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Radiofrequency Spectrum Management

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Summary

The radio spectrum, a limited and valuable resource, 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.

The federal government manages the spectrum to maximize efficiency in its use and to prevent interference among spectrum users. The National Telecommunications and Information Administration (NTIA) manages all spectrum used by the federal government and the Federal Communications Commission (FCC) manages all non-federal spectrum.

For several years, the FCC has been using auctions to distribute certain commercial spectrum licenses, instead of providing the licenses for free, raising over $23 billion for the federal treasury. By most assessments, auctions are considered more effective than previously used spectrum licensing methods, both in terms of the speed with which licenses are distributed and the revenue that can be raised. The FCC plans to continue conducting auctions, and Congress is considering giving the FCC authority to conduct auctions for other commercially used spectrum. As radio technology improves, higher frequencies may become available and spectrum may be utilized more efficiently, and demand for wireless services may increase. The Balanced Budget Act of 1997 (P.L. 105-33) contains spectrum management provisions to raise an estimated $21.4 billion by FY2002.

Potential and ongoing issues related to the new system of spectrum management are likely to continue to come to congressional attention for the remainder of the 105th Congress, including:

- the allocation of spectrum for federal vs. commercial use,
- the spectrum needs of intelligent transportation systems
- options for planning the transition to digital television,
- whether to set standards for interoperability of wireless devices,
- plans to provide spectrum for public safety services,
- congressional committee jurisdiction,
- various problems with auction procedures, and
- plans to auction broadcast licenses.

The fervor for auctions has decreased markedly over the past year, possibly due to decreased fiscal pressures, the perception that future auctions are not likely to produce the revenue that earlier auctions produced, and the possibility of obtaining federal revenue from other sources such as tobacco taxation.

Contents

List of Figures

List of Tables

Radiofrequency Spectrum Management

The radiofrequency spectrum, a limited and valuable resource, is used for all forms of wireless communication, including cellular telephony, radio and television broadcast, telephone radio relay, aeronautical and maritime radio navigation, and satellite command and control. This report provides an overview of the radiofrequency spectrum (or simply the spectrum) including definitions of commonly used terms, a summary of commercial services the spectrum, and a discussion of federal policies for managing the spectrum. In recent years, the federal government has used auctions to distribute commercial spectrum licenses, raising over $22 billion, instead of providing them for free. This report discusses the current issues related to this new system of spectrum management.

Spectrum Basics

To discuss spectrum management, some basic definitions must first be explained. **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 **radiofrequency spectrum** is the portion of electromagnetic spectrum that carries radio waves. Figure 1 shows the radio spectrum as part of the 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, measured in cycles per second, or **hertz** (Hz).[1] **Bandwidth** is the portion of the spectrum that a given telecommunications system can use. Thus a system that operates on frequencies between 150 and 200 MHZ has a bandwidth of 50 MHZ. The relationship between frequency and wavelength is depicted in Figure 2.

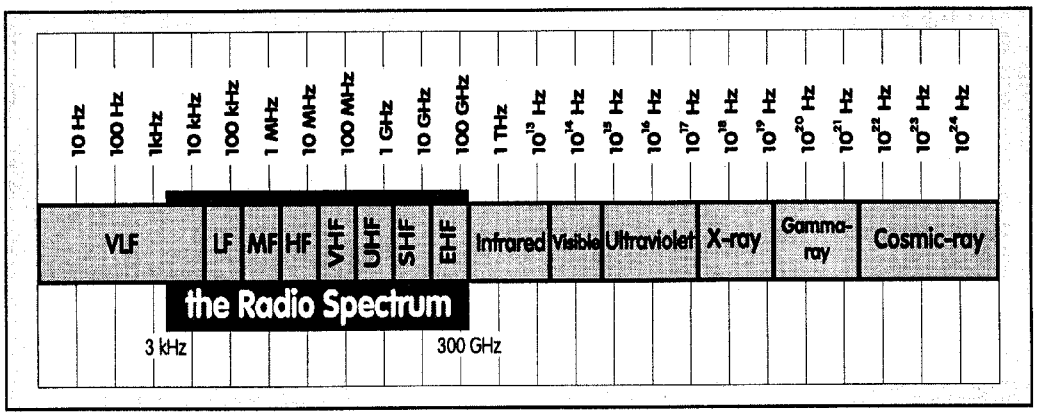

Figure 1 The Electromagnetic Spectrum

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[1]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.

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.

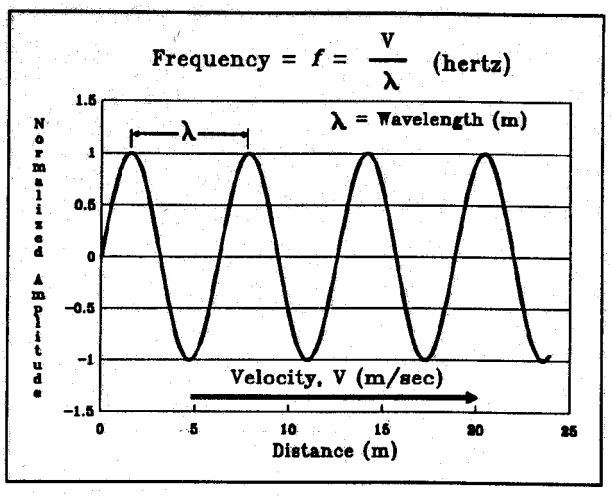

Figure 2 Frequency vs. Wavelength

Another set of important terms is analog and digital. 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. 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 greater capacity for sending information.[2]

Electromagnetic waves propagate outward in all directions. Antennas are used for transmitting and receiving signals and are designed and directed toward each other to maximize signal reception. However, the receiving antenna may still detect unintended signals that can interfere with the reception of the information sent. To avoid signal interference problems, more than one person usually cannot transmit radio signals at the same frequencies, at the same time, in the same direction. 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.

Uses of the Radio Spectrum

Spectrum is used to provide a variety of wireless communications services which are categorized as fixed or mobile voice/data services or broadcast services. Demand for all wireless services has grown rapidly in recent years. Federal agencies use spectrum for various purposes, including military and national security needs, Voice of America broadcasts, weather radio services, radars and communication systems to control commercial and private air and maritime traffic, weather satellite

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[2]For further discussion see CRS Report 96-401 SPR, *Telecommunications Signal Transmission: Analog vs. Digital*, May 7, 1996.

systems, flood warning and water control systems, and time signals. Commercial spectrum uses are equally as varied.

Commercial Voice and Data Transmission Services

- *Cellular telephone* systems consist of an array of terrestrial base stations (each covering an area called a cell) that transmit and receive signals to and from mobile or fixed wireless telephones to provide two-way voice and data communications over a geographic region.

- *Paging* is a low-cost one-way message-sending systems that use base stations similar to cellular telephone systems. An enhanced paging, called *messaging*, has a limited two-way capability.

- *Personal communications service (PCS)* is a wireless telephone service similar to cellular telephony but using higher frequencies (around 2 GHz) and digital signal transmission technology (cellular services are starting to convert to digital). Narrowband PCS can provide two-way messaging for interactive low-speed data applications (such as e-mail) but generally not voice, while broadband PCS provides a wider range of services.

- *Interactive video and data services (IVDS)* is a new subscription service that allows viewers to interact with cable and broadcast television.

