARC Preparation Activities

The process of preparing for WARCs involves four separate, but interdependent, subprocesses. The frost, and most open to the public, is the development of proposals by the FCC that reflect the interests and needs of the private sector. Second, NTIA simultaneously coordinates and develops executive branch proposals. This subprocess has been largely closed to the public in the past since the work of the agencies is generally not open to direct public access or input.[3] The third subprocess involves the more informal coordination between the NTIA, FCC, and State Department in the development of final U.S. proposals. Staff at the FCC and NTIA work closely and in parallel to ensure that their final recommendations to the State Department are as similar as possible in order to speed the determination of final proposals. The State Department, while not as actively involved in the development of specific WARC positions as the FCC and NTIA, nevertheless plays an important role in ensuring that international political considerations are adequately considered in the final proposals.[4] Fourth, after proposals have been set, the official U.S. delegation, which is composed of both government and private sector representatives, develops negotiating strategies and backup positions—positions that support the final proposals. The State Department, along with the FCC and NTIA, manages and coordinates the activities of the delegation.

Tension in the preparations process, among government interests, private sector and industry interests, and between the government and the private

[1] 47 U.S.C., sections 151, 152, 305 (1989).

[2] Executive Order No. 12,046, reprinted in 1978 U.S. Code Congressional& Administrative News, 9685-9692.

[3] Following recommendations outlined in its recent report on spectrum management, NTIA has begun opening some of its activities to mOre public participation. While too late to affect the preparations process for WARC-92, these changes could substantially improve private sector input into future NTIA spectrum management activities, including preparations for future WARCs (see sections on NTIA below). U.S. Department of Commerce, National Telecommunications and Information Administration, *U.S. Spectrum Management Policy: Agenda for the Future,* NTIA Special Publication 91-23 (Washington DC: U.S. Government Printing Office, February 1991), p. 13.

[4] Because the State Departments most concerned with the representation of U.S. policy abroad, it is generally more active in the proposal development process when an issue (or even a whole conference) has specific political overtones or when an issue appears particularly contentious internationally. This varies by issue: the more politically sensitive an issue is, the more the State Department is usually involved. The Department, for example, is usually very involved in preparations for Plenipotentiary Conferences, since they deal more with matters of governance and administration than with the more technical issues that characterize the work of the WARCs.

sector, is an inherent part of the system. Because of this tension, some of the most contentious issues may not be resolved before final proposals are set. In these rare cases, the parties involved continue negotiating, but if agreement cannot be reached, other alternatives are available. The State Department (or one of the affected parties) can, as a last resort, submit the matter to the National Security Council for resolution.[5] Other alternatives may be available, but are not well-defined. There is no formal mechanism at a level high enough (in the FCC, NTIA and State Department) to resolve such disputes. New procedures may have to be devised to expedite the decision process. However, at these higher policy levels, political compromises often play a more important role in resolving disputes than technical merit or the greater national interest.

In the WARC-92 preparation process there were many areas of intense debate, especially between industry (and the FCC representing those interests) and the Federal agencies, but only one issue remains unresolved. Throughout WARC-92 preparations, government and industry interests clashed over the use of the 1435-1525-MHz band. At the beginning of the preparations process, both Mobile Satellite Service (MSS) providers and the proponents of Broadcasting Satellite Service-Sound (BSS-Sound) sought to use this band, but the Department of Defense (DOD), its aerospace contractors, and some commercial aircraft manufacturers opposed reallocation of the band to protect their use of these frequencies for aircraft testing and other uses (see ch. 1). MSS interests dropped their proposals early in the process, but BSS-Sound advocates have maintained their need for the band.[6] If not modified, DOD's position on this issue will preclude the United States from using the band for new BSS-Sound applications, even if these frequencies are approved at WARC-92. In that case, BSS-Sound applications in the United States would have to use frequencies different from the rest of the world, and equipment and systems would be incompatible internationally.

Negotiations have been difficult, private sector representatives, complain, because DOD and its contractors have not released enough data on the use of these frequencies to make a fully informed decision. Executive branch representatives contend that all necessary information has been made available. National security concerns and lack of data have played a role in this dispute. Negotiations between the interested parties continue, and a fina1 proposal on the matter will be submitted in a supplemental proposal to the International Telecommunication Union (ITU) before WARC-92. This case highlights the interaction of domestic and international spectrum policy and demonstrates the need for well-defined procedures for resolving such disputes. The process must balance the national security concerns of the government with the private sector's need for more open access to information about radio frequency use and efficiency.

Institutional Roles

Federal Communications Commission

Structure

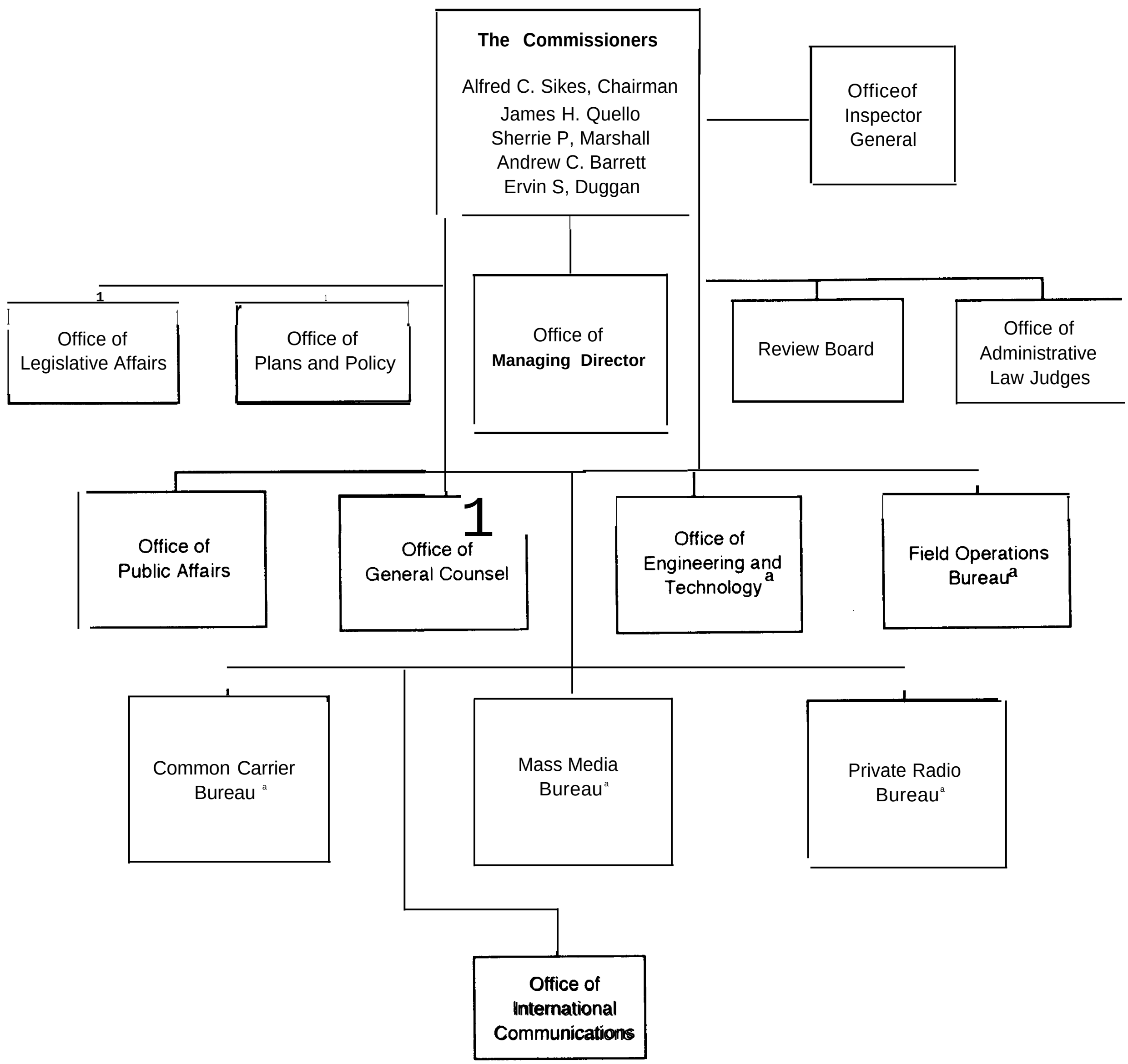
The FCC is functionally divided into bureaus and offices that manage the day-to-day activities of the Commission in radio and wireline communications and develop more long-term plans and policies (see figure 4-l). The majority of the FCC's work involves regulation of the domestic telecommunication industry, but the regulatory bureaus also have staff that deal with international matters as well. The activities of the FCC are directed by five commissioners, who are appointed by the President, confined by the Senate, and serve 5-year terms. The President also appoints the Chairman of the FCC, who usually takes the lead in establishing overall policies and direction for the Commission. The current Chairman of the FCC is Alfred C. Sikes.

Although the FCC has long maintained a commitment to international activities, there has been no ongoing, formally recognized structure within the Commission for coordinating WARC preparations. Rather, conference preparation activities have been carried out in a variety of ways. For many past conferences, the Chief of the FCC's Office of Engineering and Technology (OET) directed Com-

[5] In preparation for the 1979 WARC, for example, Voice of America (VOA) wanted additional spectrum for high frequency broadcasting, a proposal which the Department of Defense opposed. VOA took its case to the National Security Council, where its proposal was eventually accepted.

[6] The FCC included such a need in its final recommendations to the Department of State, but did not identify the specific size or location of the band. See Federal Communications Commission, "An Inquiry Relating to Preparation for the International Telecommunication Union World Administrative Radio Conference for Dealing With Frequency Allocations in Certain Parts of the Spectrum,' Gen Docket No. 89-554, *Report*, 6 FCC Rcd 3900 (1991).

Figure 4-l-Organization of the U.S. Federal Communications Commission



[a] In addition t. the Office of International Communications, these bureaus and offices also have staff working on WARC issues.

NOTE: This chart represents lines of policy and judicial authority. It should be noted that the Office of Managing Director has management and administrative authority over all other offices and bureaus with the exception of the Office of Inspector General.

SOURCE: Office of Technology Assessment and Federal Communications Commission, 1991.

mission efforts, drawing together the needed staff and coordinating the Notice of Inquiry (NOI) process. Prior to the 1979 WARC, for example, the Commission established a Conference Preparatory Group within the Office of the Chief Engineer (now OET) specifically to address WARC preparations. However, because of the specialized nature of the conferences that were scheduled for the future, the office was disbanded several years after the 1979 conference. There appeared to be a less obvious need for a central focus for international activities, and staff and responsibilities for international matters were dispersed to various operating bureaus and offices where they remain. This division has worked because many issues on the WARC agendas overlap with domestic concerns. Thus, staff are familiar with the basic technological and spectrum issues that WARCs address, and individual staff members have built up a wealth of experience in international conference preparation work.

After the 1979 WARC, international telecommunications advisors, appointed by the Chairman, oversaw FCC conference preparations. Individual bureaus also assumed responsibility for preparing for some of the conferences that dealt specifically with their areas of expertise, often coordinating with OET. Preparations for the Mobile Services WARC in 1987, for example, were concentrated in the Private Radio Bureau.

The FCC's initial preparation for WARC-92 was coordinated by OET, primarily through its Spectrum Engineering Division, and involved staff from many offices. Staff in the Private Radio Bureau worked on WARC issues in 3-30-GHz range, although they are not identified as "international' staff. The Mass Media Bureau has international staff that coordinate broadcast plans with Mexico and Canada as well as specialists in WARC broadcasting issues such as BSS-Sound and high-definition television (HDTV). Staff in the Common Carrier Bureau are responsible for several of the issues in the 1-3-GHz band. The Field Office Bureau has also been involved in WARC preparations. The Office of International Communications (OIC) was established after preparations had already begun, but was actively involved in the latter stages of the process.

Office of International Communications-h January 1990 the Commission created OIC to coordinate the FCC's international activities and policy development, not only for spectrum matters, but for all areas of international telecommunication policy. The decision appears to have been, in part, a response to the upcoming WARC, but more generally reflects the Chairman's desire to establish a focal point in the Commission for international matters. It also signals recognition of the larger importance of international telecommunication issues for the domestic policy process—the consequences of liberalization, regionalism, and global networks on U.S. companies and domestic regulation.

According to the FCC Order that established OIC, the functions of the Office are to:

> (1) Ensure the integration of Commission international policy activities; (2) ensure that the Commission's international policies are uniform and consistent; (3) assume the principal representational role for Commission activities in international fora; and (4) serve as the focal point for international activities. The Director of International Communications will provide coordination among Bureaus with regard to development of international policy, representation of this policy and participation in international conferences. Additionally, the Director will facilitate Commission guidance of Bureaus's international activities.[7]

It is important to note, however, that the new OIC: "will not replace the existing bureaus in the execution of the various international responsibilities. '

The Order gives OIC a broad mandate for coordinating the FCC's international telecommunication policy development, and OIC's activities are not confined to spectrum-related or WARC preparation issues. However, the ironically constrained nature of this mandate has caused several problems in the early life of the Office relating to its international spectrum activities. First, although the FCC received more than 300 resumes for seven professional positions, it was apparently difficult to attract staff who were experienced in international spectrum matters. While the FCC has a wealth of highly skilled personnel with extensive expertise in international radiocommunications, many observers believe that senior FCC staffers with such background were wary of moving to the new Office either because of the short life of the conference preparation group in the early 1980s or because they prefered to remain in active policymaking roles rather than merely coordinating policy development. Also, concern that the bureaus would not be able to replace the experienced staff who moved to OIC may have slowed the staffing of the Office. For whatever reason, a senior international engineer was not hired (from outside the FCC) until almost a year after OIC was created.

Second, OIC has had difficulty establishing its role and functions in regard to international spectrum matters, especially in its early months. On one hand, the emphasis in the Order establishing OIC on "coordination' may unduly narrow the scope of

[7]47 CFR 0.5 (1990).
[8]Ibid.

OIC's activities in policy development, and hamper its efforts to effectively address the problems identified in the Order. Many radiocommunication policy observers feel the office does not have enough power to set policy and lacks strong institutional authority. It is important to reiterate, however, that the stated function of OIC is not to decide policy, but only to:

> provide coordination among Bureaus and Offices with regard to development and representation of international policy and participation in international conferences.[9]

This function leaves unclear exactly what kind of input OIC can have in the policy development process, and what role the Office can or will play in *setting* international radiocommunication policy. A more aggressive mandate may be needed to ensure the long-term effectiveness of the Office. Other observers, however, complain that OIC has sometimes gone beyond its mandate in presenting FCC positions abroad and has claimed too much power for itself in international negotiations.

In the long run, it is unclear how strong a role OIC will be able to play within the FCC in establishing priorities for bureau activities in support of international conferences. The FCC maintains that OIC has sufficient authority to carry out its mandates, and that the Office's ability to fulfill its functions is no longer in question. The Commission, for example, points to OIC's success in integrating the views of the FCC on a number of matters, including specific WARC-92 issues and the planning of bilateral meetings with other countries on telecommunication matters. Without direct lines of authority, however, the ability of OIC to direct the bureaus' work in preparation for international conferences and effectively coordinate preparation activities is still uncertain. The required level of cooperation and coordination will depend on the interpersonal relationships between the Director of OIC and the bureau chiefs. Some analysts believe that OIC will not be able to to pull together the various constituencies that characterize the bureaus. These constituencies can cause conflict between bureaus on specific courses of action, and it is not clear that OIC yet has the power or ability to meld these opinions into coherent, unfiled FCC positions.

Finally, because OIC's mandate encompasses all international communication issues, of which WARC preparation is only one part, some analysts are concerned that WARC-related activities may suffer if adequate staff or funds are not assigned to them. The interests of the Director will determine how effective and aggressive OIC is in developing and coordinating spectrum policy. On the other hand, the increasing recognition of the importance of international spectrum decisions for domestic telecommunications policy and the potential regularization of the radiocommunication conference structure of the ITU may give added impetus to OIC's spectrum activities.

Although the role of OIC in international spectrum activities is still evolving, some of its specific functions are beginning to jell. OIC's main role in international spectrum activities will be to represent the FCC in bilateral negotiations and at conferences. It will also act as a "traffic cop," for the bureaus involved in international activities, coordinating their activities, and sifting through the positions of various constituencies. It will have to continue to work closely with OET to develop international spectrum policy, a functional arrangement that mirrors the division of responsibility between NTIA's Offices of International Affairs and Spectrum Management (see below). Finally, OIC will serve as the principal liaison between the FCC, NTIA and State Department on international spectrum matters. Currently, the director of OIC and the chief engineer are meeting with their counterparts in NTIA and the State Department to coordinate the upcoming bilateral negotiations the United States will conduct in preparation for WARC-92.

Because OIC is relatively new, and because the Office and its staff are still settling in and staking out their own role in the U.S. international radiocommunication policy process, the long-term future of OIC is far from clear. As a creation of Chairman Sikes, and with little institutional memory or historical power, the Office could conceivably be disbanded when he leaves the Commission. At this relatively early stage in its life, OIC is very dependent on high-level support for effectiveness. An important determining factor in the long-term success of the Office will be how effective the Director is in carving out a specific role and responsibilities, both within the FCC and in relation to NTIA and the State

947 CFR 0.51 (1990).

Department, and how effectively these responsibilities are carried out. Winning over skeptics outside the FCC will take time and effort as the Office continues to mature. Ensuring continuity in both OIC's staff and policies, and maintaining cooperative working relationships with NTIA, the State Department, and the private sector will be critical in determining the long-term success of OIC.

WARC Preparation Activities

The FCC's role in the WARC preparation process is to represent the interests of the public and gather private sector views on the specific WARC items. The Commission uses a number of mechanisms to collect this information.

Inquiry Process—The primary method the FCC uses to gather information is its public inquiry process. Before making a decision, the FCC publishes a Notice of Inquiry (NOI) in the *Federal Register* that discusses the background of the issue(s) addressed in the notice and poses questions about possible courses of action the Commission might take. The public is invited to file comments with the Commission that will be considered in reaching a final decision, which takes the form of a final Report.

For WARC-92, the Commission issued a series of three NOIs.[10] The first, released in December 1989, sought comments on the proposed agenda for the upcoming WARC (the final WARC-92 agenda was not adopted by the ITU A dministrative Council until June 1990) and proposals regarding frequency needs for several services including high frequency broadcasting, mobile services, BSS-Sound, HDTV, and new space services. In September 1990, the Commission adopted a Second NOI in response to the specific agenda released by the ITU. The Second NOI sought comments on the expanded agenda items and reaction to specific proposals for U.S. positions that had been developed up to that point. A Supplemental NOI was released in March 1991 further refining questions in the Second NOI, but primarily concentrating on digital audio broadcasting (BSS-Sound), Mobile Satellite Services (MSS), low-Earth orbiting satellites (LEOS), and future public land mobile telecommunication systems (FPLMTS). In June 1991, the Commission released a Report that outlines final FCC recommendations to the State Department on the positions the United States should take on each WARC agenda item.[11] Combined with input from NTIA, these recommendations were used to establish the official U.S. proposals for WARC-92.

In addition to the WARC inquiry, the Commission has several other proceedings or formal inquiries underway that overlap with the issues addressed in the WARC inquiry.[12] How the various proceedings affect each other, and the degree that domestic decisions will conform to the international allocations made at WARC-92 is uncertain. Submitting proposals to the WARC does not commit the United States to using a service authorized at the conference, nor does it commit the United States to use the same frequencies domestically. It will be possible after the WARC is completed for the FCC to conduct any proceedings necessary to implement disputed services. For example, it seems unlikely that the Commission will propose rules allocating and governing personal communication services before international agreements are reached at the WARC. In the case of BSS-Sound and LEOS, several applications have been filed at the FCC to provide such services (see app. C), and the FCC has received comments regarding those applications. This should give the Commission some (limited) sense about the public interest implications for this service. However, because of the short time involved, WARC positions had to be established before a full Commission proceeding could be concluded.

The result is that the FCC's WARC inquiry process has superseded Commission action on other matters. For example, the NOIs contained proposals for LEOS systems. However, the FCC has conducted no formal proceedings to determine the public interest requirements, parameters, and standards for these services.[13] Critics charge that the

[10] Federal Communications Commission, "An Inquiry Relating to preparation for the International Telecommunication Union World Administrative Radio Conference for Dealing With Frequency Allocations in Certain Parts of the Spectrum," Gen Docket No. 89-554, *Notice of Inquiry*, 4 FCC Rcd 8546 (1989); *Second Notice of Inquiry*, 5 FCC Rcd 6046 (1990); *Supplemental Notice of Inquiry*, 6 FCC Rcd 1914 (1991).

