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**Report to the Chairman, Committee on
Energy and Commerce, House of
Representatives**

January 1989

TELECOMMUNICATIONS

**Federal
Communications
Commission Spectrum
Management**



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Resources, Community, and
Economic Development Division

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The Honorable John D. Dingell
Chairman, Committee on Energy and
Commerce
House of Representatives

Dear Mr. Chairman:

As requested in your February 17, 1988, letter and in subsequent discussions with your office, this report answers several questions relating to your concern about the effectiveness of the Federal Communications Commission's (FCC) management of the radio frequency spectrum used by the private sector and state and local governments. In addition, as requested, we obtained information on the National Telecommunications and Information Administration's (NTIA) spectrum management and its views on FCC's management.¹ This report answers the following questions:

1. Does FCC have an inventory of "unused" spectrum to show which frequencies are available for future use?
2. What criteria does FCC follow in making spectrum allocation decisions?
3. What type of long-range planning process does FCC have for anticipating future spectrum demands and setting aside spectrum to meet those demands?
4. What management controls and oversight does FCC employ to ensure that the frequencies it assigns are efficiently used?
5. What internal evaluations and studies of its spectrum management has FCC undertaken in the last 10 years? What weaknesses in FCC's spectrum management were cited in these evaluations and studies? What recommendations for improvement were made? Has FCC acted on these recommendations?

¹NTIA, an agency within the Department of Commerce, manages the radio frequency spectrum used by the federal government.

Results in Brief

In summary we found the following:

- FCC does not routinely maintain an inventory of unused radio spectrum. FCC officials told us that maintaining such an inventory would have limited usefulness for FCC staff but may be useful to outside parties. NTIA also does not maintain an unused spectrum inventory.
- The overall criterion FCC follows in making radio spectrum frequency allocations is the public interest standard contained in the Communications Act of 1934, as amended. This standard simply means that the spectrum should be a resource managed for the benefit of the public. FCC has developed six general criteria, or principles, to use in determining whether the public interest will be served in an allocation decision. NTIA uses similar general guidance in its allocation of spectrum.
- FCC does not have a formal long-range planning process for anticipating future demands and setting aside spectrum to meet those demands. FCC officials question the feasibility and benefits of formal long-range planning in a period of rapid technological change. FCC does conduct various ad hoc spectrum planning activities, but these are not pulled together into a comprehensive document that is updated on a regular basis. NTIA officials, while recognizing the difficulty FCC has in conducting long-range planning, believe FCC would benefit from having a long-range plan and participating in NTIA's effort to prepare a national spectrum management plan.
- FCC relies on its rules and regulations governing license requirements and operation of radio systems to serve as controls over the efficient use of frequencies it assigns. These rules and regulations are established within the framework of FCC's rule-making process and promulgated in title 47 of the Code of Federal Regulations. The major difference between FCC and NTIA on how best to ensure efficient spectrum use is their views on monitoring radio signals. NTIA uses monitoring to help determine whether spectrum use is efficient, while FCC generally does not.
- FCC has not completed any internal evaluations or studies of its spectrum management during the last 10 years that have been officially endorsed by FCC. However, we identified eight studies on spectrum management authored by individual FCC staff members. Overall, the studies cited similar weaknesses related to time-consuming decision-making, inability to adjust past allocation decisions to reflect changing technology and consumer demand, rigid regulations, and inadequate information. The studies also made similar recommendations, encouraging more economic incentives and flexible regulations that would give licensees greater freedom to adjust their spectrum use to changing technology and regional conditions. The recommendations have been implemented to

varying degrees, except for issues involving spectrum use fees and auctions, which may require legislation. NTIA has funded three studies of its spectrum management.

A brief discussion of the information that we obtained follows. More detailed information on each question is presented in appendix I.

Background

The radio frequency spectrum is the medium that makes possible wireless communications of all sorts, such as land mobile radio, shortwave and commercial radio, television, microwave telephone relays, radar, radio navigation, radio astronomy, and various satellite transmission activities. By international agreement, the radio frequency spectrum has been defined as the range of frequencies extending from 10 kilohertz to 300 gigahertz (GHz).² One of the most important features of the radio spectrum is that some frequencies are better suited for certain communications tasks than other frequencies. This is because radio waves of different frequencies behave differently, particularly in the way they are affected by terrain and atmosphere.

As a natural resource, the radio frequency spectrum is like a river used for transportation—it cannot be used up, but it can suffer from congestion if too many people operate on it in an uncoordinated way. Therefore, the spectrum must be carefully managed, on both a national and an international level, in order to best meet the needs of a constantly increasing number and variety of users.

Pursuant to its basic legislative authority contained in the Communications Act of 1934, as amended (47 U.S.C. 151 *et seq.*), FCC is responsible for managing the radio frequency spectrum used by the private sector and state and local governments. Spectrum management for federal government uses is done by NTIA in the Department of Commerce.

FCC's spectrum management responsibilities include the allocation, assignment, and efficient use of the radio spectrum. Spectrum allocation involves setting aside bands, or blocks, of frequencies for the use of particular radio services. Spectrum assignment includes selecting and

²Radio waves are produced by the oscillation of electricity within a conductor, such as an antenna. The number of times per second that a radio wave undergoes a complete cycle of oscillation is called its frequency, which is measured in units called hertz. The terms kilohertz (thousands of hertz), megahertz (millions of hertz), and gigahertz (billions of hertz) are used in referring to the higher frequencies.

licensing the use of discrete frequencies within spectrum bands for the operation of individual radio systems. (In January 1988 FCC had about 2.1 million licensed radio users in its data base.) Efficient frequency use is sought primarily through FCC rules and regulations that govern license requirements and operation of radio systems. NTIA's responsibilities for spectrum use, which extend to agencies in the federal government, are similar to FCC's.

