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Spectrum Policy: Provisions in the 2012 Spectrum Act

Linda K. Moore
Specialist in Telecommunications Policy

February 5, 2015

Congressional Research Service
7-5700
www.crs.gov
R43256

CRS REPORT
Prepared for Members and
Committees of Congress

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 (Broadcast Incentive Auctions). 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.

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. 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. Growth industries that are, at least in part, spectrum dependent include autonomous vehicles, advanced robotics, cloud computing, and machine-to-machine communications. The integrated sensors, optical recognition, spatial awareness, cognitive computing, and dependence on networks and wireless spectrum that are key components of the Internet of Things require reliable, affordable access to spectrum.

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What Is Spectrum?

Electromagnetic spectrum, commonly referred to as radio frequency spectrum or wireless spectrum, refers to electromagnetic waves that, with applied technology, can transmit signals to deliver voice, text, and video communications. Electromagnetic waves include radio waves, microwaves, infrared radiation, visible light, ultraviolet light, x-rays, and gamma radiation. The allocation and assignment[1] of radio frequency spectrum are managed by the Federal Communications Commission (FCC) for commercial and other nonfederal 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 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,

[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."

wider bandwidths have been shown to reduce interference and mitigate other problems hampering the efficient use of spectrum.

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

[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 (FirstNet) and Next-Generation Communications for Public Safety: Issues for Congress*, by Linda K. Moore.

[6] 47 U.S.C. §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.

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.

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 Spectrum 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 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 their

[7] 47 U.S.C. §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.

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 nonfederal use.[12] The NTIA 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 at least 65 MHz of new spectrum for commercial broadband.

The FCC scheduled the first designated auction for January 2014. Frequencies at 1915-1920 MHz and 1995-2000 MHz, known as the H Block, were offered in Auction 96. The reserve price was set at $1.56 billion, that is, the combined final bids for all licenses offered must total at least $1.56

[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.

billion.[15] The licenses cover 176 Economic Areas.[16] Auction 96 was completed on February 27, 2014, with a total winning bid of $1.564 billion.[17]

On January 30, 2015, the FCC completed a second auction (Auction 97), for Advanced Wireless Service (AWS) spectrum licenses, for an additional 65 MHz of frequencies that fulfills the congressional mandate for certain auctions by 2015.[18] The frequencies cover 1695-1710 MHz; and paired licenses at 1755-1780 MHz; and 2155-2180 MHz. The auction, referred to as AWS-3, grossed almost $44.9 billion. The value of net bids, after bidding credits to designated entities (described in a later section of this report), is $41,329,673,325, of which $5.1 billion is to be applied to the costs of relocation or sharing of frequencies now used by the federal government. The FCC also will reimburse its costs for managing the auction and some bidders may default, reducing the total available for payment in to the Public Safety Trust Fund. There were 31 winning bidders for a total of 1,611 licenses. Among the top four wireless carriers with nationwide coverage, AT&T reportedly has acquired 251 licenses through the auction, at a cost of nearly $18.2 billion; Verizon Wireless acquired 181 licenses for approximately $10.4 billion; and T-Mobile received 151 licenses for bids totaling nearly $1.8 billion; Sprint, the fourth major carrier, did not participate. Dish Network (rebranded as Dish) acquired $13.3 billion in licenses through two joint ventures that qualified as designated entities, lowering the actual cost to approximately $10.0 billion. The companies are SNR Wireless LicenseCo., LLC (357 licenses) and Northstar Wireless, LLC (345 licenses). Further information about the plans of the winning bidders will be available after February 13, 2015, the due date for down payments. The deadline for final payment is March 2, 2015.

