Managing the Spectrum: Win, Lose, or Share

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Executive Summary

- Every means of wireless communications needs to operate in its own frequency. Today, the radio spectrum is a scarce resource: most frequencies are already occupied, and more potential uses are proposed than the unused portions of the spectrum can accommodate. The spectrum appears an entry barrier to new wireless service providers.

- The essence of spectrum management is resolution of conflicts—intrinsic (physical), commercial, social, and political. Three objectives—avoiding interference, apportioning scarcity, and carrying out policy goals—shape the implementation of any management system.

- In the U.S., the apportionment of the spectrum to the private sector is based on "public interest," determined by the FCC through public rule making. After an allocation is made, frequency licenses are assigned by comparative hearings or lotteries. Because this public interest-based system seems more and more ineffective as demand for the spectrum increases, the FCC has adopted flexible use of frequency licenses, pioneer's preference rules, and reallocations proposals.

- New Zealand is the first country to implement market principles in managing the spectrum. The major variations it has adopted are competitive bidding to distribute licenses and transferance of ownership to licensees. Since the inception of the market-based systemin late 1989, New Zealand has distributed hundreds of licenses using auctions.

- Now that the spectrum is scarce, its management is characterized by conflicts between *haves* and *have-nots*—the *have-nots* must take frequencies from the *haves* to offer new wireless services, but the *haves* will not give up radio licenses easily. History has determined today's *haves* and *have-nots*.

- The FCC proposed the reallocation of several bands in the 2 GHz range to emerging technologies. Incumbent microwave users complained to the government and sought help from Congress to continue reliable and inexpensive communications and to increase their leverage in private negotiations with new service providers.

- The choice of a particular management system is the result of political compromise. Any change can benefit some stakeholders and hurt others. Currently in the U.S., the NTIA and FCC advocate the use of economic principles in the apportionment of the spectrum, with two major components: the spectrum fee and competitive bidding in frequency assignments. Owing to opposing positions taken by the stakeholders involved, this reform is not likely to be adopted without modifications.

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CHAPTER ONE
INTRODUCTION

The radio spectrum is the "real estate" on which wireless communications reside. Familiar services or operations, such as broadcast television, AM and FM radio, analog cellular telephony, and space research, occupy portions of it. Thanks to the rapid pace of innovations in radio technology and the expanding demand for existing services, more potential implementations of wireless telecommunications technologies are available today than the currently unused portions of the spectrum can accommodate. Scarcity sets up tensions between certain groups: between those who want to offer one type of service and those who want to offer another, between those who have access to the spectrum and those who do not, and between those who manage the scarce resource and those who request to use it. No wonder, then, that J. D. Bedin, a French jurist, defined the spectrum as "technology, industry, money, culture and power."[1]

A national government may employ a particular spectrum management system, with certain principles outlined, to serve a particular set of purposes. In the U.S., for example, frequencies are apportioned by the federal government to the private sector "in the public interest," as mandated by the Communications Act of 1934. When the political, economic, technological, and social environments change, the system in use may no longer meet new policy objectives or market demand, and perceptions grow that changes in the system may be needed. For instance, the recent crowding of the spectrum and the many competing uses and users became a major concern of spectrum managers in developed countries; "implementation of new technology"[2] and

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[1]Center for Strategic and International Studies, *The New Spectrum Mudwrestle: WARC 1992 and Beyond* (Washington, D.C.: CSIS International Communications Studies, September 19, 1991 Symposium, 1992), p. vi (hereafter, *CSIS WARC '92 Symposium*).

[2]George Calhoun, *Digital Cellular Radio* (Norwood, Mass.: Artech House, 1988), p. 16 (hereafter, Calhoun, *Digital Cellular Radio*).

"regulatory reform"[3] have been proposed as ways to relieve the situation. Changes, like the original choice of a management system, may benefit some and hurt others.

Traditionally, spectrum management is viewed as an engineering task—the allocation of frequencies to avoid interference from different radio operations. When the spectrum becomes crowded, its management becomes an economic problem—to apportion the spectrum, a scarce resource, among possible radio uses and users.[4] The evidence and arguments presented in this paper show that spectrum management is more than engineering and economics; rather, the key to implementation of any management system is the resolution of conflicts among stakeholders—or, put another way, politics. By analyzing the making of policy and the dynamics of the political negotiation involved, the paper lays out factors and forces in spectrum management, with the aim of providing a framework for those for whom the spectrum is a stake (in both the private sector and government) to see the issues accurately and form their own strategies accordingly. In keeping with the premise that spectrum management is essentially a political process and absent any inherently feasible or impossible methods, the paper offers neither conclusions nor recommendations, because these would gratuitously favor one party or another while the aim here is solely to illuminate issues.

Chapter Two walks through elements of spectrum management, including the stakes involved, reasons why management is needed, ways to apportion spectrum, and currently emerging problems. Readers familiar with this subject can proceed directly to Chapter Three, which describes spectrum management systems and compares their philosophies and mechanics. Chapter Four presents the main idea of the paper—politics as the key factor in decisions on the domestic and international

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[3]See U.S. Department of Commerce, the National Telecommunications and Information Administration, *U.S. Spectrum Management Policy: Agenda for the Future* (Washington, D.C.: U.S. Government Printing Office, NTIA Special Publication 91-23, 1991) (hereafter, *U.S. Spectrum Management Policy*). Chapter 4 is devoted to alternatives to current regulation of spectrum management.

[4]This problem is called "economic," because the allocation of scarce resources is a major subject in economic theory.

apportionment of the spectrum. A discussion of the choice of a particular management system for a particular country as the result of politics concludes the paper.

CHAPTER TWO
BACKGROUND: THE SPECTRUM AND ITS MANAGEMENT

2.1 The Spectrum: A Scarce Resource

Signals and messages of wireless communications are transmitted by electromagnetic waves—microwaves, visible light, and x-rays—each characterized by its frequency, measured in Hertz (Hz), which is one (electromagnetic) oscillation per second. All possible frequencies constitute the full spectrum.

Portions of the spectrum are used for various purposes. Amateurs (called hams) communicate by radio. Television stations use the VHF (very high frequency) or UHF (ultrahigh frequency) bands to broadcast programs to homes. Astronomers send signals to and receive them from outer space to conduct research.[5] Cellular telephone subscribers make calls transmitted over the air. These and other wireless communications means operate in certain parts of the spectrum.

Several types of economic stakes are involved in the use of the spectrum. Certain commercial communications services, such as vehicular dispatch or airborne telephones, need to be operated without wires. For the provision of telephone services in rural, sparsely populated areas, radio communications (such as the basic exchange telecommunications radio service [BETRS]) have been shown to be more efficient economically than wire-based communications.[6] Even if other means are available and more economical to set up, operators may want to continue wireless operations because of "sunk cost"—when such entrenched users of radios as private microwave operators have made considerable investment to use the airwaves for communications purpose, they would not replace existing wireless operations with other means, such as optical fibers. There are political and social stakes also.

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[5]Most astronomical uses of the radio spectrum involve only passive reception from the space, but astronomers such as Professor Paul Horowitz of Harvard University send signals to outer space, hoping that other intelligent life forms will pick them up and reply.

[6]See, for example, George Calhoun, *Wireless Access and the Local telephone Networks* (Norwood, Mass.: Artech House, 1992), Section 5.3 (hereafter, Calhoun, *Wireless Access*).

Table 2-1
Values and Stakes in the Use of Spectrum

Economic Values and Stakes
Intrinsically wireless services ■ Vehicular dispatch ■ Airborne or maritime telephony Economically efficient radio communications ■ Rural telephone services ■ Point-to-multipoint relay of TV programs by satellite Established radio communications, whose sunk cost prevents replacement ■ Private microwave communications (which could be provided by common carriers) ■ Broadcasting television to homes (which could be provided by cable TV)
Social Values and Stakes
National security ■ Military communications ■ Intelligence activities Essential services ■ Emergency communications ■ Police dispatch ■ Air traffic control Miscellaneous benefits ■ Scientific research ■ Local government or public work

Wireless communications means are suitable for emergency situations, such as forest fires and hurricanes.[7] For reasons of national security, governments use the spectrum to facilitate military and intelligence operations. Essential activities such as air traffic control require radio communications. **Table 2-1** summarizes the values of various modes of wireless communications, thus of the use of the spectrum, to stakeholders.

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[7]Ibid., pp. 565–567.

Mathematically, the spectrum is infinite: electromagnetic frequencies have no upper bound, but because, in practice, devices (natural or artificial) cannot transmit on extremely high or low frequencies, only a limited range of frequencies is actually useful. Because waves of different frequencies have their own characteristics—ability to penetrate physical barriers, degree of attenuation in different weather conditions, refraction and reflection in various media—a particular means of wireless communications that demands a set of electromagnetic properties can use only certain bands. For example, only light waves in the range of 10^{14} to 10^{15} Hz are visible to the human eye, which is undoubtedly one of the most widely used (wireless) communications means. Further, signals from two devices transmitting in the same frequency at the same time in the same place often interfere with one another. With these limitations and a growing number of wireless communications, sooner or later the spectrum will become crowded, and, without proper coordination, conflicts in its use will inevitably occur. In theory, crowding can be relieved either by advances in wireless technology—to expand the useful portion of the spectrum and promote more efficient use of the bands—or regulatory reforms—to apportion the frequencies more efficiently—but the *possibility* of running out of suitable frequencies to accommodate new uses cannot be ruled out.

It follows that the radio spectrum, like arable land or drinking water, is a scarce resource, and, like other scarce resources, calls for management. In almost all countries, spectrum management is administered centrally,[8] in particular by the government, although the philosophy and procedures adopted in different countries vary widely.

2.2 The Essence of Spectrum Management

If the participating parties are not in conflict (that is, if their demands can all be met without problems), *any* system of management will serve to allocate a resource.

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[8]As opposed to other types of resource allocation, such as the decentralized, market-based commercial system that western capitalistic economists advocate.

Underlying all existing spectrum management systems is the need to resolve conflicts of interest, whether intrinsic, commercial, social, or political, due to use of the spectrum. Under a system of centralized management, conflicts are resolved by the central power through political, economic, and technological compromises.

The original basis for spectrum management is to avoid interference of radio signals. When devices transmit waves in the same frequency in the same location simultaneously, the waves may interfere with one another and not operate properly. Conflict arises because of this intrinsic (physical) property of wireless communications, and coordination is needed. Managing the spectrum to avoid interference is like roadway traffic control: rules or standards can require potentially interfering radio devices to use different frequencies (analogous to requiring vehicles to use different lanes), to be separated spatially (analogous to requiring vehicles to take different routes), to transmit radio waves sequentially in time (analogous to requiring different types of vehicles to travel at different hours to avoid traffic jams), or to limit the emitted power in order not to interfere with devices in adjacent bands (analogous to restricting vehicles by size for particular lanes). Avoiding interference is essentially an engineering problem, and every spectrum management system dedicates a large part of its resources to this problem.

Interference limits the number of communications means that can operate in one frequency range at one location. Until the spectrum becomes crowded, potentially interfering uses can coexist in different frequency bands; thus, conflicts of interest do not occur. When the spectrum is crowded, some uses and users of wireless communications may not be accommodated, and "apportioning scarcity," as Representative John Dingell (D-Mich.) calls it,[9] becomes the principal task of a management system. Various criteria can be adopted to choose the communications means that will use the spectrum. Frequencies may be apportioned according to commercial interest: some uses may generate more revenues or profits than others.

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[9]Quoted in Margaret Kriz, "Supervising Scarcity," *National Journal* 22, 27 (July 7, 1990), p. 1660 (hereafter, Kriz, "Supervising Scarcity").

Certain uses, such as national security, air traffic control, and emergency and public safety communications, are so essential that their provision needs to be guaranteed at all times. Other uses, such as scientific research, that are neither commercially attractive nor absolutely essential, may, however, be considered by some parties to be in the social interest. A spectrum management system resolves the conflict between commercial and social interests by selecting the wireless communications to receive frequencies.[10]

When the spectrum becomes a scarce resource, governments and private parties realize that its management could be a policy tool. The allocation of frequencies to new and emerging technologies may be tied to fostering national competitiveness.[11] A trade barrier to (wireless) telecommunications services can be formed by denying foreigners access to the spectrum. In most developing countries the spectrum is tightly controlled by the government for the sake of national security or political stability.

These three objectives—avoiding interference, apportioning scarcity, and carrying out policy goals—shape the implementation of a centralized spectrum management system. In addition to engineering and economic efficiency, negotiation among stakeholders and accommodation of various interests determine the outcome of allocations and assignments of radio frequencies.

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[10]In colloquial usage of the term "public," all means that benefit the public can be regarded "in the public interest." In theory and in practice, the public can benefit from means that is deemed either to serve the social interest, such as essential services and scientific research, or to generate commercial interest, such as analog cellular systems operated by private companies. But in certain context, the term "public interest" is used as a legal term, whose precise meaning may or may not coincide with the colloquial meaning. The discussion in later chapters will develop this point further. See, for example, **Section 3.1.1.**

[11]See, for example, Federal Communications Commission, "In the Matter of Redevlopment of Spectrum to Encourage Innovation in the Use of New telecommunications Technologies," *First Report and Order and Third Notice of Proposed Rule Making*, ET Docket 92-9, released October 16, 1992, p. 5 (hereafter, *FCC First Report & Order, ET 92-9*). The arguments are presented to the FCC by various private parties in comments on the FCC's proposal to reallocate frequencies in the 2 GHz range to emerging technologies (see **Section 4.2.3**).

2.3 Components of Spectrum Management

The management of the spectrum is a complex task. The apportionment of frequencies, the most important job of spectrum managers,[12] consists of three components—specification of a particular use (*frequency allocation*), designation of the location of usage (*location allotment*), and selection of users (*license assignment*)—and requires decisions on *what, who, how,* and *where.*

- ***What is the band used for?*** Dozens of different wireless communications means might be able to use a particular frequency band. In most countries, including the U.S., the spectrum is allocated in blocks—a band of contiguous frequencies is dedicated to a particular means of radio communications with somewhat uniform technical standards.[13] The criteria for allocation can be commercial (those with the highest commercial value), social (those that best serve social purposes), or technological (those that employ the most advanced technology or the most efficient use of the frequency band).

