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Spectrum Management: Auctions

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Summary

Spectrum policy issues before Congress are characterized by economic, technological and regulatory complexity. An increasing number of public comments have criticized the effectiveness of spectrum management and policy in the United States. Questions regarding the role of auctions in spectrum management are of immediate concern because congressional authorization of the existing auction process expires in 2007. Proceeds from spectrum sales are presently attributed to general revenue in the U.S. Budget. In the 108th Congress, however, a precedent was established with the creation of a Spectrum Relocation Fund. This fund will hold proceeds from specified sales of spectrum currently allocated to federal use; federal agencies vacating spectrum to be auctioned for commercial use will be compensated from the fund for costs of relocation. In the 109th Congress, H.R. 1323 (Representative Stupak) is the first of several anticipated bills that would place auction revenues in special funds for specific purposes. The 108th Congress also asked for a study regarding the allocation of spectrum licenses, due by October 2005. The conclusions of this report may lead to changes in spectrum policy and the auction process. Congress may also consider ways to free valuable spectrum currently occupied by broadcasters as part of a plan to encourage the move from analog to digital television (DTV). How to use the proceeds of auctions for all or some of the released spectrum is a subject of discussion in Congress. The monies might go, for example, to facilitate the transition to DTV, to fund public safety communications improvements, or to help decrease the budget deficit.

Spectrum, a valuable resource governed by available technology, is regulated by the federal government with the primary objectives of maximizing its usefulness and efficiency, and to prevent interference among spectrum users. A key component of spectrum policy is the allocation of bands for specific uses and the assignment of frequencies within those bands. Auctions, a fairly recent innovation in frequency assignment, are regarded as a market-based mechanism for allocating spectrum. Other market-driven policies include licensing fees based on fair-market valuations of spectrum and flexibility in spectrum usage within assigned bandwidths. Today, spectrum for commercial applications is typically auctioned to the highest bidder, but many commercial users have spectrum acquired before the present-day auction process was implemented.

After years of debate over the idea of using auctions to assign spectrum licenses, Congress authorized the Federal Communications Commission (FCC) to establish an auction process to award spectrum licenses for certain wireless communications services (Omnibus Budget Reconciliation Act of 1993). These provisions include opportunities for small businesses, described as entrepreneurs, to receive bidding credits to help them compete with larger companies. H.R. 1661 (Representative Rush) would create a new category of loan within the Small Business Administration to help qualifying companies bid in spectrum auctions or buy spectrum in the secondary market.

This report will be updated.

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Spectrum policy covers both satellite and terrestrial (primarily antenna broadcast) transmissions. The issues discussed here refer principally to spectrum management for terrestrial technologies. International satellite frequencies are not allocated by the auction process.

Radio frequency spectrum is used for all forms of wireless communications including cellular telephony, paging, personal communications service, radio and television broadcast, telephone radio relay, aeronautical and maritime radio navigation, and satellite command and control. Wireless (radio frequency) spectrum is measured in cycles per second, or hertz (Hz).[1] Spectrum allocations are assigned within bands that are divided into bandwidths or channels with assigned frequencies.

Spectrum is a natural resource[2] with a combination of characteristics that differentiate it from other resources. For example, spectrum is:

- Finite. Today's technology can only operate on certain frequencies; commercially viable frequencies are a scarce commodity.
- Renewable. Airwaves used to broadcast any transmission can be reused after the broadcast is completed.
- Technology dependent. Most natural resources can be harvested manually, albeit inefficiently. Spectrum is in the atmosphere and is usable because technology has been developed to exploit the properties of electromagnetic waves for sound, data and video transmission.
- A national asset with international rules and regulations. For example, most domestic uses of spectrum are assigned bands of operation through the International Telecommunications Union, an agency of the United Nations; satellites for broadcasting are governed by international treaty.
- Administered. To avoid interference from competing broadcast transmissions, frequency assignments must be managed by recognized authorities.

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[1] Standard abbreviations for measuring frequencies include kHz — kilohertz or thousands of hertz; MHz — megahertz, or millions of hertz; and GHz — gigahertz, or billions of hertz.

[2] The Code of Federal Regulations defines natural resources as "land, fish, wildlife, biota, air, water, ground water, drinking water supplies and other such resources belonging to, managed by, held in trust by, appertaining to, or otherwise controlled by the United States..." (15 CFR990, Section 990.30).

The development and implementation of better wireless communications technologies are critical to maximizing the efficiency of spectrum resources. Spectrum management policies ideally should take into account the impact of new technology, or — since it is difficult to predict the development paths of new technologies — allow for flexibility and accommodation in spectrum allocation. Although flexibility may be desirable in policy-making, most existing wireless technologies are inflexibly constructed to work on a limited range of specific frequencies. Relocation from one part of the spectrum to another can require costly equipment changes. Therefore, reallocation of spectrum to new uses is often expensive as well as technically and administratively difficult. Additionally, some uses of spectrum are governed by international regulations.

