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Spectrum Policy: Provisions in the 2012 Spectrum Act

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Summary

The Middle Class Tax Relief and Job Creation Act of 2012 (P.L. 112-96, signed February 22, 2012) contained provisions in Title VI that expedite the availability of spectrum for commercial mobile broadband. The provisions in Title VI—also known as the Public Safety and Spectrum Act, or the Spectrum Act—cover reallocation of spectrum, new assignments of spectrum rights, and changes in procedures for repurposing spectrum used by the federal government. The act established a process for television broadcasters to release spectrum licensed to them for auction as commercial licenses. The act also included provisions to apply future spectrum license auction revenues toward deficit reduction; to establish a planning and governance structure to deploy public safety broadband networks, using some auction proceeds for that purpose; and to assign additional spectrum resources for public safety communications.

Broadband capacity to support popular mobile services and devices, such as real-time viewing of video on smartphones, can be improved in several ways. Examples include (1) providing new spectrum for networks to expand; (2) investing in denser infrastructure; (3) developing new technologies, or (4) expanding opportunities for sharing spectrum. Provisions of the Spectrum Act focus on increasing the amount of spectrum as the key policy tool for spectrum management.

Current legislation to improve access to spectrum includes the Rural Spectrum Accessibility Act of 2013 (S. 1776, Sen. Klobuchar), the Efficient Use of Government Spectrum Act of 2013 (H.R. 2739, Rep. Matsui), and the Federal Spectrum Incentive Act of 2013 (H.R. 3674, Rep. Guthrie). The Rural Spectrum Accessibility Act would require the Federal Communications Commission to establish a program that would allow qualified license holders to disaggregate spectrum holdings in order to make unused spectrum available to small carriers or carriers serving rural areas, as defined by the act. The Efficient Use of Government Spectrum Act would require the timely release of additional spectrum, currently in use by the Department of Defense, for shared use or auction. The Federal Spectrum Incentive Act would clarify that federal spectrum users are eligible to participate in incentive auctions similar to what is being implemented for television broadcasters. The act would cover both shared spectrum and spectrum cleared for auction.

Going forward, other policy tools may need to be considered in order to make spectrum access more inclusive. Many policy makers and Members of Congress are concerned, for example, that the current structure of auctions to assign spectrum licenses does not provide enough opportunities for competition or new entrants into mobile communications markets. These concerns include the availability of spectrum for uses such as telemedicine or driverless vehicles. The spectrum needs of emerging technologies that some believe may be key drivers of future economic growth are not specifically addressed in the Spectrum Act and appear to receive scant attention from policy makers. In addition to autonomous vehicles, growth industries that are, at least in part, spectrum dependent include advanced robotics, cloud computing, and machine-to-machine communications (the Internet of Things).

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What Is Spectrum?

Electromagnetic spectrum, commonly referred to as radio frequency spectrum or wireless spectrum, refers to the properties in air that transmit electric signals and, with applied technology, can deliver voice, text, and video communications. The allocation and assignment[1] of radio frequency spectrum are managed by the Federal Communications Commission (FCC) for commercial and other non-federal uses and by the National Telecommunications and Information Administration (NTIA) for federal government use.

Wireless broadband,[2] with its rich array of services and content, requires new spectrum capacity to accommodate growth. Spectrum capacity is necessary to deliver high speed, high quality communications to consumers and businesses and also to support the communications needs of industries that use spectrum-dependent technologies.

Although radio frequency spectrum (air) is abundant, usable spectrum is currently limited by the constraints of applied technology. Spectrum policy therefore requires making decisions about how radio frequencies will be allocated and who will have access to them. Current spectrum policy is based on managing channels of radio frequencies to avoid interference.[3] The FCC, over many years, has developed and refined a system of exclusive licenses for users of specific frequencies. Auctions are a market-driven solution to assigning licenses to use specific frequencies and are a recent innovation in spectrum management and policy. Previously, the FCC granted licenses using a process known as "comparative hearings" (also known as "beauty contests"), and has used lotteries to distribute spectrum licenses. The FCC also allocates spectrum for designated purposes, such as WiFi, without assigning a license to a specific owner (unlicensed spectrum).

For purposes of allocation and assignment, spectrum is segmented into bands of radio frequencies measured in cycles per second, or hertz. 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. The designation can refer to an entire band, such as the 700 MHz band, or to specific frequencies within a band. Most licenses are issued on a geographic basis, serving a specific area (license coverage). More than one license, therefore, is likely to have the same frequency designation.

Technology for commercial mobile services generally is designed to operate most efficiently on frequencies below 3 GHz, although the ceiling has moved higher as technology has changed, so that frequencies through 5 GHz are now considered desirable for commercial network deployment. Similarly, the bandwidth of assigned frequencies is increasing. With new technology, wider bandwidths have been shown to reduce interference and mitigate other problems hampering the efficient use of spectrum.

