Congressional Research Service
Informing the legislative debate since 1914

Framing Spectrum Policy: Legislative Initiatives

Updated August 10, 2016

Congressional Research Service
https://crsreports.congress.gov
R44433

CRS REPORT
Prepared for Members and
Committees of Congress

Summary

As innovation advances wireless communications from the business of providing mobile broadband to consumers into new businesses built around the Internet of Things, the need to revisit spectrum policy may gain in legislative importance. Many policy decisions since the 1990s that deal with spectrum assignment and allocation have focused on assuring the "highest and best use" for spectrum rights by assigning them through competitive auctions. To facilitate the transfer of federal spectrum to commercial wireless services, Congress, in 2004, created the Spectrum Relocation Fund to reimburse federal agencies for costs incurred in vacating spectrum.

In recent legislation, the 2012 Spectrum Act (Title VI, Middle Class Tax Relief and Job Creation Act of 2012, P.L. 112-96) includes provisions to increase the amount of spectrum licenses available for auction and to improve management of the Spectrum Relocation Fund. The Spectrum Pipeline Act of 2015 (Title X, Bipartisan Budget Act of 2015, P.L. 114-74) has a similar focus on providing new spectrum licenses for auction but takes a somewhat broader approach to meeting spectrum needs, offering more support for spectrum sharing and for federal research to improve spectrum and network efficiency. Both acts also include provisions to provide unlicensed spectrum (typically allocated for Wi-Fi applications).

Additionally, the Spectrum Act (sometimes referred to as the Public Safety and Spectrum Act) establishes a process for television broadcasters to release spectrum licensed to them to be auctioned as commercial licenses for mobile broadband (Broadcast Incentive Auctions). The act also includes provisions to apply 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. Two auctions required by the Spectrum Act have been completed. The final auction required by the Spectrum Act is the Broadcast Incentive Auction, which began in March 2016 and may conclude by year-end.

The Spectrum Pipeline Act requires the release of 130 MHz of federal and commercial spectrum in three phases, with the process beginning in 2022. Licenses for exclusive use and shared spectrum as well as allocations for unlicensed spectrum are allowed uses for repurposed federal spectrum. The act gives priority to using auction proceeds deposited in the federal Spectrum Relocation Fund for research programs that improve spectrum efficiency.

A number of bills concerning spectrum policy may be considered during the second session of the 114th Congress. These are likely to include the MOBILE NOW Act (S. 2555); and the DIGIT Act (S. 2607) and its companion bill (H.R. 5117). In brief, MOBILE NOW might be described as meeting the needs for growth within the existing wireless industry, and the DIGIT Act as expanding the availability of spectrum to meet the needs of the industries developing products and services for the Internet of Things. Both of these bills reaffirm the role of the Federal Communications Commission (FCC) in directing spectrum policy. The FCC, meanwhile, is moving forward with a "Spectrum Frontiers" ruling to make additional spectrum available for new technologies. As in past proceedings regarding the allocation and assignment of spectrum rights, the FCC appears to be basing many decisions on enhancing mobile broadband services for consumers as the "best use." However, the consumers of wireless access to the Internet of Things, by most accounts, will include many other categories of users. The customers of wireless carriers have in the past been drivers of industry growth; in the future, substantial growth is expected from industry and other business sector demand for wireless access to the Internet of Things.

Contents

Spectrum Management 1
Allocation and Assignment 1
Auction Authority 2
Auction Revenue 2
Distribution of Proceeds from Auctions Required by the Spectrum Act 3
The Public Safety Trust Fund 3
Establishing the Value of Spectrum Licenses 4
Completed Auctions (H Block and AWS-3) 5
Release of Federal Spectrum for Auction 6
Broadcast Incentive Auctions 6
Spectrum Pipeline Act of 2015 8
Release of Federal Spectrum under the Spectrum Pipeline Act 9
Federal Spectrum Below 3 GHz 9
Federal Spectrum Below 6 GHz 10
Federal Spectrum Use and Reallocation 10
Making Federal Spectrum Available for Commercial Use 11
Unlicensed Spectrum 12
Unlicensed Spectrum at 5 GHz 12
FCC Measures to Improve Competition 12
Geographic Coverage of Spectrum Licenses 13
Spectrum Caps and Screens 13
Designated Entities 14
Issues for the 114th Congress: Planning for Future Needs 15
The MOBILE NOW Act 15
Congressional Budget Office Cost Estimate 16
Preparation for the Future 16
The DIGIT Act 17
Congressional Budget Office Cost Estimate 17
Introduction of 5G and the Internet of Things 18
Next Steps 18