Spectrum policy originated in the need to manage frequency assignments. Auctions are a market-driven solution to allocating frequencies. Auctions are a recent innovation in spectrum management and policy. The auction process assigns a monetary value to spectrum. The Federal Communications Commission (FCC) manages all non-federal spectrum, including that used by state and local governments. Among other responsibilities, the FCC supervises spectrum auctions. The National Telecommunications and Information Administration (NTIA) manages all spectrum used by the federal government, including the Department of Defense (DOD). The NTIA — part of the Department of Commerce — also serves as the principal adviser to the executive branch on domestic and international telecommunications issues. The NTIA and the FCC work together to coordinate spectrum policy.

Many economic models for providing the "highest and best use" for spectrum exist and have been tried, both in the United States and worldwide. Spectrum for what is widely described as "prime" frequencies (300 MHZ - 3000 MHZ) is judged by many to be the most commercially desirable and is widely sought after at auction by competing interests.[3] Several lucrative auctions have added billions to the federal treasury, applied to general revenue. The proceeds of future auctions are being eyed by some as a way to reduce the current budget deficit.[4]

Spectrum Auctions

Because two or more signal transmissions over the same frequency in the same location at the same time could cause interference (a distortion of the signals), the FCC, over many years, has developed and refined a system of exclusive licenses for

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[3] Federal Communications Commission, Office of Plans and Policy, OPP Working Paper Series No. 38, "A Proposal for a Rapid Transition to Market Allocation of Spectrum," November 2002 [http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-228552A1.pdf]. Viewed January 19, 2005.

[4] For example, Senator Ted Stevens, Chairman of the Committee on Commerce, Science, and Transportation, has been quoted as viewing spectrum auctions as a way to provide all or part of the $4.8 billion in new revenue that Congress would like to see raised by 2010. ("Today's News," TELECOM A.M., May 2, 2005.

users of specific frequencies.[5] Traditionally, the FCC granted licenses using a process known as "comparative hearings" and later using lotteries. After years of debate over the idea of using competitive bidding (i.e., auctions) to assign spectrum licenses, the Omnibus Budget Reconciliation Act of 1993 (47 U.S.C. 927) added Section 309(j) to the Communications Act, authorizing the FCC to use auctions to award spectrum licenses for certain wireless communications services. Additional provisions concerning auctions were included in the Balanced Budget Act of 1997, the Auction Reform Act of 2002, and the Commercial Spectrum Enhancement Act — all discussed below. The main category of services for which licenses may be auctioned are called Commercial Mobile Radio Services (CMRS) which include Personal Communications Service (PCS), cellular, and most Specialized Mobile Radio (SMR) and Mobile Satellite Services (MSS). With some exceptions, CMRS providers are regulated as common carriers to ensure regulatory parity among similar services that will compete against one another for subscribers. The FCC has the authority to conduct auctions only when applications are mutually exclusive (i.e., two licensees in the same frequency band would be unable to operate without causing interference with each other), and when services are primarily subscription-based. The FCC does not have authority to reclaim licenses awarded prior to the decision to permit auctions.

Auction Rules. The Communications Act of 1934 directs the FCC to develop a competitive bidding methodology.[6] The FCC initially developed rules for each auction separately (with some common elements), but after several years of trial and error it has developed a set of general auction rules and procedures. While there may be special requirements for specific auctions, the following rules generally apply. As a screening mechanism, all auctions require bidders to submit applications and up-front payments prior to the auction. Most auctions are conducted in simultaneous multiple-round bidding in which the FCC accepts bids on a large set of related licenses simultaneously, using electronic communications. Bidders can bid in consecutive rounds on any license offered until all bidding has stopped on all licenses. Even though licenses must be renewed periodically, it is generally understood that license winners will be able to keep the license perpetually, as long as they comply with FCC rules.[7]

For some auctions, the FCC gives special bidding credits to smaller companies, called entrepreneurs, defined as having annual gross revenues of less than $125 million and total assets of less than $500 million. In the first year or so of auctions, the FCC originally also gave special provisions to women-owned, minority-owned, and rural telephone companies (called designated entities). After a 1995 Supreme Court decision determined that government affirmative action policies must pass a "strict scrutiny" test to demonstrate past discrimination, the FCC removed minority-owned and women-owned groups from its list of businesses qualifying for bidding

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[5] Technically, two signals will interfere with each other even if they are not at the same exact frequency, but are close in frequency. To avoid harmful interference, the frequencies must have frequencies that are sufficiently different, known as a "minimum separation."

[6] Communications Act of 1934, 47 U.S.C. 309 (j) (3).