  An allocation can be primary, co-primary, or secondary. A primary allocation assures interference-free transmission in the band.[14] A band can be shared by several wireless communications uses, each receiving co-primary allocation, with interference and other problems negotiated privately. A secondary allocation permits use of a band, but the operation is restricted from interfering with the primary use(s).

- ***Who will use it?*** The next step is to issue one or more operating licenses for frequencies in that band. When more applicants are available than can be accommodated, license distribution can be adopted to serve different purposes.

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[12]Spectrum managers may also assume responsibilities of regulating wireless services, designating technical standards, coordinating disputes among users, and so on.

[13]See *U.S. Spectrum Management Policy,* p. 55 (*supra,* note 3).

[14]A primary user must accept interference from other primary users.

Licensees can be selected randomly by lottery. The spectrum manager can measure the applicants' qualifications against a set of rules and choose the most qualified—as in the comparative hearings often held in the U.S. by the Federal Communications Commission (FCC). Or, licenses can be distributed by competitive bidding, where they are awarded by auction to the highest bidders.

- *How will it be used?* Spectrum managers can establish rules for users or service providers to implement wireless communications. Operators may be restricted to use the band only to provide a single, agreed-on service and, because of the risk of interference, often may be subject to technical and performance standards. Or, licensees of a frequency band may be free to implement different types of wireless communications in many ways, even if the band was originally allocated to a specific use.

- *Where can it be used?* To avoid interference with other uses or users in a wide area, the operating license is often specific to a location, but it could be regional, national, or even worldwide.[15]

Although consideration of these factors separately and sequentially may seem logical, not all spectrum management systems follow these "logical" steps. Spectrum managers have adopted combinations and variations. In many countries the military is assigned a large chunk of the spectrum which it uses without specification (by spectrum managers) of the actual use, technical standards, functional specifications, or area restrictions.[16] The allocation of frequencies and the assignment of licenses can be based on a single factor, such as type of user (e.g., taxi radio dispatch versus police radio dispatch), type of use (e.g., broadcast TV versus FM radio), or type of equipment (e.g., terrestrial mobile versus satellite mobile).

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[15]No mechanism is currently available to assign worldwide spectrum licenses.

[16]However, military use of the spectrum is almost always carefully considered and coordinated internally and with friendly military users in other countries.

2.4 Emerging Problems and Possible Resolutions

In most developed countries today, the major problem for spectrum managers is that demand for frequencies exceeds supply. The demand comes from the implementation of new wireless communications technologies and the expansion of existing uses. Growth in demand for such services as paging and cellular telephony often can be met by the allocation of more frequencies. As wireless technology advances, new services are made possible, but the unused portion of the spectrum does not seem capable of accommodating them all.[17]

The most direct way to make room for new or expanded uses is to relocate or purge existing users and revoke their frequencies. In most developed countries, this solution is difficult and time-consuming, if not impractical, because the incumbents would defend their turf (see **Section 4.2.1**). Housing new users while keeping existing users happy is no small task.

"Long-term solutions to the problems of 'spectrum shortages' ... may require a redefinition of the legal and regulatory concepts underlying ... spectrum management."[18] In response to the emerging problems of spectrum management, countries such as the U.S. have adopted changes in their spectrum allocation and assignment, and, in the extreme, as in New Zealand, implement a radically different system (discussed in **Section 3.2**). A managing system can be designed to meet the growing demand for the spectrum but, in so doing, will inevitably favor some parties proposing new services over others, including incumbents or certain new users (see **Section 4.3**).

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[17]In the U.S., the very few unused frequencies below 6 GHz seem incapable of accommodating new uses that would require a contiguous band of more than 3 MHz.

[18]*U.S. Spectrum Management Policy*, p. 85 (*supra*, note 3).

Technology, it is widely believed, will help relieve the crowdedness and achieve "spectrum abundance."[19] First, previously unusable frequencies (in the higher end of the spectrum) may be put to use through technical breakthroughs.[20] Frequencies that could not be used for certain systems or services may be made available for them, as, for example, in the test by AT&T of new terrestrial wireless communications in the 6 GHz-range bands.[21] Second, even if no new parts of the spectrum can be made available, technology can enhance efficiency in the use of already usable spectrum. Improvements may come from better radio system design, new methods of airwave transmission, techniques of data compression, more efficient traffic management, or higher frequency reuse rate. Digital encoding, for instance, promises to increase the capacity of an existing cellular network, with the same frequency allocation, by three to twenty times.[22] Improvements in the efficient use of frequency bands not only help in conservation of the spectrum but also may change the economics of communications using radios as opposed to other media.[23] Last, innovations in technology may reduce interference among several uses to the extent that users can share a band without affecting one another, thus allowing more efficient use of frequencies.

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[19]Calhoun, *Wireless Access*, Section 10.6 (*supra*, note 6).

[20]Currently, propagation of waves of frequencies higher than 60 GHz appears susceptible to weather because of absorption. For practical purposes, frequencies higher than 300 GHz are unusable.

[21]See "AT&T to Test 6 GHz Band for PCNs," *Microcell Report* (July 1991), p. 1. With the exception of this trial, current terrestrial wireless communications systems with a cellular architecture concentrate on frequencies below 3 GHz; see *FCC First Report & Order, ET 92-9*, pp. 7–8 (*supra*, note 11).

[22]Competing digital encoding methods, such as code-division multiple access (CDMA) and time-division multiple access (TDMA), differ in promised compression ratios as well as availability. See, for example, the discussion in Derrick C. Huang, *Up in the Air – New Wireless Communications* (Cambridge, Mass.: Program on Information Resources Policy, Harvard University, P-92-3, 1992), Section 1.2.1 (hereafter, Huang, *Up in the Air*).

[23]For an example of how technology advancements change the economics of wireless communications systems, see Calhoun, *Wireless Access*, p. 581 (*supra*, note 6).

But advances in technology, by enabling implementation of new wireless communications systems or services, also contribute to the crowdedness of the spectrum. Experience in the management of geostationary satellite orbits sheds light on this effect: by narrowing the required separation between satellites, advances in technology allow more satellites to be accommodated in the geostationary orbit, but, at the same time, the demand for geostationary satellites is growing because technology enables implementation of new services by satellites. The potential problem of conflicting use in the geostationary orbits still exist.

None of the proposed resolutions completely solves the problem of spectrum crowding. The answer to the question, "Who gets what frequencies," would come to negotiation and accommodation of the conflicting interests of various parties, described in **Chapter Four**.

CHAPTER THREE
SPECTRUM MANAGEMENT SYSTEMS: CASES AND COMPARISON

the systems different countries adopt to manage domestic use of the radio spectrum vary. A system may reflect particular political, social, economic, and technological environments, and systems that work for some countries may be very difficult to implement in others. The domestic operation of spectrum management needs to comply with international agreements. Among signatories, frequency allocations made at the World Administrative Radio Conferences (WARCs) of the International Telecommunication Union (ITU), for instance, have the status of international treaties, acting as legal constraints in shaping the apportionment of the spectrum in individual countries.

This chapter examines and compares different spectrum management systems, distinguished on the basis of where the most crucial allocation and assignment decisions are made. At one extreme, management systems are market-based: allocation and assignment of frequencies are mostly effected in the private market. At the other, the spectrum is managed exclusively by government, according to certain mandates (e.g., the public interest) or principles (e.g., command and control). The management systems now used in the U.S. and New Zealand provide examples of how such systems work and the forces and proposals for change.

3.1 The United States: Centralized Approach

3.1.1 The System

In the U.S., spectrum management is the exclusive responsibility of the federal government.[24] The legislative branch, Congress, sets policies for management[25] and,

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[24]A centralized spectrum management system, handled by the government, is not the same as a command and control system. The latter is only one instance of the former. In the U.S., for example, public consensus, instead of command and control, is usually the most important factor in apportionment of the spectrum.

on rare occasions, manages or attempts to manage it at the micro level.[26] The Communications Act of 1934 created the FCC as an independent agency to manage the spectrum used by nonfederal users (i.e., private industries and state and local governments) to serve the "public interest":

> The Commission, if public convenience, interest, or necessity will be served thereby, subject to the limitations of this Act, shall grant to any applicant therefore a station license provided by this Act.[27]

Except in the rare instances where constitutional issues arise, the courts review administrative decisions made by the FCC for conformance with congressionally mandated standards.

Under its mandate, the FCC apportions frequencies "through public rulemakings that seek to determine the public interest."[28] "Public interest" is here a legal term that designates standards or criteria that the Commission adopts as the basis for its decisions on apportionment of the spectrum and may or may not coincide with the common English meaning of the term "public interest."[29] Whether a private sector use or user of the spectrum is "in the public interest" is determined exclusively by the FCC.[30]

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[25]As discussed below, Congress sets the policy and the FCC carries it out; by analogy to a private corporation, Congress is the board of directors and the FCC is the Chief Executive Officer or company president.

[26]Such as the proposed "Emerging Telecommunications Technology Act of 1991"; see **Section 4.1.2.**

[27]Communications Act of 1934, Section 302(a).

[28]*U.S. Spectrum Management Policy*, p. 36 (*supra*, note 3).

[29]See the interpretation in note 10.

[30]Although the FCC has exclusive right to establish standards or criteria for spectrum management, some standards may be mandatory: for example, Section 310 of the 1934 Act forbids the FCC from issuing radio licenses to foreigners.

To apportion the spectrum, the FCC first allocates frequencies to wireless communications uses in blocks (see **Section 2.3**) and then assigns licenses for a particular use to users. Operating licenses, usually geographically specific, often specify technical standards for the prevention of interference and performance standards for some minimal level of service offering. Restrictions may apply to the transfer of a license. Every frequency license carries a right to operate but not legal ownership—the spectrum is regarded as public property—although in practice licenses look very much like property rights (see **Section 3.3.2**). Until 1982, comparative hearings were the primary way to assign licenses: the FCC reviewed or held hearings to compare detailed applications filed by applicants and picked those most "appealing"—the criteria could be technical competence, financial strength and stability, social considerations, or a combination of them.[31] In 1982 Congress authorized the FCC to distribute licenses for certain services by random selection. Applicants still need to file applications, but the selection is by lottery instead of by rigorous review by the FCC.

In addition to Congress, the FCC, and the courts, a number of federal agencies in the executive branch are involved in spectrum management. The National Telecommunications and Information Administration (NTIA) of the Department of Commerce handles federal frequency allocations and assignments, which are entered into the Government Matter File (GMF). Frequencies shared by federal and nonfederal government users are managed with the coordination of the NTIA and the FCC. The NTIA, with responsibility to formulate telecommunications policies, also voices the positions of the executive branch and, thus, exerts influence on Congress and the FCC. The Department of State, through its Bureau of International Communications and Information Policy, would take part in the management process should a domestic allocation have international implications. Allocations may raise concern about interference from such large federal users as the Department of Defense

[31]In almost all the FCC's *Public Notices* regarding decisions on frequency allocation or assignment, approved applications are said to be "in the public interest." Those documents often do not make clear how the criteria used by the FCC can be generalized to judge what is or is not in the public interest.

(DOD), Department of Energy (DOE), the General Service Administration (GSA), the Federal Aviation Administration (FAA), and the Federal Bureau of Investigation (FBI).

Table 3-1 illustrates the current allocations of frequencies between 420 and 2,500 MHz in the U.S. For users or service providers in each band, **Table 3-1** shows their revenue source and the monetary value of the band.[32] Also presented are proposals for reallocation of certain frequencies.

3.1.2 The Reforms

In the early days, when the spectrum was abundant, allocations and assignments were made on a first-come, first-served basis, and the system worked well.[33] When the spectrum became crowded—analog cellular telephony and other land mobile services can be regarded as the major uses causing crowding, although broadcast radio and television had led to earlier crowding problems—and new uses and users became contentious, the determination of "public interest" through public rule making began to be problematical. Irrespective of whether they are commercially or socially oriented, most, if not all, new wireless communications means competing for the limited spectrum appear in one way or another in the "public interest."[34] Even if an unused band were found, its allocation, under the current FCC's practice of public rule making, might take a long time. These difficulties are further complicated by the inefficiency of the licensing procedures: comparative hearings conducted by the FCC can be antagonistic and time-consuming, while the anomalies created in the lottery process, especially in assignments of cellular licenses, are equally troublesome.[35] Under the current rules, the difficulty and protracted time involved for a private party

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[32]Types of monetary values recorded in **Table 3-1** include annual revenue, total investment, estimated relocation cost, and so on. See notes of the table for details.

[33]Kriz, "Supervising Scarcity" (*supra*, note 9).

[34]See the interpretation in note 10.

[35]See, for example, Calhoun, *Digital Cellular Radio*, Section 4.4 (*supra*, note 2).

Table 3-1

Spectrum Allocations in the U.S.: 420–2,500 MHz*

MHz	Allocations to Radio Uses	Direct Users, Service Providers	Customers, Revenue Sources	Dollar Values[1]	Comments	Reallocation Proposals
420.0 ➤	Amateur	Radio amateurs	N/A	N/A		
	Radio location					
450.0 ➤	Public and private land mobile	Paging carriers	Service subscribers	1,350[2]		
		Private industries	Self			
460.0 ➤	***Meteorological***		Government budget			
	Private land mobile	Private industries	Self			
		Local governments	Government budget		Police; fire; special emergency	
470.0 ➤	UHF TV: ch. 14-20 (1 of 3)	Independent TV stations	Advertisers/ consumers	16,254[3]	UHF TV is intended to provide opportunities for minorities and small community development.	
	Public and private land mobile	Local governments	Government budget		Public safety concerns	
		Private industries	Self			
512.0 ➤	UHF TV: ch. 21-36 (2 of 3)	Independent TV stations	Advertisers/ consumers	16,254[3]	UHF TV is intended to provide opportunities for minorities and small community development.	
608.0 ➤	**Radio astronomy**	Researchers	Government and school research budget			
614.0 ➤	UHF TV: ch. 38-69 (3 of 3)	Independent TV stations	Advertisers/ consumers	16,254[3]	UHF TV is intended to provide opportunities for minorities and small community development.	
806.0 ➤	Private land mobile	SMR operators	Service subscribers	250[4]	Service paired with 851-866 MHz	
		Private industries	Self			
821.0 ➤	Private land mobile	Local governments	Government budget		Public safety; paired with 866-869 MHz	
824.0 ➤	Cellular telephone (1 of 2)	Cellular carriers	Service subscribers	5,642[5]	Mobile terminals to cell sites	
					Wireline carriers: 835-845; 846.5-849 MHz	

*See Definitions at end of table.