[1] Spectrum is allocated for a type of use, such as television broadcasting or advanced wireless services, and assigned as licenses to specific users.

[2] Broadband refers here to the capacity of the radio frequency channel. A broadband channel can quickly transmit live video, complex graphics, and other data-rich information as well as voice and text messages, whereas a narrowband channel might be limited to handling voice, text, and some graphics.

[3] With technologies that rely on channel management, two signals can interfere with each other even if they are not at the same frequency, but are close in frequency. To avoid harmful interference, the signals must have frequencies that are sufficiently different, known as a "minimum separation."

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Spectrum Policy Provisions in the Middle Class Tax Relief and Job Creation Act of 2012

Provisions of Title VI of the Middle Class Tax Relief and Job Creation Act of 2012 (P.L. 112-96, signed into law on February 22, 2012) included expediting auctions of licenses for spectrum designated for mobile broadband; authorizing incentive auctions, which would permit television broadcasters to receive compensation for steps they might take to release some of their airwaves for mobile broadband; requiring that specified federal holdings be auctioned or reassigned for commercial use; and providing for the availability of spectrum for unlicensed use. Many of the provisions in Title VI, frequently referred to as the Public Safety and Spectrum Act, or Spectrum Act, focus on spectrum assignment within the existing regulatory framework, in which licenses for designated radio frequencies are awarded through competitive bidding systems (auctions).

Major provisions in the Spectrum Act that are summarized in this report cover

- Deficit reduction;
- Directed auctions;
- Incentive auctions for television broadcasters;
- Reallocation of spectrum from federal to commercial use; and
- Unlicensed spectrum.

Other provisions in the act, not covered in this report, include simplifying the approval of zoning requests for modification of cell towers at the state and local level[4] and putting in place measures to facilitate antenna placement on federal property. The act also has provided for the establishment of a new authority to plan and develop a nationwide public safety broadband network (FirstNet) and has included other measures in support of improved emergency communications.[5]

Deficit Reduction

The Spectrum Act has addressed the interlaced issues of spectrum access and deficit reduction. The issues are connected because, when radio frequency spectrum licenses are auctioned for commercial purposes by the FCC, the net proceeds are deposited in the U.S. Treasury.[6] The act has extended the FCC's auction authority until the end of FY2022. Because the FCC's authority would have expired at the end of FY2012, revenue from auctions held after FY2012 is considered new revenue.

[4] Discussed in CRS Report RS20783, *Broadband Deployment: Legal Issues for the Siting of Wireless Communications Facilities and Amendments to the Pole Attachment Rule*, by Kathleen Ann Ruane.

[5] Measures in the act that apply to public safety are covered in CRS Report R42543, *The First Responder Network and Next-Generation Communications for Public Safety: Issues for Congress*, by Linda K. Moore.

[6] 47 USC §308 (j) (8). Net proceeds are the auction revenues minus the FCC's expenses. Congress has twice in the past amended the provision in order to use auction proceeds for other purposes by creating special funds to hold and disburse auction proceeds. The Commercial Spectrum Enhancement Act, Title II of P.L. 108-494, created the Spectrum Relocation Fund; the Deficit Reduction Act of 2005 created the Public Safety and Digital Television Transition Fund.

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The legislation that first authorized the FCC to establish "competitive bidding systems"[7] for a limited period was included in the Omnibus Budget Reconciliation Act of 1993 (P.L. 103-66). The Balanced Budget Act of 1997 gave the FCC auction authority until September 30, 2007. This authority was extended to September 30, 2011, by the Deficit Reduction Act of 2005 and to 2012 by the DTV Delay Act (P.L. 111-4). The Deficit Reduction Act of 2005 also specified that $7.363 billion of proceeds from auctions required by the act be applied to deficit reduction.

Distribution of Proceeds from Auctions Required by the Spectrum Act

Most of the proceeds from auctions of licenses in designated spectrum as specified in the act are to be deposited directly into a Public Safety Trust Fund, created by the act, with nearly $28 billion designated for purposes defined in the act,[8] including $20.4 billion for deficit reduction.[9]

Proceeds from the sale of licenses of repurposed federal spectrum identified in the act will be directed first to the Spectrum Relocation Fund, to cover costs of moving federal users, with the balance going to the Public Safety Trust Fund. Proceeds from the sale of advanced wireless service licenses in the other spectrum bands identified by the act will go directly to the Public Safety Trust Fund. Proceeds from the auction of new licenses created by the release of television broadcasting spectrum will go to cover costs specified in the act, with the balance to the Public Safety Trust Fund.[10] Balances remaining in any fund created by the act will revert to the Treasury in 2022.[11]

The Federal Spectrum Incentive Act (H.R. 3674) would create an additional program for federal users that would place 1% of some auctions of federal spectrum into a Federal Spectrum Incentive Fund, with the balance to be applied to deficit reduction.