[7] The FCC provides information on auctions at [http://wireless.fcc.gov/auctions/]. Viewed February 17, 2005

credits as designated entities.[8] Many industry observers have expressed concern that some of the small businesses participating in auctions actually represent larger companies. Larger companies reportedly lament the limitations of the designated entity rule in auctions and have lobbied the FCC to eliminate it.[9]

Service Rules. The FCC also develops service rules for each new service for which a license will be used. Licenses are granted according to the amount of spectrum and the geographic area of coverage. The FCC's plan for the amount of spectrum per license, the number of licenses, and the conditions for use of the designated spectrum, known as the "band plan," is developed for each new wireless service. Licenses can cover small areas, large regions, or the entire nation. Terms used for coverage areas include basic trading areas (BTAs) which correspond roughly to metropolitan areas; major trading areas (MTAs), which are combinations of BTAs dividing the United States into 51 geographic regions of similar levels of commercial activity; and regions, which are combinations of MTAs. Metropolitan statistical areas (MSAs), rural service areas (RSAs), economic areas (EAs), and major economic areas (MEAs) — defined by the Department of Commerce for economic forecasts — are also used by the FCC to describe areas of coverage for some spectrum auctions.

The FCC has also modified some wireless service rules to help new spectrum licensees maximize the value from their licenses. Changes include allowing licensees to partition licenses for greater efficiency, sharing regions among licensees, and expediting the relocation of incumbent microwave licensees from spectrum purchased in the PCS auctions.

NextWave. The auction of one of the blocks of spectrum allocated for PCS, known as the C-block, presented legal problems for the FCC. In the original C-block auction, also called the entrepreneur's auction, the FCC gave bidding credits to small businesses to help them compete with larger entities in the auction. Winning bidders only had to pay 10% down and the remainder could be paid over ten years at below-market interest rates. At auction in 1996, broadband C- block licenses were sold for bids totaling $10.2 billion. By mid-1997, however, many of the license winners (most notably NextWave Telecom Inc.) had defaulted. In September 1997, the FCC offered a set of options for C-block licensees to restructure their debt (that offer was modified in March 1998). Some licensees opted to maintain their bankrupt status, however, preventing the C-block spectrum from being re-auctioned. Based on its interpretation of a series of decisions in 1999 and 2000 by a U.S. Court of Appeals, the FCC cancelled the licenses that had not been paid for and re-auctioned that spectrum. The auction (Auction 35) for the defaulted licenses was completed January 26, 2001, and booked $16.86 billion in projected revenue for the general treasury.[10]

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[8] Adarand Constructors Inc., petitioner v. Federico Pena, Secretary of Transportation, et al. Docket No. 93-1841, decided June 1995.

[9] Communications Daily, "FCC Expected to Reject Changing Auction Rules," page 3, June 18, 2004.

[10] Summarized in Associated Press Online, "Feds Ordered to Return Wireless Licenses," January 28, 2003.

On June 22, 2001, the United States Court of Appeals for the District of Columbia found that the FCC did not have the legal right to take back NextWave's licenses and that 216 of the licenses (worth $15.85 billion) still belonged to NextWave rather than to the winners of the later auction, such as Verizon Wireless.[11] The U.S. Supreme Court agreed to hear the case, essentially weighing NextWave's right to protection under bankruptcy laws against the FCC's right to allocate spectrum. On January 27, 2003, the Supreme Court ruled in favor of NextWave, agreeing with the earlier Court of Appeals decision that the FCC did not have the authority to recover the licenses.[12] Subsequently, NextWave agreed to return some of the disputed spectrum to the FCC for re-auction in January 2005.[13]

Spectrum Value

Spectrum value depends on many factors, such as the amount of spectrum, its frequencies (since signal transmission characteristics vary along different parts of the spectrum), the geographic area covered, the services permitted by FCC rules, the availability of equipment that can operate at those frequencies, the demand for services that do not interfere with other bands, the amount of alternative spectrum already available for similar services, the number of incumbents presently occupying the spectrum, and whether incumbents will remain in that spectrum or be relocated to other spectrum. Spectrum value may be greater if adjacent bands can be aggregated to form larger blocks and if the given spectrum is not encumbered by other licensees using the same frequencies.

The Congressional Budget Office (CBO) annually scores the anticipated receipts from planned spectrum auctions, and includes the revenue estimate in its annual report, *The Budget and Economic Outlook*. The January 2005 report estimated receipts from the sale of spectrum at $15 billion over the period 2006 through 2015.[14] The revenue expected from the auctions is used as offsetting receipts to other federal expenditures. In accordance with the Budget Enforcement Act of 1990, auction proceeds cannot be used for funding other programs.

To date, the FCC has garnered over $14 billion from completed auctions, most of which has been deposited in the U.S. Treasury as general revenue to the federal government. (The FCC keeps a small portion of auction proceeds to cover the expenses of the auctions.) This total does not include approximately $10 billion for contested licenses in the C and F Blocks awarded to NextWave and others in 1996 — some of which may be recovered. NextWave, which owes $4.6 billion for

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[11] 254 Federal Report, 3d Series, page 130.

[12] U.S. Supreme Court, Docket No. 01-653 at [http://www.supremecourtus.gov/docket/01-653.htm]. Viewed January 19, 2005.

[13] See FCC Report No. AUC-03-58 (Auction No. 58), "Broadband PCS Spectrum Auction Scheduled for January 12, 2005," available at [http://wireless.fcc.gov/auctions/]. The results of Auction 58 are also at this site.