Impact on Broadcast Incentive Auction

How the results will affect interest in the remaining mandated auction, the Broadcast Incentive Auction program, is a subject of lively debate. Some, including broadcasters interested in selling their spectrum rights, predict even higher prices for the incentive auction. Others, notably financial analysts, are concerned that lending prospects for future spectrum acquisition are limited, both by the willingness of the financial markets to provide the cash and by the ability of the major winning bidders to amortize their newly acquired debt. One analyst was reported to estimate that, to cover the cost of the auctioned licenses, wireless carriers would have to generate "an incremental $1.40 per month of wireless revenue for every man, woman, and child in America. In perpetuity."[19] The Broadcast Incentive Auctions are scheduled for early 2016. FCC Chairman Tom Wheeler reportedly told a January 2015 press conference that the FCC remained on track for the target date, that the winning bidders had acquired spectrum they could raise

[15] 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.

[16] 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.

[17] FCC Public Notice, "Winning Bidder Announced for Auction 96," DA 14-279, February 28, 2014, http://transition.fcc.gov/Daily_Releases/Daily_Business/2014/db0228/DA-14-279A1.pdf.

[18] FCC Public Notice, "Auction of Advanced Wireless Services (AWS-3) Licenses Closes," DA 15-131, January 30, 2015, http://transition.fcc.gov/Daily_Releases/Daily_Business/2015/db0130/DA-15-131A1.pdf.

[19] Financial Times, "Holiday Bonanza Takes Toll on Operators," December 10, 2014.

revenue on, and that he did not anticipate a drop in interest or participation in the upcoming incentive auction.[20]

Broadcast 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.[21] 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 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" (repacking) 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.

To increase participation in the Broadcast Incentive Auction,[22] actions the FCC announced on May 15, 2014,[23] include

[20] Broadcast and Cable, "Wheeler: Incentive Auction is on Course and Speed," January 29, 2015, http://www.broadcastingcable.com/news/washington/wheeler-incentive-auction-course-and-speed/137544.

[21] P.L. 112-96, §6402, 126 Stat. 224.

[22] FCC Docket GN 12-268; the FCC provides information on the auction preparations at http://wireless.fcc.gov/incentiveauctions/learn-program/.

[23] FCC "Staff Summary: Incentive Auction Report and Order," May 15, 2014, http://www.fcc.gov/document/staff-summary-incentive-auction-report-and-order and *Report and Order*, Docket No. 12-268, released June 2, 2014, http://www.fcc.gov/document/fcc-adopts-rules-first-ever-incentive-auction-0.

- Creating smaller license coverage areas within EAs (called Partial Economic Areas, PEAs);
- Assigning licenses for 5 MHz of paired spectrum, with an initial term of 12 years;
- Applying various measurements of spectrum ownership intended to handicap the ability of Verizon and AT&T to acquire licenses in certain areas;
- Reconsidering qualifications for Designated Entities based on a separate proceeding[24] to be applied to the Broadcast Incentive Auction;
- Requiring interoperability across the entire 600 MHz band; and
- Applying to the 600 MHz band the same technical rules as for the 700 MHz band.

The outcome of the forward auction for spectrum licenses depends on the results of the reverse auction in which the broadcasters agree to the price at which they will release spectrum. Based on the amount of spectrum released by the broadcasters, a block of spectrum will be set aside in each market with competitive bidding open to Sprint, T-Mobile, and any entrant deemed not to have national network coverage. If, for example, 60 MHz of spectrum is made available by broadcasters, 20 MHz will be reserved; as described by the staff report, all registered bidders would be eligible to compete for licenses in the remaining 40 MHz. Verizon and AT&T may also be allowed to bid on reserved licenses, if there is insufficient bidding activity.

To increase innovation and usage of unlicensed spectrum, the FCC also announced steps intended to maximize the amount of spectrum available for TV White Spaces.

A request for comments on the proposed bidding procedures for the auction was published in December 2014.[25] It discusses and seeks comment on how to integrate the reverse and forward auctions and these auctions will be conducted. The request for comments addresses such questions as opening prices and how the repacking process will be applied. The pleading cycle is scheduled to end on March 13, 2015. The ensuing timetable for reviewing comments to the incentive auction proceedings would likely lead to a finalizing of auction rules before the end of 2015. The Broadcast Incentive Auctions are currently scheduled to begin in early 2016.[26]

Federal Spectrum Use and Reallocation

The Spectrum Act 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.[27] The Commercial Spectrum Enhancement

[24] FCC, "Competitive Bidding Notice of Proposed Rulemaking," October 10, 2014, http://transition.fcc.gov/Daily_Releases/Daily_Business/2014/db1010/FCC-14-146A1.pdf.