[11] *Report*, op. cit., footnote 6.

[12] Among others, these include Notices of Inquiry for personal communication services and digital audio broadcasting and application proceedings for LEOS (above and below 1 GHz), HF broadcasting, MSS, HDTV, and PCS for data applications.

[13] The FCC has, however, placed on public notice and received comments on applications for such services and Petitions for Rulemaking that have been filed seeking Commission action on allocations and service rules for LEOS systems (below 1 GHz).

Commission skipped a step by bypassing the vital public interest part of the process. Instead of deciding these issues in the proper domestic context (a separate NOI), the FCC has forced interested parties to fight a battle of filings in the WARC proceeding, unnecessarily cluttering the preparation process. Critics believe that the Commission has assumed for the purposes of the WARC that these services are in the best interests of the country and has gone about formulating positions to support them. They also contend that this amounts to the FCC prejudging the issue—granting unfair advantage to some service providers over others.

The FCC was caught in a problem of timing. There may not have been enough time for the Commission to complete a full inquiry into LEOS systems and services. This concern is complicated by the fact that LEOS systems operating at frequencies above 1 GHz were not even proposed until well after the WARC inquiry had begun. There is also concern in the FCC that completing a domestic proceeding would reduce the flexibility of U.S. proposals at the WARC. FCC actions on personal communications services (PCS) and digital audio broadcasting (DAB) may provide a model for how such issues could be worked out in the future. In these cases, domestic proceedings were begun, but are not expected to be completed before the WARC concludes. The results of WARC-92 will be used as input to the domestic process before a final decision on these services is reached.

The FCC Commissioners vote on the final Report that outlines the Commission's recommendations to the State Department on WARC-92 issues. While the Commissioners' staffs track the issues involved and the development of the proposals, it is not clear, given the wide range of important topics the Commissioners must address, how closely individual Commissioners have been able to follow WARC preparations or how knowledgeable they are about the technologies, services, and issues involved. Some participants in the WARC preparations have expressed disappointment that the Commissioners were not more actively involved in the preparations process, given the broad scope and long-term importance of WARC-92 issues.

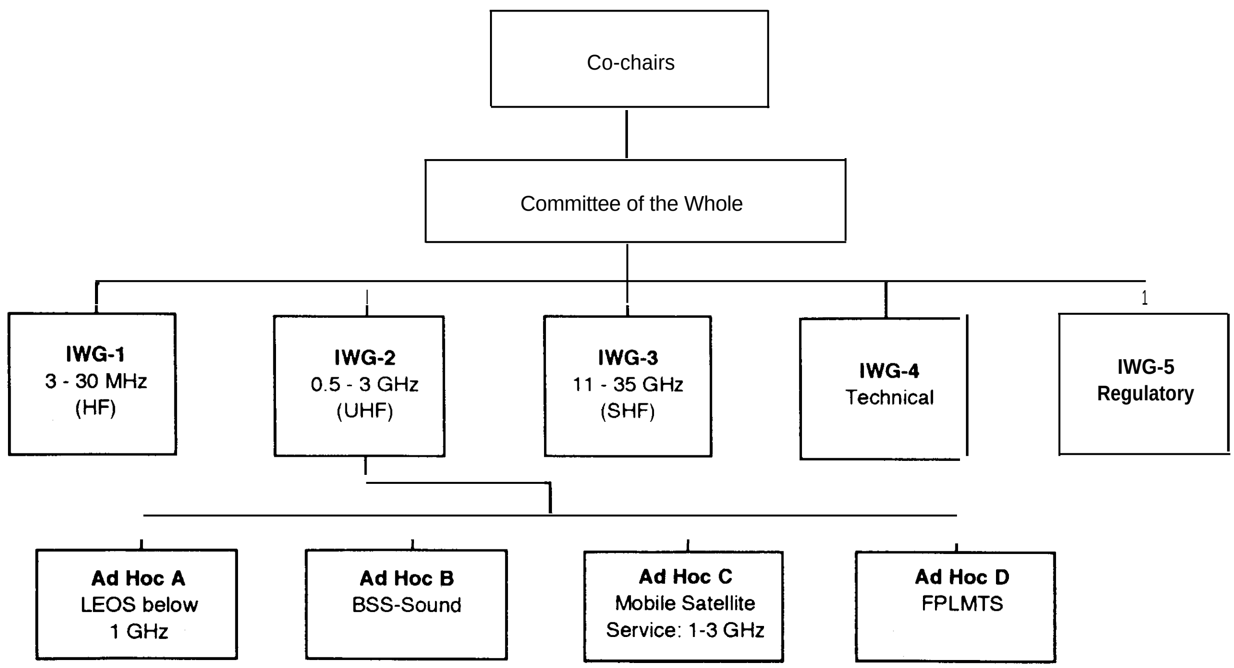
Industry Advisory Committee—In addition to the formal inquiry process, the FCC created an Industry Advisory Committee (IAC) in January 1990 to provide direct private sector input to the Commission on WARC matters. The IAC actually played a dual role in the FCC's WARC preparation process. It was a commenter on the NOIs and it developed some of the proposals later included in the FCC's final Report. Thirty-five representatives were named to the IAC, representing all areas of the private sector, including manufacturers, service providers, and user groups.[14] The Committee was cochaired by FCC Commissioner Sherrie Marshall and Frank Urbany of BellSouth. The IAC's task was to consider the needs of the U.S. private sector for the WARC, discuss the recommendations proposed by the FCC in its NOI proceeding, and propose possible WARC positions. The IAC submitted its final report to the FCC in April 1991; its charter expires in November 1991.

The IAC split its substantive work into three Informal Working Groups (IWGs), a technical committee and a regulatory committee (see figure 4-2). IWG-1 dealt with WARC issues in the 3-30-MHz band, primarily the HF broadcasting issues. IWG-2 dealt with some of the most controversial issues on the agenda, those in the 500-3000-MHz band (0.5-3 GHz), including LEOS, BSS-Sound, Mobile Satellite Service, and FPLMTS. IWG-2 created four Ad Hoc groups (A to D), to consider each of these issues separately. IWG-3 considered items on the agenda in the frequency bands above 10 GHz, including HDTV. The technical and regulatory committees played little role in the IAC process since most of their responsibilities were accomplished in the three IWGs. Participation in the substantive work of the IWGs was open to the public-not just members of the IAC-and was very broad.

The IAC played a crucial role in the development of the FCC's proposals for final WARC positions. Its work, however, is difficult to characterize. At first glance, it appears that the IAC was supposed to develop unified industry positions and present them to the FCC. In this regard, the IAC was successful in some areas (HF broadcasting), but not in others (MSS allocations). Because the IAC failed to reach

[14] Some observers have noted that the IAC is composed primarily of traditional telecommunications companies, who are heavy users of existing services. Proponents of innovative services, they claim, were fewer in number. Given the number of new proposals advanced and defended in the IAC process, this claim is doubtful.

Figure 4-2—Organizational Structure of the Industry Advisory Committee



KEY: IWG=Interim Working Group; HF=high frequency; UHF=ultrahigh frequency; SHF=superhigh frequency; LEOS=low-earth orbiting satellites; FPLMTS-future public land mobile telecommunication systems; BSS-Sound-broadcast satellite service-sound.

SOURCES: Office of Technology Assessment and Federal Communications Commission, 1991.

consensus on many issues, some observers have expressed disappointment with final IAC outcomes. The contentious nature of many of the issues made consensus a nearly impossible goal.

Some, however, argue that the IAC was never conceived to be a decisionmaking body and that expecting common industry positions to be developed for all issues is unrealistic-too many competing, parochial interests were involved. Some observers have even characterized the IAC process as little more than "make believe,"an exercise with little hope of success. The reality of the situation lies somewhere in between. The IAC was successful in negotiating some unified positions, but the conflicting demands of different industries, the participation of a large number of representatives, and the more complex nature of domestic radiocommunications made consensus impossible to achieve in other areas.

The most important factor limiting the IAC's ability to determine common industry positions was its operation as a consensus body with members who were proponents and opponents of certain services and technologies. Further, participation in the substantive work of the IWGs was a self-selecting process. These factors led to a belief among many observers that some of the participants involved were more interested in advancing their own parochial interests than in developing consensus or working for the overall benefit of the United States. These problems were complicated because there was no formal mechanism to finally resolve disputes. On some issues, closure was not possible. Some have suggested that issues should be decided by voting. Once a vote is polled, all parties would have to abide by the decision of the group. A number of problems complicate such an approach. Votes might be traded on various issues, thereby further politicizing the process. In addition, practical questions remain, such as what should constitute agreement, a majority, two-thirds, unanimous?

The real value of the IAC is not gauged by the number of issues it settled or formal industry positions it developed, rather it is the process and work of the IAC itself. The IAC contributed substantially to FCC deliberations on a number of levels. First, the IAC provided the private sector a public forum to discuss and debate their ideas and proposals face-to-face. The IAC process stimulated discussion, prompted technical studies, narrowed issues, and refined industry requirements, giving industry representatives a chance to resolve disagreements and present a united front to the FCC. This open public interaction and negotiation speeded the process, and raised the status of the IAC proposals and recommendations. The IAC's collective positions were more persuasive than individual proposals would have been. The IAC process reduced the chaos of dealing with individual proposals by weeding out the least desirable-presenting the FCC with a more cogent, limited selection of options than it would have gotten in the NOI process.

Another important benefit of the IAC deliberations was the wealth of technical material it produced. Early in the WARC preparations process, much of the regulatory and technical analysis came from industry in the form of technical requirements for services and technical studies. These studies relieved the Commission of the pressure of responding to every proposal and petition with its own technical and regulatory analysis. In relation to LEOS, for example, geostationary satellite service providers and the FCC were initially concerned that the new LEOS services operating in frequencies below 1 GHz would interfere with existing services. The Commission indicated that without a study showing the feasibility of sharing, new systems might not be approved. Industry did the study and negotiations progressed. This background was extremely valuable to the FCC in reaching final decisions.[15] In relation to LEOS systems above 1 GHz, concerns about the ability of the proposed systems to share the spectrum with other (geostationary satellite) MSS providers have not been resolved.

Finally, the meetings of the IAC and the IWGs provided an invaluable opportunity for informal contacts between IAC/IWG participants and FCC staff. FCC representatives were usually present at the meetings of the IAC and its working groups—allowing for an important informal exchange of views and discussions between industry and FCC representatives. Representatives from NTIA also attended many of the meetings, providing indirect input to NTIA from the private sector.

The members of the IAC and the IWGs were generally happy with the FCC participation in their activities and felt that the process was effective within limits. Their opinions on the outcome of the IAC process, however, reflected the ambiguous nature of the IAC noted above. Different observers had different expectations. These differing opinions, in turn, reflect a lack of clarity as to what the IAC could realistically accomplish. In retrospect, it is unclear what the IAC's function was really supposed to be. If the IAC is to develop or represent consolidated industry positions, it may have to be constituted differently, or require a change in working and decisionmaking styles. In the future, the FCC must clearly establish its expectations for such private sector groups.

Implications

The WMC preparation process has become more difficult over the last decade. Several factors are affecting the FCC's ability to execute its WARC role effectively. First, the FCC and the WARC preparation process have been significantly affected by the rapid pace of technology development. In the past, there were fewer technologies and services, private sector interests were less divisive, and fewer government staffers were involved. Today, the FCC must consider the views of a larger number of private sector participants and reconcile increasingly diverse views with those of the Federal Government.

Second, FCC officials have little more access to government spectrum use data than the private sector. It is extremely difficult for both the Commission and the private sector to develop proposals for the WARC without adequate information. In the case of L-band proposals (see ch. 1), for example, the Federal Government, through NTIA, has made the use of these bands almost non-negotiable. There is no way for the FCC to independently determine exactly which frequencies are being used, how much, or if they are being used efficiently.[16] There is concern in the Commission and the private sector that the FCC does not have adequate information to make informed decisions in such cases.

15Some advocate making such studies a more integral part of the IAC process from the very beg inning. This could improve the efficiency of the process and allow more timely discussion and decisions.

16Negotiators in the executive branch claim that similar problems of access exist for data on commercial spectrum use.

Third, the FCC lacks the personnel and financial resources to effectively and efficiently prepare for the 1992 (or a future) WARC. There are few staff members assigned exclusively to WARC preparations. The technical staff working on WARC issues are spread throughout the agency, according to their individual specialties. This has two effects. First, staff have regular duties in addition to WARC preparations; they cannot devote their full time and attention to WARC preparations. Second, staff have several constituencies to represent, including the industry they regulate as well as the bureau they work for. Internal dissension among staff over domestic policy and resources may preclude timely and effective policymaking in regard to the WARC.

Finally, the FCC serves political constituencies and interests as do other government agencies, and political factors can play a major role in deciding which proposals go forward and which do not. Decisions are not always based on solely technical merit or the public interest. The case of LEOS is an example. There has been no domestic public interest assessment of LEOS, nor is there evidence of broad global support for such a system. LEOS systems (operating in the frequencies above 1 GHz) are not even explicitly included in the WARC-92 agenda. Nevertheless, the United States will support LEOS above 1 GHz through its proposal to allocate spectrum to MSS applications, where there appears to be greater need and more widespread support for additional spectrum.[17]

National Telecommunications and Information Administration

Description

The NTIA is responsible for developing and promoting executive branch telecommunications policy. It is to:

> serve as the President's principal adviser on telecommunications policies, [and] provide for the coordination of the telecommunications activities of the Executive Branch.[18]

It is also the agency responsible for administering the Federal Government's use of the radio frequency spectrum. In this role it works closely with the FCC to coordinate the National Table of Frequency Allocations.[19]

In the international arena, Executive Order 12,046 defines the responsibilities of NTIA:

> The Secretary of Commerce shall develop and set forth, in coordination with the Secretary of State and other interested agencies, plans, policies and programs which relate to international telecommunications issues, conferences, and negotiations. The Secretary of Commerce shall coordinate economic, technical, operational and related preparations for United States participation in international telecommunications conference and negotiations. The Secretary shall provide advice and assistance to the Secretary of State on international telecommunications policies to strengthen the position and serve the best interests of the United States, in support of the Secretary of State's responsibility for the conduct of foreign affairs.[20]

NTIA plays a substantial role in the WARC preparation process. As the agency responsible for managing the Federal Government's use of the radio frequency spectrum, NTIA oversees the preparation of Federal Government WARC proposals and coordinates executive branch policies with the FCC. NTIA's work in the preparation process culminates with a final report similar to the FCC's (in form and content) that is submitted to the State Department for integration into the final U.S. WARC proposals.

Structure

Prior to 1983, all international spectrum activities were handled by NTIA's Office of Spectrum Management (OSM). In 1983 NTIA created the Office of International Affairs (OIA), which now has primary responsibility for international telecommunication policy (see figure 4-3). At the same time, a Conference Preparatory Program (similar to the group established in the FCC) was established within OIA specifically to coordinate international conference preparations and WARC-related activities. The program was abolished several years later as part of a general reorganization of NTIA. NTIA believed, as did the FCC with its group (see above), that such activities could be convened as needed. Today, one person in OIA coordinates most of NTIA's prepara-

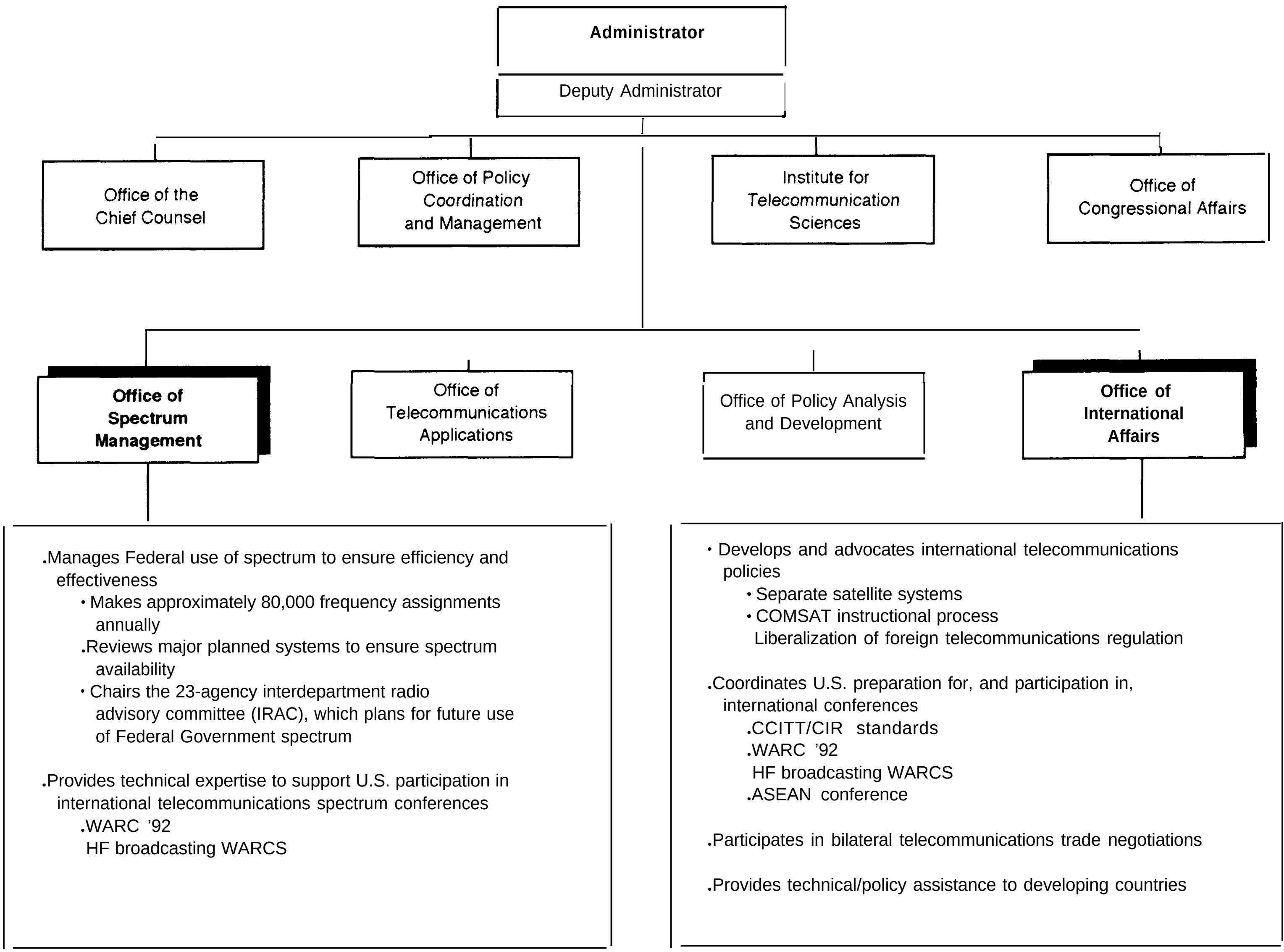
[17] See ch. 1 for a more complete discussion of the controversy surrounding LEOS (above 1 GHz) at WARC-92.

[18] Executive Order NO. 12,04.6, op. cit., footnote 2, sections 2-401 and 2-405, P. %87.

[19] The National Table of Frequency Allocations combines the U.S. Government Table of Allocations and the FCC Table of Allocations.

[20] Executive Order No. 12,046, op. cit., footnote 2, section 2404, p. 9687.

Figure 4-3-Organization of the U.S. National Telecommunications and Information Administration



KEY: CCITT=International Telegraph and Telephone Consultative Committee; CCIR=International Radio Consultative Committee; HF=high frequency; ASEAN=Association of Southeast Asian Nations.

SOURCES: Office of Technology Assessment and National Telecommunications and Information Administration, 1991.

tions for WARC-92, with help from individuals in both OIA and OSM. OSM continues to supply extensive policy advice and technical assistance to OLA in WARC matters, and is responsible for the day-to-day spectrum management activities of the Federal Government (see figure 4-3). OSM also leads NTIA's participation in the activities of the International Radio Consultative Coremittee (CCIR) (see ch. 3). Other government agencies, including Voice of America, National Aeronautics and Space Administration, the Federal Aviation Administration, and the FCC, provide technical WARC support through papers and technical studies.

In addition to the coordination and technical work done by OIA and OSM, several other entities within the Department of Commerce and NTIA have roles in the WARC-92 preparations process.

Interdepartment Radio Advisory Committee—The Interdepartment Radio Advisory Committee (IRAC) predates NTIA, having been established in June 1922.[21] The IRAC advises the Secretary of Commerce on spectrum matters and is the principal forum through which Federal Government spectrum activities are coordinated and managed.[22] Currently, the IRAC has approximately 20 members from Federal Government agencies and a liaison from the FCC. The organization of the IRAC includes three permanent subcommittees (Frequency Assignment, Spectrum Planning, and Technical) and a number of ad hoc committees that study specific spectrum issues. IRAC meetings are not open to the public for security reasons, although a public comment/ presentation period has been added to the beginning of each meeting.