[14] *The Budget and Economic Outlook: Fiscal Years 2006 - 2015*, Table 3-4. CBO does not break down the amounts in terms of individual auctions, but only provides the aggregate estimated revenue.

licenses, has agreed to repay its creditors in full, including the FCC, as part of the reorganization plan that will allow it to emerge from bankruptcy.[15] It has concluded sales of some of the contested licenses to Verizon Wireless ($3.93 billion) and Cingular Wireless ($1.4 billion).[16] The spectrum that NextWave returned to the FCC for re-auction grossed $2.2 billion before bidding credits of approximately $2 million.[17]

Technology

Several technological advances could affect the outcome and prospects for spectrum auctions and how the spectrum is managed. The usable spectrum for communications purposes is currently considered to be below 300 GHz. Higher frequencies present limitations such as a greater absorption of signals by the atmosphere and difficulties in high frequency reception. As the technology for radio transmission and reception improves, higher frequencies will likely become available for use. Technology improvements may, in turn, spur increased consumer demand for spectrum.

Some of the problems with high-frequency signal transmission and signal interference at all frequencies are being solved by engineering techniques which could make better use of the spectrum, thus reducing some of the need for more spectrum. Technologies include methods of digital signal compression, which increases the carrying capacity of currently used bands; error detection and correction, which maintain the signal integrity even in high levels of noise; and other digital techniques such as frequency hopping, in which the transmitted signal avoids frequencies that are already being used.

Advances in software defined radio (SDR) and cognitive radio, in particular, may in time change the nature of spectrum allocation policies. Software defined networks (radios, base stations, antennae) move wireless communications away from hard-wired equipment, where functionality is built into the components at the factory, by allowing changes in parameters to be downloaded remotely. Parameters that can be changed include standards and frequency assignments. Cognitive radio has the potential to eliminate entirely the need for frequency assignments. Simply put, cognitive radio is able to seek out and use any available frequency through miniaturized software programs contained within radio equipment. Advanced versions of software-defined radio (SDR) being tested today are the building blocks for commercial applications of cognitive radio.

The Department of Defense (DOD), its agencies, and military departments have been leaders in research and development for software-programmable radios and base

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[15] "FCC Approves NextWave License Sale," v Shannon D. Murray, Daily Deal/The Deal, March 7, 2005.

[16] NextWave Bankruptcy Plan Approved," by Jason Ankeny, Telephony Online, March 2, 2005.

[17] FCC News, February 16, 2005, "Broadband PCS Spectrum Auction Closes, Raising Over $2 Billion,"Headlines at [http://www.fcc.gov].

centers. A key program is the Joint Tactical Radio System (JTRS), designed to help the military migrate from its current wireless technology to SDR.[18] DOD is promoting the use of JTRS and its software communications architecture for homeland security, public safety, and commercial applications.[19]

Recent Congressional Actions Regarding Spectrum Auctions

Congress uses its oversight authority of the FCC to correct the agency's course or to steer it in new directions. Notable laws that deal with spectrum policy and auctions are the Balanced Budget Act of 1997, the Auction Reform Act of 2002 and the Commercial Spectrum Enhancement Act of 2004. The Balanced Budget Act also directs FCC actions concerning the transition to digital televison, an event with significant impact on spectrum management.

The Balanced Budget Act of 1997. The Balanced Budget Act of 1997 (47 U.S.C. 153) contained several spectrum management provisions. It amended Section 309(j) of the Communications Act to expand and broaden the FCC's auction authority and to modify other aspects of spectrum management. Whereas previous statutes gave the FCC the authority to conduct auctions, the Balanced Budget Act required the FCC to use auctions to award ownership in mutually exclusive applications for most types of spectrum licenses. It directed the FCC to experiment with combinatorial bidding (i.e., allowing bidders to place single bids on groups of licenses simultaneously), and to establish minimum opening bids and reasonable reserve prices in future auctions unless the FCC determined that it was not in the public interest. This amendment also gave the FCC auction authority until September 30, 2007. Furthermore, the act directed the FCC to allocate spectrum for "flexible use," which means defining new services broadly so that services can change as telecommunications technology evolves.

> Exempted from auctions are licenses or construction permits for
> (A) public safety radio services, including private internal radio services used by state and local governments and non-government entities and including emergency road services provided by not-for-profit organizations, that —
> (I) are used to protect the safety of life, health , or property; and
> (ii) are not made commercially available to the public;
> (B) digital television service given to existing terrestrial broadcast licensees to replace their analog television service licenses; or
> (C) noncommercial educational broadcast stations and public broadcast stations.

Examples of services exempted from auctions include utilities, railroads, metropolitan transit systems, pipelines, private ambulances, volunteer fire departments, and not-for-profit emergency road services.

The act directed the FCC to auction 120 MHZ of spectrum, most of which had already been transferred by NTIA from federal to non-federal assignment and to

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[18] See [http://jtrs.army.mil/]. Viewed February 9, 2005.

