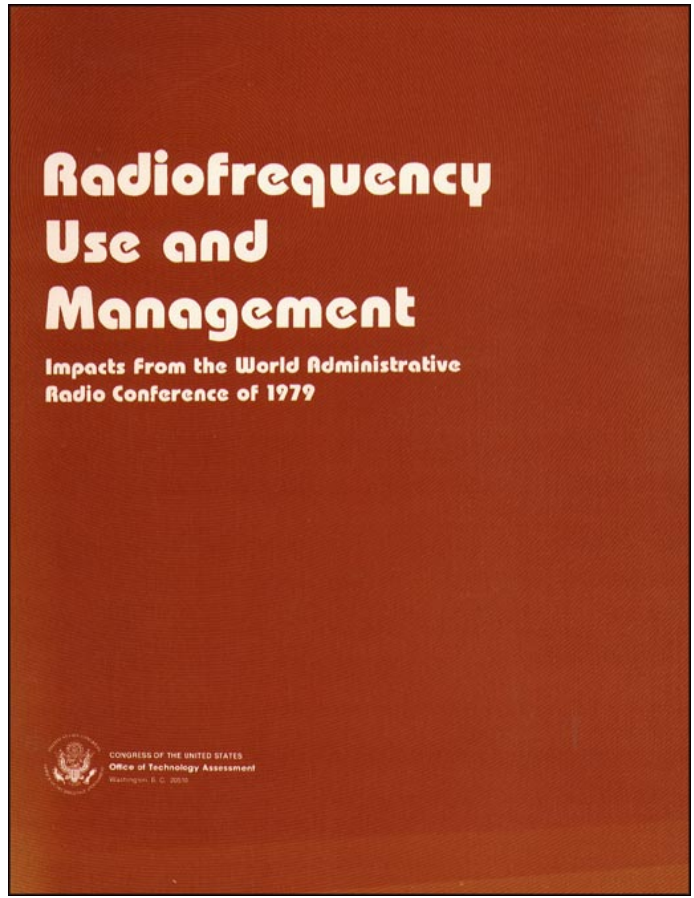
Radiofrequency Use and Management: Impacts From the World Administrative Radio Conference of 1979

January 1982

NTIS order #PB82-177536



Library of Congress Catalog Card Number *82-600502*

For sale by the Superintendent of Documents,
U.S. Government Printing Office, Washington, D.C. 20402

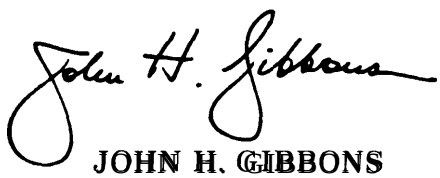
Foreword

This study responds to a request from the Senate Committee on Commerce, Science, and Transportation to evaluate the impacts on the United States of key decisions taken at the general World Administrative Radio Conference (WARC-79) and to consider options for preparation and participation in future international telecommunication conferences. It reflects congressional concern for the adequacy of existing machinery and procedures for U.S. policymaking and preparation for such conferences.

WARC-79 and related international conferences and meetings demonstrate that contention for access to the radio spectrum and its important collateral element, the geostationary orbit for communication satellites, presents new and urgent challenges to vital U.S. national interests. The growing differences among nations over the use of the radio spectrum and related satellite orbit capacity are reflected in the Final Acts of WARC-79 which will be submitted to the U.S. Senate in January 1982, for advice and consent to ratification.

Given the complexities of spectrum management in a changing world environment and the increased importance of telecommunications to both developed and developing nations, it is unlikely that traditional U.S. approaches to these issues will be sufficient to protect vital U.S. interests in the future. Problems require strategies not yet developed or tested.

OTA acknowledges with thanks and appreciation the advice and counsel of the panel members, contractors, other agencies of Government, and individual participants who helped bring the study to completion.



JOHN H. GIBBONS
Director

Radiofrequency Use and Management: Impacts From the World Administrative Radio Conference of 1979 Advisory Panel

Thomas E. Nelson, *Chairman*
Former Director, Office of International Telecommunications Policy, Department of State

Ambassador Jacob Beam
Head of the U.S. Delegation to the 1973 Plenipotentiary Conference of the International Telecommunication Union

Nolan Bowie
Former Executive Director
Citizens' Communications Center

Paul Dembling
Former General Counsel
National Aeronautics and Space Administration

John M. Eger
Former Acting Director
Office of Telecommunication Policy

James C. Fletcher
Former Administrator
National Aeronautics and Space Administration

Walter R. Hinchman
Former Chief
Common Carrier Bureau
Federal Communications Commission

Harvey J. Levin
Professor, Department of Economics
Hofstra University

Edgar T. Martin
Former Engineering Manager
Broadcasting Service
U.S. Information Agency

Ithiel De Sola Pool
Professor, Department of Political Science
Massachusetts Institute of Technology

Raymond E. Spence
Former Chief Engineer
Federal Communications Commission

M. Jon Vondracek
Director of Communications
Center for Strategic and International Studies
Georgetown University

Grover M. Yowell
Rear Admiral, U.S. Navy (Retired)
Former Manager
Navy Space Project of Naval Electronic Systems Command

NOTE:: The Advisory Panel provided advice and comment throughout the assessment, but the members do not necessarily approve, disapprove, or endorse the report for which OTA assumes full responsibility.

Radiofrequency Use and Management: Impacts From the World Administrative Ratio Conference of 1979 Project Staff

John Andelin, *Assistant Director, OTA*
Science, Information, and Natural Resources Division

Stephen E. Doyle* and Sam Hale,** *Program Manager*
Communication and Information Technologies Program

Raymond B. Crowell, *Project Director*

Administrative Staff

Jeanette Contee Liz Emanuel Shirley Gayheart

Contractors

J. D. Barnla
Philip S. Cook
Future Systems Inc.
William Hatfield
Kappa Systems Inc.
John J. Kelleher
Susan Stocker
Telecommunications Systems

OTA Publishing Staff

John C. Holmes, *Publishing Officer*

John Bergling Kathie S. Boss Debra M. Datcher Joe Henson

*Program Manager until March 1981.
** program Manager after March 1981.

Acknowledgments

Many individuals have assisted in various aspects of this study, each making a valuable contribution to the information and analyses assembled and presented here. Participation does not necessarily reflect agreement with the entire report or any particular aspect of the report. Contributors include:

Contractor Support

Linda Bower
J. Russell Burke
Ronald S. Eward
Richard Gould
George Hagn
Jack W. Herbstreit
Heather E. Hudson
Michael Jeruchim
Nicholas Marzella
Harley Radin
Leonard R. Raish
John Rheinhardt
Reinhard Stamminger
John A. Stein
Michael Stoil
Robert Tomkins
H. E. Weppler

Reviewers

Leo Buss
George Codding
William J. Cook
Robert L. Cutts
Arlan K, van Doom
Lou Feldner
Stephen J. Lukasik
Carl Matthews
Richard Parlow
Samuel E. Probst
A. R. Rasmussen
Anthony M. Rutkowski
Arthur I.. Freeman
Jonathan Gunter
Wendell Harris
Edward R. Jacobs
Donald Jansky
David Leive
Richard E. Shrum
David P. M. Struba
William R. Torak
Charles K. Watt

Agencies Providing Information and Reviews

Congressional Research Service, Library of Congress
Department of Defense
Department of State
Federal Communications Commission
National Aeronautics and Space Administration
National Telecommunications and Information Administration
U.S. General Accounting Office

Participants in the OTA Survey

Perry G. Ackerman
William Adams
Allen Anderson
Dexter Anderson
Lucian L. Arnone
Earl S. Barbely
Jerome D. Barnla
Richard Barth
George Bartlett
Jacob Bean
Martin W. Bercovici
John Paul Berry
Robert S. Black
Herbert T. Blaker
William Berman
Nolan Bowie
Lewis Bradley
Anne Branscomb
Dan Brenner
Russell Burke
Leo Buss
Paul E. Carroll
Anna L. Case
William Cooke
Anthony M. Corrado
Cullen M. Crain
Robert L. Cutts
Satyendranath Das
Wilfred Dean
Thijs DeHaas
Willis D. DeHart
Ithiel de Sola Pool
Wilson Dizard
Charles Dorian
A. James Ebel
John M. Eger
Harry A. Feigleson
Charles D. Ferris
Milford R. Fink
Arthur L. Freeman
L. S. Gallemore
Henry Geller
John Gilsenan
E. Merle Glunt
Abilio Gomez
Robert E. Greenquisit
Wendell Harris
Mervin L. Harrison
William Hatfield
Jack W. Herbstreit
Roger Herbstritt
Walter R. Hinchman
Earl J. Holliman
David Honig
Gordon Huffcutt
Marion Hayes Hull
Charles L. Hutchinson
Karyl A. Irion
Eugene Jackson
Edward Jacobs
George Jacobs
Donald Jansky
Michael C. Jeruchim
Raymond Johnson
Harold Kassens
Wayne Kay
John J. Kelleher
John W. Kiebler
Harold Kimball
Emmett Jay Kitchen
Alex C. Latker
Robert E. Lee
Stanley Leinwoll
Maury Lisann
Ray Livesay
Lloyd G. Ludwig
Stephen J. Lukasik
William A. Luther
James B. McElroy
James C. McKinney
Neal McNaughton
George Mansur
Richard B. Marsten
Edgar T. Martin
Sidney Metzger
John E. Miller
Robert P. Moore
Sharon Nelson
Thomas E. Nelson
John O'Boyle
General James D. O'Connell
James E. ogle
Lawrence Palmer
Vernon Pankonin
Edwin Parker
Richard Parlow
Paul Phillips
Neal Pike
James B. Potts
Wilbur Pritchard
Samuel E. Probst
Joseph P. Rawley
Alvin Reiner
Glen Robinson
John T. Robinson
Anthony Rutkowski
Peter Sawitz
Kalmann Schaefer
John Serafin
Richard Shrum
Hillyer Smith
Neil M. Smith
Raymond E. Spence
Ronald F. Stowe
David P. M. Struba
William R. Torak
Robert Tompkins
Phillip G. Tremper
Calvin G. Tuggle
Thomas Tycz
Arlan K. van Doom
R. J. Van Winegarten
F. W. Voege
Constantine Warvariv
James C. Warwick
Walter E. Weaver
Hans Weiss
H. Edward Weppler
Howard A. White
Clay T. Whitehead
Harold Wigren
Francis K. Williams
Elizabeth L. Young
Admiral Grover M. Yowell

Contents

Chapter *Page*

1. Summary 3
2. The Changing Requirements, Influences, and Motivations Among Nations for Use of the Radiofrequency Spectrum. 25
3. Domestic and International Management of the Radiofrequency Spectrum 37
4. WARC-79 Overview, Actions, and Impacts 67
5. Alternative Structures, Procedures, and Strategies 107
6. Findings, Conclusions, and Observations 129

Acronyms, Abbreviations, and Glossary. 147

Selected Bibliography. 157

Chapter 1
Summary

Contents

	Page
Background of Study	3
Principal Findings	4
General Observations and Trends	5
U.S. Policymaking Structure and Processes for Spectrum Management and International Strategies	6
Need for High-Level Government Policy Coordination and Accountability	6
Need for New Strategies To Address Spectrum and Related Satellite Orbit Issues	7
The Impacts of WARC-79	9
Improving U.S. Spectrum Management and Preparation for International Telecommunications Conferences	12
U.S. Strategies for Dealing With International Spectrum Issues and ITU	14
Withdrawal From IT	15
Revised ITU Voting Formula	15
Increased Regionalization of ITU	16
Better Coordination and Planning	17
Common-User System	18
“A Priori" Allotment	19
U.S. Options Regarding the Final Acts of WARC-79	20

Chapter 1

Summary

Background of Study

The Final Acts of the General World Administrative Radio Conference (WARC-79) are to be submitted to the U.S. Senate for advice and consent to ratification. Issues vital to U.S. interests in continued efficient use of the radiofrequency spectrum—including satellites operating in geostationary orbit–were addressed at WARC-79 and will be addressed at future, more specific conferences of the International Telecommunication Union (ITU).

The Senate Committee on Commerce, Science, and Transportation requested that the Office of Technology Assessment (OTA) determine the impacts on the United States of decisions negotiated at the general World Administrative Radio Conference (WARC-79), and consider options for preparation and participation in future international telecommunication conferences. The request reflects congressional concern for the adequacy of existing machinery and procedures for U.S. telecommunication policymaking and preparation for international telecommunication conferences. It also reflects an awareness of the vital and growing role that telecommunication plays in our society and our dependence on the radiofrequency spectrum.

The purpose of this study was to examine WARC-79 in a comprehensive way–describing U.S. preparations and involvement, and the impact of the conference. However, no attempt was made to examine all issues and aspects of WARC-79, but rather to focus on certain important ones and analyze their consequences for the United States. The study considered alternative structures, procedures, and strategies to improve frequency spectrum planning and management to assure the United States of continued satisfaction of its commercial, Government, and national security requirements for frequency spectrum and geostationary satellite orbit locations.

WARC-79 was convened by ITU in an effort to reach global agreement on the revised international arrangements necessary for efficient and interference-free use of the radiofrequency spectrum. The Final Acts of the conference will constitute the “radio regulations, Geneva, 1979” and enter into force on January 1, 1982 for those countries that have formally adopted the Final Acts. The 1959 Radio Regulations, as partially revised by subsequent specialized administrative radio conferences, will be superseded. WARC-79 was of special importance because of the broad scope of its agenda, which included most of the major arrangements relating to radio, and because it was the first *general* administrative radio conference since 1959 and therefore included many developing countries that had won their independence in the intervening two decades.

The telecommunication systems of the United States are the most sophisticated, efficient, and all-encompassing in the world. These systems are a vital element of our economic strength and security; they are an essential part of our culture. Other nations, recognizing the key role that telecommunications play in national and international affairs, are constantly striving to gain access to telecommunication technology. Highly industrialized nations seek to surpass the United States in technological inventiveness and in the practical exploitation of the many telecommunication subsystems that make up a modern “information society. ”

As a leader in communication technology, the United States has been able to develop domestic telecommunication systems in large measure apart from the activities of other countries. At the international level,

the United States has played a leading role in shaping an essentially benign and passive mechanism within ITU for allocating radio spectrum to certain specified purposes, and assuring spectrum users the right to operate free from harmful interference by others.

This international regime, which has succeeded in avoiding chaos in the use of radiofrequencies, is coming under considerable stress as the result of sharply increased demand for communication services and resulting congestion in economically attractive parts of the radio spectrum. WARC-79 and related international conferences and meetings demonstrate conclusively that contention for access to the radio spectrum and its important collateral element, the geostationary orbit for communication satellites, presents new and urgent challenges to vital U.S. national interests. The growing differences among nations over the use of the radio spectrum and related satellite orbit capacity are reflected in the Final Acts of WARC-79.

Given the complexities of spectrum management in a changing world environment and the increased importance of telecommunication to both developed and developing nations, it is highly unlikely that traditional U.S. approaches to these issues will be sufficient to protect U.S. vital interests in the future.

From the U.S. standpoint, the results of WARC-79 are mixed. The proceedings of an administrative conference of ITU are generally geared toward arriving at decisions and adopting provisions that are acceptable to all nations with certain exceptions identified; an ITU member country is entitled to take a reservation indicating that it will not be bound by specific unacceptable decisions of the conference. Therefore, finding a useful way to measure success and to evaluate a country's relative standing following an administrative conference is not easy. Comparing specific U.S. proposals submitted in advance to the conference with the language of the Final Acts of the conference is not a straight-forward exercise. While such a comparison is important, it does not reflect the underlying reasons and motives for particular decisions, the problems encountered, or any apparent trends important in evaluating results of an administrative radio conference. It is important to understand the intervening events that underlie decisions, compromises, reservations, and postponements; not only to evaluate the results of WARC-79, but to prepare for the many future conferences important to U.S. interests.

Principal Findings

The most significant findings of the OTA study are the following:

1. There is an urgent need for higher level attention to Government policy coordination and accountability for international telecommunication issues generally and for spectrum management issues and international negotiations specifically.
2. Streamlined processes, coordinated Government policies, and sufficient resources on a continuing basis are essential to effective and timely preparation for the several major international conferences of ITU now scheduled to occur over the next 7 years.
3. New U.S. approaches are necessary to address radio spectrum and related satellite orbit issues in a changing world environment. Solutions to satellite orbit allocation and spectrum reallocation issues as envisioned by the Third World nations require strategies not yet developed or tested.
4. WARC-79 resulted in the loss of some U.S. flexibility in certain key spectrum areas—particularly those affecting national defense—and enhanced opportunities in many other areas.

5. Operating costs will increase for certain radio services; interference protection will become less certain; and administrative costs will need to rise to adequately implement WARC-79 decisions and prepare for future radio conferences.

General Observations and Trends

• The world environment for telecommunications has changed significantly in recent years; two-thirds of the 155 member nations of ITU can be classified as developing or Third World countries. There were 65 nations and seven groups of colonies present at the 1947 Atlantic City Conference, 80 nations and five groups of colonies at the 1959 WARC, and 142 nations (no colonies) at WARC-79.

• There are basic differences between the United States and Third World countries over the principles that should govern the allocation and use of the radio spectrum and related satellite orbit capacity. There is increasing need to identify and assess options to reconcile the sometimes sharply divergent goals of developing and developed countries.

• Third World countries are increasingly able to influence and shape international communication policies in international forums.

• The United States must maintain its technological leadership and expand its influence if future actions in a "one-nation, one-vote" forum like ITU are to be favorable to U.S. positions.

• There has been a gradual shift toward recognizing the legitimacy of nontechnical factors such as political and cultural interests and values in ITU deliberations. In other international forums, Third World countries here raised related issues under concepts of the New World economic order and New World information order.

• U.S. requirements for access to the frequency spectrum and geostationary satellite orbit locations are expanding with the explosive growth in telecommunication/information technology, the growing use of satellites, and the increasing dependence on radio and satellites for military and national security purposes.

• The disparity between nations in their ability to use the spectrum is growing; this leads to growing disagreement over the allocation and use of specific frequency bands for specific services.

• Spectrum decisions arrived at as a result of voting within ITU, as opposed to the commonly practiced consensus approach, will tend to be increasingly adverse to the United States.

• International telecommunication development is entering a phase in which regional and domestic needs and policies will predominate, as opposed to more general global facilities expansion. The thrust will be on intraregional communications and the development or enhancement of interregional communication routes.

U.S. Policymaking Structure and Processes for Spectrum Management and International Strategies

Need for High-Level Government Policy Coordination and Accountability

• The responsibility for spectrum management and policymaking is divided among several Federal agencies with coordination conducted on a structured, but often informal basis without clear responsibility and accountability for policy at a high level of Government.

• The United States does not have a consistent and coordinated national telecommunication policy because of a lack of appreciation and concern at the top levels of Government and industry, a lack of high-level policy coordination for international telecommunication negotiations, and a failure to assign sufficient importance to international telecommunication matters, including spectrum management and the State Department's role in international negotiations.

• The United States is not adequately equipped to provide comprehensive assessments required to effectively plan for the future use of the radio spectrum, to forecast future requirements, to assess the costs and benefits of shifts to new technology, or to evaluate alternative strategies to deal with international issues regarding allocation and use of the radio spectrum and geostationary orbit.

• Within the U.S. telecommunications industry there has been significant growth and change over the past 15 years that have produced more competing domestic interests with conflicting demands for spectrum use.

• The U.S. permanent spectrum management analytical mechanisms are not adequately equipped to review and verify all the stated requirements of Government and nongovernment spectrum users and to adjust needs consistent with national policy objectives. The United States lacks an effective ongoing means of collecting data and developing and adjusting guidelines to evaluate the merits of one spectrum use over any other.

• The State Department's International Communications Policy Office is not at a high enough level in the Department's organization to prepare adequately for all the important upcoming international conferences of ITU and make its influence felt in the upper echelons of Government and industry.

• Experts warn that lack of high-level concern has led to a shortage of trained and experienced spectrum management personnel to replace those retiring from Federal Government service; there has been insufficient attention to the need for personnel with supplementary diplomatic, language, negotiating, economic, and legal skills.

• The rather general wording of Executive Order No. 12046 establishing the National Telecommunications and Information Administration (NTIA) leaves it ambiguous as to how far NTIA can go in its coordinating role with respect to U.S. international telecommunications policy, particularly when that mandate risks encroachment on the general regulatory responsibilities of the Federal Communications Commission.

• The schedule of 10 major international conferences over the next 7 years to consider a number of issues vital to U.S. interests underscores our concern that the United States reform its policymaking mechanisms and streamline the cumbersome and time-consuming procedures for developing U.S. proposals for international telecommunication conferences.

• A mechanism is needed for collecting and evaluating information on the perceived needs of other nations for spectrum and orbit resources; their receptivity to intraregional and/or common-user systems, and other factors.

Need for New Strategies To Address Spectrum and Related Satellite Orbit Issues

• There are critical years ahead for ITU. For the most part, communication activities have been conducted by telecommunication experts and international diplomacy has avoided debate on ideology and politically motivated objectives. The trend towards basing decisions on factors other than economic and technical matters, and demonstrated need is challenging ITU to provide mechanisms for resolving differences among nations without a further shift toward the polemical norms common to international political debate.

• ITU is a political organization that performs both political and technical functions. However, while there is a primarily technical focus for most ITU activities, there has been a gradual shift toward recognizing the legitimacy of nontechnical factors, such as political and cultural interests and values. The United States must recognize this shift and develop strategies to use its technology more broadly as a tool for resolving international issues that are not subject to technical solutions.

• The success of ITU has been due in large measure to the willingness of its members to adhere voluntarily to commonly arrived at agreements and regulations. The inherent flexibility in ITU processes has also enhanced its effectiveness. Reservations and footnotes offer escape for individual countries from disagreeable decisions of the majority. However, excessive use of these exceptions by a sufficient number of countries—or by a few large users—serves to reduce the value of the agreements and regulations for all users. Almost 500 footnotes to the International Table of Frequency Allocations, and 83 protocol reservations taken at WARC-79, reflect increasing difficulty in reaching consensus.

• Many of the nontechnical issues raised in ITU—like those concerning reallocation of spectrum and guaranteed access to the geostationary satellite orbit—are among the many issues raised by Third World countries in other international forums under the principles propounded by the New World economic order and New World information order.

• The administrative regulations of ITU serve the desirable objective—without the use of sanctions for noncompliance—of avoiding the interference, incompatibilities, and chaos that would ensue if these or simular regulations were not followed.

• Developing countries will continue to seek changes in the existing mechanism for vesting rights in the use of frequencies and access to the geostationary orbit. They seek a shift away from the current notification and coordination procedure on a “first-come, first-served” basis, toward a negotiated plan developed on an a priori basis.

• Third World countries are likely to resist drastic changes in ITU rules and procedures that operate on the principle of "one-nation, one-vote” and that provide them with increasing influence and power. They will continue to seek technical assistance from the developed countries while pursuing ITU policies favorable to their own interests.

. Third World countries will continue to advocate changes in rules and procedures that help guarantee their access to the spectrum and geostationary satellite orbit. They do not wish to rely on the “good efforts, ”

promises, and technical ability of the developed countries to "engineer-in" future systems on a case-by-case basis, as needed.

• ITU administrative radio conferences attempt to produce results that all nations can accept. Reservations, footnotes, and other means to reduce negative consequences allow each nation to more or less view the results as favorable. This approach supports the perception of having all winners and no losers. However, because of growing differences among nations these procedures are beginning to produce diluted and cumbersome results that may render existing mechanisms to regulate use of spectrum less and less meaningful.

• Because of competing interests and growing differences over use of the spectrum there will be winners and losers in the future as a result of the ITU decisionmaking process.

• WARC-79 showed the increasing influence of the Third World as a political force in ITU. The struggle for influence between the developed and developing nations will continue at future ITU conferences. At the present time, the developing countries derive their power from their collective numbers; the developed countries from their technical competence, know-how, and leadership. The influence of the developing countries can most effectively be exploited in ITU legislative forums; the developed nations' through ITU technical administrative organs.

• The preeminence of U. S technological leadership and technical ability served the United States well in international spectrum negotiations when decisions were primarily based on technical matters, but more and more U.S. problems with other countries involving the radio spectrum are influenced by political and economic considerations.

• The developed countries are expanding their use of spectrum to higher frequency bands as lower, more economical, bands become congested. They rely on technology to provide solutions to problems of accommodating new demands in the future. It is becoming increasingly difficult for the developing countries to accept the proposition that they will have access to spectrum on an interference-free basis at some future date as their needs materialize. The outlook is that the radiofrequency spectrum and the geostationary orbit will become more congested in the lower, more economic and desirable frequency bands even though use of frequencies by one country does not necessarily preempt those same frequencies from use by other countries.

• Certain U.S. spectrum requirements (e.g., for military radars) are not of interest to the majority of other countries. The difficulty that faces the United States in seeking to convince a majority of the 154 other ITU member countries to adopt regulations that accommodate U.S. radars in conflict with other possible uses by other countries is real and was demonstrated at WARC-79.

. Frequencies and satellite locations allocated to individual nations are not vested indefinitely under current ITU procedures, and changes in operating parameters require recoordination and registration. This creates uncertainty for present satellite system operators. The risks may increase that spectrum and orbit will not be available to provide for continuity of service from the present to the next generation of satellites. Moreover, this problem is not overcome by the adoption of a negotiated rigid a priori allotment plan to assure future access, since such a plan would tend to freeze technology and accommodate only those new or second generation satellites that fit the original technical scheme.

• The growing lack of agreement among nations over which specific frequency bands should be allocated for which specific ITU radio service classification (e.g., radiolocation, fixed-satellite, broadcasting) strongly suggests that mechanisms other than service classifications should be examined.

. The voluminous, complex, and detailed provisions of the international radio regulations are becoming more burdensome and less meaningful to individual users.

The Impacts of WARC-79

The specific consequence of WARC-79 decisions on U.S. interests regarding particular services can best be treated in terms of how the conference dealt with specific technical issues created by some significant trends in telecommunications. These trends include the following:

- The increasing demand for high frequency (HF) spectrum by the more developed countries to meet maritime and international broadcasting needs conflicts with the desires of the less developed countries to use HF for inexpensive domestic communications. The reduction in the use of HF (3 to 30 MHz) by international fixed point-to-point operations as satellite and cable use expands is not sufficient to offset this increasing demand.
- The rapid growth in very high frequency (VHF) (30 to 300 MHz) and ultrahigh frequency (UHF) (300 to 3000 MHz) land-mobile operations in the face of continuing vital U.S. military requirements, and the heavy use of these bands for TV broadcasting, now necessitates greater sharing of frequencies, e.g., by radiolocation-sharing with radionavigation and with other services, and by land-mobile sharing with TV broadcasting.
- There has been rapid growth of both domestic and international fixed satellite requirements in the super high frequency (SHF) (3 to 30 GHz) spectrum coupled with growth in microwave radio relay, space research, and Earth-exploration satellite services, and the continuing need to protect important radioastronomy operations. These requirements are being pressured by new demands to accommodate mobile, navigation, and broadcasting satellites (and their feeder links) in increasingly crowded orbits. Most of these satellite spectrum uses have military as well as civil applications. In addition, there is the continuing use of the SHF spectrum for terrestrial systems.

The actions of WARC-79 with respect to these operational trends, and the technical issues they raised, either closely reflected U.S. proposals or were acceptable to the United States with certain important exceptions. However, this judgment hardly does justice to the overall results of WARC-79, particularly the future implications to the United States. The long-term trends may be running against the United States in the sense that more problems without apparent solutions are foreseen. The United States finds itself increasingly in a defensive mode, trying to minimize losses rather than seeking significant changes to improve its long-term posture.

For example, at the same time that significant amounts of spectrum were added to the allocations for the fixed-satellite service (FSS), generally consistent with U.S. objectives, the conference also adopted a resolution that calls for a space planning conference to plan space services using the geostationary satellite orbit that was not consistent with U.S. objectives. The technical rules that affect the design and operation, and hence the cost, of satellite systems were in general agreement with U.S. positions, but the ability to implement new technologies and offer new services via satellite in the future depend in part on the decisions to be made at the space planning conferences in 1985 and 1987 and the broadcasting satellite conference scheduled for June 1983, to plan

broadcasting satellite service (BSS) in region 2 (the Americas) in the 12-GHz band.

There is a significant difference between the approach advocated by the United States for using the geostationary satellite orbit and any rigid a priori allotment and planning approach that may be advocated by some developing nations. The United States, as well as many other countries, has consistently favored a flexible approach that assigns orbit locations and satellite frequencies on a case-by-case basis, often referred to as "first-come first-served. " The U.S. approach seeks to accommodate needs as required and relies, at least in part, on technological advancements and good engineering practices to "engineer-in" the next satellite and accommodate all users. Such an approach is consistent with existing practice under ITU procedures for the notification, coordination, and assignment of radiofrequencies generally.

Many developing countries, on the other hand, see a detailed negotiated plan that assigns specific frequency channels and orbital positions to each country under a rigid a priori allotment plan as a means to guarantee them future access. This approach does not depend upon advances in technology or new engineering techniques to assure accommodation of newcomers, but neither does it provide for technological improvements that might accommodate growing requirements. The developed countries already have the economic and technological means of launching and utilizing domestic satellite systems; most developing countries do not, even though many do make use of joint-user systems like the International Telecommunications Satellite Organization (INTELSAT) global satellite system. The developing nations are concerned that as the "later comers" to ITU (hence later served) there will be little or no way to accommodate their domestic requirements.

Both a posteriori (the case-by-case approach usually relying on a notice and recordation procedure) and a priori (the collective subdivision approach usually relying on a negotiated plan) have won past acceptance at conferences of ITU. Over the last 75 years one or the other approach has been advocated and used by nearly all nations to allocate spectrum, both internally and internationally. On a domestic level, the a posteriori approach is often coupled with an adjudication procedure for deciding among competing applicants, as is the case in the United States. On the international level, adjudication is almost impossible because of sovereignty claims. Most nations have been unwilling to allow an international body to determine whether they can or cannot use a radio channel or satellite position. Where channels become limited, the recourse in the recent past has been to adopt an a priori method. However, for the allocation of radio bands and services, like FSS, which are affected by rapidly changing technology, or which are fraught with political controversy, a priori methods tend to promote too rigid technical specifications or exaggerated claims for channels. Much of the controversy at WARC-79, and likely to emerge at future conferences, arises from the question of the appropriate administrative arrangements to determine rights to the use of frequencies free from harmful interference.

Several countries made planning proposals at WARC-79, ranging in scope from planning all space services in all frequency bands allocated to space services, to planning only FSS in bands newly allocated to that service below 10 GHz. However, it is clear that FSS was the main target of these proposals. Developing a plan of this nature is an enormous undertaking and would not have been possible at WARC-79; however, acceptance of the principle of "planning" was a major goal of the developing countries.

The U.S. delegation worked to prevent any decision to convene a "planning" conference. When it became clear that such a conference would be approved, the United States argued successfully to keep the terms of reference rather broad. The first session of

"WARC on the Use of the Geostationary Satellite Orbit and the Planning of Space Services Utilizing It," scheduled for July 1985, will consider which services and which frequency bands to "plan." Further, the meaning of "plan" will be decided, and will not necessarily be a rigid "a priori" type. The operative thought in determining the type of planning is to provide "in practice equitable access' to the geostationary orbit. The second session of the conference, scheduled for September 1987, will meet to enact the decisions of the first.

It has been the official position of the United States, shared by a number of other countries, that a rigid a priori plan for FSS is bad planning and bad engineering; that it is likely to inhibit technological innovation, result in inefficient use of the orbit and spectrum, and have a major adverse impact on U.S. telecommunication systems. Thus, the United States faces a significant challenge over the next few years to develop compelling arguments against a rigid a priori approach and to carry that message convincingly to all parts of the world well before these conferences convene; or to find alternatives acceptable to all parties. Some possible alternatives are considered in the report and summarized below.

The adoption of the space planning conference resolution is a vigorous reminder that the effective management of orbit and spectrum utilization on both a worldwide and a regional basis is a continuing process that is becoming increasingly more difficult and complex. The achievement of U.S. objectives at ITU conferences is no longer a matter of reaching painstaking agreement on technical solutions to problems of frequency coordination and multiple usage of spectrum. It will also require sophisticated, political negotiations; imaginative, innovative approaches; and long, hard bargaining.

No immediate changes in operations using the radio spectrum or geostationary satellite orbit are required in the United States as a result of WARC-79. However, there are longer range impacts that require prompt attention: increased operating costs, reduced operating flexibility, uncertainty surrounding important pending issues, and the need for thorough preparations to address issues at future conferences.

There is no immediate cost impact imposed by WARC-79 regarding national security systems, largely because of the frequency flexibility of existing U.S. equipment, the success of the U.S. delegation at WARC, and reservations taken by the United States to counter adverse conference decisions. However, there will be future undetermined costs associated with frequency management, the development and procurement of more sophisticated equipment, compatibility studies, and coordination to prevent interference with competing users of the spectrum.

Department of Defense (DOD) interests were impacted by losses of exclusivity for radiolocation (radar) operations and by increased sharing with other services in many of the radiolocation bands. For example, demands that radar operations be discontinued in certain bands to accommodate expanded FSS operations led to considerable acrimony, which was only eased by a nonbinding U.S. commitment in a formal declaration to try to accommodate FSS in those bands. The status of radiolocation was retained but the pressure from competing fixed-satellite interests will certainly continue.

As an indication of concern for security interests, the United States took a reservation indicating that this country, in the operation of radars in certain bands, will not guarantee protection to, nor coordination with, other radio services. The action was necessary because so many countries took footnotes stating their intention to operate fixed and mobile radio stations in bands hitherto used exclusively by radars. Radars are designed to operate in the presence of interference, either purposeful or accidental. The degree to which these counterinterference techniques will have to be improved and used depends on how extensively other countries in-

troduce fixed and mobile services in these bands.

U.S. objectives for the fixed-satellite service and the mobile-satellite service (MSS), including DOD airborne, shipborne, and ground-transportable Earth station systems, were achieved in large measure. Significant amounts of spectrum were added to allocations of the FSS and no operational or economic dislocations were imposed on any existing FSS system. No major burden appears to be placed on the U.S. Government or private operating entities in complying with the decisions of WARC-79 regarding FSS. However, the differences between the United States and many developing countries over approaches to use of the geostationary satellite orbit, to be resolved by future conferences, leaves the impact on FSS uncertain.

The U.S. objective to maintain the status quo for MSS in the 235- to 399.9-MHz band used for U.S. Naval Fleet satellite communications was partially achieved; however, coordination provisions (article N13A) were added which included a condition that stations in MSS not cause harmful interference to those of other services operating, or planned to be operated, in accordance with the table of allocations. The United States found this condition unacceptable, and together with most of its North Atlantic Treaty Organization (NATO) allies entered a formal reservation in the final protocol.

While WARC-79 largely eliminated frequency-sharing between FSS and BSS in the Americas, the latter must now share frequencies with the terrestrial fixed service, including private microwave systems widely used in the United States. This sharing could result in interference to BSS Earth station receivers operating in the same area as fixed station transmitters. The private microwave users are concerned that sharing with direct-broadcasting satellites is not feasible and that they may be forced to vacate the band. This concern is reinforced by footnote 37870 of the Final Acts of WARC-79 that places terrestrial services on a noninterference basis to BSS operating in accordance with a plan to be prepared at the 1983 region 2 broadcasting satellite conference. How this conflict will be resolved within the United States is a current matter before the FCC.

A U.S. objective at WARC-79 was to gain more frequency allocations for HF broadcasting (e.g., the Voice of America). This could only be done at the expense of the fixed service and was therefore opposed by many developing countries that use HF, shortwave radio for internal domestic communications. The HF broadcasting allocations were increased conditioned on the successful outcome of a specialized HF broadcasting conference to be held in the mid-1980's to "plan" for more efficient and equitable use of the broadcasting bands. While the conference agenda will be relatively broad and open, it was apparent at WARC-79 that the United States and the developing countries have significant differences as to the type of planning to be undertaken.

Improving U.S. Spectrum Management and Preparation for International Telecommunication Conferences

Consistent with the findings of past study commissions and task forces going back to 1950, this study finds that the present U.S. Government structure for spectrum management and participation in international telexcommunication conferences is inadequate. Primarily, the problems stem from the absence of high-level Government attention to

effective policy development and coordination on a consistent and continuing basis with centralized accountability.

At least four options are available to the Congress in addressing this issue: 1) maintain the status quo and make no changes; 2) maintain the present structure, but raise the level of attention and accountability within the responsible agencies; 3) establish a mechanism—such as a task force of high-level Government officials—to develop, examine, and make recommendations on structural and procedural improvements, or; 4) establish a permanent board, council, or interagency committee of high-level Government officials to be responsible and accountable for international telecommunication policy coordination and the preparations for international conferences.

Certain shortcomings in spectrum management could be corrected without any fundamental change in the structure of FCC or NTIA. Assigning spectrum management a higher priority, particularly within FCC, and using resources more efficiently would make a significant difference. For example, FCC could improve its data base for spectrum management with the help of its own computer and spectrum experts.

The validation of spectrum requirements, and the apportioning of spectrum between Government and nongovernment users, Needs closer scrutiny. A mechanism using analytical tools to help evaluate needs and assess priorities among competing users of the spectrum would provide decisionmakers with basic information and data for use in establishing policies and reviewing requirements. While Federal spectrum requirements are reviewed by the Interdepartment Radio Advisory Committee and its Spectrum Planning Subcommittee, this function needs to be strengthened and broadened to effectively consider longer range impacts. Economic techniques (e.g., auctions, lotteries, spectrum fees, resale of frequency assignments, etc.) should be considered, at least on an experimental basis, to provide guidance on the consequences of different spectrum allocation decisions and the introduction of newer technology. These should include techniques for evaluating the relative economic viability of alternative radio uses, as well as radio v. nonradio communication systems. Experience with economic techniques could be gained by limited application to certain selected services and frequency bands.

There have been problems in the timely formation of U.S. delegations for ITU conferences arising from the need for the early inclusion of experts from industry and other nongovernment organizations. Preparations for international telecommunications conferences could be improved by replacing the ad hoc approach with an ongoing conference preparatory structure with a focal point for high-level responsibility and accountability and involving all the concerned Government and nongovernment telecommunication interests. These problems could be addressed and the effectiveness of U.S. participation in international telecommunications meetings improved by the following additional steps:

1. Industry and other nongovernment delegates could again be permitted to participate fully as U.S. representatives at international telecommunication conferences and take any assignments on the delegation for which their skills and experience qualify them. Legislation to accomplish this passed both Houses of the 96th Congress. However, the legislation to which it was added was vetoed by the President for reasons unrelated to the exemption.
2. Consideration could be given to finding means to comply with due process requirements under the Administrative Procedures Act and still name industry and other nongovernment representatives to delegations on a timely basis.
3. Guidelines and implementing mechanisms could be established for naming the chairman and individual members of U.S. delegations. The qualifications required, the distribution of skills needed, and type of representation desired could

be determined at an early stage of conference preparation. Individuals chosen to serve on the delegation could be selected from the best candidates available, especially those who participated in the preparatory effort. Whatever special Government assistance is required to assure particular representation could be made available in the early stages of conference preparations.

U.S. Strategies for Dealing With International Spectrum Issues and ITU

U.S. participation in ITU faces new and difficult challenges. Having started in 1865 as a relatively noncontroversial organization of 20 nations concerned with the interoperability of their telegraph systems, ITU has evolved into a tendencious assembly of 155 nations that look to ITU to solve fundamental issues of resource allocation increasingly vital to economic growth and development.

The ITU structure, which was well suited to the analysis of interference between radio communication systems, and to achieving a consensus on noncontroversial matters among a small number of broader issues, is sorely tested by the demands of numerous countries exhibiting the widest possible range of technical, economic, cultural, and political backgrounds. An organization that has traditionally been concerned with technical and operating standards for radio equipment and administrative mechanisms that give a country the right to operate radio stations free from harmful interference from others is being asked to satisfy the demands of developing countries for "guaranteed access" to an equitable share of the radio spectrum and satellite locations that many of them have no immediate capacity to use.

It is increasingly questionable whether U.S. negotiating skills and technological proficiency can secure essential U.S. goals and objectives in a forum that employs a "one-nation, one-vote" decisionmaking formula and in which the United States and the other industrial countries are greatly outnumbered by the less industrialized member countries.

From a strategic standpoint, the United States has a wide range of options. At one extreme, the United States could conclude that the drawbacks of continued participation in ITU outweigh the benefits, and withdraw from the organization or decline to participate in its deliberations. At the other extreme, the United States could decide to avoid controversy within ITU and simply yield to other nations on controversial matters. Between these extremes are a number of alternatives. One that requires no structural or procedural changes in ITU would be better coordination of U.S. views and objectives with other nations in advance of ITU meetings, and better U.S. planning based on improved understanding of other nations' views.

Another strategic option would be for the United States to seek to remove the most controversial issues from the ITU forum and attempt to solve them in other ways. A current example would be to respond to the demands of developing countries for "guaranteed access" to radio spectrum and satellite locations by developing the institutional arrangements to ensure domestic communication services to qualifying nations. This could be a common-user satellite system either building upon the present INTELSAT structure or creating a separate system for domestic services.

From a -structural standpoint, assuming that ITU can be changed, a number of options may be available. The United States could seek to revise the voting formula of ITU to one more fair to the United States,

perhaps by giving added voting weight to those countries that contribute most heavily to the United Nations budget. A more modest proposal would be to increase the number of ITU regions beyond the present three so that regional issues could be dealt with by a smaller number of countries most directly concerned.

Withdrawal From ITU

Would withdrawing from ITU guarantee the United States unhindered use of the spectrum allocation or frequency assignments the United States needs? Probably not. ITU members rely on the organization to avoid interference from the radio signals of others and to achieve interoperability of certain mutually used systems, such as radionavigation. The assignment of a particular frequency is of little value if others feel free to use it for purposes that cause interference. There are no effective international sanctions to force compliance with ITU decisions. Therefore, the United States relies, as do all nations, on the voluntary agreement and cooperation of other nations to refrain from interfering with its use of the spectrum.

For applications that are vulnerable to interference, U.S. preemption of spectrum (i.e., use what we wish to use) would be ineffective because any nation that chose to interfere, whether for a valid need or by intentional jamming, could greatly reduce the value to the United States of the preempted spectrum. Any preemption for uses that were invulnerable to interference (e.g., high-power radar systems with electronic countermeasure capacity) would likely result in retaliation by other nations in areas where the United States is vulnerable.

It is conceivable that the United States could abandon ITU and establish a more congenial grouping of developed countries as a forum for coordination to avoid radio interference, and simply ignore other countries. Coordination and information exchange would become less certain, but still fairly effective. However, it is likely that ITU would disintegrate if the principal developed countries abandoned it. Overall, the lack of a central spectrum allocation and coordination authority with global participation would probably lead to a more fragmented use of the spectrum, with fewer common worldwide channels, less standardization, and possible difficulties with interoperability of certain common systems, and a general increase in interference problems between services.

Revised ITU Voting Formula

As an option less drastic than withdrawal from ITU, the United States might join with other industrial nations to force a revision of the ITU's "one-nation, one-vote" decision-making formula toward one that would reflect the dominance of these nations in the actual use of the spectrum. If successful, this option would greatly reduce the ability of the Third World nations to block or force changes in U.S. positions.

A revised voting formula might reduce the contention over spectrum allocation matters at ITU; make ITU more efficient; help to make spectrum use more efficient by precluding the adoption of unworkable allocation schemes; and be no less fair than the voting practices used in a number of other international bodies that benefit Third World nations without being controlled by them. The stimulus for concurrence of Third World nations with such a proposal would be the possibility that, were it rejected, the developed countries might withdraw from ITU and render it essentially irrelevant.

The reaction of Third World nations is difficult to predict, but it seems most likely that they would bitterly resist any reversal of their recent successful trend toward fuller participation and refuse to make any concession on ITU voting formulas. From a general foreign policy standpoint, it is important to consider how much support the United States might obtain from other developed countries, many of which do not feel the

spectrum problems as acutely as the United States. The United States must also consider whether it wishes to take an assertive policy stance toward ITU apart from a generally more assertive stance toward Third World nations.

It may not be necessary that the proposed change in voting arrangements apply to all ITU spectrum decisions, but just to those allocations that might qualify as major matters. The latter case is equivalent to establishing a new, separate forum with revised voting arrangements and routing major matters to that forum rather than to ITU.

Objectively, it would seem that the interests of the developing countries lie with the continued existence of ITU and with continued technical and economic aid from the developed countries. If this choice were clearly and convincingly drawn, the Third World nations would probably come to realize that these benefits outweigh such hypothetical advantages as satellite orbital slots that many do not have the capability to use. Whether they would ultimately decide the matter on objective grounds is difficult to predict. In any event, it appears unlikely that a change in voting within ITU is possible under the present structure.

Increased Regionalization of ITU

At present, ITU divides the world into three geographic regions and many issues that can be treated separately and effectively in a single region are considered in this way. (Region 1 covers Europe, the U. S. S. R., Turkey, Mongolia, and Africa. Region 2 covers North, Central, and South Americas, the Caribbean, and Greenland. Region 3 covers South Asia, Australia, New Zealand, and the Pacific.) Regional administrative radio conferences are scheduled on a variety of specific issues, allowing WARCs to "spinoff" certain controversial matters. One option would be to extend this process of regionalization on a geographic basis to smaller subregions, and/or on an issue basis to include only those nations directly affected by the particular issue. The purpose would be to reduce the number of nations debating or voting on issues that do not affect them directly, thus reducing unnecessary contention.

WARC-79 was attended by 142 nations. Approximately 1,670 delegates and advisors met for 11 weeks and considered nearly 17,000 proposals (more than 900 from the United States), and held more than 900 meetings. Surely any approach that might help limit further WARCs to more modest proportions would be worthy of study. More importantly, when nations vote on issues that do not directly affect them the opportunities to trade votes at no cost to themselves, but which help others to sustain confrontations. Large meetings also tend to encourage bloc voting, which has already begun to emerge at ITU. Thus, subdividing ITU into smaller units, either on the basis of geographic subregions or on the basis of particular issues, would divide the Third World bloc into smaller, less dominant groups.

Decentralized decisionmaking does not guarantee that the U.S. position will prevail. Being outvoted by 10 to 1 is no more satisfying than being outvoted by 154 to 1. However, it is easier to bargain in detail with 10 nations than 154, and if a quid pro quo must be offered, the total cost is likely to be lower.

The mechanics and economics of increasing substantially the number of conferences is also important to consider. The limited U.S. professional staff available to prepare for and attend spectrum conferences is already stretched thin, and if the United States does not wish simply to skip many of the meetings—a risky proposition—this staff would need to be considerably augmented. The developing countries would find it even more difficult to prepare for a heavy schedule of meetings.