- *Specialized mobile radio (SMR)* is a wireless service for public safety and dispatch communications. Newer enhanced SMR systems connect to the public telephone network to compete against cellular and PCS.

- *Satellite systems* provide communications to very large regions using signal transmissions between satellites and ground facilities. Geostationary satellites maintain a fixed position relative to a point on Earth. Communications satellites are used for voice, data, and broadcast purposes for government and commercial operations. Low and medium Earth orbiting satellite systems are also being developed for commercial communications services including paging, voice, fax, and interactive services.

Additionally, the Federal Communications Commission (FCC) has made spectrum available for unlicensed data services used for low-power applications, such as cordless telephones, and other innovations. For example, unlicensed spectrum is used for wireless computing, whereby portable laptop computers interact with mainframes or wireless local area networks (LANs). Providing this free spectrum for unlicensed data services is known to stimulate entrepreneurial activity, and use of this spectrum is intensive. The FCC recently made another 300 MHZ in the five GHz range available for Unlicensed National Information Infrastructure (NII) devices to facilitate wireless access to the NII and stimulate the development of new devices. The FCC has also made extremely high frequency spectrum (above 40 GHz) available for future unlicensed applications and has proposed making additional spectrum available above 40 GHz.

Commercial Broadcast Services

- *Radio*, the oldest broadcast service, uses 10 kHz for each terrestrial broadcast license assigned by the FCC in AM and FM bands separated by geographic regions. The radio industry is developing new digital audio broadcasting (DAB) technology, and the FCC is developing rules for DAB services.

- *Broadcast television* includes over 1600 currently licensed full service TV stations occupying 402 MHz in the VHF and UHF bands. Each TV station has a 6 MHz license. Television broadcasters are now starting to provide new digital television services using the vacant portions of the same spectrum bands.

- *Multipoint distribution service (MDS)*, also called wireless cable, is a television broadcast system using digital encrypted signal transmissions in the microwave band (2 to 3 GHz). With small (4 inch square) receivers, MDS subscribers can receive 100 TV channels. In the FCC regulations, MDS includes both single channel and multi-channel MDS *(MMDS)* applications (a more commonly used term).

- *Direct broadcast satellite (DBS)* is a new high powered satellite television delivery system operating using small receiving antennas in the 12.2-12.7 GHz band. It is related to direct-to-home (DTH) satellite television services that use large receiving antennas that have been offered for over a decade and operate in several other frequency bands.

- *Digital Audio Radio Services (DARS)* is a new high-fidelity radio service planned by several companies to be delivered by geostationary satellite. A single DARS transmission will cover the entire nation.

- *Local multipoint distribution service (LMDS)*, also called cellular television, is a new video distribution service for urban areas. Using a cellular architecture, LMDS can also provide two-way telephony (to compete with cellular telephone services), teleconferencing, telemedicine, and data services.

Management of the Radio Spectrum

The federal government has been involved with managing the spectrum since the first radio broadcast signals were transmitted in the beginning of the 20th century. The Radio Act of 1912 required the registration of transmitters with the Department of Commerce but did not provide for the control of frequencies, operating times, or output powers. The Communications Act of 1934 established the FCC, as an agency independent from the executive branch, to manage all non-federal government spectrum (which includes commercial, state and local government uses), and preserved the President's authority to manage all federal government-owned and -operated spectrum. The President also manages frequency assignments to foreign embassies and regulates the characteristics and permissible uses of the government's radio equipment. The President delegates this authority to the Assistant Secretary of

Commerce for Communications and Information who is also Administrator of the National Telecommunications and Information Administration (NTIA).[3]

The 1934 Act directs the FCC to develop classifications for radio services, to allocate frequency bands to various services, and to authorize frequency use. The Act does not, however, mandate specific allocations of bands for federal or non-federal use, which is generally decided through agreements between NTIA and the FCC. The Act authorizes the FCC to grant licenses for radio frequency bands, but provides few details other than requiring that FCC rulings be consistent with the "public interest, convenience, and necessity." The Act authorizes the FCC to regulate "so as to make available ... a rapid, efficient, nationwide, and worldwide wire and radio communication service with adequate facilities at reasonable charges, for the purpose of the national defense, and for the purpose of promoting safety of life and property." The Telecommunications Act of 1996 (P.L. 104-104) did not change this portion of the statute.

The primary FCC offices that implement spectrum policy are the Mass Media Bureau (which regulates all U.S. television and radio stations), the Wireless Telecommunications Bureau (which manages all domestic commercial wireless services except those involving satellite communications), the International Bureau (handling international telecommunications and satellite policies), and the Office of Engineering and Technology (developing spectrum allocations and policy, experimental licensing, spectrum management and analysis, technical standards, and equipment authorization). The FCC develops rules for spectrum use and other telecommunications regulation through lengthy proceedings in accordance with the Administrative Procedures Act.

The NTIA offices that work on spectrum policy include the Office of International Affairs which represents U.S. interests in international fora, and the Office of Spectrum Management which develops policies and procedures for domestic spectrum use by the federal government. This entails developing long range plans and war and readiness plans for spectrum use, chairing the Interdepartment Radio Advisory Committee (IRAC) composed of representatives of 20 major federal agencies who develop policies for federal spectrum use, and representing the United States at International Telecommunications Union conferences such as the World Radio Conference.

NTIA assigns frequencies and approves the spectrum needs for all federal government systems to support their mandated missions.[4] NTIA strives to improve federal spectrum users' efficiency by requiring federal users to use commercial services where possible, promoting the use of new spectrum efficient technologies, developing spectrum management plans, and collecting spectrum management fees

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[3]All U.S. spectrum allocations must comply with agreements made biannually at World Radio Conferences of the International Telecommunications Union (part of the United Nations) which assigns frequencies for the various uses.

[4]Major federal spectrum users include the Departments of Defense, Justice, Transportation, Energy, Interior, Commerce, the National Aeronautics and Space Administration, and the Federal Emergency Management Agency.

(pursuant to congressional mandate). Since most spectrum is shared between government and private sector uses, NTIA is working toward increasing private sector access to the shared spectrum. As a provision of the Omnibus Reconciliation Act of 1993 (P.L. 103-66), NTIA has reallocated 235 MHz of spectrum from federal government use to the private sector (90 MHz of that amount is scheduled to be reallocated by the year 2004).[5]

Using Auctions to Manage the Spectrum

Since two or more transmissions over the same frequency in the same location could interfere with each other, a system of exclusive licenses for users of specific frequencies was developed. In the past, the FCC granted licenses using comparative hearings and lotteries. After years of debate over the idea of using competitive bidding (or auctions) to distribute licenses, the Omnibus Reconciliation Act of 1993 directed the FCC to conduct auctions for licenses for certain wireless communications services. These fall mainly under a broadly defined set of services called commercial mobile radio services (CMRS) which include PCS, cellular, and most SMR and satellite services. CMRS services are regulated as common carriers (with some exceptions) to ensure regulatory parity among similar services that will compete against one another for subscribers.[6]

P.L. 103-66 permits the FCC 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 services are primarily subscription-based.[7] The FCC does not have authority to conduct auctions for licenses that have already been issued. Several legislative provisions were enacted in the 104th Congress directing the FCC to conduct auctions for additional spectrum bands.[8] One important measure of the effectiveness of a licensing scheme is the speed with which licenses are granted. Auctions have proven to be far speedier than either comparative hearings or lotteries, cutting the time required to obtain a license from up to four years to under six months.