[19] Overview at [http://jtrs.army.mil/sections/overview/fset_overview_domestic.html]. Viewed February 9, 2005.

allocate another 55 MHZ located below 3 GHz for auction not later than September 2002.[20] These deadlines were subsequently eliminated by the Auction Reform Act.

Auctions of Spectrum Used for Television Broadcasting. The Balanced Budget Act of 1997 required the FCC to conduct auctions for 78 MHZ of the analog television spectrum planned to be reclaimed from television broadcasters at the completion of the transition to digital television and to allocate 24 MHZ for public safety services. For administrative purpose, the FCC divided the spectrum into "Upper 700 MHZ" and "Lower 700 MHz"bands. Congress instructed the FCC to hold auctions for the 700 MHZ frequencies not later than 2002. The spectrum was to have been auctioned in 2002 but not reclaimed from broadcasters until at least 2006. The act directed the FCC to grant extensions to stations — allowing them to keep the spectrum — in television markets where any one of the following three conditions exist: (1) if one or more of the television stations affiliated with the four national networks are not broadcasting a digital television signal, (2) if digital-to-analog converter technology is not generally available in the market of the licensee, or (3) if at least 15% of the television households in the market served by the station do not subscribe to a digital "multi-channel video programming distributor" (e.g., cable or satellite services) and do not have a digital television set or converter. Until these conditions are met, broadcasters are not required to surrender the spectrum.[21]

Auction Reform Act of 2002. Concerns about spectrum management, including spectrum used for public safety, prompted the introduction of the Auction Reform Act of 2002 (P.L. 107-195). Among the purposes of the act is the elimination of deadlines for auctions of Upper and Lower 700 MHZ frequencies originally scheduled by the FCC for 2002. Specifically, the law stopped auctions in the Upper 700 MHZ band that might have impacted efforts to increase the amount of spectrum available for public safety use, while requiring that some auctions in the Lower 700 MHZ band take place. The broad language of the law gives the FCC discretion in setting auction dates for all auctionable spectrum by eliminating deadlines established by the Balanced Budget Act of 1997.

Commercial Spectrum Enhancement Act. This act created the Spectrum Relocation Fund to provide a mechanism whereby federal agencies can recover the costs of moving from one spectrum band to another. The interest in relocating federal users — and accelerating the process by assuring reimbursement for the costs of moving — centers on valuable spectrum (relative to auction prices for comparable spectrum in the United States and other countries) now used by federal agencies, especially the Department of Defense. In particular, spectrum in bands within the 1710-1850 MHZ range is sought by wireless telecommunications companies to facilitate the implementation of next-generation wireless technologies, including

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[20] Demand for this spectrum is discussed in CRS Report RS20993, *Wireless Technology and Spectrum Demand: Third Generation (3G) and Beyond.*

[21] See CRS Report RS21570, *Spectrum Management: Public Safety and the Transition to Digital Television.*

high-speed mobile services (3G).[22] After much study, the NTIA and the FCC, aided by an Intra-Government 3G Planning Group, announced plans to provide for the transfer of spectrum in the 1710-1755 MHZ range from federal agencies. Frequencies in this band would be made available to the private sector through spectrum auctions conducted by the FCC. As part of the effort, the need was identified for new legislation that would permit affected federal agencies to recover costs directly from these auction proceeds. In mid-2002 the Department of Commerce proposed the creation of a Spectrum Relocation Fund. This fund could provide a means to make it possible for federal agencies to recover relocation costs directly from auction proceeds when they are required to vacate spectrum slated for commercial auction. In effect, successful commercial bidders would be covering the costs of relocation. To accomplish the NTIA and FCC goals, the Communications Act of 1934 would need to be modified to permit the agencies direct access to auction funds. This was accomplished with the passage of the Commercial Spectrum Enhancement Act, Title II of P.L. 108-494. Following the requirements of the act, the FCC has announced that it wants to schedule these auctions beginning as early as June 2006.[23]

Spectrum Management and the 109th Congress

A pressing issue in spectrum policy reform regards spectrum auctions. The FCC's auction authority expires at the end of FY2007. To ensure continuity, by that time Congress must pass legislation either to extend the existing authorization or to modify the laws governing spectrum auctions. The issue is bipartite: both the manner of spectrum allocation (auction or other method) and the use of the proceeds are of importance and interest to Congress. Congress may consider reviewing the roles of the FCC and NTIA in implementing spectrum policy. The Government Accountability Office (GAO) in a study released in 2002,[24] was critical of FCC and NTIA spectrum management policies. Among its recommendations was a suggestion that the NTIA and FCC prepare reports for Congress on developing a national spectrum policy. The GAO report contends that the United States is lacking a cohesive policy, with negative consequences both domestically and in international negotiations. A follow-on report from the GAO, released in early 2003,[25] recommended that Congress consider establishing an independent commission to evaluate the need for spectrum management reform.

Intelligence Reform and Terrorism Prevention Act. Several passages of the act (P.L. 108-458) deal with spectrum policy. For example, Title VII, Subtitle E — Public Safety Spectrum recognizes the merits of arguments for increasing the amount of spectrum at 700 MHZ available for public safety and homeland security.