FCC Does Not Routinely Maintain an Unused Spectrum Inventory

FCC does not routinely maintain an inventory of unused radio spectrum. FCC officials believe that maintaining such an inventory would have limited usefulness for FCC staff because the information is available from other sources. They explained that almost all of the readily usable spectrum (below 20 GHz) is heavily used and in demand while most spectrum above 20 GHz is unused because current technology limits practical use of this spectrum. FCC officials said that since almost all of the usable spectrum is now allocated and heavily used, most spectrum decisions deal with how to reallocate or make more extensive use of the spectrum, such as through sharing of frequencies by different radio services.

The Chief Engineer, FCC's primary spectrum management official, told us that an inventory may be useful to parties outside of FCC who may not be aware of what spectrum bands may be available for use. For this reason, he is considering maintaining the inventory.

In discussions with NTIA officials, we found that NTIA also does not have an inventory of unused spectrum. NTIA officials cited similar reasons for not having an unused inventory—the information is already known and has limited usefulness.

FCC Criteria for Allocating Spectrum

The basic criterion that FCC must follow in making spectrum allocation decisions is the public interest standard set forth in section 303 the Communications Act of 1934, as amended. Since the public interest is not specifically defined, FCC uses six general criteria for determining which allocations are in the public interest. The criteria include giving more consideration to proposed radio services that have no practical alternative to the spectrum and that will promote the safety of life and property, benefit a large number of people, and be accepted and used by consumers. NTIA also applies broad criteria similar to FCC's.

FCC's allocation criteria are applied as policy guidance, rather than as a rigid formula, on a case-by-case basis within the context of FCC's administrative rule-making process, using a notice and public comment procedure required by the Administrative Procedure Act (5 U.S.C. 551 et seq). This process allows all interested parties to be heard and their views to be considered. FCC views each request for spectrum as unique because the facts available and issues involved will differ. As a result, how the allocation criteria are applied will differ in each rule-making proceeding. In some rule-makings, national policy considerations, such as national security, may take precedence over the six general allocation criteria.

Although they believe that the allocation criteria are reasonable, FCC officials recognize the criteria's limitations. They believe the criteria must be broad to cover the many different allocation issues that come before the Commission but note that applying them to individual cases is not easy, largely because of the difficulty of obtaining adequate information on such questions as whether the public will accept and use a proposed new radio service. The officials and various internal studies also pointed out that since there is no charge for spectrum use, the criteria do not explicitly consider the economic value of the spectrum.

FCC Has No Long-Range Spectrum Plan

FCC does not have a formal long-range plan for anticipating future demands and setting aside spectrum to meet these demands. FCC officials question the feasibility and benefits of formal long-range planning. FCC does conduct various spectrum planning activities related to individual rule-making proceedings, but these are not pulled together into a comprehensive document that is updated on a regular basis. Although FCC and NTIA officials agree that anticipating future spectrum demands is more difficult for FCC, which manages thousands of private sector radio users, than for NTIA, which manages radio usage for a comparatively small number of federal agencies, NTIA officials believe that FCC would benefit from having a long-range plan.

Most FCC officials we interviewed questioned the benefits of a formal long-range planning process given the difficulty of trying to anticipate future spectrum demands in an era of rapid technological change in the telecommunications industry. They emphasized that any FCC attempt to forecast spectrum demand would be extremely difficult because of the proprietary nature of technology undergoing research and development in the telecommunications industry. FCC would also need to know industries' plans for bringing new technology to the marketplace in order to

accurately forecast spectrum demand. The questionable value of forecasting future spectrum demands was also cited by FCC officials as a reason why FCC did not fully participate in an effort by NTIA to develop a national long-range plan for management and use of the radio spectrum.

We found that FCC does conduct various planning activities related to preparing for periodic international conferences and responding on an ad hoc basis to surfacing issues affecting certain radio services or bands of the radio spectrum. FCC officials also pointed out that they keep up to date with technological developments affecting the radio spectrum by maintaining contacts with industry representatives. The officials said that these planning activities, carried out through FCC's rule-making process or at the initiative of individual FCC bureaus, are not pulled together into a comprehensive document that is updated on a regular basis.

Both FCC and NTIA officials also pointed out that anticipating future spectrum demands is a more complicated process for FCC than for NTIA. They emphasized that the nature and number of radio users FCC must regulate differs considerably from the federal agencies NTIA regulates. Whereas 20 federal agencies account for almost all federal spectrum use and meet frequently as a committee, FCC must oversee thousands of different radio users in the private sector. And whereas NTIA, as the organization responsible for managing the federal government's use of the radio spectrum, is in a position to obtain the cooperation and participation of federal agencies when developing demand forecasts, FCC is in a weaker position relative to its radio users in the private sector.

FCC Controls and Oversight for Ensuring Efficient Spectrum Use

FCC's basic management controls for ensuring that the frequencies it assigns are efficiently used are its rules and regulations governing license requirements and operation of radio systems. These rules and regulations are established within the framework of FCC's rule-making process and promulgated in title 47 of the Code of Federal Regulations. Periodically, FCC reviews its rules and regulations, eliminating or updating them to reflect technological developments and changing economic conditions. NTIA's approaches to ensuring efficient spectrum are similar to FCC's. The major difference between FCC's and NTIA's approaches is their views on monitoring.³ FCC officials believe the benefit of monitoring is not worth its cost; NTIA officials see monitoring as providing information on actual use that is vital to making spectrum management decisions.