[25] FCC, "Comment Sought on Competitive Bidding Procedures for Broadcast Incentive Auction 100, Including Auctions 1001 and 1002," FCC 14-191, December 17, 2014, AU Docket No. 14-252, https://apps.fcc.gov/edocs_public/attachmatch/FCC-14-191A1.pdf.

[26] Official FCC Blog, "Incentive Auction Progress Report," Gary Epstein, Chair of the FCC's Incentive Auction Task Force, October 24, 2014, http://www.fcc.gov/blog/incentive-auction-progress-report.

[27] P.L. 112-96, §6701, 126 Stat. 245 et seq.

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 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, nonfederal uses through competitive bidding.

The act 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 Administrator of the NTIA, 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.[28]

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[29] by the Commercial Spectrum Enhancement Act but the law was written to apply to any federally used frequencies scheduled for reallocation and possible auction.[30]

NTIA Plans to Make Federal Spectrum Available for Commercial Use

The NTIA, with input from the Policy and Plans Steering Group (PPSG),[31] 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

[28] 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.

[29] 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.

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

[31] 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.

Track Evaluation" of spectrum that might be made available in the near future.[32] Specific recommendations were to make available 100 MHz of spectrum within bands 3550-3650 MHz. The FCC has opened a proceeding for the 3.4GHz band, which may be turned into an "innovation band" for small cell networks.[33] 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.[34] 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 band 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,[35] 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[36] and followed up with a report.[37] 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 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.

[32] 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.

[33] FCC, *Further Notice of Proposed Rulemaking,* GN Docket No. 12-354, released April 23, 2014.

[34] 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.

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

[36] 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.

[37] 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.

GAO Cost Estimates for Spectrum Reallocation

In a hearing before the Senate Committee on Armed Services, Subcommittee on Strategic Forces,[38] the GAO presented preliminary findings on DOD estimates of reallocation costs from some radio frequencies.[39] 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.

Release of Spectrum for Auction

Federal frequencies at 1695-1710 MHz and 1755-1780 MHz will be reassigned for commercial use on a shared basis with federal incumbents in Auction 97.[40] The frequencies at 1755-1780 MHz are to be paired with unencumbered spectrum already allocated for commercial use at 2155-2180 MHz; auction of the latter frequencies is required by the Spectrum Act. The released federal frequencies are to be shared indefinitely with multiple federal incumbents, although some systems are to migrate to other frequencies. The frequencies at 1695-1710 MHz will be auctioned as unpaired spectrum on a shared basis with weather satellites systems. Licensees are obligated to coordinate with federal users to avoid harmful interference and to meet other requirements of transition plans.[41] The transition plans are posted on the NTIA website.[42]

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 noncommercial 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.

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[38] 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.

[39] 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.

[40] FCC, Public Notice, *Auction of Advanced Wireless Services (AWS-3) Licenses Scheduled for November 13, 2014*, Docket Np. 14-78; "Procedures," July 23, 2014, http://transition.fcc.gov/Daily_Releases/Daily_Business/2014/db0725/DA-14-1018A1.pdf.

[41] FCC, Joint Public Notice, *Coordination Procedures in the 1695-1710 MHz and 1755-1780 MHz Bands*, Docket N. 13-185, July 18, 2014, http://www.fcc.gov/document/joint-public-notice-announcing-aws-3-coordination-details.

[42] Separate links for the two bands: http://www.ntia.doc.gov/other-publication/2014/transition-plans-and-transition-data-1695-1710-mhz-band and http://www.ntia.doc.gov/other-publication/2014/transition-plans-and-transition-data-1755-1780-mhz-band.