Increased decentralization of ITU could, in principle, lead to greater fragmentation in the use of the spectrum, with the same bands being used for different purposes in different regions to a much greater extent than is now

the case. While this may be acceptable in the short run, the long-term implications are worthy of study. If, for example, a new service were proposed that would be global in character, obtaining the necessary global spectrum allocation might require changes in the allocations to many different services in many different locales. At the least, it might be necessary to create an institutionalized system for coordinating decentralized decisions.

Better Coordination and Planning

As a relatively conciliatory approach, the United States could mount a major effort to develop long-term plans for spectrum use that would take into account the spectrum requirements of developing nations, to aid them in understanding the realistic options available to meet their short- and long-term needs, to offer such technical and economic assistance as might be needed to enable them to participate actively in the planning process, and to seek their concurrence with fair, objective, and realistic proposals.

To a significant extent, the confrontations initiated by Third World nations in ITU are based on suspicion and mistrust of developed countries. Perhaps this is based on a lack of understanding of the true potential of technology to create the spectrum resources they will need in the future. But many Third World nations also question whether they will be able to take advantage of that technology and they question the good faith of the developed countries to share the benefits of advanced technology.

The fact remains that there is adequate spectrum for all nations at the present and that technology will very likely expand the effective utility of the available spectrum to satisfy future needs. The problem for the United States is to convince other nations, particularly the developing countries, that spectrum and orbit capacity will be available and that their needs for service can be satisfied. Technical assistance can be very useful in this regard, and economic assistance can help make the benefits of technology a reality. Creating a role for the developing countries in cooperative planning efforts is likely to make them more receptive to the positions and plans that are forthcoming.

Long-range planning of spectrum utilization is presently inadequate and not easily accomplished in an area where technological rate of change is rapid and in a competitive system like that in the United States where policy makers are more likely to be responding to problems than to be developing long-range plans. However, better long-range planning for telecommunication services and spectrum needs is clearly necessary to cope effectively with the ITU allocation process. Developing and sharing planning techniques and data with other countries would not make a new planning process vastly more difficult or costly, and might make it more reliable in the long run.

It is also necessary to know the extent to which developing countries' positions at ITU are based on their own vital interests rather than on misunderstandings and politics; it is unlikely that they would compromise vital interests for the sake of comity. A cooperative planning process would tend to expose true interests and clarify the negotiations.

As a practical matter, the majority of the developing countries cannot now make use of advanced communications technology without technical and economic assistance from technologically advanced countries. If the majority of nations were to vote to adopt rules that limit or preclude the use of advanced technology to which they do not have independent access, communication capability would suffer and costs would increase in the long term for all users. Thus, the cost of assisting other countries in using advanced technology must be balanced against the cost to the United States of not being able to take full advantage of such technology ourselves. This equation deserves close analysis.

Cooperative planning has worked in the past; the United States was a leader in coop-

erative planning for INTELSAT and the International Maritime Satellite Organization (INMARSAT). The exact mechanism for cooperative planning is an important and complex matter, made more difficult by divided responsibility in the United States for communications policy in general and spectrum planning in particular. However, it should be possible to graft onto the existing structure a sufficiently comprehensive mechanism with high-level responsibility to assure effective long-range planning and to foster cooperation with other nations.

As an alternative, ITU could be invested with a planning staff to undertake long-range coordination, analysis, and planning. Such a "neutral" planning expertise might be less likely to be mistrusted by Third World nations, and perhaps more capable of defusing potential disagreements. Naturally, the United States would participate in the process and perhaps may more easily influence a planning process in which the measure of power is technical expertise, rather than influence an ITU conference in which the measure of power is votes. The United States has consistently opposed any increase in the power of ITU, particularly, efforts to expand the planning role of the International Frequency Registration Board.

A broader, more extensive, and more conciliatory approach to international spectrum planning would be required under this option and could have a real chance of success, given some major changes in the U.S. approach. In the long run it could be the least expensive and most effective option available to this country.

Common-User System

As an alternative to contention for satellite slots on the geostationary orbit, the United States and other developed countries could enter into a joint venture with developing countries to construct, launch, and operate a common satellite system to meet domestic needs for telecommunication and/or broadcast services. The developed nations would provide the private capital and technological resources necessary to construct and launch the system, and would operate and manage it in conjunction with other using nations. All nations in the joint venture would have the option of purchasing a share of the common enterprise, up to their actual percentage of use of the system, and sharing proportionately in any profits. Such an arrangement would be similar to that governing the INTELSAT global satellite system used for international telecommunications. High-capacity satellite systems employing technology to make a common-user system economic and operationally attractive to developing countries for domestic services could be part of the existing INTELSAT structure or a separate structure established for this purpose.

Many developing nations are concerned that the satellite orbit locations are being occupied rapidly on a "first-come, first-served" basis, and that by the time they are in a position to use satellite systems there will be no desirable orbit locations left for them. It seems clear that the requirements of developing countries will be for satellite service and not for satellite orbit locations that they may not be able to use. This option would provide service without allocating dedicated orbit locations for individual users.

Moreover, the cost of developing and launching a dedicated satellite system is very high, well beyond the capability of most developing countries for the foreseeable future. This option could provide satellite service well in advance of the time these countries could afford their own systems, and much more cheaply. No large initial capital investment would be required from user nations, and there would be little risk.

While this policy option does not address the full range of problems before ITU, it does offer the prospect of relieving the pressure on a particularly important and contentious issue. If low cost and technically attractive domestic satellite capacity is made available through an international organization that accommodates the sovereignty interests of

each country, many developing countries could come to see access to orbital slots and satellite frequencies as a side issue with availability of service being the main objective. Increasing adoption of the INTELSAT-type alternative would free up orbital slots for those major developing countries that continue to desire their own separate domestic systems whether for political reasons, or because requirements justified such a system economically.

A common-user system need not require any Government funding by the United States. Sufficient capital and technical resources exist in the private sector in the United States, and within Europe and Japan, to construct such a system as a commercial venture with expectations of future markets for follow-on equipment and services. Alternatively, such systems could conceivably be initiated with World Bank loan guarantees.

"A Priori" Allotment

The United States could agree to participate with other nations in the development of a long-range plan for the utilization of satellite orbit locations to serve participating nations' domestic communications requirements. This plan would assure that orbital slots would be available for the use of all nations when needed. In exchange for this agreement, the developed nations would likely insist that the plan be based on sound operating principles and be updated regularly to take account of the latest, most efficient technology available.

A priori allotment of satellite orbit slots has been a cause celebre among developing countries. At WARC-79, a resolution was adopted to consider this issue at a two-part space planning WARC in the mid-1980's. The United States has opposed a priori allotment plans for satellite service as wasteful and inhibiting to technological advancement. Although this option goes a long way toward accommodating the position of the developing countries, it maintains a substantial degree of flexibility important to the United States, including the key qualification of a requirement for regular technological updating that would help to avoid the worst consequences associated with rigid allotment schemes.

As far as the United States is concerned, certain types of a priori allotment plans would not be as objectionable as others. Plans based on sound engineering and operational parameters might be workable internationally, at least on a regional basis. Indeed, U.S. domestic satellite operations are based more or less on an a priori approach. In the long run the United States may have enough satellite capacity, made possible by advanced technology, to meet domestic needs even if the orbit and system available to the United States is reduced. In the short run, the United States already has substantial numbers of operational satellites with additional satellite systems planned for operations in the near future.

In addition to the possible advantages that may result from improvements in technology, there are two factors that may help reduce the impact of a priori allotment plans on the United States. One is advanced technology, including cellular satellite technology, already on the drawing boards, which will permit the construction of a large, wideband satellite that can provide very large capacity from a single orbit slot. The other factor is the particular geography of region 2 (North and South America). From the standpoint of using the geostationary satellite orbit, region 2 is naturally divided into two parts–those nations located in the Northern Hemisphere and those in the Southern Hemisphere. A second geographic factor that serves to separate the hemispheres is the displacement in longitude of the nations in the Northern and Southern Hemispheres. Also, those nations closer to the Equator enjoy the widest possible visibility of the orbit and have the greatest flexibility in positioning satellites. Moreover, the North American Continent consists of three countries with very large land areas that made the use of

advanced technology using shaped-beam antennas attractive.

Although an a priori plan is implied in the approach, it could be implemented without the adverse limitations of a rigid a priori plan such as adopted at the 1977 WARC. If this approach is possible, then an a priori allotment to one country would not include using the same allotment for others if certain technical and operational guidelines were followed.

There may even be some benefits to the United States from adopting an a priori allotment plan. At present, there is considerable uncertainty about the outcome of the 1983 Region 2 Broadcasting Satellite Administrative Radio Conference and the space planning conferences in the mid-1980's. If a decision is postponed, the uncertainty would continue. A situation would then be perpetuated in which any existing domestic satellite orbit slot may be withdrawn in the future. Moreover, no satellite system designer could plan the logical evolution of a proposed system with confidence that the required additional allotments would be available. This would force designers to plan their systems on the basis of short-term recovery of investment.

It is also important to examine the tactical aspects of agreeing to an a priori allotment policy. By participating in the development of a plan, the United States would be in a position to influence the type of plan adopted and possibly gain concessions on other issues of importance to the United States.

In short, the linkages and tradeoffs among these and other possible approaches to future use of the geostationary satellite orbit cast each U.S. policy option in a different light. Careful review in each case is needed for sound policy formulation. Rather than rejecting a priori allotments as inherently wasteful, it may be in the U.S. interest to examine the practical effects, to examine the possibility of a quid pro quo, and if the result looks acceptable, to-work with the developing countries to implement the plan.

U.S. Options Regarding the Final Acts of WARC-79

As the largest and most technically advanced user of the radio spectrum on a worldwide basis, the United States approached WARC-79 with the greatest stake in reaching agreement on a new table of frequency allocations and a revised set of related technical and administrative regulations.

While the Department of State has indicated official U.S. satisfaction with the outcome of WARC-79, the United States ultimately took six reservations in the final protocol to the Final Acts of WARC-79, helping to bring the overall total to 83. Two of the six were directed at political issues, but the remaining four were directed at decisions that could have a direct impact on U.S. telecommunications operations.

The Final Acts of WARC-79 will ultimately come before the U.S. Senate to be considered for ratification as a treaty. There are several options available:

1. The United States can ratify the Final Acts without delay. Completing the ratification process prior to January 1, 1982 when the 1979 radio regulations enter into force will indicate to other nations our goodwill and determination to abide by our international obligations. The Final Acts constitute the “radio regulations, Geneva, 1979,” which replace the

1959 regulations as partially revised by the administrative radio conferences held in 1963, 1966, 1971, 1974, and 1978. The Final Acts also incorporate the provisions of the 1977 broadcast satellite WARC as modified by WARC-79.

2. The United States can ratify the Final Acts with conditions, thereby underscoring and making explicit the reservations taken at Geneva. In particular, the United States could reiterate the reasons for taking reservations in the protocol to the Final Acts to emphasize U.S. concern regarding the issue raised.
3. The United States can ratify the Final Acts with additional reservations that either state U.S. refusal to acquiesce to particular decisions taken at WARC-79, beyond those cited in earlier U.S. protocol statements, or set forth U.S. policy with respect to future actions by ITU or specific implementation of the WARC-79 Final Acts. While it is not uncommon for the U.S. Senate to attach conditions to a resolution of ratification of a bilateral international agreement, which the other party can readily accept or reject through its own ratification processes, attaching conditions to a multilateral agreement raises difficulties.
4. The United States can ratify the Final Acts in part, specifically withholding ratification of those provisions (which would have to be listed in precise detail) where the United States chooses to remain bound by the provisions of existing regulations previously ratified (which would also have to be listed in precise detail).
5. The United States can withhold ratification of the Final Acts pending the outcome of several important international conferences dealing with telecommunications issues. This would deny FCC and the current administration any legal basis for implementing decisions taken at WARC-79, many of which were strongly advocated by the United States and fought for by the U.S. delegation and which are scheduled for implementation by other ITU members on January 1, 1982. The most immediate international telecommunications conference of great importance to the United States is the September 1982 plenipotentiary. The actions taken at this conference to revise the ITU convention will be basic to all future conferences of ITU.
6. The United States can reject the Final Acts of WARC-79 in their entirety and announce that we intend to abide by the preexisting radio regulations, as amended. The consequences would be similar to those cited above.

Chapter 2

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

Contents

Page

Introduction 25

Can the United States Disregard the Motivations of Other Nations? 27

How Dependent is the United States on the Radiofrequency Spectrum Including Use of the Geostationary Satellite Orbit?. 27

How Different From Other Countries is the United States in Its Need and Use of the Radio Spectrum 29

Why Is It Necessary To Coordinate Radiofrequency Use Internationally?. 30

How Is the Radiofrequency Spectrum Managed in the United States?. 31

How Is the Radiofrequency Spectrum Managed Internationally? 32

Issues Addressed in the OTA Study 33

Chapter 2

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

Introduction

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

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

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

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

84-591 0 - 82 - 3

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

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

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

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

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

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

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

Can the United States Disregard the Motivations of Other Nations?

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Why Is It Necessary To Coordinate Radiofrequency Use Internationally?

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

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

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

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

How Is the Radiofrequency Spectrum Managed in the United States?

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

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

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

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

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

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

How Is the Radiofrequency Spectrum Managed Internationally?

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

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

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

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

Issues Addressed in the OTA Study

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

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

Chapter 3

Domestic and International Management of the Radiofrequency Spectrum

Contents

	Page
The Structure of Spectrum Management for the United States	37
The Role of NTIA	38
The Role of the FCC	38
The Department of State's Role	40
The Public Role	42
Past Critiques of U.S. Telecommunication Policymaking	42
Prospects for the Future	44
International Management of the Spectrum – the ITU	46
ITU Structure	47
Political Issues	49
The Future of ITU	50
The Changing ITU Environment	52
Other International Organizations Involved in Telecommunications	54
U.S. Preparations for WARC-79	56

TABLE

Table No.	Page
l. U.S. Delegates to WARC-79 by Organization	60

LIST OF FIGURES

Figure No.	Page
l. Federal Communications Commission Structure-August 1981	39
2. Actors Involved in FCC Rulemaking	41
3. 0rganizational Chart of ITU	48

Chapter 3

Domestic and International Management of the Radio frequency Spectrum

From the earliest practical utilization of radio for ship-to-shore and ship-to-ship communications in the early 1900's it was apparent that international agreements were required to coordinate use of the electromagnetic spectrum and avoid interference. For full and effective use of radio communications there had to be common standards for equipment design and mutually consistent operating techniques. Most of all, there had to be agreement on ways to achieve interference-free, compatible use of the radio-frequency spectrum by radio systems whose radiated energy may overlap in various dimensions of space, time, frequency, and other characteristics of electromagnetic radiation.

Without such agreements radio communications would be chaotic. Mutual interference would make radio reception so unreliable as to be virtually useless. The history of spectrum management has been marked by increasingly complex mechanisms for the rational and economical exploitation of increasingly congested channels of communication. The success of these arrangements is a tribute to man's commonsense and ingenuity.

The Structure of Spectrum Management for the United States

Telecommunication is an essential element in the economic and social life of the United States and a vital factor in the effective functioning of virtually every department and agency of the Federal Government. Yet, despite the nationwide and worldwide importance of rapid, reliable, responsive telecommunications, the United States does not have a centralized means to oversee and coordinate national policy decisions.

There is no single U.S. Government organization responsible for overall frequency management, policies, and processes. Instead, there are several governmental organizations having key roles and responsibilities with the National Telecommunications and Information Administration (NTIA), the Federal Communications Commission (FCC), and the Department of State being the principal agencies. The procedures followed are both formal and informal, and there are an increasing number of diverse constituencies.

Spectrum management in the United States, including the development of policy, is divided, depending on whether the spectrum user is a Government or nongovernment entity. The Communications Act of 1934 assigns to the President the responsibility for management of the electromagnetic spectrum used by agencies and departments of the Federal Government. FCC is responsible for managing all nonfederal government use.

It is the status of the user, not the frequencies employed or the particular category of service, that determines whether the President (or his agent) or FCC has jurisdiction.

For example, spectrum use by the Department of Defense (DOD) and the individual military services is under the jurisdiction of the President, while spectrum use by common carriers such as AT&T and the Communications Satellite (COMSAT), by State and local governments, and by citizens and amateur radio operators, is the responsibility of FCC.

The Role of NTIA

Under Reorganization Plan No. 1 of 1977 and Executive Order No. 12046, of March 26, 1978, President Carter transferred his authority to assign frequencies to the Secretary of Commerce, who further delegated it to the Assistant Secretary of Commerce for Communications and Information (who is also the Administrator of NTIA).

Assisting the Administrator of NTIA is an advisory body called the Interdepartment Radio Advisory Committee (IRAC). IRAC has been in continuous existence since 1922, having been established even earlier than the Federal Radio Commission, which preceded the present FCC. It has performed essentially the same functions for the past 59 years, although the organization and structure of the executive branch, and the office, or department, or administration in which IRAC has been housed have been changed many times.

IRAC is made up of representatives of 20 Federal agencies and departments. FCC participates through a liaison representative appointed by FCC. The functions of IRAC include assisting NTIA in the development of the national table of frequency allocations, the assignment of frequencies to stations owned and operated by the U.S. Government, and in the development and carrying out of basic policies, procedures, programs, and technical matters pertaining to the management and employment of the radiofrequency spectrum.

IRAC has a secretariat that provides general support to all committee activities and a variety of specialized subcommittees and ad hoc or special working groups to deal with particular matters, such as frequency assignments, international notification, and preparations for international conferences. The subcommittees are concerned with ongoing activities whereas ad hoc groups deal with specific-term subject matter.

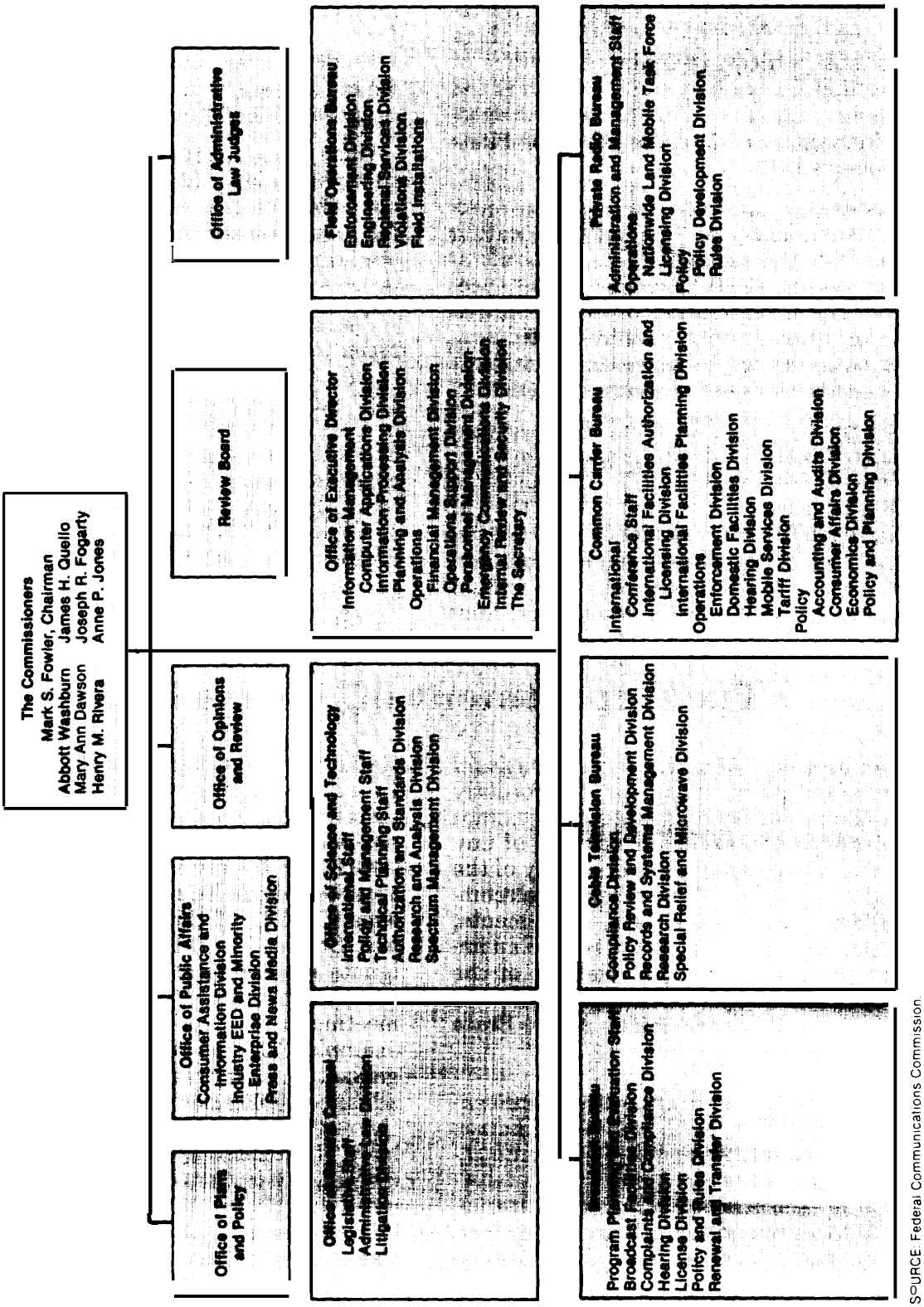
The Role of the FCC

As noted earlier, FCC, which is an independent Federal agency reporting directly to Congress, is charged with regulating interstate and foreign communications by means of radio, wire, and cable. This charter encompasses both economic regulation and the management and licensing of users of the radio spectrum.

The seven commissioners of FCC are appointed by the President with the advice and consent of the Senate. They supervise all FCC activities, with delegation of responsibilities to boards and committees of commissioners, individual commissioners, and staff units. The commissioners are aided by a staff of some 2,000 regular employees, about a fourth of whom are engaged in field operations (see fig. 1).

There are five operating bureaus, reflecting the functional basis of FCC: broadcast,

Figure 1.—Federal Communications Commission Structure—August 1981



SOURCE Federal Communications Commission

cable television, common carrier, field operations, and private radio. In addition, there are six staff offices, including the Office of Science and Technology (OST), which is the focal point within the Commission for Spectrum Management, and the Office of Plans and Policy (OPP).

Broad policy questions, having some spectrum management or frequency allocation aspects (e.g., the use and status of the ultra-high frequency (UHF) portion of the spectrum or the investigation of interim provisions for broadcasting satellites, often referred to as direct broadcasting satellites) have been the subject of studies by OPP.

The primary focus for domestic spectrum management at FCC is in the spectrum management division within OST. This division, which is responsible for, among other things, the National Table of Frequency Allocations, obtains the views of the public (and corporate representatives) through publication of notices of inquiry (NOIS), advisory committees, and from the bureaus responsible for the several radio services. The table is amended after coordination with IRAC where necessary and issuance of notices of proposed rulemaking (NPRMs) (see fig. 2).

Once a frequency band has been allocated to a particular radio service, the bureau responsible for that service will develop rules for its use on the basis of information gathered through NOIs, NPRMs, and other FCC procedures.

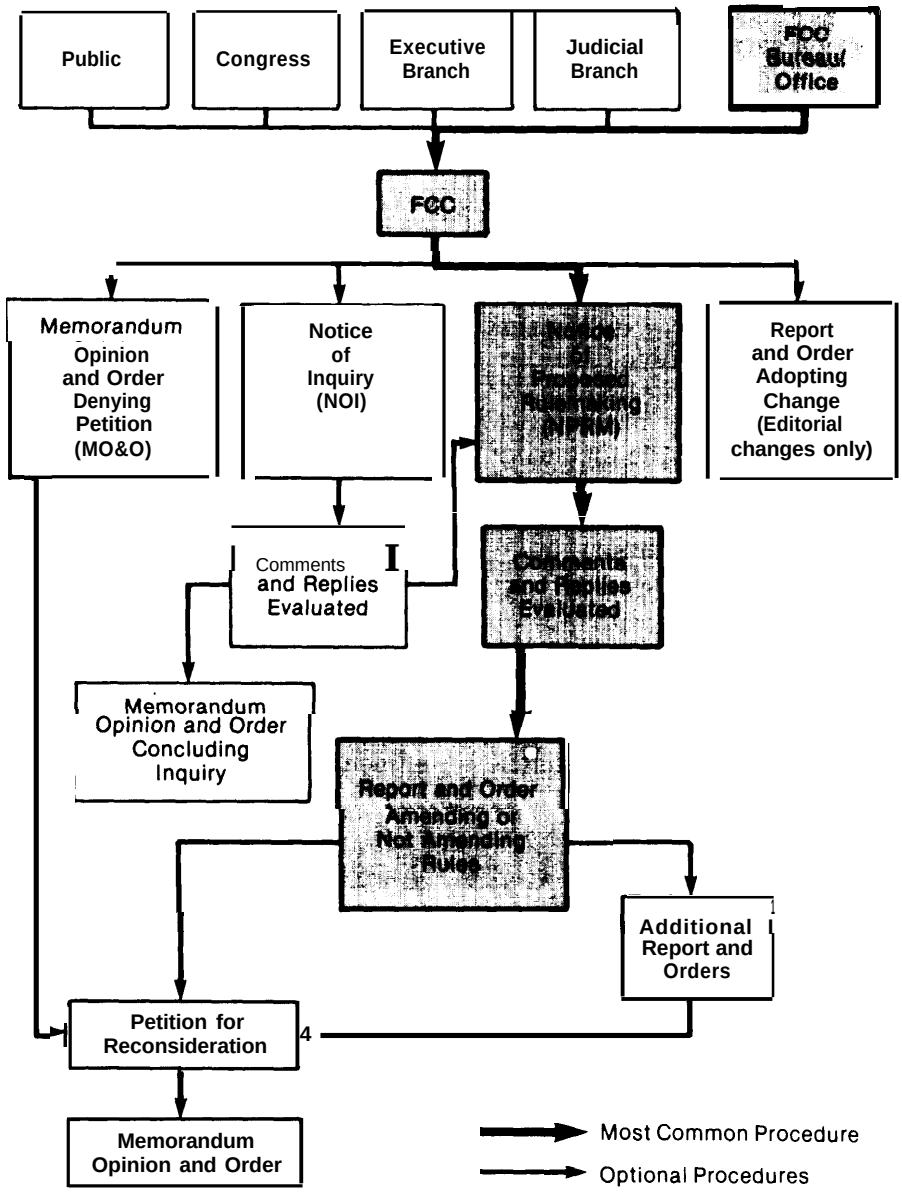
Spectrum management matters before international organizations (for example, proposals of the United States for changes to ITU radio regulations) are the responsibility of OST. This office works closely with the operating bureaus and other offices in FCC concerned with spectrum management matters. Moreover, the FCC liaison representative to IRAC is from OST. FCC's views and policies regarding its responsibilities for the private sector use of the spectrum are reflected within IRAC by this representative.

The Department of State's Role

It can be seen that policy for international telecommunication, including the orderly use of the radiofrequency spectrum, cannot be considered the exclusive concern of any single executive department or agency of the Federal Government. Nevertheless, telecommunications negotiations and agreements, both bilateral and multilateral, remain an important part of the foreign relations of the United States and therefore fall within the jurisdiction and responsibility of the State Department.

The Department of State, with recommendations from NTIA, FCC, and others, names delegations to international telecommunication meetings, whether sponsored by international organizations, such as the International Telecommunications Union (ITU) (and its permanent bodies, the International Radio Consultative Committee (CCIR), the International Telegraph and Telephone Consultative Committee (CCITT), and the International Frequency Registration Board (IFRB), or by regional bodies, such as the Inter-American Telecommunications Conference (CITEL) of the Organization of American States. The State Department can designate another agency or commission to represent the United States at a particular meeting or for a specified purpose. Thus, for example, FCC has been designated as the organization that transmits notifications and advance publication information required by the radio regulations to IFRB of ITU. Similarly, the Commission conducts bilateral meetings with Canada regarding nongovernment frequency use near the border, and DOD participates directly in the communications negotiations of the North Atlantic

Figure 2.—Actors Involved in FCC Rulemaking



SOURCE FCC *Communicator*, September 1975

Treaty Organization (NATO) and its subordinate bodies, such as the Allied Radio Frequency Agency.

Typically, U.S. delegations to international meetings in general, and ITU and its bodies in particular, have included individuals from Government agencies, and nongovernment organizations. As in the case of other specialized, highly technical international conferences and negotiations (meteorology, world health, agriculture, etc.) the State Department looks to other Government agencies, private sector organizations and companies, and individuals having knowledge of each field. In the case of international telecommunications, the State Department relies heavily on FCC, NTIA, and the na-

tional committees for CCIR and CCITT, as well as on individual agencies such as DOD, the National Aeronautics and Space Administration (NASA), and the Department of Transportation, as well as experts from the private sectors.

The Public Role

The Department of State may establish an advisory committee for specific conferences, as it did in the case of WARC-79. The public, including representatives of industrial groups and organizations, participate as individual members of such a State Department body. The public, industry, and private interests may participate in the decision-making process by filing comments and views with FCC through its public NOIS and NPRMs and in Government/industry advisory committees set up by FCC prior to many of the individual conferences. This public process to decide spectrum issues for the nonfederal government use of the spectrum is in contrast to the NTIA/IRAC nonpublic process to decide Federal use of the spectrum. Finally, individuals from industrial, scientific, research, manufacturing, and public interest organizations may be appointed to the U.S. delegations to such meetings.

U.S. international communication policy must reflect a coordinated balance of foreign and domestic policy considerations. Moreover, effective negotiations in the telecommunications field, including spectrum coordination, requires a combination of U.S. policymaking authority embodying essential features not easily combined. For example, there must be cooperation among mission-oriented Federal departments and agencies, extensive public and congressional participation, continuity over the years, and an overall sense of direction and purpose.

Past Critiques of U.S. Telecommunication Policymaking

These elements have not always been successfully brought together. A Communication Policy Board reporting to President Harry S Truman in 1951 identified five specific issues as being basic to the Nation's telecommunication problems. These were:

1. How shall the United States formulate policies and plans for guidance in reconciling the conflicting interests and needs of Government and private users of the spectrum space–that is, for guidance in making the best use of its share of the total spectrum?
2. How shall the United States meet the recurrent problem of managing its total telecommunications resources to meet the changing demands of national security?
3. How shall the United States develop a national policy and position for dealing with other nations in seeking international telecommunications agreements?
4. How shall the United States develop policies and plans to foster the soundness and vigor of its telecommunications agreements?
5. How shall the United States Government strengthen its organization to cope with the four issues stated above?

The policy board report emphasized spectrum usage, national security, and the maintenance of a sound industry as key subjects to be borne in mind when considering the issues quoted above. With regard to "inter-

national agreements, " the same report stated:*

> Just as the United States has no clear policy for dividing its share of spectrum space, so it has lacked satisfactory means of determining policy as a basis for negotiations with other nations for the world division of the spectrum. The United States, in preparing positions for international negotiations, has in effect asked Federal and other claimants to state their needs, and then presented the total as the United States requirement. In those portions of the spectrum where these totals have been small enough to fit within the world complement, our delegations to conferences have had a negotiable position. In some cases, however, the total stated requirements have exceeded not merely those which could reasonably be put forward as the proper United States share, but have actually exceeded the total physical content of the bands. Furthermore, there is no permanent mechanism by which the stated requirements of the United States users could be adjusted with equity and safety. The imperative need for means of making such adjustments hardly requires elaboration.

Sixteen years later in 1967, President Lyndon B. Johnson sent a message to Congress advising that a "Task Force on Communication Policy" was being established to examine a number of major questions in the communications policy area. While most of the thrust of the task force was aimed at the use of satellite and space technology, it was apparent that the problems identified in 1951 by President's Truman's Policy Board remained unresolved.

In chapter 9 of its report–entitled "The Roles of the Federal Government in Telecommunications, the task force stated:**

A. Traditionally, government has viewed telecommunications primarily as a mission-support function, rather than a focus for public policy. The result has been that policy has evolved as a patchwork of limited, largely ad hoc responses to specific issues, rather than a cohesive framework for planning. Government organization for the formulation and implementation of communications policies reflects this evolution.
   - Early government involvement in telecommunications often involved ad hoc responses to individual problems as they appeared.
   - The framework established by the Communications Act of 1934, although combining the broadcasting and common carrier regulatory functions, remains limited in scope.
   - The post World War I I period has been characterized by the growth of communications activities and a series of narrowly focused studies and limited organizational changes.

B. The patchwork nature of the present structure is not conducive to optimum performance of the telecommunications activities and requirements of the Federal Government.
   - Existing organizational arrangements make effective spectrum management difficult.
   - The absence of a central focus possessing the requisite technological and economic skills makes more difficult the development of a sound and forward-looking international telecommunications policy.
   - The policy coordination necessitated by the plethora of government telecommunications roles is inadequately performed by a multiplicity of committees.
   - Recent events have underscored the lack of an effective government capability for long-range telecommunications policy planning.

Thus, the 1968 report reiterates the issues raised earlier by President Truman's Communications Policy Board, and the reiteration is particularly applicable in the areas of Government organization and spectrum management. In January 1980, the U.S. Senate Committee on Commerce, Science, and Transportation requested the Chairman of the Office of Technology Assessment

*See *Telecommunications—A Program For Progress, a* report by the President's Communications Policy Board, dated March 1951, Irvin Stewart, Chairman.

**See Final *Report of the President 's Task Force onCommunications Policy,* Dec. *7, 1968.*

Board to address the following two questions:*

(1) In view of the original United States positions, what will be the probable impact of the decisions made at WARC-79 on the U. S.? How should the U.S. adjust its preparation and participation in future international telecommunications conferences in order to more effectively accomplish its objective?
(2) Should the United States modify its allocations procedures and tables in order to respond to the WARC-79 decisions? What are the major U.S. spectrum needs likely to be during the next twenty years and how will they be accommodated?

The request reflects a continued concern for the existing machinery and procedures for U.S. telecommunications policymaking and preparation for international telecommunications conferences. Similar expressions of concern in the past did lead to structural changes but with little apparent result. President Eisenhower eliminated the office of the "Telecommunications Advisor to the President" and replaced it with an "Assistant Director for Telecommunications" in the Office of the Director of Defense Mobilization. The duties assigned were focused on telecommunications policies and standards for the executive branch and the President's responsibilities for spectrum management.

Over the years, the job of "Assistant Director for Telecommunications Management" became, in 1970, the Director of the Office of Telecommunications Policy and then, in 1978, the entire telecommunications function was transferred out of the Executive Office of the President to the Department of Commerce (DOC) where the present NTIA is now located.

In the final analysis, one may conclude that, despite its worrisome deficiencies, the U.S. telecommunications policymaking and management machinery has worked. How well, and how efficiently, are matters of dispute. The good results rest on the fact that over the years highly dedicated, competent, career personnel made the system work. Since spectrum is the common denominator in all uses of radio, coordination has been essential for the various radio services to function in a compatible manner. It is this coordination, which over the years has become a very specialized and sophisticated function, that frequently bears directly on the policy decisions. The United States has been extremely fortunate in that, in the past, it has been able to send to international conferences representatives who were experienced and competent to deal with what have been essentially technical rather than political and economic matters.

*See joint letter signed by Senators Cannon, Packwood, Hollings, Goldwater, and Schmitt to the Hon. Morris K. Udall, Chairman, Office of Technology Assessment, dated Feb. 11, 1980.

Prospects for the Future

But today, more than ever, telecommunications encompasses far more than just spectrum management, and U.S. policy formulation in advance of international negotiations involves more than just those issues forced by the need for frequency coordination. The existing U.S. structure is inadequate in that the permanent, ongoing spectrum management mechanisms are not adequately equipped to review all stated requirements of Government and nongovernment spectrum users and objectively verify and adjust needs consistent with national policy objectives. There is no ongoing effective means of collecting data and developing guidelines to judge the merits of one spectrum use over any other.

In an international negotiating environment that has become increasingly political, U.S. spectrum management specialists have been called on to anticipate U.S. telecom-

munications requirements far into the future without adequate long-range analysis. The absence of such a strategic, long-term planning approach reflects the absence of concern for telecommunications issues at the highest levels of Government and hampers the effectiveness of U.S. negotiators.

Lack of high-level concern has also led to a shortage of trained and experienced engineering personnel to replace those retiring from Federal Government service. Nor has there been sufficient awareness of the need for personnel with supplementary economic, legal, and diplomatic skills, as well as foreign language proficiency.

The three principal players in conducting telecommunication negotiations are the Department of State, DOC (through NTIA), and FCC. Thus, within the executive branch there is a built-in fragmentation of telecommunications policy. The Department of State is clearly the focal point for the conduct of foreign relations but its Office of International Communications Policy is lightly manned and well down in the State Department's organizational structure. It is not in a strong position to make its influence felt in the upper echelons of Government and industry.

Under Executive Order No. 12046, NTIA is assigned functions that include developing and setting forth, in coordination with the Secretary of State and other interested agencies, plans and programs that relate to international telecommunications. From a practical standpoint, NTIA lacks sufficient resources and "clout" to fully carry out its mandate effectively. Moreover, the rather general wording of the Executive order leaves it ambiguous as to how far NTIA can go in its coordinating role, particularly when that mandate risks encroachment on the general regulatory responsibilities of FCC.

In his testimony before the Subcommittee on International Operations of the House Foreign Affairs Committee on July 31, 1980, Glenn O. Robinson, who was chairman of the U.S. delegation to the 1979 WARC, said he did not regard the fragmentation of U.S. policymaking to be a matter of great significance in preparing for future WARCs. Yet he went on to say:

> Of course, it is necessary to have some locus of final decision making; there must be some place, where in Truman's words, the "buck stops." So far as international policy is concerned the answer seems reasonably clear: the Secretary of State speaking for the President has, and must retain, the ultimate responsibility.
>
> The State Department's role extends beyond mere final review and approval of international policy positions. It also has a role to play in shaping policy positions—to ensure that international policy concerns are properly integrated into the policy making process from its inception and not merely layered on top of it at the point of final decision.
>
> An important element of future preparation will be developing appropriate linkages with other elements of international communications policy. Obviously radio spectrum use and management does not stand apart from other aspects of international communications and communications policy. Despite the highly specialized technical character of radio spectrum management which sets it apart from, say, U.N. or UNESCO debates over free-versus-balanced-flow of information or development assistance programs, the issues are often related.
>
> As a first step some permanent mechanism for intra-Departmental and interagency coordination is appropriate. Such a mechanism was developed in 1978 as a first attempt to bring together some of the major strands of international communications policy. Thereafter coordination was pursued more or less informally as part of the WARC-79 preparations. For the future, however, policy review and development ought not to be dominated by some specific major event such as WARC. The "big event" is probably of diminishing importance in international diplomacy. The process of continuing negotiations through a series of conferences has become predominant in almost all aspects of international affairs, including international communications policy. It follows that too great an emphasis on single

events, such as future WARCs, as a focal point for policy coordination could lead to a distorted perspective on policy issues and objectives.

As to what organizational structure might be needed to carry out the future role of coordinating international communications policy I have no specific recommendations. I do not think a large new office is required to handle the task, but the responsibility must be clearly recognized and given stature commensurate with its high importance.

Thus, the expressions of concern over the lack of permanent mechanisms for coordinating U.S. international communication policy persist to the present time. The present structure is not adequate to develop telecommunication policies, to effect long-range planning, and assure the achievement of U.S. goals.

International Management of the Spectrum – the ITU

ITU is the principal international institution for achieving agreement and cooperation among nations on the use of telecommunications. It is a unique organization that has managed to bring the merits of technical collaboration to a level where participating governments feel a vested interest in the agreements reached.

Adherence to ITU agreements is voluntary and cannot be enforced by higher authority. There are no sanctions to compel an ITU member to abide by ITU rules. However, membership in ITU entails a treaty obligation to conform to the collective decisions of its members. Its activities might be described by systems analysts as a nonzero or positive-sum game in which there are no winners or losers and where all the participants benefit. The mechanisms of ITU are designed to achieve the maximum utilization of the electromagnetic spectrum by the widest range of users, and to avoid a situation where one user is accommodated at the expense of another.

ITU was created in 1932 by the merger of two existing groups-the International Telegraph Union (founded in 1865) and the International Radiotelegraph Convention signatories. It has grown in breadth and scope over the years—surviving two world wars and the unprecedented diversification of communications technology.

An international agreement-making and rulemaking organization whose members adhere to many varied legal systems, it has avoided legal doctrine. Its fundamental governing principles are contained in the ITU Convention, a constitution first adopted in 1932 that remains subject to periodic revision. According to this convention the purposes of ITU are:

1. to maintain and extend international cooperation for the improvement and rational use of telecommunications of all kinds;
2. to promote the development of technical facilities and their most efficient operation with a view to improving the efficiency of telecommunications services, increasing their usefulness and making them, so far as possible, generally available to the public; and
3. to harmonize the actions of nations in the attainment of those ends.

The activities of ITU are organized for the attainment of specific objectives, the most important of which are:

- allocation, registration, and coordinated utilization of the radiofrequency spec-

trum to avoid harmful interference between radio stations of different countries;
- planned development of telecommunications facilities, particularly those using space techniques. Creating, developing, and improving telecommunication equipment and networks in developing countries;
- promoting collaboration in setting telecommunication rates as low as possible, while maintaining efficiency of services and independent financial administration; and
- conducting studies, collecting and publishing public information, adopting resolutions, and formulating regulations on matters relating to telecommunications.

ITU Structure

The ITU structure combines conferences, or policymaking bodies, and permanent organs. The plenipotentiary conference is the supreme body of ITU. It consists of the delegations of member countries meeting every 5 to 9 years to formulate general policies, establish budget guidelines, elect members and top officials, and conclude agreements between the ITU and other international organizations. Only the plenipotentiary conference can amend or revise the ITU Convention. The next such conference is scheduled for September 1982 in Nairobi, Kenya (see fig. 3).

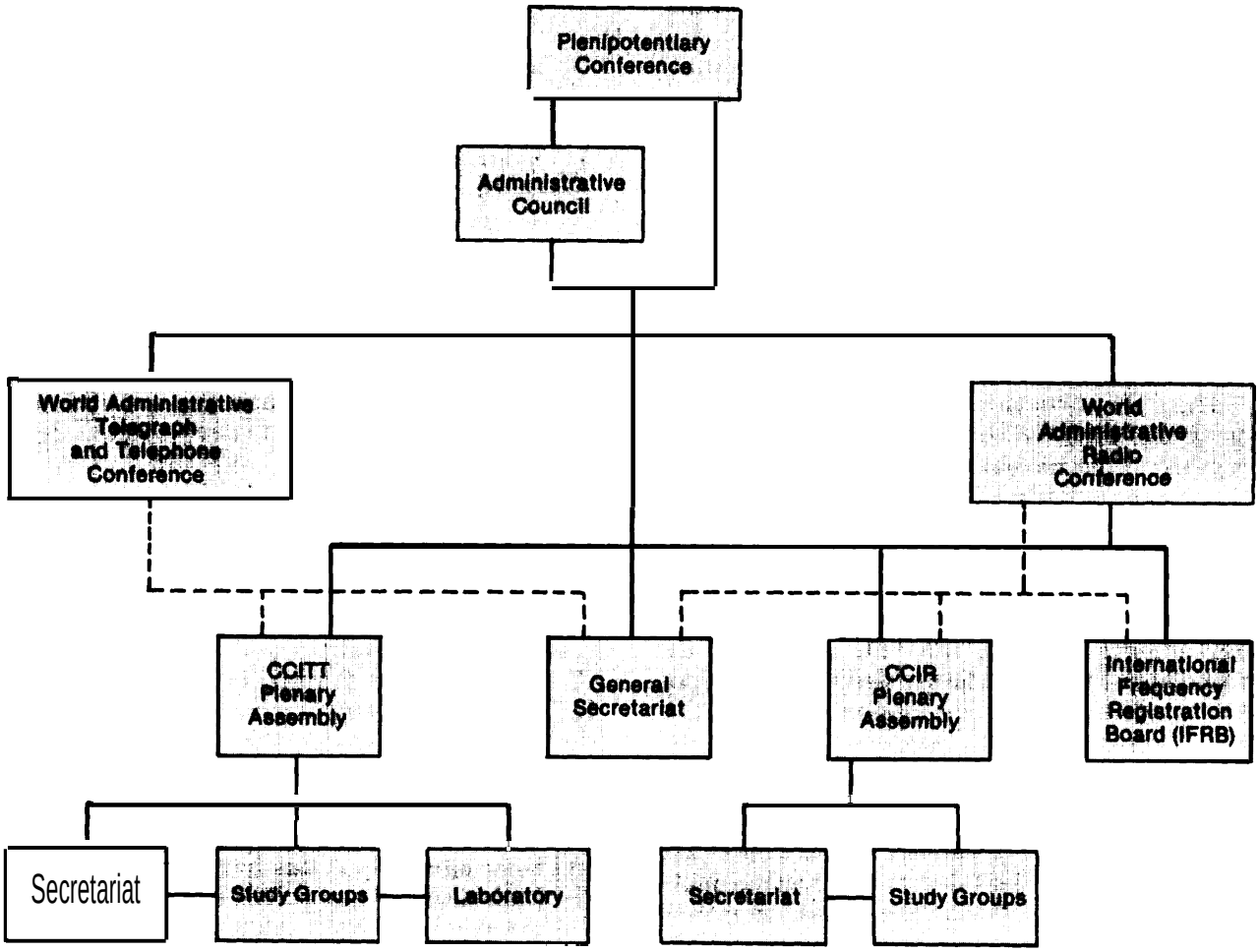
Administrative conferences are convened to consider specific telecommunication matters as the need arises. They may be either worldwide or regional in scope and participation. (ITU divides the world into three regions—region 1 covers Europe, the U. S. S. R., Turkey, Mongolia, and Africa; region 2 covers North, Central, and South Americas, the Caribbean and Greenland; region 3 covers South Asia, Australia, New Zealand, and the Pacific.) Conference agendas may concern all radio communications services and all frequency bands or may be restricted to a particular band and one or more services. Among the administrative conferences held in the 1970's were those dealing with space, maritime and aeronautical radio communications, satellite broadcasting, and WARC-79. The Final Acts of such conferences become treaties following ratification by ITU members.

In the intervals between plenipotentiary conferences, the administrative council acts on behalf of the entire membership in formulating policy and overseeing the work of ITU. First instituted in 1947 with 18 members (ITU then had 73 member states and an annual budget of 4 million Swiss francs), the council now has 36 members. (ITU has grown to 155 members and has a budget of 67 million Swiss francs, or approximately $31 million). Meeting each spring in Geneva, the council approves the annual budget, determines the size and grading of the staff, sets salaries and allowances, and determines the schedule of conferences and meetings and their agendas. It has become a forum for discussion of certain political issues such as the question of South Africa, Rhodesia, the Portuguese colonies in Africa, and the Middle East.