³Monitoring measures the amount of time a radio channel is occupied with a signal.

The responsibility for overseeing compliance with FCC rules and regulations is divided among four bureaus. Each bureau applies various approaches depending on the nature of the particular radio service, ranging from enforcement programs directed at specific radio services to public service and educational activities intended to improve public understanding of FCC requirements. Two approaches FCC uses only to a limited degree are monitoring radio signals and on-site inspections.

According to FCC officials, in recent years FCC's approach for promoting efficient spectrum use has moved away from stringent regulatory requirements in favor of less restrictive regulations that give radio users more flexibility and economic incentives to adjust use of their assignments to changing technology and regional conditions. FCC believes that giving licensees greater freedom to design and construct radio systems that meet their needs and the needs of their customers is an effective way to ensure spectrum efficiency. At the same time, the Chief Engineer cautioned that FCC's regulations are still an important element of its spectrum management.

NTIA employs a variety of approaches similar to FCC's for ensuring efficient frequency use. In contrast to FCC, though, NTIA believes that monitoring is an important "real world" input available for making spectrum management decisions and has established a spectrum monitoring program.

Internal Evaluations or Studies for Improving Spectrum Management

In the last 10 years, FCC has not undertaken any evaluation or study of its spectrum management. However, during that period individual FCC staff members prepared eight studies that evaluated the effectiveness of FCC's traditional administrative rule-making approach to spectrum management. Overall, the studies concluded that this approach was time-consuming, made adjusting to changing conditions difficult, was not able to provide the information necessary for evaluating competing services, and hindered the introduction of new technology. The studies attributed these weaknesses to rigid regulations and a lack of economic incentives. The studies made recommendations to improve the administrative rule-making approach by giving radio users greater flexibility in using spectrum and relying more on economic incentives or market forces.

None of the eight studies was endorsed or adopted by FCC as representing the Commission's official position on spectrum management, nor was there any effort to respond to the studies' recommendations. However, the recommendations are generally consistent with what FCC officials

have identified as a trend in FCC's rule-making decisions to impose less stringent regulations and more economic incentives on licensed radio users. According to FCC officials, the studies' recommendations have been implemented in varying degrees in individual rule-making proceedings except for issues involving spectrum use fees and auctions, which they feel may require legislation.

According to NTIA officials, periodic evaluations can be helpful in identifying ways to more effectively manage the spectrum. NTIA had funded three studies of spectrum management by outside contractors. Our review of these studies found two of them to be narrowly focused—one was essentially a descriptive presentation of how NTIA manages the spectrum, and another was an assessment of which spectrum management functions could be contracted out. The third study was a more comprehensive effort that evaluated information needed for long-range spectrum planning.

Objective, Scope, and Methodology

Our objective was to provide answers to a series of questions pertaining to FCC's management of the radio frequency spectrum, along with NTIA's views of spectrum management and of FCC's management. Our audit work was conducted primarily at FCC's and NTIA's headquarters in Washington, D.C., between July and September 1988 in accordance with generally accepted government auditing standards.

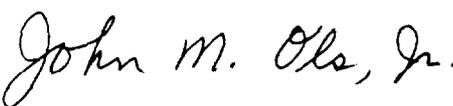
To conduct our work, we interviewed FCC and NTIA officials responsible for spectrum management, reviewed relevant studies on spectrum management conducted during the last 10 years, and reviewed various FCC rule-making decisions, which were useful examples of FCC's approach to spectrum management. Specifically, we interviewed officials from FCC's Office of Managing Director, Office of Plans and Policy, Office of Engineering and Technology, Field Operations Bureau, Private Radio Bureau, Mass Media Bureau, and Common Carrier Bureau. We also interviewed officials from NTIA's Office of Spectrum Management.

We discussed the factual information in this report with FCC and NTIA spectrum management officials during the course of our work and have incorporated their views as appropriate. However, as your office requested, we did not obtain official agency comments on this report. As agreed, we plan no further distribution of this report for 7 days from its

issue date or until you publicly release it. At that time we will send copies to interested parties and make copies available to others upon request.

Major contributors to this report are listed in appendix III.

Sincerely yours,



John M. Ols, Jr.
Associate Director

Contents

Letter		1
Appendix I		12
Answers to Questions on FCC's Spectrum Management	FCC Does Not Routinely Maintain an Unused Spectrum Inventory	12
	FCC Criteria for Allocating Spectrum	13
	FCC Has No Long-Range Spectrum Plan	15
	FCC Controls and Oversight for Ensuring Efficient Spectrum Use	20
	Internal Evaluations or Studies for Improving Spectrum Management	22
Appendix II		25
Request Letter		
Appendix III		27
Major Contributors to This Report	Resources, Community, and Economic Development Division, Washington, D.C.	27

Abbreviations

FCC	Federal Communications Commission
GAO	General Accounting Office
GHz	gigahertz, or one billion cycles per second
ITU	International Telecommunications Union
kHz	kilohertz, or one thousand cycles per second
MHz	megahertz, or one million cycles per second
NTIA	National Telecommunications and Information Administration
RARC	Regional Administrative Radio Conference
WARC	World Administrative Radio Conference

Answers to Questions on FCC's Spectrum Management

In response to a February 1988 request of the Chairman, House Committee on Energy and Commerce, we are providing answers to the following questions relating to FCC's spectrum management:

1. Does FCC have an inventory of unused spectrum to show which frequencies are available for future use?
2. What criteria does FCC follow in making spectrum allocation decisions?
3. What type of long-range planning process does FCC have for anticipating future spectrum demands and setting aside spectrum to meet those demands?
4. What management controls and oversight does FCC employ to ensure that the frequencies it assigns are efficiently used?
5. What internal evaluations and studies of its spectrum management has FCC undertaken in the last 10 years? What weaknesses in FCC's spectrum management were cited in these evaluations and studies? What recommendations for improvement were made? Has FCC acted on these recommendations?