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 will be used 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 required new studies and evaluations of frequencies at 5 GHz.[43] The FCC was required to commence a proceeding that might open access for some unlicensed devices in the 5350-5470 MHz band.[44] The NTIA was required to prepare an evaluation of spectrum-sharing technologies for the 5350-5470 MHz and 5850-5925 MHz bands.[45] Pursuant to the findings of the two agencies, the FCC has issued a *Report and Order*[46] that adds 100 MHz of spectrum for unlicensed use by changes in usage at frequencies ranging from 5.15-5.85 GHz part of the band. Future actions are likely to release additional segments of the band.

Measures to Improve Competition

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. Actions taken by the FCC that are intended to improve competitive access to spectrum include modifying FCC auction rules to provide licenses with smaller area coverage; encouraging participation by designated entities; and establishing 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.

Geographic Coverage of Spectrum Licenses

A number of comments and petitions for reconsideration have been filed to request that the FCC include licenses for Cellular Market Areas (CMAs) in its auction rules, arguing that smaller licenses are more affordable to small, primarily rural, carriers and more nearly match the location of their target customer base. For example, using auction rules that allowed only for Economic Areas (EAs), the FCC created 176 licenses for the H Block auction (Auction 96), as compared to a potential 700 CMA licenses. For the Broadcast Incentive Auction, the FCC proposes to create Partial Economic Area licenses within Economic Areas, to allow for a greater choice between urban and rural coverage among bidders for licenses.[47]

[43] P.L. 112-96, §6406.

[44] 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.

[45] 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.

[46] http://www.fcc.gov/document/5-ghz-u-nii-ro

[47] "Wireless Telecommunications Bureau Seeks Comment on a Proposal to License the 600 MHz Band Using 'Partial Economic Areas,'" FCC, DA 13-2351, December 11, 2013 and FCC Public Notice, *WTB Provides Details About Partial Economic Areas*, Docket No. 12-268, released June 2, 2014, http://www.fcc.gov/document/wtb-provides-details-about-partial-economic-areas.

Spectrum Caps and Screens

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.[48] 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 Broadcast Incentive Auction, the Spectrum Act prohibits exclusion of any qualified bidder.[49] 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.[50] The Department of Justice has filed comments regarding the important role of spectrum access for competition and innovation. It has urged the 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.[51]

A separate FCC Report and Order will establish new guidelines on the amount of spectrum that any one carrier may hold.[52] The FCC plans to apply its new criteria to the incentive auction by

[48] 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.

[49] 47 U.S.C. 309 (j) (17) (A).

[50] 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.

[51] *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.

[52] "FCC Adopts Revised FCC Mobile Spectrum Holdings Policies," FCC News, May 15, 2014, http://www.fcc.gov/document/fcc-adopts-revised-mobile-spectrum-holdings-policies; *Mobile Spectrum Holdings Report and Order,* Docket No. 12-268, released June 2, 20014, http://www.fcc.gov/document/mobile-spectrum-holdings-report-and-order; and *Small Entity Compliance Guide: Policies Regarding Mobile Spectrum Holdings*, August 4, 2014, https://apps.fcc.gov/edocs_public/attachmatch/DA-14-1135A1.pdf.

placing restrictions on bidding activity intended to handicap the ability of Verizon and AT&T to acquire licenses in certain areas. The majority of the 700 MHz band commercial licenses were purchased at auction in 2008 (Auction 73) by Verizon and AT&T,[53] which together also hold approximately 70% of commercial spectrum licenses below 1000 MHz.[54] The other two national carriers, Sprint (majority-controlled by SoftBank, Corp., a Japanese telecommunications provider) and T-Mobile, Inc. (majority-owned by Deutsche Telekom, AG), own 15% of commercial licenses below 1000 MHz. Although Sprint and T-Mobile are generally viewed as the primary beneficiaries of the bidding rules, the rules are also intended to provide opportunities for smaller carriers to bid successfully. Based on the amount of spectrum released by the broadcasters, a block of spectrum will be set aside in each market with bidding priority for Sprint, T-Mobile, and any entrant deemed not to have national network coverage. If, for example, 60 MHz of spectrum is made available by broadcasters, 20 MHz will be reserved; as described by the staff report, all registered bidders would be eligible to compete for licenses not acquired in priority bidding as well as in the remaining 40 MHz.