The Public Safety Trust Fund

The law provides for transfers from a Public Safety Trust Fund that is created by the act to receive revenues from designated auctions of spectrum licenses. A major beneficiary of funding is FirstNet (First Responder Network Authority), the nationwide broadband network to be developed for public safety communications.

Auction proceeds are to be distributed in the following priority:

- To the NTIA, to reimburse the Treasury for funds advanced to cover the initial costs of establishing FirstNet: not to exceed $2 billion.
- To the State and Local Implementation Fund for a grant program, as part of FirstNet: $135 million.
- To the Network Construction Fund for FirstNet, for costs associated with building the nationwide network and for grants to states that qualify to build

[7] 47 USC §308 (j) (3).

[8] P.L. 112-96, §6413.

[9] P.L. 112-96, §6413, 126 STAT. 235-236.

[10] P.L. 112-96, §6401 126 STAT. 223-224.

[11] P.L. 112-96, §6413, 126 STAT. 236.

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their own networks: $7 billion, reduced by the amount advanced to establish FirstNet in the first round of funding.

- To the National Institute of Standards and Technology (NIST) for public safety research: $100 million.
- To the Treasury for deficit reduction: $20.4 billion.
- To the NTIA and the National Highway Traffic Safety Administration for a grant program to improve 911 services: $115 million.
- To NIST for public safety research, phase two: $200 million.
- To the Treasury for deficit reduction: any remaining amounts from designated auction revenues.

Directed Auctions

The Spectrum Act required the FCC and the NTIA to identify specific bands for auction from spectrum designated for commercial advanced wireless services and for federal use, and in most cases to commence the auction process within three years. The act mandated spectrum license auctions for frequencies at 1915-1920 MHz; 1995-2000 MHz; 2155-2180 MHz; an additional 15 MHz to be identified by the FCC; and 15 MHz of spectrum between 1675 and 1710 MHz, subject to conditions in the act. The Secretary of Commerce was required to submit a report to the President identifying 15 MHz of spectrum between 1675 and 1710 MHz for reallocation from federal to non-federal use.[12] The NTIA has reaffirmed an initial recommendation to reassign 1695-1710 MHz and submitted a report, as required by the act, recommending that the FCC reallocate the band for commercial use.[13]

The act required that these auctions be completed and licenses issued by February 22, 2015, which would require that the auctions commence no later than the third quarter of 2014.[14] These licenses would provide an additional 65 MHz of spectrum for commercial broadband.

A bill to require the immediate release of additional federal spectrum was introduced by Representatives Doris O. Matsui and Brett S. Guthrie on July 19, 2013.[15] The bill would require the release of frequencies at 1755-1780 MHz for pairing with frequencies at 2155-2180 MHz.

In a letter to the FCC in July, the Department of Defense (DOD) offered to release frequencies between 1755-1780 MHz, based on sharing spectrum throughout the band in order to control the cost of relocation. DOD would retain access to the 1780-1850 MHz band and the 2025-2110 MHz band for relocation purposes.[16]

[12] P.L. 112-96, §6401, 126 STAT. 223.

[13] Department of Commerce, Identification of 15 Megahertz of Spectrum Between 1675 and 1710 MHz for Reallocation from Federal Use to Non-Federal Use Pursuant to Section 640 (a) of the Middle Class Tax Relief and Job Creation Act of 2012; Report to the President, February 2013, at http://www.ntia.doc.gov/report/2013/report-president-identification-15-mhz-spectrum-between-1675-mhz-and-1710-mhz-reallocati.

[14] See FCC, "Remarks of Commissioner Jessica Rosenworcel, CTIA 2013—The Mobile Marketplace, Las Vegas, Nevada, May 22, 2013, at http://www.fcc.gov/document/commissioner-rosenworcels-speech-ctia-2013.

[15] H.R. 2739, Efficient Use of Government Spectrum Act of 2013.

[16] Alina Selyukh, "In Switch, US Military Offers to Share Airwaves with Industry," *Reuters*, July 23, 2013, (continued...)

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An FCC proposal, released July 23, 2013, solicited comments on increasing the availability of spectrum that included discussion of service rules for frequencies at 1780-1850 MHz and 2025-2110 MHz.[17]

The NTIA wrote to the FCC on November 25, endorsing, in general, the DOD proposal for releasing frequencies at 1755-1850 MHz, as transmitted to the FCC.[18]

In Congress, a bipartisan group from the Senate is pressing for finalization of the proposal in a timely manner, with the objective of making the frequencies available for inclusion with other spectrum license auctions that must be completed by February 2015. This action would allow for pairing with the 2155-2180 MHz band, likely enhancing the auction value of both bands. DOD estimated that relocation of its users in the 1755-1850 MHz to clear spectrum would cost $12 billion if the bands were fully cleared. If frequencies in the 1755-1850 MHz band were shared, relocation costs would be $3.5 billion, according to DOD.[19]

The FCC has scheduled the first designated auction for January 2014. Frequencies at 1915-1920 MHz and 1995-2000 MHz, known as the H Block, will be offered in Auction 96. The reserve price has been set at $1.56 billion, that is, the combined final bids for all licenses offered must total at least $1.56 billion.[20] The licenses will cover 176 Economic Areas.[21] In the event that the reserve price is not met, the FCC may cancel the auction and propose new rules for a second auction.