Our answers to these questions are detailed in the following sections.

FCC Does Not Routinely Maintain an Unused Spectrum Inventory

FCC does not routinely maintain an inventory of unused radio spectrum. However, on June 1, 1988, FCC provided the Chairman, House Committee on Energy and Commerce, with an inventory of unused and lightly used spectrum to comply with his February 1988 request to the FCC. FCC officials told us that they have not yet decided whether they will maintain and keep the inventory updated.

FCC officials believe that maintaining an inventory of unused spectrum would have limited usefulness for FCC staff because the information is already available from other sources. They explained that most of the readily usable spectrum (below 20 GHz) is already heavily used and in demand.¹ We noted that FCC's inventory shows only 18 mostly small

¹By international agreement, the radio frequency spectrum has been defined as the range of frequencies extending from 10 kilohertz to 300 gigahertz (GHz).

bands of spectrum below 20 GHz as being unused or lightly used.² Furthermore, 15 of these bands are either subjects of current FCC rule-makings or expected soon to have increased use. FCC officials also explained that most spectrum above 20 GHz is unused because current technology limits practical use of this spectrum. At this time, frequencies above 20 GHz are used primarily for experimental or developmental purposes. Because almost all of the usable spectrum is now allocated, most spectrum decisions now deal with how to reallocate or to make more extensive use of the spectrum, such as through sharing of frequencies by different radio services.

The Chief Engineer, FCC's primary spectrum management official, told us that an inventory may be useful to parties outside of FCC who may not be aware of the status of unused or lightly used spectrum bands. For this reason, he is considering maintaining the inventory.

In discussions with NTIA officials, we found that NTIA also does not have an inventory of unused spectrum. NTIA officials cited reasons similar to FCC's for not maintaining an unused inventory—the information is already known and has limited usefulness. The officials also commented that spectrum between 20 GHz and 40 GHz was gradually opening up to practical use as technology developed. They noted several applications under development by the Department of Defense, the National Aeronautics and Space Administration, and other federal agencies that were beginning to make use of this band.

FCC Criteria for Allocating Spectrum

The overall criterion FCC follows in making radio spectrum frequency allocations is the “public convenience, interest, or necessity” standard contained in the Communications Act of 1934, as amended. This standard, commonly referred to as the public interest standard, simply means that the spectrum should be a resource managed for the benefit of the public. FCC has developed six general criteria, or principles, to use in determining whether the public interest will be served in an allocation decision. These six guiding criteria are the following:

1. Does the communication service in question really require radio spectrum or can practical substitutes, such as wire or cable, be used instead? If wirelines can be used, there may be less need for spectrum.

²Together the 18 bands total about 1.5 GHz. However, one of these bands, allocated for broadcasting satellites, accounts for about 1.0 of the 1.5 GHz. According to FCC's inventory, no broadcasting satellite systems were operational but four construction permits had been granted and seven new applications were pending.

2. Is the communication service necessary for the safety of life and property, such as for use by police and fire departments? Safety services receive more consideration than convenience or luxury services.

3. How many people will benefit from the service? FCC usually decides in favor of the service proposing to serve the most people when all other factors are equal.

4. Does the service meet a substantial public need, and is it likely that the service can be established? Given the limited availability of spectrum, FCC desires that a service be publicly accepted and used.

5. Where in the radio spectrum can the communication service best operate? A radio service may be able to use frequencies in different parts of the spectrum, but the propagation characteristics of some frequencies may be more suitable than others.

6. What will be the financial costs, time involved, and other expenses involved in requiring an existing service to relocate to another part of the spectrum in order to make room for a new service? Relocating to another part of the spectrum generally requires equipment and other changes for existing licensees.

FCC applies these six criteria in the context of its formal rule-making process, using a notice and public comment procedure required by the Administrative Procedure Act (5 U.S.C. 551 *et seq.*). This process allows all interested parties to be heard and their views to be considered. After reviewing the information collected and considering the staff's advice, the five members of the Commission reach a decision.³ As part of this process, the Commission's rationale for an allocation decision, along with other documents related to the decision, becomes part of a public record and is available for public inspection.

FCC's allocation criteria are applied as broad policy guidance rather than as elements of a rigid formula. As such, their application depends, to a large extent, on the issues involved in a particular allocation proceeding. For example, although the criteria are not ranked in any order of priority, in an allocation proceeding certain criteria can take on special importance while others may not be considered at all because they are

³FCC is directed by five Commissioners appointed by the President and confirmed by the Senate for 5-year terms. At the completion of our review, FCC had only three Commissioners; two positions were vacant.

not relevant. In addition, in some cases other national or FCC policy goals, such as national security or universal telephone service,⁴ may override the general allocation criteria.