The council has also contended with the issue of the languages to be provided in interpretation and document translation at conferences. Interpretation and translation are provided in French, English, and Spanish, plus Chinese and Russian for all official documentation. In addition, there is interpretation in Arabic at plenipotentiary and administrative conferences.

The general secretariat has grown in size and responsibilities over recent years. Since 1965, the Secretary General of ITU has been chosen from among candidates from developing countries. The present Secretary Gen-

Figure 3.—Organizational Chart of ITU



SOURCE International Telecommunication Union

eral, Mohammed Mili of Tunisia, assisted by his deputy, Richard Butler of Australia, coordinates and supervises the day-to-day activities of ITU. He employs a multinational general secretariat staff to support the other permanent organs of XTU–IFRB and the two technical committees: CCIR and CCITT. The secretariat includes a technical cooperation department that assists developing countries, using funds provided by the United Nations Development Program (UNDP). (The current members of IFRB are from the U.S.S.R, Canada, Morocco, Japan, and the United Kingdom.)

Unlike other international organizations in which sole executive direction resides in a secretary general, there is a diffusion of authority among ITU's permanent organs leading to what is sometimes described as ITU's "Federal structure. " No one element of ITU's secretariat has overall responsibility for the operation of ITU. The Secretary General cannot dictate the registration of frequencies by IFRB nor does he have technical responsibilities for the activities of the International Consultative Committees (CCIs). Also, IFRB cannot dictate the technical findings of CCIs. Nevertheless, the Secretary General, IFRB, and CCIs are required to work together to meet the needs of the members. This sharing of executive power has given rise to certain conflicts and rivalries.

Led by five officials elected by the plenipotentiary conference, IFRB records the date, purpose, and technical characteristics of frequency assignments by member countries with a view to achieving international recognition. IFRB also records orbital positions assigned to geostationary satellites. It examines each frequency notification received for conformity with the international radio regulations and for the possibility of harmful interference. If the examination is favorable, the frequency assignment is entered in the master register; if not, it is returned to the notifying country with suggestions regarding a solution to the difficulty. Through reference to the master register and the board's weekly circulars, operators worldwide have access to a listing of all registered frequency assignments.

CCIR, which is currently headed by an American, and CCITT, whose director is French, are ITU's best known permanent organs. All member countries and certain private operating companies, scientific and industrial organizations can participate in their work. The ITU Convention prescribes the duties of CCIR as the study of technical and operating questions relating to radio communications and the issuing of recommendations. The CCITT members are to study and make recommendations regarding technical, operating, and tariff questions related to telegraphy and telephony.

The work of CCIs is conducted by a number of study groups whose members include experts in each of the specialized areas of interest to the study groups. The product of these study groups is the basis for standards and specifications that are generally accepted by all administrations and users.

In practice, CCIs have studied, issued reports on, and made recommendations concerning communication systems operations and advanced technologies as they have been developed. The member nations of ITU look to CCIs for information and guidance on the use of these techniques and their reports and recommendations are respected and generally accepted by member nations in the planning, design, and operation of telecommunication systems.

The responsibilities of ITU to lend assistance to developing countries and to study their special problems is a challenge to an organization whose principal purpose is agreement-making. The rationale is simple enough. For agreement-making to be effective, all participants must be in a position to participate and cooperate. The less developed countries need help in extending their telecommunications services and in developing appropriate administrative and technical skills. Thus, technical assistance promotes better global communications generally.

The challenge to ITU lies in extending this assistance without overtaxing its limited resources. The extraordinary growth of telecommunication technologies and services has already strained ITU's capacity to produce effective international agreements on a timely basis. Furthermore, ITU must compete with other organizations for the services of telecommunications specialists that it would like to assign to assist developing countries. The costs of ITU's administration of UNDP aid programs must be met by contributions from developed countries that may prefer to see ITU concentrate on its agreement-making functions.

Political Issues

At various times, member nations of ITU and signatories to the convention have been excluded from ITU conferences for political reasons. For example, this happened to Spain in 1947, and Rhodesia, South Africa, and Portugal were excluded from a 1973 con-

ference. There have also been occasions when efforts to exclude nations have failed to win approval of the membership.

In other instances, the structure of ITU has been flexible and pragmatic enough to assign country codes for worldwide automatic telephone dialing to nations that, at the time, were not members of ITU (e.g., East Germany, the Peoples Republic of China).

Unfortunately, ITU is not always successful at agreement-making. For example, in the postwar years three incompatible standards for color TV broadcasting were adopted in several parts of the world to the obvious detriment of international coordination and standardization. As a result, European TV set manufacturers must provide parallel circuitry to accommodate the different standards and international program exchange is seriously burdened by the conversion of standards at switching points.

A similar problem developed in the search for a standardized digital transmission system. European countries were able to select a single system from among almost 20 competing designs but North American interests, committed financially to a different design, were unwilling or unable to be accommodating enough to find a compromise single standard.

Overall, the achievements of ITU are impressive considering its inherent weaknesses and the complexity of its structures and procedures. Modern states are clearly unwilling to cede substantial power to any international organization. Yet, ITU has managed to maintain order in an environment that could easily have been chaotic. The growing needs for maritime and aeronautical communications have been met. Efficient international telegraph and telephone service would have been difficult without ITU or similar organizations. Despite the strong economic interests of national equipment suppliers, there was sufficient collaboration within CCITT to accomplish the shift from operator-assisted international phone service to automatic dialing, routing, and switching.

The Future of ITU

Whether ITU can continue to function effectively in the future is another question. The influx of "new" nations to membership in ITU in recent years has brought a different set of values and concerns to the organization. The new members have brought a heightened demand for programs of aid and technical assistance to developing nations. They have fostered regionalism and, most important, they have increasingly demanded equitable access and usage of spectrum and orbital slots for geosynchronous satellites.

The needs of these developing nations are often at odds with those of the developed world. For example, industrialized countries need considerable amounts of radio spectrum to support sophisticated worldwide radionavigation and radiolocation systems considered vital to their national security and safe international air travel. Developing countries have limited need for these "radar" systems. By the same token, there is contention between the developed and less developed countries over the use of high frequency (HF) bands. The developing countries depend on HF for domestic point-to-point communication in large measure whereas the developed countries are more likely to use the same frequencies for international broadcasting, mobile, and other services.

The principal issue of contention has been the so-called "first-come, first-served" principle used by ITU member countries to register radiofrequency assignments. Basically, "first-come, first-served" has meant that whoever develops a use for a given frequency first and notifies IFRB of this intended use

has established a claim to protection from harmful interference. This has meant that the bulk of the frequency assignments have been assigned to the developed countries. Moreover, some of those assignments, particularly those used for HF fixed (point-to-point) services, have been abandoned by the developed countries in favor of microwave and satellite systems but, it is charged, have not been given up for reassignment. (It should be pointed out that to a large degree the radio spectrum is reusable. This means that a frequency assignment made to one country does not necessarily preclude its use by another country.)

The developing countries, therefore, fear that when they are finally prepared to use radio services not needed at their present stage of development, the spectrum space will no longer be available. They have translated this fear into a demand for "equitable and/or guaranteed access" to the frequency spectrum. The developed countries have responded by insisting that the fears of the developing nations are groundless, that new technology will free up certain frequencies while allowing other frequencies to be shared by a greater number of stations and services. However, frequency-sharing usually requires more sophisticated and expensive equipment and increases the need and complexity of coordination to avoid interference. Most developing countries lack trained engineers sufficiently competent in frequency management to carry out complicated coordination procedures and also lack the required sophisticated and expensive equipment to avoid interference.

"Equitable access" also refers to communications satellites and the newer members of ITU frequently cite the 1967 U.N. Treaty on Outer Space that recognized the common interest of all nations, regardless of the degree of their economic or scientific development, in the uses of outer space and in the "nonappropriation" of outer space by any one nation. While each state has the right to the free and peaceful utilization of space, the treaty is viewed as implying a corresponding obligation of nations to avail themselves of these uses without prejudice to the interests of other nations.

Claims of the developing nations to "equitable access" were further underscored by Resolution No. Spa 2-1, adopted by the 1971 WARC (and included in the Final Acts of WARC-79), dealing with space telecommunications, which states:

> . . . *considering* that all countries have equal rights in the use of both the radio frequencies allocated to various space radio communication services and the geostationary satellite orbit for these services;
>
> . . . *taking into account* that the radio frequency spectrum and the geostationary satellite orbit are limited natural resources and should be most effectively and economically used;
>
> . . . *having in mind* that the use of the allocated frequency bands and fixed positions in the geostationary satellite orbit by individual countries or groups of countries can start at various dates depending on the requirements and readiness of technical facilities of countries;
>
> *Resolves*
>
> 1. That the registration with the ITU of frequency assignments for space radio communication services and their use should not provide any permanent priority for any individual country or groups of countries and should not create an obstacle to the establishment of space systems by other countries;
> 2. That, accordingly, a country or a group of countries having registered the ITU frequencies for their space radio communication services should take all practicable measures to realize the possibility of the use of new space systems by other countries or groups of countries so desiring;
> 3. That the provisions contained in Paragraphs 1 and 2 of this resolution should be taken into account by the administrations and the permanent organs of the Union.

This 1971 position was reinforced at ITU's Malaga-Torremolinos Plenipotentiary Conference in 1973 that amended the ITU Convention to include article 33, which reads:

In using frequency bands for space radio services members shall bear in mind that radio frequencies and the geostationary satellite orbit are limited natural resources, that they must be used efficiently and economically so that countries or groups of countries may have equitable access to both in conformity with the provisions of the radio regulations according to their needs and the technical facilities at their disposal.

The Changing ITU Environment

It is clear that the developing countries have also succeeded in establishing a resource management philosophy designed to protect their interests. Although ITU may remain a viable institution, there have been some subtle and important changes in the institutional framework under which the technical functions and work of ITU are carried out. Moreover, WARC-79 clearly showed the power of the Third World as a political force in ITU. Although the collective objectives of the developing countries were limited, they were generally achieved.

The struggle for power between the developed and the less developed nations must be expected to continue at future ITU conferences. In the most basic sense, the developing countries derive power from their collective numbers via the "one-nation, one-vote" principle. The developed countries derive their power from their technical competence, know-how, and leadership. The developing countries' power can most easily and usefully be exploited in the ITU legislative forums; the developed nations' through the technical administrative organs.

The developed country strength lies in the permanent organs of ITU and the delegation of authority and work efforts within that structure. Control, in the sense of inclusion or exclusion of issues and agenda items, and in the handling of budgetary matters, is most easily exercised here. It is natural for the developing countries to seek to change these administrative organs to advance their own interests and objectives. The 1982 plenipotentiary meeting could well see a furthering of this effort.

The success of ITU, as noted earlier, has been due in large measure to the willingness of its members to adhere voluntarily to commonly arrived at agreements and regulations. There is no compulsion to comply, except common usage, custom, and a perceived stake in international order. The inherent flexibility granted ITU members has also enhanced its effectiveness. Subject to a vote of disapproval by fellow members, any nation may serve notice through a footnote that it intends to allocate a particular frequency to some usage beyond that specified by other countries, or to specify a usage as primary or secondary. A member country may also take a reservation indicating that it cannot protect a particular spectrum allocation approved by an ITU conference.

The common desire of most countries to minimize the number of footnotes and exceptions to the international table of allocations was not realized at WARC-79. Eighty-three statements, representing reservations, were included in the final protocol of the WARC-79 Final Acts. The United States took six reservations. The remaining 77 statements, some of which bear the names of several countries (up to 20, in one case), can be grouped in three categories: general reservations, political reservations, and specific reservations.

Thirty-five reservations were "general" in that they were intended to reserve a government's right to take whatever steps it considered necessary to protect its radio communication services should other ITU members fail to observe the radio regulations. Other reservations were "political" in that

they related to territorial disputes or sovereignty claims that had little impact, if any, on the ITU or on spectrum use for radio communication purposes.

The remaining reservations of other countries were addressed to specific issues, principally the allocation of HF bands among the broadcasting, fixed, and mobile services. Some dealt with localized problems associated with UHF band use.

It would be going too far to say that the taking of numerous reservations at WARC-79 signaled a sharp decline in ITU effectiveness. But it should be noted that the reservations, when coupled with the widespread use of footnotes to denote unwillingness to protect a particular frequency allocation in a particular locale, resulted in degrading of the table of allocations and thus makes future coordination more difficult.

Throughout the 1970's, repeated efforts were made both within and outside ITU to assess the competing demands being made on the radio spectrum. In addition to the various CCIR study groups that addressed the growing requirements of different services, there was a CCIR plenary assembly in Kyoto, Japan and the CCIR interim working party (4/1) in Tokyo; both met in 1978, the latter being directed primarily toward fixed satellite service considerations. In October/November 1978, the WARC special preparatory meeting (SPM) was held in Geneva.

Among some Third World countries there was a feeling that SPM was dominated by the developed countries because of its technical nature, and therefore was to be treated with some suspicion. It was natural, then, that other preparatory meetings should take place outside the framework of these traditional ITU entities. One of these was a May 1979 gathering of the nonalined movement (NAM) in Yaounde. Two specific resolutions produced at this gathering called for a future satellite planning conference and specified working arrangements for WARC-79. The vice-chairman of this meeting was Dr. M. K. Rao of India, the country selected to coordinate satellite issues for NAM.

The NAM Yaounde meeting was a clear indication that these countries will be preparing for future conferences on a collective basis, seeking to make the most of their bloc voting strength.

There were only a few collective objectives sought by the Third World at WARC-79:

- control of the selection of the conference chairman;
- a large allocation of HF frequencies to the fixed service;
- satellite planning and HF broadcasting planning conferences;
- a bar to the encroachment of land mobile and other services into frequencies reserved for broadcasting at UHF in region 1; and
- continued technical assistance.

These goals were generally achieved with the exception of the first; after a week of disagreement, the conference had to settle for a compromise chairman from Argentina who was not a candidate of either the developed or less developed nations. Overall, WARC-79 did demonstrate the increasing influence of the Third World in ITU.

The results of the OTA-sponsored survey* shows that 74 percent of the U.S. delegates to WARC-79 and 67 percent of the nondelegates responding to the survey believe that the relative influence of the Third World countries at ITU conferences has increased

*The OTA-sonsored survey consisted of a questionnaire of 51 questions mailed to 169 individuals involved directly or indirectly with preparations for WARC-79, and/or with implementation of the results of WARC-79. A total of 110 questionnaires were completed and returned: 55 from U.S. delegates to WARC-79: 29 from nondelegate Government personnel; 18 from nondelegate members of the advisory committee to the U.S. delegation; 26 from nondelegate industry personnel; and **41** from nondelegate individuals in the private sector. In addition, 20 in-depth face-to-face interviews were conducted with 13 Government officials and 7 industry officials. The results of the survey and an analysis of the answers and information received through the survey and interviews are presented in the report prepared by Kappa Systems, Inc., under contract to OTA. The report can be found in app. A to this report.

greatly over the past 5 years. Another 23 percent of those responding believe there has been only a slight increase in the influence of the Third World countries. During the same time, 51 percent of the U.S. delegates and 59 percent of the nondelegates surveyed believe there has been some decrease in U.S. influence, though only 12 percent and 18 percent of the delegates and nondelegates, respectively, saw this as a major decrease. Looking ahead, the respondents see U.S. influence from now through 1985 remaining about the same (39 percent) or slightly decreasing (45 percent). Some increase in U.S. influence is foreseen by some respondents (14 percent), while a major decrease is foreseen by only a small number (2 percent).

The interests that guide many of the less developed countries in their approach to international telecommunications issues are quite different, and often hostile, to those of the United States. As traditional advocates of the free flow of information, the United States is opposed to prior censorship of either television or radio broadcasts. Therefore, the United States rejects the idea that any country should obtain prior consent before broadcasting a radio or TV signal to another country. The issue has not been raised for HF radio broadcasting because so many countries engage in international broadcasting. The added impact of television, however, has kept the issue of prior consent at the forefront of debate on international communications within the U.N. Educational, Scientific, and Cultural Organization (UNESCO) and the U.N. Committee on the Peaceful Uses of Outer Space (COPUOS).

Other International Organizations Involved in Telecommunications

U.S. national interests in telecommunications are interwoven with a broad range of specialized international organizations. In addition to ITU, they include, UNESCO, the U. N., the World Intellectual Property Organization (WIPO), the Universal Postal Union (UPU), the Intergovernmental Bureau of Informatics, the Intergovernmental Maritime Consultative Organization (IMCO), the International Civil Aviation Organization (ICAO), CITEL, and the Organization for Economic Cooperation and Development (OECD).

UNESCO's jurisdiction is extremely broad and the organization has taken an active interest in communications through the adoption of resolutions, by publishing studies, and by sponsoring and attending specialized seminars and conferences. It has participated at ITU conferences in an observer status, for example, in an effort to promote shortwave broadcasting as a means of furthering international peace and understanding.

More recently, UNESCO has become involved in studying the potential uses of direct broadcasting satellites and has adopted a set of norms regarding their use. Within the past few years, UNESCO's International Commission for the Study of Communication Problems (commonly known as the MacBride Commission because of its chairman Sean MacBride) has focused attention on the so-called "New World information order" and Third World complaints about the imbalance in news flowing in and out of less developed countries and the need to develop a communications infrastructure in the Third World.

U.N. involvement in communications issues has surfaced most prominently within COPUOS and the Working Group on Direct Broadcasting Satellites. COPUOS and its

subcommittees on legal, scientific, and technical matters have been significant forums for the discussion of guidelines to govern the use of the geostationary orbit for radio communication. A conference on the peaceful uses of outer space is scheduled for 1982 and will consider and discuss means to resolve such issues as whether there need be prior consent obtained before one nation uses satellites in space to broadcast a signal which extends beyond its own borders into other countries. The United States opposes prior consent in principle. It is technically impossible to avoid some "spillover" when broadcasting to one's own country via space satellite. If prior consent were to be strictly enforced, it would be impossible for the United States to develop a domestic system for direct broadcasting by satellite without the prior consent of its neighbors (e.g., Cuba).

Increasingly, the United States finds itself at odds with Third World and other countries that seek to impose restrictions on the flow of information across national frontiers and on the information-gathering activities of journalists. The "New World information order" being demanded by many less developed nations within UNESCO appears to many in the United States to be adverse to commercial information gathering and dissemination that is not under tight government control.

WIPO administers a number of international conventions intended to protect the intellectual property rights of the authors of information that is stored, disseminated, or displayed through electronic systems. In recent years, WIPO and UNESCO have jointly sponsored working groups to study satellite program distribution, cable TV, and national copyright and patent legislation for developing countries.

UPU was established in 1874 and is the second oldest existing international organization. It has become embroiled in communications issues because of the rapid evolution of electronic information and communication systems, including "electronic mail." UPU is also involved in the controversial issue of the subsidization of costly mail delivery systems through high tariffs on electronic communication systems. This cross-subsidization, which is common among countries that have integrated government administration of postal, telephone, and telegraph systems, has impacted severely on transnational corporations heavily dependent on international communications.

The Intergovernmental Bureau for Informatics is a Rome-based organization, outside the U. N., which holds periodic conferences to consider broad policy and legal questions related to transborder data flows and related electronic information issues. It is influential among developing countries and its resolutions have wide impact.

IMCO has several components that consider telecommunications issues relating to maritime navigation and ICAO does the same with respect to air navigation. The most important regional organization in which the United States deals with communications matters is CITEL which seeks regional agreements and develops a consensus on common positions for Western Hemisphere countries prior to meetings of ITU. OECD, though largely oriented toward Europe, seeks to harmonize the differing views of all industrialized countries on such controversial communications issues as control of transborder data flows.

U.S. representation to these organizations comes from many levels of Government, both within and outside the Department of State. Within the department, two bureaus play major roles in the determination of international communications policy: the Bureau of International Organization Affairs and the Bureau of Economic and Business Affairs. Other State Department components that play ancillary roles are the Under Secretary for Security Assistance, Science and Technology, the policy planning staff, and the Legal Advisor's Office.

For 30 years there has been mounting concern in the United States over Government procedures for developing telecommunications negotiations. The absence of centralized management and policy coordination has frequently been noted and it would appear that the United States was fortunate to preserve its essential interests up to and through WARC-79. The question remains—will the procedures, mechanisms, and processes that gave a margin of success in the past continue to work in the future?

The United States spent approximately 5 years formulating the proposals and position papers for WARC-79. Some 800 people were involved in one way or another. It is estimated that the State Department alone spent about $1 million in preparing for WARC-79 and this amount does not include the expenses of other Government agencies involved, nor of private industry organizations. By its very nature, this was a complex and time-consuming process. With the large number of international telecommunications conferences and meetings scheduled for the 1980's and 1990's, it is clear that a more expeditious procedure for the preparation, coordination, and adoption of U.S. proposals and positions is needed.

U.S. Preparations for WARC=79

The 20-year period between the previous general World Administrative Radio Conference in 1959 and WARC-79 was one of vast change. The number of nations belonging to ITU almost doubled–from 87 to 155. There were tremendous advances in telecommunication technology, including the development of satellite communications. Worldwide demands for improved communications had greatly increased. As an added incentive to convene a general WARC, it was widely recognized that inconsistencies had developed in the general regulations having application to more than one of the individual radio services. The fact that a number of specialized radio conferences had been held since 1959 resulting in decisions not entirely consistent with each other also suggested the need for a comprehensive conference.

The United States expected WARC-79 to take place in a contentious atmosphere. The rising economic aspirations of the developing countries, coupled with their perceived requirements for a fair share of the radio spectrum and the geostationary satellite orbit made confrontation appear inevitable.

The decision of ITU in 1973 to follow U.N. General Assembly precedent and grant observer status to the Palestine Liberation Organization, and the rhetoric at the NAM conference in Havana immediately prior to WARC-79 generated further concern that telecommunication and spectrum issues were to be politicized.

As noted earlier, ITU, like the U.N. General Assembly, operates on the principle of "one-country, one-vote." The United States and other, large developed countries have no more voting power than Haiti or Vatican City. However, in practice, ITU attempts to resolve technical issues and reach decisions by consensus and reverts to voting only when a consensus cannot be obtained. Therefore, the United States embarked on an early effort to direct the focus of the conference to the major technical issues and away from extraneous political matters.

U.S. preparatory work for WARC-79 proceeded under the following broad guidelines:

- *Flexibility.*—The primary goal was to maintain flexibility to meet the future needs of users in telecommunication matters within the framework of the international radio regulations.
- *Minimal change.*–The preparatory efforts should result in proposals for only those changes to the radio regulations

that were absolutely required in order to meet the needs of users.

- *Defensible positions.* —The proponents of new requirements should be in a position to defend the required revisions of the radio regulations, including allocations, using sound and fully developed technical arguments, including accurate and current listings in the master international frequency list.
- *Accommodate world needs.* –The preparatory work should take into account the proposals for changes to the radio regulations advanced by other nations and should resist only those that might impede our national flexibility to an unacceptable degree.
- . *Point of no retreat.* — Where it was apparent that proposed U.S. changes to the radio regulations, including modified, allocations, are likely to be opposed, the preparatory work must develop, in advance of the conference, final fall-back positions.

U.S. preparations involved broad participation by Government agencies, the telecommunication industry, and the public. There was active U.S. participation in planning sessions held under the auspices of such international organizations as CCIR, as well as in multilateral forums such as NATO, the Conference of European Post and Telecommunication Administrations, and CITEL.

Within the United States, FCC, as the body responsible for the regulation of nongovernment uses of the radiofrequency spectrum, established docket 20271 as early as January 1975 to develop the nongovernment U.S. proposals for the conference. NTIA, through IRAC established Ad Hoc Committee 144 to develop the proposals of the United States affecting Government users of spectrum. IRAC also participated in Ad Hoc Committee 144. Eventually, FCC issued nine NOIs that drew comments from many segments of the telecommunication industry and the public. Through this process FCC developed and adopted the proposals for commercial, private, and non-federal government use of the spectrum.

Ad Hoc Committee 144 of IRAC had representation from all Federal agencies with a major interest in radio communications and spectrum use. It was responsible for developing recommended U.S. proposals for WARC-79 concerning Government use of the spectrum. Both FCC and NTIA staff experts were involved in commenting on the proposals of other administrations and developing position papers for the delegation to the conference, including compromise or fall-back positions.

Recommended U.S. proposals adopted by FCC (nongovernment) and NTIA (Government) were fully coordinated and submitted to the Department of State which was itself aware of the proposals as they *were* being developed through participation in FCC and NTIA processes. Therefore, the State Department was knowledgeable about large areas of agreement as they were reached, as well as the fewer areas of disagreement. Almost all the differences concerning the proposals to be made by the United States were successfully resolved between FCC and NTIA. Only one issue (proposed allocations for international broadcasting in the HF bands) was carried to the President through the National Security Council.

Industry proposals and views or those of nongovernment service suppliers or organizations are treated within the FCC mechanism. FCC, barring appeals to the courts, has the final responsibility and authority for regulating the nongovernment use of the spectrum. Therefore, FCC develops nongovernment proposals under the open and due process procedures of the Administrative Procedures Act. FCC must decide among competing and often conflicting proposals advocated by various segments of the communication industry, other commercial users, private and public users, as well as State and local government users.

84-591 0 - 82 - 5

Advance preparations for WARC-79 got underway at the State Department as early as 1975 when it began work on obtaining funds for the delegation, the selection of the head of delegation and of other members. In 1977, the State Department sought information on the views of other governments and the positions likely to be taken by them. Requests for information were cabled to U.S. embassies abroad but the results were not satisfactory for several reasons. The United States has only one telecommunication attaché (based permanently in Geneva). Embassy personnel in many posts apparently lacked the necessary expertise to discuss the subject with responsible foreign officials and effectively gather information. The reporting task was rendered even more difficult by the fact that many proposals of the Third World countries were not fully developed until shortly before the conference began.

In 1978, the State Department established a public advisory committee for WARC-79 consisting of 38 members from industry and the general public. Several public interest groups, researchers, educators, and minority interests were represented. The purpose of the advisory committee was to advise the State Department and the head of the WARC delegation in all areas related to the conference and to help develop positions and negotiating strategies. There was some criticism of the role of this advisory committee from both members and nonmembers. Some of its members felt that their views had little or no impact.

Beginning in 1977, the State Department arranged for international consultation to communicate and explain the U.S. views and proposals as they were being developed for the conference. Bilateral discussions were held in 48 countries by teams of U.S. experts involved in the preparation process. In addition, the United States participated in multilateral forums. Proposals of interest to the U.S. military were also described and coordinated through NATO and its Allied Radio Frequency Agency.

CCIR and other ITU activities also provided an opportunity for the United States to discuss its views in international forums. CCIR held an SPM in 1978 to prepare a technical base for the guidance of the conference and for administrations then preparing their own proposals. ITU itself held three seminars (in Kenya, Panama, and Australia). These seminars were primarily for the benefit of the developing nations—to acquaint them with the issues they would face in the conference and with the technologies that had been developed most recently in the radio-telecommunication field.

In January 1978, Glenn O. Robinson, professor of law at the University of Virginia and a former FCC commissioner, was named head of the U.S. delegation to WARC-79. Professor Robinson was given the rank of Ambassador for the duration of the conference. This limited appointment by the President did not require Senate confirmation. This raised some concern about the general question of the selection process for the head of U.S. delegations to international telecommunication conferences. More specifically, there was concern expressed by several Senators over U.S. preparedness for the conference, especially focused on the question of the U.S. ability to counter effectively the expected demands of the less developed countries for a greater share of frequency allocations and for changes in ITU procedures. The submission of Professor Robinson's name for Senate confirmation as Ambassador to the conference may have provided an effective opportunity to explore those concerns.

Subsequent to Robinson's designation, an initial delegation of 20 representatives from Government agencies was formed and eventually the full delegation of 67 persons was named. In addition, some 30 individuals were named to a U.S. technical support group that worked first in Washington, D. C., and later in Geneva.

Traditionally, U.S. delegations to telecommunication conferences are made up largely

of spectrum managers and technical experts from Government agencies and industry. Theoretically, representation on the delegation should not be necessary to protect the particular interests of an agency, industry, company, or other organizations or groups because the delegation is committed to work for the U.S. proposals adopted during the preparatory process described above. Not only are the U.S. proposals adopted and submitted to ITU before a conference convenes (in this instance, by January 1979), but compromise positions are likewise agreed to within the United States before the conference.

However, during a conference—and WARC-79 was no exception—new compromises and new alternate proposals are often required when previously agreed U.S. proposals are not accepted by other administrations. At such times, the delegation, in consultation with higher echelons of Government in Washington, must develop and then agree on the new positions. In such circumstances, U.S. delegations almost without exception strive for compromises that will win general acceptance and that are as close as possible to the original U.S. proposals and thoroughly consistent with U.S. goals agreed to prior to the conference.

Proposals to modify the international table of allocations are based largely on the requirements or desires of individual countries to operate particular radio services in particular bands. Needs differ among countries. Decisions are driven in many cases by such nontechnical arguments as economic and national importance of one service vis-a-vis another. On the other hand, allocation decisions may be dictated by technical considerations, particularly those allocations involving the sharing of frequencies between two or more services. The arguments supporting these latter allocations are based on complex technical factors: acceptable interference levels and noise, power flux densities, antenna patterns, etc. For these allocations, the conclusions of the technical committee of a conference on the feasibility of and conditions for sharing often determine the successful adoption of the proposed allocation. In such discussions, obviously, the participation of the technical experts on the delegation is essential. Often such technical experts are not spectrum managers but work for Government or nongovernment organizations which operate communication facilities or other radio facilities. In the case of Government agencies this includes NTIA, NASA, the Federal Aviation Administration, DOD, FCC, and others. In the case of nongovernment organizations, it includes employees of companies that provide telecommunication systems and services, such as AT&T and COMSAT, and equipment manufacturers such as Hughes Aircraft Co. and the Harris Corp. The role of these nongovernmental experts is of great importance to the work of the delegation.

Since 1959, an average of 33 percent of the U.S. delegations to the eight ITU conferences held during that period were engineers and scientists from nongovernment organizations. For example, at the broadcasting satellite WARC held in 1977, 41 percent of the U.S. delegation was nongovernment. The U.S. delegation to the WARC-79 conference was predominately Government. Only 27 percent of the delegates were nongovernment including 18 percent from the telecommunication industry (see table 1).

Delegations from other developed countries include spectrum managers from the government ministries of telecommunication (often referred to as PTT's; postal, telegraph, and telephone authority) and engineers, scientists, and technical experts involved with the design, development, and operation of telecommunication systems and other radio equipment. Unlike the structure in the United States, most other countries place the operation of “commercial,” as well as government, communication facilities in the hands of the government, or with an entity owned or controlled by the government. Therefore, the composition of foreign delegations is predominately government with

Table 1 .–U.S. Delegates to **WARC-79 by Organization**

Organizational affiliation	Number of delegates	Percent of delegates
Federal Government:		
FCC	18	26.5%
NTIA (and other Commerce Department)	8	12
Department of Defense	6	9
Department of State	6	9
NASA*	4	6
International Communications Agency**	2	3
Department of Transportation	2	3
National Science Foundation	1	1.5
Office of Science and Technology Policy (White House)	1	1.5
Total	48	71.5%
Private Corporations:		
COMSAT	3	4.5%
AT&T	1	1.5
Hughes Aircraft	1	1.5
Motorola	1	1.5
Rockwell International	1	1.5
Satellite Business Systems	1	1.5
Western Union	1	1.5
Total	9	13.5%
Industry associations	3	4.5
All other	7	10.5
Total	67	100 %

*Includes Systematics General Corp. representatives.
**Includes Board of international Broadcasting.

SOURCE: Office of Technology Assessment.

some representation from manufacturers of communication equipment.

When it comes to a discussion of technical issues, such as system design capabilities and sound operating practices, the experts on other delegations expect their proposals to be discussed by similarly knowledgeable experts from the United States. Over the years, U.S. delegations to international telecommunication conferences have included industry and private sector experts involved in the day-to-day operations of communication systems. This is a natural result of the U.S. structure whereby the ownership, operations, and management of commercial and private communication systems are functions performed by private enterprise subject to Government regulation. U.S. telecommunication companies, and not the U.S. Government, are responsible for negotiations with foreign entities for the construction and operations of international telecommunication facilities. These companies undertake the financial obligations and own the U.S. share of the commonly operated international facilities with foreign entities. For example, AT&T and the several U.S. international record carriers own and operate submarine cables between the United States and Europe under contractual agreements with European telecommunication authorities. COMSAT owns and operates the U.S. share of the satellites operating in the global International Telecommunications Satellite Organization (INTELSAT) system together with 106 other countries.

The U.S. Government conducts negotiations on telecommunication matters of a foreign policy nature including U.S. participation in ITU conferences. In forming U.S. delegations to ITU conferences, the Government has looked to the U.S. operating companies and equipment manufacturers to provide expertise not generally available within the Government. A delegation of Government and industry representatives reflects the split responsibility for telecommunication activities in the United States. The inclusion of industry experts on U.S. delegations was brought into question in 1978 as a result of an apparent conflict of interest in an international conference dealing with an entirely different subject (the renegotiation of the international coffee agreement during which representatives from coffee companies participated as members of the U.S. delegation). Following that incident, the Department of State, acting on the advice of the Department of Justice, adopted new guidelines based on the conflict of interest provisions of the U.S. Code (sees. 203, 205, 207, and 208 of title 18) that effectively limited participation of nongovernment delegates to international conferences. Although the guidelines permitted nongovernment delegates to address technical points, they prevented such delegates from addressing policy issues or serving as spokesperson for U.S. proposals.

These restrictions were first imposed during the highly technical 1978 SPM of CCIR in preparation for the WARC-79 conference.

An amendment to a State Department appropriation bill (Public Law 96-60) introduced by Sen. Harrison Schmitt, and passed by the 96th Congress, exempted WARC-79 from these guidelines. However, the exemption came only shortly before the conference, leaving the role of nongovernment delegates uncertain until late in the preparatory effort. This may account, in part, for the low percentage of industry delegates to WARC-79.

Legislation to exempt all international telecommunication conferences from the restrictions of the State Department guidelines was enacted in the 96th Congress. However, the legislation to which it was added was vetoed by the President (the reason for the veto was unrelated to the exemption). The Senate again passed the exemption provision, but the House did not consider the measure before adjournment.

Another issue concerning the makeup of U.S. delegations was highlighted in preparing for WARC-79. In formulating proposals for nongovernment use of the spectrum, FCC must evaluate needs and sort arguments among competing commercial and private interests vying for spectrum allocations. This process follows FCC guidelines for rulemaking under the Administrative Procedures Act. Basic issues about the fairness of this process were raised by the timing of establishing the U.S. delegation.

The benefits derived from early creation of a U.S. delegation to prepare for the conference were recognized for WARC-79. However, conflict of interest and violation of due process were also recognized as possible consequences of naming industry representatives to the delegation before the FCC process of adopting U.S. proposals was complete. The concern was that individuals named to the delegation would be in a position to advocate the proposals of their companies in FCC's decisionmaking process better than those *companies* without representatives on the delegation. Moreover, delegates were likely to have access to information not generally available to nondelegates, giving credence to the argument that those companies with representatives on the delegation would have an advantage in supporting positions before FCC over those companies not represented and who might be taking contrary or conflicting positions in the FCC process.

This problem was avoided by naming only Government representatives to the WARC-79 delegation during the time of the FCC deliberations. Following adoption of proposals and the conclusion of the FCC process, industry and other nongovernment representatives were named to the delegation. This may also account, in part, for the relatively small number of industry representatives on the delegation. Also, some industry and Government officials have argued that the addition of industry experts to the delegation at such a late stage (spring of 1979) reduced their role and effectiveness.

An additional issue concerning the formulation of the delegation resulted from the real or perceived need to include individuals with differing viewpoints, to add representatives from public and consumer interest groups, and provide adequate participation by minorities and by women.

This, together with the pressures from Federal agencies, various elements of industry, public, and special interest groups to be represented on the delegation made the selection and functioning of the U.S. delegation a perplexing exercise open to criticism. On the one hand, these problems can be dismissed as a reflection of the times and the increased importance of telecommunication in all sectors of society. The stakes are high and the need to be represented is perceived to be important. On the other hand, the problems may reflect the absence of a clear Government policy regarding the selection and approval of individuals to serve on delegations to telecommunication conferences.

Adding representatives to the delegation with no apparent role other than to fulfill some nonspecific requirement to include special interest, racial, or sexual representation

proved to be frustrating for all concerned with no apparent benefits. There were four delegates funded by the Department of State under the "Biden amendment."* At least two of those delegates have stated publicly that their role was never defined nor did they provide any substantive contribution to the deliberations of the delegation. Other members of the delegation were also apparently unsure of the role of the Biden amendment delegates. One of the Biden amendment delegates reported that other delegation members seemed to treat the Biden delegates as though they had not earned the right to be on the delegation.

As stated above, the function of the U.S. delegation at international telecommunication conferences is to seek agreement on U.S. proposals submitted to the conference. These proposals are developed under U.S. domestic procedures and laws. Any shortcomings in these procedures regarding participation of concerned and interested parties are unlikely to be corrected by last minute measures to add to or adjust the membership of U.S. delegations. The process of preparing for international conferences should include the natural selection of the most qualified individuals to serve on U.S. delegations with the range of skills and disciplines required to negotiate the U.S. proposals. Representation on U.S. delegations cannot overcome any perceived deficiency in U.S. domestic processes.

Clear guidelines for the type of representation to be included are necessary and measures to ensure that the right combination of skills are represented by the individuals selected to serve on U.S. delegations are essential. That individuals with these skills will be available when needed should not be left to chance. Specific action to develop and train individuals and assure that U.S. delegations are equipped with these skills would help alleviate the problems encountered in preparing for WARC-79.

The OTA-sponsored survey on WARC-79 preparations and impacts asked respondents to list the four or five most important qualifications an "ideal" member of a U.S. delegation to a WARC-type conference should have. While no human being could meet all of the qualities listed by all of the respondents, a U.S. delegate who conformed to the most frequently repeated qualifications would require the following attributes:

Personality
- good communicator, adept at self-expression;
- mature, "diplomatic" personality;
- international reputation in some field;
- willing to accept advice from technical experts;
- able to exert independence from parochial interests;
- willing to compromise; and
- willingness and ability to work hard.

Experience:
- negotiating experience, particularly at ITU meetings;
- spectrum management experience; and
- operational experience in at least one radio service.

Knowledge:
- broad understanding of telecommunications, including technical competence and an understanding of the societal impacts of telecommunication technology;
- ability and understanding necessary to support and explain U.S. positions at the conference;
- knowledge of present and planned spectrum management requirements of U.S. users;
- knowledge of ITU history and procedures;
- a "feel" for international politics, or at least a personal world view; and
- fluency in at least one foreign language, usually cited as French or Spanish.

Sensitivity:
- sensitivity to Third World positions and cultural differences;

*According t.o a amendment sponsored by Senator Joseph Biden, which became sec. 113 of Public Law 95-105, the State Department is authorized to reimburse individuals or organizations for their costs of participation in State Department activities if such persons represent an unrepresented or underrepresented interest in the proceedings and otherwise could not afford to participate.

- sensitivity to U.S. national security concerns; and
- sensitivity to users' and consumers' needs, and the ability to relate these needs to spectrum allocations.

The results of the OTA-sponsored survey also show that a majority of the respondents chose "selection of the most effective delegation possible" as the number 1 goal of the preparatory process from a list of 12 goals. However, less than half (48 percent) of the respondents felt that the process was moderately effective in achieving that goal. Another 25 percent felt that the effectiveness of the process was low and another 12 percent said it was totally ineffective in achieving that goal. Only 14 percent of the respondents rated the degree of effectiveness of the process high in achieving the goal of selecting the most effective delegation possible.

Possible actions to address the problems of industry participation and broader representation of interests and skills are discussed in chapter 5 of this report.

Chapter 4

WARC-79 Overview, Actions, and Impacts

Contents

Page

The U. S. Role. 67

How WARC-79 Differed From WARC-59. 68

The Impacts of WARC-79. 70

Key Conference Decisions and Their Consequences. 73
The Fixed-Satellite Service 73
The Fixed Service 77
The Land-Mobile Service 78
The HF Broadcasting Service. 79
National Security Systems 81
Military-Related Issues and Objectives 81
Fixed Service 84
Resolutions, Recommendations, Reservations, and Declaration 99

The Impacts of WARC-77. 103

LIST OF TABLES

Table No. *Page*

2. Service Arc of Geostationary Orbit. 74
3. Distribution of the HF Band Before WARC-79. 84
4. Distribution of the HF Band After WARC-79. 84
5. Summary of WARC Gains and Changes in Status on Fixed Allocations Between 27.5 MHz and 15 GHz. 85
6. Summary of WARC Gains, Losses, and Changes in Status on Mobile Allocations Between 27.5 MHz and 15 GHz. 86
7. Pre- and Post-WARC Radiolocation Allocations 89
8. Comparison of WARC Radiolocation Allocations and U.S. Proposed Allocations Above 40 GHz 91
9. Summary of WARC Gains and Changes in Status on Fixed- and Mobile-Satellite Allocations Above 27.5 MHz 95

Chapter 4

WARC-79 Overview, Actions, and Impacts

From the point of view of a developing country burdened with poverty, illiteracy, and disease, access to modern telecommunications is every bit as vital as it is to the United States. Conversely, whether the Department of Defense (DOD) can communicate with a missile submarine at sea or a high-flying jet bomber over Alaska is of much less consequence to the leader of a Third World country than whether he can send a simple radio message to a doctor or village administrator 100 miles outside his capital city.

The gap between the modern “information society" —with its computers, microprocessors, and multichannel satellite systems— and the developing nations struggling to harness basic, unsophisticated radio systems to the task of economic development is growing wider. At today's pace, a villager in central Africa is likely to watch an American film on a community television set long before he has an opportunity to use a telephone.

The gap in priorities is equally wide. It is difficult, for example, to persuade a representative of a developing country to give up certain radiofrequencies that provide him with a rudimentary telephone system in order that the Voice of America can broadcast more clearly. The task of persuasion is made no easier by suggesting that a satellite or a microwave system would provide the developing country with better phone service with more efficient use of the spectrum when, in fact, such systems may be too costly for many developing countries.

When the technically advanced, industrial nations get together with Third World countries to discuss telecommunications and spectrum management, their needs and priorities are so different that their negotiating goals and objectives are far apart. Viewed against this background, and the mounting frustrations of the developing countries, U.S. delegates to the World Administrative Radio Conference (WARC-79) that convened in Geneva in September 1979, had reason to be wary. It was the first general administrative radio conference in 20 years and was unquestionably the largest and most significant intergovernmental meeting on radio communications in more than a decade.

There had been tremendous advances in telecommunications since the last WARC, held in 1959. Worldwide demand for improved communications had greatly increased, together with a sharp rise in the demand to use the radio spectrum. Inconsistencies had developed in the general regulations having to do with more than one of the individual radio services. A number of specialized radio conferences had taken place since 1959 resulting in decisions that were inconsistent with one another, thus adding to the urgency of convening a general conference.

The U.S. Role

As the largest and most technically advanced user of the radio spectrum on a worldwide basis, the United States approached WARC-79 with the greatest stake in reaching agreement on a new table of frequency allocations and a revised set of related technical and administrative regulations. At previous WARCs, the United

States had been a strong advocate of compromise and had tried to set an example by not taking reservations that would indicate refusal to abide by a particular decision of the conference.

A determination to avoid needless controversy and to arrive at mutually acceptable compromises continued to guide the U.S. delegation at Geneva in 1979. The goal of the United States was to ensure that whatever changes were made in International Telecommunication Union (ITU) regulations governing the allocation and use of radio spectrum were made in light of current U.S. economic, social, and technical requirements. The United States would support incremental change, but not wholesale shifts in spectrum allocations or in ITU procedures. Because of the rapid and frequently unforeseen changes in communications technology, the United States was committed to the general principle of flexibility so that any decisions made at WARC-79 would permit future accommodation to new circumstances.

The United States was on record as supporting, in principle, changes in international spectrum allocations and related frequency management procedures that would accommodate the needs of other nations, consistent with its own interests and with the essential requirements and sound principles of international spectrum utilization.

How WARC-79 Differed From WARC-59

WARC-79 was vastly different from any previous ITU administrative radio conference, both in size and complexity. Membership in ITU stood at 154. Almost half the nations eligible to attend WARC-79 did not even exist in 1959.

These new nations brought rising expectations that increased demand for telecommunication services worldwide. New communication technologies that made increasing use of different forms of telecommunications had come into being including satellites. Other techniques made it possible for radiofrequencies to carry more information than ever before. Coordination and avoidance of interference procedures were more highly developed.

While the countries of the developed world introduced these improvements as a matter of choice, developing nations often could not afford to abandon less expensive and less sophisticated equipment and procedures even though these were not technically efficient in their use of spectrum. They had to be content with older, less sophisticated telecommunication systems while the industrialized nations pursued new technologies and services vital to their growing information economies. * The developed countries, for example, could seriously consider shifting some broadcasting services out of the radio spectrum entirely and onto cable to make room in the ultrahigh frequency (UHF) and very high frequency (VHF) bands for new mobile services. Most Third World countries could not conceive of such a move.

WARC-79 differed from WARC-59 in that demands on the radio spectrum had significantly increased; more countries were making greater use of spectrum for a greater variety of purposes. Moreover, the conference sessions, while still highly technical in nature, were influenced to a greater extent than in the past by political and economic considerations that can best be understood within the context of a confrontational North-South relationship and the so-called "New World economic order. " This new relationship is characterized by more sharply defined demands of the less developed nations for a redistribution of the world's

*It should be recognized that technically inefficient uses of spectrum may nonetheless be economically most efficient at a particular stage of development for a developing country.

wealth and resources, and for an end to what they regard as exploitation by the industrialized nations. It is also marked by a growing awareness among developing countries that in many international fora where the "one-nation, one-vote" principle prevails they enjoy an advantage in numbers.

There is a long history of international cooperation in radiofrequency matters, but there were forces at work that made agreements difficult to reach at Geneva in 1979. The developing countries were guided by a set of general principles aimed at gaining preferential treatment for themselves (e.g., an Algerian proposal to give priority to developing countries in the use of 70 percent of the high frequency (HF) fixed bands). They demanded guaranteed access to certain congested frequency bands and to the geostationary satellite orbit. They refused to accept the vital importance for national security and financial investment of some advanced U.S. communications systems. Moreover, there was an unwillingness on the part of many developing countries to accept package deals in which a U.S. concession in one area was linked to a developing country concession in another.

WARC-79 also differed in that there were recognizable ideologies in spectrum matters that were associated with particular countries or groups of countries. For example, those countries that already had extensive telecommunication systems were most interested in pursuing expensive efforts to get the most out of spectrum and to identify those frequencies that were not being fully utilized. Countries that were still developing their telecommunication services were anxious to prevent the more sophisticated users from preempting their potential use of large portions of the radio spectrum and geostationary satellite orbit space before they, themselves, could determine their own future needs.