Contacts

Author Information 20

Spectrum Management

Electromagnetic spectrum refers to electromagnetic waves that, with applied technology, can transmit signals to deliver voice, text, video, and other wireless communications. Electromagnetic spectrum is the entire range of wavelengths or frequencies of electromagnetic radiation extending from gamma rays to the longest radio waves.[1] As new technologies become perfected and demand for access to spectrum increases, the use of all parts of the electromagnetic range is expanding as well. Common terms used in discussing electromagnetic spectrum include radio frequency spectrum, wireless spectrum, and airwaves.

Allocation and Assignment

The allocation and assignment[2] 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. 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).

As wireless technologies have evolved, the preferred size of licensed bands has increased. Current technologies, such as Long Term Evolution (LTE) and advanced Wi-Fi technologies, perform best on bandwidths of at least 20 MHz (for example, 10 MHz x 10 MHz of paired spectrum, although 20 MHz x 20 MHz or greater is preferred for LTE and LTE-Advanced). Geographic coverage for many licenses has been expanded as well, providing economies of scale for larger carriers while sometimes raising barriers to entry for smaller businesses.

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 perceived by many to be a market-driven solution to assigning licenses to use specific frequencies and are a comparatively 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 Wi-Fi, without assigning a license to a specific owner (unlicensed spectrum).

[1] Electromagnetic waves include radio waves, microwaves, millimeter waves, infrared radiation, visible light, ultraviolet light, x-rays, and gamma radiation.

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

[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.” The “Radio Act of 1912” established the principle of federal assignment of licenses to mitigate interference.

Auction Authority

The legislation that first authorized the FCC to establish "a system of competitive bidding"[4] for a limited period was included in the Omnibus Budget Reconciliation Act of 1993 (P.L. 103-66). The Balanced Budget Act of 1997 (P.L. 105-33) gave the FCC auction authority until September 30, 2007. This authority was extended to September 30, 2011, by the Deficit Reduction Act of 2005 (P.L. 109-171) and to 2012 by the DTV Delay Act (P.L. 111-4).

Title VI of the Middle Class Tax Relief and Job Creation Act of 2012 (P.L. 112-96) addresses spectrum allocation and assignment in its provisions and is often referred to as the Public Safety and Spectrum Act, or the Spectrum Act. The Spectrum Act extended the FCC's auction authority until the end of FY2022.[5] The Spectrum Pipeline Act extends auction authority through FY2025 for auctions required by the act.[6]

Auction Revenue

When radio frequency spectrum licenses are auctioned for commercial purposes by the FCC, the net proceeds are typically deposited in the U.S. Treasury.[7] Each time Congress extends the FCC's authority to conduct auctions of spectrum licenses, new revenue is created for the Treasury. This revenue may be used to offset direct spending or other purposes, such as deficit reduction. For budget purposes, Congress typically does not extend auction authority more than 10 years from the effective date of any enacting legislation. Recent Administrations have recommended making the FCC's auction authority permanent.

Over $40 billion in net proceeds have been generated by two auctions conducted by the FCC to meet requirements of the Spectrum Act, of which approximately $33 billion has been applied to deficit reduction.[8] A third auction required by the act, the Broadcast Incentive Auction, began on March 29, 2016.[9] The Congressional Budget Office (CBO) has projected that this auction will provide from $10 billion to $40 billion for deficit reduction, with the expected value set at $25 billion.[10]

Separately, the CBO has projected that net revenue from various actions, including auctions, required by the Spectrum Pipeline Act will contribute $4.4 billion to deficit reduction by the end of FY2025.[11]

---

[4] 47 U.S.C. §309 (j) (1) (3).

[5] 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.

[6] P.L. 114-74, §1007, "FCC Auction Authority."

[7] 47 U.S.C. §309 (j) (8) (A). Net proceeds are the auction revenues minus the FCC's expenses. Proceeds may be further reduced by the award of bidding credits to designated entities; see discussion in section on "Designated Entities."