FCC officials that we interviewed generally agreed that the six criteria were reasonable for evaluating whether a proposed spectrum use was in the public interest. However, the officials and several studies by staff from FCC's Office of Plans and Policy raised concerns about the subjective nature of the criteria and the difficulty of obtaining adequate information for determining what is in the public interest, especially when different radio services are competing for the same spectrum. The officials and studies attribute these weaknesses, in part, to the lack of recognition given in the spectrum management process to the economic value of the spectrum. The studies conclude that more reliance on economic incentives and market forces would improve spectrum management. (These studies are discussed in more detail in the last section of this appendix.)

According to NTIA officials, FCC's spectrum allocation criteria are reasonable. In fact, NTIA uses similar general policy guidance for its allocation criteria. These criteria include judging how well the proposed service supports national security, safeguards life and property, stimulates social and economic progress, and conserves spectrum for uses for which other means of communications are not available or feasible.

FCC Has No Long-Range Spectrum Plan

FCC does not have a formal long-range plan for anticipating future demands and setting aside spectrum to meet these demands. FCC officials question the feasibility and benefits of formal long-range planning in a period of rapid technological change. FCC does conduct various spectrum planning activities related to individual rule-making proceedings, but these are not pulled together into a comprehensive document that is updated on a regular basis. Although FCC and NTIA officials agree that anticipating future spectrum demands is more difficult for FCC, which manages thousands of private sector radio users, than for NTIA, which manages radio usage for a comparatively small number of federal agencies, NTIA officials believe that FCC would benefit from having a long-range plan.

⁴One of FCC's basic obligations is to promote the general availability of residential telephone service, often referred to as its "universal service" goal.

FCC does not have a formal long-range planning process with elements such as the following: (1) a policy statement establishing a planning process and objectives to be accomplished; (2) written instructions for preparing a long-range plan; (3) a group of assigned staff or an organizational unit responsible for preparing the plan, keeping it current, and monitoring its implementation; (4) a process for review and approval of the long-range plan by top FCC management and the Commission; and (5) a system for maintaining the plan as an official agency document. Most FCC officials we interviewed questioned the benefits of such a formal long-range planning process given the difficulty of anticipating future spectrum demands in an era of rapid technological change in the telecommunications industry. They also emphasized that any FCC attempt to forecast spectrum demand would be extremely difficult because of the proprietary nature of technology undergoing research and development in the telecommunications industry. FCC would also need to know industries' plans for bringing new technology to the marketplace in order to accurately forecast spectrum demand.

We found that FCC does conduct various planning activities related to preparing for periodic international conferences and responding on an ad hoc basis to surfacing issues affecting certain radio services or bands of the radio spectrum. FCC officials also pointed out that they keep up to date with technological developments affecting the radio spectrum by maintaining contacts with industry representatives. The officials said that these planning activities, carried out through FCC's rule-making process or at the initiative of individual FCC bureaus, are not pulled together into a comprehensive document that is updated on a regular basis.

NTIA's Long-Range Spectrum Plan

Executive Order 12046, signed by President Carter in 1978, assigned responsibility for federal government spectrum management to the Department of Commerce.⁵ Section 2-409 of that order directed the Secretary of Commerce to "develop, in cooperation with the Federal Communications Commission, a comprehensive long-range plan for improved management of all electromagnetic spectrum resources." In May 1988 the Department of Commerce issued the first approved long-range plan under Executive Order 12046.⁶

⁵The Secretary of Commerce delegated spectrum management responsibility to the Assistant Secretary of Commerce for Communications and Information who serves as NTIA Administrator.

⁶The Department's May 1988 plan, Long-Range Plan for Management and Use of the Radio Spectrum, was not released to the public because portions of it were classified confidential because of certain military spectrum forecasts. In its next update of the plan expected in early 1989, the Department intends to prepare an unclassified version of the plan for public release.

NTIA's Director, Office of Spectrum Plans and Policy, told us that NTIA intended this long-range plan to be a national plan for management of both the federal and nonfederal radio spectrum. However, because FCC declined to participate fully in preparing the plan, it covers only the telecommunications requirements of the federal government. The Director stated that FCC's cooperation was limited to providing background material on the role of FCC in spectrum management and providing review comments on draft versions of the plan.

FCC officials told us that they did not develop data on nonfederal radio spectrum for the NTIA plan because anticipating future spectrum demands is an extremely complicated process for FCC. They emphasized that their ability to plan is limited because FCC must oversee thousands of different radio users in the private sector over which they have limited control. In contrast, they pointed out that NTIA's management of the federal government's spectrum involves primarily about 20 agencies from which NTIA can obtain greater cooperation and participation.

Although they recognize the difficulty FCC has in long-range planning, NTIA officials from the Office of Spectrum Management believe that FCC would benefit from having a long-range plan and participating in NTIA's effort to prepare a national spectrum management plan. They viewed FCC's spectrum management as too reactive—focused primarily on responding to immediate problems.

FCC Spectrum Planning

Although FCC does not have a formal long-range planning process, we found that it conducts various *ad hoc* planning activities related to preparations for periodic international conferences and issues affecting specific radio services or spectrum bands. We also found that although FCC appears to spend a great deal of time and effort on these planning activities, it has no management process that brings together its various planning processes into a single comprehensive spectrum plan that can be updated regularly. Rather, to the degree that these planning activities aid FCC in managing the spectrum, it is within the context of rule-making proceedings dealing with individual radio services or spectrum bands.