For the first several years of auctions, the FCC developed auction rules for each auction held, although there were some common elements. 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

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[5]From the testimony of Larry Irving, Assistant Secretary for Communications and Information and Director of NTIA, before the House Subcommittee on Telecommunications, Trade, and Consumer Protection, April 24, 1997.

[6]Other services, classified as Private Mobile Radio Services (PMRS), are prohibited from connecting to the public switched telephone network.

[7]Licenses are issued for the use of bands of spectrum, and the greater the bandwidth, the more information can be sent.

[8]For further discussion and analysis see CRS Report 95-923, *FCC Auctions: Legislation in the 104th Congress*, last updated October 11, 1996. Also see CRS Report 97-171, *Electromagnetic Spectrum Auctions: Economic and Budgetary Considerations*. February 4, 1997.

bidding, in which bids are accepted on all licenses around the country simultaneously using electronic communications in consecutive rounds until all licenses are sold. 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.[9]

In some auctions, the FCC gave 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. The FCC had originally proposed also to give special provisions to women-owned, minority-owned, and rural telephone companies (so-called *designated entities*). The FCC removed the other groups, however, after the 1995 Supreme court decision in the "Adarand" case, which determined that government affirmative action policies must pass a "strict scrutiny" test to demonstrate past discrimination.[10]

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. 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), and economic areas (EAs), developed by the Department of Commerce for economic forecasts, are also used by the FCC to define areas of coverage for some spectrum auctions.

The FCC is also modifying 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 the spectrum purchased in the PCS auctions.

By the Spring of 1997, the FCC had raised over $22 billion in auctions, and many observers in government and the private sector claimed auctions to be a success. That enthusiasm decreased somewhat, however, after the results of two auctions, held in April 1997, for wireless communications services (WCS) and digital audio radio service (DARS). The WCS auction was mandated by the FY1997 Omnibus Appropriations Act (P.L. 104-208), which directed the FCC to reallocate the use of 30 MHZ of spectrum (specifically, 2305-2320 and 2345-2360 MHZ) and to assign those frequencies by an auction to begin by April 15, 1997. The FCC was able to meet that schedule, and the WCS auction was concluded by April 25, 1997, selling 126 licenses in 5 and 10 MHZ blocks, with various regional coverage. The revenue obtained, however, was only $13.6 million, far lower than the $1.8 billion that the Congressional Budget Office (CBO) had estimated could be raised from that

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[9]The FCC provides additional information on auctions on its web site at http://www.fcc.gov/wtb.auctions.htm

[10]Nevertheless, concerns were raised that some of the "small businesses" actually were representing larger companies excluded from the auctions.

auction. Critics offered several reasons for the shortfall, one being the shortened timetable set by Congress for the FCC to complete the WCS auction.

Another possible reason that the WCS revenue was lower than expected is related to the technical constraints around the WCS spectrum. To make room for WCS spectrum, Congress directed the FCC to reallocate some of the spectrum that was previously allocated to DARS. As a result, DARS was left with only a 25 MHZ band (down from 50 MHZ) which is surrounded by the spectrum allocated for WCS. In designing the service rules for WCS, the FCC restricted the out-of-band power WCS may radiate into the DARS band so that WCS and DARS would not interfere with each other. This restriction, however, reduces the usefulness of WCS spectrum. After much delay in the DARS proceeding, the FCC conducted the DARS auction in April 1997, just before the WCS auction so that losing DARS bidders could bid on WCS licenses. Two DARS licenses were auctioned, each 12.5 MHZ around the 2.3 GHz range and having nationwide coverage, raising $173 million.

To date, the FCC has raised almost $23 billion for the U.S. Treasury from spectrum auctions, although only $12 billion in revenues have been collected.[11] The bulk of the revenue came from auctions of broadband PCS licenses, and lesser amounts were raised from auctions of other licenses including IVDS, SMR in the 900 MHZ range, MDS, and DBS. While all of the broadband PCS auctions are complete, there are still many narrowband PCS licenses (for BTA and MTA markets) that will be auctioned. Table 1 lists types of licenses auctioned to date and a revised estimate of the revenue.

Many still consider the auctions to be a success, for 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 will 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.[12] In recent years, several other countries around the world have also begun to use auctions to distribute licenses to use spectrum bands.

LMDS Auction. The auction for Local Multipoint Distribution Service (LMDS), a new television distribution service for urban areas, began on February 18 and was completed on March 25, 1998. Two LMDS licenses were auctioned in each of 493 BTA regions for a total of 986 licenses. LMDS uses much higher frequencies than existing commercial wireless services. One of the LMDS licenses is 1,150 MHZ in the 28 GHz band and the other is 150 MHZ in the 31 GHz band. LMDS is a fixed microwave service, similar to MMDS, but also offers two-way audio or video communications. LMDS could compete with cable TV, broadcast TV, MMDS, or

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[11]According to auction rules, winning bidders make payments in installments over the terms of the licenses. In addition, some auction winners have defaulted on their payments.

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

direct broadcast satellite TV, as well as wireless telephone services, high speed data transmission, and video teleconferencing.

Table 1: Licenses Auctioned to Date

license type and geographic area	amount of spectrum and its uses	number of licenses	revenue: $millions
narrowband: nationwide	0.8 MHZ: paging, messaging	10	650
IVDS: MSAs	1 MHZ: information services	594	214
narrowband PCS: regional	0.2 MHZ: paging, messaging	30	395
broadband PCS A&B blocks: MTAs	60 MHZ: full service digital telephony	102	7,736
DBS: nationwide	shared spectrum* subscription television service	2	735
MDS: BTAs	heavily encumbered spectrum* subscription TV broadcast	493	216
900 MHZ SMR: MTAs	50 MHZ: mobile dispatching	1,020	204
broadband C-Block PCS: BTAs	30 MHZ: full service digital telephony	493	9,967
broadband PCS blocks D, E, and F: BTAs	30 MHZ (three 10 MHZ licenses): digital telephony	1,472	2,523
unserved cellular areas	50 MHZ (encumbered): mobile telephone service	14	2
wireless communication service: Major/Regional Economic Areas	30 MHZ: multiple wireless uses	126	14
digital audio radio services: nationwide	25 MHZ: satellite radio broadcast	2	173
800 MHZ SMR: Economic Areas	1 MHZ, 3 MHZ, and 6 MHZ: mobile dispatching	525	96
LMDS: BTAs	1,150 MHZ and 150 MHZ	986	577
Total			$23,503

Source: FCC. Prepared by CRS.

*Due to the DBS rules for spectrum channelization and the existence of many licensees encumbering the MDS spectrum, the amount of spectrum for the DBS and MDS auctions cannot be easily established.

The LMDS auction raised $577 million in proceeds. Although no official estimates were made of expected revenue prior to the auction, based on the amount of spectrum auctioned, some in the private sector had expected far higher revenues.

Finding spectrum for LMDS was complicated due to the spectrum needs of new satellite services in the same bands. At the time when the FCC was developing plans for LMDS spectrum, several companies developing new fixed satellite services (FSS) requested the same spectrum for sending signals to their satellites. FSS systems use geostationary and non-geostationary satellites to provide world-wide voice, video, and interactive data services to users at fixed locations. Mobile satellite services (MSS), which serve mobile users as well as fixed users, also wanted these frequencies to interconnect MSS systems to other communications networks, and the FCC had already granted licenses to several of these companies. Also, this frequency range is currently used by several point-to-point microwave terrestrial systems (those in which signals originate from ground stations). These frequencies are being used increasingly by terrestrial systems around the world, making the equipment used for these systems more valuable for export. The equipment manufacturers wanted to preserve this spectrum for their terrestrial systems.