Incentive Auctions

The Spectrum Act has permitted the FCC to conduct incentive auctions, that is, to establish a mechanism whereby spectrum capacity may be relinquished for auction by some license-holders, who would then share in the proceeds.[22] Many commercial wireless licenses can be resold directly by their license-holders for comparable uses; the purpose of incentive auctions is to reward license-holders, such as television broadcasters, who repurpose their spectrum for a different use. Although incentive auctions might be used for other types of license-holders, the act specifically addresses spectrum assignments for over-the-air television broadcasters.

The act established procedures and guidelines for the FCC to follow in reallocating television broadcasting spectrum licenses for commercial auction. Through a reverse auction process, the

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(...continued)

http://www.reuters.com/article/2013/07/23/usa-defense-spectrum-idUSL1N0FT0KG20130723.

[17] FCC Proposes to Increase Availability of Spectrum, FCC 13-302, GN Docket No, 13-185 and WT Docket No. 07-195, released July 23, 2013.

[18] Letter at http://www.ntia.doc.gov/files/ntia/publications/ntia_aws-3_ltr_11252013_.pdf.

[19] Adam Mazmanian, "Senators Seek Specific Spectrum Relocation Proposal from DOD," *FCW*, August 5, 2013, http://fcw.com/articles/2013/08/05/defense-spectrum.aspx.

[20] FCC Public Notice, "Auction of H Block Licenses in the 1915-1920 MHz and 1995-2000 MHz Bands," AU Docket No. 13-178, September 13, 2013, http://www.fcc.gov/article/da-13-1885a1.

[21] An Economic Area (EA) is a geographic area established by the Bureau of Economic Analysis of the Department of Commerce and used by the FCC to define the coverage of spectrum licenses for certain services. There are 172 EAs, plus three EA-like areas, encompassing the Northern Mariana Islands, Guam, American Samoa, the United States Virgin Islands, and Puerto Rico. FCC map at http://wireless.fcc.gov/auctions/data/maps/ea.pdf.

[22] P.L. 112-96, §6402, 126 STAT. 224.

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broadcasters would establish the amount of compensation they are willing to accept for the spectrum they voluntarily release for auction. Additionally, broadcasters that do not voluntarily relinquish spectrum rights, but are required to relocate or incur certain other costs, may be compensated. In lieu of cash payments as compensation for relocation, broadcasters may choose to accept regulatory relief that would allow new uses for their spectrum.

Spectrum voluntarily released by TV broadcasters would be repurposed for commercial broadband communications, with licenses sold through what the law refers to as a "forward auction." At least one successful reverse auction is required to set minimum prices for a forward auction. For the results of a forward auction to be valid, auction proceeds must at a minimum cover (1) payments to broadcasters that relinquished spectrum for auction, (2) the costs to the FCC of conducting the auctions, and (3) the estimated costs for relocation of other broadcasters, which are not to exceed $1,750 million, deposited in a TV Broadcaster Relocation Fund for relocation costs. If auction revenues do not cover costs as specified in the act, the FCC may not assign new licenses and planned reassignments and reallocations may not occur. If the reverse auction and forward auction conditions are met, the FCC may "make such reassignments of televisions channels" as appropriate in its consideration, subject to certain conditions. Examples of conditions include a general prohibition against reassigning licenses to frequencies from one band to a band below an existing assignment, and obligations to determine that a reassigned channel is not adversely affected by cross-border channel assignment agreements with Canada and Mexico. The auction and channel reassignment process may only occur once.

Among the many challenges the FCC faces in establishing incentive auctions is identifying a band plan that will meet the many goals and requirements of the legislation. The band plan must identify which portion of the broadcaster spectrum should be released and how it will be divided into licenses that can be successfully auctioned. Many of these challenges were discussed at a Senate hearing on incentive auctions, on December 10, 2013.[23]

The Chairman of the FCC, Tom Wheeler, has announced that the incentive auction process will begin by mid-2014.[24] The FCC Incentive Auction Task Force is expected to submit its final policy recommendations in January 2014, after which the Commissioners will vote to begin the final stages that are to conclude with the successful auction of licenses for wireless services.