[1]U.S. dollars in millions. N/A: Dollar value not appropriate.
[2]Total paging service revenues in 1991, estimated by Frost & Sullivan, in *Radio Communications Report* (September 23, 1991), p. 1.
[3]Total advertising expenditures on syndicated and spot (national and local) TV in 1989, from Department of Commerce, *Statistical Abstract of the United States 1991*, Table No. 939.
[4]Total service revenues of SMRs operating in 800 MHz range, from Doron Fertig, *Specialized Mobile Radio* (Washington, D.C.: FCC, February 1991).
[5]Total cellular service revenues for the year ending June 1991. Source: Cellular Telecommunications Industry Association.

Text Formats:

Boxed-bold-italic	Exclusive federal government allocation
Boxed-shaded-bold	Allocation shared by federal government and private sector
Normal	Exclusive private sector allocation

Table 3-1, cont.

MHz	Allocations to Radio Uses	Direct Uses, Service Providers	Customers, Revenue Sources	Dollar Values[1]	Comments	Reallocation Proposals
824.0 ➤ (cont.)					Nonwireline carriers: 824-835; 845-846.5 MHz	
849.0 ➤						
	Air-to-ground telephone	Service carriers (e.g., GTE Airfone)	Service users		Service paired with 894-896 MHz	To PCN (proposed by, e.g., Advanced Wireless Communications)
851.0 ➤						
	Private land mobile	SMR operators Private industries	Service subscribers Self	250[4]	Service paired with 806-821 MHz	
866.0 ➤						
	Private land mobile	Local governments	Government budget		Public safety; paired with 821-824 MHz	To PCN (e.g., experimental license of BellSouth)
869.0 ➤						
	Cellular telephone (2 of 2)	Cellular carriers	Service subscribers	5,642[5]	Cell sites to mobile terminals Wireline carriers: 880-890; 891.5-894 MHz Nonwireline carriers: 869-880; 890-891.5 MHz	
894.0 ➤						
	Air-to-ground telephone	Service carriers (e.g., GTE Airfone)	Service users		Service paired with 849-851 MHz	To PCN (proposed by, e.g., Advanced Wireless Communications)
896.0 ➤						
	Private land mobile	SMR operators Private industries	Service subscribers Self	10[6]	Service paired with 935-940 MHz	
901.0 ➤						
	Mobile (general purpose)				Paired with 940-941 MHz	FCC 8/14/1992 NPRM (GEN 90-314) to narrow-band PCN
902.0 ➤						
	Radio location		Government budget		FCC designates as ISM frequencies	To PCN (e.g., experimental licenses of BellSouth and Advanced Mobile-Comm)
	Amateur	Radio amateurs	N/A	N/A		
928.0 ➤						
	Private fixed microwave	Private industries	Self			

Text Formats:

Boxed-bold-italic	Exclusive federal government allocation
Boxed-shaded-bold	Allocation shared by federal government and private sector
Normal	Exclusive private sector allocation
Italic	Foreign or international reallocations that may affect decisions made in the U.S.

Table 3-1, cont.

MHz	Allocations to Radio Uses	Direct Uses, Service Providers	Customers, Revenue Sources	Dollar Values[1]	Comments	Reallocation Proposals
929.0 ➤	Paging (advanced)	Service carriers	Service subscribers	1,350[2]		FCC 8/14/1992 NPRM (GEN 90-314) to narrow-band PCN
932.0 ➤	**Fixed**				Service paired with 941-944 MHz	
935.0 ➤	Private land mobile	SMR operators	Service subscribers	10[6]	Service paired with 896-901 MHz	
		Private industries	Self			
940.0 ➤	Mobile (general purpose)			N/A	Paired with 901-902 MHz	FCC 8/14/1992 NPRM (GEN 90-314) to narrow-band PCN
941.0 ➤	**Fixed**				Service paired with 932-935 MHz	
944.0 ➤	Auxiliary broad-casting					*<944-948 MHz> Canadian allocation for digital cordless telephones*
952.0 ➤	Fixed microwave	International public				
960.0 ➤	**Aeronautical radio navigation**					
1215.0 ➤	***Radio navigation satellite***		Government budget		GPS	
	Radio location		Government budget			
1240.0 ➤	***Radio location***	Military	Government budget			
	Amateur	Radio amateurs	N/A	N/A		
1300.0 ➤	**Aeronautical radio navigation**					
1350.0 ➤	***Radio location***		Government budget			
1400.0 ➤	**Radio astronomy**	Researchers	Government and school research budget			
1427.0 ➤	**Space operation**					
	Fixed and mobile telemetering					

[1]U.S. dollars in millions. N/A: Dollar value not appropriate.
[2]Total paging service revenues in 1991, estimated by Frost & Sullivan, in *Radio Communications Report* (September 23, 1991), p. 1.
[4]Total service revenues of SMRs operating in 800 MHz range, from Doron Fertig, *Specialized Mobile Radio* (Washington, D.C.: FCC, February 1991).
[5]Total cellular service revenues for the year ending June 1991. Source: Cellular Telecommunications Industry Association.
[6]Total service revenues of SMRs operating in 900 MHz range, from Fertig.

Table 3-1, cont.

MHz	Allocations to Radio Functions	Direct Users, Service Providers	Customers, Revenue Sources	Dollar Values[1]	Comments	Reallocation Proposals
1429.0 ➤	**Fixed and mobile telemetering**					
1435.0 ➤	**Mobile aeronautical telemetering**	Aerospace industry	Self		Aircraft flight testing	*<1452-1492 MHz> WARC '92 worldwide primary allocation to DAB*
1530.0 ➤	**Maritime mobile satellite** **Mobile aeronautical telemetering**	Maritime satellite carriers (e.g., Inmarsat)	Service subscribers		Service paired wit 1625.5- 1645.5 MHz (downlink)	
1544.0 ➤	**General mobile satellite**				Service paired with 1645.5-1646.5 MHz (downlink)	
1545.0 ➤	**Aeronautical mobile satellite**				Service paired with 1646.5-1660.5 MHz (downlink)	
1559.0 ➤	**Aeronautical radio navigation**					*<1610-1626.5 MHz> WARC '92 worldwide primary allocation to LEO MSS (uplink)*
1626.5 ➤	**Maritime mobile satellite**	Maritime satellite carriers (e.g., Inmarsat)	Service subscribers		Service paired with 1530-1544 MHz (uplink)	
1645.5 ➤	**General mobile satellite**				Service paired with 1544-1545 MHz (uplink)	
1646.5 ➤	**Aeronautical mobile satellite**				Service paired with 1545-1559 MHz (uplink)	
1660.5 ➤	**Radio astronomy**	Researchers	Government and school research budget			
1670.0 ➤	**Meteorological**					
1710.0 ➤	***Fixed; mobile***	Dept. of Defense Dept. of Agriculture	Government budget	18,300[7]	Primary TT&C uplink band	Proposed "Emerging Telecommunications Technology Act"

Text Formats:

Boxed-bold-italic	Exclusive federal government allocation
Boxed-shaded-bold	Allocation shared by federal government and private sector
Normal	Exclusive private sector allocation
Italic	Foreign or international reallocations that may affect decisions made in the U.S.

Table 3-1, cont.

MHz	Allocations to Radio Uses	Direct Users, Service Providers	Customers, Revenue Sources	Dollar Values[1]	Comments	Reallocation Proposals
1710.0 ➤ (cont.)		Other federal agencies				may reapportion this band to private sector To PCN (proposed by, e.g., Motorola)
1850.0 ➤						
	Fixed point-to-point microwave	Private industries Local governments	Self Government budget	2,750[8]		FCC 2/7/1992 NPRM (ET 92-9) to emerging technologies <1,850-1,895 and 1,930-1,975 MHz> FCC 8/14/1992 NPRM (GEN 90-314) to licensed wide-band PCN <1,910-1,930 MHz> FCC 8/14/1992 NPRM (GEN 90-314) to un-licensed wide-band PCN
1990.0 ➤						
	Auxiliary broad-casting	Broadcasting net-works; service providers	Self Service Users	2,750[8]	Studio transmission; ENG	
2110.0 ➤						
	Point-to-point microwave	Telecommuni-cations common carriers	Self	2,750[8]	Landline and cellular point-to-point connections Service paired with 2,160-2,180 MHz	FCC 2/7/1992 NPRM (ET 92-9) to emerging technologies
2130.0 ➤						
	Point-to-point microwave	Private industries Local governments	Self Government budget	2,750[8]	Service paired with 2,180-2,200 MHz	FCC 2/7/1992 NPRM (ET 92-9) to emerging technologies
2150.0 ➤						
	Point-to-multipoint microwave	Wireless cable multipoint distributors	Self Service Users	2,750[8]		
2160.0 ➤						
	Point-to-point microwave	Telecommuni-cations common carriers	Self	2,750[8]	Landline and cellular point-to-point connections Service paired with 2,110-2,130 MHz	FCC 2/7/1992 NPRM (ET 92-9) to emerging technologies
2180.0 ➤						
	Point-to-point microwave	Private industries Local governments	Self Government budget	2,750[8]	Service paired with 2,130- 2,150 MHz	FCC 2/7/1992 NPRM (ET 92-9) to emerging technologies

[1]U.S. dollars in millions.
[7]Total replacement costs of all federal systems in this band, from Ernesto Cerezo, *Federal Spectrum Usage of the 1,710-1,850 and 2,220-2,290 MHz Bands* (Washington, D.C.: NTIA TR 92-285, March 1992), Table 5-1 [Draft].
[8]Estimated total costs to relocate all facilities in the 1,850-2200 MHz band to above 3 GHz by the FCC, as shown in FCC, *Creating New Technology Bands for Emerging Telecommunications Technology* (Washington, D.C.: FCC, OET/TS 92-1, January 1992), p. 33.

Table 3-1, cont.

MHz	Allocations to Radio Functions	Direct Users, Service Providers	Customers, Revenue Sources	Dollar Values[1]	Comments	Reallocation Proposals
2200.0 ➤						
	Fixed; mobile	Dept. of Defense	Government budget	26,840[9]	Primary TT&C downlink band	Proposed "Emerging Telecommunications Technology Act" may reapportion this band to private sector
		Other federal agencies			For line-of-sight propagation only, including aeronautical telemetering	
	Space research	NASA	Government and school research budget			To PCN (proposed by, e.g., Northern Telecom, as part of its 1,710-2,290 MHz proposal)
		Researchers				
2300.0 ➤						
	Radio location		Government budget			
	Amateur	Radio amateurs	N/A	N/A		
2310.0 ➤						
	Mobile					<2,310-2,360 MHz> FCC 11/6/1992 NPRM to satellite DARS
	Radio location					
2390.0 ➤						
	Radio location		Government budget			To PCN (e.g., experimental license of LiTel Telecommunications)
	Amateur	Radio amateurs	N/A	N/A	<2,400-2,500 MHz> FCC designates as ISM frequencies	
2450.0 ➤						
	Fixed; mobile	Private industries	Self		More than 500 assignments, mostly to petroleum and auxiliary broadcast	To PCN (e.g., experimental license of LiTel Telecommunications)
		Radio location service providers	Service subscribers		<2,400-2,500 MHz> FCC designates as ISM frequencies	
2483.5 ➤						
	Radio-determination satellite				Approximately 150 assignments, mostly to oil and petroleum industry services	*WARC '92 worldwide primary allocation to LEO MSS (downlink)*
					<2,400-2,500 MHz> FCC designates as ISM frequencies	
2500.0 ➤						

[1]U.S. dollars in millions. N/A: Dollar value not appropriate.
[9]Total replacement costs of all federal systems in this band, from Cerezo, Table 6-1.

Text Formats

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Boxed-shaded-bold	Allocation shared by federal government and private sector
Normal	Exclusive private sector allocation
Italic	Foreign or international reallocations that may affect decisions made in the U.S.

Table 3-1, cont.

Table 3-1 Definitions	
DAB	Digital Audio Broadcasting
DARS	Digital Audio Radio Service
ENG	Electronic News Gathering
FCC	Federal Communications Commission
GPS	Global Positioning Satellite
ISM frequencies	Industrial, Scientific, and Medical frequency bands, designated by the FCC for unlicensed radios (Part 15.247)
LEO	Low-Earth-Orbit (satellite)
MSS	Mobile Satellite Service
NPRM	Notice of Proposed Rule Making (by the FCC)
PCN	Personal Communications Network
SMR	Specialized Mobile Radio
TT&C	Tracking, Telemetry, and Command (satellite system)
UHF	Ultrahigh Frequency (television broadcasting)
WARC	World Administrative Radio Conference

to secure an allocation and assignment of the use of the spectrum to implement new technologies are a source of complaint and have led to pressure for reform. The FCC has responded in three ways.

Flexible Use of Frequencies by Licensees In certain areas, the FCC has allowed a more flexible use of the assigned frequencies by spectrum license holders. If present users of the spectrum can find unused portions in their own bands, they may be permitted to provide services other than their licensed uses. For example, licensees of cellular spectrum are permitted to offer, in addition to the agreed-on analog cellular telephone services, advanced cellular technologies or auxiliary communications services in their assigned frequencies.[36] This flexibility permits intended cellular carriers to provide the type of proposed personal communications services in their

[36]FCC, "In the Matter of Amendment of Parts 2 and 22 of the Commission's Rules to Permit Liberalization of Technology and Auxiliary Service Offerings in the Domestic Public Cellular Radio Telecommunications Service," *Report and Order*, GEN Docket 87-390 (December 12, 1988), p. 1 (hereafter, *FCC R&O, GEN 87-390*).

cellular bands and thus to compete directly with future wireless communications systems such as the personal communications network (PCN).[37]

Pioneer's Preference In April 1991 the FCC initiated the "pioneer's preference" rule making, intended to make spectrum allocations and assignments more flexible and accessible to entrepreneurs and firms with technology innovations. Its key element is the recognition that "new services" and "new technologies used to improve an existing service" should receive preferential treatment in spectrum allocation and assignment.[38] A company awarded a pioneer's preference for a wireless communications service is guaranteed an operating license for that service after the frequency allocation is made.