Designated Entities

One tool that the FCC regularly uses to improve competition among current and potential wireless network providers is the establishment of bidding credits for smaller companies, referred to as Designated Entities. A Designated Entity meets established criteria for size and revenue and is awarded a credit against the purchase price of an auctioned license, based on these criteria.[55] Presently, small businesses with average gross revenue of no more than $40 million in the preceding three years receive a credit of 15%. A very small business, with revenue of $15 million or less over three years, receives a credit of 25%. Rules governing eligibility for designated entity status include restrictions on the use of spectrum assets acquired through a successful bid at auction. For example, currently not more than 25% of spectrum assets acquired with a bidding credit can be leased to a larger partner with which the company has what is described as an attributable material relationship (AMR).

The FCC has reconsidered the rules for designated entities in a Notice of Proposed Rulemaking.[56] Among the rules reevaluated are those for AMR, which the FCC believes may be discriminating against entrepreneurs that have formed partnerships with larger companies. In preparation for the Broadcast Incentive Auction, the FCC has granted a waiver to a private equity company that exceeds the income limits; this may set a precedent for future waivers that will widen the pool of potential bidders through more generous interpretations of designated entity rules.[57] The history of Designated Entity status and benefits—especially for minority ownership—of relaxing the rules are detailed in a report by the Minority Media and Telecom Council (MMTC).[58]

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[53] The major auction of licenses for the 700 MHz band was Auction 73. Some information about the top ten successful bidders in Auction 73 is available at Wireless Strategy, FCC Auctions, http://www.wirelessstrategy.com/700auction.html.

[54] "Fact Sheet FCC Mobile Spectrum Holdings," May 2014, FCC staff report, http://www.fcc.gov/document/fact-sheet-fcc-mobile-spectrum-holdings-rules.

[55] For complete description of current rules, see http://www.law.cornell.edu/cfr/text/47/1.2110.

[56] FCC, Competitive Bidding NPRM, October 10, 0114, http://transition.fcc.gov/Daily_Releases/Daily_Business/2014/db1010/FCC-14-146A1.pdf.

[57] FCC, *Order,* Docket No. 12-268, released July 23, 2014, http://www.fcc.gov/document/commission-grants-grain-management-waiver-section-12110b3.

[58] MMTC, *Digital Déjà vu: A Road Map for Promoting Minority Ownership in the Wireless Industry*, S. Jenell Trigg (continued...)

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 much of the Internet of Things, such as advanced robotics, autonomous vehicles, cloud computing, and machine-to-machine communications. Spectrum resources are also needed, for example, for smart grid communications, railroad safety,[59] water conservation,[60] the safe maintenance of critical infrastructure industries,[61] and for many other applications that may not have an immediate commercial value but can provide long-lasting value to society as a whole.[62]

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.[63] Congress may consider these and other policy options as it evaluates how to meet future spectrum needs.

Author Contact Information

Linda K. Moore
Specialist in Telecommunications Policy
lmoore@crs.loc.gov, 7-5853

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and Jeneba Jalloh Ghatt, February 25, 2014, http://mmtconline.org/mmtc-white-paper-wireless-ownership-02-24-14/.

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

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

[61] 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.

[62] A brief discussion of the role of spectrum access in the development of the Internet of Things is provided in CRS Insight IN10221, *The Robot Did It: Spectrum Policy and the Internet of Things*, by Linda K. Moore.

[63] These issues are discussed in CRS Report R43595, *Mobile Technology and Spectrum Policy: Innovation and Competition*, by Linda K. Moore.