Ad Hoc 206-Within the IRAC, Ad Hoc Committee 206 was established in mid-1989 to coordinate executive branch preparations for WARC-92, and was responsible for developing Federal Government proposals for the WARC. Since it is a subcommittee of IRAC, membership in Ad Hoc 206 is limited to government agencies (approximately 15 Federal agencies actively participated in the work of Ad Hoc 206), and because of the classified nature of many of the issues addressed, the public was not allowed to attend meetings. Ad Hoc 206 was chaired by NTIA's Office of International Affairs, and divided its work into four subgroups: high frequency (3-30 MHz), 1-3 GHz, above 20 GHz, and international regulatory affairs, each also chaired by NTIA staff from either OSM or OIA. The work of these groups was closely coordinated with the official FCC liaison to facilitate the development of common positions and FCC staffers also acted as liaisons with the four substantive subgroups. Ad Hoc 206 finished its work in May 1991. It is still in force, but inactive.

The objective of Ad Hoc 206 was to develop U.S. government proposals for WARC-92. The group developed papers that were submitted to OIA, OSM, and IRAC; prepared position papers for meetings of the CCIR's study groups (see ch. 3); and provided input to the U.S. group preparing for the Inter-American Telecommunications Conference (CITEL) Working Group meetings. Although IRAC/ Ad Hoc 206 is the titular focal point of executive branch WARC preparations, it is important to note that the IRAC group itself does not develop proposals. Individual members draft proposals that are then reviewed and reworked in Ad Hoc 206. IRAC/Ad Hoc 206 served more as a controller, enabling the various agencies to forward their positions for response by others. In addition, IRAC/Ad Hoc 206 did not develop detailed proposals on all WARC-92 issues. It concentrated primarily on issues directly related to Federal Government activities, such as the space service proposals. In the case of proposals involving commercial or private sector interests, such as the mobile services, the FCC took the lead in drafting proposals that were then shared with NTIA/IRAC/Ad Hoc 206. This division of labor has prompted some critics in the private sector to complain that IRAC and Ad Hoc 206 functioned mostly as reviewers or censors, passing or blocking specific proposals, and that much of the substantive work was actually done by staff of the FCC and members of industry.

Frequency Management Advisory Council/Spectrum Planning Advisory Committee—The Frequency Management Advisory Council (FMAC) was established in 1965 to provide private sector advice to the executive branch agency responsible for managing government use of the spectrum-first the Office of Telecommunications Policy within the

[21]For more information on early IRAC and spectrum allocation, see Stanley D. Metzger and Bernie R. Burrus, ' 'Radio Frequency Allocation in the Public Interest: Federal Government and Civilian Use," *Duquesne University Law Review,* vol. 4, No. 1, 1965-66, pp. 1-96.

[22]For more information on the role of IRAC, see NTIA, *U.S. Spectrum Management Policy,* op. cit., footnote 3.

White House, and beginning in 1978, NTIA. April 1991, the FMAC was rechartered as the Spectrum Planning Advisory Committee.

The original FMAC was composed of 15 to 20 representatives from industry appointed by the Secretary of Commerce for 2-year terms. Membership included individuals with technical or administrative experience in spectrum matters—with a balance of views. The FMAC was directed to:

> review, as appropriate, recommendations of the IRAC; review the progress of electromagnetic compatibility programs; and provide recommendations for United States positions on spectrum matters with respect to International Telecommunication Union conferences.[23]

The Chair of the FMAC was the Associate Administrator of OSM.

Historically, the role of the FMAC was limited. Without a statutory base of power outside the informal backing of the Administrator of NTIA, the aggressiveness of the FMAC in pursuing outside, private sector interests was diminished. Agendas for FMAC activities were set by NTIA through the Chair, making the Chair extremely important in guiding the Council and determining its aggressiveness. As a result, the FMAC was primarily a reactive body, responding to the initiatives and requests of NTIA. In large part, the activism of the FMAC reflected and depended on the activism of NTIA as a whole. The current Administrator of NTIA, Janice Obuchowski, emphasizes the role of the private sector, so the FMAC was perhaps the focus of greater attention during her tenure than in the past.

Over its lifetime, subcommittees of the FMAC examined specific issues (in response to NTIA interests), such as trunking for government agencies and CITEL (see below), but, by and large, the FMAC did little substantive work. The one area in which the FMAC had substantial input was in NTIA's study of U.S. spectrum management. Council members worked closely with NTIA over the course of the study and provided advice on implementing the recommendations in the report. The FMAC's role in preparing for WARC-92 was limited, because positions for the Council to respond to were not finalized. The FMAC was also not deeply involved in past WARCs, although it was active in preparing for Plenipotentiary Conferences. The FMAC on several occasions, however, indicated strongly the need to establish delegations for WARCs sooner, and for the United States to reevaluate its policies regarding zero budget growth for the ITU.

Many felt that the FMAC could have been more effective in presenting its views and that the members of the FMAC, highly qualified and experienced individuals, could reflect the views of industry effectively if given the opportunity. Members garnered prestige by serving on the FMAC and turnover was low. Many recommendations contained in the spectrum report involve "opening" the Federal process to more private sector involvement, and the FMAC was the focus for several of those recommendations. The report proposed, for example, to broaden the membership of the FMAC to include government representatives, and to:

> . . . expand its role to include a strategic planning function. . . This advisory committee could address both specific, immediate problems and long-term issues to assist NTIA and the FCC in developing rational, unified spectrum management plans and policies based on the best interests of the nation as a whole.[24]

As a result of these recommendations, in April 1991, the FMAC was rechartered as the Spectrum Planning Advisory Committee. While the basic functions of the FMAC were carried over to the new Committee, its mandate was broadened to include a strategic planning function and its membership was expanded to include government representatives.[25] It will still function only in an advisory capacity.

FMAC Subcommittee—In addition to the activities related to WARC-92, NTIA also examined the functions and effectiveness of CITEL (see box 3-B) in relation to regional and U.S. telecommunication interests. A special subcommittee of the FMAC was established in July 1990 to prepare draft proposals for the CITEL VI conference scheduled for Septem-

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23NTIA, *U.S. Spectrum Management Policy,* op. cit., footnote 3, p. 27.

24Ibid, p. 28.

25The new Committee will consist of 15 private sector representatives and 4 Federal Government participants, each appointed for a l-year term. The Committee is expected to meet at least twice a year or more, if necessary.

ber 1991.[26] The subcommittee's approximately 30 members were mostly from the private sector, but government representatives from the NTIA, FCC, State Department, NASA, National Science Foundation, and U.S. Information Agency also participated. Members of the subcommittee regard the working partnership between government and private sector representatives leading to the development of U.S. proposals as a major accomplishment. The subcommittee examined the organization of CITEL, evaluated U.S. interests in the conferences, and discussed the role CITEL could play in future regional and international telecommunications policymaking.[27] Upon presentation of its final report to NTIA, the work of the subcommittee was finished and it was abolished in April 1991.

The work of the subcommittee reflects the growing importance of Latin America and the Caribbean in international telecommunications negotiations, especially in the ITU. The changes suggested by the subcommittee are too late to affect planning for WARC-92, but there is increasing pressure in the government to improve the effectiveness of CITEL in order to forge stronger common positions for the Western Hemisphere at future world conferences. Many in the United States see CITEL as a way to counter the increasing power of the European countries in international radiocommunications, and an improved CITEL could give the United States another (stronger) forum for pursuing its agendas at future WARCs. Private sector interest in CITEL reflects the growing importance of the region as a market for telecommunications equipment and services. Many members of the private sector as well as government policymakers from the United States and other countries of the region view CITEL as a valuable forum for discussing the region's telecommunication needs and addressing common telecommunication issues.

Implications

To the outsider, the conference preparatory structure at NTIA seems mostly informal and ill-defined. While preparation procedures do exist, the long experience and collegiality of the staff is vital in allowing the process to work effectively. This process works now, but staff turnover through job changes or retirement and the lack of younger experienced staff could devastate the process. Possible changes in the ITU and regularization of conference schedules present an opportunity for NTIA to reevaluate its conference preparatory structure and processes.

The process for coordinating the exchange of views between NTIA and FCC is structured but also largely informal. The FCC's liaison to the IRAC also serves as the liaison to Ad Hoc 206, and other members of the Commission staff work with the four subgroups. NTIA staff (usually the chairs of the subgroups) attended meetings of the IAC and the IWGs to get informal private sector input and work with FCC staff in developing government positions. Much informal work took place between NTIA and the private sector Chair of the IAC.

NTIA has been criticized in a number of areas for its spectrum management practices and policy development.[28] In contrast to the FCC inquiry process and the role of the IAC, which are considered accessible and open to the public, the WARC preparation process at NTIA, and more broadly among all government agencies, is widely seen as closed off from public participation. In its recent report, NTIA recommended several changes that could substantially improve the domestic spectrum management process-changes that could alter the ways in which WARC preparations are conducted. Some of these changes have already been implemented. To increase private sector participation in its activities, for example, NTIA has begun opening IRAC meetings with a public comment/presentation period. This may broaden the domestic policymaking process-opening NTIA deliberations on international proceedings to greater public participation and improving industry input into the Federal Government's WARC preparation process.

Several other improvements in the NTIA preparations process have been suggested. First, a full-time permanent subcommittee of the IRAC responsible for international radio conference preparations (sim-

[26] That meeting will consider the organization and functioning Of the CITEL conference structure and could recommend changes that would increase CITEL's stature and effectiveness-making it more of a force in regional and international (WARC) telecommunications policy.

[27] The subcommittee's findings and recommendations are detailed in its final report: U.S. Department of Commerce, National Telecommunications and Information Administration, ''United States Preparations for the 1991 Inter-American Telecommunication Conference [CITEL], '' Washington, DC, April 1991.

[28] NTIA itself summarized these criticisms in *U.S. Spectrum Management Policy,* op. cit., footnote 3.

ilar to Ad Hoc 206) could be created. Second, the Radio Conference Preparatory Program that existed early in the 1980s could be revived. Expansion and improvement of WARC activities will require additional personnel and funds that may be difficult to get.

The arcane nature of international radiocommunication policymaking, combined with the relatively low level occupied by NTIA in the Department of Commerce structure have made it difficult for NTIA to pursue international spectrum issues as aggressively as some would like. For the past several years, for example, a battle (for staff and resources) has been fought within the Department of Commerce between NTIA/OIA and the trade sections over responsibility for international telecommunications trade. A failed attempt was made in 1989 to subsume NTIA under another division within the Department of Commerce. Such a demotion would have made it even more difficult for NTIA to carry out its international activities. Raising the status of NTIA —through clarification or amendment of Executive Order 12,046-could remedy some of the problems of funding and prestige. In July 1991, H.R. 3031, the NTIA Organization and Authorization Act, was introduced. This legislation, if passed by the Congress, would codify the authority of NTIA as outlined in Executive Order 12,046, and could add legitimacy to its policy role.

Department of State

Description

According to Executive Order 12,046, the role of the State Department in international telecommunications is to represent the United States at international meetings:

> With respect to telecommunications, the Secretary of State shall exercise primary authority for the conduct of foreign policy, including the determination of United States positions and the conduct of United States participation in negotiations with foreign governments and international bodies. In exercising this responsibility the Secretary of State shall coordinate with other agencies as appropriate, and, in particular, shall give full consideration to the Federal Communications Commission's regulatory and policy responsibility in this area.[29]

Compared to the FCC and NTIA, the State Department's role in the WARC preparation process is limited, especially in the initial stages. It helps determine the broad directions and focal points of overall U.S. policy and attends the meetings of the IRAC, but does not actively participate in the development of specific proposals, leaving that work to the FCC and NTIA. The State Department monitors the preparations process and helps resolve disputes, but its most important function early in the preparations process is representing the United States, with technical support from the FCC and NTIA, at preliminary bilateral and multilateral international negotiations. The State Department also coordinates U.S. WARC activities with the ITU and handles the procedural and administrative duties related to the WARC, including correspondence with the ITU, meeting deadlines, and submitting all official documents.

The State Department becomes more active in WARC preparations in the final stages of the process. The Department is responsible for determining the official U.S. WARC proposals to be submitted to the ITU based on the recommendations of the FCC and NTIA. Usually, these recommendations are nearly identical, having been previously coordinated by FCC and NTIA, but in some cases, issues cannot be reconciled and are left unresolved. In these cases, the Department has the authority to set final proposals (see below for the case of BSS-Sound in WARC-92 preparations) .30 The State Department also is responsible for designating the official U.S. delegation that will attend WARC-92 (based on lists submitted by FCC, NTIA, and the State Department itself) and for appointing an official Head of Delegation, who is granted temporary Ambassador status for the WARC.

The primary role of the State Department is to promote U.S. interests and proposals abroad and to ensure that they are presented as effectively as possible. It represents U.S. interests in bilateral meetings between the United States and other countries and in multilateral fora such as CITEL and the WARC itself. Its main contributions come, however, after final proposals have been set, and the United States turns its attention to the preparation of negotiating strategies and preliminary negotiations. The Department will act as the lead agency coordinat-

[29]Executive Order No. 12,046, op. cit., footnote 2, section 5-201, p.

[30]The State Department doea not, however, have the legal authority to overturn FCC and NTIA determinationa.

ing all negotiations in preparation for the WARC, including the extensive travel and meetings scheduled for late 1991. At the WARC, the Head of the U.S. delegation assisted by the State Department will coordinate the presentation of U.S. policy in all meetings.

In addition to its direct involvement in the preparations process, one of the more important roles the State Department plays is its coordination and oversight of the national CCIR and International Telegraph and Telephone Consultative Committee (CCITT) committees that function as advisory bodies to the Department. It is through these committees that technical papers written by domestic (often private sector) contributors are prepared, reviewed, and submitted to the (international) CCIR study groups (see ch. 3). The work of the study groups, in turn, is crucial in the international preparation for WARCs, establishing the technical bases for the conferences.

Structure

Primary responsibility for international telecommunication policy rests with the Bureau of International Communications and Information Policy (CIP), in the Office of the Under Secretary of State for Economic Affairs. CIP was originally established by the Congress in 1982 as the Office of United States Coordinator of International Communications.[31] The purpose of this legislation was to establish:

> . . . a central point within the State Department for coordinating the increasingly important issues involving international telecommunications.[32]

The office was upgraded to its present Bureau status in 1985, and is currently directed by Ambassador Bradley P. Holmes.

Responsibility within CIP for ITU and WARC-related activities is diffused throughout the Bureau. Specific activities are assigned to individual staff members on the basis of experience and interest. WARC preparation and U.S. participation in the ITU's High Level Committee (HLC), for example, are being coordinated by Ambassador Holmes' Senior Advisor, CCIR and CCITT activities by a Deputy Director, and activities in CITEL and the ITU's Voluntary Group of Experts by other members of the staff. CIP has a very flat organizational structure that operates more according to overlapping topics than to strict organizational boundaries. CITEL activities, for example, are directly involved in WARC preparations, and staff working in both areas must coordinate closely. This is accomplished through some formal meetings but mostly informally through internal personal interaction.[33]

Telecommunications Advisory Committee—The State Department established a Telecommunications Advisory Committee in 1987 to provide private sector input on telecommunications matters. Membership consists of high-ranking representatives from major telecommunications companies. The Committee has been following the proceedings of the HLC, and was briefed by Ambassador Gerald Helman, the U.S. representative to the ITU's High Level Committee, in April 1991. Input by the Advisory Committee to the HLC process, however, has been virtually nonexistent (see below), and in matters relating to WARC-92, the impact of the Advisory Committee is unclear. Some industry representatives believe the Advisory Committee to be mostly show, having little real impact on State Department policy.

Implications

The work of the State Department and CIP in the WARC preparation process is very important, but the constrained nature of CIP's role is the source of many complications in the development and presentation of proposals, and has given rise to uncertainties concerning the Department's (and CIP's) effectiveness. CIP's work is handicapped by several factors. First, the technical nature of the WARCs limits CIP's contributions until late in the conference preparation process. CIP does not have sufficient technical staff or resources to become deeply involved in the actual preparation of proposals. This may make it difficult for CIP to substantially affect the course of preparations. Second, it is not clear from the mandates of Executive Order 12,046 exactly what role the State Department should play

[31] Public Law 98-164, Nov. 22, 1983.

[32] U.S. Department of State, "Bureau of International Communications and Information Policy," Publication 9860 (Washinton, DC: U.S. Government Printing Office, March 1991.

[33] There is some question how extensive this interaction actually can be. CIP staff is located in several different locations within the main State Department building.

in setting international radiocommunication policy, including the development of WARC proposals and strategies. Critics have accused the Department of not being aggressively or substantively involved in the development of specific policies or issues. This may result from several factors. Past Directors of CIP may not have interpreted Executive Order 12,046 broadly, resulting in a lack of prominent involvement. It is also possible, because of the way responsibilities are divided, that NTIA and FCC have, in the past, shut out (CIP or deflected its attempts to become more involved earlier in the process, thus discouraging more active involvement. These factors have led critics to charge that CIP contributes little leadership in radiocommunications matters, preferring to wait and see how issues are resolved rather than taking a leading policy role.

On the other hand, CIP staff have been accused of overstepping their authority on occasion. Many of CIP's staff came from FCC and NTIA, are experienced in WARC activities, and are used to taking more of an active role in the preparations process. Such activism, however, is often rebuffed by NTIA and FCC staff, who prefer to work out the technical details themselves, turning issues over to CIP only when specific problems arise. This conflict can carry over to the conference itself, where NTIA and FCC expect CIP staff to limit their activities to administrative matters and let NTIA and FCC technical staffs handle the details of allocations and negotiations in the working groups and committees.

These "turf battles" give rise to tension in the preparations process between the FCC, NTIA, and the State Department. CIP staffers perceive themselves to be an important part of the process, but there is belief among many FCC and NTIA staff that CIP is little more than a rubber stamp for the work accomplished in NTIA and FCC. They believe that when CIP staff understand their own role, and its limitations, the process works smoothly. If, however, CIP staff are perceived to overstep their bounds, the other agencies consider them troublemakers. These problems stem from the vague division of international telecommunications authority laid out in Executive Order 12,046. Until roles are more clearly defined and coordination mechanisms firmly in place, CIP's activities will continue to be buffeted by the forces of aggressiveness and passivity.

Several specific criticisms have been made about the way CIP prepares for conferences. First, the Department has been criticized-primarily by industry leaders—for forming delegations and naming Heads of Delegations too late.[34] Most critics would prefer that the delegation be formed at least 9 months before the WARC, to allow enough time for the (private sector) delegates to understand the U.S. government's priorities and develop effective negotiating strategies and back-up positions. Even for those delegates that served on the IAC or who have been involved in the preparations process from the beginning, there is a learning curve related to the government's plans for the WARC, and without sufffcient lead time, delegates may not understand what the government is trying to accomplish or what the negotiation strategies entail. This reduces the effectiveness of the delegation. As of mid-September 1991, the final list of delegates had not been released, although members had been notified of their selection and had begun to meet. The Head of Delegation, Jan Baran, was not officially announced until late August.

Another problem identified by analysts and past participants is that the Head of Delegation changes from conference to conference.[35] Some have complained that lack of continuity makes it difficult for the United States to establish long-term relationships at high levels that could enhance U.S. presence and effectiveness in international meetings.[36] On the other hand, some observers play down the importance of such continuity, noting that the participants in the delegations are relatively consistent over the years.[37] Without long-lasting personal relationships and trust, negotiation becomes more difficult.

[34] For a discussion of the issues involved in putting together a delegation, see U.S. Congress, Office of Technology Assessment, *Radiofrequency Use and Management*, OTA-CIT-163 *(Washington* DC: U.S. Government Printing Office, January 1982).

[35] Other countries often maintain Heads of Delegation across many conferences.

[36] Some believe that the FCC's Office of International Communications is attempting to fill this gap, If true, this could be perceived as undermining the State Department's authority. More importantly, the problem indicates a leadership vacuum and the need for a focal point for U.S. spectrum dealings abroad.

[37] Ironically, the rapid changing of telecommunications officials in many of the Latin American countries has been identified by U.S. government officials as one of the key problems affecting the effectiveness of CITEL.