This rule was designed to eliminate the classical "free-rider" problem due to the FCC's usual separation of decisions on frequency allocation from those on license assignment. Traditionally under FCC rules, an innovative company is required to file a petition with the FCC for allocation for a newly invented or initiated wireless communications service. If the FCC approves that, however, other parties also can apply for operating licenses on equal footing with the petitioning company, which holds no advantage in the licensing process. After spending time and money, the original petitioning company may fail to obtain a license and, in effect, only create a business opportunity for its competitors. As a result, many parties tend to wait for others to petition for spectrum allocation and then apply for operating licenses. The new rule is meant to correct the free-rider problem:

> Under the pioneer's preference procedures, a party granted such a preference is effectively guaranteed a license because it is permitted to file a license application without being subject to

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[37]"PCN" here describes a loosely defined class of future wireless communications systems, conveying approximately the same meaning as, among others, PCS as used by the FCC, Future Public Land Mobile Telephone Services (FPLMTS) by the European Community on a number of occasions, or Telepoint and PCN by the U.K. For details, see Huang, *Up in the Air*, Section 1.4 (*supra*, note 22).

[38]"FCC Adopts 'Pioneer's Preference' for New Services, Technologies," *Telecommunications Reports* (April 15, 1991), p. 12.

> competing applications. This process is intended to insure that parties that develop innovative services or technologies and successively pursue authorization of such innovations in proceedings before the Commission have an opportunity to benefit directly from their efforts.[39]

In this way, the FCC believes that pioneer's preference would "help to insure that the innovators have an opportunity to participate either in new services that they take the lead in developing or in existing services to which they wish to apply new technologies."[40]

On the qualification for a pioneer's preference award, the Commission indicated that "a qualifying innovation could be an added functionality, a use of the spectrum different than previously available, or a change in the operating or technical characteristics of a service,"[41] but conceded that establishing criteria for innovation could be difficult:

> [I]t is necessary to make the standard for a pioneer's preference as specific as possible to provide guidance to innovators and financial institutions as to when a preference might be granted. However, the standard must be somewhat flexible in order to be applicable to the various types of proceedings in which it might be used.[42]

As of late 1992, the pioneer's preference rule has been used by the FCC to make frequency allocations and assignments to a variety of new services: for example, a low-earth-orbit (LEO) satellite communications system by Volunteers in Technical

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[39]FCC, "In the Matter of Establishment of Procedures to Provide a Preference to Applicants Proposing an Allocation for New Services," *Memorandum Opinion and Order*, GEN Docket No. 90-217 (February 26, 1992), p. 2 (hereafter, *FCC Memorandum Opinion and Order, GEN 90-217*).

[40]"FCC to Grant 'Pioneer's Preference' for New Services and Technologies Requiring Spectrum Allocation Rule Changes," *Federal Communications Commission News Release*, Report No. DC-1838, April 9, 1991.

[41]*FCC Memorandum Opinion and Order, GEN 90-217*, p. 2 (*supra*, note 39).

[42]Ibid., p. 4.

Assistance[43] and a nationwide wireless network by Mobile Telecommunications Technologies Corporation.[44] In October 1992, the FCC granted pioneer's preferences for PCNs to three companies—American Personal Communications, Cox Enterprises, and Omnipoint Communications—and rejected fifty-three other seemingly similar applications.[45]

This new rule invited numerous questions and challenges to the FCC. Since its announcement in 1991, companies have petitioned to clarify procedures and criteria.[46] To the rejected applicants and to competitors to awarded companies, the FCC's decisions based on this rule could seem arbitrary and are open to challenge. After the FCC turned down thirty-five applications for pioneer's preference for PCN licensing in June 1992, some of the rejected threatened to take the Commission to court[47]; among them, TRW, Inc., claimed that the FCC's decision to dismiss applications without a full hearing violates Section 309 of the Communications Act of 1934, according to the U.S. Supreme Court decision in 1945 in the case of *Ashbacker Radio Corp. v. FCC.*[48] TRW is also involved in the dispute over Motorola's application for pioneer's preference for its Iridium project, a LEO system:[49] as a potential competitor to Motorola, in July 1992 TRW filed suit to the U.S. Appeals Court in D.C. to prevent

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[43]FCC, "In the Matter of Request for Pioneer's Preference in Proceeding to Allocate Spectrum for Fixed and Mobile Satellite Services for Low-Earth Orbit Satellites," *Tentative Decision*, ET Docket 91-280 (February 11, 1992).

[44]"MTEL Receives Tentative FCC 'Pioneer's Preference' for a Two-Way, Nationwide Wireless Network," *PR Newswire* (July 17, 1992) [NEXIS].

[45]FCC, "In the Matter of Amendment of the Commission's Rule to Establish New Personal Communications Services," *Tentative Decision and Memorandum Opinion and Order*, GEN Docket 90-314 (released November 6, 1992).

[46]*FCC Memorandum Opinion and Order, GEN 90-217*, p. 2 (*supra*, note 39).

[47]"Rejected Pioneer's Preference Applicants Seek FCC Reconsideration of OET's 'Arbitrary' Decision to Dismiss 35 of 73 PCS-Related Preference Requests; TRW Argues that Depriving Pioneer Applicants of Full Hearing Violates Communications Act, 'Ashbacker' Doctrine," *Telecommunications Reports* (June 29, 1992), p. 4.

[48]Ibid.

[49]For a description of the Iridium proposal and other "big LEOs," see below, **Section 4.2.2.**

the FCC from granting pioneer's preference to the Iridium project in the Commission's meeting on August 5.[50] Given the number of ongoing and potential lawsuits about this rule, no wonder Chief Engineer Thomas Stanley of the FCC acknowledged that it could be viewed as an "attorney's dream."[51]

Reallocation of Frequencies Pressured by potential users and uses of new wireless technologies, the FCC has tried, when the unused spectrum available was insufficient, to make room for certain newcomers by reallocating incumbents' frequencies. As early as 1968, the FCC initiated an examination (in Docket 18262) of the reallocation of a substantial portion of the 806–960 MHz band to private and public land mobile communications services.[52] A large part—806–890 MHz—was then UHF channels 70–83. Although very few UHF stations operated in that band, the FCC received considerable opposition from broadcasters before 115 MHz was finally set aside in 1974.[53] Common-carrier analog cellular telephony and specialized mobile radio (SMR) services were created by using those frequencies.

Reallocation seemed necessary again in the early 1990s because of proposals for implementing the many technology innovations in wireless communications. In 1992, the FCC proposed reallocation of 220 MHz of microwave frequencies for "the use of new telecommunications technologies," including PCN, mobile satellite services

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[50]"Suit Filed Anyway; FCC Staff: No Pioneer Preference for LEOs This Go-Around," *Communications Daily* (July 31, 1992), p. 3 [NEXIS].

[51]"Chief Engineer Stanley Says Commission Likely to Issue 'General Policy Statement,' Call for 'En Banc' Hearing on Personal Communications Services Before End of Year," *Telecommunications Reports* (September 16, 1991), p. 11.

[52]Kenneth E. Hardman, "A Primer on Cellular Mobile Telephone Systems," *Federal Bar News and Journal* **29**, 11 (November 1982), pp. 385–391.

[53]FCC, "In the Matter of an Inquiry Relative to the Future Use of the Frequency Band 806–960 MHz; and Amendment of Parts 2, 18, 21, 73, 74, 89, 91, and 93 of the Rules Relative to Operations in the Land Mobile Service Between 806 and 960 MHz," *Second Report and Order*, Docket No. 18262 (May 2, 1974).

(MSS), and digital audio broadcasting (DAB) services.[54] This time the reallocation seems even more difficult, because the bands proposed are heavily used by the incumbents (see **Table 3-1**). Despite the Commission's effort to smooth the transition by designing a compensation system and a long transition period—ten to fifteen years—for relocation of the incumbents,[55] its proposal still encountered strong opposition (see **Section 4.2.3**).

In addition to efforts by the FCC, Congress has been involved in the allocation of frequencies. In 1991, the "Emerging Telecommunications Technologies Act," introduced as H.R. 531 and S. 2904 in the 101st Congress, was intended to transfer 200 MHz of the federal frequencies to the private sector, the allocation and assignment to be managed by the FCC.[56] The Bush administration and industries supported this legislation.

3.2 New Zealand: Privatizing the Air Waves

New Zealand is the first country to apportion, on a large scale, the radio spectrum primarily according to market principles rather than by government administration. The Radiocommunications Act of 1989 defined the rules for privatization of frequency bands between 44 MHz and 3.6 GHz.[57] The Act created two types of tradeable spectrum property rights—management right and license right;

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[54]FCC, "In the Matter of Redevelopment of Spectrum to Encourage Innovation in the Use of New Telecommunications Technology," *Notice of Proposed Rule Making*, ET Docket No. 92-9, (February 7, 1992) (hereafter, *FCC NPRM, ET 92-9*).

[55]Ibid., p. 11.

[56]H.R. 531, as amended, was passed in the House in July 1991, with a two-thirds majority vote; S. 2904 was pending in the Senate as of August 1992.

[57]The Act was passed on December 19, 1989.

the government, originally "owner" of the whole spectrum, would auction off and transfer these rights to private parties.[58]

A management right, equivalent to exclusive ownership of a frequency band, is nationwide in scope, fully tradeable, and lasts for twenty years. Holders are protected from interfering radio emission from users outside their bands and are themselves restricted from spilling excess energy into other frequencies. Holders can subdivide their bands and license other parties to use the subbands; in effect, the government delegates the function of apportioning the spectrum to holders of a management right.

A license right to a frequency band is a "right to use," like a radio license in the U.S. It specifies the holder, band, location, and transmission power. In New Zealand a license right, unlike a traditional radio license, is fully tradeable[59] and does not mandate implementation of a specific service (although specification of the location and the power level by a license right may be designed with a particular use in mind). Besides the government, holders of management rights can define and issue license rights.

The government of New Zealand initially distributes both management and license rights by auctions to private parties. A second-price,[60] sealed-bid tendering method is used. Since enactment of the Act, about 200 UHF television license rights (518–806 MHz), three cellular telephone band management rights (806–890 MHz),

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[58]Milton Mueller, *Reform of Spectrum Management: Lessons from New Zealand* (Los Angeles, Calif.: Reason Foundation, Policy Insight No. 135, November 1991) (hereafter, Mueller, *Lessons from New Zealand*); I.R. Hutchings, *Spectrum Deregulation in New Zealand,* paper presented to the Spectrum Management Division of the International Chamber of Commerce, Washington, D.C., April 1989, p. 17 [Draft] (hereafter, Hutchings, *Spectrum Deregulation in New Zealand*). The following description of the New Zealand case follows closely the discussions in these papers.

[59]In the U.S., a spectrum license is usually tradeable, but its transfer may require approval by the FCC, e.g., transfers of licenses of TV broadcasting stations. See **Section 3.3.2** for details.

[60]In a second-price bidding, the successful bidder pays the second highest price to obtain a license. The philosophy of the second-price tendering method is that, given the importance of the spectrum to business operations, parties may be tempted to bid above the "true market value" of a band. See Hutchings, *Spectrum Deregulation in New Zealand,* p. 17 (*supra,* note 58).

twelve microwave-band management rights (2,300–2,396 MHz), and more than 150 AM and FM broadcasting license rights have been auctioned and transferred to private companies.[61]

The auctioned bands were originally unoccupied. The crowding of the spectrum has not posed a serious problem in New Zealand, and, as of late 1992, the government has not been engaged in the reallocation of frequencies. The law protects incumbents of the spectrum: they can continue to use their frequencies (for free or by paying a fee) if the frequencies are not tendered; in the case of auctions, they are allowed to match and pay the highest bid to obtain a license. To guarantee access to radio communications by nonprofit users who may not be able to pay for the use of the spectrum, certain classes of users are exempt from the auction process.

The market-based management system of New Zealand, though radically different from traditional centralized systems, has seen relatively few problems as of mid-1992. Yet fewer management rights than originally proposed were successfully auctioned by the government because of opposition from incumbents and nonprofit organizations; instead, license rights were issued. The second-price tendering method also created anomalous results: in some instances the second highest bid was extremely low, and overall variation among prices for equivalent bands was quite high.[62] New Zealand's new spectrum management system has been in effect only since 1989, so whether it can be called a success or a failure is not yet clear.[63]

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[61]For details of the auction results, see Mueller, *Lessons from New Zealand*, pp. 9–13 (*supra*, note 58).

[62]Ibid., pp. 19–20.

[63]No universal yardstick for success or failure exists. Every party, depending on its own stakes, may have a different set of rules for measuring success. Some seemingly reasonable criteria, from a public policy point of view, may be the ability and timeliness of the implementation of new technologies, smooth process of spectrum allocation and license assignment, and so on.

3.3 Comparison

Since the 1980s, spectrum management based on centralized decision making, which the U.S. and many other countries adopted, has been viewed by experts as inefficient, inflexible, and inadequate to cope with economic, social, and technological changes, and a growing number of parties advocate a market approach.[64] The NTIA, under the Bush administration, voiced supports for "economic incentives" in spectrum management—"for most purposes, a spectrum management system that provides users with both incentives and opportunities to use spectrum in ways that are economically efficient will produce greater benefits for society."[65] Until New Zealand adopted a market-based system, the discussion of possible benefits of such a reform was only theoretical. New Zealand's experience has shown that, in addition to theoretical and philosophical deviations, a market-based management system differs from the traditional centralized decision making one primarily in the assignment of frequency licenses and ownership of the spectrum.[66]

The approaches to the apportionment of the spectrum used in the U.S. and New Zealand can be compared to point out the advantages and limitations of various management systems based on both theories and evidence. The different political and economic backgrounds of different countries, however, can lead to very different results in the actual implementation of a system. For instance, in countries where the spectrum is relatively lightly used, a U.S.-style, public interest-based approach may not exhibit problems now confronting the U.S. Similarly, compared with the U.S.,

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[64]See, for example, Charles L. Jackson, "Use and Management of Spectrum Resource," in *New Directions in Telecommunications Policy*, Paula R. Newberg, ed., Vol. 1 (Durham, N.C.: Duke University Press, 1989); Henry Geller and Donna Lampert, *Charging for Spectrum Use* (Washington, D.C.: The Benton Foundation, 1989) (hereafter, Geller and Lampert, *Charging for Spectrum Use*); Janice Obuchowski, "Wireless Communications and Spectrum Conservation: Sending a Signal to Conserve," *IEEE Communications* (February 1991), p. 26 (hereafter, Obuchowski, "Sending a Signal to Conserve").