[8] Letter from Shaun Donovan, Director, Office of Management and Budget, to Senator Jerry Moran, et al., August 31, 2015.

[9] FCC, *Public Notice*, "FCC Establishes Incentive Auction Bidding Procedures," August 11, 2015, https://www.fcc.gov/document/fcc-establishes-incentive-auction-bidding-procedures-0.

[10] Letter from Keith Hall, Director, Congressional Budget Office, to Senator Dean Heller, April 21, 2015.

[11] 114th Congress (H.R. 1314), Bipartisan Budget Act of 2015, https://www.cbo.gov/sites/default/files/114th-congress-2015-2016/costestimate/hr1314.pdf.

Distribution of Proceeds from Auctions Required by the Spectrum Act

Net proceeds from auctions of spectrum licenses as specified in the Spectrum Act are directed to the Public Safety Trust Fund, created by the act. Some revenue in the Public Safety Trust Fund is designated for specific purposes, primarily public safety.[12] Of the initial projected revenue of nearly $28 billion, $20.4 billion was directed for deficit reduction.[13] Additional auction revenues in excess of the projected amount are to be applied to deficit reduction.

Proceeds from the sale of licenses of repurposed federal spectrum identified in the Spectrum Act are to 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 are to go directly to the Public Safety Trust Fund. Proceeds from the auction of new licenses created by the release of television broadcasting spectrum are to go to cover costs specified in the act, with the balance to the Public Safety Trust Fund.[14] Balances remaining in any fund created by the act are to revert to the Treasury in 2022 to be used "for the sole purpose of deficit reduction."[15]

The Public Safety Trust Fund

The law provides for specific transfers from the Public Safety Trust Fund. A major beneficiary of funding is FirstNet (First Responder Network Authority), the nationwide broadband network to be developed for public safety communications as a federal agency within the NTIA.

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 grants to states to assist in their planning for 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 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.

[12] P.L. 112-96, §6413, 126 Stat. 235.

[13] P.L. 112-96, §6413, 126 Stat. 235-236.

[14] P.L. 112-96, §6401 126 Stat. 223-224.

[15] P.L. 112-96, §6413, 126 Stat. 236.

- To the Treasury for deficit reduction: any remaining amounts from designated auction revenues.

All of the funding obligations of the Spectrum Act have been met with proceeds from auctions held in 2014-2015. As required by the act, remaining net proceeds will be deposited in the Treasury for the purposes of deficit reduction.[16]

Establishing the Value of Spectrum Licenses

In scoring the Spectrum Act, CBO had originally projected that net revenue from all three auctions required by the Spectrum Act would be approximately $30 billion for three auctions.[17]

In order to score a bill[18] that includes the auctioning or reassigning of spectrum licenses the CBO must establish a value for licenses. Three key estimates of value considered by the CBO are quantity of spectrum auctioned; market value of spectrum; and net proceeds. It also considers the historical values of earlier auctions. Spectrum license auctions that were considered in scoring the Spectrum Act were held during the period FY2001-FY2010. They yielded an average MHz-pop[19] of $0.80, within a range of $0.55 to $1.10. Weighing these and other factors, the CBO initially projected that spectrum licenses auctioned during the FY2013-FY2021 period would have an average market value of $0.70 per megahertz per person.[20] The score was subsequently revised slightly upwards to cover the period FY2013-FY2022.[21]

The results for completed auctions required by the Spectrum Act, in MHz-pop, are

- H Block, concluded February 2014; $0.50 MHz-pop, by a single winning bidder.
- AWS-3, concluded January 2015; average $2.21 MHz-pop.

As noted in the section on auction revenue, the CBO later provided a new estimate for the remaining required auction, the Broadcast Incentive Auction. The expected value for this auction of $25 billion in net proceeds is based on a number of assumptions. At the time of the estimate, the quantity of spectrum to be auctioned was unknown as was the total amount broadcasters might be paid for relinquishing spectrum.[22] The CBO reported that it assumed that the MHz-pop value would be similar to the $2.21 average of the AWS-3. An estimate in a February 2015 report commissioned by the FCC projected the MHz-pop would average $1.50.[23]

---

[16] In addition to FCC expenses paid from auction proceeds, $1.75 billion is required to be set aside to cover certain broadcaster expenses.