Finally, some believe that the Head of Delegation is more a political or honorary choice than a choice based primarily on merit. Some Heads of Delegation have had little or no telecommunication experience. However, past Heads have proven to be extremely competent. Troubles at conferences have more often been attributed to institutional failures or lack of effective preparation than to a lack of leadership at the conference. These concerns apply also to the delegation as a whole. The selection process is often political. In addition to the government staff that have been working on the WARC issues, many members of industry wish to participate. The IAC will form the core of the private sector's participation, but there are too many people for too few spots. Filling out the delegation is a matter of achieving a political balance so that all interests are represented.

Although not specifically related to WARC-92 preparations, the State Department has been criticized for its handling of U.S. participation in the activities of the HLC. While the Department was seemingly open to comments from all interested parties in and out of the government, the overall impact of this input is uncertain. In addition, although State Department staff and the Ambassador were available to brief interested parties, there is still a perception among some of those involved that the progress and results of the HLC proceedings were held closely. The consultant report the ITU commissioned, for example, was not released until the final report of the HLC was released.[38]

Ambassador Helman had staff support from CIP, FCC, and NTIA, but aside from the specific staffers assigned to him, few other government officials had direct input. The extent to which the staff from NTIA and FCC affected the process is uncertain. Participation by the private sector in the HLC process was even more limited, and the impact private sector comments had is also unclear. One problem was the extremely short time the HLC had to do its job and the short periods of time the State Department had for sending out proposals and receiving comments. To oversee the progress of the HLC, both the national CCITT and CCIR committees set up task forces, but they simply could not respond quickly enough in many cases to provide comprehensive comments. Industry representative were illustrated because the process was not open to public scrutiny, making it difficult to judge how well input was considered, and what goals the State Department was pursuing. Industry was not privy to the ambassaor's instructions and had no part in determining final U.S. positions. Indifference or even outright hostility of some members of the private sector to changes in the ITU also may have contributed to their lack of impact.

Private Sector and User Groups

Opportunities for Input

FCC-IAC, Notices of Inquiry—Participation of the private sector in the preparation for WARC-92 has been extensive, and comments from both government and private sector representatives reveal mostly satisfaction with the process and its outcomes. By almost all accounts the FCC takes careful consideration of the work and recommendations of the IAC as well as the comments received in response to the NOIs. FCC staff attendance at the meetings of the working groups fostered effective cooperation and coordination between the Commission and the private sector. Nevertheless, several changes have been suggested to improve the effectiveness and efficiency of the IAC. Some have suggested a switch from operating by competition and negotiation to some form of formal voting. If the objective of the IAC is to develop specific industry proposals, voting may be a solution. But if the most effective role of the IAC is to develop a wide range of proposals and negotiate compromises, voting may actually be harmful. Votes can be traded, voting does not build the same support as negotiation, and rivalries could be deepened rather than resolved. Various industry sectors could try to "stack the vote,' and there are practical questions as to who would be allowed to vote-members of the working groups or only members of the IAC. Many private sector representatives regard voting as counterproductive and there is some doubt that companies would participate in such a forum, or support its outcomes, when their positions could be summarily defeated.

Although participation in the preparations process by industry was extensive, the number of individuals and companies involved was relatively small. There is a great deal of overlap in the membership of various private sector groups engaged in WARC

[38] See Annex 2 in Final Report of the High Level Committee (H.L.C.) to Review the Structure and Functioning of the International Telecommunication Union, "Tomorrow's ITU: The Challenges of Change," Document 145-E (Geneva: International Telecommunication Union, April 1991).

preparatory activities. The industry participants in the work of the IAC, for example, are roughly the same as those who helped prepare U.S. positions for the CITEL working group. Although there are no rules against entry, the extent of small company participation was limited. The majority of IAC participants represent traditional radiocommunication companies and interests. Some other companies with consultants or lawyers in Washington, DC are also informed about the process, but many smaller companies may remain uninformed or only vaguely aware of the importance of the WARC proceedings and how WARC outcomes may affect them. The Telecommunication Industries Association, among others, tries to bridge this gap for smaller companies by representing those who cannot afford a private consultant.

NTIA—Private sector/industry input to NTIA is less extensive than the FCC. Three factors constrain the private sector' s role in executive branch proceedings. First, NTIA's primary constituency (through the IRAC) is not industry, but the Federal Government users of spectrum. As a result, NTIA seems hampered by conflicting functions and mandates. On the one hand, NTIA is the organ of administration telecommunications policy. This would imply that policy decisions be made with input from all relevant sectors of society, including industry, and that a broad range of policy considerations be integrated, including trade. On the other hand, NTIA's primary spectrum duties focus on representing only government interests. As an advocate for the government, NTIA currently does not take direct account of the needs of the private sector in spectrum policy decisions.[39] It is also possible in spectrum and radiocommunication matters that government spectrum interests, represented by specific Federal agencies, will prevail over the less-focused interests of trade, for example. NTIA is aware of private sector concerns, and has taken steps to improve private sector involvement in the policy development process, but current efforts to open the NTIA process are too new to judge their effectiveness, and it remains to be seen how well NTIA will be able to reconcile its dual responsibilities to government users and private sector interests in the future.

Second, much of the deliberations and decision-making processes of NTIA remain closed to the public. IRAC meetings, which were previously attended only by government representatives, have only recently been opened to allow some private sector participation. The new Spectrum Planning Advisory Committee (SPAC, formerly the FMAC) provides for private sector input to NTIA on spectrum matters. However, the work of the group has been much more limited in scope and participation than, for example, the LAC. By and large, the FMAC fell short of private sector needs and aspirations. Its ability to be an effective voice for the private sector was limited by its narrow mandate and the nature of the body itself: competing interests and services can cancel each other out as services vie for prominence (broadcasting v. mobile). The new SPAC does, however, serve a useful and important function for its participants. It provides a' 'window' into NTIA, allowing members of industry to get a feel for the people making policy at NTIA, and the ebb and flow of interests the agency is concerned with. NTIA has identified this type of informal sharing and cooperation as very important and has recommended ways to increase such interchanges to improve strategic planning efforts.[40] While some of these recommendations, as noted, have already been acted on, it is still too soon to tell what longer term impacts they will have on opening NTIA's processes and improving domestic spectrum management and WARC preparations.

Third, participants in the WARC-92 preparations process complain that the lack of private sector (or even FCC) access to data on government frequency use makes it very difficult for industry representatives to develop proposals for the WARC. Without access to relevant data, without knowing exactly what frequencies are being used and how, private sector representatives do not know what frequencies are available and what technical considerations might affect their proposals. As a result, the development of new technologies or uses for the spectrum may be inhibited by. A more fundamental issue in providing access to data is first gathering the information. It is not clear that adequate data exists on government spectrum use. Data may be incomplete, outdated, or may not have even been collected.

[3]-note of this perceived lack of private sector input NTIA has proposed to establish two vice-chairs of the IRAC, one of whom will "coordinate activities of the IRAC with the private sector." NTIA, *U.S. Spectrum Management Policy,* op. cit., footnote 3, p. 22.

[40]Ibid, p. 28.

Providing access to data means little if that data is not reliable and complete.

NTIA has proposed several remedies to improve government data and access to it, including: a unified database of spectrum use information combining the frequency lists of both FCC and NTIA, a proposal to declassify some government frequency data, and improved distribution of data either through on-line computer access or compact disc-read-only-memory (CD-ROM).[41] Other improvements and solutions to these problems have been identified, and some of them have already been implemented or are being planned. NTIA has a plan for addressing these issues over the next 2 fiscal years. However, because of resource constraints, it is unclear how many of NTIA's recommendations can and ultimately will be implemented, and how effective they will be. Mechanisms must be put into place to ensure industry access to both relevant data and policymakers if private sector participation in the WARC preparation process is to be effective, timely, and fair.

State Department—The private sector had the least direct input into State Department preparations for WARC-92. This is largely a function of the limited role it plays in the formation of the proposals. Once the official U.S. delegation is formed, State Department officers will become much more involved with industry representatives in the formation of negotiating strategies and as the lead U.S. agency at the WARC itself.

CCIR and CITEL Work—Some of the most important input that industry had on the WARC-92 preparation process is through participation in the work of the CCIR national study groups and through the informal work of the CITEL working group (see box 3-C). Internationally, U.S. industry participates extensively in the work of the CCIR study groups. The participation of the private sector in these groups is one of the most important ways in which the United States can directly and indirectly influence the WARC process.[42]

Conference Participation

Private sector participation at conferences is somewhat limited, but extremely important. Representatives from the private sector are allowed to participate as official members of the U.S. delegation to WARCs upon filing conflict of interest and financial disclosure statements. The State Department accredits all delegates. Principal spokesmen, however, are usually government representatives from the State Department, FCC, and NTIA. The private sector will be represented by a vice-chair appointed by the head of delegation, to accompany the vice-chairs from the FCC, State Department, and NTIA.

In the past there have been problems with members of industry representing the United States abroad, but they appear to have been resolved.[43] Members of the private sector contribute mostly in the conference's working groups and study groups, where their extensive technical experience and expertise is used most effectively.

Industry participants from past conferences complain that government leaders often isolate themselves from industry representatives during the course of the conference, and that the private sector has little say in strategy setting. Government representatives advance positions and pursue goals that had not been previously discussed with all the delegates. This may be necessary at times to react to fast-moving developments, but it circumvents private sector interests. Greater cooperation of government and industry delegates from the inception of the delegation could alleviate some of these problems. Building trust among the members of the delegation is crucial if the United States is to be effective in negotiating from a unified position. Forming delegations earlier and involving the private sector extensively in the preparation of negotiating positions could help achieve this goal.

Improving Private Sector Participation

As the role of the private sector in radiocommunications becomes increasingly important, the United States must find ways to raise the level and effectiveness of private sector input into the U.S.

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[41] Ibid., pp. 29-32.

[42] Ch. 3 provides a more in-depth discussion of the U.S. participation in the work of the CCIR and its influence on the WARC proceedings.

[43] For a full discussion of the problems surrounding private sector participation in international meetings, and the effects on the 1979 WARC, see OTA, *Radio frequency Use and Management,* op. cit., footnote 34, pp. 60-62.

international spectrum policymaking process, while at the same time protecting U.S. public policy interests.[44] Changes now underway show recognition of the importance of private sector input, and should be followed through. At the FCC, OIC will serve as a focal point for industry input on an ongoing basis. This should allow FCC international policy and industry perspectives to be more easily coordinated and integrated on an ongoing basis. The activities and problems of the WARC-92 IAC can serve as a learning tool for future FCC advisory committees. With the completion of the IAC's work, industry has no coordinating body and no unified voice to represent its interests before the FCC or the executive branch. Some analysts have called for industry to fund their own IAC to keep close ties and oversee the work of individual companies in the CCIR study groups on a continuing basis. This group could serve as liaison not only to the FCC, but also to the State Department and NTIA, and could be an important link and focal point for industry activities in international spectrum matters. Changes recommended by NTIA in its spectrum report are far--reaching and could substantially improve the quantity and quality of the private sector input to the executive branch.

Changes on the international scene have propelled the private sector to center stage. Proposed changes in the structure of the ITU and current efforts to increase the level of industry participation in the work of CITEL (see ch. 3) offer the private sector an opportunity to increase its participation in the ongoing radiocommunication policy process. Continued active involvement of the U.S. private sector will be crucial to maintain the technological leadership the United States now enjoys in many radiocommunications sectors, and the opening of international bodies to more private sector participation could enhance U.S. effectiveness in international radiocommunication negotiations and conferences.

[44] As private sector participation in U.S. international policy activities increases, questions arise as to what constitutes an "American" company. Many companies that are headquartered in foreign countries have substantial manufacturing and service operations in this country. Should they be allowed to participate in U.S. WARC preparation activities? Whose interests would they represent? The United States may have to revisit policies defining foreign company participation in U.S. policy as contained in section 310 of the Communications Act.

Chapter 5

Implications of WARC-92 for U.S. Radiocommunication Policymaking

Introduction

The U.S. process of preparing for WARCs is based on a democratic approach that guarantees participation by a broad range of interests. This process has been described as "loose," "good and bad,' and having 'no rules." Overall, the domestic preparations process for WARCs works relatively well in the current environment. However, the divided nature of the U.S. telecommunications policy process may not serve long-term U.S. spectrum interests nearly as well in the future, and may threaten the effectiveness of the United States at future WARCs.

Rapid advances in technology coupled with a more competitive international telecommunications environment will challenge the United States to adapt its conference preparation and negotiation strategies in order to remain successful in international policymaking. Such changes have already prompted the International Telecommunication Union (ITU) to take steps to improve its structure and processes in order to better meet the needs of its members. These same forces are increasing pressure on U.S. policymakers to integrate international radiocommunication policies with broader political and economic goals. A broader, more strategic approach to international radiocommunication policymaking will require increased speed, flexibility, and decisiveness in domestic decisionmaking. WARC preparations are a crucial element in the long-term development of radiocommunication services and policies, and should reflect the broader goals and priorities of overall U.S. telecommunications policy. It is not clear that this happened in the WARC-92 preparations. Some of the difficulties with the WARC preparations process reflect a more general lack of vision or coordination of long-term strategic international U.S. radiocommunications policy. Thus, the issues raised by WARC-92 preparations have significant implications for the entire U.S. radiocommunication policy process.[1]

WARC Preparations: An Exercise in Democracy

The domestic approach to WARC preparation—in both the government and the private sector—is adversarial in nature, but ultimately results in some form of negotiated consensus. Competing private sector companies file comments with the Federal Communications Commission (FCC) in response to Notices of Inquiry (NOIs), and proponents and opponents of different systems, technologies, and proposals debate their positions in the Industry Advisory Committee (IAC). Federal agencies vie for spectrum to support their mission-related activities through the Interdepartment Radio Advisory Committee (IRAC), which advises the National Telecommunications and Information Administration (NTIA). In the negotiations between the FCC and NTIA, the interests of the private sector compete with the interests of the government. This competitive process is not necessarily neat, but it conforms to U.S. notions that every voice be heard, every opinion expressed. No single interest gains absolute control, and a rough balance of power is achieved. Diversity of interests is the strength of the U.S. process, and this freedom and variety should serve as the basis for any effort to improve the U.S. WARC preparations process.

However, while diversity is the strength of the process, it can also be a major weakness. Deregulation in the telecommunications industry has expanded the number and variety of radiocommunication interests in the United States. Companies and groups which normally compete (for spectrum and/or customers) are forced to work together to negotiate and support common WARC proposals that will serve broader national needs. Entrenched interests are often reluctant to compromise and consensus is sometimes impossible. As a result, negotiating the most contentious issues can be time-consuming and frustrating. These divisions are also reflected at conferences, where the timely and

[1] For a more complete discussion of the issues, options, and strategies for improving domestic telecommunications policy coordination, see U.S. Congress, Office of Technology Assessment *Critical Connections: Communication for the Future*, OTA-CIT-407 (Washington, DC: U.S. Government Printing Office, January 1990).

effective execution of negotiating strategies maybe impeded when many individuals are involved representing a myriad of interests.

Government officials often criticize private sector interests for resisting compromise and delaying the development of proposals. Even when agreement is reached, it is not clear that compromises between competing factions reflect sound decisions that best serve U.S. interests. They may represent little more than a politically expedient solution—the least common denominator of agreement-rather than a thoughtful part of a broader conference strategy or well-defined policy goals. For the government agencies that must sort and consider the various proposals and compromises, making the final decisions is very difficult and time-consuming.

Critics charge that the preparation process, especially the development of private sector proposals, is made more difficult because of the lack of strong government leadership. Industry representatives, and some government policymakers, complain that when compromise and consensus cannot be reached, the government does not step in quickly enough to provide substantive policy direction and resolve specific disputes. These criticisms have been made before. Glen O. Robinson, Chairman of the U.S. WARC-79 delegation, in testimony said, "Of course, it is necessary to have some locus of final decision making; there must be someplace, wherein Truman's words, the 'buck stops.'"[2] Many participants involved in WARC-92 preparations have voiced similar complaints-that the process got bogged down in negotiation and compromise, and that decisions were often not made until the last minute. Some industry representatives, for example, would have liked more explicit FCC direction in the IAC. Such direction would not necessarily have stifled private sector views, but could have given more focus to the preparations process and the development of proposals.

The solutions suggested by members of the private sector to these problems vary, but represent a range of increased government activism. Some suggest that the government could exert stronger direction within the existing division of responsibility. Others believe that a closer partnership between government and nongovernment interests would allow policymakers to better define goals and priorities and lead to a more effective process. Still others maintain that in order to bring the needed amount of discipline and direction to the preparation process (as well as to the larger spectrum policymaking process) a single authority for domestic and international spectrum policymaking should be created.

overall, the government agencies involved (FCC, NTIA, State Department) have been either unable or unwilling to take strong policy stands in the absence of clearly developed or stated objectives. Government policymakers appear to have been content to follow the lead of the private sector in many cases rather than take an active policy role themselves. This lack of aggressive leadership often conflicts with the need for incisive international decisionmaking, and is due to several factors (discussed below). New approaches are needed in the preparations process-and during conferences—that accommodate the need for decisive action with the need to ensure effective public and private participation.

Implications for International Radiocommunication Policy

The difficulties uncovered in the WARC-92 preparations process may have serious consequences for the development of broader U.S. international spectrum policy. These concerns derive from several basic problems with the U.S. radiocommunication policy process. First, the system is fragmented. In the absence of a single agency or focal point for policy development, coordination mechanisms for strategic long-range policy development in radiocommunications are inadequate. Further, there is no overarching vision or plan to guide U.S. spectrum policy; that is, goals and priorities are not being cooperatively set by the Federal agencies responsible with sufficient input from the private sector. Finally, there has been a lack of commitment to international spectrum issues at high levels of the Federal Government that could encourage a more aggressive and integrated policy development process. However, recent efforts, especially in the FCC and NTIA, indicate heightened awareness of both domestic and international spectrum issues. How long this attention will continue is uncertain and

[2] Glenn O. Robinson quoted in U.S. Congress, Office of Technology Assessment, *Radiofrequency Use and Management,* OTA-CIT-163 (Washington, DC: U.S. Government Printing Office, January 1982), p. 45. Robinson goes onto argue that such power should rest with the State Department.

may depend on the interests of the senior government policymakers involved.

System Is Fragmented

The division of responsibility for international spectrum issues between three Federal Government agencies complicates both the WARC preparations process and the development of overall international radiocommunication policy. In the WARC preparations process, which deals with fairly well-defined issues, the problems of divided responsibility have been worked out relatively well over time. Each of the agencies involved has long-established internal procedures for WARC preparations, and mechanisms exist that allow the coordination of proposals between agencies to take place. These interagency coordination mechanisms, however, are generally less well-defined than the agencies' internal procedures, and consist primarily of assigning liaisons to other agencies-establishing a path through which communication and coordination can take place-and reviewing and responding to various draft proposals.[3] Beyond that, the substance of coordination is murky. No guidelines exist that describe what interagency coordination will entail, and no explicit rules outline each agencies' responsibilities vis-`a vis the others. Furthermore, there is no mandate that relevant information be made available or even what types of information should be shared. This situation makes accountability very difficult to judge and creates an atmosphere that is best described as "clubby.' ' In this context, what makes these mechanisms work is the experience and personal relationships that individuals have developed over many years of working together, both in and out of the government.

While these coordination mechanisms are relatively effective vis-`a-vis the specific issues of WARC-92, at the broader levels of strategic and long-term policy development, the fragmented nature of the system is much more problematic. The three Federal agencies that have jurisdiction over international spectrum matters (FCC, NTIA, State Department), each have their own interests and priorities. Adequate mechanisms do not exist at the policy level to bridge divided responsibilities, and forge common goals. The result is that despite the enormous importance of telecommunications to the domestic economy and in international activities, the United States has no central authority or focus for international telecommunication or radiocommunication policy development. The inadequacies of such an arrangement have long been clear:

> There is no high-level agency within the Government to resolve conflicts arising among governmental interests, much less those arising between governmental and nongovernmental interests. Government policy and administrative development have not kept pace with technical and industrial development in communications.[4]

OTA echoed these comments in 1990:

> Although all agencies now have to be more cognizant of international developments, the fragmented nature of the agencies means that no one agency is equipped to fully present a coherent and clear-cut U.S. communications policy perspective.[5]

Finally, this divided policy process has long been recognized as hampering the development of international spectrum policy in the United States:

> The existing split in responsibility whereby the regulation of private communications resides in the Commission and Government communications (titularly) in the President fosters a deplorable lack of accountability aggravated by recourse to the cloak of security. The dichotomy precludes effective overall telecommunications planning. At present there is solely the avenue of coordination and compromise, a hopeless device when authoritative leadership is lacking.[6]

In terms of WARC preparations, this means that no individual or agency is accountable for ensuring that the proposals advanced for the WARC support the broader goals of U.S. policy. Because of the essentially reactive nature of WARC preparations, no conscious attempt was made to link WARC proposals to an already established, more long-term

[3] "Well-defined" as used here is a relative term. To those involved, the processes are very well-defined, roving been in place and familiar to them for many years. However, to the outside observer, there are few explicit rules that govern the process and no formal guides that outline the substance of coordination- i.e., what information should be exchanged.