[65]*U.S. Spectrum Management Policy*, p. 86 (*supra*, note 3).

[66]See Mueller, *Lessons from New Zealand*, p. 14 (*supra*, note 58). Mueller calls the former a "surface reform" and the latter a "deep reform."

New Zealand had fewer entrenched frequency users and fewer spectrum-crowding problems; therefore, some of the benefits of the market-based system realized in New Zealand may not be so easily obtained in the U.S. Great caution is needed in generalizing the merits and demerits of each approach, from country to country.

3.3.1 Assignment of Frequency License

In the U.S., the FCC, required to apportion the spectrum "in the public interest," assigns licenses either by comparative hearings or lotteries.[67] The market-based system, proposed by the NTIA and similar to that used in New Zealand, would use auctions to assign new frequency licenses.[68] These three methods of assignment—comparative hearings, lotteries, and auctions—differ in style, procedure, and possible effect on wireless communications industries.

In comparative hearings, applicants for licenses file applications with the spectrum administration, which compares and evaluates them against a set of comparative criteria and selects the winners. According to policy requirements and objectives (such as serving the "public interest"), spectrum managers set up criteria that may include financial competence and technical expertise of an applicant, the design of systems and services shown in an application, and so on. Once these are

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[67]Whether, without a legislative mandate, the FCC can use auctions to distribute spectrum licenses is a matter for debate. Henry Geller, former head of the NTIA, argues that the FCC already has the power, but legislation would help avoid litigation. Others believe that, implicit in the 1982 amendment, Section 331(a), to the Communications Act, the FCC is forbidden from using auctions. See, for example, *Spectrum Auction: FCC Proposals for the Airwaves,* Hearing before the Subcommittee on Telecommunications, Consumer Protection, and Finance, 99th Congress, 2nd Session, Serial No. 99-170, October 1, 1986, pp. 65–80 (hereafter, *Spectrum Auctions Hearing*); Geller and Lampert, *Charging for Spectrum Use,* pp. 7–11 (*supra,* note 64).

[68]Section 4-II of *U.S. Spectrum Management Policy* (*supra,* note 3) is devoted to a detailed discussion of the free-market approach and its merits.

established, the decision is based on documents presented to the spectrum managers, who then handpick licensees "deemed the most worthy."[69]

Comparative hearings offer a vehicle for spectrum managers to carry out or enforce policies, especially when applications are relatively few and spectrum managers have the resources to review and compare them. This advantage may be reduced if licenses are freely transferable, because the ultimate users of the spectrum may not be those originally selected by the spectrum managers. Comparative hearings also exhibit problems. First, they emphasize the preparation of applications; applicants who have more resources to prepare better applications hold a competitive advantage. Second, as the number of applications increases, the ability of the spectrum managers to make licensing decisions and the timeliness of their decisions both decline. As in the early stage of the distribution of analog cellular licenses in the U.S., comparative hearings may overload the applicants—who must file applications as complete and detailed as possible, which is often very costly—as well as the spectrum managers—who must inspect and compare all the long documents presented by the applicants, a process that can be lengthy.[70] Third, because applicants usually carefully prepare their applications to cover all details, the licensing decision may come down to minor or even insignificant differences.[71]

A lottery selects winners randomly and as such gives every applicant for spectrum licenses an equal chance to obtain one. It offers a relatively fast and easy procedure for both applicants and spectrum managers. When no careful pre-lottery screening is held, spectrum managers cannot control the qualifications of the applicants. A lottery may attract speculative applicants, who have almost nothing to lose—the cost of preparation of a required filing to enter a lottery is usually not

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[69]FCC, "In the Matter of Amendment of the Commission's Rules to Establish New Personal Communications Services," *Notice of Proposed Rule Making and Tentative Decision*, GEN Docket 90-314 (August 14, 1992), p. 87 (hereafter, *FCC NPRM, GEN 90-314*).

[70]See, for example, Calhoun, *Digital Cellular Radio*, p. 122 (*supra*, note 2).

[71]One example is the selection of the nonwireline cellular carrier for the Los Angeles area by the FCC, based on less than 1 percent difference in system coverage by two proposals. See ibid., p. 123.

high—but a valuable resource to gain by applying for a license.[72] Applicants may even submit multiple entries to increase the probability of winning. For example, the FCC received about 288,000 applications for 428 cellular licenses between July 1988 and January 1989, and in a lottery for the selection of mobile service providers in 220 MHz in May 1991 it received more than ten thousand applications from one firm alone.[73]

Competitive bidding, or auction, conforms to the "market principle" of resource allocation advocated by western economists. Instead of a central agency that makes the decisions, an initial price determined by a private market (i.e., an auction) can be tagged onto every frequency band to be distributed. From the viewpoint of public policy, at least in theory, competitive bidding offers several advantages. It yields economically efficient distribution of licenses by market mechanism. It encourages effective use of frequencies, because users are required to pay for the amount of the spectrum they use and thus would generally not obtain more frequencies than needed, although speculative purchase cannot be ruled out.[74] And it seems to expedite the licensing process, in contrast to comparative hearings—New Zealand issued hundreds of new licenses in less than two years, compared with the usually lengthier proceedings of the FCC. To countries burdened with budget deficit or national debt, auctions are particular attractive, because they generate revenues for the government.

Competitive bidding also offers disadvantages. Except for pre-auction screening, spectrum managers have little control over the process and bidders to exercise particular policy preferences. To realize the benefits discussed above, auctions require a large pool of technically and financially capable bidders, because a few powerful firms may successfully bid for all available frequencies, thus shutting out access to the spectrum and competition by others. Although in theory small firms could obtain the

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[72]Ibid., pp. 124–129; Mueller, *Lessons from New Zealand*, p. 17 (*supra*, note 58).

[73]*FCC NPRM, GEN 90-314*, p. 88 (*supra*, note 69).

[74]See *U.S. Spectrum Management Policy*, pp. 109–111 (*supra*, note 3).

proper financing from a *rational* financial market, in practice financial markets often fail to recognize the value of the spectrum licenses. The New Zealand experience suggests that large companies—Telecom Corporation of New Zealand and BellSouth in the auctions of cellular frequencies —still hold a decisive advantage over small ones in competitive bidding.[75]

Each of the three methods of assignment has merits and demerits. Choice among them would depend on the political, economic, and social environment of a country and the philosophy and purposes a spectrum management system is intended to serve.

3.3.2 Ownership of Spectrum

Ownership of spectrum is treated very differently in the systems used in the U.S. and New Zealand. In the U.S., the spectrum is regarded public property; the Communications Act of 1934 specifically states that a frequency license does not carry ownership of the spectrum, and the Supreme Court decision of *FCC v. Sanders Brothers* confirmed this view.[76] In New Zealand, exclusive ownership is transferred to holders of management rights for twenty years. Some experts believe that a market-based management system would need to be associated with explicit property rights.[77]

But what constitutes ownership? Ownership of (or private property right to) a resource requires a legal definition. Without excursion into rigorous legal discussion, the following may be regarded as necessary conditions for property rights:[78]

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[75]See Mueller, *Lessons from New Zealand*, pp. 8, 22-23 (*supra*, note 58).

[76]Communications Act of 1934, Section 301; *Federal Communications Commission v. Sanders Brothers Radio Station*, 309 U.S. 470, 1940, p. 475.

[77]*U.S. Spectrum Management Policy*, p. 111 (*supra*, note 3).

[78]The first three conditions are adapted from Douglas W. Webbink, "Radio Licenses and Frequency Spectrum Use Property Rights," *Communications and the Law* 9 (June 1987), pp. 3-29.

(i) *Exclusive access to and use of the property* If a party owns a property, it will have exclusive access to and use of that property. The owner can deny access to everyone else. If A owns a piece of land, anyone entering it without permission is trespassing.

(ii) *Right to generate income from the property* When a party owns a property, it should be able to use it for purposes that do not affect others outside this property. Possible use includes business conduct, and the price or rent of acquiring the property will usually be considered a cost. Thus A can rent the land, or buildings on that land, to others for a profit; or A can build a factory on it to manufacture soap and keep the profit, within the limitation of the zoning laws.[79]

(iii) *Freedom to transfer the property* The owner of a property can usually transfer the property right to someone else for free or for profit. If A wishes, A can sell the land to someone else and keep the money.

(iv) *Freedom from revocation of the property* If a certain body, say the government, can claim the right to a piece of property at any time it wants, the property right cannot be regarded as complete. In A's case, unless some extreme situation (such as natural catastrophe, war, etc.) occurs, A's right to the land will not be revoked.

According to these four conditions, ownership of spectrum is not so different in the U.S. and New Zealand systems. In the U.S., in practice "many licensees function as if they 'own' the spectrum they use."[80] If an allocation is ruled primary, users can operate free of interference, that is, have exclusive access to the frequency band. Licensees can use frequencies to provide services for profit. In most cases, the

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[79]Zoning laws place lands into different classes, such as industrial, commercial, and residential, and restrict their use accordingly. See ibid., pp. 4–5.

[80]*U.S. Spectrum Management Policy*, p. 113 (*supra*, note 3).

freedom to transfer licenses generally exists in practice, if not in theory: the right to transfer is limited by the Communications Act of 1934[81] and may require approval by the FCC, but buying and selling frequency licenses happens frequently, especially in TV and radio broadcasting and in mobile communications, such as cellular telephony and SMR. Short of a drastic change in the political and economic environment, revocation of licenses is unlikely. From a practical standpoint, the current practice in the U.S. of issuing a license for a frequency band ("the right to use") is similar, if not identical, to transferring ownership to the licensee—in the words of one expert, a frequency license in the U.S. is "but a zero-priced club admission to unlimited use of the band."[82] Property right has not appeared as a central problem in the spectrum management system in the U.S.

[81]See Section 310(b) of the Act.

[82]Thomas Hazlett, "The Rationality of U.S. Regulation of the Broadcast Spectrum," *Journal of Law and Economics* XXXIII (April 1990), pp. 133-175 (hereafter, Hazlett, "Regulation of the Broadcast Spectrum"); quotation from p. 135.

CHAPTER FOUR
SPECTRUM MANAGEMENT AS A POLITICAL PROCESS: WHO GETS WHAT, WHEN, AND HOW

With proliferation of new wireless communications technologies and scarcity of unused radio frequencies, the stakes in spectrum apportionment are increasingly high. In the operation of wireless communications systems, the spectrum is an insurmountable barrier to entry. Companies without frequency licenses simply cannot compete with licensed companies in operating wireless systems to provide communications services.[83] For a firm with a new wireless service to offer, no matter how economically efficient or technically advanced the offering may be, access to the spectrum is the precursor to entry (and, later on, to success). The effect of frequency management is not limited to service providers. An allocation can create a market for a new kind of wireless service, benefitting manufacturers who produce equipment for the providers of that service.[84] The whole economy may feel the impact of an allocation, because the creation of new services, such as television broadcasting and cellular telephony, may profoundly change the way people live.

Conflicts in commercial, social, and political interests increase with stakes, and the function of a spectrum management system as the medium for resolving these conflicts becomes more pronounced. The selection and implementation of a particular management system as the "best" one can hardly satisfy every party, because each approach creates winners and losers among stakeholders. Thinking of the systems as conflict resolution—who gets what, when, and how[85]—may help those involved in

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[83]This statement could be modified in two ways. First, it is true for any snapshot in time; as a practical matter, over time licenses may be transferred, so the entry barrier is *insurmountable but not permanent.* Second, companies may use other transmission media, such as cable or fiber, to provide services similar to those offered by a particular wireless system, thus effectively competing in the same market. But without a license, companies *cannot* operate the same *wireless* systems.

[84]Manufacturers are very much aware of this, hence many of them strongly advocate allocation of the spectrum for the PCN.

[85]This phrase is borrowed from the title of Harold D. Lasswell's classic, *Politics: Who Gets What, When, How* (Cleveland, Ohio: World Publishing, 1958).

frequency management (spectrum administrators, private industries, service users) to devise ways to achieve their goals in allocations and assignments.

4.1 Current Requirements and Future Needs

In the U.S., frequency allocation has been reactive: spectrum management is tailored to existing demand. The FCC responds to requests for frequencies and decides the allocations. In an era of both rapidly changing technology and the crowded spectrum, spectrum managers frequently need to find bands for new services; the reactive approach may hardly meet current and potential demands for frequencies. A long-term approach to spectrum management, which would leave room for future expansion, might produce a more stable system.

Among proposals for long-term spectrum management, in 1991 the NTIA recommended a planning system for frequency allocation in four steps: (*i*) identification of requirements, (*ii*) forecasting (of future demands and technology capabilities), (*iii*) development of long-range plans, and (*iv*) planning for unforeseen requirements.[86] Such long-term planning is difficult, if not impossible: all four steps require plenty of foresight (predictions), which may not be reliable for regulatory decisions. As the NTIA acknowledges, the two groups that could resist planning are those who believe they stand to lose (mostly incumbents) and those who will themselves have to do the planning.[87] Without the support of both, long-term spectrum management will have little chance to succeed. The rewards of a successful planning system may be high, but actual implementation can be quite difficult.

One of the most publicized proposals for long-term frequency allocation, presented as if it could solve the spectrum crunch for good, is "the glassing of

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[86]*U.S. Spectrum Management Policy*, p. 161 (*supra*, note 3).

[87]Ibid., p. 163.

America," or moving broadcast television to cable,[88] which would free more than 400 MHz of spectrum.[89] Advocates claim that by putting such services as broadcasting television on wire—copper wire or optical fiber—the spectrum would no longer be a scarce resource.[90] The argument seems plausible: television, with the exception of such portable sets as limo TV and Watchman, is essentially a fixed service, going from broadcasting stations to homes, that can be provided by wire-based transmission; radio, however, is most suitable for mobile services or long-haul communications. But by moving broadcast TV away to make room for two-way mobile telecommunications, "the glassing of America" is essentially another reallocation proposal. No systematic change will result in improvement of spectrum management—what happens when these 400-plus MHz of frequencies are used up?