FCC Planning for International Radio Conferences

The United States plans and participates in international radio conferences as a member of the International Telecommunications Union (ITU), which is a United Nations agency that provides for allocating the electromagnetic spectrum for cooperative use by radio services around the world. At these World or Regional Administrative Radio Conferences

(WARC or RARC), ITU allocates frequency bands. The international spectrum allocations agreed to by ITU members establish the basic rules for subsequent national allocations.

WARCs are held whenever an issue arises that must be addressed by all member nations to facilitate efficient spectrum use. For example, a WARC was held in 1979 to reach global agreement concerning the international arrangements necessary for efficient and interference-free use of the radio spectrum. The purpose of the 1979 WARC was to reassess frequency allocations to all radio services throughout the world, as well as to reassess administrative and regulatory aspects of the radio regulations. WARCs with such broad agendas are held infrequently—the 1979 WARC was the first international conference in two decades to consider the entire range of radio services.

The agenda of most international conferences are generally more narrowly defined and deal with specific radio services or portions of the radio spectrum. For example, during the 1980s a WARC and RARC were held to address issues relating to the use and planning of the geostationary satellite orbit,^{7,8} a WARC for Mobile Services was held to consider and revise many of the provisions of the international Radio Regulations pertaining to the use of radio by mobile services, and a RARC (the Expanded Band Conference) was held to plan use in the Western Hemisphere of the AM broadcasting band from 1605 to 1705 kHz.⁹

U.S. preparations for these international conferences typically involve participation by FCC, NTIA, the State Department, and representatives from the private sector. In addition, as part of its rule-making process, FCC provides the opportunity for interested parties to comment and submit relevant information on issues to be considered at the conferences.

⁷Above the earth's equator, at an altitude of 22,300 miles, is an area called the geostationary satellite orbit. A satellite placed there completes one revolution of the earth at precisely the same rate as the earth makes one rotation on its axis (24 hours). Thus, a satellite placed in the geostationary orbit maintains the same position relative to any point on earth at all times. This is advantageous to communications satellites since it allows them to communicate steadily without changing positions. Since this is a finite space, there is competition for slots within it.

⁸GAO has issued two reports discussing preparations and results of one of these international conferences—the 1983 RARC on the broadcast satellite service. These are U.S. Preparations for an International Conference on Broadcast Satellites (GAO/RCED-83-121, Mar. 4, 1983) and U.S. Objectives Generally Achieved at Broadcasting Satellite International Conference—Improvements Can Help in Future Conferences (GAO/RCED-84-157, Aug. 2, 1984).

⁹The AM radio broadcasting band 535 to 1605 kHz in the Western hemisphere was expanded at the 1979 WARC to include 1605 to 1705 kHz.

FCC officials cited preparations for the 1979 WARC as the primary comprehensive long-range planning effort conducted by FCC, although many other agencies participated. FCC's contribution to the 1979 WARC preparations began in 1974 when an FCC Steering Committee, having overall management responsibility, and four specialized functional committees were established. Twenty-two industry advisory committees also were created, each representing a particular radio service, in order to study spectrum requirements and to suggest appropriate changes to the ITU Radio Regulations. In 1975 FCC instituted a public proceeding that served as the vehicle by which comments and recommendations were obtained from the public regarding the proposals that the United States would make to the Conference. Although not as extensive, FCC's preparations for other WARCS and RARCS are similar to those undertaken for the 1979 WARC.

Although a great deal of effort is expended by FCC in developing future spectrum requirements for these international conferences, FCC has no management process to organize and maintain this information in an ongoing data base of long-range planning information.

FCC Ad Hoc Planning

FCC conducts various ad hoc planning activities in response to surfacing issues affecting certain radio services or bands of the radio spectrum. FCC officials also pointed out that through contacts with industry representatives, they keep up to date with technological developments, which could have an impact on the radio spectrum. As an example of an issue affecting certain radio services, when questions were raised about whether currently allocated spectrum would be adequate for meeting expanding private land mobile spectrum requirements, the Private Radio Bureau initiated a study in 1981 of future spectrum requirements of the private land mobile service and alternatives for meeting those requirements.¹⁰

Since FCC does not maintain a list of all its planning activities, we were not able to readily document their extent and amount. However, on the basis of our discussions with FCC officials and prior reviews of spectrum management, we identified the following examples of long-range planning studies (other than those associated with international conferences):

¹⁰To help carry out its licensing responsibilities and to recognize that various types of radio users have different technical requirements, FCC has classified radio services into various categories. The private land mobile radio service covers two-way land mobile communications by individuals, organized groups, businesses and state and local government agencies.

- Projecting the Growth of Television Broadcasting: Implications for Spectrum Use, prepared for FCC by the Rand Corporation, February 1976;
- The Future of Digital Technology in the Private Radio Services, Policy Development Division, Private Radio Bureau, August 1981;
- Future Private Land Mobile Telecommunications Requirements, Planning Staff, Private Radio Bureau, August 1983;
- Comparison of Capacity and Demand for Determining Long-Term Spectrum Requirements of Cellular Radio, James Vorhies, Office of Science and Technology, December 1984;
- Report on Future Public Safety Telecommunications Requirements, Private Radio Bureau, June 21, 1985; and
- Public Safety National Plan, FCC, Docket No. 87-112, November 24, 1987.