[4] "Commission T. Investigate Utilization of Radio Frequencies Allocated to the Government, " Report to the Senate Committee on Interstate and Foreign Commerce, Report No. 1854, July 18, 1958, p. 3.

[5] OTA, *Critical* Connections, op. cit., footnote 1, p. 366.

[6] Additional views of Edward L. Bowles in "Allocation of TV Channels," Report of the Ad Hoc Advisory Committee on Allocations to the Committee on Interstate and Foreign Commerce, U.S. Senate, 85th Cong., 2d sess., Committee Print, Mar. 14, 1958, p. 12.

strategic policy. This is not a failure of the WARC process, however, because a long-term framework for making spectrum decisions or developing long-term radiocommunication policy does not exist in the United States.

Instead, formal coordination mechanisms and the development of unified policy have been replaced by interagency coordination and cooperation that is heavily dependent on the goodwill and personalities of the individuals involved (see below). "Unfortunately, accomplishing such coordination is dfficult when faced with disputes among agencies, competing demands for high-level attention, time pressures, and often inadequate resources. '

There have been several attempts in the past to coordinate U.S. international telecommunication policy development, including radiocommunications, but most have been short-lived. In the early 1980s, for example, a group made up of senior staff from the NTIA, FCC, and State Department-the ''troika'—attempted to coordinate telecommunications policy issues. The troika was not a formal, institutionalized group, but it did hold regular meetings and address ongoing policy issues, including international matters. Although the regular meetings of the troika eventually faded, meetings between high-level staff continued on an ad hoc basis. The next major effort to coordinate international telecommunications policy came in 1984 when a Senior Interagency Group was formed to examine international telecommunications policy issues. It was abolished approximately 5 years later. Another attempt to establish a more formal process was made in late 1989, when Ambassador Bradley Holmes, director of the State Department's Bureau of International Communications and Information Policy (CIP), set up regular meetings with FCC chairman Alfred C. Sikes and NTIA Administrator Janice Obuchowski to discuss international issues that involve all three agencies. The meetings were scheduled quarterly, and were to be supplemented by informal contact among key aides. The impact of these meetings on WARC preparations is unclear.

There is a growing sense that the United States is fast approaching a point at which its fragmented system may inhibit the development of coherent radiocommunication policy and ultimately reduce the effectiveness of the preparations process for international conferences such as the WARC. Multiple layers of decisionmaking slow U.S. responsiveness, confuse negotiation strategies, and provide additional opportunities for domestic (and foreign) interests to play off the agencies against each other. The multitude of players and a democratic decision-making process also confuses foreign officials and delegates who do not understand the U.S. processor the pressures it responds to.

Despite the problems with the fragmented U.S. system, however, many observers believe that a rigidly centralized domestic spectrum management system would be worse. With policy authority concentrated in one agency or person (a telecommunications "czar"), the development of policy could be made more efficient, but could also reduce the amount of private sector and industry input into the process. Critics of such a solution in both the private sector and government fear that this approach would make the preparations process more bureaucratic, less open, and perhaps even more secretive than it is now.

No Coordinated U.S. Radiocommunication Policy

The United States process for formulating telecommunication policy has long been criticized for lacking focus, direction, and coordination.[8] OTA has previously identified the lack of coordinated policymaking as a serious impediment for the United States in the near term:

> The lack of a coherent and coordinated national process for making communication policy is likely to severely hinder efforts to develop and execute an appropriate strategy for dealing with the myriad of communication policy issues that will emerge as the United States takes its place in an increasingly global information economy.[8]

[7] U.S. Department of Commerce, National Telecommunications and Information Administration *NTIA Telecom 2000*, NTIA Special Publication 88-21 (Washington, DC: U.S. Government Printing Office, October 1988), p. 179. See also OTA, *Critical Connections*, op. cit., footnote 1.

[8] For a discussion of such issues, see Henry Geller, *The Federal Structure for Telecommunications Policy* (Washington DC: The Benton Foundation, 1989); OTA, *Critical Connections*, op. cit., footnote 1; OTA, *Radiofrequency Use and Management*, op. cit., footnote 2; and *NTIA Telecom 2000*, op. cit., footnote 7, ch. 9.

[9] OTA, *Critical Connections*, op. cit., footnote 1, p. 361.

Because this issue has not been adequately addressed in the past, many of the problems of international radiocommunication policy development still exist today. Beyond responding to specific WARC issues, broad goals are few and ill-defined. No single vision guided U.S. policy development in preparation for WARC-92, and there is no long-term plan that incorporates and integrates domestic spectrum needs and policy with international spectrum policy. In its report to the ITU, the Advisory Group on Telecommunication Policy notes:

> It is to be expected that in the future governments will need to incorporate telecommunication policy directly into a cross-sectoral, long-term socio-economic strategy for new technologies, within a framework of economic and social growth. In some countries governments are already seriously studying this issue.[10]

Government policymakers generally agree that more long-term strategic planning is needed for spectrum, but do not want to concretely ''plan' for future spectrum use and development. In pointing out the difficulty of centralized planning, they maintain that it is virtually impossible to develop a plan that specifies what bands will be used for what purposes when future needs, technologies, and applications are unknown. The present strategy of responding to evolving uses ensures that the system is flexible enough to adapt to new technologies and services. Specific planning, they fear, would destroy this flexibility and force the United States to commit to applications and systems that might not be efficient or needed in the long term. This view reflects long-held U.S. opposition in international spectrum policymaking to a priori planning of the radio frequency spectrum. While there is merit in this position, especially given the diverse nature of the U.S. radiocommunications industry, it does not mean that the present market-driven system is meeting all needs in a timely fashion. Legislation that has been proposed in the Congress to shift some frequencies from Federal Government use to commercial and public use indicates, in fact, that the U.S. market-driven system does have problems.[11]

It is important to note that coordinated and focused spectrum policy development does not necessarily imply centralized spectrum planning. Philosophical opposition to government planning does not necessarily preclude the setting of long-term priorities and goals and developing strategies to achieve those goals, including strategies for WARCs. Between a rigid spectrum "plan" and a completely market-driven system, it may be possible to develop a flexible framework that allows radio technology and system development to respond in a timely way to market forces, while at the same time marshaling those forces in the context of a longer range, more comprehensive framework for developing radiocommunication policy and services. A cooperative partnership with the private sector to establish some general direction to the process and define some basic goals and priorities could satisfy private sector calls for more direction and aggressive government involvement without putting government policymakers in the position of spectrum "planner."

Finally, from an international perspective, the proposed regularization of the ITU WARC schedule affords the United States an opportunity to revisit the issue of more formal spectrum planning. An ongoing series of conferences, conducted at regular intervals, may allow the United States to develop plans and coordinate resources in a more effective manner. Efforts to develop strategic goals and objectives for WARC preparations should be an integral part of the long-range planning process for spectrum use. Goals and priorities must be established, and resources allocated to ensure that government and industry representatives working on ITU or WARC preparations have the funds, time and staff necessary to prepare U.S. positions in an effective and timely manner.

Personal Relationships Drive Preparations

The WARC preparation process depends on the power of individual personalities and the interpersonal relationships among major players. While formal mechanisms do exist through which coordination takes place, individual experience and personality are the most important determinants of effective coordination in the WARC process. The process works because the individuals involved have a commitment to work cooperatively, not because rigid procedures necessarily force them to. In short, the mechanisms for coordinating WARC

[10] International Telecommunication Union, ''The Changing Telecommunication Environment,'' Report of the Advisory Group on Telecommunication Policy, February 1989, p. 3.

[11] See the Emerging Telecommunications Technologies Act of 1991 (H.R. 531, H.R. 1407, and S. 218).

proposals work because the people involved make them work.

When participants "play by the rules," the process works smoothly, but when individuals will not compromise or cooperate, government officials and private sector representatives complain that the process cannot work because people do not understand what they are doing. It is not clear that if the current players were replaced, the system would continue to work as well. Some analysts maintain that changing the individuals involved would not harm the process, that company and/or agency perspectives and goals would still be adequately communicated and addressed. While this may be true to some extent, the individual experience gained through many years of involvement in the process will not be easily replaced. The individuals involved and the personal relationships they have forged are more important than the procedures they follow or the formal institutional arrangements that exist.

In WARC-92 preparations, the individuals involved got along well, and cooperation among agencies was good. Several factors contributed to this cooperative atmosphere. First, the individuals involved have, in many cases, been participating in WARC preparations for many years. Relationships and a basis for understanding each other have been formed over a long period of time. Second, a great deal of crosspollination occurs between the three Federal telecommunication policy agencies and between the government agencies and the private sector. Many State Department staff, for example, came from the FCC. This fosters an understanding of how the process works, what individuals' roles require, and what pressures are put on their colleagues. The private sector also benefits from government experience. Many of the consultants and lawyers representing industry came from government and understand how the process works and what is important. These good relations-especially among the heads of NTIA, FCC, and CIP-represent a tremendous opportunity to reform the international spectrum policy process in this country. U.S. policymakers must capitalize on the current spirit of cooperation in order to ensure the long-term effectiveness and responsiveness of U.S. international spectrum policy.

Despite the relative success of the WARC-92 preparations, however, the current dependence **on** individuals and personal relationships for guiding the WARC process may ultimately undermine long-term U.S. interests. First, the mechanisms for coordinating international policy may prove inadequate in the near future. The successor failure of the preparations process depends on people working together, within the government and between the government and the private sector. Changes in personnel as staff retires or transfers, and shifts in emphasis or philosophy may threaten future cooperation; current collegial relations may vanish and battles over responsibilities and roles could recur.[12] Especially troubling is the aging of current government spectrum policymakers and radiocommunication industry representatives. The cadre of spectrum policymakers in this country is small, and many of the most experienced U.S. international radiocommunication experts will retire in the next 5 to 10 years. Few young people have entered the field, and fewer are being trained by the government agencies to replace these retiring staff.[13] The lack of experienced younger staff could reduce U.S. effectiveness in international negotiations as inexperienced spectrum policymakers assume more important roles. This problem is especially critical because the international spectrum policy process is built on personal involvement and individual memory rather than on formal mechanisms and institutional memory. Without these individuals, the (little) continuity and the direction in U.S. international spectrum policy could be lost.[14]

Second, in the absence of larger policy goals and more involved high-level oversight, a danger exists

[12] At the higher levels of the three agencies, such battles have occurred in the past, and personality conflicts—e.g., at the 1989 Nice Plenipotentiary-have caused problems.

[13] NTIA recognizes the seriousness of this problem in an appendix to its report: "The need for the training of personnel is more critical today than it was when the earlier NTIA/OTP [Office of Telecommunications Policy] training program started, because of the increased complexity of managing the spectrum and the aging of current agency staffs, with few replacements entering this field." U.S. Department of Commerce, National Telecommunications and Information Administration *U.S. Spectrum Management Policy: Agenda for the Future*, NTIA *Special* Publication 91-23 (Washington, DC: U.S. Government Printing Office, February 1991), p. H-3.

[14] The problem is less serious in the private sector, which is better able to attract and keep qualified young spectrum engineers and managers. Other countries also are aggressively bringing along young staff. Japan, for example, often sends large delegations to conferences, many of whom are young staffers whose primary role is to observe and learn.

that instead of national policies or even agency/ departmental policies, that individuals may project their own goals and values into the process. These goals, although based on years of experience, may nonetheless be very narrowly focused and take inadequate account of all perspectives. Stronger, more formalized arrangements to coordinate international policies may need to be imposed to ensure that adequate and ongoing cooperation occurs in the long term.[15]

Little High-Level Commitment

The domestic process of preparing for WARCs suffers from a lack of high-level attention and inspired policy guidance. Spectrum issues must be addressed at a high enough level in the government and industry to ensure that radiocommunication policy is clearly linked to policy goals guiding trade and other economic, social, and political objectives. High-level coordination between FCC, NTIA, and the State Department would provide leadership, direction, and coordination for WARC preparations and for the development of broader radiocommunication policies. But more fundamental change may be needed. Some analysts, for example, maintain that the United States suffers from the absence of a permanent Head of Delegation who could represent the United States at all major international radiocommunication conferences, build long-term relationships and alliances with other delegates, and who could provide continuity to U.S. delegations across WARCs. Officials at NTIA, FCC, and the State Department do not have the necessary position to accomplish this objective. Some have suggested that the United States should establish a position similar to the U.S. trade representative to address international telecommunications matters.

Recent government initiatives indicate that spectrum issues have become more important than in the past, and U.S. agencies are beginning to tackle them more aggressively. NTIA's recent report on spectrum management, for example, indicates that the Federal Government is beginning to take the issues of spectrum management more seriously, and is beginning to think more strategically about the radio frequency spectrum as an important competitive resource.[16] The FCC has also responded to the increased importance of spectrum issues through its ongoing study on the creation of a spectrum reserve for new technologies and services.

Resource Constraints

The lack of high-level support for ongoing international spectrum activities translates into shortages of funds and personnel. One of the critical problems with domestic and international spectrum decisionmaking is a serious shortage of qualified personnel to manage spectrum resources and develop policy.[17] Because of their small numbers, staff at both the FCC and NTIA are stretched thin. At the FCC, for example, when an international conference such as WARC-92 takes place, FCC staff must add WARC issues to their existing duties. Not only does this take time away from "official" duties, it also gives inadequate time to the new, but equally important and more time-consuming, task Of preparing for the conference.[18] Although the work is getting done, more staff devoted to conference preparation and international activities in general could help ease the agencies' workloads, speed decisionmaking, and contribute to a higher quality of policymaking.

Inadequate funding for FCC, NTIA, and State Department international spectrum activities hurts the U.S. preparations process in several ways. First, lack of funds means that these agencies cannot start preparing for international conferences early enough. Preparation times are compressed, with the result that a lot gets done at the last minute and some things may not get done at all. Second, many personnel problems are the direct result of inadequate funding. Without adequate funding, government agencies cannot attract, train, and keep qualified young spectrum engineers and managers. Third, lack of travel funds curtails preconference activities that are crucial for building alliances with other countries and developing conference strategies. If the United States is to be successful at future conferences,

[15]More formalized coordination of domestic spectrum policymaking was recommended in NTIA, *U.S. Spectrum Management Policy*, o 13, p. 51.

[16]Ibid., p. 13.

[17]The shortage is especially acute among minorities and women. Few are involved in international spectrum policymaking.

[18]More time-consuming in the sense that much of the preparation process entails engaging in bilateral and multilateral talks with foreign administrations. This usually means frequent travel, and often for extended periods of time.

representatives from U.S. Government agencies must have adequate time and money to develop new alliances and cultivate existing relationships. Without such preconference work, the United States may seriously threaten its effectiveness when decisions are made at conferences.

Government Frequency Data Is Inadequate

The lack of coordinated policymaking is complicated by the lack of adequate information from the government agencies themselves regarding spectrum use, another problem that goes back decades. In 1959 hearings on spectrum allocation, one witness stated:

> . . . although all the non-Government [civilian] users present information of use and justification for what they request in the spectrum, similar information is not submitted with respect to the [Federal] Government use of the spectrum which might indicate how the entire natural resource could best be utilized. The [Federal] Government users are not required to justify before Congress, public opinion, or any impartial body, their use of frequencies . . . and there is certainly an inability on the part of non-Government users to obtain the information regarding Government usage which is pertinent to any resolution of the problems.[19]

Today, the situation remains unchanged. Many in the private sector complain that it is difficult for them to apply for new services or propose new positions for the U.S. internationally when they do not have adequate information about government spectrum use.[20] In preparing for a WARC, such information is crucial for both the FCC and the private sector—inadequate information severely limits their ability to develop effective proposals.

Summary and Implications

WARC-92 represents a significant opportunity for the United States to capitalize on its technological leadership, influence world opinion, and guide negotiations on spectrum allocations. It also represents a challenge for the United States to protect the gains that U.S. innovation and research and development have provided. Changes in domestic priorities and the international scene offer an opportunity for individual agencies to reassess their conference preparation processes. Proposed changes in the ITU, especially, provide the United States with an opportunity to reevaluate how international telecommunications policy is made and how government agencies and industry prepare for international conferences. A regular conference schedule would help regularize planning for future conferences and would make the preparations process less subject to the "fits and starts" of the past. The FCC has already taken a step in this direction with the establishment of Office of International Communications. More cooperation and continuous institutionalized leadership would serve to smooth out the bumps and plan U.S. preparations for the long term.

The fundamental problem with domestic WARC preparations is that roles and functions are not specifically defined. Processes are not always well understood, and while a structure for coordination between the NTIA, FCC, and State Department exists, it is highly dependent on the abilities and personal relationships of the individuals involved. In order to rationalize the process and lessen its dependence on the individuals involved, many have called for a clarification of the roles of the three agencies regarding international activities and negotiations possibly by modifying Executive Order 12,046 and/or by restructuring the agencies themselves in a more rational and complementary manner. The objectives of such a restructuring would be to provide formal mechanisms for coordination of policy, including specific recommendations for resolving conflicts, and promote increased high-level interaction by the heads of the various agencies in order to build a common vision to guide U.S. policy overseas and to guide the actions of U.S. delegations at international conferences. Some analysts believe that merely clarifying roles is not enough, and have called for the creation of a single agency to oversee telecommunications policy and

[19] Harold E. Fellows, testimony at hearings before a Subcommittee of the House Committee on Interstate and Foreign Commerce, on Allocation of Radio Spectrum Between Federal Government Users and Non-Federal Government Users, 86th Cong., 1st sess., June 8 and 9, 1959, p. 36.

[20] One of the stronger themes that appeared in OTA'S workshop on WARC-92 was the inadequacy of data on government (and commercial) spectrum use. Many of the participants, both government and private sector, recognized easy and timely access to such information as a prerequisite to better spectrum management overall. For a detailed discussion of the problems of access to government spectrum information and proposals for opening up the government process, see NTIA, *U.S. Spectrum Management Policy,* op. cit., footnote 13. The report makes many recommendations for improving access to information and statistics on government use of the spectrum. NTIA has already begun to implement many of the proposed changes, and expects to begin others in the next several years.

development in this country.[21] Some industry participants in the WARC-92 process have called for a similar agency or office that would coordinate international spectrum policy, including WARC preparations.

Improving the WARC preparations process will entail serious tradeoffs. Centralizing authority could make the process more efficient, but could also jeopardize the free exchange and representation of ideas. Instituting formal voting arrangement among private sector participants might produce decisions more quickly, but the process of attracting and brokering votes could make the outcome highly political. Improving existing coordination procedures seems most realistic in the present and short term, but such incremental changes may have limited effects. More serious study of such problems and options is needed.

[21] *NTIA Telecom 2000*, op. cit., footnote 7, ch. 9; @her, Op. Cit., footnote 8.

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Appendix A
Acronyms and Glossary of Terms

Ad Hoc 206: A subcommittee of the IRAC that was established to coordinate Federal agencies' preparations for WARC-92.

Allocation: The designation of a band of frequencies to a specific radio service or services. Allocations are made internationally at World Administrative Radio Conferences and are incorporated into the international Table of Frequency Allocations. International allocations are usually, but not always, incorporated into domestic frequency tables.

Analog: In analog radio communication, information is transmitted by modulating a continuously varying electronic signal, such as a radio carrier wave. Voice and video messages originate in analog form since sound and light are wave like functions. In order to send these analog signals over digital media, such as fiber optics or digital radio, they must be converted into a digital format. See digital, and modulation.

APC: Aeronautical public correspondence. APC refers to radiocommunication services that allow airline passengers to place telephone calls while in flight. Also known as air-to-ground (ATG) communication.

Assignment: The granting by a government of the right to use a specific frequency (or group of frequencies) to a specific user or station. Each television station, for example, is granted a small group of frequencies that correspond to a specific channel number.

Bandwidth: The total range of frequencies required to transmit a radio signal without undue distortion is its bandwidth. It is measured in hertz. The bandwidth of a radio signal is determined by the amount of information in the signal being sent. More complex signals contain more information, and hence require wider bandwidths. An AM radio signal, for example takes 10 kHz, while an FM signal requires 200 kHz, and a television signal takes up 6 MHz. The bandwidth required by a television channel is 600 times greater than that of an AM radio channel.

BSS: Broadcasting-Satellite Service. An ITU-designated service that refers to the delivery of information or programming from satellites directly to user receivers. Subsets of BSS include new systems planned to deliver high-definition television services (BSS-HDTV) and audio services (BSS-Sound).