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[22] Discussed in CRS Report RS20993, *Wireless Technology and Spectrum Demand: Third Generation (3G) and Beyond*.

[23] See CRS Report RS21508, *Spectrum Management: Special Funds.*

[24] *Better Coordination and Enhanced Accountability Needed to Improve Spectrum Management*, GAO-02-906, September 30, 2002

[25] *Comprehensive Review of U.S. Spectrum Management with Broad Stakeholder Involvement Is Needed*, GAO-03-277, January 31, 2003.

It requires the FCC, in consultation with the Secretary of Homeland Security and the NTIA, to conduct a study on the spectrum needs for public safety, including the possibility of increasing the amount of spectrum at 700 MHZ.[26] The study is to be submitted by year-end 2005. The act conveys the sense of Congress that the first session of the 109th Congress must act to establish a comprehensive approach to the timely return of spectrum at 700 MHZ currently held by television broadcasters.[27]

Administration Plans for Spectrum Policy. On November 30, 2004, President George W. Bush issued a memorandum to the heads of Executive Departments and agencies regarding steps to be taken to improve the management of spectrum assigned for federal use.[28] Most of these steps are to implement recommendations made by the Federal Government Spectrum Task Force in its report to the President in June 2004.[29] The memorandum states,

> "The existing legal and policy framework for spectrum management has not kept pace with the dramatic changes in technology and spectrum use. Under the existing framework, the Federal Government generally reviews every change in spectrum use. This process is often slow and inflexible and can discourage the introduction of new technologies. Some spectrum users, including Government agencies, have argued that the existing spectrum process is insufficiently responsive to the need to protect current critical uses."

To address this, a multi-step planning process will pull together analyses of spectrum needs. Notably the Secretary of Homeland Security will lead the preparation of a Spectrum Needs Plan, "to address issues related to communication spectrum used by the public safety community, as well as the continuity of Government operations." Concurrently, the Secretary of Commerce will be developing a Federal Strategic Spectrum Plan. These two plans, due by the end of 2005, will form the backbone of a National Strategic Spectrum Plan.

User License Fees. The President's budget for FY2004 and again for 2006 proposed that 1) the FCC's authority to conduct auctions be extended indefinitely; 2) user fees be levied on unauctioned licensed spectrum; and 3) broadcasters pay an annual lease fee on analog TV spectrum that they are holding as part of the Congressionally-mandated transition to digital television.[30] Congress, in the Commercial Spectrum Enhancement Act, requires the Comptroller General of the Government Accountability Office (GAO) to examine "national commercial

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[26] P.L. 108-458, Title VII, Subtitle E, Sec. 7502 (a).

[27] P.L. 108-458,Title VII, Subtitle E, Sec. 7501 (b) (1).

[28] "Presidential Determination: Memorandum for the Heads of Executive Departments and Agencies," November 30, 2004, Office of the Press Secretary, News & Policies, at [http://www.whitehouse.gov/news/releases/2004/11/20041130-8.html]. Viewed January 19, 2005.

[29] *Spectrum Policy for the 21st Century: The President's Spectrum Policy Initiative*.

[30] The Budget for Fiscal Year 2006, pp. 329-330. In his budget for 2005, the President supported proposals for indefinitely extending the FCC's auction authority and giving the FCC the authority to set user fees on unauctioned spectrum.

spectrum policy as implemented by the Federal Communications Commission and report on its finding before October 2005."[31] The GAO is to examine the impact of auctioning licenses on the economic climate for broadcast and wireless technologies. It is to assess whether the holders of spectrum licenses received before the auction process was instituted (i.e., largely for free) have an economic advantage over license holders that have purchased spectrum through the auction process. The GAO is also to evaluate whether the disparate methods of allocating spectrum have had an adverse impact on the introduction of new services. The conclusions of the study are to be reviewed in the context of the Administration proposal to introduce license user fees on assigned (not auctioned) licenses and an evaluation provided for Congress regarding the impact of assessing license fees on the competitiveness of the wireless and broadcast industries.[32]

New Trust Funds. Building on the precedent of establishing a trust fund to pay for specific purposes, Representative Stupak has introduced the Public Safety Interoperability Implementation Act (H.R. 1323), a bill that would place some auction proceeds in trust for grants to improve public safety communications. The introduction of other bills creating trust funds for specific purposes is anticipated.[33] The Public Safety Interoperability Implementation Act[34] would establish in the U.S. Treasury a Public Safety Communications Trust Fund[35] to be funded in part with annual appropriations of $500 million for each of three fiscal years,[36] and in part with a percentage of certain spectrum auction proceeds.[37] The fund is to be administered by the NTIA, in consultation with a board of five directors appointed by the Secretary of Commerce. The board is to consult with the Department of Homeland Security, which may also be represented by one or more members on the board.[38] The NTIA Administrator is to make grants from the fund "to implement interoperability and modernization . . . for the communications needs" of public safety organizations and related agencies or entities.[39] Preference for grants is to be given to those proposing inter-agency or regional and multi-jurisdictional interoperability programs.[40]

Small Business Loans. Legislation proposed by Congressman Bobby L. Rush would create within the Small Business Administration a Telecommunications

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[31] P.L. 108-494, Title II, Sec. 209 (a).