The FCC is engaged in a process to manage the spectrum with a long-term view. Flexibility in apportionment (discussed in **Section 3.1.2**) enables variations in spectrum allocation and frequency assignment to be made easily over time in response to technological or economic changes. Any massive reallocation, which would involve relocation of incumbent users, will itself be a long-term process; the reallocation proposed in the *Notice of Proposed Rule Making* (ET Docket 92-9), discussed in **Section 4.2.3**, would take a long time—possibly ten to fifteen years—to accomplish. With the pace of technological change, spectrum management planning beyond that time span seems almost impossible.

4.2 Haves vs. Have-Nots

At the center of decisions on allocation and assignment among competing uses and users or on reallocation from incumbent uses to new wireless communications is

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[88]See George Gilder, "What Spectrum Shortage?" *Forbes* (May 27, 1991), p. 328.

[89]Combing and adding VHF and UHF bands, the total frequencies currently allocated to TV broadcasting are 402 MHz.

[90]See, for example, remarks by Peter Huber in *CSIS WARC '92 Symposium*, pp. 98-99 (*supra*, note 1).

the dividing line between the *haves*—those who already have access to the desirable frequencies—and the *have-nots*. In the U.S., often the federal government is the *have* and in general the private sector the *have-not*.[91] In private industries, current users of the spectrum are the *haves*, and, as Travis Marshall of Motorola put it, "if you have something new to offer, you are the *have-nots*."[92] **Table 3-1** illustrates the status in the U.S. of the *haves* and the proposals for change for the *have-nots*. Internationally, more often than not, the advanced countries are the *haves* and developing countries the *have-nots*.[93]

The *haves* have many reasons not to give up their frequencies. Their main business operation may be contingent upon use of the spectrum, as is true for satellite communications and cellular telephone service providers. Or, the *haves* might be able to provide their services in other ways, but uncertainty, inflexibility, or higher cost prevents them from doing so—the broadcasting industry would hardly give up its VHF and UHF bands to deliver programs on cable, and the petroleum industry does not want to surrender its established and convenient microwave communications and instead use common carrier services. Last but most important, frequencies can be used as an entry barrier to deter competitors, as in the mobile communications industries, such as the SMR services. By reversing or generalizing these arguments, the reasons the *have-nots* want frequencies from the *haves* can similarly be laid out. There is, thus, a major conflict of interest between these groups.

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[91]A gross generalization, of course, of the public feeling that the federal government owns a huge part of the spectrum without putting it to efficient use, while the private sector is looking for small bits and pieces to provide new wireless communications.

[92]*CSIS WARC '92 Symposium*, p. 5 (*supra*, note 1).

[93]In comparison with developed countries, developing countries may well have adequate wireless communications—indeed, many are implementing various modes of new radio communications faster than, say, the U.S. But international spectrum allocation has largely been shaped by the requirements of the developed, not developing, countries.

4.2.1 Significance of History

Historic events determine who are the *haves* and who the *have-nots*. Before the spectrum became crowded, users and uses could all obtain frequencies (often on a first-come, first-served basis). Few, if any, allocations or assignments have been revoked by spectrum managers; as a result, yesterday's innovators become today's incumbents, or *haves*, and today's innovators, the *have-nots*, must fight to take frequencies from them.

From the viewpoint of the *haves*, history counts. They believe they do not need to give up frequencies, because they have invested in facilities to operate in those bands. The original assignment, in the U.S. in particular, gives the incumbents free, guaranteed access to the spectrum, and they have built their businesses on such promises. Therefore, argue incumbents, renewals of licenses should not be subject to competition for frequencies from newcomers.[94]

But the *have-nots* (as well as many experts) see matters differently. They argue that many allocations and assignments were made without consideration of efficiency and conservation, and the consequence is slow development and implementation of new technologies, as in the case of analog cellular telephony:

> [I]n some respects, efficiency is not natural. Waste is natural.... When, in the past, the FCC has granted licenses with no care for the efficiency with which the spectral real estate has been used, the predictable result has been that radio technology stagnated. We are still using today the same basic radio system demonstrated by Edwin Armstrong in 1935. On the other hand, it was only the FCC's tough stand when, less than two years after the beginning of cellular service, the cellular operators came pleading for more spectrum to continue using their slash-and-burn technology, that has propelled us forward toward the next technological chapter. Had more spectrum been granted to

[94]For the incumbents' arguments, see *U.S. Spectrum Management Policy*, p. 119–121 (*supra*, note 3).

> the cellular operators at that time, we would certainly not have a digital cellular standard today.[95]

They also argue against the *haves* holding onto the right to a piece of the spectrum that could be given to other wireless users or uses.[96] Because in most countries (New Zealand being an exception) private parties do not pay the public to use the spectrum, frequency licenses should be considered a privilege rather than a right. From this viewpoint, when a frequency band may be apportioned to alternative uses or users, both incumbents and newcomers should compete for it; automatic renewal of frequency licenses in the presence of competition should not be allowed. In rapidly changing technological, economic, and social environments, the original objective of an allocation may no longer be valid after a period of time. For instance, the FCC allocated more than 300 MHz to UHF television, partly out of the belief that small communities and minorities would more easily develop their own networks using these UHF bands, because VHF frequencies were in high demand.[97] Today, cable TV offers better access to community networks than UHF channels.[98] Finally, because the spectrum is an insurmountable entry barrier to wireless services, incumbent users may engage in anticompetitive actions against new businesses—many cellular carriers have opposed allocation for PCN, even though their own frequencies are unlikely to be affected.[99]

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[95]Calhoun, *Wireless Access*, p. 582 (*supra*, note 6). In the case of analog cellular systems, higher capacity can be achieved by splitting cells, though the process may be very expensive. Thus, cellular carriers instead asked for more spectrum. See the description and references in Calhoun, *Digital Cellular Radio*, p. 114 (*supra*, note 2).

[96]For arguments against incumbents' right, see Calhoun, *Digital Cellular Radio*, p. 122 (*supra*, note 2).

[97]There are only twelve VHF channels in each region.

[98]The example of UHF allocation was furnished by General Lee Paschal (retired), former director of the U.S. Defense Communications Agency (now the Defense Information Systems Agency), in an interview with the author, May 1, 1991.

[99]See, for example, Cellular Telecommunications Industry Association, *Comments in the Matter of Amendment of the Commission's Rules to Establish New Personal Communications Services*, FCC's *Notice of Inquiry*, GEN Docket 90-314 (October 1990), pp. 4–9.

As a practical matter, taking frequencies from the *haves* to give them to the *have-nots* is difficult. Reallocation can incur many displacement costs. If the incumbents cannot continue radio communications operation when their frequencies are revoked, it costs them to use functionally equivalent alternatives to that operation. Unless fully depreciated, the facilities for the discontinued radio operation cannot be scrapped without cost to the operators who made the investments. Even if the incumbents are relocated to a different band to continue radio operation (on the assumption that a suitable band to which they can move can be identified), investment in equipment to operate in the new band needs to be made.[100] These displacement costs have to be borne by the incumbents themselves, newcomers, or the public—incentives for relocation, such as tax credit for new investment or an accelerated depreciation schedule, can be issued to incumbents, but they cost the government (thus the taxpayers) money. Compensation arrangements and relocation schedules can be complicated and will not please everyone.

Relocation is so difficult and complex that the *haves* often receive much sympathy. In the U.S., in any reallocation effort, "the Commission must also demonstrate maximum sensitivity to the needs of incumbent users."[101] The FCC has paid much attention to the incumbents in the expansion of existing services with new technologies. Proposals to establish the new digital audio radio service (DARS)[102] and advanced television (ATV) services[103] allow or encourage the incumbents—FM and

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[100]A counter argument asserts that relocation may result in the adoption of new and better technology, which saves operators money in the long run.

[101]"In Re: Amendment of Section 2.106 of the Commission's Rules to Allocate Emerging Technology Bands for Future Requirements," Separate Statement of Commissioner Ervin S. Duggan, January 16, 1992.

[102]FCC, "In the Matter of Amendment of the Commission's Rules with Regard to the Establishment and the regulation of New Digital Audio Radio Services," *Notice of Proposed Rule Making and Further Notice of Inquiry*, GEN Docket No. 90-357 (released November 6, 1992). In this *Notice*, the FCC proposed to allocate 2,310–2,360 MHz for satellite DARS and solicited comments on the possible conversion of existing FM and AM broadcasting into digital.

[103]FCC, "In the Matter of Advanced Television Systems and Their Impact upon the Existing Television Broadcast Service," *Second Report and Order/Further Notice of Proposed Rule Making*, MM Docket 87-268 (released May 8, 1992).

AM broadcasters and TV broadcasters, respectively—to take the first action, although new services are not made in incumbents' frequencies. In New Zealand, after the government implemented its new management system based on economical principles, the private market approach to allocating and assigning frequencies was not extended to incumbent users (see **Section 3.2**).

The central mechanism for resolving the problems of *haves* and *have-nots* is the political engine of persistent pursuit and compromise. For the parties involved, the task may be to identify allies and foes, join forces with the former to establish common positions and favorable arguments against the latter, and, if inevitable, give up something less important for something crucial. For negotiators, the task may be to generate alternatives to accommodate conflicting positions.[104] The following are examples of this political process.

4.2.2 International Mud Wrestling—Big LEOs at WARC '92

Air waves travel freely and know no national boundaries. Allocations in one country may affect radio operations in others—especially in a region where many countries are adjacent to one another as in Europe or Africa. Therefore, spectrum management needs international coordination. Worldwide and regional allocations are made by the International Telecommunication Union (ITU) World Administrative Radio Conferences (WARCs), the most recent held in Spain in February 1992 (WARC '92),[105] where several new wireless communications, including the "big LEOs," received allocations, but not without controversy.

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[104]Kurt Borchardt, *Towards A Theory of Legislative Compromise* (Cambridge, Mass.: Program on Information Resources Policy, Harvard University, P-76-4, 1976), pp. 3-5; Roger Fisher, William Ury, and Bruce Patton, *Getting to Yes* (New York, N.Y.: Penguin, 2nd ed., 1991).

[105]For a detailed discussion of spectrum allocation at the ITU, see, for example, Edward Reinhart, Robert Taylor, Ann Heyward, and Joe Miller, "WARC's Last Act?" *IEEE Spectrum* (February 1992), pp. 20-23.

The proposed big LEOs—mobile communications systems using satellites in low orbit—would offer mobile communications services to a wide area. The first big LEO system, called Iridium and proposed in 1990 by Motorola, is designed to enable customers to communicate by hand-held mobile telephone worldwide, using a network of seventy-seven LEO satellites.[106] The Iridium system, targeted primarily to less developed countries (LDCs) and newly industrialized countries (NICs), is expected to start service in 1997.[107] Other companies, including Constellation Communications (the Aries system), TRW (the Odyssey system), and Inmarsat (Project 21), came up with similar proposals, all promising that subscribers could make or receive phone calls with hand-held terminals or fixed telephone stations.[108]

Prompted by Motorola and other potential operators,[109] the U.S. brought a proposal to WARC '92 to allocate frequencies for the big LEOs worldwide. The Europeans regarded big LEOs as a competitive threat to their own implementation of a pan-European digital mobile wireless communications network, and the thirty-two member countries of the Conference of European Postal and Telecommunications Administrations (CEPT) were poised to oppose the U.S. proposal.[110] LDCs and NICs, in Africa, South America, and Asia had mixed feelings: as direct users, they stand to benefit from extensive implementation of big LEOs, which would improve their

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[106]"Iridium" was named after the element with atomic number seventy-seven. The new plan for Iridium calls instead for sixty-six satellites. See Tracy Anderson, "What's in a Name? Plans Still As Sweet, According to Iridium," *Radio Communications Report* (August 31, 1992), pp. 1, 34.

[107]"Motorola, Lockheed Sign Letter of Intent to Develop International Team for LEO Iridium Satellite Construction; FCC Accepts Application; Motorola Says AMSC Objections Invalid," *Telecommunications Reports* (April 8, 1992), pp. 19–21.

[108]For a detailed description of these systems, see Edward Reinhart, "Mobile Communications," *IEEE Spectrum* (February 1992), pp. 27–29.

[109]The positions and efforts of Motorola and others can be seen in the FCC's recommendation to the Department of State. See FCC, "In the Matter of an Inquiry Relating to Preparation for International Telecommunication Union World Administrative Radio Conference for Dealing with Frequency Allocations in Certain Parts of the Spectrum," *Report*, GEN Docket 89-554 (June 20, 1991), pp. 17–19 (hereafter, *FCC Report, GEN 89-554*).

[110]"Industry Representatives Agree U.S. Achieved Major Objectives," *Telecommunications Reports International* (April 3, 1992), pp. 12–14.

telecommunications abilities; yet, by giving these systems access to their local markets, the developing countries stand to lose telephone revenues. Furthermore, governments of these host countries were concerned that by allowing foreigners to operate, they might compromise national sovereignty, because through foreign-owned networks they would themselves lose control of international telephone traffic.[111]

For the U.S. to obtain the allocation it sought, the support of the *have-nots* was essential—the policy of the ITU is one country, one vote; because the LDCs numerically overwhelm developed countries, their votes were crucial. To alleviate the concern of LDC host countries, Motorola claimed that Iridium would complement rather than compete with existing communications services.[112] U.S. negotiators assured the developing countries that the big LEOs will not take calls from unlicensed regions and that countries that sign up will receive part of the operating revenues of the system.[113] The U.S. made concessions also to the CEPT: the Europeans obtained the allocation of 1,442–1,492 MHz for broadcasting satellite service-sound (BSS-sound; called DAB or DARS in the U.S.), which U.S. companies intended to offer in a different frequency band,[114] and an allocation of future public land mobile telephone services (FPLMTS) in the 1,700–2,600 MHz band,[115] which U.S. negotiators originally

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[111]"Tug of WARC," *The Economist* (March 7, 1992), p. 89.

[112]"Motorola Official Stresses PTT's Role As Local Gateway Operator for 'Iridium' System," *Telecommunications Reports* (September 24, 1990), p. 29.

[113]Ibid.

[114]See *FCC Report, GEN 89-554*, pp. 22–24 (*supra*, note 109).