This is not to say that there was unanimity among the Third World nations. They differed sharply in their goals and interests. For example, Brazil was anxious to develop its own satellite communications system and disputed the claims of Colombia and other equatorial nations to sovereignty over the space above their territories where geosynchronous satellites could be parked.

Nor did the developed countries always share the same sense of priority. Other North Atlantic Treaty Organization (NATO) members gave only lukewarm support for certain U.S. military requirements for spectrum and the United States and Canada split over some important issues.

The United States has found it necessary in the past to take reservations and other actions at ITU conferences to protect its interests. The United States took a substantive reservation at the 1937 WARC, refused to sign the Final Acts of the 1950 Mexico City WARC, and did not become a party to the additional radio regulations. However, as noted earlier, the United States has been a strong advocate of compromise and has for the most part refrained from using the accepted practice of taking a reservation on a particular clause or section of the Final Acts of a conference to indicate that the provision would not be considered binding. The only substantive reservation dealing with radio communication taken by the United States in recent years was at the 1974 maritime WARC.

At WARC-79, the U.S. delegation found it necessary to deviate from this policy of setting an example for resolving differences within the conference. The United States ultimately took six reservations, helping to bring the total to 83. Two of the six were directed at political issues but the remaining four have a direct impact on U.S. telecommunication operations. In one of these, the United States rejected the terms of a footnote to the ITU radio regulations that could jeopardize the continuing use of U.S. military mobile satellite systems in the UHF band.

The Impacts of WARC-79

Finding a meaningful way to measure success and evaluate results of an administrative radio conference is not as simple as comparing specific U.S. proposals submitted to the conference with the Final Acts of the conference. While such a comparison is important, it does not reflect the underlying reasons and motives for particular decisions, the problems encountered, or any apparent trends important in evaluating results of an administrative radio conference. It is important to understand the intervening events that underlie decisions, not only to evaluate the results of WARC-79, but to prepare for the many future conferences important to U.S. interests.

The specific consequences of WARC-79 decisions on U.S. interests regarding particular services can best be treated in terms of how the conference dealt with specific technical issues created by some significant trends in telecommunications. These trends include the following:

- A reduction in the use of HF (3 to 30 MHz) by international fixed point-to-point operations as satellite and cable use expands, coupled with the increasing demand for HF spectrum by the more developed countries to meet maritime and international broadcasting needs, conflicts with the desires of the less developed countries to use HF for inexpensive domestic communications.
- The rapid growth in VHF (30 to 300 MHz) and UHF (300 to 3000 MHz) land-mobile operations in the face of continuing vital military requirements and the heavy use of these bands for TV broadcasting now necessitates greater sharing of frequencies, for example, by radiolocation sharing with radionavigation and with other services, and by land-mobile sharing with TV broadcasting.
- There has been rapid growth of both domestic and international fixed-satellite requirements in the super high frequency (SHF) (3 to 30 GHz) spectrum coupled with growth in microwave radio relay, space research, and Earth-exploration satellite services, and the continuing need to protect important radio-astronomy operations.

These requirements are being pressured by new demands to accommodate mobile, navigation, and broadcasting satellites (and their feeder links) in increasingly crowded orbits. Most of these satellite spectrum uses have military as well as civil applications. In addition, there is the continuing use of the SHF spectrum for terrestrial systems.

The actions of WARC-79 with respect to these operational trends and the technical issues they raised either closely reflected U.S. proposals or were acceptable to the United States with certain important exceptions. However, this judgment hardly does justice to the overall results of WARC-79, particularly the future implications for the United States. The long-term trends may be running against the United States in the sense that more problems without apparent solutions are foreseen. The United States finds itself increasingly in a defensive mode, trying to minimize losses rather than seeking significant changes to improve the long-term posture of the United States.

For example, significant amounts of spectrum were added to the allocations for the fixed-satellite service (FSS) in general accordance with U.S. objectives. The technical rules that affect the design and operation, and hence the cost, of satellite systems were generally in agreement with U.S. positions. Where U.S. desires were not precisely met, no significantly adverse repercussions resulted. No immediate or significant changes in the structure or operation of U.S. fixed-satellite telecommunication services will result from conference decisions. No operational or economic dislocation was imposed

on any existing FSS system, and no major burden appears to be placed on the Government, or private operating entities, in order to comply with the decisions of WARC-79 regarding FSS.

However, the conference also adopted a resolution that calls for a space planning conference to be held in two sessions to plan space services using the geostationary satellite orbit. The first session, to be held in 1985, will define the type of planning and determine which services and which frequency bands should be planned. The second session, scheduled for 1987, will do the actual planning. The space conference, as well as the previously scheduled broadcasting satellite conference set for June 1983 to plan broadcasting satellite service in region 2 (the Americas) in the 12-GHz band, are of vital importance and concern to the United States. The ability to implement new technologies and offer new services via satellite in the years ahead depend in part on the decisions taken at these future conferences.

There is a significant difference between the approach advocated by the United States for using the geostationary satellite orbit and any rigid a priori allotment and planning approach advocated primarily by some developing nations. The United States, as well as other countries, has consistently favored a flexible approach that assigns orbit locations and satellite frequencies on a case-by-case basis, often referred to as "first-come, first-served. " The U.S. approach seeks to accommodate needs as required and relies, at least in part, on technological advancements and good engineering practices to "engineer in" the next satellite and accommodate all users. Such an approach is consistent with existing practice under ITU procedures for the notification, coordination, and assignment of radiofrequencies generally.

Many developing countries, on the other hand, see a negotiated plan that assigns specific frequency channels and orbital positions to each country under a rigid a priori allotment plan as a means to guarantee future access. This approach does not depend upon advances in technology or new engineering technologies to assure accommodation of newcomers, but neither does it provide for technological improvements that might be necessary to accommodate growing requirements. The developed countries already have the economic and technological means of launching and utilizing domestic satellite systems; most developing countries do not, even though many do make use of joint user systems like the International Telecommunications Satellite Organization (INTELSAT) global satellite system. The developing nations are concerned that as "late comers" (hence later served) there will be little or no way to accommodate their domestic requirements.

Both a posteriori (the case-by-case approach usually relying on a notice and recordation procedure) and a priori (the collective subdivision approach usually relying on a negotiated plan) have won past acceptance at conferences of ITU. Over the last 75 years one or the other approach has been advocated and used by nearly all nations to allocate spectrum, both internally and internationally. On a domestic level, the a posteriori approach is often coupled with an adjudication procedure for deciding among competing applicants, as is the case in the United States. On the international level, adjudication is almost impossible because of sovereignty claims. Most nations have been unwilling to allow an international body to determine whether they can or cannot use a radio channel or satellite position. Where channels become limited, the recourse in the recent past has been to adopt an a priori method. However, for the allocation of radio bands and services like FSS, which are affected by rapidly changing technology, or which are fraught with political controversy, a priori methods tend to promote too rigid technical specifications or exaggerated claims for channels. Much of the controversy at WARC-79 and that likely to emerge at future conferences, arises from the question

of the appropriate administrative arrangements to determine rights to the use of frequencies free from harmful interference.

Several countries made planning proposals at WARC-79, ranging in scope from planning all services in all frequency bands to allocated space services, planning only FSS in bands newly allocated to that service below 10 GHz. However, it is clear that FSS was the main target of these proposals. Developing a plan of this nature is an enormous undertaking and would not have been possible at WARC-79; however, acceptance of the principle of "planning" was a major goal of the developing countries.

The U. S. delegation worked to prevent any decision to convene a "planning" conference. When it became clear that such a conference would be approved, the United States argued successfully to keep the terms of reference rather broad. The first session of the "WARC on the Use of the Geostationary Satellite Orbit and the Planning of Space Services Utilizing It," scheduled for July 1985, will consider which services and which frequency bands to "plan." Further, the meaning of "plan" will be decided, and will not necessarily be a rigid "a priori" type. The operative thought in determining the type of planning is to provide "in practice equitable access" to the geostationary orbit. The second session of the conference, scheduled for September 1987, will meet to enact the decisions of the first.

It has been the official position of the United States, shared by a number of other countries, that a rigid a priori plan for FSS is bad planning and bad engineering; that it is likely to inhibit technological innovation, result in inefficient use of the orbit and spectrum and have a major adverse impact on U.S. telecommunication systems. Thus, the United States faces a significant challenge over the next few years to develop compelling arguments against a rigid a priori approach and to carry that message convincingly to all parts of the world well before these conferences convene; or to find alternatives acceptable to all parties. Examples of such alternatives are discussed in chapter 5.

The adoption of the space planning conference resolution is a vigorous reminder that the effective management of orbit and spectrum utilization on both a worldwide and a regional basis is a continuing process that is becoming increasingly more difficult and complex. The achievement of U.S. objectives at ITU conferences is no longer a matter of reaching painstaking agreement on technical solutions to problems of coordination and multiple usage of spectrum. It will require sophisticated, political negotiations; imaginative, innovative approaches; and long, hard bargaining.

Perhaps an acceptable compromise will be found regarding the satellite orbit planning issue prior to the 1983 region 2 conference. Nevertheless, the mechanism to develop and test a possible solution before the meeting is not now apparent, and the task of shaping a compromise during the meeting may prove too difficult. While there is no certainty that the majority of the region 2 countries will favor a rigid orbital and frequency allotment plan like the one adopted for regions 1 and 3 at WARC-77 for broadcasting satellite service (BSS), the United States must be prepared for such a prospect nevertheless. According to the OTA survey cited in chapter 3, only 8 percent of the respondents believe that a compromise between the United States and the Third World positions on a priori allotment is impossible; an additional 15 percent believe that a compromise is possible, but undesirable. A majority of the respondents, 68 percent, believe that a practical compromise is possible and desirable, although relatively few have any specific concept of the form such compromise could take. The remaining 9 percent expressed no opinion.

Key Conference Decisions and Their Consequences

The Fixed-Satellite Service

FSS is defined as "a radio communication service between Earth stations at specified fixed points when one or more satellites are used; in some cases this service includes satellite-to-satellite links, which may also be effected in the intersatellite service; FSS may also include feeder links for other space radio communications services."

This definition fails to convey fully both the diversity of applications that already exist, and those that are expected to be accommodated in FSS in the future. The emergence of the wide variety of applications for fixed-satellite service stems in a major way from the properties of a natural phenomenon known as the geostationary satellite orbit. This orbit is circular, some 165,000 miles in circumference, and in the plane of the Equator approximately 22,300 miles above the Earth's surface. At this altitude, a satellite in orbit rotates about the Earth's axis at the same rate as the Earth (one revolution per day) and appears to be stationary when viewed from a point on the Earth. This special characteristic of the geostationary orbit allows an Earth station antenna to point at a geostationary satellite without the need for expensive antenna-tracking equipment. Earth stations in the intended coverage area and a geostationary satellite are continuously visible to each other in contrast to a satellite in any other orbit. These unique characteristics have caused the member nations of ITU to view the geostationary orbit as a "natural resource." The ITU convention recognizes the geostationary satellite orbit as a limited natural resource.

With consideration only for avoidance of physical collisions between satellites, the number of satellites that can be placed in the geostationary orbit is nearly unlimited. However, the current ITU convention recognizes that satellites operating in a common-frequency band must be sufficiently separated to avoid harmful interference. For example, U.S. communication satellites currently operating in the 4- to 6-GHz frequency bands and serving the same or adjacent coverage areas are presently required by the Federal Communications Commission (FCC) to be separated by 4°. It is important to note that the required separation between satellites operating in the same frequency band could be greatly reduced if the coverage areas are separated geographically. For example, satellites operating in FSS with proper antennas could be essentially colocated in the geostationary orbit when one satellite serves the United States while the second satellite serves a South American country.

A second limitation to the capacity of the geostationary orbit occurs as a consequence of geometric considerations. Only a portion of the geostationary orbit is visible from a particular coverage area on Earth. To illustrate, table 2 shows the portions of the geostationary orbit "available" to the various countries in region 2.

Sharing of the geostationary orbit in a particular frequency band is principally a problem of sharing between adjacent countries. For the United States, the sharing problem is largely with Canada and Mexico. The dimensions and capacity of the geostationary orbit available to the United States, assuming an appropriate international coordination approach, is essentially independent of the use of the orbit by countries in regions 1

85-591 0 - 82 - 6

Table 2.—Service Arc of Geostationary Orbit

World region	Coverage range	**Visibility arc** for minimum elevation angle of 100 (degrees in west longitude)
North America	Canada, including Yukon and Northwest Territories	**114-116**
	Canada, Vancouver to Halifax.	61-128
	USA, including Hawaii, Alaska, and Puerto Rico.	133-134
	USA, CONUS only.	61-134
	USA, CONUS and Hawaii. .	91-134
Latin America	Brazil	0-109
	Columbia.	10-143
	Chile/Argentina.	10-130
	Total regional coverage . . .	10-109
	Mexico/Caribbean	46-143

SOURCE: Telecommunications Systems Inc.

or 3, or in South America. Conversely, the use of the geostationary orbit by countries in North America should not significantly limit the availability of the orbit for countries in the other regions or in South America. Again, this assumes an appropriate international coordination approach.

In summary of the points made above, the capacity of the geostationary orbit for a particular country operating in a given frequency band is determined primarily by four factors. These are:

1. the dimensions of the available arc as determined by geometric considerations;
2. the characteristics of individual satellites at each orbital position;
3. the separation between satellites operating in that band as required to avoid harmful interference; and
4. the number of adjacent countries planning to operate in the same frequency band.

The usable capacity of the geostationary orbit available to a particular nation may be increased under three of the limiting factors enumerated above. First, the capacity at each orbital position may be increased through application of technology improvements. Frequency reuse, higher satellite power, more efficient and higher gain antennas, and lower noise receivers are examples. The required separation between satellites is a second category of improvement possible through improvements in technology. Interference-resistant modulation methods and improved antenna sidelobe performance are examples. In the third category, the dimensions of the available orbit arc may be extended through the application of intersatellite links. As a first approximation, the available arc may be increased by the latitude extent of the service area. For the United States, the use of intersatellite links might more than double the available arc.

The ability of a country to make these improvements depends on its own level of technological advancement, ability to pay for such improvements, and the sociopolitical needs and trends within the country. Also, the extent to which a country can take advantage of these improvements is determined in part by the actions of other countries. Again, appropriate international coordination and cooperation are required. Chapter 5 discusses alternative approaches for coordinating use of the geostationary satellite orbit.

During the last decade many countries have taken advantage of the telecommunication capabilities offered by the orbit/spectrum resource. As a result there are many domestic satellite systems in operation and being planned, as well as international systems (e.g., INTELSAT) shared by many countries throughout the world. These systems support a variety of services, including broadcasting and maritime-mobile. The specific functions rendered by these established services, and those being planned or foreseen, include:

- Domestic and international point-to-point connections for trunk telephony and television distribution.
- “Thin-route” telephony and instructional television to remote areas.
- Data transmission and computer-to-computer communication.

- Facsimile, teletext, videotext (viewdata), and electronic mail.
- Interoffice connections for teleconferencing, inventory control, and the like, for large organizations.

Central to the utility and the economic attractiveness of satellite systems is their almost unlimited "connectivity" or flexibility; i.e., the possibility of mutually connecting a large number of Earth terminals through a single satellite. Thus, many nations believe that many of their future telecommunication needs can be satisfied by geostationary satellite systems, whether wholly owned or jointly operated by regional entities. This is true for both advanced and developing countries but particularly the latter who hope through the use of satellites to leapfrog many of the problems and much of the time and expense required to install conventional terrestrial communication systems.

At WARC-79, the United States sought to expand the allocations to FSS for both domestic and international use. There was a particular need for frequencies below 10 GHz and this requirement gave rise to considerable controversy throughout the conference. The United States was determined to preserve the status of the radiolocation service in the 3400- to 3600-MHz band, now used by important military radar systems. The band has long been shared with FSS, and in order to facilitate use of FSS systems, particularly INTELSAT, some delegations proposed to downgrade radar to secondary status. A compromise was ultimately worked out that restored primary status for radars subject to a footnote provision urging, but not mandating, ITU members to phase out of the band and to take practicable steps to protect FSS. The United States and several other countries formally declared their intention to accommodate FSS when it is feasible to do so. (This topic is covered in greater detail in a later section.) Allocations to FSS were also made in the 4- and 6-GHz bands.

In other actions, WARC made additional uplink allocations acceptable to the United States, including those at 6425 to 7175 MHz and 17.3 to 18.1 GHz. The former band was allocated to provide the uplink for fixed satellite service in the bands 3400 to 3700 and 4500 to 4800 MHz. Both bands (6425 to 7175 MHz and 19.3 to 18.1 GHz) were needed for feeder links to satellites in other services such as broadcasting and maritime-mobile satellites. Still other downlink frequencies were allocated to FSS in the band 10.7 to 11.7 GHz as the United States had proposed. These frequencies will also be used for the increasing requirements of INTELSAT.

A major objective of the United States was to resolve the difficult sharing situation in region 2 between FSS and BSS in the 1000-MHZ bandwidth at 12 GHz. The conference agreed with the U.S. proposal to separate the two services by allocating the 12.1- to 12.7-GHz segment to the BSS and the 11.7- to 12.3-GHz segment to the FSS. Although the frequency-sharing between the space services was thus largely eliminated (12.1 to 12.3 GHz remains a shared band, but sharing may be completely eliminated by the 1983 regional conference), BSS must now share with the *terrestrial* fixed service including private microwave systems widely used in the United States. This sharing could result in interference to BSS Earth station receivers operating in the same area as private microwave fixed-station transmitters. The private microwave users are concerned that sharing with direct-broadcasting satellites is not feasible and oppose sharing in the 12-GHz band. The concern is that home receivers for direct-broadcasting satellites would receive interference from terrestrial microwave transmitters. As a practical matter, the microwave users anticipate the burden to resolve any resulting interference problems will be placed on them. This concern is reinforced by footnote 3787D of the Final Acts of WARC-79, which places terrestrial services on a noninterference basis to BSS operating in accordance with a plan to

be prepared at the 1983 region 2 broadcasting satellite conference. How this conflict will be resolved within the United States is a current matter before FCC.

Existing FSS allocations at higher frequencies were maintained. In general, all U.S. objectives were met in the bands above 40 GHz (to 275 GHz). These bands will be used in future years as advanced technology is developed and as communication requirements continue to grow.

Apart from the decision to convene a space WARC to "plan" use of the geostationary orbit and related spectrum, WARC-79 will have some longer range impacts on FSS. For example, new allocations to FSS are likely to motivate system designers to exploit these frequencies, especially in the 4- to 6- and 11- to 14-GHz bands where bandwidth was more than doubled. In order to take advantage of this increased capacity, a spacecraft payload built on current technology would have to double in size, weight, and power requirements. To keep these at a minimum we may see renewed efforts at material development, to build, for example, lighter weight filters, more efficient solar cells and space-qualified solid-state amplifiers. The availability of the U.S. Space Transportation System (Shuttle) will have increasing impact on the capacity and costs of satellite systems, particularly when the shuttle attains full capability to locate spacecraft in geostationary orbit. The large bandwidth available may also create opportunities in traffic routing flexibility not possible with smaller bandwidths. This may stimulate spacecraft switching technology and the associated satellite-switch logic, as well as the development of shaped spot beams.

Generally speaking, the impact of WARC-79 on the availability and cost of FSS systems was favorable because substantial increases were granted in the "lower" frequency bands where technology is well developed and relatively economical. WARC also reaffirmed the FSS allocations near 20 and 30 GHz where the next generation of domestic communication satellites is now under development. When this new generation of satellite systems becomes operational, in a decade or more, there are likely to be lower costs and higher availability both in new types of services and in number of users, particularly those in remote areas.

U.S. operating practices for planning, allocating, managing, and using the spectrum allocated to FSS have not been altered as a result of WARC-79 decisions. The expansion of allocations would seem to mitigate some policy conflicts that might have existed before. For example, the guiding U.S. policy for commercial FSS systems has been to permit any financially and technically qualified entity to compete in the marketplace. The decision to allocate separate bands to FSS and BSS about 12 GHz serves to alleviate, at least temporarily, a potential problem area.

The results of WARC-79, insofar as FSS is concerned, do not impose any hardships on the Government to comply with the demands contained in the Final Acts. Some effort will be required to amend the existing documentation, manuals, and computer programs to reflect the new regulations and modifications to the old ones, but this is a one-time effort.

A related obligation concerns technical assistance to developing countries. WARC-79 adopted a series of resolutions and recommendations that call on the industrialized nations to give additional help to the Third World in telecommunciations. FSS is the service that developing countries look to for satisfying many of their needs. These resolutions and recommendations are basically in line with the U.S. approach to technical assistance since they regard the United Nations Development Program (UNDP) as the primary source of financing. They do not call for the establishment of either mandatory or voluntary funds for technical cooperation. But the question arises as to whether, and to what extent, it is desirable or necessary, as an extension of U.S. foreign policy, to offer unilateral assistance to developing countries

with a view to influencing their attitudes on FSS "planning" and other issues. The potential benefits of using U.S. technology and expertise to provide assistance and develop closer coordination and planning activities with developing countries are discussed in chapter 5.

The Fixed Service

The fixed service above 1 GHz supports communication systems that are more commonly known as microwave, radio-relay systems and widely used in the United States by common carriers, Government agencies, and business.

Substantial frequency allocations between 1 and 40 GHz were made to the fixed service by the 1959 WARC. Those allocations (particularly those between 1 and 15 GHz) have been used extensively and considerable effort has been expended on the design of radio-relay equipment and field engineering methods. As a result, the available allocations have been used very efficiently. Increasingly large volumes of communication have been squeezed into each radio channel and there has been careful planning of adjacent systems to avoid excessive interference.

Because of the highly efficient use of existing allocations, there were few proposals at WARC-79 for changes. Those changes that were adopted by the conference consisted mainly of attempts to aline the allocations among the three regions and, by means of footnotes, to accommodate the specific needs of individual countries.

More significant for the fixed service were new allocations made to the space services that will permit additional use by those services, on a coequal basis, of bands already allocated to the fixed service. Such sharing was first included, on a limited basis, in the allocation table of 1963 as a means of accommodating the new concept of communication satellites. At that time technical criteria were introduced to control the amount of interference each service might impose on the other.

Sharing is not without cost, but these penalties have been felt to be in the interest of overall efficient use of the spectrum by all services in order to permit additional use of the frequency bands. There is a price paid in the practical use of radio-relay systems in the shared environment because of the need to shorten repeater spacings and to undertake complex route engineering to avoid interference to or from satellite Earth stations. This can result in the need to build more expensive repeater sites or even the addition of extra repeater stations to bypass a problem; it can also require a shift in frequency bands or, in extreme cases, switching to cable for some route segments.

With new provisions for sharing in additional bands, and with additional types of space services, the pressure on radio relay system design will be increased. The conference recognized this as a complex problem and identified several aspects of sharing on which further consideration and refinement are needed and asked the International Radio Consultative Committee (CCIR) to undertake appropriate studies.

The decisions of WARC-79 affecting the use of microwave radio relay systems do not mandate any drastic reconsideration of U.S. practices in allocating and managing the spectrum. The principal new allocations are those between 40 and 275 GHz, which open up a number of new, wide bands for the fixed service that are shared with several other services. There will be decisions to be made on whether any of these bands is to be limited domestically to an individual service instead of being shared broadly as provided in the international table, and whether any should be identified exclusively for U.S. Government or nongovernment use.

In order to simplify the administrative process for certain countries which otherwise might need to coordinate with a number of neighboring states, the radio regulations were revised and simplified at the risk of creating future interference problems. The changes were opposed by the United States, Canada, and others as counterproductive.

Potential policy conflicts involving the fixed service arise from WARC decisions on the shared use of frequency bands with space services. Such sharing requires accommodation or even sacrifices on the part of each service. How much sharing will be allowed, and the degree to which one service will be affected in order to facilitate the other, become policy determinations that are little appreciated at present.

The most conspicuous case that will require action in the near future is the treatment of the 12.1- to 12.7-GHz band. There, BSS will now share with private microwave systems. The use of sensitive receiving installations in BSS coupled with the necessity to locate them at any place within the service area of the satellite, essentially precludes radio-relay operation within the coverage area of a broadcasting satellite on any radio-frequency channel to be used for satellite broadcasting. Hence, the extent to which channels and areas are reserved for broadcasting, to the exclusion of private microwave systems, is under study in the United States and will be a major policy determination.

Another area of potential conflict is the sharing of frequency bands by the mobile-satellite service (MSS) and FSS. MSS is a different category of service than the discrete services like maritime MSS or land MSS. It was developed primarily for military satellite communications use, wherein the Earth station may be located from time to time anywhere within a defined area (and even operated in moving vehicles such as aircraft and ships), rather than being limited to a fixed, predetermined location. So far there has been little practical experience of this type, but the idea that a small essential area around the radio-relay station would be protected, while a large area would be reserved for the convenience of the mobile-satellite Earth station is a concept not fully understood or accepted. Because of these concerns, the conference made only very limited allocations to MSS.

As noted earlier, the provisions for space systems to share frequency bands with the fixed service tend to complicate, make more expensive, and even inhibit the growth of radio-relay systems, but in the past this has not resulted in the dislocation of existing services or systems.

The new allocations for broadcasting satellites to share in the 12.2- to 12.7-GHz band may well cause dislocations to private microwave systems. Frequency sharing will be quite a different problem from that in other "shared" bands. In fact, licenses being issued now for private microwave stations bear a warning to the effect that continued operation is not assured.

Distribution of television by terrestrial radio-relay systems may also suffer dislocations, depending on the ultimate decisions on sharing conditions. The 6.425- to 6.525-GHz band, which is the principal band used by common carriers for service to broadcasters and for closed-circuit uses such as medical demonstrations and sporting events, and the band 6.875 to 7.075 GHz, which is heavily used by the broadcasters, are now to be shared with satellites.

The Land-Mobile Service

For the past 20 years, land-mobile has been one of the fastest growing radio services. Not only has use of land-mobile radio systems increased for local governments, businesses and for other specialized uses, but land-mobile use as part of the terrestrial telephone network has increased greatly. Further growth can be expected with the advent of cellular public telephone systems and the increase of private radio requirements.

The United States has already added land-mobile to portions of the UHF television band 470 to 890 MHz in the U.S. domestic table of allocations, an action permitted under the ITU's radio regulations, provided no interference is caused to stations of other countries operating in those frequencies. The

United States proposed at WARC-79 that most of the band 470 to 960 MHz be allocated to the land-mobile service, sharing on a primary basis with broadcasting in the lower part, and with fixed and radiolocation services in the upper part. This would permit each country in region 2 to determine which of the internationally allocated primary services would be implemented in their own areas.

WARC only partially accepted these proposals. The mobile service was added to the bands 806 to 902 MHz on a primary basis, but on a secondary basis in the bands 470 to 512 MHz and 614 to 806 MHz. A footnote raises mobile to primary status in the United States, with the provision that such use is subject to the coordination procedures of article 14 of the radio regulations. The United States submitted a protocol statement rejecting the article 14 procedure, however, the requirement for coordination, coupled with the continued use of 470 to 512 MHz in Canada for broadcasting, and the use of band 614 to 806 MHz in both Canada and Mexico for the same purpose, makes our use of these bands for the mobile service problematic. A similar situation prevails regarding U.S. proposals for the 902- to 960-MHz band where the United States, Canada, and Mexico use the same segments for competing services and where coordination in border regions may be difficult.

The United States must determine its policies and means to follow through on this declaration. There are no FSS Earth stations currently operating in the 3.4- to 3.6-GHz band. In its declaration, the United States agreed not to withhold support if INTELSAT decided to undertake FSS in that band. If such a decision was implemented, the United States would be under strong pressure to restrain radar operations that might interfere with international satellite operations.

The HF Broadcasting Service

In recent decades, growing numbers of countries have turned to HF (shortwave) broadcasting to carry news, entertainment, comment, and propaganda to audiences beyond their own borders. The potential effectiveness of these broadcasts has been hampered by two factors: 1) the congestion of the shortwave frequency bands by more and more stations with ever-higher transmitter power, resulting in unintentional interference; and 2) jamming—the deliberate interference with broadcast signals.

WARC-79 offered the first opportunity since 1959 for the international community to attempt to alleviate the present congestion in HF broadcasting and the United States went to the conference seeking a substantial expansion of spectrum allocated to this service. The United States did not win approval for all its proposals but the overall outcome was satisfactory from both the technical and political standpoints. As a result of WARC-79, congestion and interference should be reduced considerably by the end of the 1980's and reception of HF broadcasts should be clearer. For the United States, this will benefit the Voice of America, Radio Free Europe/Radio Liberty (RFE/RL), the Armed Forces Radio and Television Service, and several private organizations engaged in HF broadcasting.

To reduce interference and congestion, the conference agreed to an increase of 850 kHz in the HF broadcasting bands between 9 and 21 MHz, including the creation of a new 13-MHz band. This represents an overall increase of 33 percent in the allocation for HF broadcasting. The United States had proposed a 46 percent increase, while the Soviet Union asked for no increase at all. The compromise was the result of an initiative by nonalined countries and it was especially welcomed because the allocation will ulti-

mately become exclusive, although it remains shared until the fixed service operations now using it can be reaccommodated. Despite appeals by the United States and other countries, proposals to expand the important 6- and 7-MHz bands failed by very narrow margins, largely because many developing countries claimed a continued need for these bands for other forms of communication.

WARC-79 also agreed to convene a specialized HF broadcasting conference in the mid-1980's to plan for the more efficient and equitable use of the broadcasting bands, and it tied the bringing into force of the new allocations to the effectiveness of this conference. The United States initially opposed this follow-on conference but switched to support the idea when it became apparent that WARC was running behind schedule and that U.S. interests might suffer substantial damage in the atmosphere of frustration that prevailed.

The United States achieved one goal by keeping open the scope and character of the follow-on conference; the agenda will be open and the meeting does not constitute an assignment or allocation conference. Nevertheless, there are potential problems with this follow-on conference. Political issues, such as "prior consent," could prove troublesome. Also, as noted above, the increased allocations to HF are dependent upon success in accommodating the fixed services that were ousted from the spectrum given to international broadcasting. For this reason, the United States, together with the United Kingdom, Spain, Greece, Saudi Arabia, Cyprus, Sri Lanka, and Zambia in a multinational protocol statement, reserved the right—in the absence of an adequate plan—to take the necessary steps to meet the needs of the HF broadcasting services. Similar independent reservations were made by 17 other countries. (Three host countries for RFE/RL transmitters–West Germany, Spain, and Portugal–were among those taking reservations.)

In an effort to deal with the continued problem of deliberate jamming by the Soviet Union and other Communist bloc countries, the United States made the following protocol statement at the conclusion of the conference:

> Administration of the United States of America, calling attention to the fact that some of its broadcasting in the high frequency bands allocated to the broadcasting service are subject to willful, harmful interference by administrations that are signatory to these Final Acts, and that such interference is incompatible with the rational and equitable use of these bands, declares that for as long as this interference exists, it reserves the right with respect to such interference to take necessary and appropriate actions to protect its broadcasting interests. In so doing, however, it intends to respect the rights, to the extent practicable, of administrations operating in accordance with these Final Acts.

Other smaller countries, like Iran, also complained of Soviet jamming which, although not directed at them, interfered with their broadcasting. Neither the Soviet Union nor any of the other Eastern bloc nations that currently jam U.S. broadcasts submitted an official statement to answer the U.S. complaint.

U.S. delegation representatives who dealt with HF broadcasting issues reported that the nonalined movement countries generally supported or opposed U.S. positions on the basis of their own interests and not for ulterior political motives. Some of the strongest opposition to U.S. proposals came from Latin America, especially on the issue of fixed services v. broadcasting. Brazil and Costa Rica proved to be more influential than Cuba in controlling the Latin American delegations.

The Soviet Union, which often operates HF broadcasting stations "out of band," i.e., using frequencies allotted to some other service, did not request additional HF broadcasting frequencies. However, this

may be explained by the fact that the Soviet Union entered a protocol statement in the Final Acts of the 1959 General Administrative Radio Conference regarding HF frequency bands and thus the Soviet Union does not consider their operations "out of band."

National Security Systems

This report deals at length with the consequences to U.S. national security of decisions reached at WARC-79. The extensive treatment is not intended to disparage the importance of WARC for other U.S. interests. It arises, rather, from the peculiar nature of DOD communications requirements and their broad-ranging use of satellites and radiofrequency spectrum.

The Final Acts of WARC-79 represent a generally acceptable compromise that satisfied most U.S. national security needs but will require some significant changes in the coming years. Greater numbers of different operations will have to make use of the same frequency bands; systems will need greater frequency flexibility to cope with competing users of the spectrum. The magnitude and cost of these changes cannot be known for some time; they will be determined in part by the manner in which the new radio regulations agreed on at WARC-79 are actually implemented worldwide.

Without being pessimistic, it should be noted that most of the major reservations that the U.S. delegation took at WARC-79 involved national security considerations. This fact by itself justifies a thorough look at the short- and long-term consequences for U.S. security of decisions reached at the conference.

Military systems must be prepared to operate anywhere in the world, and geographical restrictions on some bands generate additional requirements for frequency flexibility—sometimes demanding costly increased design and operational complexity.

The problem of "universality" is partly solvable through bilateral and multilateral agreements, but there is still a significant impact on system planning and operation. Some military systems are fielded in a less advanced state of development than their civil counterparts. As a result, they must be adjusted more. They are also used in field tests and exercises, and the frequency coordination is an important component of the planning. Nevertheless, advanced technology developments can provide some solutions.

Military-Related Issues and Objectives

The security of the United States depends on economic health as well as defense posture. The following discussion, however, focuses on the major military-related issues and objectives that were identified going into WARC-79:

- Radiolocation (radar)
  - – Minimize encroachment of radar bands, below 1000 MHz, especially in the 400- and 800-MHz bands, and at 3.4 and 5 GHz.
- Satellites (radionavigation)
  - – Provide for NAVSTAR Global Positioning Satellite (GPS) at 1,227 and 1,575 MHz.
- Satellites (communications)
  - – Recognize and provide for MSS.
  - – Obtain reasonable sharing criteria for MSS.
  - – Avoid any a priori plans that would allocate or preposition geostationary orbit spacing.
- High frequency (HF)
  - — Insure adequate HF allocations for non-line-of-sight (NLOS) nonsatellite strategic communications, beyond line-of-sight (LOS) tactical communications.
  - – Avoid regulatory limitations that would inhibit over-the-horizon (OTH) radars.
- . Fixed and mobile (terrestrial)
  - – Maintain status quo in the 4400- to

4900-MHz band, pertinent to NATO requirements.
  - Retain the 14.5- to 15.35-GHz bands for fixed and mobile systems pertinent to NATO requirements, and minimize the growth of the space services in these bands.
- Intelligence
  - Avoid any regulations that limit or reduce flexibility of operation.

One part of the U.S. preparation strategy was to participate in and strengthen the International Radio Consultative Committee (CCIR) of ITU as a technical forum. Toward that end, DOD participated actively in the work of CCIR study groups, the CCIR XIV Plenary held in Kyoto, Japan (June 1978), and in the CCIR special preparatory meeting (SPM) for WARC-79 held in Geneva in October 1978. DOD prepared substantial documentation for SPM in the following technical areas:

- G P S
- Mobile-satellite systems
  - Sharing criteria
  - Coordination areas
- Radiolocation
  - Sharing
  - Signal characteristics
- Mobile sharing with fixed service (HF band)
- Spread-spectrum techniques
- Techniques above 50 GHz.

The documents prepared for the CCIR plenary and SPM by DOD were in most cases adequate technically to support the DOD positions at WARC; however, the decisions ultimately taken at WARC-79 did not necessarily turn on technical data. It should be recognized that CCIR work is a continuing program and future active U.S. and DOD participation is essential.

The results of WARC-79 are provided in the Final Acts, and the overall results as they pertain to the United States have been summarized by Ambassador Robinson and the members of the delegation. The national security impacts have been considered in a report to the Air Force, and DOD has provided a national security assessment to the Senate that will consider the Final Acts for ratification as a treaty. The DOD consensus is that with some exceptions, the WARC-79 outcome did not degrade the national security of the United States. However, it is recognized that costs must increase in the future. Some of the results and an estimate of their impact on national security were apparent immediately after the conference. For example, our national security posture was improved when the United States:

- Obtained provisions in the allocation table that accommodate the NAVSTAR-GPS on a worldwide basis; and
- Obtained provisions for the operation of mobile-satellite terminals at 7 and 8 GHz (although the specific frequency bands are not consistent with the current design and channelization plans for the DSCS [Defense Satellite Communications System] III).

While the United States as an entity minimized its losses due to conference actions, DOD (as a major U.S. international user of the radio spectrum) did bear the brunt of the loss of flexibility for use of the spectrum (e.g., radiolocation). The United States took six reservations, four of which dealt directly and one of which dealt peripherally with decisions that could adversely affect national security.

It should be recognized that the total impact of WARC-79 will take some time to assess due to the interdependence with implementing actions of other nations, particularly those with whom the United States is allied militarily.

Spectrum Availability for National Security

Major national security questions are: "What portions of the radiofrequency spectrum are available for DOD use, and what was the effect of WARC-79 allocation actions on DOD's capability to perform its mission?" There is no simple, single answer to

these questions. However, one method of gaining some perspective is to examine the status of the major radio bands and services employed by DOD in the revised table of allocations developed by WARC-79 and compare it with the existing table. The bands below 27.5 MHz and above 15 GHz are treated on a *band* basis; whereas, between 27.5 MHz and 15 GHz the changes are treated on a *service* basis for the fixed, mobile, radiolocation and fixed-satellite and mobile-satellite services. All of these bands and services are vital to U.S. national security. They are used: for example, for command, control, and intelligence systems; for radionavigation; for military weapon systems that use radiosignals for guidance and targeting; for early warning and all forms of communication. Moreover, they must operate in all parts of the world under various conditions of competing spectrum use.

Bands Below 4 MHz

The following changes were made in the bands below 4 MHz:

- The radionavigation service in the very low frequency (VLF) and low frequency (LF) bands was expanded. This was a U.S. proposal for protection of nongovernment and military operations.
- The medium frequency (M F) spectrum for AM broadcasting was expanded to 1605 to 1705 kHz.
- Fixed and mobile operations between 2 and 4 MHz were maintained; however, footnotes and power limitations were specified in an attempt to reduce interference.

The HF Band (4 to 27.5 MHz)

The United States proposed to reduce allocations to the fixed service by 18 percent and reallocate these frequencies to the maritime-mobile, broadcasting, radio astronomy, amateur, and mobile (except aeronautical-mobile) services. While there was only a 14-percent reduction in HF spectrum available to DOD, the exclusive bands were reduced by over 65 percent. The shared use of bands by service was greatly increased. The conference made significant reallocations to maritime (including several new bands above 10 MHz) and to international broadcasting operations. This led, in part, to U.S. reservations. The aeronautical-mobile service bands were not changed. A detailed reaccommodation procedure, whereby services displaced would be provided for elsewhere in the spectrum, was a part of the revised HF allocation agreement. The conference action lessened the number of assignments that may be affected. The time frame for completion of the changeover as specified by the conference further reduces the overall impact on DOD and other HF users. The immediate procedure is for each administration to review all the HF fixed service listings in the international frequency list as furnished by the International Frequency Registration Board (IFRB). This review will:

- Delete entries not required.
- Identify remainder by category, regular operational use, standby, occasional use on a reserve basis.
- Determine hours of operation.

IFRB was to be advised by March 1981 of the administrations' findings. Then, beginning in July 1984, administrations will be required to effect the changeover from the old assignment to a new assignment. For bands above 10 MHz the changeover will be completed by July 1, 1989, and for bands below 10 MHz by July 1, 1994. (Tables 3 and 4 show the distribution of the HF band before and after WARC-79.)

The 20-, 30-, 40-GHz Bands

In the bands at 20, 30, and 40 GHz, virtually all U.S. requirements for FSS and MSS were met, though in certain instances the sharing with other services as agreed by the conference may not prove to be feasible. The MSS proposals in these bands were companion to MSS proposals in the 7- to 8-GHz bands. The successes achieved will strengthen military communications by satellite.

Table 3.–Distribution of the HF Band (4000 to 27,500 kHz) Before WARC-79

Service	Exclusive		Shared		Total	
	kHz	Percent	kHz	Percent	kHz	Percent
Fixed service	10,157	43.2%	4,348	18.5%	14,505	61.7%
Maritime mobile	3,850	16.4	2,202	9.4	6,052	25.8
Land mobile	—	—	4,177	17.7	4,177	17.7
Broadcasting	2,350	10.0	300	1.3	2,650	11.3
Aeronautical fixed and mobile	1,795	7.6	50	0.2	1,845	7.8
Amateur	900	3.8	–	–	900	3.8
Others	116	0.5	–	–	116	0.5

SOURCE. H A. Feigleson, "High Frequency in the Future," IEEE *Trans. EMC,* vol. *23, No. 3,* August 1981, draft

Table 4.–Distribution of the HF Band (4000 to 27,500 kHz) After WARC-79

Service	Exclusive		Shared		Total	
	kHz	Percent	kHz	Percent	kHz	Percent
Fixed service	3,704	15.8%	8,191	34.9%	11,895	50.7%
Maritime mobile	4,650	19.8	158	0.6	4,808	20.5
Land mobile	—	—	2,120	9.0	2,129	9.0
Other mobile	—	—	6,442	27.4	6,442	27.4
Broadcasting	2,930	12.5	250	0.1	3,180	12.6
Aeronautical	1,815	7.7	80	0.3	1,895	8.0
Amateur	1,300	5.5	50	0.2	1,350	5.7
Others	200	0.8	66	0.2	266	1.0

SOURCE: H. A. Feigleson, "High Frequency in the Future," IEEE *Trans. EMC,* vol. *23, No, 3,* August 1981, draft.

Fixed Service

Table 5 is a summary of WARC-79 gains and changes in status on fixed allocations between 27.5 MHz and 15 GHz as reflected in the allocation tables. Between 15 to 40 GHz there were no changes to the fixed service allocation tables; and, above 40 GHz, the gains were extensive—virtually assuring frequency support for DOD fixed requirements above 40 GHz. The table does not show those fixed bands that were unchanged, but does give a measure of the gains made by the fixed service. However, between 1 and 15 GHz, the fixed service gains were made by sharing with the radiolocation and FSS.

Some gains in spectrum allocations for the fixed service are not in DOD's best interests, though the results were expected at the conference. The 420- to 430-MHz and 440- to 450-MHz bands contain important DOD radiolocation systems that are expected to have a long lifetime. These systems will now have to share with the fixed service. The allocation changes imposed by WARC will have a significant effect on the operation of these systems. The allocation of the fixed service on a primary basis to the 7250- to 7300- and 7975- to 8025-MHz bands was also expected (but not welcomed) by DOD. DSCS operates uplinks in the 7900- to 8400-MHz band and downlinks in the 7250- to 7750-MHz band. Airborne satellite communication operations are planned for the 7975- to 8025-MHz band, which was an exclusively allocated satellite band in most of the world prior to WARC-79, although this "exclusivity" was already diluted significantly by footnotes. Coordination of airborne satellite operations in a band with existing fixed systems within the United States has been very difficult. The proliferation of fixed communication systems will exacerbate this problem.

The band 4400 to 4990 MHz, is in heavy use by the military service for tactical communications, including tropospheric scatter operations; and in NATO Europe it has been designated a military band. In 1963, a

Table 5.—Summary of WARC Gains and Changes in Status on Fixed Allocations Between 27.5 MHz and 15 GHz

Frequency band (MHz or GHz)	Region(s)	Bandwidth MHz (nearest tenth) Primary	Secondary	Change MHz	Prior major use of the band
27.5-28 MHz	1	0.5		+ 0.5	Met aids
41.015-47	1	6		6	BC
54-68	2		14	14	BC
68-72	2		4	4	BC
74.6 -74.8	2 and 3	0.2		+ 0.2	Aero nav
75.2 -75.4	2 and 3	0.2		+ 0.2	Aero nav
76-88	2		12	12	BC
136-138	All		2	+ 2	Space research
146-148	3	2		+ 2	AM
174-216	2		42	42	FX MO BC
220-225	2	5		+ 5	AM RL
230-235	1	5		5	Aero nav
420-430	2 and 3	10		+ 10	RL
440-450	2 and 3	10		+ 10	RL
470-512	2		42	+42	BC
470-610	3	140		+ 140	BC and Rnav
614-890	2	84	192	+ 276	BC
1435-1525	2	90		90	MO
1530-1535	1 and 3		10	10	Space OPS
1660.5-1670	All	1.6	7.9	+ 9.5	Met aids
2300-2450	2 and 3	150		150	RL
3300-3400	2		100	+ 100	RL
3400-3500	2 and 3	100		+ 100	RL and FX satellites
4990-5000	2	10		+ 10	Radio astronomy
5850-5925	2	75		+ 75	RL
7250-7300	All	50		+50	FX satellite
7975-8025	All	50		+50	FX satellite
10-10.45 GHz	1 and 3	450		+ 450	RL
10.5-10.55 GHz	2 and 3	50		+50	RL
14.3 -14.4 GHz	1 and 3	100		+ 100	FX satellite and nav satellite

SOURCE Systematics General Corp., "The World Administrative Radio Conference 1979," final report

U.S.S.R. proposal for the inclusion of FSS, Earth-to-space on a primary basis in the band 4400 to 4700 MHz was accepted as part of a conference compromise among the United States, United Kingdom, and the Union of Soviet Socialists Republics. To date there is no known satellite use of this band; however, the INTELSAT intentions to use this band became apparent at WARC-79. This desired use became coupled to negotiations related to the band 3400 to 3700 MHz. In order best to protect current known operations in the band, FSS was shifted to 4500 to 4800 MHz (sharing with the fixed and mobile services), and its direction was changed to space-to-Earth. The bands 4400 to 4500 MHz and 4800 to 4990 MHz remain primarily fixed and mobile, except that in the subbands 4825 to 4835 MHz and 4950 to 4990 MHz the aeronautical-mobile service is excluded.

Mobile Service

The summary of WARC-79 gains, losses, and changes in status on mobile allocations between 27.5 MHz and 15 GHz is given in table 6. As can be noted, the differences between tables 5 and 6 are minor, and many of the comments concerning the fixed service changes apply to the mobile service. While the mobile service has several reductions in the status of the service, it suffered no loss of a band.