[32] P.L. 108-494, Title II, Sec. 209 (a) (5).

[33] "Democrats Again Seek to Pump Spectrum Money into Education Technology," by Joelle Tessler, CQ Today - Technology & Communications, February 25, 2005.

[34] For a discussion of interoperability and its role in public safety communications, see CRS Report RL32594, Public Safety Communications: Policy, Proposals, Legislation and Progress.

[35] H.R. 1323, Sec. 3, "Sec. 106 "(a) "(1). (Pre-publication edition.)

[36] H.R. 1323, Sec. 3, "Sec. 106 "(f). (Pre-publication edition.)

[37] H.R. 1323, Sec. 3, "Sec. 106 "(a) "(2). (Pre-publication edition.)

[38] H.R. 1323, Sec. 3, "Sec. 106 "(b) "(1). (Pre-publication edition.)

[39] H.R. 1323, Sec. 3, "Sec. 106 "(c) "(1). (Pre-publication edition.)

[40] H.R. 1323, Sec. 3, "Sec. 106 "(c) "(2). (Pre-publication edition.)

Finance Office[41] and a Telecommunications Spectrum Installment Loan Program[42] to provide direct loans for the purchase of spectrum at auction.[43] Loans guarantees would also be provided for spectrum purchases at auction or in the secondary market and for needed equipment.[44] The Communications Act of 1934 would be amended to allow the FCC to accept letters of credit, instead of cash, from auction participants that are qualified telecommunications borrowers, as defined by an amended Small Business Act.[45]

Conclusion

Spectrum is a natural resource with its own unique set of characteristics. Most assigned spectrum was allocated prior to the adoption of the auction process. The amount of spectrum available for new uses, given current technology, is limited; the amount available for commercial use and development is smaller still.

Auctions are the primary mechanism used for implementing market-based spectrum allocation policies in the United States. Auctions as a means of allocating spectrum are considered a success by many observers because of the federal revenue generated, as well as for the speed with which licenses auctioned have gone to the companies that value them the most and are most likely to put them to use. Moreover, many prefer letting businesses determine whether to invest in a new service rather than relying on the government to decide who receives a spectrum license. The FCC has concluded that auctioning of spectrum licenses has contributed to the rapid deployment of new wireless technologies, increased competition in the marketplace, and encouraged participation by small businesses.[46] However, many have questioned whether auction policy should be supplemented more aggressively with other market-driven solutions such as licensing fees and whether the existing auction process and administration can be improved.[47] In particular, a number of wireless companies are perceived to have a competitive advantage because they were granted large blocks of spectrum before the auction process was put in place. Newer entrants to wireless communications have had to purchase spectrum at market prices to compete with the entrenched companies.

Spectrum management is an exercise in reconciling divergent interests. Over time, developments in technology may significantly increase the amount of useable spectrum and consequently the ease with which a policy of equitable allocation and

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[41] H.R. 1661, Sec. 3, "Sec. 37 (a). (Pre-publication version.)

[42] H.R. 1661, Sec. 3, "Sec. 38 (a). (Pre-publication version.)

[43] H.R. 1661, Sec. 3, "Sec. 38 (a) (1). (Pre-publication version.)

[44] H.R. 1661, Sec. 3, "Sec. 39 (a). (Pre-publication version.)

[45] H.R. 1661, Sec. 5. (Pre-publication version.)

[46] FCC 97-353, *FCC Report to Congress on Spectrum Auctions*, WT Docket No. 97-150, released October 9, 1997.

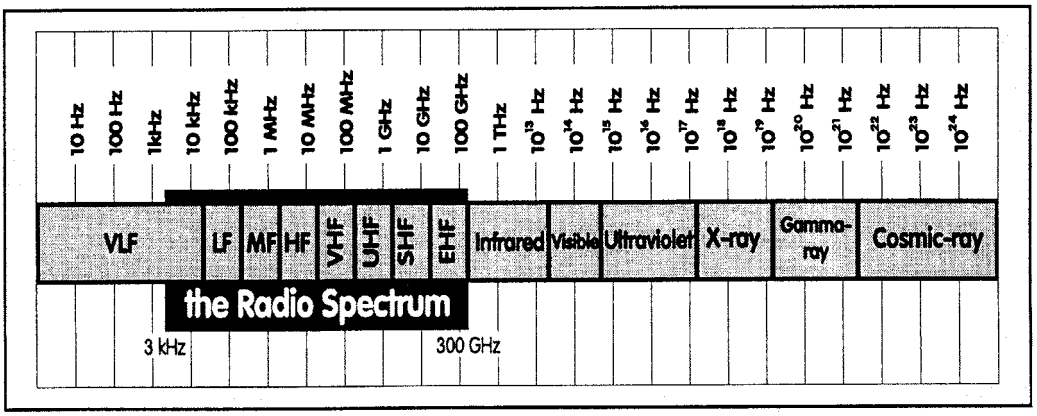
[47] The GAO, among others, analyzes auction policies and documents alternative mechanisms in*Comprehensive Review of U.S. Spectrum Management with Broad Stakeholder Involvement Is Needed*, GAO-03-277, January 31, 2003.