FCC Controls and Oversight for Ensuring Efficient Spectrum Use

FCC's basic management controls for ensuring that the frequencies it assigns are efficiently used are its rules and regulations governing license requirements and operation of radio systems. These rules and regulations are established within the framework of FCC's rule-making process and promulgated in title 47 of the Code of Federal Regulations. Periodically, FCC reviews its rules and regulations, eliminating or updating them to reflect technological developments and changing economic conditions. NTIA's approaches to ensuring efficient spectrum use are similar to FCC's. The major difference between FCC's and NTIA's approaches is their views on monitoring: FCC officials believe the benefit of monitoring is not worth its cost; NTIA officials see monitoring as providing actual usage information that is vital for making spectrum management decisions.

FCC's rules and regulations include various requirements relating to technical standards restricting signal strength, bandwidth, distortion in the signal, type of emission, and hours of operation; construction deadlines mandating that certain licensed radio systems be built and placed in operation within a certain period of time, usually 1 to 3 years; eligibility requirements dictating what type of service is permitted on specified frequencies; and reporting requirements directing that licensees submit certain information on radio operations to FCC.

The responsibility for overseeing compliance with FCC rules and regulations is divided among the three bureaus responsible for licensing radio users—the Mass Media Bureau, the Private Radio Bureau, and the Common Carrier Bureau—and the Field Operations Bureau. Each bureau applies various approaches based on the nature of the particular radio service, bureau objectives and priorities, and the availability of staff

resources. The approaches include enforcement programs directed at specific radio services, public service and educational activities intended to improve public understanding of FCC requirements, and a complaint process allowing the public and licensees to bring improper frequency use to FCC's attention.

FCC makes little use of on-the-air monitoring and on-site inspections—two approaches for assessing whether spectrum is being used efficiently. FCC believes that these approaches are expensive and resource intensive and, therefore, their benefits are generally not worth their costs.¹¹ Monitoring studies measure the amount of time a licensed radio channel is occupied with a signal. While there are no generally accepted standards for spectrum efficiency, monitoring proponents contend that it can serve as an indicator of efficient spectrum use. On-site inspections involve visits to the physical installation of licensed radio systems to verify, first hand, that the licensed radio system is in operation and in compliance with FCC's rules and regulations. (Monitoring and on-site inspections are conducted by the Field Operations Bureau.)

According to FCC officials, in recent years FCC's approach for promoting efficient spectrum use has tended to move away from stringent regulatory requirements in favor of less restrictive regulations that give radio users more flexibility and economic incentives to adjust use of their assigned frequencies to changing technology and regional conditions. FCC believes that giving licensees greater freedom to design and construct radio systems that meet their needs and the needs of their customers is an effective way to ensure spectrum efficiency. At the same time, the Chief Engineer cautioned that FCC's regulations are still an important element of its spectrum management.

NTIA also employs a variety of approaches for ensuring efficient frequency use that are similar to FCC's. The major difference between FCC and NTIA on how best to ensure efficient spectrum use is their views on monitoring. In contrast to FCC, NTIA believes that monitoring is an important "real world" input available for making spectrum management decisions and has established a spectrum monitoring program.

¹¹Our July 1988 report, *Telecommunications: Actions Needed for Better Management of Public Safety Spectrum* (GAO/RCED-88-173), contains additional information on monitoring and on-site inspections along with their advantages and disadvantages.

Internal Evaluations or Studies for Improving Spectrum Management

FCC has not completed any internal evaluations or studies of its spectrum management during the last 10 years that have been officially endorsed by FCC. However, we identified eight studies on spectrum management authored by individual FCC staff members. These studies are listed below.

Internal Studies of FCC Spectrum Management

Using Auctions To Select FCC Licensees, Evan Kwerel and Alex D. Felker, Office of Plans and Policy (May 1985).

Spectrum Management Policy in the United States: An Historical Account, John O. Robinson, Office of Plans and Policy (Apr. 1985).

Spectrum Management: Issues and Planning, Margorie S. Reed, Office of Engineering and Technology (May 1984).

Implementing New Technology in the Land Mobile Radio Services, Philip B. Gieseler, Office of Plans and Policy (Sept. 1983).

A Framework for a Decentralized Radio Service, Alex Felker and Kenneth Gordon, Office of Plans and Policy (Sept. 1983).

A Comparison of Alternative Spectrum Regulatory Approaches, Rodney T. Small, Office of Science and Technology (Sept. 1982).

Allocation of Scarce Resource: An Analytical Framework and Its Specific Application to Orbital Slots, Satellite Transponders and Radio Interference, Charles Needy, Common Carrier Bureau (Sept. 1981).

Frequency Spectrum Deregulation Alternatives, Douglas W. Webbink, Office of Plans and Policy (Oct. 1980).

Generally, the studies cited similar weaknesses related to time-consuming decision-making, inability to adjust past allocation decisions to reflect changing technology and consumer demand, rigid regulations, and inadequate information. The studies also made similar recommendations, encouraging more economic incentives and flexible regulations that would give licensees greater freedom to adjust their spectrum use to changing technology and regional conditions.

Five of the eight studies are "working papers" prepared by FCC's Office of Plans and Policy, the primary policy adviser to the Commission. The

Office's working papers are intended to stimulate discussion and critical comment within FCC, as well as outside the agency, on issues in telecommunications policy. The eight studies generally focused on evaluating the degree to which FCC should rely on regulatory or economic approaches to spectrum management rather than evaluating the management processes or functions themselves. The studies, for example, did not evaluate FCC's planning systems, policy and decision-making process, organizational structure, management controls, rule-making process, allocation criteria, staffing levels and expertise, or information databases—fundamental elements of spectrum management. The eight studies cited some similar weaknesses concerning FCC's spectrum management, including the following:

- The administrative decision-making process is time-consuming and often causes extensive delays before a final decision is reached.
- Adjusting to changing market demand and facilitating the introduction of new technologies is difficult because of inflexible regulations that limit spectrum use to existing kinds of technology and narrowly defined radio service.
- The absence of a charge for spectrum use causes excessive demand and inefficient use.
- Sufficient information to independently and objectively evaluate competing claims for spectrum is lacking.