Carrier: **A** radio wave that is used to communicate information. Information to be transmitted is impressed onto the carrier, which then carries the signal to its destination. At the receiver the carrier is filtered out from the radio signal to recover the original information. See modulation.

CCIR: International Radio Consultative Committee. An organ of the ITU that studies and makes recommendations on the technical standards for radiocommunication.

CCITT: International Telegraph and Telephone Consultative Committee. An organ of the ITU that studies and makes recommendations on the technical and operational standards for international wireline communications. CCITT also addresses international tariff issues.

CDMA: Code division multiple access. CDMA is a recently developed radiocommunication format that uses digital technology and spread spectrum transmission to send information. Each radio signal is assigned its own unique code and is then spread over a range of frequencies for transmission. At the receiving end the receiver can reconstruct the original signal by following the code.

CEPT: Conference of European Postal and Telecommunications Administrations. Established in 1959, CEPT consists of 31 European telecommunications administrations. It acts to coordinate and reconcile regional telecommunications policy.

CIP: Bureau of International Communications and Information Policy. Bureau of the State Department that represents the United States in international telecommunications negotiations and conferences.

CITEL: The Inter-American Telecommunications Conference. A specialized conference of the Organization of American States (OAS) that deals with both radio and wireline communications. CITEL is a permanent, ongoing series of conferences that has 35 members from North and South America and the Caribbean.

C-band: C-band is the designation for satellite communications that use 6 GHz uplinks and 4 GHz downlinks. These frequencies are also extensively used for terrestrial microwave communication.

CT2: Cordless telephone 2. Personal communications system that allows users to make calls, but not receive them. CT2 systems have been demonstrated in Europe, but only one system has been demonstrated in the United States.

DAB: Digital audio broadcasting. DAB refers to the transmission of audio broadcasts in digital form as opposed to today's (AM or FM) analog form. DAB promises compact disc quality sound over the air. Many formats are being developed, and transmission is possible via terrestrial transmitters, satellites, or hybrid systems.

DBS: Direct broadcast satellite. Medium- to high-power satellites that are designed to transmit programming directly to small satellite receive dishes at users' homes. No DBS systems are operating in the United States, although several systems are planned.

Digital: In digital communication, the continuously varying signals of images and voice are converted to discrete numbers represented in binary form by O's and 1's. These binary digits, or bits, can then be sent as a series of 'on' '/''off pulses or can be modulated onto a carrier wave by varying the phase, frequency, or amplitude according to whether the signal is a 1 or a O.

Downlink: In satellite communications, the signal that travels from the satellite down to the receivers on Earth. The direction the downlink signal travels is also called space-to Earth. See uplink.

FCC: Federal Communications Commission. An independent Federal agency that regulates private and all non-Federal government use of the radio frequency spectrum. The FCC is also responsible for regulating most other forms of communication, including broadcast and cable television, and some telephone services.

FMAC: Frequency Management Advisory Committee. A committee within IRAC, composed of representatives from the private sector, that advised IRAC on matters of spectrum policy. The FMAC was recently rechartered as the Spectrum Planning Advisory Committee and will include government representation and a broader mandate.

FPLMTS: Future public land mobile telecommunication systems. FPLMTS is the ITU designation for terrestrial public mobile services, including PCS.

Frequency: The number of complete cycles a radio wave completes in 1 second. Frequency is measured in hertz (1 cycle per second equals 1 hertz). Radio frequencies are described as multiples of hertz:

kHz, kilohertz: thousand cycles per second;
MHz, megahertz: million cycles per second;
GHz, gigahertz: billion cycles per second.

Groundwave: Groundwaves are characteristic of very low frequency radio waves that follow the curve of the Earth as they travel. see ***also*** skywave.

GSM: Global System for Mobile communications, formerly, Groupe Special Mobile. A digital mobile communications standard that has been proposed to provide next generation cellular/mobile services all over Europe.

HDTV: High-definition television. Refers to future generations of television that will have higher picture resolution, a wider aspect ratio, and digital quality sound.

Hertz (Hz): Cycles per second. See frequency.

HF: High frequency. Refers to radio frequencies in the range 3-30 MHz. These frequencies are used by international broadcasting services including Voice of America, religious broadcasters, and fixed services such as the point-to-point communication systems used by developing countries.

HFBC: High Frequency Broadcasting Conference. Specialized world radio conferences were held in 1984 and 1987. A future conference on planning the HF bands has been proposed for 1995.

HLC: High Level Committee. The HLC was established by the Administrative Council of the ITU, in response to instructions from the Nice Plenipotentiary, in November 1989 in order to review the structure and various functions of the ITU. The study included structure, organization, finance, staff, and coordination. The group finished its work in June 1991.

IAC: Industry Advisory Committee. The FCC setup the IAC to coordinate and focus private sector input for the WARC-92 preparation process. It consisted of 35 representatives from the private sector and was co-chaired by FCC Commissioner Sherrie Marshall. It issued its final report in April 1991.

IFRB: International Frequency Registration Board. The organ of the ITU responsible for maintaining the list of radio frequencies used worldwide. It also conducts technical and planning studies for the ITU.

IRAC: Interdepartment Radio Advisory Committee. Established in 1922 and now located in the Department of Commerce, the IRAC consists of approximately 20 to 25 representatives from the various Federal Government agencies involved in or using radio frequencies. The IRAC advises NTIA on matters relating to Federal Government use of the radio frequency spectrum.

ITU: International Telecommunication Union. The ITU is a specialized agency of the United Nations responsible for international regulation of telecommunications services of all kinds, including telegraph, telephone, and radio.

Ka-band: Ka-band is the designation for frequencies in the 30/20-GHz range that will be used for future generations of communications satellites.

Ku-band: Ku-band colloquially refers to frequencies in the 14/12-GHz bands that are used for satellite communications.

LEOS: Low-Earth orbiting satellite. LEO satellites are smaller and cheaper to design, build, and launch than traditional geosynchronous satellites. Networks of these small satellites are being planned that will provide data and voice services to portable receivers all over the world.

Modulation: The process of encoding information onto a radio wave by varying one of its basic characteristics —amplitude, frequency, or phase-in relation to an input signal such as speech, music, or television. The input signal, which contains the information to be transmitted, is called the modulating or baseband signal. The radio wave that carries the information is called the carrier wave. The radio wave that results from the combination of these two waves is called a modulated carrier. Two of the most common types of modulation are amplitude modulation (AM) and frequency modulation (FM).

MSS: Mobile Satellite Service. MSS is an ITU-designated service in which satellites are used to deliver communications services (voice or data usually, one- or two-way) to mobile users such as cars, trucks, boats, and planes. It is a generic term that encompasses several types of mobile services delivered by satellite, including Maritime MSS (MMSS), Aeronautical MSS (AMSS), and Land MSS (LMSS).

NTIA: National Telecommunications and Information Administration. The agency in the Department of Commerce that oversees all Federal Government use of the radio frequency spectrum. NTIA also serves as the President's adviser on all telecommunication matters.

OIA: Office of International Affairs. The office in NTIA responsible for international aspects of telecommunications, including preparation and participation in international communications negotiations and conferences.

OIC: Office of International Communications. Established by the FCC in January 1990 to coordinate and serve as the focal point for international activities in the FCC.

OSM: Office of Spectrum Management. The office of NTIA responsible for day-to-day management of Federal Government spectrum use. Also provides technical assistance to OIA in preparation for international negotiations and conferences.

PCN/PCS: Personal communication network/service. Although the terms are not yet clear, PCS seems to be emerging as an umbrella term that refers to any of the many services (voice and data) designed to serve individuals wherever they are (walking, driving, flying). PCN generally refers to specific networks (in specific locations) that providers want to set up to provide communication services. Alternatively, *the* **PCN** has been used to describe the evolution of the current (wire-based) public telephone network into a comprehensive network integrating wire-based and PCS services.

Period: The length of time it takes a radio wave to complete one full cycle. The inverse of the period is a radio wave's frequency.

Phase: A measure of the shift in position of a radio wave in relation to time. Phase is measured in degrees.

PTC: Permanent Technical Committee. Three PTCs provide technical support to ClTEL. PTC-I deals with public (wireline) telecommunications systems, PTC-11 addresses broadcasting issues, and PTC-III deals with all other areas of radiocommunication.

PTT: Post, telegraph, and telephone administration. PTTs are the government agencies that have been the sole providers of telecommunication services in many foreign countries for years. Today, their power and monopolies are declining in the face of liberalization and privatization.

RDSS: Radiodetermination-Satellite Service. RDSS is an ITU-designated service in which satellites provide location information to ships, planes, vehicles, and even individuals such as hikers.

Refraction: The bending a radio wave experiences as it travels through the atmosphere. As frequency increases, the amount of bending or refraction decreases.

RPOA: Recognized private operating agency. A category for participation in CCIR activities. RPOAs are private telecommunication service providers such as AT&T and COMSAT.

Sideband: Sideband frequencies are generated as part of the modulation process. They consist of newly created frequencies both above (upper sidebands) and below (lower sidebands) the carrier wave frequency. While AM produces a set number of sideband frequencies, FM produces a theoretically infinite number of sidebands.

SI0: Scientific and industrial organizations. A specific category for participation in CCIR activities. SI0s are designers or manufacturers of telecommunication equipment.

Skywave: Skywaves are characteristic of higher frequency radio waves that travel straight (as opposed to groundwaves) and can be bounced off the atmosphere in a process called reflection. This allows radio signals to travel many miles and makes long-distance radiocommunication possible.

SMR: Specialized Mobile Radio. SMR is a radio service created by the FCC to allow providers to offer mobile radio services, such as dispatch and two-way voice communications, to users on a private (as opposed to public cellular service) basis.

Spectrum: The spectrum of an individual radio signal is the range of frequencies it contains. The width of the spectrum is also called the bandwidth of the signal. More broadly, the radio frequency spectrum consists of all the radio frequencies that are used for radio communications.

SSB: Single sideband. A method of transmitting radio signals in which only one sideband is transmitted and, often, the carrier is transmitted at reduced power. See sideband.

Uplink: In satellite communications, the signal that travels from an Earth transmitting station up to the satellite. The direction the uplink signal travels is also known as Earth-to-space. See downlink.

VGE: Voluntary Group of Experts. The VGE was established by the ITU Administrative Council in 1990 to examine ways to simplify the international Radio Regulations. The first meeting of the **VGE** was held in January 1991. Representatives from 22 Administrations participated and observers from 4 international organization also attended.

WARC: World Administrative Radio Conference. WARCs are the primary forum for distributing the frequencies of the spectrum to the various radiocommunication services. They can address all radio services (a general WARC) or only specific portions of the spectrum (specialized WARC). The Final Acts of a WARC have international treaty status and must be signed by member governments. The allocations decided on at a WARC usually are incorporated into domestic tables of allocations.

SOURCES: Harry Mileaf (cd.), ***Electronics One,*** revised 2d ed. (Rochelle Park, NJ: Hayden Book Company, Inc., 1976); U.S. Congress, Office of Technology Assessment ***The Big Picture: HDTV & High-Resolution Systems,*** OTA-BP-CIT-64 (Washington DC: U.S. Government Printing Office, June 1990); William Stallings, ***Data and Computer Communications (New*** York NY: MacMillan Publishing Co., 1985).

Agenda for the 1992 World Administrative Radio Conference

Document 7042E
(CA45-136)
20 June 1990
Original: English

Resolution
(approved at the fourth Plenary Meeting)[1]

R No. *995* WORLD ADMINISTRATIVE RADIO CONFERENCE FOR DEALING WITH FREQUENCY ALLOCATIONS IN CERTAIN PARTS OF THE SPECTRUM (WARC-92)

The Administrative Council,

considering, inter alia

a) that Resolution No. PL-B/1 of the Plenipotentiary Conference, Nice, 1989, scheduled a World Administrative Radio Conference for Dealing with Frequency Allocations in Certain Parts of the Spectrum (WARC-92) to be convened in Spain in the first quarter of 1992 for a period of four weeks and two days;

b) that in accordance with Resolution No. PL-B/1 of the Plenipotentiary Conference, Nice, 1989, the agenda of the WARC-92 shall take into account the Resolutions and Recommendations of WARC HFBC-87, WARC MOB-87 and WARC ORB-88 relating to frequency allocations;

c) that, pursuant to Resolution No. PL-B/1, the WARC-92 may in addition consider defining certain new space services and consider allocations to these services in frequency bands above 20 GHz;

d) that the Plenipotentiary Conference, Nice, 1989, having recognized that the Plan for the aeronautical mobile (OR) service, contained in Appendix 26 of the Radio Regulations requires appropriate adjustments, adopted Resolution No. PL-B/2;

e) that in accordance with Resolution No. PLEN/8 of the Plenipotentiary Conference, Nice, 2989, the WARC-92 should consider the provisions of Articles 55(rev.) and 56(rev.) of the Radio Regulations, as amended by WARC MOB-87.

considering further that the radio spectrum to be considered by this Conference is already allocated to certain radio services, and the requirements of these services must be taken into account.

welcoming the invitation of the Administration of Spain to the ITU to hold WARC-92 in that country.

resolves

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1 Subject to approval being received from a majority of the Members concerned.

1. that the World Administrative Radio Conference for Dealing with Frequency Allocations in Certain Parts of the Spectrum (WARC-92) be convened in Spain from 3 February 1992 for a period of four weeks and two days;

2. the agenda for WARC shall be as follows:

on the basis of proposals by administrations and taking account of reports from the IFRB and the CCIR:

2.1 to consider definitions for certain new space applications and to review the relevant provisions of Article 1;

2.2 to review the provisions of Article 8, taking account of considering further above, with a view to:

2.2.1 the consideration of possible allocations of frequency bands above 20 GHz to the new space service applications[2]

2.2.2 the possible extension of the frequency spectrum allocated exclusively to HF broadcasting, as indicated in Recommendation No. 511 (HFBC-87);

2.2.3 the consideration of the allocation of frequency bands to the broadcasting-satellite service and the associated feeder links:

a) for the broadcasting-satellite service (sound) in the range 500-3000 MHz, as indicated in Resolution 520(Orb-88), including the accommodation of complementary terrestrial sound broadcasting uses within this allocation;

b) for the development in the approximate range 1 -3 GHz of a would-wide system of public correspondence with aircraft, as indicated in Recommendation No. 408(Mob-87), or designate for this use a band already allocated to the mobile service in the same range;

c) for the development of the international use of the mobile service for future public land mobile telecommunication systems, as indicated in Recommendation No. 205(Mob-87), or designate for this use a band already allocated to the mobile service;

d) consider possible allocations of up to 5 MHz of a frequency band below 1 GHz to low-orbit satellites on the basis of appropriate sharing criteria;

2.2.5 the consideration of the allocation of the frequency band 14.5 -14.8 GHz to the fixed-satellite service (Earth-to-space) with due protection of assignments appearing in Appendix 30A of the Radio Regulations, and to take account of services to which these frequency bands are currently allocated;

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2 Communications with manned space vehicles may be defined as a new space application which may require the indication of the space service and the frequency bands that this service may use for this purpose.

2.2.6 the examination of the frequency bands 2.025-2110 MHz and 2200-1 290 MHz for the space operations and space (research services, as indicated in Recommendation 716(Orb-88);

2.2.7 the consideration of footnotes relating to the radiodetermination-satellite service in the frequency range 1.6-25 GHz with the view to harmonizing them and allowing administrations to revise the status of their respective allocations to this service and to review the sharing criteria as indicated in Resolution No. 708(Mob-87);

2.2.8 the examination of the footnotes RR 635 and RR 797B;

2.3 to consider the provisions of Articles 55(Rev.) and 56(Rev.) of the Radio Regulations which concern the mandatory carriage on board ships of personnel equipment, as indicated in Resolution No. PLEN/8[3];

2.4 to consider minimum modifications to Article 12 of the Radio Regulations as a result of actions taken with regard to Appendix 26, as indicated in Resolution No. PL-B/2[4];

2.5 to consider appropriate action, in light of the decision of the Conference relating to definitions in accordance with Resolution No. PL/10[5];

2.6 to make such consequential changes and amendments in the Radio Regulations as may be necessitated by the decisions of the Conference;

2.7 to develop new Recommendations and Resolutions in relation to the agenda of the Conference including Meteorological aids service in frequency bands below 1000 MHz and present allocations to space services above 20 GHz which were not placed on this agenda;

2.8 to consider problems associated with the use of the frequency bands in the range 401 -403 MHz by the meteorological satellite and earth exploration satellite services with the view to recommend their consideration by the next competent administrative radio conference;

2.9 to consider, revise as necessary, and take other appropriate action upon the relevant Recommendations and Resolutions;

2.9.1 to safeguard the interests of services that may be affected by changes in the Table of frequency allocations by adopting appropriate sharing criteria when required and to adopt appropriate schedule for the entering into force of the decisions adopted by the Conference;

2.9.2 to review Resolution No. 703 in the light of the procedure adopted by the XVIIth CCIR Plenary Assembly (Resolution PLEN/75) for the approval of Recommendations in the interval between Plenary Assemblies;

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3 Plenipotentiary Conference, Nice, 1989.

4 Plenipotentiary Conference, Nice, 1989.

5 Plenipotentiary Conference, Nice, 1989.

2.10 to identify the financial implications of the decisions of the Conference, taking into account the Union's budgetary provisions, and as necessary to submit a statement thereon to the Administrative Council in accordance with Article 80 of the International **Telecommunication Convention and Resolution No. 48 of the Plenipotentiary Conference, Nairobi, 1982,**

invites

1. **the CCIR to prepare the technical and operational bases for the Conference and to submit to administrations and a report setting out the results of its work at least eight months prior to the opening of the Conference.**

2. the IFRB to provide technical assistance for the preparation and organization of the Conference and to submit to all administrations a report on results with respect to the appropriate above agenda items at least ten months prior to the opening of the Conference.

instructs the Secretary-General

1. **to make all the arrangements necessary for holding the Conference;**

2. to communicate this Resolution to ICAO, IMO, WMO and to other concerned international organizations.

Appendix C

Applications for New Services

The following is a list of companies that have applied to the Federal Communications Commission for licenses (both operational and experimental) in four new services: Broadcasting-Satellite Service-Sound (BSS-Sound); direct broadcasting satellites (DBS); low-Earth orbiting satellites (LEOS); and personal communication networks (PCN).

Broadcasting-Satellite Service-Sound

Company	Band	Status	Comments
Afrispace (WorldSpace)	1470-1530 MHz, 29.9-30.0 GHz	Experimental—granted Operational—pending	Experimental license to broadcast direct radio services all over Africa and the Middle East. Trying to prove that direct, high-quality radio broadcasts will work over large regions. Plans to lease channels to governments and will donate capacity to the World Health Organization.*
Radio-Satellite Corp.	1545-1559 MHz, 1646.5-1660.5 MHz	Pending	Applications to use American Mobile Satellite Corp. satellites for digital audio broadcasting service.
Satellite CD Radio	1470-1530 MHz	Pending	Two satellites and hundreds of terrestrial transmitters, which would broadcast up to 100 compact disc-quality radio program channels nationwide.
Strother Communications	225-2700 MHz	Pending	No specific band was requested, just the allocation of 48 MHz in the range listed.

Direct Broadcast Satellite[2]

Company	Band[3]	Status[4]	Comments
Advanced Communications	12.2-12.7 GHz	Granted	Will provide entertainment programming, as well as two full-time transponders, cost free, to the Foundation for Educational Advancement Today.
Continental Satellite Corp.	12.2-12.7 GHz	Granted	Plans to operate largely or exclusively on a common carrier basis.
Direct Broadcast Satellite Corp.	12.2-12.7 GHz	Granted	No programming information available.
Directsat Corp.	12.2-12.7 GHz	Granted	Plans to lease transponders to other providers
Dominion Video Satellite, Inc.	12.2-12.7 GHz	Granted	Plans to focus on educational programming.
Echostar Satellite Corp.	12.2-12.7 GHz	Granted	Will provide entertainment (pay-per-view movies, comedy, and children's programming) plus religious programming.
Hughes Communication	12.2-12.7 GHz	Granted	Plans to operate as a common carrier.
Tempo Satellite, Inc.	12.2-12.7 GHz	Pending[5]	Expected to be the DBS platform to which the K Prime Partner venture would migrate.
United States Satellite Broadcasting Co.	12.2-12.7 GHz	Granted	Plans to use 3 satellites to deliver 11 channels of diversified entertainment programming nationwide. It is the highest powered DBS service yet proposed.