[115]FPLMTS is similar to the proposed PCN or PCS in the U.S. (see note 37). The European countries intended to operate the terrestrial portion of FPLMTS in 1,885–2,025 MHz and 2,100–2,200 MHz bands and the satellite link portion in 2,010–2,025 MHz and 2,185–2,200 MHz bands. See "Special WARC '92 Issue: New Services Win in Spectrum Allocations," *Global Telecom Report* (March 26, 1992), pp. 2–3.

opposed.[116] Furthermore, the U.S. promised to enter bilateral talks on implementation of big LEOs with the European Community (EC) after WARC '92.[117]

The support of *have-not* countries and the compromise with the opponents resulted in a worldwide allocation for big LEOs in 1,610–1,626.5 MHz and 2,483.5–2,500 MHz bands, exactly as the U.S. requested at WARC '92 (see **Table 3-1**), but the battle may not stop there. In July 1992, as the CEPT gained support from central and eastern European countries, it threatened to block big LEO services from Europe because, as it claimed, of possible interference with the proposed pan-European FPLMTS system.[118] The fight seems far from over.

4.2.3 The Squeeze Is On—Finding Homes for Emerging Technologies

A similar process of balancing between the *haves* and *have-nots* is at work in the U.S. Many new technologies, PCN among them, need homes in the crowded spectrum. According to Janice Obuchowski, former Assistant Secretary for Communications and Information, Department of Commerce, and Administrator of the NTIA, under the present U.S. spectrum management system, taking unused or underused frequencies away from the *haves* is almost impossible[119]:

> We recognize that entrepreneurs and innovators must fight for years to obtain a tiny slice of spectrum to bring their ideas to market. Many good ideas are lost when these pathfinders give up. They are daunted by a complex regulatory process and the power of incumbents to retain their spectrum, no matter how obsolete or inefficient the incumbents' use. Our country is

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[116]*FCC Report, GEN 89-554*, pp. 11-13 (*supra*, note 109).

[117]"U.S. Accepts EC Commission Request for Informal Talks on Policy, Market Issues Related to Big, Little LEO Proposals, WARC Allocations; Initial Meeting Date, Agenda Uncertain," *Telecommunications Reports* (July 27, 1992), p. 15.

[118]"CEPT Strengthens Role in East," *Eastern European & Former Soviet Telecom Report* (August 1, 1992), pp. 4–5.

[119]Obuchowski, "Sending a Signal to Conserve" (*supra*, note 64).

> fighting an international battle for technological competitiveness. We cannot afford this waste.[120]

Parties have been lobbying the government for allocations for new wireless communications, and the government has recognized that this position is growing stronger politically. Because essentially no frequencies in suitable bands remain unused,[121] reallocation—redistribution among the *haves* and *have-nots*—is necessary to accommodate new uses and users. The major difficulty is to find which *haves* to move, where to relocate them, and how.

Congress, whose role in all levels of spectrum management has become increasingly important, targeted units of the executive branch, especially the military. As a *have*, the military and its use of the spectrum became politically less significant with the collapse of the former Soviet Union and the end of the cold war. "The Emerging Telecommunications Technologies Act of 1991" proposed transfer of 200 MHz of federal frequencies below 5 GHz to the private sector to implement new wireless services. The major focus in the Act is the 1,710–1,850 and 2,200–2,290 MHz bands, where the DOD is the largest user.[122] As of 1992, the private sector and the FCC favor this proposal, the executive branch supports it on general grounds (with some modifications), while those who stand to lose, including the military, the Coast Guard, and other federal users, oppose it.[123] The DOD says it understands the private sector's need for frequencies but, like everyone else, does not want to make the sacrifice:

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[120]Ibid., p. 29.

[121]Proposals for allocations mostly focus on frequencies below 3 GHz.

[122]See Ernesto A. Cerezo, *Federal Spectrum Usage of the 1710–1850 and 2200–2290 MHz Bands* (Washington, D.C.: U.S. Department of Commerce, NTIA TR 92-285, March 1992) [Draft] (hereafter, Cerezo, *Federal Spectrum Usage*).

[123]See, for example, statements by witnesses at the hearings on H.R. 531, February 21, and March 12, 1991, in *Emerging Telecommunications Technologies*, Hearings Before the Subcommittee on Telecommunications and Finance, 102nd Congress, 1st Session, Serial No. 102-2, February 21 and March 12, 1991 (hereafter, *H.R. 531 Hearings*).

> There are several [military] systems in each band of the [federal] spectrum. Therefore, no single system could be terminated or moved to free up a particular band. Additionally, there is no segment that can be totally vacated without impacting the Military services' responsibilities and response capabilities. The reallocation of frequencies used by our complex military systems, unless adequately planned, would be dangerous to our National Defense, expensive to the taxpayers, and disruptive to operations.... We fully support the initiative of U.S. industry to provide new, advanced, efficient systems and services. And we sympathize with their need to compete with foreign entrepreneurs offering similar services. But, this additional spectrum should not come at the expense of the military spectrum.[124]

Negotiators from the Bush administration made room to maneuver, such as designating the 200 MHz a "goal" rather than a minimum,[125] extending the upper limit from 5 to 6 GHz, and including provision for reimbursement to the federal government by private users who receive these frequencies. In general, support for the bill overwhelmed the opposition, but it halted when the Bush administration insisted that the bill should be amended to state clearly that the new frequencies would be auctioned off, with which many members of Congress disagreed.[126]

The FCC took its own action and, in ET Docket 92-9, proposed to reallocate 220 MHz point-to-point microwave frequencies to new technologies (see **Table 3-1**) and to relocate incumbent microwave users to higher frequencies.[127] This proposal reflects the Commission's considerations for both the potential new service providers (the *have-nots*), who focused attention on frequencies below 3 GHz, and the incumbent

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[124]Ibid.; Statement of Lt. Gen. James S. Cassity, Jr., Director, Command, Control, Communications, and Computer Systems, Joint Staff, at the hearings on H.R. 531.

[125]If the bill designates 200 MHz as a "minimum," then at least 200 MHz would be transferred, by statutory requirement, from the public to the private sector; however, if this is regarded as a "goal," the government would try to vacate 200 MHz for private use but holds no responsibility if the goal cannot be reached.

[126]See the exchange on this subject at the hearings, in *H.R. 531 Hearings*, pp. 86–98 (*supra*, note 123).

[127]*FCC NPRM, ET 92-9* (*supra*, note 54).

spectrum users (the *haves*), among whom private and common-carrier microwave operators seem the least difficult group to relocate.[128] As expected, those with new services to offer embraced the FCC's proposal, although the degree of support varies, because some of them are also microwave operators in those bands.[129] Potentially affected incumbent users strongly opposed the proposed reallocation. In one Commissioner's assessment, "It is no secret that this has been a contentious proceeding, involving intense lobbying by the parties most at risk—incumbent microwave licensees, on the one hand, and new technology providers ... on the other. Both sides in this debate have strong policy arguments, both have strong allies on Capitol Hill."[130]

Opposition's rationales fall into three categories.[131] The first is the question of the basis for such a reallocation. Parties argue that this action implies that existing microwave operations are less in the public interest than new services and that reallocation would be premature when replacement services are not yet even defined.[132] The commission's lack of consideration for frequencies outside 1–3 GHz also was questioned.[133]

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[128]The FCC did a careful study of the reallocation of the spectrum and relocation of the microwave-band users. See Office of Engineering and Technology, *Creating New Technology Bands for Emerging Telecommunications Technology* (Washington, D.C.: the FCC, OET/TS 92-1, 1992).

[129]"PCS Proponents, Microwave Users Generally Continue on Opposite Sides of 2 GHz Debate; Comments Reveal Concerns about Operating at Higher Frequencies, Costs of Relocation," *Telecommunications Reports* (June 15, 1992), p. 17–18 (hereafter, "2 GHz Debate").

[130]"In the Matter of Redevelopment of Spectrum to Encourage Innovation in the Use of New Telecommunications Technology," Separate Statement of Commissioner Ervin S. Duggan, September 17, 1992.

[131]Arguments presented below are mostly drawn from "2 GHz Debate," *supra*, note 129, and comments by various parties on *FCC NPRM, ET 92-9*, as summarized in *FCC First Report and Order, ET 92-9*, pp. 5–11 (*supra*, note 11).

[132]*FCC First Report and Order, ET 92-9*, p. 6 (*supra*, note 11).

[133]Ibid.

The second category is the feasibility of such a reallocation. Given that, in theory, fixed microwave communications can be functionally replaced by landline communications (provided by telephone companies or by the users themselves), the primary incentive for incumbents to resist reallocation is economic—an existing microwave operation may be the most inexpensive and stable one, and relocation may incur large costs. Another concern is the practicality of relocating displaced users to other frequencies. Incumbent microwave operators have expressed doubts about suitable bands above 3 GHz for relocation, while existing users of higher bands, such as MCI Communications Corporation and satellite operators, voiced concern that relocation might affect their portions of the spectrum.[134]

The third category is the question of federal use of the spectrum. Recognizing that trends for new wireless communications may not be reversible and that someone has to make a sacrifice, *haves* tried to divert the focus of reallocations from their frequencies to federally held bands and asked the NTIA to search for unused federal spectrum for the *have-nots*.[135] Also, incumbent microwave users proposed relocation to 1,710–1,850 MHz, a federally held band, rather than frequencies above 3 GHZ, as proposed by the FCC. The NTIA, which supports the FCC's proposal, claimed that relocation of microwave users to higher frequencies is plausible, because "Currently, both government and nongovernment fixed microwave services operate reliably and efficiently at frequency bands above 3 GHz."[136] In a response similar to that of everyone else when concession is requested, the NTIA has so far shown considerable

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[134]"2 GHz Debate" (*supra*, note 129); FCC, "In the Matter of Redevelopment of Spectrum to Encourage Innovation in the Use of New telecommunications Technologies," *Further Notice of Proposed Rule Making*, ET Docket 92-9 (released September 4), 1992, p. 8 (hereafter, *FCC Further NPRM, ET 92-9*).

[135]"Rail, Power Groups Ask FCC, NTIA for Government Spectrum to Accommodate 2 GHz Needs," *Telecommunications Reports* (April 13, 1992), p. 37.

[136]NTIA, *Comments in the Matter of Redevelopment of Spectrum to Encourage Innovation in the Use of New Telecommunications Technologies*, FCC's *Notice of Proposed Rule Making*, ET Docket 92-9 (June 8, 1992), p. ii.

reluctance to release federal frequencies for private use.[137] A study it made shows that, although a limited number of microwave users can be moved to 1,710–1,850 MHz, "this band could not accommodate all or even most of the existing 2 GHz private-sector fixed microwave links."[138]

Present users voiced complaints in conferences and filed opposing comments in response to the FCC's *Notice of Proposed Rule Making* in ET Docket 92-9.[139] Incumbents such as utilities and railroads threatened to sue the Commission if the plan were carried out.[140] The case was taken to Capitol Hill, where in June 1992 a hearing on this issue was held. Senator Ernest Hollings (D-S.C.), chairman of the Senate Commerce Committee, who emerged as a strong supporter for incumbent microwave operators, marked up appropriation bill S. 3026, which passed the Senate floor, to ensure that the FCC would not force the microwave users out of the proposed bands for eight years.[141] The block-out period of eight years would have given incumbents time to find functional substitutes for existing communications means and, perhaps more important, increase their leverage in private negotiations with potential service providers of emerging technologies.[142] However, many members of Congress, among

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[137]See NTIA, *Reply Comments in the Matter of Redevelopment of Spectrum to Encourage Innovation in the Use of New Telecommunications Technologies*, FCC's *Notice of Proposed Rule Making*, ET Docket 92-9 (July 8, 1992), pp. 13–17; Cerezo, *Federal Spectrum Usage* (*supra*, note 122).

[138]Gerald F. Hurt and Philip E. Gawthrop, *Feasibility of Relocating Non-Government Fixed Systems into the 1710–1850 MHz Band* (Washington, D.C.: U.S. Department of Commerce, NTIA Report 92-286, 1992), p. iii.

[139]See "PCS-Microwave Battle Continues in Hollings' 'Unusual' Hearing on FCC's 2 GHz Proposal; Sikes Defends Plan; Sugrue Offers Modifications, Says Government Spectrum Can Help in Some Special Cases; Microwave Interests Oppose Plan But Are Not Unwilling to Negotiate," *Telecommunications Reports* (June 8, 1992), pp. 4–8; "2 GHz Debate" (*supra*, note 129).

[140]"Microwave Users Threaten Suits to Counter New Services Plan," *Advanced Wireless Communications* (June 10, 1992), pp. 3–5.

[141]"Sen. Hollings Writes Funds-Bill Limit for 2 GHz Docket; House Bill Axes FCC Budget," *Telecommunications Reports* (July 27, 1992), p. 27.

[142]Hollings' proposed amendment would have given eight years of exclusive access to incumbent microwave users, during which they would not be obligated to negotiate with new service providers—unlike the FCC's proposal for transition period, which would require incumbents to do so. The block-out period would strengthen the position of microwave users in private

them Representatives John Dingell, chairman of the House Energy and Commerce Committee, and Edward Markey (D-Mass.), chairman of the House Telecommunications Subcommittee, are strongly against moves to impede the FCC's reallocation proposal.[143] The final appropriations legislation, after negotiation in a House-Senate conference committee, does not contain this amendment by Hollings.

Faced with opposing contentions, the FCC tried to strike a middle ground in its *Further Notice of Proposed Rule Making* (September 1992)[144] and *First Report and Order* (November 1992).[145] The reallocation is to be made, but the transition is designed to favor incumbents. More than 5 GHz of frequencies above 3 GHz would be made available for relocation on a co-primary basis.[146] Voluntary relocation by incumbents as a result of private negotiations between them and new service providers is encouraged. If no voluntary agreement can be reached, existing users would move out after a transition period (yet to be determined; probably three to ten years), but replacement users would be responsible for finding new frequencies and constructing and testing new facilities for the displaced users. In the case of involuntary relocation, all relocation costs would be borne by new service providers. Other measures, such as tax incentives for displaced operators and arbitration between existing and new users, are being considered.

The private negotiation proposal has interesting implications. It may relieve the FCC of the burden of making rules for relocation and compensation—rules likely to invite opposition and even litigation—but may also create confusion among *haves* and

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negotiations, because newcomers would have to offer additional incentives just to bring incumbents to the negotiation table.