The satellite services industry convinced the FCC not to auction the spectrum allocated for their services. They argued that since satellites can potentially cover any geographic area on the earth, satellite frequencies are shared among all nations that use its services. Thus a satellite service provider might have to obtain a spectrum license from every nation it plans to service. If every nation holds auctions for that spectrum, satellite companies might not be able to bid effectively for U.S. licenses.[13]

Against protests from both sides, however, the FCC divided the 28 GHz band among LMDS, geostationary FSS, non-geostationary FSS, and MSS. The FCC also adopted auction rules for LMDS licenses.[14] A frequency band around 18 GHz was designated for FSS downlink signals to share with several other services.[15] The wireless services industry has shown strong interest in LMDS auction, which has raised over $500 million to date.

Planned Future Auctions

The FCC plans to use auctions in the future to distribute licenses for the following other wireless services:

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[13]*Public Harms Unique to Satellite Spectrum Auctions*. March 18, 1996. Strategic Policy Research. Bethesda MD.

[14]FCC CC Docket 92-297 Fourth NPRM and First Report and Order on Domestic Public Fixed Radio Services, released July 22, 1996, amended by an Order on Reconsideration, released May 16, 1997, and Second Order on Reconsideration, released September 12 1997 to Establish Rules and Policies for LMDS and FSS.

[15]Licenses for a new service, called digital electronic messaging service (DEMS), which may also be distributed using auctions, was proposed for the 18 GHZ range, but the FCC decided to move DEMS to the 24 GHz range, also to be shared with other satellite services. DEMS could compete with LMDS.

Additional IVDS licenses. The FCC had planned to offer two IVDS licenses in each of the 428 rural service areas (RSAs), plus 127 MSA licenses on which the previous winning IVDS bidders defaulted. Just prior to the scheduled start date (February 18, 1997), the auction was postponed indefinitely as a result of numerous petitions from industry and Congress to revise the service rules to make these licenses more attractive to bidders.

220 MHz Band. The FCC has allocated 908 narrowband licenses in the 220 MHZ band: three nationwide licenses (each 100 kHz paired), 30 regional licenses (150 kHz paired), and 875 Economic Area licenses (100 kHz paired) to provide voice, data, and paging services. The auction is scheduled to begin on May 19, 1998.

General Wireless Communications Services (GWCS). The FCC has allocated five licenses, 5 MHZ each, between 4660-4685 MHZ, to be auctioned in each of 175 Economic Areas, for a total of 875 licenses. There are, however, incumbent licensees in that spectrum in many parts of the country. GWCS licenses, conceived to be similar to WCS, may be used to provide any fixed or mobile communications services except broadcast, radiolocation, and satellite services. These may include voice, video, and data services, private microwave, broadcast auxiliary, and ground-to-air signals. GWCS auctions will begin on May 27, 1998.

The FCC is also planning auctions for additional commercial spectrum licenses. These include the re-auction of the PCS C-block licenses for which previous winners defaulted, the rest of the narrowband PCS licenses (auction scheduled to begin September 29, 1998), new paging systems (planned as a series of auctions of small frequency bands between 35 MHZ and 930 MHZ for common carrier and private carrier paging),[16] and the remaining SMR licenses in the 800 MHZ range. Other spectrum licenses the FCC is considering for possible auction include location monitoring services, licenses in the 39 GHz range, public coast stations, and analog broadcast licenses for commercial radio and television stations, all of which would begin later in 1998. Licenses the FCC is planning or considering for future auctions are listed in table 2.

Table 2: Future FCC Auctions

License Type: Geographic Area	Frequency Range
IVDS: MSA and RSA	500 kHz licenses at 218 and 219 MHZ
220 MHZ services	220-222 MHZ
GWCS	4600-4685 MHZ
narrowband PCS: MTA and BTA	50 KHz paired licenses in the 900 MHZ range
paging	licenses of varying sizes between 35-930 MHZ
Location Monitoring Services	25 KHz licenses in the 900 MHZ range
39 GHz services	50 MHZ paired licenses from 38.6-40.0 GHz

[16]FCC WT Docket 96-18 Second Report and Order and Further NPRM, to Facilitate Future Development of Paging Systems, released February 24, 1997. Auction to begin in 3rd quarter 1998.

Spectrum Value

Spectrum value depends on many factors, such as the amount of spectrum, its frequency locations (since 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 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. Thus it is impossible to determine in advance precisely the revenue that can be obtained from a given spectrum auction.

After an auction closes, spectrum value is often measured by the total dollars raised per "MHZ-pop" (the number of MHZ provided in a license multiplied by the total population covered by the license, similar to a unit price). However, the MHZ-pop value of a given license can vary significantly from one auction to another. In the PCS auctions, for example, the narrowband PCS licenses drew over six times more revenue per MHZ-pop than the broadband PCS licenses, but drew much less revenue because of the smaller amount of spectrum auctioned.

Technology Considerations

Several technological advances could affect the outcome and prospects for spectrum auctions. Today, the usable spectrum is considered to be below 300 GHZ. The limitations with using higher frequencies include greater absorption of higher frequency signals by the atmosphere, and difficulties of high frequency reception. As the technology for radio transmission and reception improves, increasingly higher frequency ranges will likely become available, opening up more spectrum for use. These technology improvements may spur increased consumer demand for spectrum.

Some of the technical problems with high frequency signal transmission are being solved by engineering techniques which could offset some of the spectrum demand. These 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 advanced digital techniques such as frequency hopping, in which the transmitted signal avoids frequencies that are already being used. The use of fiber optic cables (which carry signals over wires rather than propagating through the air, and therefore do not require frequency allocations) also alleviates some of the demand for spectrum.

Spectrum Flexibility, Overlay Licenses, and Other New Provisions

In planning for future spectrum license auctions, the FCC is considering a policy to allow users the maximum flexibility. "Spectrum flexibility" is a concept of utilizing competitive market forces whenever possible to determine what use will be made of any given band of spectrum. This may entail using auctions for most new

terrestrial spectrum licenses. It also entails defining new services broadly enough to allow services to change as the technology evolves.

Some auctions will be for licenses where incumbent licensees are already using the same frequencies within the geographic coverage of the new license. These new licenses are called *overlay licenses* because they use frequencies that surround the frequency of an existing licensee. The auction winner must prevent the operations of its overlay license from interfering with those of an incumbent licensee. The new licensee could either "work around" the spectrum of the incumbent licensee (by using frequency hopping) or else the new licensee can buy out the incumbent within pre-established conditions set by the FCC.

Overlay licenses were auctioned in the PCS auctions since there were already incumbent licensees (called microwave licensees) using that spectrum. To help clear the PCS spectrum of microwave incumbents, the FCC provided higher frequency spectrum for the incumbents and required PCS licensees to pay for the costs of relocating incumbents to higher frequencies. Placing that sort of requirement on the new licensee, however, lowers the value of the license. Most licenses that the FCC is considering for auction in the future will be encumbered with existing licensees to an even greater extent than the PCS spectrum. In some cases the cost of relocating the incumbent may exceed the value of the license, making it impossible to conduct an auction. A further difficulty is that for some proposed auctions, the FCC has not provided new spectrum to relocate incumbents.