[1]Mary Lu Carnevale, "FCC Gives License to WorldSpace for Radio Satellite," *Wall Street Journal*, June 24, 1991, p. B1.
[2]All information on DBS bandwidths and status are from "Crowded DBS Field Awaits Orbit/Channel Allocations by Fee," *The DBS Report*, June 1990, pp. 1,7-8,
[3]This range was preset as the band for DBS services by the FCC.
[4]All DBS applications are for operational systems.
[5]The FCC is holding capacity in reserve until a character qualification issue is resolved.

Low-Earth Orbiting Satellite[6]

Company	Band	Status	Comments
Constellation Communications, Inc.	1610- 1625.5 MHz (uplink), and 2483.5-2500 MHz (downlink)	Pending for both operational and experimental licenses	Aries system of 48 satellites would include position determination/reporting, two-way telephony, dispatch voice, facsimile, and data collection, distribution, and control services.
Ellipsat	1610- 1626.5 MHZ (uplink), and 2483.5-2500 MHz (downlink)	Pending	Ellipso unit will connect to a cellular phone-converting 800-MHz cellular to the 2.5/l.6-GHz Radiodetermination-Satellite Service (RDSS) bands.
Leosat	148-149 MHz (uplink) and 137-138 MHz (downlink)	Pending	Planning to provide communications for an intelligent vehicle highway system (IVHS).
Loral Cellular Systems Corp.	1610-1626.5 MHz, 2483.5-2500 MHz	Pending	The Globalstar system will use 24 satellites for U.S. coverage (48 for global coverage) and will provide RDSS, voice and data communications using Code Division Multiple Access (CDMA) spread spectrum. They have three alternative spectrum proposals, with feeder links in the C-band. Loral is jointly owned by Loral Aerospace and Qualcomm.
Motorola, Inc.	1610- 1626.5 MHz[7]	Pending	The Iridium system would use 77 satellites to provide mobile and portable phone service to any location on Earth. Planned startup in 1997.
Orbital Communications Corp.	137-38 MHz and 148-149.9 MHz	Experimental—granted Operational—pending	Requesting a 370-kHz band in the frost range (downlink) and a 478-kHz band in the second (uplink). The Orbcomm system would be used for low-cost, low-speed data transmissions.
Starsys, Inc.	137-38 MHz and 148-149.9 MHz	Pending	The Starnet system will use the same bandwidths as Orbcomm, providing data services.
TRW, Inc.	29.5 -30.0 GHz 19.7 -20.2 GHz 1610-1625.5 MHz 2483.5-2500 MHz	Pending	The 12-satellite Odyssey system (operating at medium earth orbits) plans to provide voice, radiolocation, messaging, and data services using CDMA spread spectrum modulation.
Volunteers in Technical Assistance, Inc. (VITA)	137-138 MHZz 148-149.9 MHz, 400.15-401 MHz	Operational—pending Experimental—granted	VITA is a nonprofit organization that plans to offer data services, including file transfer. The system would offer services in health, education, and technical assistance primarily for developing countries. Experimental system has been operating since 1990, and system is planned to be operational in 1993-94.

[6] All bandwidth information for LEO satellites is from Federal Communications Commission, "An Inquiry Relating to Preparation for the International Telecommunication Union World Administrative Radio Conference for Dealing With Frequency Allocations in Certain Parts of the Spectrum,"Gen Docket No. 89-554, *Supplemental Notice of Inquiry*, *6 FCC* Rcd 1914 (1991); and "TRW, Loral/Qualcomm Venture . . ." *Telecommunications Reports*, vol. *57, No. 24*, June 17, 1991, pp. 28-30.

[7] Andrew Jenks, "Flurry of Low Earth Orbit Filings Flood the FCC," *Washington Technology*, vol. *6, No. 6*, June 13, 1991, p. 9.

Personal Communication Services

Company	Band	Status[9]	Comments
Adelphia Cable Communications	902-928, 1850-1990, 2400-2483.5 *MHz*, 12.7 -13.5 GHz	Pending	Personal communication services (PCS) test by cable company using fiber optic in Pittsburgh, Miami, Buffalo, and Tequesta, FL.
Advanced Cordless Technologies	930.5 MHz (paging), 902-928, and 940-941 MHz. Also 864-868.1 MHz	Granted	Using CT2 technology in New York City. Second application (864-868 MHz) granted for use in Monticello, NY.
Advanced Mobilecom Technologies, Inc.	901-902,930-931, 940-941 MHz (902-928: Part 15 Spread spectrum device)	Granted	Two simultaneous applications granted: one in Boston and one in Miami-Ft. Lauderdale.
Advanced Wireless Communications, Inc.	849-851,864-868, 894-896,901-902, 930-931,940-941, 1850-1990 MHz	Pending	Tests of CT2 and PCN systems, testing possible sharing with air-to-ground in San Francisco and Cincinnati.
American Personal Communications, Inc.	901-902,930-931, 940-941 MHz.	Granted	Partnership with the *Washington Post* to provide service in and around Washington, DC.
	Also 1850-1990 MHz	Granted	A second application has been granted to test services in Washington, DC and Baltimore, MD.
American Telezone	2400-2483.5 MHz	Granted	For use in eastern Texas, using Part 15 telepoint service. Application also granted for southern California.
Ameritech Direct Communications, Inc.	1850-1990 MHz	Granted	Spread spectrum in Chicago.
Associated PCN Corp.	1850-1990 *MHz*	Granted	For use in Los Angeles, using spread spectrum. Pending application for the same technology and frequency for New York, Chicago, and Washington, DC.
Atlantic Cellular Co., L.P.	902-928,931-932, 941-948, 1850-1990MHz	Pending	PCN equipment test in Manchester, NH, Providence, RI, and Boston. A second application is pending for a PCS test in San Francisco and San Jose.
AT&T	1850-1990 *MHz*	Granted	Research of different types of PCN equipment in Chester, NJ.
AT&T	5.9-6.4 GHz	Pending	Systems would use existing microwave relay towers to trial PCN hardware and software in Boston, Atlanta, and Los Angeles.
Barden Communications, Inc.	902-928, 1850-1990, 2400-2483.5,5725-5850 *MHz*, 12.7 -13.5 GHz	Pending	PCS test by cable company using fiberoptic in Detroit.
Bell Atlantic Mobile Systems, Inc.	902-928,1850-1990, 2400-2483.5 *MHz*	Pending	Development of PCS equipment for Pittsburgh, Philadelphia, Bedminister, NJ, and Washington, DC.
BellSouth Enterprises, Inc.	866-869,902-928, 1850-1990 *MHz* Also 846.5-849 *MHz*	Granted	Two separate applications granted. First in Atlanta, second in Athens, GA. CT2 in Athens, using cellular frequencies.

[8] All information on PCS *was provided* in Federal Communications Commission "PCS Experimental Applications by Filed Date," May 30, 1991, unpublished document.
[9] All applications are for experimental systems.

Personal Communication Service[8]

Company	Band	Status[9]	Comments
Bell South Services, Inc.	864-869,902-928, 1850-1990 MHz	Granted	Tests of wireless Access Business Systems in Birmingham, AL and Atlanta.
BNR, Inc. (Subsidiary of Northern Telecom)	864-868,902-928,930-960, 1850-1990,2400-2483.5, 5725 -5850 MHz	Pending	CT2 and PCN in Richardson, TX, Mountain View, CA, and ResearchTriangle Park, NC. Also have an application pending for a 1-day demo of equipment (nationwide) on same frequencies.
Cable TV of East Providence, Inc.	902-928,1850-1990,2400-2483.5, 5725 -5850 MHz	Pending	Use of cable to tie cells together in East Providence, RI.
Cable USA, Inc.	866-868, 1850-1990 MHz	Granted	CT2 and PCN in Omaha, Kearney, Grand Island, and Hastings, NE.
Cablevision	902-928,2400-2483S,W25-5850 MHz and 12.7-13.5 GHz	Granted	PCN interfacing with existing cable system in Cleveland, New York City, Chicago, and Boston.
CASCO Cable Television, Inc.	902-928,1850-1990,2400-2483.5,5725-5850 MHz	Pending	Cable used to tie cells together in Brunswick, ME.
Cellular 21, Inc.	866-868 MHz and 940-941 MHz	Granted	Two applications have been granted. The first (866-868 MHz) was for a test of British equipment in Gillet, PA and Elmira-Ithaca, NY. The second (940-941 MHz) was for a 50-mile radius around the Empire State Building, with only one base station.
Cellular General, Inc.	866-868 MHz	Granted	A test of British equipment in Deerfield, FL.
Cellular Services, Inc.	901-902,930-931,940-941, 1850-1990 MHz	Pending	PCS test in Los Angeles.
Cencom Cable Associates, Inc.	1850-2120 MHz, 12.7-13.5 GHz	Pending	Development of PCS equipment by cable company using fiber optic in Riverside, CA, Alhambra, CA, Olivette, MO, and Fultondale, AL.
Cincinnati Bell Telephone Co.	864-868, 1850-1990 MHz	Pending	CT2 and PCN test in Cincinnati.
Citizens Utilities Company of CA	902-928, 1850-1990 MHz	Pending	Development to replace local loop in Elk Grove, CA.
COMCAST Corp. "	902-928,1850-1990,2400-2483.5 MHz and 12.7-13.5 GHz	Pending	Cable will be used to tie cells together in Indianapolis, Baltimore, Philadelphia, West Palm Beach, and Los Angeles.
Continental Cablevision of California, Inc.	1850-1990 MHz and 12.7-13.5 GHz	Granted	Uses cable to tie cells together in Stockton, CA.
Continental Cablevision of Jacksonville, Inc.	1850-1990 MHz and 12.7-13.5 GHz	Granted	Uses cable to tie cells together in Jacksonville, MS.
Continental Cablevision of Massachusetts, Inc.	1850-1990 MHz and 12.7-13.5 GHz	Granted	Uses cable to tie cells together in Boston.
Cox Enterprises, Inc.	902-928,2400-2483.5,5725-5850, and 1850-1990 MHz	Granted	For use in San Diego and New York City.
Cylink Corp.	902-928,2400-2483.5,5725-5850 MHz	Pending	Nationwide demo of Part 15 devices,
Dial Page, L.P.	866.1 -868.1 MHz	Pending	Test of foreign equipment in High Point, NC.

[8]All information on PCS was provided in Federal Communications Commission "PCS Experimental Applications by Filed Date," May 30, 1991, unpublished document.
[9]All applications are for experimental systems.

Personal Communication Service[8]

Company	Band	Status[9]	Comments
Digital Spread Spectrum Technologies, Inc.	902-928,2400-2483.5,5725-5850, and 1850-1990 MHz	Granted	PCN and Part 15 devices in San Jose and San Francisco.
Easyphone, Inc.	864-866, and930-960 MHz	Granted	CT2 in San Francisco and Los Angeles.
Ericsson Paging Systems, Inc.	940-952 MHz	Granted	A wireless PBX system, in building, for use in Washington, DC, and Anaheim, CA.
General Instrument Corp.	864-868,902-928, 1850-1990,2400-2483.5 MHz	Pending	Development of PCS equipment in Hatboro, PA.
Graphic Scanning Corp.	1910-1920 MHz	Granted	Application granted for Detroit, White Plains, New York City, and Chicago.
GTE Mobile Communications	849-851, and 894-896 MHz	Pending	Test will cover the continental U.S. near Airfone stations. Will use CT2 to test the potential use of air-to-ground frequencies for CT2 use.
Hewlett Packard Co.	864-868 MHz	Pending	Test of foreign equipment at own office in Camel, IN.
Intermedia Communications of Florida, Inc.	1850-1990 MHz	Pending	Development of PCS by cable company in Tampa and Orlando.
LDH International, Inc.	901-902,902-928,930-931,940-941,2400-2483.5,5725-5850 MHz and27.5-21L14and28.5-29.14 GHz	Granted	For Greenville, NC, Denver CO and Atlanta.
Linkatel Communications, Inc.	1850-1990 MHz	Pending	PCN in San Diego, Palm Springs, Phoenix, and Las Vegas.
LiTel Telecommunications Corp.	2400-2483.5,5725-5850MHZ	Granted	2400-MHz band for communication between users and base station, 5700-MHz band used to tie base stations together. Both bands Part 15 Spread spectrum device. For use in Columbus, OH.
LiTel Telecommunications Corp.	864-868,902-928,930-960, 1850-1990,2400-X83.5, 5725-5850 MHz	Pending	PCS test in Cleveland and Cincinnati.
			Local Area Telecommunications, Inc.
	1850-1990 MHz	Pending	PCN in San Juan, Puerto Rico.
Matrix Personal Communications, Inc.	901-902,930-931, and 940-941 MHz	Granted	For use in Chicago.
McCaw Cellular Communications, Inc.	864.1 -868.1 MHz	Granted	For use in Orlando, Seattle, and West Palm Beach. CT2 service and equipment would be converted to cellular frequencies later.
Media General Cable of Fairfax County, Inc.	902-928,1850-1990,2400-2483.5,5725-5850MHz	Pending	Development of PCS equipment by cable company in Fairfax, VA.
Micronet, Inc.	864-868 MHz	Pending	Test of foreign equipment in Lancaster, Jamison, and Philadelphia, PA, and Austin, Dallas, and Houston, Texas.
			Test of equipment within office in Duluth, GA. Also has a pending application for 862-864 MHz in various locations nationwide.

[8]All information on PCS was provided in Federal Communications Commission, "PCS Experimental Applications by Filed Date," May 30, 1991, unpublished document.
[9]All applications are for experimental systems.

Personal Communication Service[8]

Company	Band	Status[9]	Comments
Motorola, Inc.	1850-1990 MHz	Granted	For use in Chicago and Atlanta, using spread spectrum. Motorola also has an application pending in the 864-868 MHz band (test of PCS at factory in Chicago).
MTEL PCN, Inc.	1850-1990 MHz	Granted	For use in Dallas-Ft. Worth area.
Novatel Communications, Inc.	940-952 MHz	Pending	
NYNEX Science& Technology	1850-1990 MHz	Granted	For use in Boston, New York City, and White Plains, NY.
Omni-Point Data Co., Inc.	902-928,2400-2483.5, and 5725-5850 MHz	Granted	CT2 service covering continental United States.
Pacific Telesis Group	614-806,824-849,869-894,849-851,894-896, 901-902,930-931,940-941,902-928, 1850-1990,2110-2130,2160-2180,2400-2483.5 MHz	Granted	Use in San Francisco, Chicago, Dallas, New York City, and Los Angeles.
PCN America, Inc. (Millicom)	1850-1990 MHz	Granted	A test of a spread spectrum digital system in Houston and Orlando.
PCS Network, Inc.	901-902,940-942 MHz	Granted	For use in Boston, Philadelphia, and New York City.
Personal Communications Network Services of New York, Inc.	1850-1990 MHz	Granted	For New York City and Newark, using spread spectrum.
Personal Communications Network Services of New York	940-952 MHz	Pending	Wireless PBX in New York City.
Pertel, Inc.	902-928,2100-2483 .5,5735-5850,1850-1990 MHz, and 12.7 -13.5 GHz	Granted	Used in Philadelphia, Cleveland, and Pittsburgh. Cable is used to tie cells together.
Prime II Management, Inc.	902-928,941-948, 1270-1350,1850-1990,2400-2483.5,5725 -5850 MHz	Pending	Development of PCS equipment by cable company in Anchorage, Atlanta, Chicago, Las Vegas, and Houston.
SCS Mobilecom, Inc.	1850-1990 MHz	Pending	Spread spectrum in Long Island, NY.
Satcom, Inc.	866-868, 1850-1990 MHz	Granted	Testing in rural areas around Spokane, WA, Missoula, MT, and Billings, MT.
Tele-Financing Corp., Inc.	1850-1990 MHz	Pending	PCN in Appleton, WI.
Telepoint Personal Communications, Inc.	940-941 MHz	Granted	CT2 demonstration system in Atlantic City.
Tel/Logic Inc.	1850-1990 MHz	Pending	CDMA spread spectrum, in Pittsburgh and Dallas-Ft. Worth.
Time Warner Cable Group	902-928,1850-1990,2400-2483.5,5725-5850 MHz and 12.7-13.2, and 17.7-19.7 GHz	Granted	In New York City, St. Petersburg, Cincinnati, and Columbus, using cable to tie cells together.
Timex Communications Corp.	864.15-868.05 MHz (902-28 MHz Part 15)	Granted	For use within the Timex Building in Middlebury, CT

[8] All information on PCS was provided in Federal Communi *cations* Commission, "PCS Experimental Applications by Filed Date," May 30, 1991, unpublished document.
[9] All applications are for experimental systems.

Personal Communication Services[8]

Company	Band	Status[9]	Comments
Unicell Corp.	940-948 MHz	Granted	For use in Boston.
United Artists Cable Corp.	866-868,901-928,930-931,940-941, 1710-1850,1850-1990,1990-2110,2110-2200,2200-2290, 2400-2483.5 MHz	Pending	PCN in Denver, Baton Rouge, Westchester, NY, Oakland, and Tulsa.
USA Mobile Communication, Inc. II	788-794, 800-806 MHz	Granted	For use in Indianapolis, Cincinnati, Louisville, Toledo, Cleveland, and Columbus.
Viacom International, Inc. ,	900-901,902-928,930-931,940-941, 1850-1990, 2400-2483.5, 5725-5850 MHz and 12.7-13.5 GHz	Pending	

[8]All information on PCS was provided in Federal Communications Commission, "PCS Experimental Applications by Filed Date," May 30, 1991, unpublished document.
[9]All applications are for experimental systems.

Appendix D

U.S. Proposals for WARC Malaga=Torremolinos, Spain, 1992

INTRODUCTION

I. General Remarks

The 1992 International Telecommunication Union World Administrative Radio Conference provides the opportunity **to** update the Radio Regulations to facilitate further advances in telecommunications. The United States, in preparing for the 1992 WARC, has been guided by certain principles in line with the purposes of the Union. These are:

a. To promote the implementation of a variety of new operational programs as rapidly as practicable so that all countries may realize the benefits and spectrum savings promised by modern telecommunication technologies;

b. To provide flexibility in the international regulations to ensure that the needs of all countries can be met;

c. To reduce regulatory, technical, and operational barriers so that technologies can rapidly be introduced and used to the benefit of all mankind; and

d. To provide up-to-date regulations that assure greater safety-of-life on land, on the sea, in the air, and in space.

During the last Plenipotentiary cycle (1982-1989), several radio conferences were held that addressed mobile, space, and broadcasting services. These conferences recognized that technology was advancing rapidly and recommended that future conferences address a number of topics in adapting to changing needs.

The Plenipotentiary Conference, Nice, **1989,** responded by deciding to hold a conference in **1992, to once again** examine and update the Radio Regulations. The agenda adopted by the ITU Administrative Council provides for consideration of a broad range of telecommunication topics. The reports from the International Radio Consultative Committee (CCIR) and the International Frequency Registration Board (IFRB), together with proposals of ITU Members, will constitute the principal input documentation for the work of the conference. We are hopeful that a collaborative effort will enable the ITU Members to update the Radio Regulations to further advance the development and availability of telecommunications services, economically, on a worldwide basis.

This document sets forth the views of the United **States** regarding the needs of the changing telecommunications environment. Study of some of these matters is continuing and there may be some additional United States proposals at a later date.

II. Broadcasting Service at High Frequency

There is a need for additional high frequency (HF) spectrum for broadcasting. To meet that demand we propose an additional 1325 kHz for HF broadcasting above 5900 kHz in ITU Region 2, and an additional 1125 kHz in Regions 1 and 3. Except for the proposal at 18/19 MHz, these new allocations are contiguous to existing broadcasting bands. We also propose that reduced carrier single sideband (SSB) emission be implemented earlier in the existing broadcasting bands and in the new bands, that the fixed and mobile services have access to any new broadcasting allocations, and that a reaccommodation procedure be adopted which would assure protection of displaced existing HF assignments.

New Allocations for Broadcasting.

We **propose** the following additional allocations for HF broadcasting:

5900-5950 kHz	13800-13900 kHz
7400-7525 kHz	15600-15700 kHz
9350-9500 kHz	17450-17550 kHz
11550- 11650 kHz	18900- 19300 kHz

Changes Consequential to Aligning Broadcasting Allocations at 7 MHz.

We also propose to shift broadcasting in Regions 1 and 3 from the current *7100-7300* kHz to the band 7200-7400 kHz. For Region 2, we propose to allocate 7200-7300 kHz to broadcasting in place of the current amateur allocation. To compensate for this loss of 100 kHz by the amateur service, we propose to allocate the band 6900-7000 kHz to amateur; this would be a consequential action. These actions result in an exclusive worldwide proposed allocation for the amateur service from 6900-7200 kHz, and for the broadcasting service from 7200-7525 kHz. The present unsuitable regional sharing situation would be resolved with this proposal.