Radiolocation (Radar)

In the United States, the radiolocation service provides the spectrum support for

Table 6.—Summary of WARC Gains, Losses, and Changes in Status on Mobile Allocations Between 27.5 MHz and 15 GHz

Frequency band (MHz or GHz)	Region(s)	Bandwidth MHz		Change MHz	Prior major use of the band
		Primary	Secondary		
27.5-28 MHz	1	0.5		+ 0.5	Met aids
41.015-47	1	6		6	BC
54-68	2		14	14	BC
68-72	2		4	4	BC
74.6 -74.8	2 and 3	0.2		+ 0.2	Aero nav
75.2 -75.4	2 and 3	0.2		+ 0.2	Aero nav
76-88	2		12	12	BC
100-108	1	8		–8	BC
136-138	All		2	+ 2	Space research
146-148	3	2		+ 2	AM
174-216	2		42	42	FX MO BC
220-225	2	5		+ 5	AM RL
230-235	1	5		5	Aero nav
420-430	2 and 3	10		+ 10	RL
440-450	2 and 3	10		+ 10	RL
470-512	2		42	+42	BC
470-610	3	140		+ 140	BC and Rnav
614-980	2	110	236	+ 346	BC FX RL
862-960	1	98		+ 98	BC FX
1660.5-1670	All	1.6	7.9	+9.5	Met aids
2300-2450	2 and 3	150		150	RL
3300-3400	2		100	+ 100	RL
3400-3500	2 and 3		100	+ 100	RL and FX satellites
3400-3600	1		200	200	FX and FX satellites
4990-5000	2	10		+ 10	Radio astronomy
5850-5925	2	75		+ 75	RL
7250-7300	All	50		+ 50	FX satellite
7975-8025	All	50		+ 50	FX satellite
10-10.45 GHz	1 and 3	450		+ 450	RL
10.5-10.55 GHz	2 and 3	50		+ 50	RL
11.7 -12.5 GHz	1		800	800	FX BC and BC satellites
11.7 -12.1 GHz	2		400	400	FX FX satellite BC satellite
14.3 -14.4 GHz	1 and 3	100		+ 100	FX satellite nav satellite

SOURCE Systematics General Corp., "The World Administrative Radio Conference 1979," final report,

certain Government operations—principally military radars. Frequency management for this service, including assignments, coordination, etc., is under the jurisdiction of the National Telecommunications and Information Administration (NTIA) but operational responsibility is with DOD and the Federal Aviation Administration. As such, radiolocation proposals and associated position papers were generated in DOD with the aims of national security in mind. It should be noted that radar systems for different purposes and with different technical characteristics and operational requirements are used by many other telecommunication services and are administered by other agencies. Thus, radionavigation radars generally fall under the operational purview of the Department of Transportation, meteorological radars under the Department of Commerce, and Earth exploration satellite radars with the National Aeronautics and Space Administration. Nongovernment radar users are regulated by FCC.

It should be noted further that not all systems in the radiolocation service are radar systems. These other systems include highly accurate, position-fixing systems similar in principle to the Loran and Omega hyperbolic radionavigation systems. Used for surveying purposes such as offshore oil exploration, these systems are technically navigation devices but have been traditionally operated in the radiolocation service, using its frequency allocations and subject to its technical

standards. The existing allocation for radiolocation (and the proposals to retain them) have a firm foundation in the technical aspects of radio wave propagation and radar system missions.

During the preparation for WARC, problems were foreseen in three major areas involving seven different bands. Problems in the UHF band were deemed particularly important because this is the frequency range best suited for the long-range, air-surveillance mission. Prior to WARC-79, a worldwide primary allocation existed for radiolocation in the band 430 to 440 MHz, while in regions 2 and 3 it extended from 420 to 450 MHz. It was known that there would be intensive pressure for allocation of these bands to the fixed and mobile services. The U.S. position, therefore, was to retain at least the existing worldwide primary allocation and acquiesce to secondary status in the adjoining bands, if necessary. WARC did, in fact, arrive at this result along with a reduction to secondary status in the 890- to 942-MHz band. By country footnote, the United States retained a primary allocation for itself in those bands where the status had been reduced. It is the position of DOD that the radar system using these bands have sufficient flexibility to perform their mission. All of the systems involved have some modes of operation that could create undesirable interference. However, the retention of primary status in the United States will provide sufficient training opportunities to maintain operator proficiency in these modes. The WARC results fell reasonably within the U.S. fall-back position in these bands until the fixed and mobile footnotes started mounting up. Unable to control the flood of countries participating in these footnotes, the United States entered the reservation contained in Protocol Statement No. 38.

Of the three bands noted as problem areas in the fixed-satellite and radar sharing area, only the 3.5-GHz band was a serious problem. The 17.5-GHz band will require further study but raises no immediate hardships, and the anticipated problems at 5.5 GHz never materialized. The U.S. proposal contained provisions to meet the well recognized need for additional bandwidth for FSS in the frequency bands below 10 GHz. At the same time, the United States was committed to retaining spectrum support for major military radar systems in the 3.4- to 3.6-GHz band. Predictions of pressures to turn this band over to FSS were indeed fulfilled at WARC. The intensive, and sometimes acrimonious, negotiations included at one time the submission of a proposed footnote by the United States that would exclude FSS in the United States from operating in the 3.4- to 3.7-GHz band. The final result was a compromise; a compromise achieved by the removal of any mandatory requirement to stop radar operations in the band. In addition to the allocation status defined in the table of allocations and the footnotes, a declaration was signed by several members of INTELSAT (the United States included) that says, in part, “they shall make reasonable effort to accommodate FSS.” Thus the status of radiolocation was retained, but with the foreknowledge that the pressure from the fixed-satellite community, both internal and external to the United States, would continue.

In the 17.3- to 17.7-GHz band, the secondary status for radiolocation was part of the U.S. fallback position because of the very limited current use of the band by radar systems. By footnote, WARC-79 decreed that the band could be used for broadcast satellite uplinks, and this action was acceptable to the United States. With such usage, further study may show that radiolocation operations are possible with an acceptably low probability of interference.

The United States was well aware of the spectrum crowding occurring in the radionavigation bands and had made several proposals to alleviate it. Proposals from other countries sought to temper the problem by combining radionavigation and radiolocation into a common service—radio-determination—or by adding radionavigation as a coequal sharing partner with the radiolocation service. In addition to adopting some of

the U.S. proposals for beacons, transponders and the like, WARC opted for making radionavigation an equal partner. However, WARC came painfully close to defining aeronautical and maritime radionavigation as safety services, an action that would have included these services in the regulation regarding harmful interference to safety services. This action may be interpreted to give preferential status to the radionavigation service and bodes ill for the equality of the partnership. The U.S. recognition of this state of affairs is contained in the reservations taken in the affected bands in Protocol No. 38.

The radiolocation portion of the U.S. proposals to the WARC sought the following four major items:

1. retain radiolocation allocations in all existing bands except 216 to 225 MHz;
2. provide adequate provision for radiolocation above 40 GHz;
3. include allocations for space radar; and
4. provide worldwide primary allocations for high-accuracy, position-fixing radiolocation systems between 1615 and 3400 kHz.

In a strictly literal sense, all four objectives were met. From a practical point of view, however, only items 2, 3, and 4 can be claimed as truly successful. Concerning the first point, the existing radiolocation allocations were indeed retained, but the addition of other services on a primary basis will have a significant effect on the design, development, performance and operations of radiolocation systems operating between 400 MHz and 40 GHz.

Item I.–Table 7 compares the status of the radiolocation allocations between the existing radio regulations and those created by the Final Acts of WARC-79, indicating in the final column the changes that were made in the table of allocations. It is seen that the status of radiolocation was reduced in six bands. In all of these bands, pre-WARC negotiations had indicated that pressure for reductions was likely to be heavy. Consequently, fallback positions were prepared and, with one exception, adhered to during WARC. The one exception was in the 890-to 942-MHz band where radiolocation was reduced to a secondary service in region 2. This reduction was mitigated by the addition of footnote 3669A, which provides primary status to this service in the United States. The footnote was weakened by Canada's insistence on making the footnote subject to the procedures of article N13A. This amendment was unacceptable to the United States and formed the basis for a portion of the bands covered by the reservation noted in paragraph 4 of Protocol Statement No. 38 (which deals with the larger band 890 to 960 MHz). Thus, the objective of retaining radiolocation allocations has been met and, as such, continues to make available the frequencies required for the development and operation of radiolocation systems in the United States.

Not apparent from table 7, however, is a host of key decisions with respect to four other services that will greatly affect the radiolocation service. These four services are the fixed and mobile services (which will be discussed as a pair), the radionavigation services (including the aeronautical and maritime radionavigation service), and FSS.

The decisions made for the fixed and mobile service involved inserting these services by footnote in virtually every radiolocation band (as well as in bands for other services) between 420 MHz and 36 GHz. The footnotes are the so-called "country footnotes" in which each country claims band usage for a service that is in addition to or alternative to the service stated in the table of allocations itself. On the average, about 25 percent of the member nations of ITU are involved in these footnotes; however, over 40 percent of the member countries are involved in the band 430 to 440 MHz. A precedent for these country footnotes did exist in the previous radio regulations but the number of countries involved was small, generally less than 10 in a given band. These few exceptions were quite manageable in terms of worldwide

Table 7.—Pre- and Post-WARC Radiolocation Allocations

	Frequency band	Region	Bandwidth - MHz Primary Old	Primary New	Secondary Old	Secondary New	Change
	216-225 MHz	1		—	—	—	NOC
		2	‘9	–	–	9	1 9
		3	—	—	9	7	- 2
†	420-450 MHz	1	10	10	20	20	NOC
		2	30	10	–	20	↓ 20
		3	30	10	– 20		↓ 20
†	890-942 MHz	1	—	—	52	52	NOC
		2	52	–	–	52	I 52
		3	—	—	52	52	NOC
	1215-1400 MHz	1	135	135	50	50	NOC
		2	135	135	50	50	NOC
		3	135	135	50	50	NOC
	2300-2500 MHz	1	—	—	200	200	NOC
		2	200	200	–	–	NOC
		3	200	200	–	–	NOC
	2700-3400 MHz	1	300	300	400	400	NOC
		2	300	300	400	400	NOC
		3	300	300	400	400	NOC
	3400-3700 MHz	1	—	—	200	200	NOC
		2	300	(200) + –	300	↓ 300	
		3	300	(200) +	–	300	I 300
t	5250-5925 MHz	1	300	300	300	300	NOC
		2	375	300	300	375	↓ 75
		3	300	300	375	375	NOC
†	8.5-10.0 GHz	1	1100	1100	400	400	NOC
		2	1100	1100	400	400	NOC
		3	1100	1100	400	400	NOC
t	10.0-10.68 GHz	1	500	500	180	180	NOC
		2	550	550	130	130	NOC
		3	550	550	130	130	NOC
t	13.4-14 GHz	1	600	600	–	–	NOC
		2	600	600	–	–	NOC
		3	600	600	–	–	NOC
t	15.7 -17.7 GHz	1	2000	1600	—	400	↓ 400
		2	2000	1600	–	400	↓ 400
		3	2000	1600	—	400	1 400
	24.05-24.25 GHz	1	200	200	–	–	NOC
		2	200	200	–	–	NOC
		3	200	200	–	–	NOC
t	33.4-36 GHz	1	2600	2600	–	–	NOC
		2	2600	2600	–	–	NOC
		3	2600	2600	–	–	NOC

t U S reservation
– Lost bandwidth
↓ Status reduced
+ See text
NOC No change

SOURCE Telecommunications Systems Inc.

operations. Now, however, the exceptions can become extremely difficult with the expected proliferation of the fixed and mobile services. The difficulty will be particularly severe for airborne radar operations because the large LOS distances these signals travel when aircraft are at high altitudes can cause interference over large areas extending into other countries.

Because of this incompatibility between the fixed and mobile services on the one hand and radiolocation service on the other, the United States entered reservations to the Final Acts in Protocol Statement No. 38 for the frequency bands 430 to 440 MHz, 5650 to 5850 MHz, 8500 to 8750 MHz, 10,000 to 10,500 MHz (where the fixed and mobile services were added as a primary service in the table of allocations rather than by footnote), 13.4 to 14 GHz, 15.7 to 17.3 GHz, and 33.4 to 36 GHz. Fixed and mobile footnotes were also included in the bands 1215 to 1300 MHz and 3300 to 3400 MHz, but some mitigating circumstances precluded the need for U.S. reservations.

In the band 1215 to 1300 MHz, one-third of the countries present in the fixed and mobile footnote are also represented in a radionavigation footnote for the same frequency band. It was felt that the fixed and mobile usage would not be so severe as to warrant a U.S. reservation. In the 3300- to 3400-MHz band a clause was inserted in the footnote that negates the primary status of the fixed and mobile services in the regions around the Mediterranean Sea. It was felt that this was sufficient to obviate a need for a reservation in this band.

A second key decision was made in connection with the radionavigation services. The decision here was to add maritime radionavigation as a primary service in the radiolocation bands 8850 to 9000 MHz and 9200 to 9300 MHz, and to add radionavigation as a primary service in the band 9500 to 9800 MHz.

The third key decision concerned FSS in the band 3400 to 3700 MHz. The existing radio regulations showed that the radiolocation and FSS would share this band equally at least in regions 2 and 3. In the U.S. national table of allocations, the band was alloted to (and in use by) the radiolocation service. Studies conducted in preparation for WARC showed that the specific systems being used by these services could not share the band. On the basis of the radar system usage, the U.S. position was to retain radiolocation as a primary service with the provision that a part of the band could be made available to support fixed-satellite communications.

This position was steadfastly maintained through a protracted period of intense negotiations at WARC. The final result did, indeed, reduce radiolocation to a secondary service in the table of allocations, but, by footnote, primary status was restored in regions 2 and 3 over the band 3400 to 3600 MHz. The footnote contains a directive for administrations to take all practical steps to protect FSS after 1985 along with a nonbinding plea for radiolocation systems to cease operations by the same year. As part of the compromise, a formal declaration was signed by the United States, Canada, the United Kingdom, the Netherlands, Australia, and Belgium vowing to make reasonable effort to accommodate FSS in the band. The national table of allocations, currently under development jointly by FCC and IRAC, will make limited allowance for FSS in the band 3600 to 3700 MHz with the remainder of the band being retained in the radiolocation service.

In the FCC's third notice of inquiry concerning implementation of the Final Acts of WARC-79 (Docket 80-739), the FSS allocations in the bands 3.7 to 3.7 GHz and 4.5 to 4.8 GHz are proposed to be limited to international satellite systems and excludes domestic satellite systems. According to the third notice of inquiry, the expectation is that no more than one Earth station on each U.S. coast can be successfully coordinated with stations operating in the radiolocation service.

Item 2.–WARC-79 presented the first opportunity to allocate the frequency bands above 40 GHz to terrestrial services. The U.S. radiolocation position in this frequency range was to obtain four primary bands and three secondary bands primarily in the regions of reduced atmospheric absorption, the so-called "propagation windows. " WARC allocated six primary bands and four secondary bands. A comparison of the U.S. proposals with the WARC action is shown in table 8. It is clear that there is adequate frequency support for radiolocation system development in these bands.

Item 3.—Prior to WARC-79 there was no provision for spaceborne radars in the radio regulations. The matter has been rectified by the WARC-79 action of permitting spaceborne radars in every radiolocation band between 1 and 36 GHz as well as the band 78 to 79 GHz. The U.S. proposal was to accommodate space radars on a secondary basis in the bands below 14 GHz and on a primary basis above 14 GHz regardless of the service that was employing the radar systems. The actual wording in the WARC-79 footnotes provides secondary status to space radiolocation systems in all the radiolocation bands from 1 to 14 GHz and in the band 35.5 to 35.6 GHz it has primary status. Radars used in the Earth-exploration satellite service have primary status in the bands 35.5 to 35.6 GHz and 78 to 79 GHz, with secondary status in all the radiolocation bands from 1 to 24.25 GHz. Thus, the status of spaceborne radiolocation systems is considerably enhanced from that which existed prior to WARC-79.

Table 8.—Comparison of WARC Radiolocation Allocations and U.S. Proposed Allocations Above 40 GHz

Bands in U.S. proposal (G Hz)	Bands allocated (GHz)
—	59-64 Primary
76-81 Primary	76-81 Primary
92-95 Primary	92-95 Primary
95-101 Secondary	95-101 Secondary
—	126-134 Primary
142-150 Secondary	134-142 Secondary
165-170 Primary	144-149 primary
221-229 Secondary	231-235, 238-241 Secondary
240-250 Primary	241-248 primary

SOURCE. Telecommunications Systems Inc.

Item 4.–It was the U.S. objective to obtain more substantial frequency support for the accurate position-fixing systems in the MF band. While WARC did not provide a common, worldwide band for these nonradar radiolocation systems, it did provide primary status over 30 kHz in region 1, 245 kHz in region 2, and 193.5 kHz in region 3 coupled with secondary status over 80 kHz in region 2 and 200 kHz in region 3.

Reservations

The U.S. reservations on radiolocation matters, noted above, were contained in the initial set of reservations filed by various administrations in the Final Protocol of December 3, 1979. About 20 of the 51 reservations submitted contained a statement by the submitting government that it would take the steps necessary to protect its interests in the event of noncompliance with or reservations to the Final Acts by other administrations. The following day, 32 additional reservations were entered, 24 of which contained similar statements. Three of those twenty-four made specific mention of the U.S. Reservation No. 38.

The reservation by the United States contained in paragraph 4 of Protocol Statement No. 38, relating to the 890-to 960-MHz band will, in all probability, cause a problem along the U.S. borders primarily relating to nongovernment operations. The issue will become one of the many topics for discussion and negotiation in the future U.S. bilateral meetings on telecommunication matters with Canada, Mexico, and other nearby countries. The reservation merely places these countries on notice that the United States will coordinate its usage of the band but will not seek agreement prior to making assignments. Although radar users must protect nongovernment operations in this band, one reason agreements will not be sought is that U.S. radiolocation usage in-

volves the newest long-range surveillance radar in operation by the Navy, as well as another Navy surveillance radar now in the advanced development stage.

The reservations involving the bands where radionavigation was added as a primary service along with radiolocation (8500 to 9000, 9200 to 9300, and 9500 to 9800 MHz) can, if not forestalled, result in long-term, worldwide problems. Radar usage by the radiolocation service is extremely heavy in the radiolocation bands between 8500 and 10,000 MHz. The addition of the radionavigation service and the multicountry fixed and mobile footnotes in this band have taken 900 MHz of virtually exclusive radiolocation in the current radio regulations and added one or more primary services over the entire band. Technical and administrative solutions must be sought if radiolocation is to retain its effectiveness. Some effective technical solutions were proposed to the 1978 CCIR special preparatory meeting by the United States and the United Kingdom. Study of the technical solutions to radiolocation-radionavigation sharing needs to be pursued in CCIR. A more immediate solution, albeit partial, could be found administratively.

The U.S. International Radio Advisory Committee (IRAC) has shown no inclination to add radionavigation to the national table of allocations. IRAC might examine the matter more thoroughly and develop a set of recommendations for use by the State Department in discussions with other countries. The recommendations should propose an orderly introduction of radionavigation on an "as-needed" basis rather than throwing the bands open to any and all navigation use. The intent would be to buy time for the introduction of technical solutions. In the absence of such a planned introduction, the radiolocation service may soon find itself having a de facto secondary status because of the safety-of-life aspects of the radionavigation service.

The insertion of multiple country fixed and mobile footnotes into the table of allocations threatened chaos for many services. Through strenuous efforts by the United States, Brazil, and other countries, the situation was eased for some "passive" services (Earth-exploration satellite, space research, and radio astronomy) and the meteorological aids service. Radiolocation did not fare as well. Although many countries deplored these footnotes as being counter to the development of a rational table of allocations, the United States was the only country to act on them. The action noted in paragraph 3 of Protocol No. 38 indicated that the United States, in the operation of radiolocation stations, will not guarantee protection to, nor coordination with, other services. The action was necessary because the existence of the fixed and mobile footnotes in every radiolocation band between 1 and 40 GHz jeopardized all radars operating to serve national defense. Straightforward as it is with regard to the interference radars might cause to other services, the U.S. reservation contains the implicit statement that the radars can operate in the presence of interference from fixed and mobile emitters. All radars are designed to be operated in the presence of interference, either purposeful or accidental. The degree to which these interference rejection techniques will have to be improved and used depends on how extensively other countries introduce fixed and mobile services in these bands.

This implementation is not expected to occur equally in all the bands to which the footnotes have been added primarily due to economic considerations. However, early implementation is expected in the bands around 1 GHz and below where economical hardware already exists for fixed and mobile applications.

The U.S. reservations in Protocol No. 38 contain the only specific reference to the radiolocation service. Of the remaining protocol statements, a few are political, many deal

with specific bands and services, and the majority contain protective clauses indicating that the country or countries submitting the protocol will take necessary action in the event that other signatories abrogate the Final Acts. Only three protocol statements mention No. 38 and even in those cases the concern seems to be more with the 6- and 7-MHz bands than with radiolocation. Thailand, in Protocol No. 60, notes that it will allocate the band 435 to 438 MHz to the mobile, except aeronautical-mobile, service on a primary basis. Thus, while there is no specific threat to the radiolocation service, the mechanism is in place for electronic and political harassment should any country decide on this course of action.

Radar Spectrum Availability and Costs

The availability of spectrum for the radiolocation service had been significantly increased below 200 MHz and above 40 GHz and has remained virtually intact between these two frequencies. The principal benefit is that the new table of allocations (including the footnotes to the table) in the radio regulations continue to provide basic allocations for radiolocation service in all the currently used bands as well as some new bands.

Of equal importance is the retention in the United States of a primary status (by footnote) for radiolocation in the bands 420 to 430, 440 to 450, and 890 to 942 MHz. It is in these bands, which were reduced to secondary status in the table of allocations, that the United States has, and is developing, sophisticated surveillance radars. While these radars have operational modes suitable for worldwide use in a secondary status, the footnotes will provide the opportunity for exercising all modes of operation at U.S. training sites. The results of WARC have, therefore, done little to reduce the spectrum available for radar operations.

Adequacy of spectrum availability notwithstanding, the costs of radar development and operation must increase as a result of WARC-79. The increased costs will be associated with additional needs for operational frequency flexibility, development, and procurement of hardware for interference-free operation while retaining existing performance, and increased participation in international forums such as CCIR.

Frequency management is a continuing task, occupying staff people at the headquarters and unit level. Internationally, frequency managers ensure equitable allocations for various services as dictated by national needs; at the national level, they allot the allocated frequencies as appropriate to national usage; at the unit level, they assign frequencies in accordance with the local conditions. At all levels there is the need to deal with the incidence of interference. It is clear that all of these functions as applied to the radiolocation service will increase because of the additional services added by WARC to the radiolocation bands.

New coordinating activities must now take place between the radiolocation service and the fixed, mobile, Earth-exploration satellite, space research, radio astronomy, aeronautical radionaviagation, maritime radionavigation, radionavigation, and FSS. These activities are expected to be particularly heavy as the allowed usage in the fixed, mobile, and radionavigation bands are implemented. Significant numbers of interference incidents are also expected in these bands entailing the development of techniques to eliminate or reduce this interference.

As noted earlier, all military radars are designed to operate in the presence of intentional (jamming) and unintentional (interference) signals. Numerous electronic counter-countermeasure (ECCM) techniques are incorporated into systems to reduce the effects of unwanted electromagnetic emissions. However, ECCM is not a panacea for interference problems. In this regard, a few comments on radars, ECCM, and interference are in order.

First, radar performance is measured in terms of a clear radiofrequency environment

with no interference present. Most ECCM techniques involve some performance degradation. For this reason, a particular ECCM should be used only when it is needed. Of course, when interference is present, ECCM will improve system performance but will generally not bring it back to its clear environment performance. Second, ECCM techniques are largely signal-specific. Thus, a radar will have several techniques to be able to continue to operate in a changing radiofrequency environment. Not all techniques are compatible so that use of one may preclude the use of another. When multiple techniques are used, the performance degradation due to each is cumulative. And third, radar emissions, which generate interference into other services, are seldom considered as part of an ECCM package.

These factors when coupled with the expected proliferation of radiolocation band usage by other services means that radiolocation systems will spend more time with ECCM circuits operating and, through their radiofrequency emissions, be interfering with more systems in other services. In the short term, the need for extensive modifications to existing systems is not anticipated. However, planning should begin now for necessary modifications to radars operating in the frequency bands where the United States took a reservation. In the long term, development work on new and existing systems will have to be increased to ensure mission-fulfilling performance in the presence of increased interference. This additional development work should concentrate both on keeping unwanted signals out of the receiver and on reducing the level and direction of unnecessary ("spurious") emissions coming from the radar. This represents more than just an incremental increase in the ECCM budget of radar development, since performance in the presence of the "friendly" interference should equate to the current performance in a clear environment. The increase may range from 5 to 15 percent depending on the type of radar and the proliferation of the other services in the radar bands.

The third cost increase derives from a need for radar developers to expand their participation in CCIR. This expansion is extremely important in light of the many new sharing situations created by WARC. Prior to WARC, CCIR participation was considered relatively unimportant by radiolocation users since there was little sharing or interaction with other services. During preparations for WARC, it became apparent that the many exclusive bands employed by the radiolocation service would be reallocated or shared. Because of this likelihood, representatives of the radiolocation service participated in the IRAC preparing for the WARC-79 AD Hoc 144 and CCIR study group activities, served as members of the SPM delegation, and were part of the U.S. delegation to WARC.

This representation should continue at CCIR in order to establish a sound and consistent technical background for radar topics in the reports of CCIR plenary meetings (the CCIR Green Books). The absence of this technical basis may have been part of the reason that radiolocation received little support at WARC-79. The representation should consist of not only headquarters policy personnel but also scientists and engineers from Government laboratories and from Government contractors. Perhaps CCIR participation should become a "line item" in the budget of every radar system development. And CCIR should not be the only involvement. Future ITU conferences dealing with specific services and specific regions will continue to have an effect on radiolocation matters. It would be prudent to have radar expertise at these meetings as well.

Fixed-Satellite and Mobile-Satellite Services

Table 9 provides a summary of WARC-79 gains and changes in status on fixed and mobile satellite allocations above 27.5 MHz as reflected in the allocation tables. The data in the bandwidth and change columns illustrates that all the changes in the FSS and

Table 9.—Summary of WARC Gains and Changes in Status on Fixed- and Mobile. Satellite Allocations Above 27.5 MHz

Type of satellite	Frequency band (MHz or GHz)	Region(s)	Bandwidth MHz		Change MHz	Prior major use of the band
			Primary	Secondary		
MO	608-614 MHz	2		6	+6	BC
MO	1544-1545	All	1		+1	Aero mobile satellite
FX	5850-5925	2	75		+ 75	RL
FX	6425-7075	All	650		+ 650	FX MO
FX	10.7-10.95 GHz	All	250		+ 250	FX MO
FX	11.2-11.45	All	250		+ 250	FX MO
FX	12.1 -12.3	2	200		+ 200	FX MO and BC
FX	12,75-13.25	All	500		+ 500	FX MO
FX	14.5 -14,8	All	300		+ 300	FX MO
FX	17,3 -17.7	All	400		+ 400	RL
MO	19.7 -20.2	All		500	+ 500	FX satellite
FX	27-27.5	2 and 3	500		+ 500	FX and MO
MO	29.5-30	All		500	+ 500	FX satellite
FX	30-31	All	1000		+ 1000	FX satellite
FX	37.5 -39.5	All	2000		+ 2000	FX and MO
FX and MO	39.5 -40.5	All	2000		+ 2000	FX and MO
FX	42.5 -43,5	All	1000		+ 1000	BC satellite
MO	43.5-47	All	3500		+ 3500	Various MO satellites
FX	47.2 -50.2	All	3000		+ 3000	Not allocated
MO	50.4 -51.4	All		1000	+ 1000	FX satellite
MO	66-71	All	5000		+ 5000	Various MO satellites
FX and MO	71-74	All	3000		+ 3000	Not allocated
FX	74-75.5	All	1500		+ 1500	Not allocated
FX and MO	81-84	All	3000		+ 3000	Not allocated
MO	95-1oo	All	5000		+ 5000	Various MO satellites
MO	134-142	All	8000		+ 8000	Radio astronomy
FX	149-150	All	1000		+ 1000	Various MO satellites
FX	152-164	All	12000		+ 12000	Not allocated
MO	190-200	All	20000		+ 20000	Various satellites
FX	202-217	All	15000		+ 15000	Not allocated
FX	235-236	All	1000		+ 1000	Radio astronomy
FX	238-241	All	3000		+ 3000	Radio astronomy
MO	252-265	All	13000		+ 13000	Various satellites

SOURCE Systematics General Corp., "The World Administrative Radio Conference 1979, " final report, vols I and II

MSS allocations were positive and generally provided primary service status. The impression that everything went well for FSS and MSS (and for DOD satellite interests) does not reflect the full implications of WARC-79 decisions. There may be problems in satisfying the DSCS requirements in the 7- to 8-GHz band. DOD's WARC-79 initial goal for satellite operations was to increase the two partially exclusive 50-MHz FSS bands to 125 MHz for both fixed-satellite and mobile-satellite communications, and to add mobile-satellite as a secondary service in the two 500-MHz FSS bands 7250 to 7750 MHz and 7900 to 8400 MHz. Footnote 3764B was added to the table of allocations that authorized the bands 7250 to 7375 MHz (space-to-Earth) and 7900 to 8025 MHz (Earth-to-space) for use by MSS (subject to agreement obtained under the procedure set forth in article N13A)—a major gain. An additional footnote 3762B does not permit aircraft stations to operate in the 8025- to 8400-MHz band in region 2. So, although the goal of 125 MHz for up and downlinks for fixed-satellite and mobile-satellite communications was achieved, this meant that the partial exclusivity that existed for FSS was lost in the two 50-MHz bands (7250 to 7300 MHz and 7975 to 8025 MHz). The DOD plans for use of ground-mobile forces (transportable) and airborne satellite terminals in the United States, NATO countries, and in selected areas of the Pacific must take account of the WARC-79 decisions. Frequency support for these types of DSCS operations will require long lead times to coordinate with host administrations.

The coordination requirements for mobile-satellite use in the 235- to 399.9-MHz band have become more complex due to WARC-

79. Previously, under footnote 3618/308A, the use and development of this service was only subject to the agreement among the administrations concerned and those having services operating in accordance with the table, which may be affected. Now the modified 308A (3618) requires two conditions to be fulfilled:

. Agreement must be obtained under the procedure set forth in article N13A.
  – Under this article agreement among administrations now becomes more complex due to increased data to be furnished–and adding IFRB to the coordination process.
- Stations in MSS do not cause harmful interference to those of other services operating (or planned to be operating) in accordance with the table.

The United States and most NATO countries took a reservation in the final protocol against this second provision on the basis that this imposes a condition of noninterference that could lead to a request to cease operation of a previously coordinated satellite system in the case where an administration, despite having agreed to such a satellite system, puts into service (or merely plans) a system that might receive harmful interference.

Costs Pertinent to National Security

Costs have been discussed earlier in this report. Summarized here are the cost impacts of WARC-79 from the standpoint of national security. There is no major immediate cost impact of WARC-79 regarding national security systems. No heavily used equipment must be moved to another band or phased out and no expensive retrofits are required to existing DOD equipment because of WARC-79 actions. Three reasons explain this lack of immediate cost impact:

- frequency flexibility of existing U.S. equipment;
- success of the U.S. delegation at WARC-79; and
- reservations taken by the United States.

It should be emphasized that there will be future costs resulting from the actions at WARC-79. The nature of these costs are varied. The military, in particular, is affected by the number of footnotes (about 500) to the table of frequency allocations that make it impossible in some cases to know which countries will use which frequency bands for which services. Attempting to design military systems and plan operations on a worldwide basis with such uncertainty will increase system costs and decrease operational flexibility. This means, among other things, that system planners will need to design military systems that have the flexibility to operate in several different frequency bands. The extent of the changes and the magnitude of the costs associated with WARC-79 decisions will not become clear for some time. Discussions between the United States and other countries–particularly our NATO allies—about implementation plans will help clarify the future operating environment.

WARC-79 resulted in a large number of future conferences and DOD should actively participate in the preparation for national and international meetings pertinent to these conferences—including the activities of CCIR—to ensure that DOD spectrum needs are accommodated and that our national security interests are protected. DOD should also provide technically knowledgeable, experienced (and, to the extent possible, multilingual) members to the U.S. delegations. Of the three world conferences and seven regional conferences recommended in the Final Acts of WARC-79, the most important from a national security standpoint are:

- World Administrative Radio Conference on the Geostationary Orbit and the Planning of Space Services (1985 and 1987); and
- World Administrative Conference for Mobile Services (1983).

Mobile services were popular with the developing nations, and, with little regard for the technical aspects of sharing between different radio services, many additions were made to the table of frequency allocations in support of these services. The conference added many provisions impacting radar and weapon system frequency bands, both for terrestrial and satellite operations.

The overall DOD impact of these and other changes related to sharing will be a greater need for U.S. planners, managers, equipment suppliers, and operational forces to be aware of frequency band limitations, and a need to ensure better system development review to understand how U.S. systems can live with those of other countries. These changes add up to one thing for DOD—increased costs. These include: costs associated with additional needs for operational frequency management; costs associated with the development and procurement of the more sophisticated equipment (e.g., increased tunability) needed to permit interference-free operations with other services in the same band; and costs associated with proving the system is compatible, such as electromagnetic compatibility (EMC) studies. And there will be increased costs of coordination with our allies. Other costs may become apparent over time (e.g., as the HF reaccommodation takes effect in the coming years).

Summary of the National Security Impact of WARC-79

The major DOD-related issues and objectives were enumerated earlier. Here is a summary of the major impacts on those issues and objectives. Before beginning a more detailed summary, however, it should be reiterated that in general the national security interests of the U.S. were not endangered by WARC-79 actions. Nevertheless, continued active participation by DOD in the planning and conduct of future discussions and conferences will be required to ensure that follow-on actions to WARC-79 do not jeopardize national security. This will require adequate budget support.

Radiolocation (Radar) .-The service retained almost all of its allocations above 200 MHz; the only actual reduction of allocation to the radiolocation service occurred in the 216- to 230-MHz band in region 3. This occurred when 9 MHz of a secondary allocation (216 to 225 MHz) was reduced to 7 MHz (223 to 230 MHz). When considering the magnitude of spectrum allocated for radiolocation use, this reduction of 2 MHz is minor. Consistent with the U.S. proposals, radiolocation was reduced to a secondary service—except that in region 2 (the Americas) it will be on a primary basis until 1990 after which no new stations are to be authorized. However, significant loss in radiolocation status resulted from WARC-79 in certain radiolocation bands below 20 GHz. This loss of status plus the movement of other users into the bands combined to force the United States to take a reservation (No. 38) affecting certain radiolocation bands.

Although there was little actual loss of allocations, the provisions for radar were probably changed more by WARC-79 than for any other single radio operation. For example, in the band 3400 to 3600 MHz, there are provisions for radar to operate worldwide, but radar users must afford some measure of protection to satellite and radio relay operators. The United States operates the Airborne Warning and Control System (AWACS), the Navy's AEGIS, and several other systems of importance to DOD (e.g., missiles, air traffic control, air surveillance, etc.) in the band 2900 to 3700 MHz, and their operations may be affected through the need for added planning coordination. If there is extensive implementation of satellite communications in this band below 3600 MHz, then the problems mentioned above would be compounded–especially in Europe. The radiolocation service lost some exclusivity in the band 8500 to 10,000 MHz where DOD operates navigation, air search, fire control radars, and various airborne systems. When footnotes are considered, radiolocation effectively lost exclusivity over the whole band (8500 to 10,000 MHz). This could eventually

place constraints on radar operations and increase demands on system designers. Short-term relief is provided by Protocol Statement No. 38, and intermediate term relief can be negotiated with U.S. allies through bilateral and multilateral agreements outside of the radio regulations. Nevertheless, radar as it currently operates will become increasingly unwelcome in many parts of the world, and new design and operational strategies will be needed before the end of the century.

Radionavigation.–The U.S. objective of providing two bands (1215 to 1240 MHz and 1559 to 1610 MHz) for space-to-Earth navigation signals to accommodate the NAVSTAR/GPS was achieved. NAVSTAR/GPS is the cornerstone of future DOD high accuracy global navigation. It can also provide for improved civil navigation.

Satellite Communications.—The U.S. objective to maintain the status quo for MSS in the 235- to 399.9-MHz band used by the Naval Fleet Satellite Communication System (FLTSATCOM) was partially achieved; however, coordination provisions (article N13A) were added that included a condition that stations in MSS not cause harmful interference to those of other services operating, or planned to be operated, in accordance with the table of allocations. To forestall the potential negative impact, the United States and most of its NATO allies, took a reservation in the Final Protocol.

A major U.S. objective was achieved through the recognition of MSS. The bands 7250 to 7750 MHz and 7900 to 8400 MHz had been allocated to FSS (DSCS I, II, III, NATO SATCOM). Now, the MSS can operate on a primary basis in the bands 7250 to 7375 MHz and 7900 to 8025 MHz; however, there was a corollary loss of the partial exclusivity for FSS in two 50-MHz bands (7250 to 7300 MHz and 7975 to 8025 MHz). There was a net gain for national security objectives through these changes, although deployment of satellite systems without causing interference to radio relay systems in some areas will become increasingly difficult.

All U.S. objectives were met in the 20-,30-, and 40-GHz bands that may be used by future generation military satellite systems (e.g., DSCSs), including provisions for accommodating MSS.

The United States sought to avoid the possible future loss of system design flexibility and orbit locations associated with a rigid a priori allocation plan for satellites in the geostationary orbit. While no plan was adopted at WARC-79, plans were made for a future conference on space systems to be held no later than 1985–with a follow-on conference about 18 months later. These space conferences will probably result in some form of orbit spectrum planning that could inhibit technological development. The impact on all future DOD space systems is potentially very large. Proper preparation for these conferences is essential, including adequate budget allocations.

High Frequency.–The U.S. objectives of providing for the increasing requirements of international broadcasting (e.g., Radio Free Europe, Voice of America, etc.) and maritime operations (while limiting the loss of HF spectrum for DOD operations) were met, although the United States took reservations below 10 MHz for both of these services. The net reduction of only 14 percent in HF spectrum available to DOD should not adversely affect U.S. strategic networks, which rely increasingly on satellites, and the available spectrum should accommodate our tactical and other HF national security requirements.

Fixed and Mobile (Terrestrial) .-The U.S. objective of maintaining the status quo in the important NATO band of 4400 to 4990 -MHz was not met. The band is heavily used by the military for tactical communications (primarily radio relay and troposcatter systems). Although the present and past allocations provided for FSS in this band, there is no known satellite system operating as such.

In order to provide some protection, the fixed-satellite was changed from uplink to downlink and shifted from 4400 to 4700 MHz to 4500 to 4800 MHz, which is shared with fixed and mobile. (The aeronautical-mobile service is excluded from 4825 to 4836 MHz and 4950 to 4990 MHz by footnote.) The band 14.5 to 15.35 MHz was also designated by NATO as a primary military band for fixed and mobile services. WARC-79 included the FSS (Earth-to-space) in the band 14.5 to 14.8 MHz shared equally with fixed and mobile. By footnote, FSS would be limited to the broadcast feeder links and would be reserved for countries outside Europe. The effect is that, if satellite service is instituted, the military systems would have to be located and operated in a manner that would not cause interference. Analyses of potential interference might lead to the requirement for sharing sensitive military technical data with civil administrations. The impact of these changes cannot be fully determined until after discussions with our NATO allies.

Intelligence, –The impact of WARC-79 on U.S. intelligence systems is not discussed in this report.

Resolutions, Recommendations, Reservations, and Declaration

Many of the important consequences of WARC-79 derived from resolutions and recommendations approved by the conference and from reservations and declarations by individual countries indicating a refusal to be bound by a particular decision of the conference or agreeing to undertake certain actions in order to conform to a decision.

A total of 87 resolutions and 90 recommendations were adopted by WARC-79. Many of the resolutions referred certain topics for study by CCIR or proposed the convening of world or regional administrative radio conferences. In addition, the developing countries introduced several resolutions seeking increased assistance in the following areas:

- technical cooperation in maritime telecommunications, especially by providing technical advice and by assisting in training personnel;
- technical cooperation in national radio propagation studies in tropical areas designed to improve and develop the developing countries' radiocommunications;
- development of national radio frequency management within the developing countries through such means as regional seminars and training;
- transfer of technology in telecommunications for the purpose of developing services and attaining social, economic, and cultural objectives of the developing countries; and
- use or role of telecommunications in rural development.

Those resolutions look to UNDP as the primary source of funding. However, the United States will be expected to participate directly or indirectly in the areas described. Some decisions must be made how the United States should respond to requests for assistance.

Many of the resolutions and recommendations relating to the CCIR study topics have to do with such highly controversial subjects as the use of the geostationary satellite orbit and the planning of space services utilizing it; the convening of a WARC for the planning of the HF bands allocated to the broadcasting service; and, the convening of a regional administrative radio conference for this detailed planning of the broadcasting-satellite service in the 12-GHz band and associated feeder links in region 2.

About 2 dozen specialized world or regional administrative radio conferences were proposed at WARC-79, many of which can affect U.S. interests. The conference recommended that three world conferences and seven regional conferences be held. (The recommended conferences and their projected dates are listed at the end of chapter 6.)

A reservation, as noted earlier, is a formal statement, as part of a protocol, wherein an ITU member indicates that it will not abide by a particular decision of a conference. These reservations are called protocol statements in the Final Acts of WARC-79 and this time the United States took a total of six. (Reservations generally provide a means by which countries can accept the majority of decisions reached by a WARC without being bound by a particular decision.)

Two of the six were rebuttal statements in which: 1) the United States rejected a Cuban complaint that U.S. use of radiofrequencies at our Guantanamo Naval Base was an impediment to Cuba's communication services and Cuban sovereignty; and 2) the United States joined with 22 other countries in noting that the claims of equatorial countries to sovereignty over segments of the geostationary orbit were not germane to the work of the conference. Such rebuttal statements are common in conferences such as WARC-79 to indicate that political rhetoric should not be confused with international agreements.

A third U.S. reservation called attention to the fact that our international broadcasting in the HF bands was being intentionally jammed by other ITU members and reserved the right to take "necessary and appropriate action" to protect U.S. broadcasting interest. The statement was included primarily to put the jamming problem on the record inasmuch as the subject was not mentioned during the course of the conference, although Israel made a reference to jamming in its statement for the final protocol.

None of these three reservations will impact on telecommunications operations directly; however, all three are likely to resurface at future conferences.

The remaining three U.S. reservations dealt directly with spectrum matters. In Protocol No. 32, the United States participated in a joint NATO statement rejecting the terms of a footnote affecting the operation of MSS in the bands 235 to 322 MHz and 335.4 to 399.9 MHz. The NATO countries agreed that they could meet the prescribed coordination procedures called for in the footnote. However, they rejected an additional provision of this footnote imposing a condition of noninterference. The concern was that this condition could lead to a request to cease operation of a previously coordinated satellite system when another country merely planned a system that might receive harmful interference from a MSS operating in the band. A separate reservation of Canada supported the U.S. view that future or planned terrestrial systems should not jeopardize existing MSS.

In Protocol No. 36, the United States joined the seven other countries in protesting the inadequate provision for HF broadcasting–particularly at 6 and 7 MHz. Fourteen other countries individually took reservations on this same matter. They all expressed concern that the forthcoming HF broadcasting conferences (1984 and 1986) will be hampered by the lack of adequate allocations, and reserved the right to take the necessary steps to meet the needs of their HF broadcasting services.

The United States took a major reservation in Protocol No. 38 that was submitted in five parts. The first two parts referred to Protocol Nos. 36 and 32. The third part stated that the United States could not guarantee protection to or coordination with other services that experienced interference from radars operated on a primary basis in a variety of specified bands. The fourth part stated that the United States reserves the right to operate fixed, mobile, and radiolocation services in the bands 470 to 806 MHz and 890 to 960 MHz without the required coordination procedures specified in footnotes pertaining to these bands. The United States agreed to coordinate its usage of such services with neighboring countries that are affected, but not with all the other countries that might, for no apparent good reason, request coordination under article 14.

Part five of the reservation addresses the failure of the conference to provide adequate

allocations for the maritime-mobile service below 12 MHz. In this reservation, the United States indicated that allocations to the mobile service below 10 MHz would be used to satisfy maritime mobile requirements.

The U.S. reservations contained in Protocol Statement 38 represent a conscious decision to take whatever steps are necessary to protect vital U.S. national interests. They cannot be regarded simply as a failure by the U.S. delegation to get what it wanted at WARC-79. This is no more valid than listing the hundreds of U.S. proposals that won approval and thereby claiming overall success.

Foreign Reservations

The remaining 77 reservations, some of which bear the names of several countries, can be grouped in three categories:

- general reservations;
- political reservations; and
- specific reservations.

Some 35 reservations can be categorized as "general" in that they were merely statements of a country's intent to do whatever is necessary to protect its radio-communication services should other ITU members fail to observe the radio regulations or take other detrimental measures.

Another 17 reservations are "political" in that they relate to territorial disputes (United States and Cuba over Guantanamo; Great Britain and Argentina over the Falkland Islands; Chile and Great Britain over the Antarctic). two others relate to sovereignty claims to the geostationary orbit.

Finally, 28 reservations address specific issues. Of these, 19 are concerned with the allocation of HF among the broadcasting, fixed, and mobile services. The majority of these were entered by developing countries and state that they may not be able to satisfy their fixed and mobile service requirements with the reduced allocations and they reserve the right to continue using these frequencies for those services. The large number of reservations on this single subject shows that the issue of HF allocations is far from settled. Continuing difficulties are likely, including actual interference with existing services, the inability of some countries to satisfy their requirements, and a troublesome time at future scheduled broadcasting conferences.

This leaves nine specific foreign reservations on all other subjects. Of these nine, four deal with the UHF band. All are related to localized problems, none of which greatly affect the United States. The remaining five are as follows:

- Belgium warned that it will use the band 100 to 104 MHz for a new network of broadcasting stations. Since the band is now, and has been, allocated for this service, the reservation addresses the question of allotments or assignments in a region 1 broadcasting plan, a subject outside the agenda of WARC-79.
- Japan said in another statement that it will continue to use the band 130 to 526.5 kHz for aeronautical radio-beacons. If region 1 broadcast stations continue to cause interference in the band 190 to 285 kHz, Japan will reallocate to protect itself.
- Nigeria claimed that the allocation of 14 to 14.8 GHz for feeder links to broadcasting satellites is not acceptable. This reservation is apparently intended to indicate that 14.0 to 14.5 GHz will be used for INTELSAT satellite services in Nigeria leaving only 300 MHz for feeder links to broadcasting satellites. However, sharing arrangements between those services should help assure adequate spectrum for feeder links.
- In a joint reservation, France and Switzerland objected to high-power broadcast stations below 5000 kHz and above 41 MHz. Brazil expressed opposition to a WARC resolution establishing the period of validity of frequency assignments to satellites prior to the 1985 and 1987 space planning conferences, arguing that the resolution would prevent

the planning conferences from deciding on other distributions of frequency and orbit allotments. However, the resolution specifically stated that its application should not prejudge decisions of the planning conferences.