In 1997, the FCC added two other provisions to help designated entities participate in many of its auctions. One was to allow license winners to partition a license into smaller geographic areas than were defined by the FCC. This allows a smaller wireless service provider to set up a business in a smaller community without having to serve an entire region. The other change was to allow licensees to "disaggregate" a portion of the spectrum assigned to their license, that is, to divide the spectrum into several smaller spectrum blocks. This enables smaller companies to use a portion of the spectrum for some specialized service.

In December 1997, the FCC adopted a single set of rules for all subsequent auctions.[17] The new rules were designed to simplify the auction process, such as the applications and payment procedures for bidders. In an attempt to create incentives for small businesses, women-owned, minority-owned, and rural telephone companies the FCC adopted uniform affiliation rules and ownership disclosure rules. The new rules also provide for higher bidding credits for small businesses (15, 25, and 35 percent, based on the size of the business). However, the new rules no longer allow installment payments for designated entities in future auctions.

The Balanced Budget Act of 1997

On August 5, 1997, the Balanced Budget Act of 1997 was enacted as P.L. 105-33. Title III, sections 3001-3008, of the Act contained budget-related communications and spectrum allocation provisions, and are summarized below.

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[17]Third Report and Order/ Second Further Notice of Proposed Rulemaking (FCC-413).

3002(a) provides for the expansion of the FCC's auction authority to nclude any spectrum licenses for which there are mutually exclusive applicants, with xceptions for public safety radio services, and certain private internal radio services as utilities, railroads, transit systems, pipelines, private ambulances, an volunteer fire departments.

September y exclusiv applications for new radio or television broadcast licenses received after 30, 1997. For applications filed prior to that date, bidding will be limited to e who have already filed. The FCC was also directed to experiment wit combinatorial f licenses simultaneously, and to establish minimum opening bids and reasonable

Sections 0 M ecifically, the transfer and planned auction o already reallocated by NTIA from government use will b the FCC is required to auction an additional 55 MHZ located below is required to reallocate another 20 MHZ below three GHz or commercial uses. Additionally, private parties are permitted to reimburse entities for the costs of relocation if the private parties want to expedite the

Section o be ptured in 2006. The Act requires the FCC to conduct auctions for the 78 of analog television spectrum to be reclaimed from television broadcasters That spectrum is to be auctioned in 2006. It the s where e of the following three conditions exist: (1) if one or more of the stations affiliated with the four national networks are not broadcasting a igital television signal, (2) if digital-to-analog converter technology is not generally able in the market of the licensee, or (3) if at least 15% of the televisio households - c ing distributor" (e.g.., cable or satellite services) and do not h al television set or converter. To maximize the pool of potential bidders i returned analog TV spectrum, the FCC may not disqualify bidders due duopoly or cross-ownership rules if the population of the city in question is

Section s t TV channels 60-69 for public safety services a MHZ in that band for commercial use. The public safety li must be assigned in 1998 and the auction must start by January 1, 2001. the transition to DTV, the FCC must ensure that new spectrum users an existing television licensees could bill di e reassigned other spectrum where possible.

3005 directs the FCC to allocate spectrum for "flexible use," whic means d e telecommunications technology evolves. These allocations must be consistent with

internat agreements, must be required by public safety allocations and in the

Section 3006 made a change to the universal service fund payment schedule that as later repealed in the FY1998 Appropriations Act (P.L. 105-119). The universal vice fund is a congressionally mandated account managed by the Nationa Exchange Carriers Association, and financially supported from s compa were to pay into the universal service fund $3 billion less than they therwise would have paid, and a federal appropriation to the FCC would cover the 3 billion shortfall. Then in FY2002, the telecommunications companies would pay he fund $3 billion more than would otherwise be paid, and those proceeds would be red to the federal treasury to balance the budget. Several Members an private e revenue e f the improving revenue forecasts by the Fall of 1997, t longer needed to balance the federal budget. Table 3 provides a of auctions mandated by the Balanced Budget Act and Table 4 lists the CBO tes of the additional auction revenue that can be obtained from the

Table 3: Auctions to Be Scheduled per Balanced Budget Act of 1997

Frequency Band Name		**Amount (MHZ)**	**Planned FCC Actions**
Government Fixed and Mobile		45	begin auction after 1/1/01
	2110-2150	40	
Broadcast Auxiliary; (MSS)	1990-2110		complete assignment by 9/30/02
Government Spectrum		20	complete assignment by 9/30/02
Recaptured Broadcast Channels (from 46-59)	668-746		complete assignment and report
portion of Broadcast Channels 60-69	746-806		allocate by 1/1/98; begin auction after 1/1/01
		234	

source: FCC Report to Congress on Spectrum Auctions, released October 9, 1997 (page 38).

Table 4: CBO Revenue Estimates for Spectrum Auctions Mandated by the Balanced Budget Act ($millions)

Provision	**Revenue**
analog TV broadcast	4,000
portion of channels 60-69	2,100
broaden and extend FCC authority	5,800
directed allocations (120 MHZ)	9,500
Total	**$21,400**

Source: CBO transmittals

Spectrum Issues for Congressional Consideration

Allocation of Spectrum for Federal vs. Commercial Use

One issue that has already received some congressional attention is whether to transfer additional federal spectrum to the private sector. Most federal agencies require spectrum to support their missions. As a result of the Omnibus Budget Reconciliation Act of 1993 (P.L. 103-66), federal agencies are vacating a 235 MHZ band of spectrum below 3 GHz, and giving it to the FCC to make available for commercial uses. In recent years, industry has increased pressure on Congress to release additional federal spectrum for commercial use. Consequently, federal agencies have become increasingly concerned over the potential loss of spectrum. NTIA, manager of all spectrum used by the federal government, claims that releasing any additional spectrum could result in costs greater than the potential revenue from an auction, and could compromise national security, public safety, law enforcement, and air traffic control operations.[18]

The Department of Defense (DOD), the largest federal user of spectrum, argues that it needs all of the spectrum it is currently allocated to maintain high quality communications to support national security. Some in DOD were concerned about a provision in the FY1997 Omnibus Appropriations Act (P.L. 104-208) directing the FCC to auction 30 MHZ of spectrum previously allocated for shared commercial and government radio services. Some claim that those frequencies were highly desirable for military use.[19] Despite these questions, the Administration has continued with the spectrum reassignment process. In January 1997, NTIA released another 25 MHZ of the spectrum (4635-4660 MHZ) from federal use to the FCC to use for commercial applications. The Navy had planned to use that spectrum, combined with another 25 MHZ of spectrum released in 1995, for a radar and communications systems in development.

A General Accounting Office (GAO) report investigated the potential impact of the transfer of that 50 MHZ from DOD to commercial uses.[20] The report recommended that DOD consolidate its spectrum management functions and expand an ongoing study of its spectrum uses, and that the "FCC suspend plans for auctioning the reallocated 50 MHZ and other transfers of spectrum until Congress and the President have reviewed the DOD report" of its frequency requirements. The FCC is mandated by P.L.104-208 to issue licenses for part of that 50 MHZ and does not plan to suspend its auction. DOD was not able to reclaim the spectrum since it had already been transferred to the FCC by a Presidential Directive.