[143]Jeffrey Silva, "PCS Allocation Debate Forces a Wedge between Legislators," *Radio Communications Report* (August 31, 1992), p. 9.

[144]*FCC Further NPRM, ET 92-9* (*supra*, note 134).

[145]*FCC First Report & Order, ET 92-9* (*supra*, note 11).

[146]The frequencies are 3.7–4.2, 5.925–6.425, 6.525–6.875, 10.7–12.2, 12.7–13.25, and 17.7–19.7 GHz bands. This new allocation is made "co-primary" and thus does not involve new forced relocations. See *FCC Further NPRM*, ET 92-9, pp. 2-3 (*supra*, note 134).

have-nots. The FCC has stated that it "will accommodate any agreed move to other bands consistent with [its] rules."[147] On the assumption that PCN were to be established in those frequencies, could an incumbent negotiate with all interested parties on the terms of relocation and ask the FCC to license the company that promised the best compensation? What if the FCC issued a PCN license to one company while the incumbent reached a compensation agreement with another? Because a company can always negotiate with itself, could an incumbent offer PCN in its own microwave bands without needing to win a license from the FCC? The last question is particularly intriguing, because many microwave incumbents, such as telecommunications common carriers, may want to offer PCN themselves. The proposal for private negotiation may open a door for them to become de facto PCN providers.

4.3 Spectrum Management Systems—A Return Visit

Adoption of a spectrum management system may itself be a result of the resolution of a country's political conflicts.[148] The establishment of generic criteria for choosing the "best" procedure for frequency allocation and assignment would be difficult, if not wholly impractical. A particular system might be good for some purposes and bad for others and could benefit some stakeholders and hurt others.

In the U.S., pressure has been mounting to transform the public interest-based spectrum management system to a market-based one (see **Section 3.3**). Experts generally advocate the reform, because the proposed free-market approach is, in

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[147]*FCC First Report & Order, ET 92-9*, p. 12 (*supra*, note 11).

[148]That a system can be the result of political battles is not news. Hazlett called this argument the "error theory": "government frequency assignment, while logically uncompelling as a solution to the common property problem in spectrum allocation sans property rights, was a logical—if naive—response to a series of regulatory events that occurred in the early days of commercial radio broadcasting" (Hazlett, "Regulation of the Broadcast Spectrum," pp. 138-139, in *supra*, note 82).

theory, economically plausible.[149] Beyond theoretical discussion, the use of any particular system to apportion the spectrum reflects the balance of political powers among various groups of stakeholders—the current system is "a compromise designed to generate significant rents for each constituency influential in the process"[150]—as does a switch to the proposed market-based system. **Table 4-1** summarizes the positions of stakeholders on options for spectrum management.

The Bush administration strongly supported market-based reform. Evidence suggests that Democrats, and, for that matter, now the Clinton administration, may also favor market-based spectrum management.[151] Regardless of party, the government stands to gain from the change for several reasons. The delegation of responsibility for spectrum allocation and frequency assignment to the private market would relieve the FCC of a considerable administrative burden. Revenues generated from auctions or fees paid by users could cover all or part of the administrative costs and are potentially an important revenue source for the government. As for its mandate to apportion spectrum in the public interest, the FCC argues that, although spectrum allocation and frequency assignment through public ruling making and comparative hearings enable it to evaluate applications from that standpoint, after original awards, the licenses may be transferred to other parties anyway.[152] The NTIA, under the Bush administration, claimed that in some cases social benefits can be served by market principles, because "commercial users serve society by pursuing economic returns through the provision of services that the public values highly. In

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[149]See *U.S. Spectrum Management Policy*, p. 98, footnote 333 (*supra*, note 3), for academic papers advocating use of economic principles as the basis for spectrum apportionment.

[150]Hazlett, "Regulation of the Broadcast Spectrum," p. 134 (*supra*, note 82).

[151]"Democrats Advocate Radio Auctions, Electric Utilities' Help on Fiber, Junking REA," *Telecommunications Reports* (December 14, 1992) p. 7; the evidence was drawn from *Mandate for Change* by the Progressive Policy Institute (think-tank affiliated with the Democratic Leadership Council), December 1992.

[152]*FCC NPRM, GEN 90-314*, p. 87 (*supra*, note 69).

Table 4-1

Pros and Cons of Spectrum Management Options to Stakeholders

Stakeholders	License Assignment			Spectrum Fee
	Comparative Hearing	Lottery	Competitive Bidding	
Administration				
▪ Pros	Can be policy tool	Quick and easy	Less administrative burden Generates revenues	Generates revenues
▪ Cons	Consumes time and energy	May be flooded with applications	Difficult to carry out policies	Calculation of fee may raise disputes
Nonprofit Users				
▪ Pros	Easy to obtain allocations and licenses	N/A	N/A	N/A
▪ Cons	N/A	Outcome unpredictable	Must compete for access	Spectrum use costly
Large Users				
▪ Pros	Easy to show financial and technical strengths	N/A	Financial strength helps outbid others	N/A
▪ Cons	Special favor may be given to entrepreneurs	Outcome unpredictable	Access to spectrum no longer free of charge	Spectrum use costly
Small Users				
▪ Pros	May be favored politically	N/A	Documents may be less demanding	Increases incumbents' operating costs
▪ Cons	Preparation of applications costly	Outcome unpredictable	May not have financial resources to bid	Own use not free

N/A: either not applicable (no suitable positions can be ascribed) or not available (the stakeholder has no stated position).

this fashion, societal benefits result from users' private decisions to maximize profits."[153] But the proposed reform also offers disadvantage to policymakers and regulators. Competitive bidding moves the decision-making process from within government to an open market; as a result, the government may lose its power in exercising public policies in the apportionment of the spectrum. The considerations in favor of comparative hearings may outweigh economic benefits from auctions when developing countries issue radio communications licenses: in those countries, spectrum managers may not be overwhelmed by a large number of applicants, and the policy goals—technology transfer, among others—can be more easily satisfied by examination of detailed applications.

Parties who now have guaranteed access to the spectrum and use it for free, such as local governments, nonprofit organizations, and broadcasters, stand to lose in this reform, because they might be required either to compete against other potential users for access or to pay for their own use of the spectrum. They strongly reject the notion that a market-based system can be in the public interest and oppose the proposed reform.[154]

To stakeholders in private industries, the central issues of the controversy are whether auctions (competitive bidding) should be used to assign frequency licenses, instead of administrative procedures such as comparative hearing or lottery, and whether use of the spectrum should be a cost to the users or be free. These issues are intertwined, because unless a spectrum fee is adopted, auctions will put newcomers at a competitive disadvantage in relation to spectrum incumbents. If, for example, a company has obtained a PCN license from the FCC in an auction and paid to use the band, the services it offered might compete directly or indirectly with those of other wireless communications, such as cellular telephony and SMR. If incumbents are not required to pay for their use of the spectrum, their costs may well be lower than those

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[153]*U.S. Spectrum Management Policy*, p. 89 (*supra*, note 3).

[154]See comments filed with the NTIA cited in *U.S. Spectrum Management Policy*, Section 4-II (*supra*, note 3).

of the new PCN provider.[155] From the point of view of industry competition, the policymakers and spectrum managers may want a reform that simultaneously implements competitive bidding and a spectrum fee. The attitude of private industries toward the reform varies from sector to sector.

On the issue of spectrum fees, large and small firms take opposite positions. Large companies, most of them incumbents, oppose paying to operate in their current frequencies, because "they incurred risks and made investment based on the understanding that if they qualified to use the spectrum, that use was without charge."[156] Small, nonincumbent firms favor the fee, because it poses a cost to their competitors.

Large companies are more or less neutral on the reform of frequency assignments—they see merits in both competitive bidding and comparative hearings. Their vast financial resources can help them win licenses in auctions, despite the theory that all contestants, large and small, can obtain financing from a (perfectly rational) financial market—in New Zealand, four giant companies (Telecom Corporation of New Zealand, BellSouth, Broadcast Communications Limited, and Sky Network Television) consistently outbid others and won in almost all auctions they participated in.[157] Large companies, with more resources to prepare applications to demonstrate technical expertise and financial commitment, hold an advantage over small firms also in comparative hearings. To them, what differentiates the procedures is that the outcome of an administrative process depends on political battles (as in comparative hearings) or random selection (as in lotteries), and who wins or loses is less certain than in auctions. But, in the long run, for large firms different methods of assignment tend to produce the same result. As long as licenses are freely transferable, it does not matter what method is used or what parties the FCC

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[155]Although the cellular carriers and SMR operators obtained licenses from other parties rather than from the FCC, and thus have paid a (usually high) market price.

[156]Statement of AT&T, quoted in *U.S. Spectrum Management Policy*, p. 121 (*supra*, note 3).

[157]See the list of bidders and bids in Mueller, *Lessons from New Zealand*, pp. 9–13 (*supra*, note 58).

originally selects, because large companies can always purchase licenses later. In the case of analog cellular telephony, most licenses, originally distributed in comparative hearings or lotteries, ended up in the hands of large corporations—as if frequencies had been assigned by competitive bidding but auctions had been held in the private market rather than by the government.

Most small firms strongly oppose competitive bidding for the assignment of frequency licenses. Auctions may benefit them and entrepreneurs, because, unlike administrative procedures, auctions do not require applicants to pay high-priced lawyers to prepare detailed documents to be filed with the FCC. But the price of a license won in an auction may be quite high—if the sale price of cellular franchises is an indication of the price of, say, PCN licenses in an auction, enterprises may need to pay millions or even billions to obtain a metropolitan PCN license.[158] For small firms, the necessary financial resources to bid for frequencies may be hard to come by—financial institutions may not always recognize the value of the licenses and provide enough financing for small enterprises to bid and win.[159] In addition, the price to be paid up front in auctions appears an entry barrier to many firms because of the uncertainty associated with the offering of new services. If "tax dollars" have to be collected on radio communications, it is argued, a spectrum fee linked to revenues may be preferable to the cost of bidding.[160] In comparative hearings or lotteries, small firms can obtain licenses (almost) for free.[161] Besides, in an administrative procedure entrepreneurs may be politically favored over large firms, as

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[158]See, for example, Geraldine Fabrikant, "Comcast's $1.1 billion Phone Deal," *The New York Times* (May 8, 1991).

[159]In economics, when the financial market cannot provide proper financing, a "market failure" occurs. Though treated as a special case in textbooks, it happens regularly in practice.

[160]See, for example, statement of Michael L. Exner at the House hearing on the FCC's proposal for spectrum auctions on October 1, 1986, in *Spectrum Auctions Hearing*, pp. 58-62 (*supra*, note 67).

[161]After paying for the preparation of applications.

some FCC Commissioners indicated regarding the establishment of PCS[162]; such politics will be difficult in competitive bidding.

Whether competitive bidding can and will be used by the FCC is being debated publicly and in Congress. With support of the government, neutrality of large firms,[163] and strong opposition from nonprofit users and small companies, this reform is not likely to be adopted without modification. Contrary to the arguments for a system at one extreme or the other, hardly any plan for spectrum management can be implemented according to its original, theoretically proved, form. Room for political maneuvering always exists. If competitive bidding were used to distribute frequency licenses, numerous provisions could be built in to safeguard the interests of different parties—in New Zealand, incumbents and nonprofit organizations are protected from competitors in auctions (see **Section 3.2**). The amount of the spectrum fee could be determined arbitrarily, based on such factors as the cost of the spectrum management administration,[164] revenues generated on the use of spectrum,[165] the total present value of the frequency band to the licensee,[166] or other politically designed measures. Whichever system is used, there will always be political ways to placate the maximum number (or a particular group) of stakeholders.

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[162]See, for example, "Re: Amendment of Commission's Rules to Establish New Personal Communications Service," Separate Statement of Commissioner Andrew C. Barrett, October 25, 1991.

[163]Large firms sometimes show lukewarm support for spectrum auctions. See, for example, statement by Leo P. Labbe of AT&T at the House hearing on the FCC's proposal for spectrum auctions on October 1, 1986, in *Spectrum Auction Hearing*, pp. 51–53 (*supra*, note 67).

[164]A practice in the U.K. See Department of Trade and Industry, *Deregulation of the Radio Spectrum in the U.K.*, by CSP International (London: Her Majesty's Stationery Office, 1987), pp. 14–16. Japan plans to follow suit on April 1, 1993, by collecting fees for administrative use through the Ministry of Posts and Telecommunications. See "'Spectrum Users' Fee' to Be Introduced," *MPT News* (June 29, 1992), p. 3.

[165]*U.S. Spectrum Management Policy*, p. 121 (*supra*, note 3).

[166]The valuation is highly dependent on the assumptions and methods chosen to make it. See, for example, Douglas W. Webbink, "The Value of the Frequency Spectrum Allocated to Specific Uses," *IEEE Transactions on Electromagnetic Compatibility* EMC-19, 3 (1977), pp. 343–351.

Acronyms

AM	Amplitude Modulation
AT&T	American Telephone and Telegraph Company
ATV	Advanced Television
BSS	Broadcasting Satellite Service
CEPT	Conference of European Post and Telecommunications Administrations
CSIS	Center for Strategic and Information Studies
DAB	Digital Audio Broadcasting
DARS	Digital Audio Radio Service
DOD	Department of Defense
DOE	Department of Energy
EC	European Community
FAA	Federal Aviation Administration
FBI	Federal Bureau of Investigation
FCC	Federal Communications Commission
FM	Frequency Modulation
FPLMTS	Future Public Land Mobile Telephone Services
GHz	Gigahertz
GMF	Government Matter File
GSA	General Service Administration
HDTV	High-Definition Television
Hz	Hertz
ITU	International Telecommunication Union
LDC	Less Developed Countries
LEO	Low-Earth Orbit (Satellite)
MHz	Megahertz
MSS	Mobile Satellite Services
NIC	Newly Industrialized Countries
NOI	Notice of Inquiry
NPRM	Notice of Proposed Rule Making
NTIA	National Telecommunications and Information Administration
PCN	Personal Communications Network
PCS	Personal Communications Services
SMR	Specialized Mobile Radio

UHF	Ultrahigh Frequency
VHF	Very High Frequency
WARC	World Administrative Radio Conference

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