. Finally, a Thailand reservation extended its allocation to the mobile service (except aeronautical-mobile) to the entire band 430 to 440 MHz. The effect is minimal because of the many other services and countries already included by footnotes.

Declaration

The United States signed a formal declaration of intent together with other countries at the WARC-79 conference as part of the effort to resolve the controversy surrounding use of the band 3.4 to 3.7 GHz.

In ITU regions 2 and 3 (the Americas, Oceania, and Asia) this band is allocated on an equal basis to both the fixed satellite and radiolocation services. Based on studies showing that it is not feasible for these two services to share the same band, the United States has not implemented FSS, but has carried on important military radar operations in this band. Commercial satellite systems—both the global INTELSAT system and U.S. domestic systems—operate in the adjacent band 3.7 to 4.2 GHz. The U.S. proposal to the WARC-79 was to maintain the status quo and retain radiolocation as a primary service in the 3.4 to 3.7 GHz band. While the United States was prepared to make some provision for FSS to use a part of the band, other countries, particularly from the developing world, insisted that the entire band be made available to expand satellite service.

From the viewpoint of the satellite operator, this proposal represents a logical and cost effective expansion into a band contiguous with existing operations. The problem for the United States, of course, is that it has large investments in radar equipment that is vital to national security and these radars would interfere with satellite operations in the same band.

Negotiations were intense and a compromise was found late in the conference. The final result did, indeed, reduce radiolocation to a secondary service in the International Table of Allocations. However, by a footnote to the table of allocations, primary status was restored to the radiolocation service in regions 2 and 3 for the bands 3.4 to 3.6 GHz. The footnote includes a directive for ITU members to take all practical steps to protect FSS after 1985 with a nonbinding appeal for radiolocation systems to cease operations by 1985. The compromise was made possible by the removal of any mandatory requirement to cease radar operations in the band. As part of the compromise, a declaration was signed by the United States, Canada, the United Kingdom, the Netherlands, Australia, and Belgium vowing to make reasonable effort to accommodate FSS in the band.

The United States will determine how to implement the intent of the declaration through its domestic processes. There are no FSS Earth stations currently operating in the 3.4- to 3.7-GHz band. However, the United States agreed not to withhold support if INTELSAT decided to undertake FSS operations in that band. If such a decision was made, the United States would be under strong pressure to restrain radar operations that might interfere with international satellite operations.

In the FCC's third notice of inquiry concerning implementation of the Final Acts of WARC-79 (General Docket 80-739) FCC proposed that only limited use be made of the FSS allocations in the 3.6- to 3.7-GHz and 4.5- to 4.8-GHz bands. The FCC's notice proposes a limitation on the use of these bands to international satellite systems (specifically the INTELSAT global system) and excludes domestic satellite systems. FCC expects, according to its third notice of in-

quiry, that no more than one Earth station on each coast of the United States can be successfully coordinated with stations operating in the radiolocation service.

The Impacts of WARC-77

The 1977 World Administrative Radio Conference for broadcasting satellites was convened to plan the use of the 11.7- to 12.2-GHz band that had been allocated in 1971 on a primary basis to the broadcasting satellite service, the fixed service, broadcasting service, and (in region 2 only) FSS. The decisions reached at WARC-77 are superseded by the Final Acts of WARC-79, but the manner in which these decisions were reached, and their longer term consequences, deserve some discussion.

Because the broadcasting satellite service was in an early stage of development, the United States produced elaborate technical arguments in advance against the adoption of a detailed geostationary orbit and channel allotment plan, believing that such a plan would waste orbit and spectrum and hinder technological advances. The United States proposed instead that the conference approve certain actions that would encourage planning that was evolutionary and flexible, rather than detailed and restrictive, and would make adequate provision for FSS in region 2 (the Americas).

The conference ignored the U.S. technical arguments and embraced the concept of detailed planning for two basic reasons:

- the majority of developing countries wanted to be assured of guaranteed access to specific orbital slots and channels and were convinced that a detailed a priori plan offered them that assurance; and
- a number of European countries believed that the adoption of an a priori plan would permit them to proceed with development of terrestrial services in the 11.7- to 12.2-GHz band.

Neither of these two goals would have been helped by adoption of an evolutionary plan that was subject to change. Moreover, the United States, Canada, and Brazil were the only countries planning use of the band for FSS and therefore concerned with problems of sharing between broadcasting satellites and FSS. Also, the United States and Canada had unilaterally ruled out primary domestic use of the band for terrestrial services.

The U.S. delegation made extensive efforts to find fallback positions, or supporting technical documentation, which, while encompassing U.S. views, would meet the concerns of other countries. These efforts were unsuccessful. The United States failed to forestall the adoption of a detailed plan for regions 1 and 3, but succeeded in putting off detailed planning for BSS in region 2 until 1983.

It can be argued that the United States prepared for the wrong conference in 1977. The delegation was thoroughly armed with technical arguments based on experimental operation of ATS-6 and CTS, satellites with broadcasting capabilities. The United States sent representatives to a series of regional ITU seminars and held bilateral discussions with a number of countries, including West Germany, Japan, the U. S. S. R., and the United Kingdom. Reports from these meetings made it clear that the U.S. position was shared by very few countries and was more than likely doomed to failure from the start.

Thus, in spite of a major U.S. effort, the principle of a “negotiated plan” for the space services was established and fully accepted by a large majority of ITU members at WARC-77, and the “planning” adopted was

detailed planning including specifications of national orbital positions, channel assignments, service areas, and a variety of detailed technical characteristics. There is no reason to assume that this approach will not be advocated for other space services, such as FSS, in future conferences.

A major challenge for the United States will be to develop alternate planning approaches that will satisfy renewed demands for "guaranteed access" for all countries and still permit the introduction of advanced technology to increase the capacity of the geostationary orbit and related spectrum to meet increasing requirements.

Chapter 5

Alternative Structures, Procedures, and Strategies

Contents

Page

Introduction 107

A More Restrictive Global Information Environment. 108

Renewed Focus on Regional Telecommunications 108

A More Active and Stronger Government Presence. 109

U.S. Government Communications Policy and Structures. 109

U.S. Structure and Processes for Spectrum Management. 110

Possible procedural and Structural Improvements. 111
- Procedural Improvements. 111
- Structural Improvements. 112

U.S. Strategies for Dealing With International Spectrum Issues and ITU. . 114
- Policy Option No. l: Withdrawal From ITU. 116
- Policy Option No. 2: Revised ITU Voting Formula 117
- Policy Option No.3: Increased Regionalization of ITU 118
- Policy Option No. 4: Better Coordination and Planning 119
- Policy Option No. 5: Common-User System 121
- Policy Option No.6: “A Priori" Allotment. 123

LIST OF FIGURES

Figure No. *Page*

4. Displacement in Longitude for Countries in the Northern and Southern Hemispheres. 124
5. Available Geostationary Arc. 125

Chapter 5

Alternative Structures, Procedures, and Strategies

Introduction

Countries planning for the extension and growth of their telecommunications networks and improvements in communications generally have to set out a reasonably long-term strategy since a number of very important factors (resources, investments, socio-political needs and trends, international relations, technological possibilities and threats) must be considered concurrently.

Communications and information systems technology has reached the stage where concepts such as the "information-based society" are the subject of intense national and international discussion. High technology systems of advanced computer-communications including digital/switched facsimile, computer polling systems, packet switching data networks, distributed processor-controlled switching, and multiple-access satellite systems are appropriate to the needs of both developed and less developed countries. The use of such technology can greatly reduce costs for important services; they can extend service to rural or remote points; they can give these countries fast and convenient access to the best and most advanced information banks in the world. Many nations are beginning to grasp these implications. As a result, telecommunications is increasingly viewed as a "tool for development" and as a key to greater information capacity and power. This suggests that national communication and telecommunication planning must take account of broader considerations than were once considered necessary.

The telecommunication planner faces a new and potentially explosive situation. The facilities and services now being considered create a new infrastructure—an electronic infrastructure that makes possible and promotes electronic information transfer that will have significant, often radical, effects on the structures of cities, transportation, economics, education, banking, postal services, the nature and control of information media, the privacy and security of citizens, as well as general lifestyles. Changing political, sociological, and economic needs or constraints will, in turn, strongly influence the range, tariffs, and structure of the telecommunications facilities and services. The future environment is considerably more uncertain than the present volatile scene. It is also more political and characterized by a growth in the "communications consciousness" of people.

There is growing recognition that electronic and telecommunication technologies and their application to new integrated systems are an important source of economic stimulus. The importance of these technologies in social and economic development, national security, cultural diffusion, and influence over popular thinking combine to create a strong bias and argument for promoting and protecting national information industries and U.S. electronics manufacturing capability.

Information power is being increasingly recognized and used by the nations of the world to increase and enhance their economic and political power. Telecommunications is a key resource in the creation and exploitation of information capacity and power. As nations realize and appreciate the pivotal role and importance of information and information power, telecommunication policies will be viewed as strategic means for increasing national sovereignties and reordering world affairs.

A More Restrictive Global Information Environment

Information exchange between and among nations is essential if nations of the world are to function as viable societies in a multipolar, information interdependent world. The global flow of information is essential to the sustenance of the current level and pattern of the world's collective intelligence and economic production, development, and growth. The underlying principles of freedom of information and freedom of expression have given rise, in some countries, to the doctrine of free flow of information. For 30 years, the idea, given legitimacy at the United Nations, was that no barriers should prevent or distort the flow of information among nations. This doctrine is presently under serious attack.

The absence of, or loss of confidence in freedom of information rights or privileges in many of the Third World nations, as well as the Communist countries, is a fundamental threat to the global flow of information. In conjunction with the indirect barriers imposed by other international information issues and concerns, namely transborder data flow, the potential regulation of information imports and exports (contained in national policies for patents, advertising technology transfers, direct investment, appropriate technology, etc.), the protection of domestic electronics and information industries, and the global patterns of information power, the future suggests a much more restrictive global information environment.

On the way to this new global information infrastructure, the United States and other nations will face a broad range of major problems and issues including:

- international technical operating standards and procedures;
- privacy and other considerations affecting transborder data flows;
- international marketing rules;
- reconciliation of national differences concerning service availability and accessibility, information availability and accessibility, sociocultural variations, frequency assignments and management, national telecommunications and information policies;
- impacts on national sovereignty;
- influence and control of information on world events, attitudes, and outcomes; and
- the benefits of information imports v. the cost of information dependency.

Many of the developing countries are already evidencing an awareness of the linkages among these issues and of the interplay and interdependency that exists with radio spectrum matters.

Renewed Focus on Regional Telecommunications

The 20 years ranging from about the mid-1950's to the mid-1970's can be considered the global expansion phase in the development of international telecommunications. This was dominated by the initial laying of undersea telephone cables and the establishment of international satellite communication facilities and institutions (e.g., INTELSAT). The thrust was towards intercontinental connections and national access to the global satellite network. Dramatic decreases in international satellite communica-

tion costs and a corresponding increase in demand reflected and characterized this global expansion period.

We are presently in a phase in which regional needs and policies will predominate. Nations will become more interested in specific connectivity of external communication routes in support of national and regional political and economic goals and information policies as contrasted with the more general nature of global facilities expansion. The thrust will be on intraregional communications along with focused development or enhancement of specific interregional communication routes.

Corresponding to this shift in needs and opportunities will be a change in institutional influence. Regional bodies such as the European Conference of Postal and Telecommunications Administration (CEPT), the Arab satellite consortium (ARABSAT), and entities that support regional policies of political and economic integration (such as the Association of Southeast Asian Nations (ASEAN) will grow in influence relative to such bodies as the International Telecommunication Union (ITU), which will be compelled to accommodate these pressures and make strategic changes.

A More Active and Stronger Government Presence

Without doubt, governments around the world will become increasingly involved in the development, management, and control of communications technologies, products, and applications. They will seek to utilize and manipulate telecommunications, including frequency matters, in furtherance of national and international goals.

In most of the world, telecommunication services are provided by a state-sanctioned monopoly, that whether state owned or not, is likely to be a government or quasi-government institution. This is not the case in the United States and it is a factor that assumes added importance as computer and communications services continue to converge, eroding the boundaries between the private and public sector in communication and information goods and services.

U.S. Government Communications Policy and Structures

How is the United States likely to fare in this new environment? While it can be argued that the present structure of the U.S. Government and its policymaking processes in the telecommunication areas have protected and sustained our vital national interests to date, the question is whether it will be adequate for tomorrow. Since spectrum is the common denominator in all uses of radio, coordination is essential for the various services to function in a compatible manner. It is this coordination, which has over the years become a very specialized and sophisticated art, that frequently bears directly on policy decisions. Much of the ITU-sponsored negotiations relate to spectrum use. Because of this, spectrum management in the United States has been scrutinized many times, sometimes criticized, and sometimes praised, down through the years.

Starting at least 30 years ago there has been concern over the effectiveness of the government structure to cope with the international aspects of telecommunications—particularly the negotiation of agreements within ITU and other United Nations (U. N.) organizations. Most of the international negotiations have been motivated by technical considerations, primarily radio spectrum issues, without the advantage of a clearly stated overall national telecommunication policy.

The United States has done well in most of these negotiations but with each international conference the maneuvering room has decreased and thus the preparation and actual negotiating have become more difficult.

As we go into the decade of the 1980's, the international aspects of telecommunications are becoming more preeminent than ever. No longer can fundamental telecommunication policy issues be avoided by relying on technical agreements, motivated by technical considerations, and negotiated on the presumption that only technical issues need resolution. Unfortunately, the present Federal Government structure, while responding to the technical aspects of international communications negotiations, has not developed a mechanism or procedure for developing comprehensive policy.

There are three fundamental weaknesses in the present structure:

1. The lack of appreciation at the top decision levels of the Federal Government and industry as to the vital role of telecommunications in the international and domestic political, economic, and private affairs of the United States, and the need for policy coordination.
2. There is a lack of centralized policy coordination and guidance for international telecommunication negotiations at a high enough level in the Federal Government to be effective.
3 The State Department's Office of International Communications Policy is neither staffed nor institutionally organized to carry out effectively all of the functions involved in international telecommunications negotiations.

These structural weaknesses are a direct reflection of the lack of clear U.S. policy for telecommunication matters including spectrum management issues. Moreover, the U.S. permanent spectrum management mechanisms are not adequate to review all stated requirements of Government and nongovernment spectrum users objectively or to verify and adjust needs consistent with national policy objectives. The United States also lacks an effective means of collecting data and developing guidelines to judge the merits of one spectrum use over any other.

U.S. Structure and Processes for Spectrum Management

The planning and management of the spectrum in the United States is handled by-the Federal Communications Commission (FCC) (as manager for nongovernment users) and by the National Telecommunications and Information Administration (NTIA) (as manager for Federal Government agencies requiring spectrum for their radio-communication systems). Each executive branch agency develops its requirements for spectrum and orbit use and-these are discussed and coordinated through the mechanisms of the Interdepartment Radio Advisory Committee (IRAC) and its several subcommittees. The nongovernment requirements of commercial public and private users are developed through the FCC notice of inquiry (NOI) process often with the aid of advisory

committees. NTIA and FCC coordinate to resolve differences and together with the State Department develop a single set of U.S. proposals for ITU administrative radio conferences such as WARC-79.

NTIA and FCC must agree on the bands that are proposed for individual services and this requires agreement on the eventual domestic allocation of each band: whether for Government use, nongovernment use, or shared use. The State Department serves as ombudsman in resolving disagreements, if any, over U.S. proposals to international radio conferences and the President acts as final artiber if the State Department cannot resolve the problem. Depending on the portion of the spectrum involved, shared use ranges from about 20 percent for the region between 100 and 1000 MHz to 100 percent for the band 10 to 100 kHz. The working level forum for the generation of Government proposals and coordination between them and the nongovernment proposals is usually a special ad hoc committee of IRAC. Such ad hoc committees include participation by FCC liaison representatives who present the nongovernment view.

Consensus between NTIA and FCC on the division of spectrum between Government and nongovernment users does not necessarily ensure the most efficient use of spectrum. Moreover, IRAC is an advisory committee to NTIA and it can recommend but cannot compel spectrum-efficient design or technology on large, powerful agencies like the Department of Defense (DOD). The power and resources of NTIA to successfully challenge spectrum decisions of such agencies are limited.

Possible Procedural and Structural Improvements

Procedural Improvements

Improvements needed in the present procedures for managing and planning Government and nongovernment use of the spectrum include better means to provide adequately for:

- validation of requirements, giving particular attention to current spectrum usage, technology and development trends, and sharing opportunities between competing users of the spectrum;
- inclusion of spectrum and orbit efficient techniques and technology in system design of both Government and nongovernment systems;
- apportionment of frequency spectrum between Government and nongovernment services based on national priorities;
- effective planning for future spectrum and orbit needs;
- efficient and timely preparation for and participation in ITU conferences; and
- effective management of existing services and users on a continuing basis.

Some of these shortcomings could be corrected without any fundamental change in the structure of FCC or NTIA. Assigning spectrum management a higher priority and using resources more efficiently would help improve the present situation. For example, FCC should be able to improve its data base for spectrum management with the help of its own computer and spectrum experts. The establishment of deadlines for inclusion of licensing information in FCC master files can be accomplished by FCC action. A more fundamental procedural change would be to place all incoming applications for licenses, construction permits, authorizations, etc., in FCC computer on receipt. In other words, FCC could institute an information and data processing system approach to aid its spectrum management activities.

The validation of spectrum requirements, and the apportioning of spectrum between Government and nongovernment users, should receive closer scrutiny. A mechanism using analytical tools to evaluate needs and assess priorities among competing users of the spectrum would provide decisionmakers with basic information and data for use in establishing policies and reviewing requirements. Federal spectrum requirements are reviewed by IRAC and its Spectrum Planning Subcommittee, but this function needs to be strengthened and broadened to effectively consider longer range impacts. FCC needs to be better equipped to assess future spectrum requirements of the private sector, including the use of new technology.

Economic techniques (e.g., auctions, lotteries, spectrum fees, resale of frequency spectrum assignments, etc.) should be considered, at least on an experimental basis, to provide guidance on the consequences of different spectrum allocation decisions and the introduction of newer technology. These should include techniques for evaluating the relative economic viability of alternative spectrum uses, as well as radio v. nonradio communication systems. The use of economic techniques in spectrum management might require legislative action. FCC, perhaps with the aid of a task force, other Government agencies that have studied the question, industry groups, and private experts, could select a few services for detailed analysis of the prospects of using one or more economic techniques. FCC could then present its recommendations for the experimental application of a selected technique, or techniques, to one or a limited number of services and frequency bands to Congress for its information and action, if necessary.

Problems relating to forming a U.S. delegation for WARC-79 could be addressed and the effectiveness of U.S. participation in international meetings could be improved by several steps: 1) industry and other nongovernment delegates could again be permitted to participate fully as U.S. representatives at international telecommunication conferences and take any assignments on the delegation for which their skills and experience qualify them. Legislation to accomplish this passed both Houses of the 96th Congress. However, the legislation to which it was added was vetoed by the President for reasons unrelated to the exemption. The measure was again passed by the Senate and reported by the responsible House committee, but the House of Representatives did not consider it before adjournment; 2) consideration could be given to finding means to comply with due process requirements under the Administrative Procedures Act and still name industry and other nongovernment representatives to delegations on a timely basis; and 3) establish guidelines with an implementing mechanism to name the chairman and individual delegates to the U.S. delegation. Qualifications required, distribution of various skills needed, and type of representation desired would be selected from the best candidates available, especially those who participated in the preparatory effort. If special Government support is necessary to assure certain representation, then that support should be available early in the preparatory stages.

Structural Improvements

Chapter 3 discussed the present structure within the Federal Government to perform spectrum management and participate in international telecommunication conferences. Consistent with the findings of past commissions and task forces going back to 1950, this study also finds that structural improvements are necessary. Primarily, the problems stem from the absence of high-level Government attention to effective policy coordination. Accountability for spectrum management issues and international negotiations is difficult to assign under the present structure.

Congress could consider ways to improve the present structure or examine possible changes in the structure. A detailed analysis of alternatives is beyond the scope of this study that concentrates on the results of

WARC-79. However, at least four options are available to Congress:

1. maintain the status quo and make no changes;
2. maintain the present structure, but raise the level of attention and accountability within the responsible agencies;
3. establish a mechanism—such as a task force of high-level Government officials—to develop, examine, and make recommendations on structural and procedural improvements; or
4. establish a permanent board, council, or interagency committee of high-level Government officials to be responsible and accountable for international telecommunication policy coordination and the preparations for international conferences.

Option 1: Status Quo.

The relatively low priority given to spectrum management issues within the Government will likely continue under the status quo as discussed in this report. This reflects the relative lack of appreciation and attention at a high level of Government to telecommunications generally. Even with the unprecedented number of upcoming conferences of ITU and the direct importance of these conference decisions to the United States, the State Department, particularly, will find it difficult to raise the priority of radio spectrum issues vis-a-vis other nontelecommunication foreign policy issues. Moreover, FCC is unlikely to assign a higher priority to spectrum management in light of other pressing regulatory policy issues.

Option 2: Raise the Level of Attention Within the Present Structure.

Congress could take steps through its oversight activities to focus attention on ways to improve coordination and develop coherent policies and strategies for international telecommunication matters generally and spectrum issues in particular. Congress could require special reports from responsible agencies on steps taken to improve the status quo spectrum management throughout the Government. Several possible procedural measures were discussed earlier. In addition to those, it may be beneficial to establish a more formal and continuing conference preparatory mechanism within the existing structure of divided responsibilities among several Government agencies. This would replace the more "ad hoc" approach followed in the past. If such a mechanism was not justified when ITU conferences were held at infrequent intervals, it appears necessary now when over a dozen conferences are scheduled over the next 7 or 8 years. Complex issues of vital concern to the U.S. with direct consequences for both international and domestic telecommunications are on the agendas of these meetings. Developing and recommending skilled delegates for U.S. delegations could be made a part of this process. Formal training in negotiating, language, and diplomatic skills could also be included.

Option 3: Create a Task Force To Examine and Make Recommendations on Structural Changes.

Congress could mandate that an interagency task force of high-level officials from responsible Government agencies be established. This task force would examine alternative structural changes, assess the pros and cons of each, and report to the President with recommendations. The President, in turn, could make a report to Congress with specific proposals where legislation is required. Because of the divided responsibilities and direct influences of several Government agencies, the task force might include representatives from the following agencies: Department of Commerce—including NTIA, Department of State, FCC, DOD, Department of Justice, Office of Management and Budget, and possible representation from the Office of the U.S. Trade Representative.

Option 4: Establish a Permanent Board or Other Mechanism.

Congress could consider the establishment of a permanent board, council, or inter-

agency committee to coordinate international telecommunication policy. Spectrum management issues and international negotiations would be key elements of the work of this body. Such a board could be charged with the continuing responsibility to: coordinate international telecommunication policy; plan and direct strategies to achieve policy objectives; assess the need for personnel and other resources within the Government to conduct an effective international program including ways to use resources more effectively; - and prepare for international conferences and meetings.

Depending on the specific mandate for such a board, the present structure for spectrum management within the Government would be altered to a greater or lesser extent. For example, the present structure could be left intact with the board providing the centralized point of coordination. However, the board could be made accountable for seeing that policies and actions are coordinated and that a coherent and effective program for U.S. international telecommunication matters is maintained. As a part of its functions, the board would assure that the necessary linkages are made among the various elements within Government agencies, between agencies, between Government and industry, and among the international forums concerned with telecommunication matters.

Bills have been introduced in the Senate and House recently to establish a mechanism aimed at improving the U.S. posture for international telecommunication matters. Also, in recent years, other legislation has been introduced that would alter the present Government structure for telecommunication matters. These and other approaches could be considered under options 2 and 3 above.

U.S. Strategies for Dealing With International Spectrum Issues and ITU

The United States may have reached a crossroads in its relationship with ITU. Having started in 1865 as a relatively noncontroversial organization of 20 nations concerned mainly with the interconnection of their telegraph systems, ITU has evolved into a contentious assembly of 155 nations that look to the Union to solve fundamental issues of allocation and regulation of radio spectrum resources.

The ITU structure, which was well suited to the analysis of interference between radio communications systems, and to achieving a consensus on noncontroversial matters among a small number of broader issues, is sorely tested by the demands of numerous countries exhibiting the widest possible range of technical, economic, cultural, and political backgrounds. Many of these issues did not originate at ITU, but have ended up there, often argued by delegates unschooled in the technical language that has been the sine qua non of ITU. Thus, the mechanism that brought together highly trained engineers to consider abstruse issues of interference between sophisticated communications systems is becoming a focal point for broader policy issues with political posturings by delegates to further national and political objectives. ITU structure, procedures, and mechanisms have not changed, but the problems have changed enormously. The ITU must now develop greater flexibility if it is to function effectively in a new and dynamic environment.

The radio spectrum is essential to the communications infrastructure of the United States, and it is not an easy matter for the United States to concede its vital national interests to satisfy the demands of many nations that repeatedly assert their “equal right” to the radio spectrum even though

they have no immediate need or capability to use additional allotments for the foreseeable future. U.S. officials must ask themselves whether this nation can continue to accept these same structures, procedures, and mechanisms in an important, essentially allocative forum as are routinely tolerated in other situations that are more abstract or political in nature, and less concerned with vital U.S. interests. Will U.S. negotiating skills and technological proficiency enable us to achieve our essential goals and objectives in a forum that employs *a* "one-nation, one-vote" decisionmaking formula and in which the United States and the other developed countries are greatly outnumbered by the less developed member countries?

The answer is not readily apparent. What is apparent is that our technically oriented approach that has served so well in negotiating the technical issues of the past two or three decades, is simply not sufficient for the broader issues of today. The United States must make some policy decisions, reflecting changes in U.S. strategy or in the structure or procedures of ITU, and then augment the scope and training of the responsible U.S. personnel consistent with those decisions.

The United States has essentially two alternatives: it can seek various improvements in the present means for solving spectrum allocation problems within ITU as it is now constituted, or it can seek to alter the existing structure, procedures, or mechanisms of ITU itself. The policy options considered here may be divided into two broad categories, strategic and structural.

From the strategic standpoint, assuming no significant changes in ITU, the United States has a wide range of options. At one extreme, the United States may conclude that the drawbacks of continued participation in ITU outweigh the benefits, and withdraw from the organization or decline to participate in its deliberations. At the other extreme, the United States could decide to yield to other nations on controversial matters and play a passive role within ITU. Between these extremes there are a number of alternatives. One that requires no structural or procedural changes in ITU would be a serious attempt at better coordination of our views and objectives with other nations in advance of ITU meetings, and better U.S. planning based on improved understanding of other nations' views.

Another strategic option that might help to achieve U.S. objectives even if ITU remained essentially unchanged would be for the United States to seek to remove controversial issues from the ITU forum and attempt to solve them in other ways. A current example would be to respond to the demands of developing countries for "guaranteed access" to radio spectrum and satellite locations by developing the institutional arrangements to ensure domestic communication services to these nations. This could be a common-user system either building upon the present INTELSAT structure or creating a separate system for domestic services. Such a solution would offer each nation all of the satellite services or capability it could realistically use, without allocating to small nations significant amounts of satellite spectrum and orbit locations that might then remain unused for the foreseeable future.

From the structural standpoint, assuming that ITU can be changed, a number of options are available. One relatively extreme example would be to seek revision in the voting formula of ITU to one that was more advantageous to the United States, perhaps by giving added voting weight to those countries that contribute most heavily to the U.N. budget. A more modest option would be to increase the number of ITU regions beyond the present three so that regional issues could be dealt with by a smaller number of countries most directly concerned.

Policy Option No. 1: Withdrawal From ITU

Would withdrawing from ITU guarantee the United States unhindered use of the spectrum allocation or frequency assignments we need? Probably not. Member nations of ITU rely on the organization to avoid interference from the radio signals of others and to achieve interoperability of certain mutually used systems. Avoidance of interference is the essence of spectrum allocation or frequency assignment processes. The assignment of a particular frequency is of little value if others feel free to use it for purposes that cause interference. There are no effective sanctions to force compliance with ITU decisions. Therefore, the United States, as do all nations, relies on the voluntary agreement and cooperation of other nations to refrain from interfering with its use of the spectrum.

Abrupt withdrawal from an ITU in which the United States was unable to have its own way could well intensify the risk of interference. For applications that are vulnerable to interference, it seems clear that preemption of spectrum would be ineffective. Any nation that chose to interfere, whether due to a valid need for the particular frequency band or by intentional jamming, could greatly reduce the value to the United States of the preempted spectrum.

There are some important spectrum uses that are relatively invulnerable to interference (e.g., high-power radar systems with electronic countermeasures capability), but any preemption of spectrum by the United States would likely result in retaliation by other nations in areas where it was vulnerable. There might also be spill-over into nonspectrum relationships with other nations, such as transborder data flow or telecommunication equipment trade matters. Extreme forms of retaliation, such as refusal to interconnect telephone or telex systems with the United States, would be unlikely since these services are probably as much in the interest of many other nations as in our own.

What would happen to the generally friendly process of coordination to avoid harmful interference? The bulk of our coordination takes place with the developed countries that are fewer in number and with whom the United States has fewer fundamental differences than with the Third World nations that have recently begun challenging and, in some cases, outvoting the United States. It is conceivable that the United States could abandon ITU and establish a more congenial grouping of developed countries as a forum for coordination to avoid interference, and simply ignore other countries. Coordination and information exchange would become less certain by the omission of the majority of nations, even if their spectrum use is relatively limited, but would still be fairly effective. We could also continue to coordinate with many of them informally, since that would also continue to be in their interest. Eventually they might even seek to join the coordinating forum of the developed countries, although the terms of reference and voting basis might be much different from ITU.

It seems likely that ITU–or that part that deals with radio matters, as opposed to telephone and telegraph-would disintegrate if the principal developed countries abandoned it. A major mechanism for technical assistance to developing countries would disintegrate with it, leading perhaps to negotiations for a new mechanism. Probably these negotiations would be conducted on a basis that would more nearly reflect the relative technical and economic strengths of the various nations involved, rather than the ITU's "one-nation, one-vote" formula.

In the resulting "free-for-all" atmosphere, large nations and organizations would probably get whatever spectrum they needed, subject only to coordination among themselves. In the short run, smaller nations could take whatever spectrum they wanted.

But in the long term, if the larger nations developed technology and systems for their own purposes, rather than for common usage, the smaller nations could find spectrum unavailable, or perhaps limited to those frequencies that are complicated and expensive to use.

Overall, the lack of a central spectrum allocation and coordination authority would probably lead to a more fragmented use of the spectrum, with fewer common worldwide channels, less standardization, and possible difficulties with interoperability of certain common systems, and a general increase in interference problems between services. In short, the result of spectrum preemption and withdrawal from ITU would lead to a relatively less organized mechanism for spectrum management having significant disadvantages for both developed and developing countries. Whether these disadvantages would at some time be outweighed by the benefits of increased access to frequency bands vitally needed by the United States would depend on the specifics of those needs and the degree of conflict present in ITU at that time.

The results of the OTA-sponsored survey show that a clear majority of the survey respondents would strongly oppose, or even consider U.S. withdrawal from ITU. Nearly two-thirds of the respondents strongly disagree with the suggestion that the United States view withdrawal from ITU as an option even under hypothetical "worst case" conditions. And 18 percent of the respondents agreed or agreed strongly with the suggestion that the United States consider withdrawal from ITU.

Policy Option No. 2: Revised ITU Voting Formula

As an option less drastic than withdrawal from ITU, the United States might join with other developed nations to force a revision of the ITU's "one-nation, one-vote" decision-making formula toward one that would reflect the dominance of the developed nations in the actual use of the spectrum. If successful, this option would greatly reduce the ability of the Third World nations to block or force changes in U.S. positions.

One possible formula for revised voting is a combined weighting factor based on land area and population. Another possibility is the proportion of present use of telecommunications, or investment in telecommunications, which would clearly favor the developed countries in the short run. A third formula might be based on the relative proportion of overall contributions to the United Nations and its various specialized agencies.

There are numerous precedents for unequal voting arrangements in international organizations. In the INTELSAT board of governors, voting is in proportion to investment in the system (which is in turn proportional to utilization of the system), and voting in the World Bank is in proportion to contributions. There are, of course, a number of agencies and conferences which adhere to the "one-nation, one-vote" principle. Examples are the United Nations Educational Scientific and Cultural Organization, the International Labor Organization, and the Law of the Sea Conference. None of these is an operational organization, and none is especially well known for reaching accommodations efficiently and expeditiously.

A revised voting formula might reduce the contention over spectrum allocation matters at ITU; make ITU more efficient; help to make the use of the spectrum more efficient by precluding the adoption of unworkable allocation schemes; and be no less fair than the voting practices used in a number of other international bodies that benefit Third World nations without being controlled by them. The stimulus for concurrence of Third World nations with such a proposal would be the possibility that, were it rejected, the developed countries might withdraw from ITU and render it essentially irrelevant.

The reaction of Third World nations is difficult to predict but it seems most likely that they would bitterly resist any reversal of

their recent successful trend toward assertiveness and refuse to make any concession on ITU voting formulae. From a general foreign policy standpoint, it is important to consider how much support the United States might obtain from other developed countries, many of which do not feel the spectrum problems as acutely as the United States. The United States must also consider whether it wishes to take an assertive policy toward ITU apart from a generally more assertive stance toward Third World nations. Should spectrum and communications policy be the "leading edge" of a new U.S. posture of asserting our interests vigorously? This issue needs to be faced early, in the broadest possible forum, since the answer will be one of the key factors in the selection of any policy option.

It can also be asked whether the proposed change in voting arrangements should apply to all ITU spectrum decisions, or just to those allocations that might qualify as major matters. The latter case is equivalent to establishing a new, separate forum with revised voting arrangements and routing the major matters to that forum rather than to ITU.

Objectively, it would seem that the interests of the developing countries lie with the continued existence of ITU and with continued technical and economic aid from the developed countries. If this choice were clearly and convincingly drawn, the Third World nations would probably come to realize that these benefits outweigh such hypothetical advantages as satellite orbital slots that they may never use. Whether they would ultimately decide the matter on objective grounds is difficult to predict. In any event, it seems unlikely that a change in the voting formula within ITU will occur given the present structure of ITU.

Policy Option No. 3: Increased Regionalization of ITU

At present, ITU divides the world into three geographic regions and many issues that can be treated separately and effectively in a single region are considered in this way. Regional administrative radio conferences are scheduled on a variety of specific issues, allowing the World Administrative Radio Conferences to "spinoff" certain controversial matters. One option would be to extend this process of regionalization on a geographic basis to smaller subregions, and/or on an issue basis to include only those nations directly affected by the particular issue. The purpose would be to reduce the number of nations debating or voting on issues that do not affect them directly, thus reducing unnecessary contention.

WARC-79 was attended by 142 nations. Approximately 1,670 delegates and advisors met for 11 weeks (one week more than scheduled), considered nearly 17,000 individual proposals (more than 900 from the United States), and held more than 900 meetings. Surely any approach that might help limit further WARCs to more modest proportions would be worthy of study. More importantly, when nations vote on issues that do not directly affect them, opportunities for trading votes arise at no cost to themselves, but which help others to sustain confrontations. Large meetings also tend to encourage bloc voting, which has already begun to emerge at ITU. Thus, subdividing the ITU into smaller units, either on the basis of geographic subregions or on the basis of particular issues, would divide the Third World bloc into smaller, less dominant groups.

There are numerous precedents for this. In addition to the three ITU spectrum regions, there are five International Telegraph and Telephone Consultative Committee regions, three ocean basin groups within INTELSAT, and a North American Regional Broadcasting Agreement, which coordinates broadcasting in the United States, Canada, and Mexico.

While a potentially useful approach, and one ITU has tried to some extent (e.g., the forthcoming WARCs on Mobile Services, high frequency planning, and the geostationary satellite orbit), decentralization is

not applicable to all problems. Some services cannot be considered separately from others with which they interfere. Frequency bands in which signals propagate for many thousands of miles cannot be considered on a regional basis, and some issues (e.g., interoperability of aircraft communications systems) are fundamentally global in character. The key is to define a spectrum problem in a way which leaves significant numbers of nations unaffected. For example, the ultra-high frequency TV and microwave fixed (radio relay) service, which use signals of limited propagation range, might be treated on a subregional basis.

Decentralized decisionmaking does not, of course, guarantee that the U.S. position will prevail. Being outvoted by 10 to 1 is no more satisfying than being outvoted by 153 to 1. However, it is easier to bargain in detail with 10 nations than 153; and if a quid pro quo must be offered, the total cost is likely to be lower.

The mechanics and economics of increasing substantially the number of conferences is also important to consider. The limited U.S. professional staff available to prepare for and attend spectrum conferences is already stretched thin, and if the United States does not wish simply to skip many of the meetings (a very risky proposition) this staff would need to be augmented. The developing countries would find it even more difficult to prepare for a heavy schedule of meetings.

Developing countries tend to have very few professionals available to consider spectrum matters; a few key people might decide spectrum policy for an entire country. Also, in some cases even the key individuals lack sufficient expertise to comprehend the needs and technical requirements of their own country, let alone understand and appreciate the complex spectrum problems of the United States. Assuming that this effect overbalances any possible advantage to the United States from keeping them in ignorance, it may be in our interest to assist these nations in their planning and conference preparation.

One way to assist the Third World nations would be on a regional basis. This could take the form of providing special regional rapporteurs; of educating and assisting key countries, which would in turn assist others or act on their behalf; or of establishing and supporting a joint planning capability for a group of nations in a region. Apart from the regional approach, we could assist certain country blocs in their planning and preparation.

Increased decentralization of ITU could, in principle, lead to greater fragmentation in the use of the spectrum, with the same band being used for different purposes in different regions to a much greater extent than is now the case. Advanced technologies may increase the opportunity for regions and subregions to operate reasonably independent of one another. While this may be acceptable in the short run, the long-term implications are worthy of study. If, for example, a new service were proposed that would be global in character, obtaining the necessary global spectrum allocation might require changes in the allocations to many different services in many different locales. At the least, it might be necessary to create an institutionalized system for coordinating decentralized decisions.

Policy Option No. 4: Better **Coordination and Planning**

As a relatively conciliatory approach, the United States could mount a major effort to develop long-term plans for spectrum use that would take into account the spectrum requirements of developing nations, to aid them in understanding the realistic options available to meet their short- and long-term needs, to offer them such technical and economic assistance as might be needed to enable them to participate actively in the planning process, and to seek their concurrence with fair, objective, and realistic proposals.

The acceptance at WARC-79 of U.S. proposals for new spectrum allocations devoted to remote-sensing activities offers support for the view that advance coordination and a concerted effort to explain and justify requirements can have a significant impact on countries that might otherwise be skeptical or indifferent. The delegation of Senegal came to WARC-79 with specific instructions to support U.S. remote-sensing proposals, thanks to a special effort by the National Aeronautics and Space Administration (NASA), backed by the State Department, to enlist the help of U.S. embassies overseas in lobbying appropriate authorities in their host countries. A NASA slide presentation, with tape-recorded commentary in English, French, and Spanish drew appreciative audiences from delegations at the conference itself. Of the some 50 remote-sensing proposals made by NASA for both passive- and active-sensing programs, all were accepted by the conference to a greater or lesser degree and, contrary to expectations, there was no opposition to U.S. proposals that could be traced to political motivations.

To a significant extent, the confrontations initiated by Third World nations in ITU are based on suspicion and mistrust of developed countries, perhaps based on a lack of understanding of the true potential of technology to create the spectrum resources they will need in the future. But many Third World nations also question whether they will be able to take advantage of that technology and they question the good faith of the developed countries to share the benefits of advanced technology.

The fact remains that there is adequate spectrum for all nations at the present and that technology will very likely expand the effective utility of the available spectrum to satisfy future needs of all nations. The problem for the United States is to convince other nations, particularly the developing countries that spectrum and orbit capacity will be available and that their needs for service can be satisfied. Technical assistance can be very useful in this regard, and economic assistance can help make the benefits of technology a reality. Creating a role for the developing countries in cooperative planning efforts is likely to make them more receptive to the positions and plans that are forthcoming, even though they benefit both the developed nations and themselves.

Long-range planning of spectrum utilization is presently inadequate and not easily accomplished in an area where technological rate-of-change is rapid and in an open competitive system like that in the United States where policy makers are more likely to be responding to problems than to be developing long-range plans. However, better long-range planning for telecommunication service and spectrum needs is clearly necessary in order to cope effectively with the ITU allocation process. Developing and sharing planning techniques and data with other countries would not make a new planning process vastly more difficult or costly, and might make it more reliable in the long run.

It is also necessary to know the extent to which developing countries' positions at ITU are based on their own vital interests rather than on misunderstandings and politics; it is unlikely that they would compromise vital interests for the sake of comity. A cooperative planning process would tend to expose true interests and clarify the negotiations.

As a practical matter, the majority of the developing countries cannot now make use of advanced communications technology without technical and economic assistance from technologically advanced countries. If the majority of nations were to vote to adopt rules that limit or preclude the use of advanced technology to which they do *not* have independent access, communications capability suffer and costs increase in the long term for all users. Thus, the cost of assisting other countries in using advanced technology must be balanced against the cost to the United States of *not* being able to take full advantage of such technology ourselves. This equation deserves close analysis.

It can also be argued that giving technical and economic assistance to the Third World nations will simply provide them with the sophistication they need to challenge our own positions more effectively in the future. While not invalid on its face, this argument ignores our ability to live in relative harmony with dozens of highly developed nations, and to avoid excessive contention in spectrum allocation matters with some of these nations that are sworn enemies. We have more to lose from ignorance than from true disagreement.

It is useful to recall what can happen in the absence of cooperative planning. As preparation for the 1977 Broadcast Satellite WARC, the United States developed comprehensive data and explanations to show that a technologically based "first-come, first-served", or evolutionary approach, would assure adequate access to the geostationary satellite orbit for all nations. However, other nations were intent on adopting a rigid a priori plan and simply were not interested in the U.S. arguments. Most of the U.S. preparatory work was of little value and the U.S. delegation was thus forced to develop alternative positions on an ad hoc basis, during the conference.

This experience serves as a reminder that it is no longer feasible to go to an ITU conference with a well-documented technical solution to a problem and expect other nations to embrace the U.S. position. A certain degree of advance coordination is necessary, as a minimum, and probably was one of the reasons that the United States achieved certain objectives at WARC-79. The prior coordination undertaken by NASA on U.S. remote-sensing proposals is a case in point.

Cooperative planning has worked in the past; the United States was a leader in cooperative planning for INTELSAT and INMARSAT. The exact mechanism for cooperative planning is an important and complex matter, compounded by divided responsibility in the United States for communications policy in general and spectrum planning in particular. It should be possible, however, to graft onto the existing structure a sufficiently comprehensive mechanism with high-level Government responsibility to assure effective long-range planning and to foster cooperation with other nations.

As an alternative, ITU could be invested with a planning staff to undertake long-range coordination, analysis, and planning. Such a neutral planning expertise might be less likely to be mistrusted by Third World nations, and perhaps more capable of defusing potential disagreements. Naturally, the United States would participate in the process and perhaps could more easily influence a planning process, in which the measure of power is technical expertise, rather than an ITU conference, in which the measure of power is votes. The United States has consistently opposed any increase in the power of the ITU, particularly efforts to expand the planning role of the International Frequency Registration Board (IFRB).

A broader, more extensive, and more conciliatory approach to international spectrum planning would be required under this option and could have a real chance of working, given some major changes in the U.S. approach. In the long run it could be the least expensive and most effective option available to this country.

Policy Option No. 5: Common-User System

As an alternative to contention for geostationary satellite orbit slots, the United States and other developed countries could enter into a joint venture with developing countries to construct, launch, and operate a common satellite system to meet domestic needs for telecommunication and/or broadcast services. The developed nations would provide the private capital and technological resources necessary to construct and launch the system, and would operate and manage it in conjunction with other using nations. All nations in the joint venture would have the option of purchasing a share of the com-

84-591 0 - 82 - 9

mon enterprise, up to their actual percentage of use of the system, and sharing proportionately in any profits. Such an arrangement would be similar to that governing the INTELSAT global satellite system used for international telecommunication. High-capacity satellite systems employing technology to make a common-user system economic and operationally attractive to developing countries for domestic services is needed to make a common-user system for domestic services viable. Such a system could be part of the existing INTELSAT structure or a separate structure established for this purpose.

Many developing nations are concerned that the satellite orbit locations are being occupied rapidly on a "first-come, first-served" basis, and that by the time they are in a position to use satellite systems there will be no desirable orbit locations left for them. It seems clear that the requirements of developing countries will be for satellite service and not for satellite orbit locations that they may not be able to use. This option would provide service without allocating dedicated orbit locations for individual users.

Moreover, the cost of developing and launching a dedicated satellite system is very high, well beyond the capability of most developing countries for the foreseeable future. This option could provide satellite service well in advance of the time these countries could afford their own systems, and much more cheaply. No large initial capital investment would be required from user nations, and there would be little risk. The technical expertise required to use such a system is far less than is needed to construct one.

This is not a new concept. The precedent for such an initiative is the global INTELSAT satellite system. Today 106 countries, the great majority of them developing, share in the management and operation of the satellites that have been optimized for international usage.

A further indication of INTELSAT's success, and of the developing countries' stake in the INTELSAT organization has been that organization's evolution towards playing a larger role in provision of domestic satellite services. In 1974, Algeria proposed to lease spare INTELSAT capacity for enhancement of its domestic telecommunication network. Since then a total of 20 countries have leased capacity from INTELSAT for domestic services and an additional 15 countries have expressed interest in leasing capacity in the next 2 years. By mid-decade, the total number of clients could easily grow to 50 countries.

INTELSAT has responded to this demand by committing itself to include planned domestic capacity, as opposed to relying solely on preemptible, spare capacity, in future generations of satellites and has also sought to develop higher powered satellites to be compatible with the small ground stations that have proven to be the most economical for domestic services.

While this policy option does not address the full range of problems before ITU, it does offer the prospect of relieving the pressure on a particularly important and contentious issue. If low cost and technically attractive domestic satellite capacity is made available through an international organization that accommodates the sovereignty interests of each country, many developing countries could come to see access to orbital slots and satellite frequencies as a side issue with availability of service being the main objective. Adoption of the common-user system alternative would free-up orbital slots for those major developing countries that continued to desire their own separate domestic systems whether for political reasons, or because requirements justified such a system economically.

A common-user system need not require any Government funding by the United States. Sufficient capital and technical resources exist in the private sector in the

United States, and within Europe and Japan to construct such *a* system as a commercial venture with expectations of future markets for follow-on equipment and services. Alternatively, such systems could conceivably be initiated with World Bank loan guarantees.