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[18]Testimony of Hon. Larry Irving to House Commerce Committee, Telecommunications and Finance Subcommittee, March 21, 1996, and Senate Commerce Committee, June 20 and 25, 1996.

[19]Congress Spectrum Raid Riles DOD. *Military Space*, November 25, 1996 p. 1.

[20]GAO Report to Congressional Committees. *Defense Communications: Federal Spectrum Sale Could Impair Military Operations*, June 1997. GAO/NSIAD-97-131.

Despite DOD's concerns over reallocating spectrum, the Balanced Budget Act of 1997 (P.L.105-33) directed NTIA to reassign an additional 20 MHZ below 3 GHz to the FCC for auction. In February 1998, NTIA identified five spectrum bands and a schedule for reallocation from federal agency use with the next ten years. The report concluded, however, that such a spectrum release could adversely affect critical agency missions and the ability to provide services to the public.[21] The report also estimated the costs to federal agencies to modify existing equipment and facilities to use alternative frequencies. The total costs estimate is $1.056 billion at a minimum, including $1.01 billion estimated by the Army, Navy, and Air Force, assuming that suitable spectrum will be available such that extensive system modifications will not be required to avoid interfering with new commercial users. The report concluded that the loss of the identified spectrum could restrict spectrum use during defense training exercises, ultimately affecting operational readiness and national security.

There are several reasons that one could question whether it would be prudent to proceed with plans to reallocate the spectrum identified by NTIA. From a budgetary standpoint, the amount of revenue that can be obtained from the auction of the 20 MHZ is uncertain. It is possible that the revenue would be less than the $1 billion estimated cost to reallocate federal users. Policymakers might also consider the potential loss of defense readiness, the potential disruption of federal services, and other possible unforeseen costs related to the reallocation.

One of the main criteria that NTIA used in selecting the spectrum for reallocation was the potential desirability of a particular frequency band among commercial users. Perhaps other spectrum bands would be less costly for federal agencies to vacate and would not have as great an impact on federal operations. As an alternative to the current spectrum allocation plan, NTIA might be able to re-negotiate with federal agencies to identify other spectrum bands for reallocation, placing the commercial viability of the spectrum on a lower priority.

Spectrum Needs of Intelligent Transportation Systems

For several years, the automotive industry and the federal government have been working together to develop the electronics, communication systems, and information processing to improve the efficiency and safety of surface transportation systems. These planned systems are collectively referred to as intelligent transportation systems (ITS).[22] In 1997, the Intelligent Transportation Society of America, an organization established by Congress to coordinate the development and deployment of ITS, filed a petition for rulemaking with the FCC, to reallocate 75 MHZ between 5.850 and 5.925 GHz on a co-primary basis with current users of this spectrum (meaning that ITS users would receive the same level of protection from interference as other primary users, and a higher level of protection than secondary

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[21] *NTIA Spectrum Reallocation Report (Publication 98-36): Response to Title III of the Balanced Budget Act of 1997.*

[22] For further information on ITS, see CRS Report 97-691 SPR, *Intelligent Transportation Systems Program: Importance, Status and Options for Reauthorization*, June 27, 1997.

users). That frequency band is currently assigned to be shared between federal operations (used primarily by DOD) and commercial fixed satellite (Earth to Space) services, each with co-primary status (Amateur radio has a secondary status in this band).[23] ITS would use this spectrum for dedicated short range communications between roadside traffic systems and vehicles traveling at highway speeds. ITS America proposed possible applications such as electronic toll collection (a system that automatically reads a debit card located on the vehicle, removing the need to stop at toll booths), and automatic safety checks to weigh trucks, check permits, track hazardous materials, and authorize further inspections as necessary.[24]

The FCC responded to the petition with a Public Notice and request for comments from interested parties. The FCC is currently reviewing comments and further action on the item is expected some time in 1998. If the FCC decides to reallocate the spectrum identified by the ITS America Petition, the next step is to decide how to distribute licenses. The FCC could propose to auction the ITS spectrum to commercial users, or grant licenses to non-commercial ITS spectrum users such as state and local governments, or some combination of the two options.

In addition to the FCC's action, both House and Senate versions of the federal highway reauthorization legislation, currently in conference, include provisions to allocate spectrum for ITS. The House bill, known as the Building Efficient Surface Transportation and Equity Act of 1998 (H.R.2400), contains a provision directing the Secretary of Transportation, "in consultation with the Secretaries of Commerce and Defense and the FCC, ... to secure the necessary spectrum for the near-term establishment of a dedicated short-range vehicle to wayside wireless standard."[25] The Senate bill, known as the Intermodal Transportation Efficiency Act of 1998 (S.1173), contains a similar provision.[26] If this legislation is enacted, the FCC would have a statutory mandate to continue with its proceeding on allocating ITS spectrum.

Digital Television Spectrum

A major debate took place in the 104th Congress over whether to direct the FCC to conduct auctions for the spectrum allocated for advanced television, later called digital television (DTV). CBO estimated that $12.5 billion could be raised from DTV auctions. With the defeat of an amendment in the House to prohibit the FCC from assigning DTV licenses, however, the FCC did not gain the authority to auction the those licenses.[27] In April 1997, the FCC adopted a plan to issue 6 MHZ DTV

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[23]U.S. Table of Spectrum Allocations. *Code of Federal Regulations*, Title 47, Chapter 1, Section 2.106, October 1, 1996 Edition.

[24]Petition for Rulemaking before the FCC by ITS America. 1101 30th St. NW, Washington, DC 20007. May 19, 1997.

[25]H.R.2400, Part III, Subtitle B, Sec. 653(b)(4), passed by the House April 1, 1998.

[26]S.1173, Title II, Subtitle B, Sec. 2103(f), passed by the Senate on April 2, 1998.

[27]For a discussion and analysis of the debate over whether to conduct auctions for the DTV licenses, see *archived* CRS report 96-74, *Advanced Television: Radiofrequency Spectrum Issues*, updated January 23, 1997.

licenses, free of charge, to all full power incumbent television broadcasters.[28] Once the DTV licenses were granted to some 1600 broadcasting stations across the country, it was no longer possible to auction the DTV spectrum.

The FCC ruling requires broadcasters to use the DTV spectrum to provide free digital programming that is at least comparable in resolution to today's analog television service and aired during the same times. Broadcasters may also use the DTV spectrum to provide subscription services such as electronic publications, Internet access, video programming, interactive media, and audio services. The FCC gave broadcasters this flexibility to stimulate consumer acceptance of the new technology and the purchase of digital television receivers.

The ruling requires affiliates of the four networks (NBC, CBS, ABC, and Fox) in the top 10 markets to provide a digital signal by May 1, 1999, and affiliates in markets 11-30 to provide a digital signal by November 1, 1999. Broadcasters in the top ten markets promised to begin operations by November 1, 1998. All DTV licensees must provide a digital signal by 2003. The rules enable the FCC to grant an extension to licensees that are unable to meet the requirement due to unforeseeable or uncontrollable circumstances, such as an inability to secure tower locations for new antennas. Broadcasters will cease broadcasting the analog signal and return their analog television licenses in 2006, and that spectrum will be auctioned for other commercial purposes. The Balanced Budget Act of 1997 (P.L.105-33) contained a provision enabling broadcasters to delay the return of the analog licenses under certain circumstances.