use can be crafted. For the immediate future, Congress may choose to debate and act on questions such as reforming spectrum management and allocation mechanisms. Some observers argue that a fully-developed policy should take into account issues such as international competitiveness, the communications needs of public safety agencies and the military, the role of wireless technology in economic growth, and the encouragement of new technologies that make spectrum use more efficient and more beneficial to society as a whole. The stated objective of many policy reformers is a coherent national policy that provides the proper balance for existing applications while at the same time providing opportunities for future growth and development. Auctioning spectrum to help close existing budget deficits is being advocated by some as a desirable policy choice.

Appendix: Spectrum Technology Basics

Electromagnetic radiation is the propagation of energy that travels through space in the form of waves. The most familiar form is light, called the visible spectrum. The radio frequency spectrum is the portion of electromagnetic spectrum that carries radio waves. Figure 1 shows the radio spectrum as part of the measured electromagnetic spectrum. Wavelength is the distance a wave takes to complete one cycle. Frequency is the number of waves traveling by a given point per unit of time, in cycles per second, or hertz (Hz).[48] The relationship between frequency (*f*) and

Figure 1: The Electromagnetic Spectrum



wavelength (λ) is depicted in Figure 2. Bandwidth is a measure of how fast data are transmitted or received whether through wires, air or space. Signals are transmitted over a range of frequencies which determines the bandwidth of the signal. Thus a system that operates on frequencies between 150 and 200 MHZ has a bandwidth of 50 MHZ.[49] In general, the greater the bandwidth, the more information that can be transmitted.

An important distinction in spectrum technology is the difference between narrowband and broadband. Narrowband signals have a smaller bandwidth (on the order of kHz) and are used for limited services such as paging and low-speed data transmission. Broadband signals have a large bandwidth (on the order of MHZ) and can support many advanced telecommunications services such as high-speed data and video transmission. The precise dividing line between broadband and narrowband is not always clear, and changes as technology evolves.

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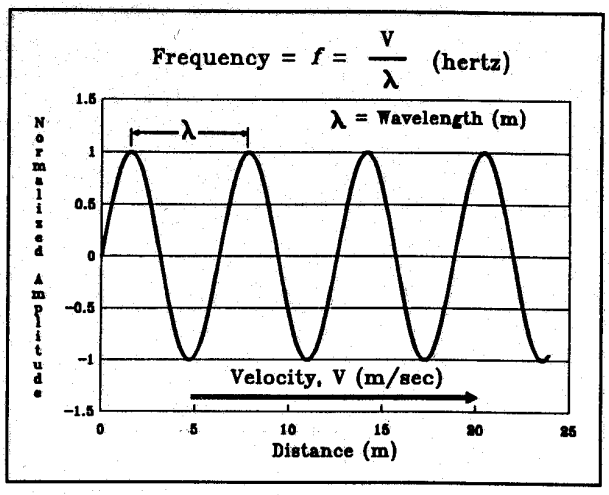
[48] Radiofrequency is usually measured in kilohertz (kHz), which is thousands of hertz, megahertz (MHz) which is millions of hertz, and gigahertz (GHz) which is billions of hertz.

[49] Bandwidth is also measured in bits per second (bps) instead of cycles per second. especially in digital systems.

Two other important terms are analog signals and digital signals, depicted in Figure 3. In analog signal transmissions, information (sound, video, or data) travels in a continuous wave whose strength and frequency vary directly with a changing physical quantity at the source (i.e., the signal is directly analogous to the source). In digital signals, information is converted to ones and zeros which are formatted and sent as electrical impulses. Advantages of using digital signals include greater accuracy, reduction in noise (unwanted signals) and a greater capacity for sending information. Analog signals have the advantage of greater fidelity to the source, although that advantage can be made very small by increasing the rate at which signals are digitized. Digital signals are acknowledged to be superior to analog signals for the majority of applications.

Figure 2: Frequency vs. Wavelength



Electromagnetic waves have many characteristics that govern how spectrum can be used in telecommunications systems. For example, antennas are used for transmitting and receiving signals, and can be designed to transmit in all directions or can be directed toward specific receivers. Receiving antennas are typically aligned with the transmitting antenna to maximize signal reception, but unintended signals can still interfere with the reception of the information sent. To avoid signal interference from stray signals, more than one radio signal usually cannot be transmitted in the same frequency range, at the same time, in the same area. Another characteristic is that the spectrum, unlike other natural resources, is not destroyed by use. As soon as one user stops transmitting signals over a portion of the spectrum, another can immediately re-use it. The spectrum is scarce, however, because at any given time and place, one use of a frequency precludes its use for any other purpose.

Figure 3: Schematic Comparing Analog vs. Digital Signals