In summary, to the extent that developing countries can be persuaded to evaluate their needs for domestic satellite service apart from political considerations, they may come to believe that a common-user system can serve many of these needs at an early date and more cheaply than can dedicated systems, which could be many years away. Whether operated by INTELSAT or by a separate organization, whether financed with public or private funds, such a common-user system could relieve the pressures now creating the international tensions over use of the geostationary satellite orbit. And while not a precedent in any specific way for dealing with the broader range of ITU spectrum problems, a successful common-user system might at least show that difficult problems can in some cases be removed from ITU for separate treatment.

Policy Option No. 6: "A Priori" Allotment

The United States could agree to participate with other nations in the development of a long-range plan for the utilization of satellite orbit locations to serve participating nations' domestic communications requirements. This plan would assure that orbital slots would be available for the use of all nations when needed. In exchange for this agreement, the developed nations would likely insist that the plan be based upon sound operating principles and updated regularly to take account of the latest, most efficient technology available. Technical planning assistance would be provided.

A priori allotment of satellite orbit slots has been a cause celebre among developing countries and at WARC-79 a resolution was adopted to consider this issue at a two-part space WARC in the mid-1980's. The United States and others have opposed a priori allotment plans for satellite service as wasteful and inhibiting to technological advancement, Although this option goes a long way toward accommodating the position of the developing countries, need not be adverse to U.S. interests. It maintains a substantial degree of flexibility important to the United States including the key qualification of a requirement for regular technological updating that would help to avoid the worse consequences associated with rigid allotment schemes like the one adopted at WARC-77 for regions 2 and 3.

As far as the United States is concerned, certain types of a priori allotment plans would not be as objectionable as others. Plans based on sound engineering and operational parameters might be workable internationally, at least on a regional basis. Indeed, U.S. domestic satellite operations are based more or less on an a priori approach. In the long run, the United States may have enough satellite capacity made possible by advanced technology to meet domestic needs even if the orbit and spectrum available to U.S. satellites is reduced. In the short run, the United States already has substantial numbers of operational satellites with additional satellite systems planned for operations in the near future.

In addition to the possible advantages that may result from updates to presently unforeseen technology, there are two factors that may help reduce the impact of a priori allotments on the United States. One is advanced technology including cellular satellite technology, already on the drawing boards, which will permit the construction of large, wideband satellites that can provide very large capacity from a single orbit slot. The other factor is the particular geography of region 2 (North and South America). As far as the geostationary orbit is concerned, region 2 is naturally divided into two parts—those nations located in the Northern Hemisphere and those in the Southern Hemisphere. A second geographic factor that serves to separate the hemispheres is the dis-

placement in longitude of the nations in the two hemispheres (see figs. 4 and 5). Moreover, those nations situated close to the Equator enjoy the widest possible visibility of the geostationary satellite orbit from within their borders and have the greatest flexibility in positioning satellites in that orbit.

Limitations on the number of satellites that can be placed in the geostationary orbit is the fundamental factor that must be addressed to arrive at a solution to equitable access for all nations in region 2. The capability of the geostationary satellite orbit is primarily limited by the need to separate satellites operating in the same frequency band. When serving the same or adjacent coverage areas are not in close proximity, the required separation between satellites serving these areas may be significantly reduced. For example, current U.S. requirements for separation between satellites in the fixed-satellite service serving a common coverage area is 4 to 5 degrees. However, a satellite serving the United States and another one serving a South American country, if properly designed, could be essentially colocated without harmful interference.

Figure 4.— Displacement in Longitude for Countries in the Northern and Southern Hemispheres



SOURCE Off Ice of Technology Assessment

A plan could be devised to take advantage of the geographic and technological factors discussed above, which would serve to isolate the capacity of the geostationary satellite orbit into subregional areas. Specifically, it is technically feasible and could be operationally practical for the geostationary orbit to be used by nations of North America essentially independent of the use of the orbit to be used by nations of South America. Moreover, the North American Continent consists of three countries with very large land areas that make the use of advanced technology using shaped-beam antennas attractive. Except for some possible coordination problems near the border areas, it may be possible to reuse the entire orbital arc separately for each of the three countries.

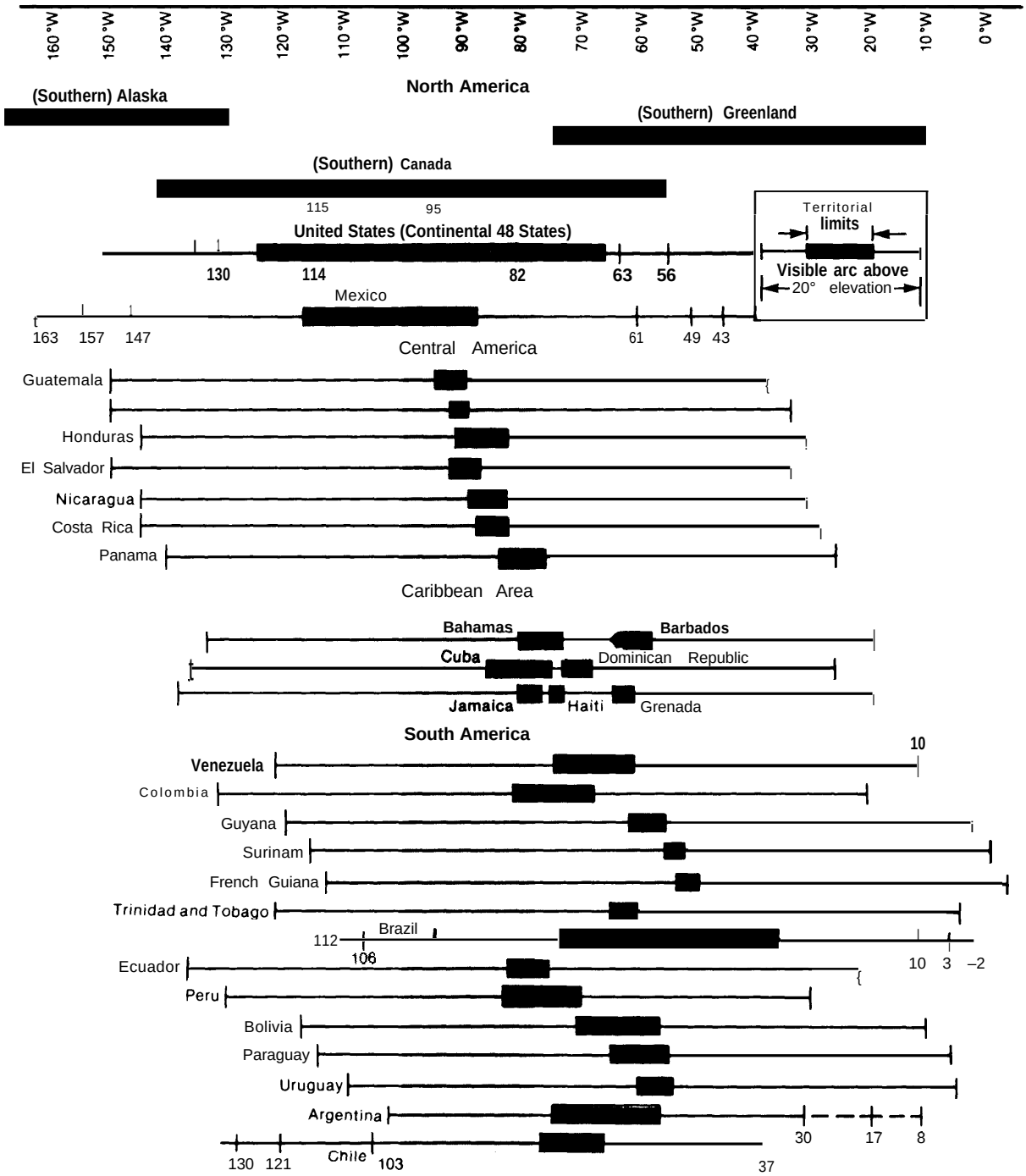
The implications of this approach and its linkage to the policy options discussed above are as follows:

1. This solution will require both coordination and planning by the member nations of region 2 (Policy Option No. 4).
2. This solution would essentially lead to a subdivision of region 2 into two parts (Policy Option No. 3).
3. The practical use of a common-user system would be enhanced by this approach (Policy Option No. 5).

Although an a priori plan is implied in the approach, it could be implemented without the adverse limitations of a rigid a priori plan such as adopted at WARC-77. If this approach is possible, then an a priori allotment to one country would not preclude using the same allotment for others if certain technical and operational guidelines were followed.

There may even be some benefits to the United States from adopting an a priori allotment plan. At present, there is considerable uncertainty about the outcome of the 1983 Region 2 Broadcasting Satellite Administrative Radio Conference and the Space Planning Conference in the mid-1980's. If a decision is postponed, the uncertainty would continue. A situation would then be perpetuated in which any existing

Figure 5.—Available Geostationary Arc



SOURCE J D. Barnia

domestic satellite orbit slot may potentially be withdrawn in the future. Moreover, no satellite system designer could plan the logical evolution of a proposed system with confidence that the required additional allotments would be available.

It is also important to examine the tactical aspects of agreeing to an a priori allotment policy. By participating in the development of a plan, the United States would be in a position to influence the type of plan adopted and possibly gain concessions on other issues of importance to the United States.

In short, the linkages and tradeoffs among these and other possible approaches to future use of the geostationary satellite orbit cast each U.S. policy option in a different light. Careful review in each case is needed for sound policy formulation. Rather than rejecting a priori allotments as inherently wasteful, it may be in the U.S. interest to examine the principle, to modify it to avoid its worst aspects, to examine the practical effects, to examine the possibility of a quid pro quo, and if the result looks acceptable, to work with the developing countries to implement the plan.

The results of the OTA-sponsored survey show that the majority (68 percent) of the respondents believe that a practical compromise is possible and desirable between the evolutionary approach and a rigid a priori plan for use of the geostationary orbit. Another 15 percent of the respondents think that a compromise is possible but undesirable from a U.S. standpoint. Only 8 percent of the respondents said that a practical compromise is impossible.

Chapter 6
Findings, Conclusions, and Observations

Contents

Page

Introduction 129

Principal Findings of the OTA Study 130

General Observations and Trends 130

U.S. Policymaking Structure and Processes for Spectrum Management and International Strategies. 131
- Need for High-Level Government Policy Coordination and Accountability 131
- Need for New Strategies to Address Spectrum and Related Satellite Orbit Issues 132
- Options 134

Strategies to Address International Issues and Deal With ITU. 136
- Strategic Approaches—Options. 136
- Structure of ITU—Options. 137

Consequences of WARC-79. 138
- General Observations. 138
- Major Decisions and Consequences 139

Options Regarding Ratification of the Final Acts of WARC-79. 141

Future Conferences and Issues 142
- 1982 Plenipotentiary. 142
- Space Planning Conference.. 142
- HF Broadcasting Conference. 143
- 1983 Broadcasting Satellite Conference for Region 2. 143
- Other Conferences 143

Chapter 6

Findings, Conclusions, and Observations

Introduction

The telecommunication systems of the United States are the most sophisticated, efficient, and all-encompassing in the world. These systems are a vital element of our economic strength and security; they are an essential part of our culture. Other nations, recognizing the key role that telecommunication plays in national and international affairs, are constantly striving to surpass the United States in technological inventiveness and in the practical exploitation of the many telecommunication subsystems that make up the modern "information society. "

As a leader in technology, the United States has been able to proceed with its domestic telecommunication programs more or less independent of international concerns. The United States has played a major role in shaping what has been essentially a benign and passive international mechanism responsive to the task of providing order to the key element in 20th century communications—the radiofrequency spectrum.

This international regime is coming under considerable stress as the result of sharply increased demand for new communication services and resulting congestion in key parts of the radio spectrum. WARC-79 and related international conferences and meetings demonstrate conclusively that contention for access to radio spectrum and its important collateral element, the geostationary orbit for space satellites, presents new and urgent challenges to vital U.S. national interests.

Given the complexities of spectrum management in a changing world environment and the increased importance of telecommunication to both developed and developing nations, it is highly unlikely that traditional U.S. approaches to these issues will be sufficient to protect U.S. vital interests in the future. The growing differences among nations over the use of the radio spectrum and related satellite orbit capacity are reflected in the Final Acts of WARC-79.

Overall, the results of WARC-79 are mixed. Generally, the proceedings of an administrative conference of the International Telecommunication Union (ITU) are geared toward arriving at decisions and adopting provisions that are acceptable to all nations. It is expected that all nations will report favorable results with certain exceptions identified. Even then, a country is free to take a reservation and not be bound by specific unacceptable results. Therefore, finding a useful way to measure success and evaluate a country's relative standing following an administrative radio conference is not easy. Comparing specific U.S. proposals submitted to the conference with the Final Acts of the conference is not a straightforward exercise. Too many events intervene to color the comparison between the preconference position and the ultimate result on many important issues. While such a comparison is important, it does not reflect the underlying reasons and motives for particular decisions, the problems encountered or any apparent trends important in evaluating results of an administrative conference.

It is important to understand the intervening events that underlie decisions, not only to evaluate the results of WARC-79, but to prepare for the many future conferences of consequences for the United States. As a highly developed user of spectrum and a

world leader in telecommunication technology, the United States has much to offer and much to lose in the international process of establishing rules and regulations.

Principal Findings of the OTA Study

The most significant findings of the study are the following:

1. There is an urgent need for higher level attention to Government policy coordination and accountability for international telecommunication issues generally and for spectrum management issues and international negotiations specifically.
2. Streamlined processes, coordinated Government policies and sufficient resources on a continuing basis are essential to effective and timely preparation for the several major international conferences of ITU now scheduled to occur over the next 7 years.
3. New U.S. approaches are necessary to address radio spectrum and related satellite orbit issues in a changing world environment. Solutions to satellite orbit allocation and spectrum reallocation issues as envisioned by the Third World nations require strategies not yet developed or tested.
4. WARC-79 resulted in the loss of some U.S. flexibility in certain key spectrum areas—particularly those affecting national defense—and enhanced opportunities in many other areas.
5. Operating costs will increase for certain radio services; interference protection will become less certain; and administrative costs will need to rise to adequately implement WARC-79 decisions and to prepare for future radio conferences.

General Observations and Trends

• The world environment for telecommunications has changed significantly in recent years; two-thirds of the 155 member nations of ITU can be classified as developing or Third World countries.

• The United States must develop approaches to use its technology and expand its influence if future actions in a "one-nation, one-vote" forum, like ITU, are to be favorable to U.S. positions.

• There has been a gradual shift toward recognizing the legitimacy of nontechnical factors such as political and cultural interests and values in ITU deliberations. In other international forums, Third World countries have raised related issues under concepts of the New World economic order and New World information order.

• There are basic differences between the United States and Third World countries over the principles that should govern the allocation and use of radio spectrum and related satellite orbit capacity. There is increasing need to identify and assess middle range options to reconcile the sometimes sharply divergent goals of developed and developing countries.

• The disparity between nations in their ability to use the spectrum is growing; this leads to growing disagreements over the allocation and use of specific frequency bands for specific services.

• Third World countries are increasingly able to influence and shape international communication policies in international forums.

- Spectrum decisions arrived at as a result of voting within ITU, as opposed to the commonly practiced consensus approach, will tend to be increasingly adverse to the United States.
- U.S. requirements for access to the frequency spectrum and satellite orbit locations are expanding with the explosive growth in telecommunication/information technology, the growing use of satellites, and the increasing dependence on radio and satellites for military and national security purposes.
- International telecommunication development is entering a phase in which regional and domestic needs and policies will predominate, as opposed to more general global facilities expansion. The thrust will be on intraregional communications and the development or enhancement of interregional communication routes.

U.S. Policymaking Structure and Processes for Spectrum Management and International Strategies

Need for High-Level Government Policy Coordination and Accountability

- The responsibility y for spectrum management and policymaking is divided among several Federal agencies with coordination conducted on a structured, but often informal, basis without clear responsibility and accountability for policy at a high level of Government.
- The United States does not have a consistent and coordinated national telecommunication policy because of a lack of appreciation and concern at the top levels of Government and industry, a lack of high-level policy coordination for international telecommunication negotiations, and a failure to assign sufficient importance to international telecommunication matters, including spectrum management and the State Department's role in international negotiations.
- The United States is not adequately equipped to provide comprehensive assessments required to effectively plan for the future use of the radio spectrum, to forecast future requirements, to assess the costs and benefits of shifts to new technology, or to evaluate alternative strategies to deal with international issues regarding allocation and use of radio spectrum and the geostationary satellite orbit.
- Within the U.S. telecommunication industry there has been significant growth and change over the past 15 years, which has produced more competing domestic interests with conflicting demands for spectrum use.
- The United States' permanent spectrum management mechanisms are not adequately equipped to review and verify all the stated requirements of Government and nongovernment spectrum users and to adjust needs consistent with national policy objectives. The U.S. lacks an effective ongoing means of collecting data, developing and adjusting guidelines to evaluate the merits of one spectrum use over any other.
- The State Department's International Communications Policy Office is not at a high enough level in the Department's organizational structure to be in a position to prepare adequately for all the important upcoming conferences of ITU and make its influence felt in the upper echelons of Government and industry.
- Lack of high-level concern has also led to a shortage of trained and experienced

spectrum management personnel to replace those retiring from Federal Government service; there has been insufficient attention to the need for personnel with supplementary diplomatic, language, negotiating, economic, and legal skills.

- The rather general wording of Executive Order 12046 establishing the National Telecommunications and Information Administration (NTIA) leaves it ambiguous as to how far NTIA can go in its coordinating role with respect to U.S. international telecommunications policy, particularly when that mandate risks encroachment on the general regulatory responsibilities of the Federal Communications Commission (FCC).

- The schedule of 10 major international conferences over the next 7 years to consider a number of issues vital to U.S. interests underscores the fact that the United States must reform its policymaking mechanisms and streamline the cumbersome and time-consuming procedures for developing U.S. proposals for international telecommunication conferences.

- A mechanism is needed for collecting and evaluating information on the perceived needs of other nations for spectrum and orbit resources; their receptivity to intraregional and/or common-user systems, and other factors.

Need for New Strategies to Address Spectrum and Related Satellite Orbit Issues

- There are critical years ahead for ITU. For the most part, the manner in which activities have been conducted by telecommunication experts and international diplomacy has avoided debate on ideology and politically motivated objectives. The trend toward basing decisions on factors other than economic and technical matters, and demonstrated need is challenging ITU to provide mechanisms for resolving differences among nations without a further shift toward the polemical norms common to international political debate.

- Third World countries are likely to resist drastic changes in ITU rules and procedures that operate on the principle of "one-nation, one-vote" and that provide them with increasing influence and power. They will continue to seek technical assistance from the developed countries while pursuing compromises favorable to their own interests.

- The developed countries are expanding their use of spectrum to higher frequency bands as lower, more economical bands become congested. They rely on technology to provide solutions to problems of accommodating new demands in the future. It is becoming increasingly difficult for the developing countries to accept the proposition that they will have access to spectrum on an interference-free basis at some future date as their needs materialize. The outlook is that the radiofrequency spectrum and geostationary orbit will become more congested in the lower, more economical and desirable frequency bands even though use of frequencies by one country does not necessarily preempt those same frequencies from use by other countries. It seems increasingly clear that the United States will need to explore new strategies and policy options to reconcile Third World interests with the objectives of the United States.

- WARC-79 showed the increasing influence of the Third World as a political force in ITU. The struggle for influence between the developed and developing nations will continue at future ITU conferences. At the present time, the developing countries derive their power from their collective numbers; the developed countries from their technical competence, knowhow, and leadership. The influence of the developing countries can most effectively be exploited in the ITU legislative forums; the developed nations through ITU technical administrative organs.

• The success of ITU has been due in large measure to the willingness of its members to adhere voluntarily to commonly arrived at agreements and regulations. The inherent flexibility in the ITU processes has also enhanced its effectiveness. Reservations and footnotes offer escape for individual countries from disagreeable decisions of the majority. However, excessive use of these exceptions by a sufficient number of countries—or by a few large users—serves to reduce the value of the agreements and regulations for all users.

• Existing ITU procedures that vest rights in the use of spectrum to countries on an "as needed, first-come, first-served basis" are viewed by developing countries as not serving their objectives and they now seek to alter those procedures.

• The growing lack of agreement among nations over which specific frequency bands should be allocated for which specific radio services (the International Table of Frequency Allocations) strongly suggests that mechanisms other than service classifications should be examined.

• ITU is a political organization that performs both political and technical functions. However, while there is a primarily technical focus for most ITU activities, there has been a gradual shift toward recognizing the legitimacy of nontechnical factors, such as political and cultural interests and values. The United States must recognize this shift and develop strategies to use its technology more broadly as a tool for resolving these broader international issues that are not subject to technical solution.

• Many of the nontechnical issues raised in ITU—like those concerning reallocation of spectrum and guaranteed access to the geostationary satellite orbit—are among the many issues raised by Third World countries in other international forums under the principles propounded by the New World economic order and New World information order. Those countries seek to alter the age-old pattern and structure of trade, communication, and information flow by developing and using telecommunication infrastructure themselves.

• Developing countries will continue to seek changes in the existing mechanism for vesting rights in the use of frequencies and access to the geostationary orbit. They seek a shift away from the current notification and coordination procedure on a "first-come, first-served" basis, toward a negotiated plan developed on an a priori basis. This is expected to reduce the uncertainties they fear in gaining access through the current approach, albeit at the expense of a possible "freezing" of technology.

• The administrative regulations of ITU serve the desirable objective—without the use of sanctions for noncompliance—of avoiding the interference, incompatibilities and chaos that would ensue if these or similar regulations were not followed.

• The voluminous, complex, and detailed provisions of the international radio regulations are becoming more burdensome for the world and less meaningful to individual users.

. Third World countries will continue to advocate changes in rules, regulations, and procedures that help guarantee their perceived right of access to the spectrum and geostationary satellite orbit. They do not wish to rely on the "good efforts, promises, and technical ability of the developed countries to "engineer-in" future systems on a case-by-case basis, as needed.

• ITU administrative radio conferences seek to produce results that all nations can accept. Reservations, footnotes and other means to reduce negative consequences allow each nation to more or less view the results as favorable. This approach supports the perception of having all winners and no losers. However, because of growing differences among nations, these procedures are beginning to produce diluted and cumbersome results that may render existing mechanisms to regulate world spectrum use less and less meaningful.

84-591 0 - 82 - 10

- Because of competing interests and growing differences over use of the spectrum there will be winners and losers in the future as a result of the ITU decisionmaking process.

- The preeminence of U.S. technological leadership and technical ability served the United States well in international spectrum negotiations when decisions were primarily based on technical matters. But more and more U.S. problems with other countries involving spectrum use are nontechnical.

- Certain U.S. requirements to use spectrum, such as radars for military purposes, are not of interest to the majority of other countries which prefer to have this same spectrum allocated to services they need or desire. The difficulty that faces the United States in seeking to convince a majority of the 155 other ITU member countries to adopt regulations that accommodate U.S. radars that conflict with other possible uses by other countries is real and was demonstrated at WARC-79.

- Rights to frequencies and satellite locations to individual nations are not vested indefinitely under current ITU procedures, and changes in operating parameters require recoordination and registration. This creates uncertainty for present satellite system operators. The risks may increase that spectrum and orbit will not be available to provide for continuity of service from the present to the next generation of satellites. Moreover, this problem is not overcome by the adoption of a negotiated rigid a priori allotment plan to assure future access, since such a plan would tend to freeze technology and accommodate only those new or second generation satellites that fit the original technical scheme.

Options

Possible Structural Improvements

There are three fundamental weaknesses in the present Federal Government policymaking structure:

1. The lack of attention at the top decision levels of the Government and industry as to the vital role of telecommunications in the international and domestic political, economic, and private affairs of the United States and the need for policy coordination;
2. There is a lack of high-level centralized policy coordination and guidance for international telecommunication negotiations at a high enough level in the Government to be effective.
3. The State Department's International Communications Policy Office is neither staffed nor institutionally organized to carry out effectively all of the functions involved in international telecommunication negotiations.

Congress could consider ways to improve the present structure or examine possible changes in the structure. A detailed analysis of alternative structures was beyond the scope of this study, which concentrates on the results of WARC-79. However, at least four options are available to Congress:

1. maintain the status quo and make no changes;
2. maintain the present structure, but raise the level of attention and accountability within the responsible agencies;
3. establish a mechanism—such as a task force of high-level government officials—to develop, examine, and make recommendations on structural and procedural improvements; or
4. establish a permanent board, council, or interagency committee of high-level Government officials to be responsible and accountable for international telecommunication policy coordination and the preparations for international conferences.

Possible Procedural Improvements

- Improvements needed in the present procedures for managing and planning Government and nongovernment use of the spectrum include better means to provide adequately for:

- evaluation and validation of spectrum requirements, giving particular attention to current spectrum usage, technology and development trends, and sharing opportunities between competing users of the spectrum;
- inclusion of spectrum and orbit efficient techniques and technology in system design of both Government and nongovernment systems;
- apportionment of frequency spectrum between Government and nongovernment services based on national priorities;
- effective planning for future spectrum and orbit needs;
- efficient and timely preparation for and participation in ITU conferences; and
- effective management of existing services and users on a continuing basis.

• Many of these shortcomings could be corrected without fundamental changes in the Government structure.

The validation of spectrum requirements, and the apportioning of spectrum between Government and nongovernment users, needs closer scrutiny. An enhancement of existing mechanisms using analytical tools to help evaluate needs and arrange priorities among contentious users would provide better information for decisionmakers. Military requirements are reviewed by the Interdepartment Radio Advisory Committee (IRAC) and its Spectrum Planning Subcommittee, but this function needs to be strengthened and broadened to be more effective in the future.

• Economic techniques should be considered, at least on an experimental basis, to provide guidance on the consequences of different spectrum allocation decisions and the introduction of newer technology. These should include techniques for evaluating the relative economic viability of alternative spectrum uses, as well as radio v. nonradio communication systems.

• FCC, perhaps with the aid of a task force including other Government agencies that have studied the question, industry groups and private experts, should select a few services and frequency bands for detailed analysis of the prospects of using one or more economic techniques. The Commission could then present its recommendations for the experimental application of a selected technique, or techniques, on one or a limited number of services and frequency bands to the Congress for its information and action, if necessary.

• Problems relating to forming a U.S. delegation for WARC-79 could be addressed and the effectiveness of U.S. participation in international meetings could be improved by several steps:

1. industry and other nongovernment delegates could again be permitted to participate fully as U.S. representatives at international telecommunication conferences and take any assignments on the delegation for which their skills and experience qualify them;
2. consideration could be given to finding means to comply with due process requirements under the Administrative Procedure Act and still name industry and other nongovernment representatives to delegations on a timely basis;
3. permanent guidelines to name the chairman and individual delegates to the U.S. delegation could be established;
4. qualifications required, distribution of various skills needed, and type of representation desired could be determined at an early stage of preparation for conferences;
5. individuals chosen to serve on U.S. delegations could be selected from the best candidates available, especially those who participated in the preparatory effort; and
6. any special Government support necessary to acquire particular representation on the delegation could be available early in the preparatory stages.

• Preparations for international telecommunication conferences could be improved

by replacing the ad hoc approach with an ongoing conference preparatory structure with a focal point for high-level responsibility and accountability involving all the concerned Government and nongovernment telecommunication interests.

Strategies to Address International Issues and Deal With ITU

The United States must make some policy decisions reflecting changes in U.S. strategy or in the structure or procedures of ITU, and then augment the scope and training of the responsible U.S. personnel consistent with those decisions.

The United States has essentially two alternatives: 1) it can seek various improvements in the present means for solving spectrum allocation problems within ITU as it is now constituted; or 2) it can seek to alter the existing structure, procedures, or mechanisms of ITU itself. The policy options considered here may be divided into two broad categories, strategic and structural.

Strategic Approaches – Options

• From the strategic standpoint, assuming no significant changes in ITU, the United States has a wide range of options. At one extreme, the United States may conclude that the drawbacks of continued participation in ITU outweigh the benefits, and withdraw from the organization or decline to participate in its deliberations. At the other extreme, the United States may decide to yield to other nations on controversial matters, accept all decisions taken within ITU, and play a passive role in its deliberations. Between these extremes there are a number of alternatives.

1 Seek to remove the most controversial issues from the ITU forum and attempt to solve them in other ways. A current example might be to respond to the demands of developing countries for "guaranteed access" to radio spectrum and satellite locations by developing the institutional arrangements to ensure domestic communication services to qualifying nations. This could be a common user satellite system either building upon the present INTELSAT structure or creating a separate system for domestic services. Such a solution would offer each nation a role and stake in the system with satellite services or capability it could realistically use. This could avoid the issue of allocating to small nations significant amounts of the radio spectrum and satellite orbit locations which might then remain unused for the foreseeable future.

2. Develop a comprehensive program with necessary resources to better coordinate U.S. views and objectives with other nations, in advance of ITU meetings, and adjust U.S. proposals based on improved understanding of other nations' views.

3. Develop a range of options for "planning" the use of the geostationary satellite orbit–between the evolutionary approach advocated by the United States and any rigid a priori allotment plan that may be advocated by some developing countries—and consider these options informally with key countries prior to ITU conferences.

4. Seek to raise the level of technical competency among ITU member states and raise the level and quality of communications and information capabilities accessible to them through educational and technical assistance programs.

Structure of ITU – Options

• From the structural standpoint, assuming that ITU can be changed, a number of options are available. One relatively extreme option would be for the United States to withdraw from ITU. Another option would be to seek to revise the voting formula of ITU to one more advantageous to the United States, perhaps by giving added voting weight to those countries that contribute most heavily to the U.N. budget. A more modest option would be to increase the number of ITU regions beyond the present three so that regional issues could be dealt with by a smaller number of countries most directly concerned.

1. *Withdrawal from* ITU—Member nations of ITU rely on the organization to avoid interference from the radio signals of others and to achieve compatibility of interconnected telecommunication systems. Avoidance of interference is the essence of spectrum allocation or frequency assignment processes of ITU. Withdrawal from ITU could well intensify the risk of interference. It seems clear that preemption of radio spectrum by the United States would be ineffective and that U.S. radio services would be vulnerable to interference without recourse to the protections provided under the international radio regulations. Any nation that chose to interfere, whether due to a valid need for a particular frequency band or by intentional jamming, could greatly reduce the value to the United States of the preempted spectrum. Withdrawal from the ITU organization would not eliminate the mutual desirability for the United States and other countries to coordinate spectrum use as well as other telecommunication activities now performed through ITU.
2. *Revised ITU voting formula–As* an option less drastic than withdrawal from ITU, the United States might join with other developed nations to force a revision of the ITU's "one-nation, one-vote" decisionmaking formula toward one that would reflect the dominance of the developed nations in the actual use of the spectrum. If successful, this option would greatly reduce the ability of the Third World nations to block or force changes in U.S. positions. But those nations are likely to resist such revisions vigorously and given their current voting strength it is difficult to see how any weighted voting scheme could be forced in ITU short of amassing pressure in many other areas.
3. *Increased regionalization of* ITU–At present, ITU divides the world into three geographic regions and many issues that can be treated separately and effectively in a single region are considered in this way. Regional administrative radio conferences are scheduled on a variety of specific issues, allowing the World Administrative Radio Conferences to "spinoff" certain controversial matters (and incidentally, to delay their consideration). One option would be to extend this process of regionalization on a, geographic basis to smaller subregions, and/or an issue basis to include only those nations directly affected by the particular issue. The purpose would be to reduce the number of nations voting on issues that do not affect them directly, thus reducing unnecessary contention and possibly reducing costs and time of reaching a multilateral agreement.

Consequences of WARC-79

General Observations

- ITU administrative radio conferences are difficult to rate in terms of success or failure. The box score approach, which measures proposals submitted against the conference Final Acts, is inadequate and misleading because it fails to take account of the importance and consequences of particular decisions. The underlying trends and the bases for decisions and compromises, which have important future consequences, are not captured in the win, loss, and tie columns.

- WARCs are conducted and apply mechanisms that allow each member-nation to perceive that most of its needs are met no matter how unfortunate the results may be for the collective international community.

- In general and apart from any specific proposal or action, the members of the informed community responding to the OTA-sponsored survey perceived WARC-79 as producing results that were either somewhat better than expected or about what was anticipated before the conference. However, expectations may have been colored by the growing concern over possible confrontation with the Third World that preceded WARC-79.

- The OTA-sponsored survey found that most individuals responding to the questionnaire believe that WARC-79 had a favorable impact on both U.S. national interests (53 percent) and their own organization (58 percent). The major exception to this view is found among a minority of individuals mainly in the private sector, who maintain that WARC-79 had a net unfavorable impact on their organizations' operations (15 percent). A substantial number of respondents (33 percent) said that the results of WARC-79 were neither favorable or unfavorable to U.S. national interests.

- The 1977 broadcasting satellite WARC was of great importance for the United States because it demonstrated conclusively that the developing countries could unite to pursue a collective goal. In this case, the goal was consistent with the objectives of the Western European countries goal (albeit for different reasons), but inconsistent with U.S. (and others) proposals and efforts to adopt a different approach based on technical arguments to support the U.S. position. It also showed that the perceptions and priorities of the developing countries differed from ours and that technical arguments could not be counted upon to win out over political considerations.

- At WARC-79, there was too much to do, too little time to do it, and too many conflicting interests to deal effectively with many of the issues. Therefore, the conference made use of the several vehicles available to an administrative conference to proceed without forcing agreements or attempting to resolve difficult issues that could be postponed. Taking footnotes to the allocation table; adopting resolutions; postponing issues to future conferences; and taking reservations are vehicles that have always been available, but at WARC-79 ITU members found it necessary to use them more than ever before.

- No immediate changes in operations using the radio spectrum or geostationary satellite orbit are required in the United States as a result of WARC-79. However, the longer range impacts in terms of increased operating costs, reduced operating flexibility, uncertainty surrounding important pending issues, and the need for thorough preparations to address issues at future conferences require immediate attention.

- The radio regulations serve essentially two functions: 1) to establish technical standards and regulations about what kinds of services can use what parts of the spectrum under given conditions; and 2) to establish procedures for countries to acquire operating rights and protection from interfer-

ence. Developed countries participate in WARCs with a strong focus on improving and elaborating on technical standards and procedures to protect existing spectrum users; developing countries want to focus on underlying principles, alternative ways to vest rights in the use of frequencies, and ways to make ITU more responsive to their needs.

- INTELSAT, as a world organization of 106 member countries, had significant influence at WARC-79 on fixed-satellite service (FSS) matters.
- The nonalined nations played a significant role at WARC-79, frequently operating as an effective force.
- WARC-79 adopted several resolutions and provisions that call for increased assistance in various forms to developing countries.
- The conference resolutions calling for a number of future conferences, including those to "plan" space services and the international broadcasting service, demonstrate that the achievement of U.S. objectives at ITU conferences will no longer be a matter of reaching agreement on technical solutions to problems of spectrum allocations and frequency coordination; it will require imaginative approaches, with political negotiations involving long, hard bargaining.

Major Decisions and Consequences

- There is no major immediate cost impact imposed by WARC-79 regarding national security systems, largely because of the frequency flexibility of existing U.S. equipment, the success of the U.S. delegation at WARC, and reservations taken by the United States. However, there will be future, undetermined costs resulting from actions at WARC-79—costs associated with frequency management, the development and procurement of more sophisticated equipment, compatibility studies, and coordination to prevent harmful interference with competing users of the spectrum.
- Department of Defense (DOD) interests were impacted by losses of exclusivity for radiolocation (radar) operations and by increased sharing with other services in many of the radiolocation bands. For example, demands that radar operations be discontinued in certain bands in order to accommodate expanded FSS operations led to considerable acrimony, which was only eased by a nonbinding U.S. commitment in a formal declaration to try to accommodate FSS in those bands. The status of radiolocation was retained but the pressure from FSS interests will certainly continue.
- Radar usage by the radiolocation service is extremely heavy in the radiolocation bands between 8500 and 10,000 MHz. The addition of the radionavigation service and the multicountry fixed and mobile footnotes in this band have taken 900 MHz of virtually exclusive radiolocation allocations in the current radio regulations and added one or more primary services over the entire band. Technical and administrative solutions must be sought if radiolocation is to retain its effectiveness. IRAC, in particular, could develop a set of recommendations for use by the State Department in discussions with other countries with a view to encouraging the orderly and restrained introduction of radionavigation on an "as needed" basis in order to buy time for the development of technical solutions to sharing problems. In the absence of such a planned introduction, the radiolocation service may soon find itself having a de facto secondary status because of the safety-of-life priorities accorded the radionavigation service.
- The United States took a reservation indicating that the United States, in the operation of radars, will not guarantee protection to, nor coordination with, other services. The action was necessary because the existence of the fixed and mobile services footnotes in every radiolocation band between 1 and 40 GHz jeopardized radar operations to serve national defense.
- Notwithstanding the fact that WARC-79 did little to reduce the total spectrum

available for radar operations, and also, that U.S. military radars are now required to operate worldwide in a secondary status, the costs of radar development and operation must increase as a result of decisions taken at WARC. New coordinating activity must now take place between the radiolocation service and a number of other services that will share the same frequency bands, particularly the fixed, mobile, and radionavigation services. A significant number of interference incidents can be anticipated in these bands. In the long term, modifications of existing systems and development of new ones must be increased to guarantee the performance of military radars in the presence of increased interference. A further added cost derives from the need for radar developers to expand their participation in CCIR in order to lay a better foundation for U.S. proposals concerning radars at future conferences.

- U.S. objectives for FSS and the mobile-satellite service (MSS) (including DOD satellite interests) were achieved in large measure. The DOD goal of adding 125 MHz for up- and down-links for the two services was achieved, but this meant that the partial exclusivity that existed for FSS was lost. There may be problems in satisfying some DOD satellite communication requirements in the 7- and 8-GHz bands. Also, the United States and most NATO countries took a reservation regarding language in the Final Acts that requires that stations in MSS operating in the band 235 to 399.9 MHz not cause harmful interference to those of other services operating, or planning to operate, in accordance with the table of allocations.

- Significant amounts of spectrum were added to allocations for FSS, in general accordance with U.S. objectives. The technical rules that affect the design, operation, and cost of satellite systems were generally in agreement with U.S. positions. Where U.S. desires were not precisely met, no significantly adverse repercussions resulted. No immediate or significant changes in the structure or operation of U.S. fixed-satellite telecommunication services will result from conference decisions. No operational or economic dislocation was imposed on any existing FSS system. No major burden appears to be placed on the U.S. Government or private operating entities in order to comply with the decisions of WARC. However, the differences between the United States and many developing countries over approaches to use of the geostationary satellite orbit, to be resolved by future conferences, leaves the impact on FSS uncertain.

- While, based on U.S. proposals, WARC-79 largely eliminated frequency sharing between FSS and broadcasting-satellite services (BSS) in the Americas, BSS must now share with the terrestrial-fixed service. This sharing could result in interference to BSS Earth-station receivers operating in the same area as fixed-station transmitters. This could have a negative impact on private microwave systems that use the band 12.3 to 12.7 GHz. These private systems are widely used in the United States by a variety of users. If required to vacate the band to protect BSS and move to a higher frequency band, there would be economic and operational consequences.

- WARC-79 made substantial increased allocations to FSS in the "lower" frequency bands where technology is well developed and relatively economical. WARC-79 also reaffirmed the FSS allocations near 20 and 30 GHz where the next generation of domestic communication satellites is now under development. This new generation of satellites is likely to offer a greater variety of services to more users and lower costs.

- Because of the highly efficient use already being made of existing allocations for the fixed service, the changes adopted at WARC-79 consisted mainly of attempts to aline the allocations among the three regions and, through footnotes, to accommodate the specific needs of individual countries.

- The decisions of WARC-79 affecting the use of microwave radio relay systems do not

mandate any drastic U.S. changes in spectrum allocation and management.

• In order to simplify the administrative process for certain countries which otherwise might need to coordinate with a number of neighboring states, the radio regulations were revised and simplified at the risk of creating future interference problems. The changes were opposed by the United States, Canada, and others that felt that sound technical judgments should not be eroded by political or administrative considerations.

• The U.S. objective to gain more frequency allocations for high frequency (HF) broadcasting could only be done at the expense of the fixed service, and was therefore opposed by many developing countries. The HF broadcasting allocations were increased conditioned on the successful outcome of a specialized HF broadcasting conference to be held in the mid-1980's to "plan" for more efficient and equitable use of the broadcasting bands. While the conference agenda will be relatively broad and open, it was apparent at WARC-79 that the United States and the developing countries have significant differences as to the type of planning to be undertaken. Also, political issues, such as "prior consent," could prove troublesome, at this conference.

Options Regarding Ratification of the Final Acts of WARC-79

1. The United States can ratify the Final Acts without delay with the normal clarification of U.S. statements in the Final Protocol. Completing the ratification process prior to January 1, 1982, when the 1979 radio regulations enter into force will indicate to other nations our goodwill and determination to abide by our international obligations. The Final Acts constitute the "Radio Regulations, Geneva, 1979, " which replace the 1959 regulations as partially revised by the administrative radio conferences held in 1963, 1966, 1967, 1971, 1974, and 1978. The Final Acts also incorporate the provisions of the 1977 broadcast satellite WARC as modified by WARC-79.

2. The United States can ratify the Final Acts with conditions, thereby underscoring and making explicit the reservations taken at Geneva. In particular, the United States could reiterate the reasons for taking reservations in the Final Protocol to emphasize U.S. Government concern regarding these issues.

3. The United States can ratify the Final Acts with additional reservations that either state U.S. refusal to acquiesce to particular decisions taken at WARC-79, beyond those cited in earlier U.S. protocol statements, or set forth U.S. policy with respect to future actions by ITU or specific implementation of the WARC-79 Final Acts. While it is not uncommon for the Senate to attach conditions to a resolution of ratification of a bilateral international agreement, which the other party can readily accept or reject through its own ratification processes, attaching conditions to a multilateral agreement raises difficulties.

4. The United States can ratify the Final Acts in part, specifically withholding ratification of those provisions (which would have to be listed in precise detail) where the United States chooses to remain bound by the provisions of existing regulations previously ratified (which would also have to be listed in precise detail).

5. The United States can withhold ratification of the Final Acts pending the outcome of several important international conferences dealing with telecommunication issues. This would deny FCC and the current

administration any legal basis for implementing decisions taken at WARC-79, many of which were strongly advocated by the United States and fought for by the U.S. delegation, and which are scheduled for implementation by other ITU members on January 1, 1982. The most immediate international telecommunication conference of great importance to the Unites States is the September 1982 plenipotentiary. The actions taken at this conference to revise the ITU convention will be basic to all future conferences of ITU.

6. The United States can reject the Final Acts of WARC-79 in their entirety and announce that we intend to abide by the preexisting radio regulations, as amended. The consequences would be similar to those cited above.

Future Conferences and Issues

1982 Plenipotentiary

• This conference provides the United States with an opportunity to propose changes in the structures and procedures of ITU, and to resist changes proposed by others that are not in the interest of the United States. It is vital that the United States make thorough preparations for this meeting and to anticipate fully the proposals that may be put forward by other ITU members.

• The basic principles contained in the ITU convention will be reviewed and modifications made in accordance with the will of the majority. The convention serves to guide international cooperation for use of telecommunications of all kinds, and governs the functioning of ITU itself. Changes in the convention will be fundamental to future meetings of ITU. For example, any change in article 33 of the convention concerning use of the spectrum and the geostationary satellite orbit would have a direct bearing on the WARC scheduled to plan space services using the geostationary orbit.

• The United States should give careful consideration to the future role of ITU vis-a-vis international information policy issues and the New World information order demands of Third World countries.

The results of the OTA-sponsored survey shows that more than 80 percent of the respondents agree that the conflicting positions and approaches between the United States and other countries for use of the radio spectrum and the geostationary satellite orbit are issues for the 1982 ITU plenipotentiary conference and justify a major U.S. effort to prepare for the conference.

Space Planning Conference

• This specialized WARC on the use of the geostationary satellite orbit and the planning of space services utilizing it will have two sessions—July 1985 and September 1987. It poses a serious threat to potential U.S. use of space communications because it could result in a form of "planning" contrary to U.S. interests. The extent to which a flexible and efficient method of planning space services can be devised and "sold" to the conference represents a challenge to the United States.

• The conference will also determine which frequency bands used for space services are to be planned. U.S. efforts to have the conference concentrate on those higher frequency bands that are unoccupied, or little used, will collide with the demands of developing countries to have the conference concentrate on planning the use of the more economical, lower frequency bands. The United States must determine its own readiness to incur the expense of moving to higher frequencies and its readiness to understand the motivations and deal effec-

tively with the pressures to plan a broad range of frequency bands.

HF Broadcasting Conference

• This conference, to be held in two sessions starting in January 1984, is to plan the efficient and equitable use of the HF broadcasting bands. Active U.S. participation and careful preparation will help ensure that the increased allocations to HF broadcasting made at WARC-79 are not jeopardized by failure to accommodate the fixed services that were removed from the international broadcasting bands, but must be reaccommodated in other parts of the spectrum.

• Rapid developments in direct broadcasting from satellites are likely to rekindle debate on such political issues as "prior consent" at the HF planning conference. The United States will need to be prepared to address this and other current issues over the question of the free flow of information.

1983 Broadcasting Satellite Conference for Region 2

• To prepare for the 1983 region 2 conference, the United States will need to develop its detailed requirements for broadcasting satellite channels and submit them to ITU a year in advance of the meeting. Also, the desired satellite coverage areas are required to be submitted. A U.S. position will need to be taken on the total bandwidth to be allocated to broadcasting satellites as opposed to satellites operating in the fixed satellite service in the 12 GHz band.

• The United States could be faced with the prospect of a majority of region 2 countries voting for a rigid orbital and frequency allotment plan such as the one adopted for regions 1 and 3 at the 1977 WARC for BSS. According to the OTA-sponsored survey, a majority of the respondents, 68 percent, believe that a practical compromise is possible and desirable, although relatively few have any specific concept of the form such compromise could take; an additional 15 percent believe that a compromise is possible, but undesirable; only 8 percent of the respondents believe that a compromise between the United States and the Third World positions on a priori assignment is impossible; another 9 percent expressed no opinion. This underscores the need to identify and analyze specific strategies and options which might provide the basis for such a compromise.

• WARC-79 made allocations for BSS from 12.3 to 12.7 GHz and for FSS from 11.7 to 12.1 GHz. Left to be resolved at the 1983 conference is the band 12.1 to 12.3 GHz allocated in 1979 to both services. Decisions surrounding the 1983 conference bear directly on the future growth of domestic satellite service. FSS and BSS both will be affected by these decisions. Domestic issues involving direct broadcasting satellites planned for operation in the 12-GHz band must be addressed as a part of the overall policy considerations by the United States.