In February 1998, after over 200 petitions for reconsideration from broadcasters and others, the FCC modified its allotment table for DTV licensees, and made other changes to DTV rules.[29] One FCC Commissioner (Furchtgott-Roth) dissented to part of that ruling that increased the amount of "core spectrum" to be retained for DTV broadcasters, stating that the "costs of this decision could be enormous in terms of the new services that consumers never see, or savings on existing service they never realize."

Several issues related to the transition to DTV remain unresolved. The FCC and Congress plan to establish specific public interest obligations for DTV licensees. Another question is whether cable television providers will be required to provide any part of the DTV programming content, as they are for analog television broadcasting. Many also want to ensure that the analog television spectrum will be returned to the FCC for auction as planned. Some Members want to save low power television stations from losing their licenses in the transition to DTV. Finally,

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[28]FCC Fifth Report and Order on Advanced Television Systems and Their Impact on Existing Television Service, released April 21, 1997.

[29]Memorandum Opinion and Order on Reconsideration of the Sixth Report and Order (FCC-98-24), released February 25, 1998.

Congress is confronted with the controversy between state and local authorities and broadcasters over the placement and construction of transmission towers.[30]

Interoperability Standards

Another issue concerns the adoption of standards to insure Interoperability. Many wireless systems in use or being developed are potentially incompatible with each other, making it difficult for mobile users to roam outside their home system or to switch service providers. In general, the FCC avoids mandating standards for new wireless communications devices, preferring to let the market determine which technologies prevail, except for insuring that signal interference does not occur.

The FCC also considers the special need for interoperability in establishing a new service. In the FCC's proceeding over selecting a standard for DTV, for example, the television manufacturing industry argued that a single video transmission standard was needed to expedite the transition to digital television and the return of currently used television spectrum. The computer manufacturing industry, however, criticized the standard proposed by the television manufacturers for having interoperability problems with personal computers. Finally, the FCC decided to let the market determine which standard, if any, manufacturers may use for DTV video transmission.

Public Safety Spectrum Needs

Public safety services such as police, fire department, and emergency medical services are concerned about having enough spectrum for future needs. With congressional prompting, the FCC and NTIA set up the Public Safety Wireless Advisory Committee (made up of appointees from the federal, state, local, and private sector public safety organizations). In September 1996, the Committee submitted a report outlining public safety needs for additional spectrum, improved interoperability, more flexible licensing policies, and an increased sharing of spectral resources. As a result, Congress included a provision in the Omnibus Appropriations Act (P.L. 104-208) instructing the FCC to take into account these needs in its WCS auction.

In January 1997, Senator McCain introduced the Law Enforcement and Public Safety Telecommunications Empowerment Act (S. 255) to reallocate and auction portions of television channels 60-69.[31] However, most of the provisions of S.255 were included in the Balanced Budget Act (P.L.105-33), and the McCain bill has not been pursued further. The FCC plans to reallocate 24 MHZ of the spectrum between channels 60-69 for public safety services in 1998 and auction the remaining 36 MHZ in 2001. This will require moving existing television stations to other frequencies and revoking the licenses of some low power television and translator stations.

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[30]For further analysis of these issues, see CRS Report 97-925, *Digital Television: Recent Developments and Congressional Issues*, updated December 23, 1997.

[31]Congressional Record, February 4, 1997, p. S945-949.

Congress might want to monitor the FCC's actions to minimize the impact on these licensees.

Committee Jurisdiction

Tension continues to exist in both Houses between the Commerce Committee and the Budget Committee over spectrum management jurisdiction. In September 1996, the Chairman and ranking Member of the Senate Committee on Commerce, Science and Transportation sent a letter to the Senate leadership and the Budget Committee chairman and ranking Member, expressing their concern that auctions were being used as an instrument of budget policy potentially at the expense of communications policy. One indication of this trend was seen in the Omnibus Appropriation Act, which required the FCC to reallocate and auction 30 MHz of additional spectrum by April 15, 1997, for budgetary purposes. That auction brought in far less revenue than had been estimated by CBO prior to the auction. Many feel that the time constraint prevented the FCC from working with industry to properly establish the service and auction rules for the WCS spectrum, and potential bidders did not have time to secure the financing necessary to participate in the auction.

Many policymakers agree that potential revenue should not be used as the main argument for auctioning spectrum used by the government or public safety officials. Some argue that potential revenue should not even be used as the main criteria for auctioning commercial spectrum. In recent years, however, Congress has used spectrum auctions to reduce the federal deficit, and legislation has been introduced to use auctions to offset various spending programs (see examples in **Box 1**). Last year the Budget Committees again asserted their authority over spectrum policy in provisions for spectrum auctions in the Balanced Budget Act of 1997.

For FY1999, however, neither the President's budget proposal nor the Budget Resolution includes provisions to obtain additional federal revenue from auctioning spectrum beyond what has already been allocated for auction by previous legislation. This could be a result of a decreased fiscal pressures as well as the acknowledgment that recent auctions have produced less than expected revenues. Instead, other potential sources of federal revenue, such as tobacco taxation, have been proposed.

Problems With Auction Procedures

C-Block Auction. Despite widespread praise for auctions, several significant problems have occurred, causing anger and frustration among some groups of bidders. One auction, known as the *C-block* auction, ultimately presented some complex legal problems for the FCC. In the 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. The C-block auction was completed in May 1996, when the FCC announced that it had raised $10.2 billion from winning bidders. By mid-1997, however, several of the license winners, unable to obtain the financing to build their PCS systems, had requested extensions to their installment payments to the FCC. Some licensees had filed for bankruptcy. If the FCC had tried to reclaim and re-auction the licenses, the winning bidders could have filed legal suits against the FCC, presumably arguing that the FCC had undermined the value of the

C-block licenses by selling other licenses for significantly less in subsequent auctions. Then the licenses could have possibly been held by the courts for an indefinite period, defeating the FCC's main goal of increasing competition in the wireless telephone market. If the FCC had granted everything that the C-block licensees requested, then the losing bidders and license winners from other auctions might have sued.

Box 1: Legislation Using Auctions to Raise Revenue for Other Programs

- The Health Care Assurance Act of 1997 (S. 24), introduced January 21, 1997, would extend and expand the FCC's auction authority, and direct the FCC to make 100 MHZ of additional spectrum available for auction.
- The Infrastructure Improvement Act of 1997 (H.R. 918), introduced March 4, 1997, would direct the FCC to conduct additional spectrum auctions to raise $26 billion and make the proceeds available for construction and maintenance of state highways.
- The Healthy Children's Pilot Program Act of 1997 (S. 435), introduced March 13, 1997, would extend the FCC's auction authority from 1998 (when it will currently expire) to 2002, and expand the authority to include auctions for noncommercial mobile radio services. The bill would also direct the FCC to make an additional 100 MHZ available for auction.

In September 1997, the FCC compromised with the provision of a "menu" of options for C-block licensees to restructure their debt (modified in March 1998). The options include (1) status quo, in which the licensee would continue making installment payments; (2) amnesty, in which the licensee would return all of its licenses and in exchange have its outstanding debt forgiven; (3) disaggregation, in which the licensee could return half of its spectrum for any or all of its licenses and in exchange have 50% of its debt forgiven; or (4) pre-payment, in which the licensee pays for as many of its licenses as it can using 70% of the down-payments it has already made, plus any additional money it can raise. Even with these special provisions, some C-block licensees are expected to file for bankruptcy, preventing the spectrum from being used and forfeiting potential competition in the wireless market.