[17] 112th Congress (H.R. 3630), https://www.cbo.gov/sites/default/files/112th-congress-2011-2012/costestimate/hr363020.pdf.

[18] For a discussion of the congressional budget process, see CRS Report RL31943, *Budget Enforcement Procedures: The Senate Pay-As-You-Go (PAYGO) Rule*, by Bill Heniff Jr., and CRS Report 98-721, *Introduction to the Federal Budget Process*, coordinated by James V. Saturno.

[19] The standard expression for market value is in dollars "per MHz-pop"—a unit determined by the bandwidth, in MHz, assigned to a license multiplied by the number of people in the geographic area covered by the license.

[20] 112th Congress (S. 911), https://www.cbo.gov/sites/default/files/112th-congress-2011-2012/costestimate/s9111.pdf.

[21] 112th Congress (H.R. 3630), https://www.cbo.gov/sites/default/files/112th-congress-2011-2012/costestimate/hr363020.pdf.

[22] A description of the Broadcast Incentive Auction procedure is in a later section of this report, "Broadcast Incentive Auctions."

[23] Greenhill, "Incentive Auction Opportunities for Broadcasters," prepared for the Federal Communications Commission, February 2015, http://wireless.fcc.gov/incentiveauctions/learn-program/

Completed Auctions (H Block and AWS-3)

The Spectrum Act requires 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 mandates 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.[24] 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.[25]

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 had to total at least $1.56 billion.[26] The licenses cover 176 Economic Areas.[27] Auction 96 was completed on February 27, 2014, with a total winning bid of $1.564 billion from Dish (rebranded from Dish Network) for all licenses.[28]

On January 30, 2015, the FCC completed a second auction (Auction 97), for Advanced Wireless Service (AWS) spectrum licenses, providing an additional 65 MHz of frequencies to fulfill the congressional mandate for certain auctions by 2015.[29] 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, of which $5.1 billion is to be applied to the costs of relocation or sharing of frequencies now used by the federal government. There were 31 winning bidders for a total of 1,611 licenses. AT&T reportedly acquired 251 licenses for approximately $10.4 billion; Verizon acquired 181 licenses for approximately $10.4 billion; and T-Mobile received 151 licenses for nearly $1.8 billion. Sprint, the fourth national carrier, did not bid. Dish acquired 702 licenses with a value of $13.3 billion through two joint ventures that had registered as designated entities[30]—SNR Wireless LicenseCo., LLC (357 licenses) and Northstar Wireless, LLC (345 licenses)—thereby receiving a discount of over $3 billion. The FCC subsequently reversed the

Incentive_Auction_Opportunities_Book_Information_Sessions_2_5_15.pdf.

[24] P.L. 112-96, §6413, 126 Stat. 236.

[25] Department of Commerce, *Identification of 15 Megahertz of Spectrum Between 1675 and 1710 MHz for Reallocation from Federal Use to Nonfederal 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.

[26] 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.

[27] 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. See "Geographic Licensing Schemes" at http://wireless.fcc.gov/auctions/default.htm?job=maps#Geographic%20Licensing%20Schemes.

[28] 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.

[29] 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.

[30] A company that meets certain financial and market criteria may qualify for up to a 25% credit on successful bids; see *Designated Entities* in a later section of this report.

designated entity status, requiring the companies to pay the full auction price.[31] The Dish affiliates consequently returned roughly 200 licenses, valued at approximately $3.5 billion, and paid penalties for defaulting.

Release of Federal Spectrum for Auction

Federal frequencies at 1695-1710 MHz and 1755-1780 MHz were reassigned for commercial use on a shared basis with federal incumbents as part of Auction 97.[32] The frequencies at 1755-1780 MHz are 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, with multiple federal incumbents, are to be shared indefinitely with successful commercial bidders, although some federal systems are to migrate to other frequencies. The frequencies at 1695-1710 MHz were auctioned as unpaired spectrum on a shared basis with weather satellite systems. Licensees are obligated to coordinate with federal users to avoid harmful interference and to meet other requirements of transition plans.[33] The transition plans are posted on the NTIA website.[34]

Broadcast Incentive Auctions

The Spectrum Act permits 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.[35] 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, for repurposing 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 establishes 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 decide on the amount of compensation they are willing to accept for the spectrum they voluntarily release for auction.[36] 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 is to be repurposed for commercial broadband communications, with licenses sold through what the law refers to as a forward auction. At least

[31] FCC, Commission Document, "Chairman's Statement on Decision to Deny Bidding Credits," August 17, 2015, https://www.fcc.gov/document/chairmans-statement-decision-deny-bidding-credits.