Other Conferences

• The 10 additional administrative radio conferences to be held over the next 7 years include some that will be as important, if not more so, than WARC-79 itself. (Scheduling is tentative and some could be delayed by action of the ITU's administrative council and/or the 1982 plenipotentiary conference.) Some of these conferences offer the United States an opportunity to reopen the question of allocation proposals that were not accepted by WARC-79 (e.g., WARC for the mobile services in 1983).

• These future conferences offer a forum for the United States to reiterate the importance of the radiolocation service and to help resolve coordination problems arising from the sharing of bands with the fixed and mobile services.

. The following is a list of the future ITU conferences currently scheduled:

November 1981,6 weeks, region 2, MF-BC RARC, second session;

August 1982, 4 weeks, region 1, FM-BC RARC, first session;
September 1982, 6 weeks, ITU Plenipotentiary Conference;
February 1983, 3½ weeks, Mobile Services WARC;
June 1983, 5 weeks, region 2, Broadcasting Satellite RARC;
January 1984, 5 weeks, HF-Broadcasting WARC, first session;
October 1984, 6 weeks, region 1, FM-BC RARC, second session;
July 1985, 6 weeks, Space Services WARC, first session;
January 1986, 7 weeks, HF-Broadcasting WARC, second session;
September 1986, 4 weeks, region 2, HF-Broadcasting RARC (New Bands);
January 1987, 4 weeks, African VHF/UHF-Broadcasting RARC;
September 1987, 6 weeks, Space Services WARC, second session;
March 1988,6 weeks, region 3, VHF/UHF Bands RARC; and
September 1988, 6 weeks, Mobile Services WARC.

Acronyms, Abbreviations, and Glossary

Acronyms and Abbreviations

AFNAVSAT	— Air Force Navigation Satellite
AM	— amplitude modulation
ARFA	— Allied Radio Frequency Agency (NATO)
AWACS	— Airborne Warning and Control System
BSS	— broadcasting-satellite service
C-E	— communications-electronics (DOD parlance)
CCIR	— International Radio Consultative Committee of the International Telecommunication Union
CCIs	— reference to both the CCIR and CCITT
CCITT	— International Telegraph and Telephone Consultative Committee of the International Telecommunication Union
CITEL	— Inter-American Telecommunication Conference of the Organization of American States
COMSAT	— Communications Satellite Corp.
COPUOS	— The United Nations Committee on the Peaceful Uses of Outer Space
C^3I	— command, control, communications, and intelligence (DOD parlance)
DNS	— The Department of Defense Navigation Satellite system
DOD	— Department of Defense
DSCS	— Defense Satellite Communication System
ECAC	— Electromagnetic Compatibility Analysis Center (DOD), Annapolis, Md.
EHF	— extremely high frequency (30 to 300 GHz)
EIRP	— effective isotropically radiated power (measured in watts)
EMC	— electromagnetic compatibility
FAS	— Frequency Assignment Subcommittee of the Interdepartment Radio Advisory Committee
FCC	— Federal Communications Commission
FLTSATCOM	— Fleet Satellite Communication System (Naval)
FM	— frequency modulation
FMAC	— Frequency Management Advisory Committee to the National Telecommunications and Information Administration
FSS	— fixed satellite service
FX	— fixed service
GHz	— gigahertz (1 billion cycles per second)
GPS	— global positioning satellite (sometimes NAVSTAR/GPS) (DOD)
HF	— high frequency (3 to 30 MHZ)
Hz	— hertz (one cycle per second)
IBI	— International Bureau of Informatics
ICA	— International Communications Agency
ICAO	— International Civil Aeronautical Organization
IFL	— International Frequency List
IFRB	— International Frequency Registration Board
IMCO	— Intergovernmental Maritime Consultive Organization
INMARSAT	— International Maritime Satellite Organization
INTELSAT	— International Telecommunications Satellite System
IRAC	— Interdepartment Radio Advisory Committee
ITU	— International Telecommunication Union
kHz	— kilohertz (1000 cycles per second)
LF	— low frequency (30 to 300 kHz)
LR	— radiolocation service (fixed)
MF	— medium frequency (300 to 3000 kHz)
MHz	— megahertz (1 million cycles per second)
MO	— mobile service
MR	— radiolocation service (mobile)
NASA	— National Aeronautics and Space Administration
NATO	— North Atlantic Treaty Organization
NTIA	— National Telecommunications

and Information Administration
RARC — Regional Administrative Radio Conference
RL — radionavigation service (fixed)
RO — radionavigation service (mobile)
SHF — super high frequency (3 to 30 GHz)
UHF — ultrahigh frequency (300 to 3000 MHz)
U.N. — United Nations
UNDP — United Nations Development Program
UNESCO – United Nations Educational, Scientific, and Cultural Organization
UPU – Universal Postal Union
VHF — very high frequency (30 to 300 MHz)
VLF — very low frequency (3 to 30 kHz)
WARC – World Administrative Radio Conference
WIPO – World Intellectual Property Organization

Glossary

A priori planning—procedure by which frequencies and orbital locations are allotted to individual countries according to a plan negotiated by member-nations and implemented by ITU,

Aeronautical mobile service-a mobile service between aeronautical stations and aircraft stations, or between aircraft stations, in which survival craft stations may participate; emergency position-indicating radiobeacon stations may also participate in this service on designated distress and emergency frequencies.

Aeronautical mobile-satellite service-a mobile-satellite service in which mobile Earth stations are located onboard aircraft; survival craft stations and emergency position-indicating radiobeacon stations may also participate in this service.

Aeronautical radionavigation-satellite service-a radionavigation-satellite service in which Earth stations are located onboard aircraft.

Aeronautical radioavigation service—a radionavigation service intended for the benefit and for the safe operation of aircraft.

Allocation (of frequency band) –entry in the table of frequency allocations of a given frequency band for the purpose of its use by one or more terrestrial or space radiocommunication services or the radio astronomy service under specified conditions. This term shall also be applied to the frequency band concerned.

Allotment (of a radio frequency or radio frequency channel) —entry of a designated frequency channel in an agreed plan, adopted by a competent conference, for use by one or more administrations for a terrestrial or space radiocommunciation service in one or more identified countries or geographical areas and under specified conditions.

Amateur service-a radiocommunication service for the purpose of self-training, intercommunication, and technical investigations carried out by amateurs, i.e., by duly authorized persons interested in radio technique solely with a personal aim and without pecuniary interest.

Analog transmission—a technique that transmits the signal in a continuous electrical waveform. The information context of the signal is conveyed by the value or magnitude of some characteristics of the signal such as the amplitude, phase, or frequency of a voltage.

Assigned frequency–the center of the frequency band assigned to a station.

Assigned frequency band–the frequency band within which the emission of a station is authorized; the width of the band equals the necessary bandwidth plus twice the absolute value of the frequency tolerance. Where space stations are concerned, the assigned frequency band includes twice the maximum Doppler shift that may occur in relation to any point of the Earth's surface.

Assignment (of a radiofrequency or radiofrequency channel) —authorization given by an administration for a radio station to use a radiofrequency or radiofrequency channel under specified conditions.

Band–in radio, frequencies that are within two definite limits and are allocated for a definite purpose or service, e.g., the standard AM broadcast band.

Broadcasting-satellite service–a radio-communication service in which signals transmitted or retransmitted by space stations are intended for direct reception by the general public.

Broadcasting service– a radio-communication service in which the transmissions are intended for direct reception by the general public. This service may include sound transmissions, television transmissions, or other types of transmission.

CCIR–International Radio Consultative Committee, a permanent organ of ITU where member-nations and recognized private operating agents formulate recommendations concerning technical and operational radio matters.

CCITT–International Telegraph and Telephone Consultative Committee, a permanent organ of ITU where member-nations and recognized private operating agents formulate recommendations concerning technical, operational, and tariff aspects of telecommunication.

CCIR SPM–special preparatory meeting of CCIR convened in 1978 by the Secretary General of ITU to provide technical support to WARC-79.

dBW–a measure of power, decibels referened to 1 watt,

Digital transmission—a technique that transits the signal in the form of one of a discrete number of codes. The information content the signal is concerned with discrete state

the signal, such as the presence or absence of a voltage, a contact in the open or closed position, or a hole or no hole in certain positions on a card.

Earth exploration-satellite service–a radio-communication service between Earth stations and one or more space stations, which may include links between space stations, in which: 1) information relating to the characteristics of the Earth and its natural phenomena is obtained from active sensors or passive sensors on Earth satellites; 2) similar information is collected from airborne or Earth-based platforms; 3) such information maybe distributed to Earth stations within the system concerned; and 4) platform interrogation may be included. This service may also include feeder links necessary for its operation.

Emission–radiation produced, or the production of radiation, by a radio transmitting station.

Evolutionary planning approach–procedure by which frequency assignments and orbital locations are notified by member-nations and recorded by ITU on a more or less first-come, first-served basis without any rigid a priori plan.

Facsimile–a form of telegraphy for the transmission of fixed images, with or without halftones, with a view to their reproduction in a permanent form.

Feeder link-a radio link from an Earth station at a specified fixed point to a space station, or vice versa, conveying information for a space radio-communication service other than for the fixed-satellite service.

Fixed-satellite service-a radio-communication service between Earth stations at specified fixed points when one or more satellites are used; in some cases this service includes satellite-to-satellite links, which may also be effected in the intersatellite service; the fixed-satellite service may also include feeder links for other space radio-communication services.

Fixed service–a radio-communication service between specified fixed points.

Footnote– in the international table of frequency allocations a "footnote" conveys special information and often is a means by which an ITU member-nation may claim frequency band usage for a service that is in addition to or alternative to the service stated in the cable of allocations.

Frequency allocation table (international)–a table in the radio regulations allocating bands for frequencies, in the usable portion of the radio spectrum, to radio-communication services.

Frequency allocation table (national)–a table in the FCC Rules and Regulations allocating bands of frequencies, in the usable portion of the radio spectrum, to radio-communication services.

Geostationary satellite–a geosynchronous satellite whose circular and direct orbit lies in the plane of the Earth's Equator and which thus remains fixed relative to the Earth; by extension, a satellite that remains approximately fixed relative to the Earth.

Geostationary satellite orbit–the oribit in which a satellite must be placed to be a geostationary satellite.

Geosynchronous satellite–an Earth satellite whose period of revolution is equal to the period of rotation of the Earth about its axis.

Harmful interference–interference that endangers the functioning of a radionavigation service or of other safety services or seriously degrades, obstructs, or repeatedly interrupts a radio-communication service operating in accordance with these regulations.

HF broadcasting—high frequency, or shortwave broadcasting, used primarily for government-sponsored information services (e.g., Radio Moscow, Voice of America), and for domestic broadcasting in many developing countries.

IFRB–International Frequency Registration Board, a permanent organ of ITU with five officials elected by the plenipotentiary conference, examines notifications of frequency assignments from member-nations for conformity with the radio regulations.

INTELSAT– International Telecommunication Satellite Organization with 106 member-nations that own and operate the satellites in the Global Communication Satellite System.

Interference–the effect of unwanted energy due to one or a combination of emissions, radiations, or inductions upon reception in a radio-communication system, manifested by any performance degration, misinterpretation, or loss of information that could be extracted in the absence of such unwanted energy.

International frequency list-a listing of all the frequencies in use in the world, as notified by administrations to the International Telecommunication Union.

IRAC–Interdepartment Radio Advisory Committee; a body of 20 Federal agencies and de-

partments that assists NTIA in the development of the National Table of Frequency Allocations, the assignment of frequencies to stations operated by the Federal Government and other spectrum management functions.

IRAC Ad Hoc 144–the ad hoc group established within IRAC to develop recommended U.S. proposals for WARC-79 pertaining to the Federal Government use of the spectrum and to comment on U.S. position papers.

ITU—International Telecommunication Union; the U.N. related organization with responsibilities in the field of international telecommunications including spectrum management; present membership of 155 nations.

ITU Convention–the governing instrument of ITU that sets forth the structure and activities of the Union; only the plenipotentiary conference of ITU can amend or revise the Convention; it last met in Malaga-Torremolinos in 1973.

Land mobile-satellite service-a mobile-satellite service in which mobile Earth stations are located on land.

Land mobile service—a mobile service between base stations and land mobile stations, or between land mobile stations.

Maritime mobile-satellite service–a mobile-satellite service in which mobile Earth stations are located onboard ships; survival craft stations and emergency position-indicating radiobeacon stations may also participate in this service.

Maritime mobile service-a mobile service between coast stations and ship stations, or between ship stations, or between associated onboard communication stations; survival craft stations and emergency position-indicating radiobeacon stations may also participate in this service.

Maritime radio-navigation-satellite service—a radio-navigation-satellite service in which Earth stations are located onboard ships.

Maritime radionavigation service-a radionavigation service intended for the benefit and for the safe operation of ships.

Meteorological aids service—a radio-communication service used for meteorological, including hydrological, observations and exploration.

Mobile-satellite service—a radio-communication service: 1) between mobile Earth stations and one or more space stations, or between space stations used by this service; or 2) between mobile Earth stations by means of one or more space stations.

Mobile service—a radio-communication service between mobile and land stations, or between mobile stations.

Orbit–the path, relative to a specified frame of reference, described by the center of mass of a satellite or other object in space subjected primarily to natural forces, mainly the force of gravity.

Permissible interference–interference at a higher level than that defined as permissible interference and which has been agreed upon between two or more administrations without prejudice to other administrations.

Permitted service-a class of allocation. Permitted and primary services have equal rights, except that in the preparations frequency plans, the primary service should have prior choice of frequencies (printed in "grotesque light" type in the ITU table of allocations.)

Plenipotentiary conference–the supreme body of ITU that has the power to amend or revise the ITU convention.

Power flux density—a measure of the power radiated by a transmitter, used as a constraint on certain services to protect other services in a shared band.

Primary service–a class of allocation. Stations in a primary service may not cause harmful interference to stations in the same, or another primary service, and can claim protection from interference from stations in primary, permitted, and secondary services. Printed in solid capitals in the ITU table of allocations.

Private operating agency–any individual or company or corporation, other than a governmental establishment or agency, which operates a telecommunication installation intended for an international communications service or capable of causing harmful interference with such a service.

Radar-a radiodetermination system based on the comparison of reference signals with radio signals reflected, or retransmitted, from the position to be determined.

Radiation–the outward flow of energy from any source in the form of radio waves.

Radio–a general term applied to the use of radio waves.

Radio astronomy service–a service involving the use of radio astronomy.

Radio Regulations, Geneva, 1979–the Final Acts

of WARC-79 will constitute the Radio Regulations, Geneva, 1979 and enter into force on January 1, 1982, for those countries that have formally adopted the Final Acts.

Radio waves or hertzian waves–electromagnetic waves of frequencies arbitrarily lower than 3000 GHz, propagated in space without artificial guide.

Radio communication–telecommunication by means of radio waves.

Radiocommunication service-a service involving the transmission, emission, and/or reception of radio waves for specific telecommunication purposes.

Radiodetermination–the determination of the position, velocity, and/or other characteristics of an object, or the obtaining of information relating to these parameters, by means of the propagation properties of radio waves.

Radiodetermination-satellite service–a radiocommunication service for the purpose of radiodetermination involving the use of one or more space stations.

Radiodetermination service–a radio-communication service for the purpose of radiodetermination.

Radiolocation—radiodetermination used for purposes other than those of radionavigation.

Radiolocation service—a radiodetermination service for the purpose of radiolocation.

Radionavigation-radiodetermination used for the purposes of navigation, including obstruction warning.

Radionavigation-satellite service–a radio-determination-satellite service used for the purpose of radionavigation.

Radionavigation service—a radiodetermination service for the purpose or radionavigation.

Recognized private operating agency–any private operating agency, as defined above, which operates a public correspondence or broadcasting service and upon which the obligations provided for in article 44 of the convention are imposed by the member in whose territory the head office of the agency is situated, or by the member that has authorized this operating agency to establish and operate a telecommunication service on its territory.

Regions of ITU–for the allocation of frequencies, the world has been divided into three regions by ITU. Exact boundaries of the regions are given in the radio regulations; a general description follows: *region* I—Europe, Africa, the U. S. S. R., Turkey, the Territory of the Mongolian People's Republic, and areas to the north of the U. S. S. R.; *region* 2–North, Central, and South Americas, the Caribbean, and Greenland; and *region* 3—Asia, Oceania, Australia, and New Zealand.

Safety service—a radio-communication service used permanently or temporarily for the safeguarding of human life and property.

Satellite-a body that revolves around another body of preponderant mass and that has a motion primarily and permanently determined by the force of attraction of that other body.

Satellite link-a radio link between a transmitting Earth station and a receiving Earth station through one satellite.

Satellite system—a space system using one or more artificial Earth satellites.

Secondary service—a class of allocation. Stations on a secondary service may not cause interference to stations in a primary or secondary service, and may not claim protection against interference from stations in a primary service existing or subsequently installed. Printed in upper and lower case in the ITU table of allocations.

Services—a functional use of the radio spectrum where designated frequency bands are allocated for particular uses, e.g., broadcasting service, radiolocation service.

Space-radio communication—any radio communication involving the use of one or more space stations or the use of one or more reflecting satellites or other objects in space.

Space research service—a radio-communication service in which spacecraft or other objects in space are used for scientific or technological research purposes.

Space system–any group of cooperating Earth stations and/or space stations employing space-radio communication for specific purposes,

Telecommunications—any transmission, emission, or reception of signs, signals, writing, images, and sounds or intelligence of any nature by wire, radio, optical, or other electromagnetic systems.

Telegram—written matter intended to be transmitted by telegraphy for delivery to the addressee. This term also includes radiotelegrams unless otherwise specified.

Telegraphy–a form of telecommunication that is concerned in any process providing transmis-

sion and reproduction at a distance of documentary matter, such as written or printed matter or fixed images, or the reproduction at a distance of any kind of information in such a form. For the purposes of the radio regulations, unless otherwise specified therein, telegraphy shall mean a form of telecommunication for the transmission of written matter by the use of a signal code.

Telephony–a form of telecommunication set up for the transmission of speech or, in some cases, other sounds.

Television—a form of telecommunication for the transmission of transient images of fixed or moving objects.

Terrestrial radio communication—any radio communication other than space-radio communication or radio astronomy.

WARC-77—a specialized World Administrative Radio Conference that met in Geneva in the winter of 1977 to plan for the broadcasting-satellite service in the band 11.7 to 12.5 GHz.

WARC-79–a General World Administrative Radio Conference that met in Geneva in the fall of 1979 to revise the international radio regulations of ITU.

Selected Bibliography

Selected Bibliography

1. Abrams, E., "Should the U.S.A. Go It Alone on International Frequency Allocation?" *Television International,* April 1978.
2. Adserman, P. G., and Weinberger, H. L., "Satellite Systems for Industrialized Nations—After WARC '79, " *8th AIAA Conference,* Orlando, Fla., April 1980.
3. A-M M'Bow, UNESCO document, April 1980, Paris.
4. Agnew, C. E., Gould, R. G., Dunn, D. A., and Stilbolt, R. D., Mathtech, Inc., and Telecommunications Systems, "Economic Techniques. for Spectrum Management, " study prepared for NTIA, Boulder, Colo., Dec. 20, 1979.
5. Armstrong, A. A., "Was WARC a Victory for the U.S.?" *Information World,* February 1980.
6. Arthur D. Little, Inc., report on "An Analysis of Probable Worldwide Reactions to United States Proposals to the 1979 World Administrative Radio Conference, " prepared for the Senate Committee on Commerce, Science and Transportation, September 1979, Congressional Record, Sept. 6, 1979, S12113.
7. Astrain, S., "Telecommunications and the Economic Impact of Communications Satellites, " paper presented at the International Astronautical Federation 31st Congress, Tokyo, Japan, pp. 21-28, September 1980.
8. *Aviation Week and Space Technology,* "U.S. Abandons Its 'Evolutionary' Approach to Space Broadcasting, " May 5, 1980.
9. Ballinger Publishing Co., *High and Low PoZitics: Information Resources for the 80's*— Oettinger, Berman, Read (Part Three–For *eign Policy: The High and Low Politics of Telecommunications* by William H. Read), pp. 202, 228-229, and 235, 1977.
10 Berry, L. A., and Haakinson, E. J., "Spectrum Efficiency for Multiple Independent Spread-Spectrum Land Mobile Radio Systern, " NTIA Report (for the FCC), November 1978, ITS, NTIA, Department of Commerce, Boulder, Colo.
11. Bowers, R., Lee, A. M., and Hershey, C. (eds.), *Communications for a Mobile Society* (Beverly Hills, Calif.: Sage Publications, 1978).
12 Bowie, N. A., "Third World Countries at WARC: Positions and Achievements, " presented at the Conference on World Communications: Decisions for the Eighties, Annenberg School of Communication, University of Pennsylvania, Philadelphia, Pa., May 1980.
13. Bradley, W. E., "Communications Strategy of Geostationary Orbit, " *Astronaut, vol. 6, No. 4,* April 1968.
14. Bray, C. W., III, "Assuring the Future: A Diplomat's Concerns, " paper presented before the Conference on Improving American Competence in World Affairs: An Agenda for Action, San Francisco, Calif., Jan. 19, 1981.
15. *Broadcasting,* "WARC-79, The Haves and the Have-Nets, " Jan. 1, 1979.
16. Butler, R, E., "Current International Communication Policy—Deliberations and Dilemmas," paper presented at the Pacific Telecommunications Conference, Honolulu, Hawaii, January 1981.
17. _____, "Overview of the WARC-79—Future Cooperation Considerations, " paper presented at the AIAA/IEEE symposium, January 1981.
18. Clark, A. C., "Extraterrestrial Relay s," *Wireless World,* October 1945, pp. 305-308.
19. Cease, R. H., Meckling, W., and Minasian, J., "Problems of Radio Frequency Allocation, " RM-3598-NASA, Rand Corp., Santa Monica, Calif., May 1963.
20. Cease, R. H., "The Federal Communications Commission, " *Journal of Law and Economics,* Oct. *2, 1959.*
21. Codding, G. A., Jr., "Decisionmaking in the International Telecommunications Union: The Nature and Role of the New Third World Majority, " final report to the National Science Foundation, NSF Award No. OAR-7910228, 1980.
22 _____, The International Telecommunications Union, An Experiment in International Cooperation (Leiden, Netherlands: E. J. Brill, 1952), reprint edition, 1972, Arno Press Inc.
23. _____, The U.S. and the ITU in a Changing World, Office of Telecommunications, Department of Commerce, special publication 75-6, December 1975.
24. Comsat 17th Annual Report to the President and the Congress, December 1980.
25. Cook, W. J., and Weatherford, J. E., "The

World Administrative Conference 1979 Results and Impact on Defense and National Security, " Proceedings of IEEE International Communications Conference, Seattle, Wash., IEEE Catalog No. 80CH15-5-6CSCB June 1980.
26. Cook, W. J., "WARC-79 and Its Impact on Defense and National Security," *Signal*, vol. 34, No. 9, pp. 11-15, July 1980.
27. Cooper, G. R., Nettleton, R. W., and Grybos, D. P., "Cellular Land-Mobile Radio: Why Spread Spectrum?" *IEEE Spectrum*, March 1979, pp. 17-24.
28. Cooper, G. R., and Nettleton, R. W. "A Spread-Spectrum Technique for High-Capacity Mobile Communications, " *IEE Transaction Vehicle Technology*, vol. VT-27, November 1978.
29. Cooper, G. R., "Multi-Service Aspects of Spread-Spectrum Mobile Communications Systems, " Conference Record, MIDCON/78, Dallas, Tex., Dec. 12-14, 1978.
30. Cox, R. W., and Jacobson, H. K., *The Anatomy of Influence, Decisionmaking in International Organization (New* Haven and London: Yale University Press, 1973), ch. 3, ITU: A Potpourri of Bureaucrats and Industrialists.
31. Craven, T. A. M., "Report of the Chairman of the United States Delegation to the 1959 WARC, " Department of State, ID serial No. 906, document No. 46, March 1960.
32. Crowell, R. B., "Developing Strategies to Use Technology and Plan Systems in a Changing World: Can All the Variables Be Integrated?" *Signal*, August 1981, p. 92.
33. Cutts, R. L., "The FCC Role in National Spectrum Management–A Brief Overview," paper presented at the George Washington University Seminar: The Government's Role in Radio Spectrum Management, May 1980.
34. de Sola Pool, I., "The Problems of WARC, " *Journal of Communication%* winter, 1979.
35. Dean, W., Jr., letter report to Dr. M. J. Stoil of KAPPA Systems, Inc., dated Feb. 11, 1981.
36. *Demodular*, "WARC-79," pp. 2-8, January/February 1980.
37. Dinneen, G. P., letter to W. Bader, Staff Director, Committee on Foreign Relations, U.S. Senate, and attached report on DOD assessment of the impact of WARC-79 on U.S. national security, Mar. 21, 1980.
38. Dorian, C. J., Potts, B. E., Reinhart, E., and Weiss, H., "The 1979 World Administrative Radio Conference and Satellite Communications, " *COMSAT Tech. Rev.*, vol. 10, No. 1, spring, 1980.
39. Dougherty, H. T., and Smith, E. K., "The CCIR and Radio Propagation–A Mini-Review, ' *IEEE Trans. Ant. an Prop.*, vol. *AP-24, No. 6*, pp. 910-912, November 1976.
40. Dunn, D. A., and Own, B., "Policy Options in Mobile Radio Spectrum Management, " unpublished manuscript, September 1978.
41. Dunn, D. A., and Eric, M. J., "The Economics of Packet Switches, " Stanford University, 1973.
42. Ebel, A. J., Chairman, Frequency Management Advisory Council, letter to Ward H. White, Subcommittee on Communications, Senate Committee on Commerce, Science, and Transportation attaching views on "Organization of Telecommunications Policy and Management in the New Administration, " Nov. 25, 1980.
43. Edward, R., "The Needs and Dilemmas of U.S. International Information Policy, " a study prepared for NTIA, October 1978.
44. Ehrlich, N., "The Advanced Mobile Phone Service, " *IEEE Communications Magazine,* March 1979, IEEE, New York, 0163-6804/79/0300-0009.
45. Federal Communications Commission, 76-677, docket No. 20468, "An Inquiry Relating to the Preparations for the 1977 World Administrative Radio Conference of the International Telecommunication Union for Planning of the Broadcasting–Satellite Service in the 11.7 -12.2 GHz Band, " report and order released Aug. 6, 1976.
46. _____, 78-849, docket No. 20271, "An inquiry Relative to Preparation for a General World Administrative Radio Conference of the International Telecommunication Union to Consider Revision of the International Radio Regulations, " report and order released Dec. 28, 1978.
47. _____, 80-695, general docket No. 80-739, "Implementation of the Final Acts of The World Administrative Radio Conference, " first notice of inquiry, released Dec. 30, 1980.
48. _____, 81-323, general docket No. 80-739, "Implementation of the Final Acts of The World Administrative Radio Conference, " third notice of inquiry, released Aug. 7, 1981.

49. _____, public notice No. 25215, Staff Report to the Commission on the Results of the 1979 World Administrative Radio Conference, Jan. 15, 1980.
50. Feigleson, H., "High Frequency in the Future," *IEEE Transactions on Electromagnetic Compatibility,* vol. EMC-23, No. 3, August 1981.
51. Foreign Relations Authorization Act, fiscal year 1979, Public Law 96-426,92 STAT 963, sec. 601.
52. Feigleson, H. A., "High Frequency in the Future," *IEEE Transactions on Electromagnetic Compatibility,* vol. EMC-23, No. 3, August 1981, draft.
53. Fuenzalida, J. C., "A Comparative Study of the Utilization of the Geostationary Orbit," in Proceedings of the INTELSAT/IEE Conference Digital Satellite Communication, November 1969.
54 Galloway, J. F., "The Politics and Technology of Satellite Communications," Lexington Books, D.C. Heath & Co., 1972.
55 Ganley, O., "Why Communications and Information Resources Deserve Policy Attention: Chronical of International Communication," vol. II, No. 4, April 1981.
56 General Secretariat of ITU, International Telecommunications Union, Final Acts of the International Telecommunication and Radio Conferences, Atlantic City, 1947, Geneva, Switzerland.
57. _____, International Telecommunications Union, International Telecommunication Convention, Geneva, 1959, Geneva, Switzerland.
58. _____, International Telecommunications Union, International Telecommunication Convention, Montreux, 1965, Geneva, Switzerland.
59. _____, International Telecommunications Union, International Telecommunication Convention, Final Protocol, Additional Protocols, Resolutions, Recommendations, and Opinions, Malaga-Torremolinos, Geneva, Switzerland, 1973.
60. Gould, R. G., and Reinhart, E. E., "The 1977 WARC on Broadcasting Satellites: Spectrum Management Aspects and Implications," *IEEE Transactions on Electromagnetic Compatibility,* vol. EMC-19, No. 3, August 1977.
61 Gunter, J. F., "An Introduction to the Great Debate," *Journal of Communication,* autumn, 1978, pp. 143-157.
62. _____ Senior Project Director, Academy For Educational Development, Inc., "The United States and the Debate on the World Information Order," Washington, D. C., 1979 for USICA.
63. Grybos, D. P., and Cooper, G. R., "A Receiver Feasibility Study for the Spread-Spectrum High Capacity Mobile Radio System," Conference Record, 28th Vehicle Technology Conference, Denver, Colo., Mar. 22-24, 1978, pp. 98-1.14.
64. Hagn, G. H., Jansky, D. M., and Dayharsh, T. I., "Definition of Measurement Capability for Spectrum Managers," *IEEE Transactions on Electromagnetic Compatibility, 13* MC-19:3, *1977,* pp. *216-224.*
65. Henry, P. S., "Spectrum Efficiency of a Frequency-Hopped DPSK Mobile Radio Systern," Conference Record, 29th IEEE Vehicle Technology Conference, March 1979, pp. 7-12, Chicago, Ill.
66. Hinchman, W. R, "The Electromagnetic Spectrum: What It Is and How It Is Used," app. A to a task force staff report, "Use and Management of the Electromagnetic Spectrum," President's Task Force on Telecommunication Policy, 1968.
67. _____ "Risks In Reliance on Spectrum Pricing," paper presented at the George Washington University Workshop on Challenges in Telecommunications and Information Handling, Mar. 18, 1981.
68. Honig, D. E., "Lessons for the 1999 WARC," *Journal of Communication,* spring 1980, vol. 30:2, The Annenberg School of Communications, 1980.
69. House Document No. 157, *Message From the President of the United States to the Congress of the United States,* 90th Cong., 1st sess., Aug. 14, 1967.
70. Hudson, H. E., Study Director. Academy for Educational Development, "Results and Implications of WARC-79 for Development Communications," a report to USAID, February 1980.
71. Hult, J. L., et al., "The Technology Potentials for Satellite Spacing and Frequency Sharing," Rand Corp., Santa Monica, Calif., Memo RM-5785-NASA, October 1968.
72. _____, and Reinhart, E. E., "Satellite Spacing and Frequency Sharing for Communication and Broadcast Services," *Proc. IEEE,* vol. 59, February 1979.
73. *IEEE Communications Society Magazine,*

"Editor's Note," vol. 17, No. 3, March 1979, p. 17.
74. *IEEE Communications Magazine,* Survey of Communication Satellites, September 1980.
75. *IEEE Spectrum,* "Single-Sideband Mobile Radio," March 1979, pp. 25-28.
76. _____, special issue, "Communications Onward to the BOS," October 1979.
77. _____, "SSB Transmission for Land Mobile Radio," vol. 15, pp. 33-37, July 1978.
78. _____, The Joint Technical Advisory Committee, "Engineering-The Key to Progress," a report on Technical Policies and Procedures for Increased Spectrum Utilization, March 1968.
79. *IEEE Transactions,* special joint issue on communications, AES, EMC, and V. T., in preparation, August 1981.
80. *IEEE Transactions on Electromagnetic Compatibility,* vol. EMC-19, No. 9, August 1977.
81. INTELCOM '79, "AGC, AFC and Tone Select Circuits for Narrowband Mobile Radio," Dallas, Tex., February 1979.
82 International Telecommunications Satellite System, *Annual Report,* Washington, D. C., 1979.
83 International Telecommunication Union. *Final Acts, WARC-79,* Geneva, Switzerland:
84. _____, *Final Acts, WARC-79,* 1979.
85 _____, *Final Acts of the World Administrative Radio Conference for Space Telecommunications* (Geneva: ITU, 1971).
86 *ITU Telecommunication Journal,* Regional Administrative MF Broadcasting Conference, region 2, vol. 47, No. 7, pp. 434-435, July 1980.
87. _____, Telecommunications in the United States, vol. 47, No. 6, pp. 307-411, June 1980.
88. _____, 35th Session of the Administrative Council, vol. 47, No. 8, pp. 492-494, August 1980.
89. Jackson, C. L., "Policy Options for the Spectrum Resource," *Options Papers,* prepared by the staff for use by the Subcommittee on Communications, Interstate and Foreign Commerce Committee, U.S. House of Representatives, Washington, D. C., May 1977.
90. _____ *Technology for Spectrum Markets,* Ph. D. 'dissertation, Massachusetts Institute of Technology, November 1976.
91. Jansky, D. M., and Jeruchim, M. C., "A Technical Basis for Communication Satellites to Share the Geostationary Orbit," paper 70-441, AIAA 3rd Communications Satellite Systems Conference, Los Angeles, Calif., April 1970.
92, Jansky, D. M., "Spectrum Management Techniques," Multi-Volume EMC Encyclopedia Series, vol. II (Germantown, Md.: Don White Consultants, Inc., 1977).
93. Jeruchim, M. C., "Orbit Utilization," presented at Electronics and Aerospace Systems Convention, Washington, D. C., October 1971.
94. _____ and Lilley, F. E., "Spacing Limitations o'f Geostationary Satellites Using Multilevel PSK Signals," IEEE Transaction Communication, vol. COM-20, October 1972.
95. Jowett, J. K. S., and Jefferis, A. K., "Ultimate Communications Capacity of the Geostationary-Satellite Orbit," Proc. Inst. Elec. Eng., vol. 116, August 1969.
96. Kane, D. A., and Jeruchim, M. C., "Orbital and Frequency Sharing Between the Broadcasting-Satellite Service and the Fixed-Satellite Service," Proc. Int. Conference on Communications, Philadelphia, Pa., June 1972.
97 Kelleher, J. J., "Regulatory Procedures and WARC-1979," IEEE Transactions.
98 Kelleher, J. J., Weatherford, J., et al., "The WARC-79," final report, Systematic General Corp., vols. I and II, McLean, Va.
99. Kelley, R. L., Khatri, R. K., Kiesling, J. D., and Weiss, J. A., "Communications Systems Technology Assessment Study," Fairchild Space and Electronic Co., 1976,
100. Kirby, R. C., and Smith, E. K., The International Radio Consultative Committee, part 2, *IEEE Corn. Soc.,* vol. 12, No. 5, pp. 12-19, 1974.
101. Kirby, R. C., "WARC Plots Spectrum Use," *IEEE Spectrum,* February, 1980.
102. Kleinrock, L., *Queueing Systems,* vol. 1 (New York: Wiley, 1976).
103. Krassner, G. M., and Michael, J. V., "Introduction to Space Communications Systems," McGraw-Hill, 1964, pp. 87-89.
104. Levin, H. J., *The Invisible Resource,* Johns Hopkins University Press, 1971.
105. _____, "Alternative Strategies for Managing Orbit and Spectrum Resources—Third World Demands for Domestic Satellite Service," paper presented at the Third Pacific Telecommunications Conference, Honolulu, Jan. 12-14, 1981.

106. Lieve, D. M., "International Telecommunications and International Law: The Regulation of the Radio Frequency Spectrum," A. W. Sijthoff/Leyder (Dobbs Ferry, N. Y.: Oceana Publications, Inc., 1970).
107. Lusignan, B. B., "Spectrum Efficiency of SSB Radio With Amplitude Compandors," *29th Vehicle Technology Conference,* Chicago, Ill., 1979.
108. MacBride Report, issued by UNESCO at its 21st general conference in Belgrade, Yugoslavia, Sept. 23 to Oct. 28, 1980.
109. Matsushita, M., and Majima, J., "Efficient Utilization of Orbit/Frequency for Satellite Broadcasting," *IEEE Trans. Aerosp. Electron. System,* vol. AES-9, January 1973.
110. McElroy, J. H., Director, Communications Division, Office of Space and Terrestrial Applications, NASA, U.S. Congress, House Committee on Science and Technology, Subcommittee on Transportation, Aviation, and Communications, and Subcommittee on Science, Research, and Technology, June 1980.
111. Michaelis, A. R., "From Semaphore to Satellite, International Telecommunications Union, Geneva, Switzerland, 1965.
112. Mikulski, J. J., "Mobile Radio, To Spread or Not to Spread?" *IEEE Communications Magazine,* July 1979, p. 2.
113. Minasian, J. P., "Property Rights in Radiation: An Alternative Approach to Radiofrequency Allocation s," *Journal of Law and Economics 18,* April 1975, pp. 221-272.
114. Mizuno, T., Ito, Y., and Muratani, T., "Efficient Use of Geostationary Satellite Orbit Through Optimization of Satellite Locations," *IEEE ICC,* June 1979, p. 40.7.1.
115. Nelson, S. L., Report on WARC 2979, Washington, Consumers Union.
116. Nettleton, R. W., and Cooper, G. R., "Mutual Interference in Cellular LMR Systems: Narrowband and Broadband Techniques Compared," Conference Record, MIDCON/77, Chicago, Ill., Nov. 8-10, 1977.
117. Nettleton, R. W., "Spectral Efficiency in Cellular Land Mobile Communications: A Spread-Spectrum Approach," Purdue University, West Lafayette, Ind., Ph. D. dissertation, 1978.
118, New *York Times,* editorial, "The Media and the Goats," New York, N. Y., Nov. 27, 1978.
119, NTC, Conference Record, "Error Performance of a Spread-Spectrum Mobile Communications System in a Rapidly Fading Environment, Los Angeles, Calif., Dec. 5-7, 1977.
120, National Telecommunications and Information Administration, "A Summary of the Federal Government's Use of the Radiofrequency Spectrum," Washington, D. C., July 1977.
121. _____, Executive Order No. 12046, establishing, March 1978.
122. _____, Manual of Regulations and Procedures for Federal Radiofrequency Management, Washington, D. C., revised periodically.
123. _____, "Report of the IRAC," Washington, D. C., issued semiannually.
124. OTP (now NTIA), "The Radiofrequency Spectrum: U.S. Use and Management," Washington, D. C., August 1975.
125. Pelton, J. N., and Snow, M. S., Economic and Policy Problems in Satellite Communications (New York: Praeger Publishers, 1977).
126. Plotkin, H. A., "Measurement and Analysis of Some Economic Effects of Land Mobile Radio Congestion," Stanford University, Ph. D. thesis, 1972.
127. Possner, K. B., "Legislative Involvement in Telecommunications Policy: The 1979 World Administrative Radio Conference," paper presented at the November 1978 International Law Weekend, printed by the Communications Media Center, New York Law School, 1979.
128. *President's Task Force on Communications Policy,* final report, Dec. 7, 1968.
129. Public Law 404, 60 Stat. 237, 5 U.S.C. 1001-1011, The Administrative Procedure Act, as amended, June 1946.
130 Public Law 624, 76 Stat. 419, 47 U.S.C. 701-744, Communications Satellite Act of 1962.
131, Regier and Meekling, Rand memorandum RM-2709-NASA, "Communications Satellites: An Introductory Survey of Technology and Economic Promise," September 1960.
132, Reinhart, E. E., "Impact of the 1979 WARC on Certain Space Communication Services," Proc. Int. Conference Communications, Seattle, Wash., June 1980.
133. Rendink, D. O., Acampora, A. S., and Yeh, Y. S., "The Transmission Capacity of Multibeam Communication Satellites," *Proc. IEEE,* vol. 69, February 1981.
134. Report of the "Commission on the Organiza-

tion of the Government for the Conduct of Foreign Policy," June 27, 1975.
135, Roberts, C., "Spectrum Economics for Land Mobile Radio," remarks before the 14th Annual Meeting of the National Association of Business and Educational Radio, Hershey, Pa., July 12, 1979.
136. Robinson, G. O., U.S. Congress, House Committee on Foreign Affairs, statement on Subcommittee on International Operations, unpublished statement, June 14, 1979.
137. _____, "Regulating International Airwaves: The 1979 WARC," Virginia Journal of International Law, vol. 21, No. 1, fall 1980.
138. _____ "Report of the Chairman of the United States Delegation to the World Administrative Conference of the International Telecommunication Union, Geneva, Switzerland, Sept. 24 to Dec. 6, 1979," TD Serial No. 116, Department of State, Office of International Communications Policy, Washington, D. C., 1980.
139. _____, Chairman, U.S. Delegation to WARC-79, testimony before the Subcommittee on International Operations, Committee on Foreign Affairs, House of Representatives, to review the results of WARC-79, July 31, 1980.
140. Robinson, J. O., "An Investigation of Economic Factors in FCC Spectrum Management," Federal Communications Commission, FCC/OCE 76-01, August 1976.
141. _____, "Assignment of Channels in the Multipoint Distribution Service by Auction," presented at the Sixth Telecommunications Policy Research Conference, Airlie, Va., May 1978.
142. Rosenblum, V. G., "Low Visibility Decisionmaking by Administrative Agencies: The Problem of Radio Spectrum Allocation," *The Administrative Law Review*, vol. 18, fall 1965.
143, Rutkowski, A. M., "Six Ad-Hoc Two: The Third World Speaks Its Mind," *Satellite Communications*, March 1980, pp. 22-27.
144, _____, "A Structured Analysis of WARC-79" study prepared for the United Nations Educational, Scientific, and Cultural Organization, March 1980.
145. _____, "United States Policymaking for the Public International Forums-on Communication," *Syracuse Journal of International Law and Commerce*, vol. 8, No. 1, summer 1981.
146. Satellite Communications, "1979 9-WARC: Advisory Committee Meets for First Time," pp. 19-21, August 1978.
147. Sawitz, P. H., "Spectrum-Orbit Utilization: an Overview," presented National Telecommunication Conference, New Orleans, La., December 1975.
148. Schmitt, H. H., one Senator's view, *Journal of Communication*, winter 1979.
149. *Science*, "Encounters With The Third World Seen in Allocating Frequencies," vol. 201, pp. 24-25, August 1978.
150. Signitzer, B., "Regulation of Direct Broadcasting From Satellites," *The UN Involvement, (New* York: Praeger Publishers, 1976).
151. Smith, E. K., "The History of the ITU With Particular Attention to the CCITT and the CCIR, and the Latter's Relations With URSI," *Radio Science*, vol. 11, No. 6, pp. 497-507, June 1976.
152 Smith, E. K., and Kirby, R. C., The International Radio Consultative Committee (CCIR): part 1, *IEEE Corn. Soc.*, vol. 12, No. 4, pp. 12-19, 1974.
153. Smith, M. S., "The 1979 World Administrative Radio Conference: Issues Concerning U.S. Preparatory Activities for ITU Conferences," report prepared by the Congressional Research Service, Library of Congress, at the request of the Subcommittee on Government Information and Individual Rights, Committee on Government Operations, U.S. House of Representatives, Dec. 16, 1980.
154, Stewart, I., Chairman, a report by the President's Communications Policy Board, *Telecommunications—A Program for Progress*, March 1951.
155. Systematic General Corp., "The World Administrative Radio Conference 1979," final report, vols. I and II, McLean, Va., July 1980.
156, Tycz, T. S., and Schaefer, K., paper on "The Role of the FCC Within the United States Organization for the International Radio Consultative Committee," Dec. 5, 1980.
157. U.S. Department of Commerce, "A Summary of the Federal Government's Use of the Radio Frequency Spectrum," report by NTIA project 9037102, July 1980.
158. _____, Bureau of the Census, *Statistical Abstract of the United States, 1980* (Washington, D. C.: Government Printing Office).
159. U.S. Government Printing Office, The Communications Act of 1934, as amended.

160. _____, *Economic Report of the President,* Washington, D. C., 1980.
161. _____ "International Information Flow: Forgin'g a New Framework, " 32d report by the Committee on Government Operations, House Report No. 96-1535, 1980.
162. _____, Federal Communications Commission, *Annual Report,* Washington, D. C., 1980.
163. U.S. National Aeronautics and Space Administration, summary report on "The 1979 General World Administrative Radio Conference, ' memorandum for the record, May 23, 1980.
164. U.S. Senate, Sen. Barry Goldwater, speech at the Armed Forces Communications and Electronics Association luncheon concerning WARC-79 and U.S. participation in international telecommunication conferences, Mar. 12, 1981.
165. _____, Sen. Harrison Schmitt, letter dated Sept. 28, 1978, to Charles Ferris, Chairman, FCC, and reply letter dated Oct. 20, 1978, from Charles Ferris to Sen. Harrison Schmitt.
166. _____, Sen. Harrison Schmitt, letter dated Aug. 3, 1979, to Glenn O. Robinson, Chairman, U.S. Delegation 1979 WARC; and reply letter dated Aug. 29, 1979, from Glenn O. Robinson to Sen. Harrison Schmitt.
167. U.S. Department of State, proposals of the United States for WARC-79, January 1979.
168. _____, summary report No. 9, "World Administrative Radio Conference, " December 1979.
169, _____, TD Serial No. 80, Report of the U.S. Delegation to the World Administrative Radio Conference for the Planning of Broadcasting Satellite Service in Frequency Bands 11.7 to 12.2 GHz, in regions 2 and 3, and 11.7 to 12.5 GHz, in region 1, p. 40, Geneva, Switzerland, Jan. 10 to Feb. 13, 1977.
170. Wallenstein, G. D., "International Telecommunication Agreements" (Dobbs Ferry, N. Y., Oceana Publications, Inc., 1977).
171. Webbink, D. W., "How Not to Measure the Value of a Scarce Resource: The Land Mobile Controversy, " *Federal Communications Bar Journal, 1969,* pp. 202-209.
172. _____ "The Value of the Frequency Spectrum Allocated to Specific Uses, " *IEEE Transactions on Electromagnetic Compatibility,* EMC-19, *No. 3,* August 1977, pp. 343"351.
173. Wilmotte, R. M., "Spectrum Efficient Technology for Voice Communication, VHF Task Force Report, Office of Plans and Policy, FCC, Washington, D. C., February 1978.
174. Withers, D. J., "Effective Utilization of the Geostationary Orbit for Satellite Communications, " Proc. IEEE, vol. 65, March 1977.
175. _____ "International and Mobile Satellite Systems After WARC-79, " 8th AIAA Conference, Orlando, Fla., April 1980.
176. Yates, R. D., and Cooper, G. R., "Design of Large Signal Sets With Good Aperiodic Correlation Properties, Purdue University, West Lafayette, Ind., technical report TR-EE66-13, September 1966.

U.S. GOVERNMENT PRINTING OFFICE : 1982 0 - 84-591