Federal Spectrum Use and Reallocation

The Spectrum Act has addressed how spectrum resources might be repurposed from federal to commercial use through auction or sharing, and how the cost of such reassignment would be defined and compensated, among other provisions.[25] The Commercial Spectrum Enhancement Act of 2004 (P.L. 108-494, Title II) was amended to facilitate the transfer of spectrum rights to commercial purchasers from the agencies relinquishing spectrum. (See following section.) Expenditures incurred by federal agencies for planning may now be included among those costs eligible for reimbursement as part of the transfer of spectrum to the commercial sector. Other reimbursable costs cover a wide range of technical options, including spectrum sharing. Although

[23] Senate, Committee on Commerce, Science, and Transportation, "Crafting a Successful Incentive Auction: Shareholders Perspectives."

[24] Official FCC Blog, "The Path to a Successful Incentive Auction, Tom Wheeler," http://www.fcc.gov/blog/path-successful-incentive-auction-0.

[25] P.L. 112-96, §6701, 126 STAT. 245 et seq.

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spectrum sharing to facilitate the transition from federal to commercial use is supported in the act's provisions, the NTIA has been required to give priority to reallocation options that assign spectrum for exclusive, non-federal uses through competitive bidding.

The act has required the establishment of a Technical Panel within the NTIA to review transition plans that each federal agency must prepare in accordance with provisions in the act. The Technical Panel is required to have three members qualified as a radio engineer or technical expert. The Director of the Office of Management and Budget, the Assistant Secretary of Commerce for Communications and Information, and the Chairman of the FCC have been required to appoint one member each. A full discussion and interpretation of provisions of the act as regards the technical panel and related procedural requirements such as dispute resolution have been published by the NTIA as part of the rulemaking process.[26]

Commercial Spectrum Enhancement Act of 2004

The Commercial Spectrum Enhancement Act of 2004 put in place statutory rules for covering the costs to federal agencies of relocating wireless communications facilities to new spectrum assignments. The act created the Spectrum Relocation Fund to provide a means for federal agencies to recover relocation costs directly from auction proceeds when they are required to vacate spectrum slated for auction. In effect, successful commercial bidders cover the costs of relocation. Among key provisions of the act were requirements that the auctions must recoup at least 110% of the costs projected by the NTIA, and that unused funds would revert to the Treasury after eight years. These provisions remain in effect. Specific frequencies were designated for immediate auction[27] by the Commercial Spectrum Enhancement Act but the law was written to apply to any federally used frequencies scheduled for reallocation and possible auction.[28]

The Federal Spectrum Incentive Act, H.R. 3674

If enacted, the provisions of H.R. 3674 would likely provide opportunities to users of federal spectrum to release spectrum for commercial use either through incentive auctions or through the process established by the Commercial Spectrum Act of 2004, as amended. The act would create a Federal Spectrum Incentive Fund that would receive 1% of the auction proceeds of certain federal spectrum. For example, of $10 billion dollars in auction proceeds from the sale of commercial licenses created from federal spectrum, as defined in existing law, $100 million would be placed in the Federal Spectrum Incentive Act. That money would be available to cover relocation costs, including costs incurred to provide shared spectrum, for federal agencies that opt to seek funding from the Federal Spectrum Incentive Fund instead of the Spectrum Relocation Fund.

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[26] NTIA, *Notice of Proposed Rulemaking*, July 17, 2012, and replies, docket no. 110627357-2209-03 at http://www.ntia.doc.gov/federal-register-notice/2012/technical-panel-and-dispute-resolution-board-nprm. Final Rule, January 25, 2013, at http://www.ntia.doc.gov/federal-register-notice/2013/spectrum-relocation-final-rule-technical-panel-and-dispute-resolution-b.

[27] Following the procedures required by the act, the FCC scheduled an auction for Advanced Wireless Services (AWS), designated Auction 66, which was completed on September 18, 2006. The AWS auction attracted nearly $13.9 billion in completed bids. The cost to move federal agencies to new spectrum locations was set at almost $936 million.

[28] The creation of the Spectrum Relocation Fund is discussed in CRS Report RS21508, *Spectrum Management and Special Funds*, by Linda K. Moore.

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NTIA Plans to Make Federal Spectrum Available for Commercial Use

The NTIA, with input from the Policy and Plans Steering Group (PPSG),[29] has produced a 10-year plan and timetable that identifies bands of spectrum that might be available for commercial wireless broadband service. As part of its planning efforts, the NTIA prepared a "Fast Track Evaluation" of spectrum that might be made available in the near future.[30] Specific recommendations were to make available 100 MHz of spectrum within bands from 3550 MHz to 3650 MHz. The fast track evaluation also recommended studying two 20 MHz bands to be identified within 4200-4400 MHz for possible repurposing.