800 MHZ SMR Auction. Another FCC auction that met with some disapproval was the auction for SMR licenses in the 800 MHZ range, completed in December 1997. The FCC originally envisioned the 800 MHZ SMR licenses to be similar to those created in the 900 MHZ SMR auctions. The main difference, however, was that many more incumbent SMR licensees existed in the 800 MHZ range than were in the 900 MHZ range. The incumbents were not only concerned about potential interference, but also that they would never again be able to request additional spectrum from the FCC to expand their services.

After much contention in a proceeding that lasted three years, the FCC adopted rules for the 800 MHZ licenses, despite the continued dissatisfaction of incumbent SMR licensees. Their biggest argument against the FCC plan was the FCC's decision to require incumbents to relocate to other frequencies after a mandatory negotiation period with new SMR licensees. Even though the new licensees would have to pay for the relocation, incumbents argued that being forced off of their current frequency would influence their current customers to switch their subscription to the new SMR licensee at that frequency.

A total of 525 licenses were sold in the auction, with three licenses in each of 175 Economic Areas. As expected, one large SMR company, Nextel, won 90 percent of the licenses. Smaller SMR providers contend that they were not able to compete against a large entity like Nextel in the auction. Congress might want to investigate whether the FCC has resolved this since A similar set of issues surrounds the FCC's proposals to auction other new services such as the 220 MHZ licenses, paging systems, and location monitoring services.

Incidents of Collusion. In the PCS auction of D, E, and F Block licenses, held in late 1996, some bidders complained that competing bidders were using unusual bid amounts as a means of signaling their market intentions to each other during the auction. By early 1997, the Department of Justice began an investigation into bidding practices employed by participants of the PCS auctions. Based on this investigation, the FCC found specific parties liable for violating FCC auction anti-collusion rules that prohibit bidders from their bidding strategies with competing bidders.[32] When the investigation began, the FCC modified its bidding procedures so that all bids must be made in specific increments instead of any dollar amount. The new procedure was intended to prevent the specific form of collusion from occurring in the future. This event, however, raises the question over whether other unforeseen types of collusion might be possible in future FCC auctions.

FCC Recommendations to Congress and Adoption of New Auction Rules. As a result of these and other problems, the FCC has recommended the following legislative actions:[33]

1) to clarify that FCC licensees who default on their installment payments may not use bankruptcy litigation to refuse to relinquish their spectrum licenses for re-auction;"
2) to grant the FCC explicit statutory authority to manage its installment payment portfolio flexibly;

3) to exempt all auction rulemakings from regulatory requirements of the Contract With American Advancement Act;

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[32]FCC. Notice of Apparent Liability for Forfeiture (FCC-98-42) for Facilities in the Broadb and PCS in the D, E, and F Blocks. Adopted March 16, 1998.

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

4) to exempt auction contracts from certain provisions of the Federal Acquisitions Regulations (FAR); and

5) to modify the statute of limitations for forfeiture proceedings against non-broadcast licensees from one to three years.

In addition to the above recommendations to Congress regarding its auctions, the FCC, in December 1997, adopted streamlined auction rules for all services to be auctioned in the future.[34] The rule changes are intended to ensure uniform auction procedures involving the application, payment, and certain concerns regarding designated entities (i.e., small businesses, women, minorities and rural telephone companies). For example, the FCC will specify a minimum opening bid for each auction, and will provide additional time prior to the start of future auctions for potential bidders to develop business plans, assess market conditions, and evaluate the availability of equipment. Congress might consider further investigation into both the FCC's recommendation and the its new auction rules to determine the merits or problems that may be associated with each recommendation and the rules that have been adopted.

Auctions for Broadcast Licenses

The Balanced Budget Act (P.L.105-33) expanded the FCC's authority to conduct auctions for mutually exclusive licenses applications for certain types of broadcast stations. Previously, the FCC granted all broadcast licenses through comparative hearing procedures. After a 1993 court case in which FCC criteria for selecting license winners was challenged, however, the FCC has stayed all ongoing comparative hearings pending resolution of the case. As a result of P.L.105-33, the FCC has proposed to establish auction procedures for all broadcast services that would be allowed by law.[35] These would include all licenses for new commercial radio and television stations filed in the future, as well as some competing applications for new stations filed before July 1, 1997. The FCC also sought comment on whether to use auctions for mutually exclusive applications to provide Instructional Television Fixed Service (ITFS), and on how to resolve pending proceedings on the renewal of existing broadcast licenses.

In written comments to the FCC, several groups from the broadcasting industry argued that the proposed auctions should not be used for their particular applications for licenses. No commenters, however, have argued that auctions for broadcast licenses should not be used at all. The FCC is currently reviewing the comments, and a final ruling is expected soon. Some of these groups have also petitioned Members

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[34]FCC WT Docket 97-82, ET Docket 94-32. Third Report and Order and Second Further NPRM (FCC 97-413)on Streamlining Auction Rules, released December 31, 1997.

[35]FCC NPRM on Competitive Bidding for Commercial Broadcast and Instructional Television Fixed Services Licenses (MM Docket No. 97-234), Reexamination of the Policy Statement on Comparative Broadcast Hearings (GC Docket No. 97-52), and Proposals to Reform the Commission's Comparative Hearing Process to Expedite the Resolution of Cases (GEN Docket No. 90-264), released November 26, 1997.

of Congress to direct the FCC to exempt certain types of broadcast licenses from auction.

Other Spectrum-Related Legislation

Several other bills have been introduced in the 105th Congress that contain provisions concerning spectrum management and auctions. While to date, none have moved out of Committee, some of their provisions have been incorporated into the Budget Act or other legislation. The bills look to spectrum management to serve a variety of purposes.

- The Department of Commerce Dismantling Act (H.R. 1319), introduced April 14, 1997, would transfer the spectrum management functions of NTIA to the FCC.

- The Reserve Price Act (S. 663), introduced April 29, 1997, would direct the FCC to establish a minimum bid for each spectrum license auctioned. If no bid is received above the minimum amount, the FCC would not be allowed to auction the license. Provisions of this bill were incorporated into the Balanced Budget Act, which directed the FCC to establish minimum opening bids and reasonable reserve prices in all future auctions, unless the FCC determines that such an assessment is not in the public interest.

- The Digital Television Conversion Act of 1997 (S. 705), introduced May 6, 1997, would establish statutory rules for the conversion of television broadcast stations from analog to digital transmission consistent with the FCC's Fifth Report and Order, and requires DTV licensees to return their analog licenses by January 1, 2006.

- The Private Wireless Spectrum Availability Act (S. 741), introduced May 14, 1997, would direct the FCC to allocate 12 MHZ of spectrum for private wireless services. Licensees of this spectrum would pay lease fees based on the approximate value of the spectrum.

- The Community Broadcasting Protection Act of 1997 (H.R. 1539), introduced May 6, 1997, would require the FCC to preserve low-power television (LPTV) stations by granting them status equal to full-power stations, and finding alternative spectrum on which to locate LPTV stations.

- Communications Satellite Competition and Privatization Act of 1997 (H.R.1872), introduced June 12, 1997, would prohibit the FCC from assigning by auctions orbital slots or spectrum used for the provision of international or global satellite communications services.