The Use of SSB.

Our proposals require that any new frequency allocations for HF broadcasting be limited to reduced carrier SSB using characteristics as specified in Appendix 45 of the Radio Regulations. Additionally, in order to encourage the early use of reduced carrier SSB, we are proposing the advancement of the date when all broadcasting must be converted to SSB from 2015 to the year 2007. These proposals promote spectrum efficiency and enhance frequency utilization.

Reaccommodation.

The protection of existing radio services through a reaccommodation procedure is an essential part of any new allocation of spectrum to the broadcasting service. We have used Resolution Nos. 8 and 9 from the 1979 WARC as a basis for a procedure to ensure reaccommodation of displaced assignments. This procedure requires that the changeover from the old to the new assignment take place not later than 1 July 2007.

Access bv Non-Broadcasting Services in Broadcasting Allocations.

Technical studies and current operational practice demonstrate that in certain instances, time and geographical sharing amongst different HF radio services is feasible. Therefore, we propose permitting access to new broadcasting allocations by fixed and mobile services on a secondary basis. This proposal does not replace the requirement to accommodate the existing fixed and mobile assignments.

III. Low Earth Orbiting Satellites Below 1 GHz

Recent research and operational testing indicates that low earth orbit satellite systems can offer a number of radio services which can complement those provided by geostationary satellite operations. These newer technologies offer the potential to meet demands for data communication services using lightweight pocket-sized terminals. Low earth orbit systems offer the possibility of providing low-cost two-way data communications. A wide range of applications can be implemented to support economic development worldwide. To obtain efficiencies in the satellites and earth terminals, VHF bands are preferred. As these bands are used extensively, techniques have been developed to facilitate sharing with existing services.

The United States proposes allocations for the mobile-satellite service to be added to three bands for use by low earth orbit systems. The bands proposed are: 137-138 MHz (downlink), 148-149.9 MHz (uplink), and 400.15-401 MHz (downlink). In the 137-138 MHz band we propose an additional provision to protect the meteorological-satellite service.

IV. New Space Service Applications for Communications with Manned Space Vehicles Conducting Space Research Activities around 400 MHz

Extra-Vehicular Activity at 410-420 MHz.

Extra-vehicular activity (EVA) is work activities undertaken by astronauts outside the shelter of their base space vehicle, protected only by a life support space suit. A primary allocation in an appropriate radio service is needed to provide for communications between astronauts and base spacecraft, such as the Space Shuttle and Space Station Freedom, while they are performing activities, such as maintenance, outside the base vehicle.

Operating range for an EVA link would normally be confined to about 100 meters of the primary spacecraft, though reliable operation at up to 1 km is required to support contingency operations. The band selected must be between 270-575 MHz to comply with extremely limited power, on the order of 250 mW, and size restrictions of the astronaut's life support suit. Limited EVA communication capabilities are currently provided below 300 MHz. However, with the future expansion of EVA activities, new systems require additional capacity up to 10 MHz bandwidth. Because of present spectrum usage, a frequency band below 400 MHz is not available. For these reasons, the United States proposes that this new space service application concerning manned space vehicles be satisfied with a primary space research (space-to-space) allocation at 410-420 MHz, restricted to these activities by a footnote. We also propose to protect fixed and mobile operations in this footnote.

Proximity Operations at 400.15-401 MHz.

There is a requirement to communicate with approaching space vehicles, for example, during docking maneuvers and for interrogation of co-orbiting unmanned experimental containers, at distances up to 37 km. This activity requires transmit power levels somewhat higher than those available from an astronaut's suit. The United States proposes to allocate the frequency band 400.15-401 MHz to the space research service (space-to-space direction) for communications with manned space vehicles. The restriction to manned space vehicles in the proposed footnote to the allocations table is important, but further restriction as to distance would not be useful.

V. Mobile Services In The Approximate Range 1-3 GHz

Mobile Service Allocations and Future Public Land Mobile Telecommunications Systems

The demand for spectrum for the mobile services is growing. Considerable emphasis has been placed on accommodating future mobile service needs by providing suitable allocations in the 1700-2450 MHz band. These needs include personal communication networks, cordless telephones and future public land mobile telecommunication systems (FPLMTS). As the table of frequency allocations contains a primary mobile allocation in Region 2 from 1700-2690 MHz, which could permit future implementation of mobile services, we see no need to make specific allocation proposals for Region 2.

Further, we note that the WARC will specifically consider possible designation of a band of frequencies for use by future public land mobile telecommunication systems (FPLMTS). This concept, which embraces a wide variety of personal communications applications, has been under intensive study by the CCIR. Proponents wish to set aside a band of frequencies for future use which they indicate would facilitate global roaming of personal stations. While we support the work of the CCIR on FPLMTS, we believe that the WARC must exercise caution before reserving spectrum, particularly because of the numerous demands in the 1-3 GHz frequency range. Furthermore, technical standards such as modulation parameters, protocols, and channelization schemes will be just as important as an allocated band in facilitating any requirements for global roaming. These standards and protocols may obviate the need for a common worldwide band for international roaming. We believe that it is premature to designate a frequency band until the CCIR has progressed further in its work.

<u>Terrestrial Aeronautical Public Correspondence</u>.

The United States and some other administrations have already implemented a terrestrial aeronautical public correspondence system in the 849-851 MHz and 894-896 MHz bands. Since this system has become fully operational and hundreds of aircraft are already equipped with systems operating in these bands, we believe that these band segments should be used for this purpose on a worldwide basis. Therefore, we propose to allocate 849-851 MHz (air-ground) and 894-896 MHz (ground-air) for this purpose.

VI. Mobile-Satellite Services at 1-3 GHz

The demand for additional spectrum for the mobile-satellite service is growing. The CCIR recognized this situation and estimated the spectrum requirements of these services. Our proposals exceed the minimum amount projected by CCIR.

Because of the demands being placed on the 1-3 GHz spectrum by a multitude of services, we believe it is extremely important to utilize the spectrum efficiently. The current service specific allocations in the 1.5/ 1.6 GHz bands are too restrictive to permit flexible usage to adapt to dynamic changes in communication needs. We recognize, however, that special provisions are necessary so that safety services will be protected from interference, and that these services will be ensured priority access over other communications in these bands.

The United States proposes to reallocate the land mobile-satellite and maritime mobile-satellite service bands at 1530-1544 MHz (space-to-Earth) and at 1626.5 -1645.5 MHz (Earth-to-space) to the mobile-satellite service. These proposals provide additional spectrum, permit flexibility based on operational demands, and provide priority access with real-time preemptive capability for maritime safety needs. We also propose to allocate the band 1525-1530 MHz to the mobile-satellite service (space-to-earth) to balance the amount of spectrum allocated downlink with that already available in the corresponding 1.6 GHz uplink band.

In the bands 1545-1559 MHz (space-to-Earth) and 1646.5 -1660.5 MHz (Earth-to-space), the United States proposes to reallocate the aeronautical mobile-satellite (R) (AMS(R)S) and land mobile-satellite services to the mobile-satellite service. This proposal for a mobile-satellite service also provides priority access with real-time preemptive capability for the aeronautical mobile-satellite service (R).

These allocation proposals will enhance flexibility for future usage. Existing operations in the bands will not be adversely affected, as we have been careful to preserve the integrity of distress and safety communications for the Global Maritime Distress and Safety System (GMDSS) and AMS(R)S. We do so by continuing to provide sufficient capacity and priority access with real-time preemptive capability over all other communications in the bands proposed for reallocation from service specific use. This is accomplished by linking our proposals to specific footnotes, (ADD) RR's 726C and 730B, addressing safety requirements in the maritime mobile-satellite service bands and the AMS(R)S bands. Along with **these** footnotes, we propose a consequential change in Article 61. These measures assure that the GMDSS and the AMS(R)S can fulfill their respective safety requirements.

The United States proposes new worldwide allocations of 40 MHz, in each direction, for the mobile-satellite service. The proposed allocations are 2110-2130 MHz and 2160-2180 MHz in the space-to-Earth direction, and 2390-2430 MHz in the Earth-to-space direction.

The United States proposes to add a co-equal primary allocation for the mobile-satellite service in the radiodetermination-satellite service (RDSS) bands at 1610 -1626.5 and 2483.5-2500 MHz. Footnotes are proposed to require that such use would be in accordance with appropriate CCIR Recommendations to ensure compatibility with the RDSS. The MSS and RDSS complement one another in these bands and in some cases may be provide by the same system. Therefore, in order to ensure equality of these services on a worldwide basis, we are proposing to upgrade the radiodetermination-satellite allocations in these bands in Region's 1 and 3. We also propose a secondary allocation (space-to-Earth) for the mobile-satellite service from 1613.8 -1626.5 MHz to permit a possible bi-directional use of the band.

We also propose an allocation footnote to add the mobile-satellite service to the band 1850-1990 MHz. This addition is intended to complement the existing services. The added flexibility should permit greater sharing of the band and promote development of a variety of personal communications services.

We are examining the use of low earth orbit satellite systems in the mobile-satellite service at 1-3 GHz. Mobile-satellite service allocations can accommodate this requirement; some systems of this type contemplate use of common bands for both uplink and downlink. The CCIR has already begun studies on the sharing parameters for these systems and some information is provided in its report to the WARC.

VII. Broadcasting-Satellite Service at 500-3000 MHz

The United States is evaluating possible spectrum allocations for the broadcasting-satellite service (sound) in the spectral region between 500 and 3000 MHz. The radio listener markets that may be served by this allocation include both domestic and international radio program listeners of direct satellite broadcasts, as well as complementary local terrestrial broadcasts. The CCIR and other international organizations have performed recent additional studies. A United States proposal on particular bands for this service will be presented in a supplemental proposal.

VIII. Space Research and Space Operation Services at 2 GHz

WARC-ORB-88 in Recommendation 716 noted that the 2025-2110 MHz and 2200-2290 MHz bands are allocated to the space research and space operations services, subject to the provisions of Article 14 of the Radio Regulations. The WARC recognized that there is increasing use of these bands by the space research and space operation services, leading to increased coordination difficulties under the provisions of Article 14.

Major space programs of several administrations depend on use of the allocations at 2 GHz for reliable communication, data acquisition, and command and control. In the United States, these include the shuttle, Space Station Freedom, Hubble Space Telescope, and the Tracking and Data Relay Satellite Systems. For these reasons, the United States proposes that the space service allocations in these bands be upgraded to primary with consequential regulatory changes to apply existing power flux density (PFD) limits.

IX. Fixed-Satellite Service at 14.5 -14.8 GHz

The WARC agenda includes consideration of the allocation of the frequency band 14.5 -14.8 GHz to the fixed-satellite (Earth-to-space) service. Because of mobile and fixed uses, the United States cannot agree to fixed-satellite service operations in this band. In the United States, we cannot agree to any licensing of fixed-satellite operations, nor can we agree to protect such operations from interference from other users of the band. Accordingly, the United States proposes no change in the allocation at 14.5 -14.8 GHz and associated footnote 863.

X. High Definition Television Broadcasting-Satellite Service

The United States proposes a two-pronged approach to satisfying future needs for high definition television (HDTV) via satellite. We believe that the existing 12 GHz broadcasting-satellite service (BSS) allocations and associated plans can serve as the basis for meeting this demand. We recognize that this approach may require changes to the modification procedures for these plans. Such changes, however, should not be extensive and could be accomplished at some future conference. We further note that there could be difficulty in accommodating a few specific HDTV-BSS assignments within the 12 GHz BSS plans, so we also propose to allocate the 24.65-25.25 GHz band for use by the broadcasting-satellite service.

XI. Space Services Above 20 GHz

A. Inter-Satellite Service Requirements.

The WARC agenda permits consideration of allocations for new space service applications above 20 GHz, and we propose a number of allocations. We also propose a minor modification to the inter-satellite definition to provide for links between data relay satellites and other satellites that may not necessarily be Earth-orbiting.

1. Inter-Satellite Requirement at 22 GHz.

We propose to allocate the 21.7-22 GHz band to accommodate projected requirements such as cross-links between satellites of the mobile-satellite services.

2. Future Data Relay Satellite and Space Station (Proximity) Wideband Links.

The United States proposes a primary allocation in an appropriate service and associated sharing criteria for wideband space-to-space links. The wideband links would be between low orbiting user spacecraft, such as the United States space shuttle or space station Freedom, and geostationary data relay satellites (DRS), such as the U.S. Advanced TDRS. Forward DRS-to-user links are planned to operate in the inter-satellite service in the 22.55-23.55 GHz band based on the availability of bandwidth and the feasibility of sharing. For similar reasons, return user-to-DRS links are proposed to operate in a new primary allocation in the 25.25-27.50 GHz band. In addition, wideband space-to-space links are required between the space station and a variety of co-orbiting space vehicles in close proximity to the space station. It would be preferable if these proximity links operate under the same service allocation as used for the DRS links.

B. Space Research Service Requirements.

1. Narrowband and Wideband Space Research Links for Future Planetary Mission and Other Applications.

The United States, in cooperation with other countries, plans to establish a lunar settlement early in the 21st century followed by manned exploration of Mars. These activities will require wideband communications. There are no frequency bands allocated in the Radio Regulations that could be used for wide bandwidth links between the Earth and the Moon and between the Earth and Mars. Use of the same band for both sets of links is desirable because it would permit use of common equipment. Smaller bandwidth transmissions can occur in the space research allocations near 2 and **8** GHz. In addition, other space research activities such as Very Long Baseline Interferometry (VLBI) by satellite will require wider operating bandwidths. The definition of deep space does not permit space research service allocations for deep space to be used to communicate with the Moon. For these reasons, the United States proposes that 37-38 GHz and 39.5 -40.5 GHz be allocated on a primary basis for space research to support communications associated with a lunar or Martian research base or colony. These bands should not be restricted to deep space.

2. Space Research (Deep Space) Allocations Near 32/34 GHz.

The trend toward international cooperative missions for deep space exploration creates the need for a worldwide primary allocation for space research (deep space) service with direction indicators. The nature and status of allocations to the space research service near 32 and 34 GHz are complex, not uniform and not worldwide. For three administrations, the space research allocations are restricted to deep space only. There is a serious potential for interference to national and international deep space missions because the current allocations allow uplinks and downlinks for space research conducted by Earth orbiters to use the same bands as deep space links. These links are not compatible because of the widely different transmission e.i.r.p. and received signal strengths. Therefore, the United States proposes an upgrade of the space research service (deep space) allocations at 32/34 GHz. The proposal is for a worldwide primary allocation to support increasing space activities in these bands.

C. Earth Exploration-Satellite (passive) near 61 GHz and 157 GHz.

The passive bands are being used increasingly by space sensors to obtain higher quality data and data in regions of the atmosphere that are not available by the use of other bands.

To avoid the potential of future interference to passive bands now in use or planned for use in the near term, allocation of passive bands above 60 GHz are proposed. Bands below 60 GHz are affected by Earth's magnetic field when being used to measure mesospheric temperatures at heights between 45 and 75 km. The band at 157 GHz is needed to avoid interference from local oscillators in the same sensor measuring temperatures in the 50 to 60 GHz bands. Therefore, the United States proposes primary earth exploration-satellite (passive) allocations at 60.7 -60.8 GHz and 156-158 GHz.

D. Uplink Power Control Beacon near 27 GHz.

The United States notes that uplink power control systems will be required for fixed-satellite (FSS) systems operating near the 20/30 GHz range to achieve FSS uplink availability and performance standards. To accomplish this, the uplink earth station should monitor a narrow-band beacon transmission from the satellite. At present, the 27.5 -29.5 GHz band is allocated to the FSS for uplink use only. To accommodate a downlink beacon transmission in this band, the United States proposes to add a footnote to permit the use of downlink beacon operations within the 27.5 -29.5 GHz band in support of uplink power control.

E. General-Satellite Service near 20/30 GHz.

In a number of administrations throughout the world, including the United States, efforts are underway to develop and implement communications satellites integrating a wide variety of capabilities on a single space platform. These include fixed, mobile, and point-to-multipoint applications. Accordingly, the United States proposes a new service definition. The United States proposes the creation of a primary allocation to the general-satellite service at 19.7 -20.2 GHz and 29.5 -30.0 GHz, replacing current primary fixed-satellite and secondary mobile-satellite service allocations within these frequency bands.

F. Radiolocation-Satellite Service Near 25 GHz.

We propose to define a new space service - the radiolocation-satellite service - and to provide a primary allocation for this service in the band 24.55-24.65 GHz. The Radio Regulations currently define the radiodetermination-satellite service and a sub-category, the radionavigation-satellite service. However, the regulations do not now provide for a radiolocation sub-category of radiodetermination. This new definition and allocation will provide for satellite-based radiolocation services to a variety of users. The type of protection associated with a radionavigation service need not be applied.

XII. Aeronautical Mobile Off-Route (OR) Service Issues

In its report to WARC-92 concerning aeronautical mobile (OR) service, the IFRB noted that it is not possible to develop modifications to Article 12 without modifying Appendix 26. The IFRB suggests changes to Article 12, a draft revision to Appendix 26 (except for the allotment plan which is being developed) and draft resolutions to implement the changes. The United States considers that the IFRB has carried out the Plenipotentiary Conference action assigned to it and met administration requirements to retain flexible and maximum access to the exclusive aeronautical mobile (OR) service frequency bands.

While the United States generally concurs with the IFRB work mentioned above, a final determination will be made when the frequency allotment plan being developed by the IFRB is available. Concerning draft Resolution AER-1, the United States agrees with the implementation date for new assignments but proposes that the dates for operating on replacement frequencies and ceasing all double sideband emissions should be respectively, 1 March 1994 and 1 March 1996. Dates in draft Resolution AER-2 should be aligned accordingly. Consequential to adopting changes to Article 12 and Appendix 26, WARC-92 should suppress Recommendation 406 as no further action will be required.

XIII. Licensing of Radio Operators

The WARC Mob-87 revised Articles 55 and 56 of the international Radio Regulations to specify certificates for radio personnel operating in the Global Maritime Distress and Safety System (GMDSS). Unfortunately, the outcome of the 1987 Conference was at variance with the decisions at the 1988 International Convention for the Safety of Life at Sea (SOLAS) concerning radiocommunications for the GMDSS. Many countries delivered protocol statements to the Final Acts of the WARC Mob-87 and the ITU Plenipotentiary Conference, Nice, 1989, which reserved their position on Articles 55 and 56.

As a result of study of Articles 55 and 56 and the SOLAS Convention, the United States seeks to realign the texts so as to make them consistent. The United States proposes to do so by deleting the mandatory First-Class Radio Electronic and Second-Class Radio Electronic Certificates from Article 55, while making consequential changes to Article 56. The United States proposals reaffirm the need to ensure adequate safety is provided aboard ship by qualified individuals.

XIV. Updating of Definitions (Resolution 11)

The WARC agenda requires the Conference to provide, under the terms of Resolution 11, that any changes to definitions appearing in the Radio Regulations *and* in Annex 2 to the Convention (Nairobi, 1982) “shall be submitted to the Administrative Council for onward transmission to the Plenipotentiary Conference...”. The United States proposes changes to some definitions appearing in Article 1; however, none of these proposals affect the definitions appearing in Annex 2 to the Convention.

XV. Sharing Between Space and Terrestrial Services (Resolution 703)

The WARC agenda requires the Conference to review Resolution 703 in light of the procedure adopted by the XVIIth CCIR Plenary Assembly. The United States proposes to amend Resolution 703 to bring it into conformance with the approval process adopted by the CCIR.

XVI. New Resolutions and Recommendations

Resolution and Recommendation Relating to Wind Profiler Radars.

The WARC-92 agenda invites development of recommendations and resolutions in relation to the agenda of the Conference including the meteorological aids service in frequency bands below 1000 MHz. The wind profiler is a radar operating as a meteorological aid to measure wind direction and speed. Experimental units operating near the 406 MHz region cause interference to the COSPAS-SARSAT system at 406-406.1 MHz. The United States proposes a Resolution to urge administrations to avoid making frequency assignments to wind profiler radars in the 402-406 MHz band, and suggests that this issue be treated at a future conference.

Resolution Relating to Meteorological Satellites 401 -403 MHz.

The WARC agenda also permits inclusion of future consideration of meteorological satellites in the 401 -403 MHz band. We propose in a resolution that a future WARC address this issue.

SOURCE: Reproduced from U.S. Department of State, ***United States Proposals for the 1992 World Administrative Radio Conference for Dealing With Frequency Allocations in Certain Parts of the Spectrum,*** Publication No. 9903 (Washington DC: July 1991).

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