Working through the PPSG, the NTIA studied federal spectrum use by more than 20 agencies with over 3,100 separate frequency assignments in the 1755-1850 MHz band.[31] After evaluating the multiple steps involved in transferring current uses and users to other frequency locations, the NTIA concluded that it would cost $18 billion to clear federal users from all 95 MHz of the band. Based on this assessment, the NTIA report included recommendations for seeking ways for federal and commercial users to share many of the frequencies, although some frequencies were identified to be cleared for auction to the private sector. DOD estimated that relocation of its users from the 1755-1850 MHz to clear spectrum would cost $12 billion if the bands were fully cleared. Industry estimates have valued the licenses at as much as $12 billion.

The NTIA assumptions for the estimates of the cost of relocating federal agencies from the 1755-1850 MHz band were challenged at a hearing of the House Committee on Energy and Commerce, Subcommittee on Communications and Technology,[32] leading to a request to the Government Accountability Office (GAO) to examine the process. In particular, the NTIA was criticized during the hearing by some committee members for not separately evaluating the 1755-1780 MHz band, which might be auctioned separately with another spectrum band already available for commercial use. At the hearing, the GAO provided testimony regarding its preliminary findings on spectrum sharing[33] and followed up with a report.[34] Both the hearing and the report indicated that spectrum sharing technology and policies were largely undeveloped. Some of the options to encourage sharing spectrum, as identified by the GAO, include considering spectrum usage fees to provide economic incentive for more efficient use and sharing; identifying more spectrum that could be made available for unlicensed use; encouraging research and development of technologies that can better enable sharing; and improving and expediting regulatory processes

[29] Created in response to Department of Commerce recommendations to improve spectrum efficiency through better management, see http://www.ntia.doc.gov/legacy/reports/specpolini/factsheetspecpolini_06242004.htm.

[30] NTIA, *An Assessment of Near-Term Viability of Accommodating Wireless Broadband Systems in the 1675-1710 MHZ, 1755-1780 MHz, 3500-3650 MHz, and 4200-4220 MHz, 4380-4400 MHZ Bands (President's Spectrum Plan Report)*, November 15, 2010, at http://www.ntia.doc.gov/report/2010/assessment-near-term-viability-accommodating-wireless-broadband-systems-1675-1710-mhz-17.

[31] U.S. Department of Commerce, *An Assessment of the Viability of Accommodating Wireless Broadband in the 1755-1850 MHz Band,* March 2012, at http://www.ntia.doc.gov/report/2012/assessment-viability-accommodating-wireless-broadband-1755-1850-mhz-band.

[32] Hearing, House of Representatives, Committee on Energy and Commerce, Subcommittee on Communications and Technology, "Creating Opportunities Through Improved Government Spectrum Efficiency," September 13, 2012.

[33] GAO, *Spectrum Management: Federal Government's Use of Spectrum and Preliminary Information on Spectrum Sharing*, September 13, 2012, GAO-12-1018T at http://www.gao.gov/products/GAO-12-1018T.

[34] GAO, *Spectrum Management: Incentives, Opportunities, and Testing Needed to Enhance Spectrum Sharing*, November 14, 2012, GAO-13-7 at http://gao.gov/products/GAO-13-7.

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related to sharing. Given the challenges for implementing spectrum sharing policies, the GAO found that further study by the NTIA and the FCC was needed.

GAO Cost Estimates for Spectrum Reallocation

In a hearing before the Senate Committee on Armed Services, Subcommittee on Strategic Forces,[35] the GAO presented preliminary findings on DOD estimates of reallocation costs from some radio frequencies.[36] The GAO evaluated DOD relocation cost estimates of $12 billion for frequencies at 1755-1850 MHz and reported that the "preliminary cost estimate substantially or partially met GAO's identified best practices." In particular, the GAO noted the variable nature of a number of assumptions for costs and revenues, such as the characteristics of the spectrum to which services would be relocated, the availability of new technology, and market demand for spectrum.

Unlicensed Spectrum

Unlicensed spectrum is not sold to the highest bidder and used for the services provided by the license-holder but is instead accessible to anyone using wireless equipment certified by the FCC for those frequencies. Both commercial and non-commercial entities use unlicensed spectrum to meet a wide variety of monitoring and communications needs. Suppliers of wireless devices must meet requirements for certification to operate on frequency bands designated for unlicensed use. Examples of unlicensed use include garage door openers and WiFi communications. WiFi provides wireless Internet access for personal computers and handheld devices and is also used by businesses to link computer-based communications within a local area. Links are connected to a high-speed landline either at a business location or through hotspots. Hotspots are typically located in homes or convenient public locations.

New technologies are being developed by companies in various industry sectors to expand the usefulness of unlicensed spectrum without causing interference. For example, to use unassigned spectrum, known as white spaces, between broadcasting signals of digital television, geolocation database technology is being put in place to identify unencumbered airwaves. Similar technologies are being considered to expand the availability of spectrum for unlicensed use at 5 GHz. Commercial providers, such as for wireless Internet, currently share parts of the spectrum at 5 GHz with federal users. With the objective of improving future WiFi capacity, the Spectrum Act has required new studies and evaluations of frequencies at 5 GHz.[37] These would lay the groundwork to expand commercial use of unlicensed spectrum within the federally managed 5 GHz band. The FCC has been required to commence a proceeding that might open access for some unlicensed devices in the 5350-5470 MHz band.[38] The NTIA was required to prepare an

[35] Hearing, Senate, Committee on Armed Services, Subcommittee on Strategic Forces, "Oversight: Military Space Programs and Views on DoD Usage of the Electromagnetic Spectrum," April 24, 2013.