The studies' recommendations for improvement are also similar in that they are all directed at encouraging technical flexibility and economic incentives in spectrum management. The recommendations range from more broadly defining the types of uses that are permitted in certain spectrum bands, to restricting operational and technical rules to only those needed to define interference limits, to auctioning and charging use fees for spectrum. Several FCC officials emphasized that none of the recommendations proposed that FCC should rely totally on market forces to allocate and license spectrum.

None of the eight studies was endorsed or adopted by FCC as representing the Commission's official position on spectrum management, nor was there any overall FCC effort to respond to the studies' recommendations. However, the recommendations are generally consistent with what FCC officials have identified as a trend in FCC's rule-making decisions to impose less stringent regulations and more economic incentives on licensed radio users. As a result, the studies' recommendations have

been implemented in varying degrees in individual rule-making proceedings with the exception of issues involving spectrum use fees and auctions, which may require legislation. Fees and auctions have proved to be controversial and have generated opposition from various groups.

The policy question of whether economic incentives or regulation is the more effective way to manage the spectrum has been debated for years. For example, our 1974 report, Information on Management and Use of the Radio Frequency Spectrum—A Little-Understood Resource (B-159895, Sept. 13, 1974), discussed the views of some economists who promoted the use of market forces for managing the spectrum in contrast to other knowledgeable parties who believed that more and improved regulation was required.

NTIA officials in the Office of Spectrum Management told us periodic evaluations can help improve spectrum management. They added, however, that evaluations should be conducted by individuals who are independent and objective. That is, the individuals should be knowledgeable about spectrum management but not involved themselves in the spectrum management process. Consequently, evaluations may be more useful if conducted by experts outside the agency. The NTIA officials said that they had funded three studies of their spectrum management by outside contractors. These studies, prepared between 1982 and 1984, were titled The National Telecommunications and Information Administration, Office of Spectrum Management, Review of the NTIA Office of Spectrum Management Functions and Activities Regarding Contracting Out, and Collection and Development of Information to Support Long-Range Spectrum Planning. Our review of these studies found two of them to be narrowly focused, as indicated by their titles. The first study was generally a description of how NTIA's Office of Spectrum Management functions and the second study dealt with identifying what activities of the Office of Spectrum Management could be contracted out. The third study, partially funded by FCC, was a more comprehensive effort that evaluated the information requirements of a long-range spectrum management planning system and made recommendations for improving the planning process. According to NTIA officials, their development of a long-range spectrum plan for the federal government was NTIA's basic response to the study's recommendations. FCC officials told us that they took no direct action on the study's recommendations.

Request Letter

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WM. MICHAEL KITZMILLER, STAFF DIRECTOR

U.S. House of Representatives
Committee on Energy and Commerce
 Room 2125, Rayburn House Office Building
 Washington, DC 20515

February 17, 1988

The Honorable Charles A. Bowsher
 Comptroller General
 General Accounting Office
 441 G Street, N.W.
 Washington, D.C. 20548

Dear Mr. Bowsher:

My September 15, 1987 letter to you requested that your office investigate ways to improve the methods used by the Federal Communications Commission (FCC) to allocate and manage the radio spectrum. Based on your staff's preliminary work and discussions with my office, I would now like to focus GAO's remaining work on answering the following questions:

1. Does the FCC have an inventory of "unused" spectrum to show what frequencies are available for future use?
2. What criteria does the FCC follow in making spectrum allocation decisions?
3. What type of long-range planning process does the FCC have for anticipating future spectrum demands and setting aside spectrum to meet those demands?
4. What management controls and oversight does the FCC employ to ensure that the frequencies it assigns are efficiently used?
5. What internal evaluations and studies has the FCC undertaken, in the last 10 years, of its spectrum management? What weaknesses in the FCC's spectrum management were cited in these evaluations and studies? What recommendations for improvement were made? Has the FCC acted on these recommendations?

In answering these questions please obtain the views of the National Telecommunications and Information Administration.

Appendix II
Request Letter

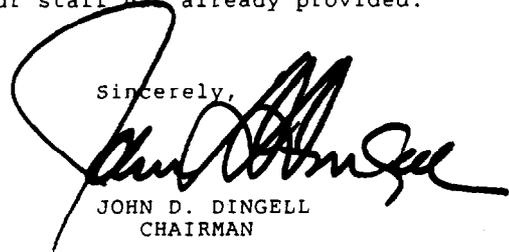
The Honorable Charles A. Bowsher
February 17, 1988
Page 2

I have been concerned for some time about the effectiveness of the Commission's management of the radio spectrum. The spectrum is a valuable public resource vital to the communication requirements of the government and private industry. This Committee will require GAO's assistance as we continue evaluating the Commission's spectrum management over the next few years.

I request that you provide a short written report on these matters by September 30, 1988. Please contact Mr. Mark MacCarthy of my staff for further details on this request. I appreciate the timely assistance your staff has already provided.

With best wishes.

Sincerely,

A handwritten signature in black ink, appearing to read "John D. Dingell", written over a large, stylized flourish.

JOHN D. DINGELL
CHAIRMAN

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