[36] GAO, *Spectrum Management: Preliminary Findings on Federal Relocation Costs and Auction Revenues*, April 24, 2013, GAO-13-563T at http://www.gao.gov/products/GAO-13-563T. Full report, GAO-13-472 at http://www.gao.gov/products/GAO-13-472.

[37] P.L. 112-96, §6406.

[38] FCC, *Notice of Proposed Rulemaking: 5GHz Unlicensed Spectrum (UNII)*, FCC13-22, released February 20, 2013, http://www.fcc.gov/document/increased-spectrum-available-unlicensed-devices-5-ghz-band.

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evaluation of spectrum-sharing technologies for the 5350-5470 MHz and 5850-5925 MHz bands.[39]

Testimony at a November 13, 2013, hearing[40] regarding uses of the three spectrum bands covered by the act focused on issues such as recent advances in WiFi technologies, managing interference, and assuring spectrum for continued use and development of the technologies used for automobile safety. Currently, technologies for vehicle-to-vehicle and vehicle-to-infrastructure communications[41] operate on frequencies within the 5850-5925 MHz band.

Conclusion

Implementation of the Spectrum Act raises a number of policy issues such as how to structure incentive auctions and how best to utilize spectrum assigned for federal use. Inherent to these debates is the question of how to provide access to spectrum on a competitive basis. Numerous parties have expressed concern that spectrum license auctions are likely to be dominated by the two major wireless carriers, Verizon Wireless and AT&T Mobility.[42]

Proposals intended to improve competitive access to spectrum include modifying FCC auction rules to provide licenses with smaller area coverage than currently proposed and to establish limitations on the number of licenses available to Verizon or AT&T. Spectrum caps might limit the amount of spectrum available through auction to the top two carriers in key auctions such as those for repurposed television spectrum. Another proposal, the Rural Spectrum Accessibility Act (S. 1776), would require the Federal Communications Commission to establish a program that would allow qualified license holders to disaggregate spectrum holdings in order to make unused spectrum available to small carriers or carriers serving rural areas, as defined by the act. Licenses covered by the program would be extended for three years.

Geographic Coverage of Spectrum Licenses

A number of comments and petitions for reconsideration have been filed by the Rural Wireless Association (RWA) and others to request that FCC auction rules include licenses for Cellular Market Areas (CMAs). The geographic license coverage currently favored by the FCC is for the larger geographic coverage of Economic Area (EA) licenses. The RWA and its supporters argue that smaller licenses are more affordable to small, primarily rural, carriers and more nearly match the location of their target customer base. Auction rules that allow only for EAs would create

[39] Department of Commerce, Evaluation of the 5350-5470 MHz and 5850-5925 MHz Bands Pursuant to Section 6406 (b) of the Middle Class Tax Relief and Job Creation Act of 2012, January 2013, http://www.ntia.doc.gov/files/ntia/publications/ntia_5_ghz_report_01-25-2013.pdf.

[40] House of Representatives, Committee on Energy and Commerce, Subcommittee on Communications and Technology, "Challenges and Opportunities in the 5 GHz Spectrum Band," November 13, 2013.

[41] The primary technology is Dedicated Short-Range Communications (DSRC). In August 2013, the Department of Transportation completed a year-long test of DSRC, conducted with eight automakers. Analysis of the pilot program is expected to inform new regulations permitting the use of DSRC.

[42] The two market leaders have a combined market share of approximately two-thirds. One estimate, based on number of subscribers for the third quarter 2013, gives the combined share (including the acquisition of Leap by AT&T) at 70%. Source: Statista, http://www.statista.com/statistics/199359/market-share-of-wireless-carriers-in-the-us-by-subscriptions/.

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about 176 licenses for auction as compared to 700 CMA licenses. A compromise solution has been proposed by the Common Carriers Association[43] that would allow the FCC to create 350 Partial Economic Area licenses. This plan would allow for a greater choice between urban and rural coverage among bidders for licenses.

Spectrum Caps

Auction rules that limit participation of the two major carriers might impose some form of spectrum cap. The history of spectrum caps as a policy to promote competition dates to preparations for the first spectrum license auctions. The FCC decided to set caps on the amount of spectrum any one company could control in any geographically designated market. The FCC's support of spectrum capping was based on the theory that each license has an economic value and a foreclosure value. The economic value is derived from the return on investment in spectrum licenses and network infrastructure. The foreclosure value is the value to a wireless company that already has substantial market share and wants to keep its dominant position by precluding competition. Spectrum caps were chosen as the method to prevent foreclosure bidding. The intent was to ensure multiple competitors in each market and to restrict bidding to only the licenses that could be used in the near term.

Beginning in 2001, spectrum policy placed increased emphasis on promoting spectrum and market efficiency. The FCC ruled to end spectrum caps, citing greater spectral efficiency from larger networks as one benefit of the ruling. Spectrum caps were seen as barriers to mergers within the wireless industry, to the growth of existing wireless companies, and to the benefits of scale economies. The spectrum caps were eliminated on January 1, 2003.[44] Auction rules requiring the timely build-out of networks became a key policy tool to deter hoarding. The FCC instituted a policy for evaluating spectrum holdings on a market-by-market, case-by-case basis—a practice referred to as spectrum screening—as a measure of competitiveness.

Current proposals to reinstate spectrum caps reflect different perspectives on competition and the role of spectrum license auctions. Although some would like to see Verizon and AT&T excluded from participation in the incentive auctions of TV spectrum, the Spectrum Act prohibits exclusion of any qualified bidder.[45] The FCC might, however, use existing policies for spectrum screens and aggregation to limit the amount of spectrum that any bidder may acquire.[46] How this approach might be implemented and how limitations might affect auction revenue have been the topic of spirited debate. Numerous position papers have argued effectively that any form of spectrum cap would depress auction revenues or, from a different perspective, that spectrum caps would have no impact on revenue and might even enhance it.[47] The Department of Justice has filed comments regarding the important role of spectrum access for competition and innovation. It has urged the

[43] CCA, "Smaller Geographic License Sizes and Spectrum Aggregation Limits Must be Ensured for a Successful Auction," November 27, 2013, http://competitivecarriers.org/press/rca-press-releases/smaller-geographic-license-sizes-and-spectrum-aggregation-limits-must-be-ensured-for-a-successful-auction/9112774.

[44] FCC News, "FCC Announces Wireless Spectrum Cap to Sunset Effective January 1, 2003," November 8, 2001. Report and Order FCC-01-328. See Docket No. 01-14, *Notice of Proposed Rulemaking*, released January 23, 2001, at http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-01-28A1.pdf.

[45] 47 U.S.C. 309 (j) (17) (A).

[46] As specifically permitted by the Spectrum Act, 47 U.S.C. (j) (17) (B).

[47] Many of these papers have been filed with the FCC and can be accessed under the docket for *Policies Regarding Mobile Spectrum Holdings*, WT Docket N0. 12-269.

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FCC to promulgate auction rules that would prevent bids based on the foreclosure value of spectrum and that would enhance bidding opportunities for smaller carriers. The third- and fourth-ranked carriers, Sprint and T-Mobile, are likely to be significant beneficiaries of spectrum caps for the auction of TV spectrum.[48]

Planning for Future Needs

The Spectrum Act employs three key policy tools for increasing the availability of radio frequency spectrum for wireless broadband: allocating additional spectrum; reassigning spectrum to new users; and opening up spectrum for unlicensed use. Other policy options that may be employed to increase spectrum capacity include requiring that wireless network infrastructure be shared; changing the cost structure of spectrum access; moving to more spectrum-efficient technologies; and sharing spectrum. Facilitating the adoption of new wireless technologies that enable spectrum sharing is emerging as a major policy consideration for spectrum management.

Policies to auction licenses for exclusive use of spectrum appear to have generally prevailed in spectrum management planning. However, a number of new spectrum-dependent industries are emerging that do not seem well served by current policies. These industries include advanced robotics, autonomous vehicles, cloud computing, and machine-to-machine communications (the Internet of Things). Spectrum resources are also needed, for example, for smart grid communications, railroad safety,[49] water conservation,[50] the safe maintenance of critical infrastructure industries,[51] and for many other applications that may not have an immediate commercial value but can provide long-lasting value to society as a whole.

Without abandoning competitive auctions, spectrum policy may benefit from including additional ways to assign or manage spectrum that might better serve the deployment of a broader range of wireless technology and the implementation of national policies. Congress may consider these and other policy options as it evaluates how to meet future spectrum needs.

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[48] *Ex parte* submission to the FCC by the Department of Justice, *In the Matter of Policies Regarding Mobile Spectrum Holdings*, WT Docket No. 12-269, April 11, 2013.

[49] The railroad industry uses wireless communications as part of their information networks to monitor activity.

[50] For example, sensors buried at the level of plant roots recognize when watering is needed and communicate this information over wireless networks.

[51] In general, critical infrastructure industries facilitate the production of critical goods and services such as safe drinking water, fuel, telecommunications, financial services, and emergency response. A discussion of key issues appears in CRS Report RL30153, *Critical Infrastructures: Background, Policy, and Implementation*, by John D. Moteff.

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