[32] 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.

[33] 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.

[34] 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.

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

[36] The FCC has set a ceiling on the opening bid for each broadcaster in Auction 1001. Broadcasters who participate are expected to offer their spectrum at prices lower than the ceiling; the lowest bid below the ceiling will be the winning bid, representing the amount the broadcaster will receive if the auction process is completed successfully.

one successful reverse auction is required to set minimum prices for a forward auction. 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. 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.[37]

The Public Notice establishing Incentive Auction bidding procedures was released on August 11, 2015.[38] Auction 1000, as it is called, consists of two parts, as required by the Spectrum Act: Auction 1001 (reverse) and Auction 1002 (forward). The notice also describes the process for setting the initial target of spectrum to be cleared in the repurposed 600 MHz band.

Among other actions, the FCC also issued an Order on Reconsideration, reaffirming an earlier Report and Order that created a "market-based spectrum reserve of up to 30 MHz" to enhance competitive bidding.[39] 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 any wireless company deemed not to have national network coverage.

The Broadcast Incentive Auctions began on March 29, 2016, with the first phase of the reverse auction.[40] Broadcaster participation was described as "robust" by FCC Chairman Tom Wheeler in an April 29, 2016, announcement,[41] after broadcasters volunteered to make up to 126 MHz of spectrum available for sale to commercial interests and for unlicensed use. The FCC had developed nine separate scenarios for creating licenses from relinquished broadcast spectrum: 126 MHz was the highest target analyzed. The next phase of the reverse auction, which established final prices payable to broadcasters, began on May 31, 2016.[42] This phase concluded on June 29, 2016. The total value of commitments is over $86 billion and the amount of spectrum

[37] Information on the broadcast auction process is at https://www.fcc.gov/about-fcc/fcc-initiatives/incentive-auctions/resources.

[38] FCC, *Public Notice*, "FCC Establishes Incentive Auction Bidding Procedures," August 11, 2015, https://www.fcc.gov/document/fcc-establishes-incentive-auction-bidding-procedures-0.

[39] FCC, *Order on Reconsideration*, "FCC Reaffirms Pro-Competitive Reserve Spectrum in Incentive Auction," August 11, 2015, https://www.fcc.gov/document/fcc-reaffirms-pro-competitive-reserve-spectrum-incentive-auction-0.

[40] FCC, "FCC Establishes Bidding Procedures for 2016 Incentive Auction," August 6, 2015, https://www.fcc.gov/document/fcc-establishes-incentive-auction-bidding-procedures.

[41] FCC News, "Statement of FCC Chairman Tom Wheeler on the Announcement of Initial Spectrum Clearing Target for the Incentive Auction," April 20, 2016, http://transition.fcc.gov/Daily_Releases/Daily_Business/2016/db0429/DOC-339130A1.pdf.

[42] FCC, "126 MHz Initial Clearing Target; Reverse Clock Bidding Begins May 31," April 29, 2016, https://www.fcc.gov/document/126-mhz-initial-clearing-target-reverse-clock-bidding-begins-may-31.

that might be reassigned through licensing is 100 MHz.[43] The amount committed to paying broadcasters that are releasing spectrum, plus the costs to the FCC of the auction, plus the $1.75 billion for the TV Broadcaster Relocation Fund represent the minimum amount that must be recovered in the forward auction for spectrum licenses. This would be in excess of $88 billion for licenses totaling 100 MHz. Although it may be possible for bids for spectrum licenses to achieve the required total, the possibility of the auction generating extra revenue for the federal treasury seems slight. CBO predictions for auction revenue, for example, were predicated on spectrum values averaging $2.21 MHz-pop. To meet $88 billion in an auction would require a market value of at least $2.76 MHz-pop.

Many industry analysts believe that there is not enough demand in the wireless industry to cover the $88 billion, with some citing $40 billion as the total amount potential buyers might be willing to invest in new spectrum.[44] If, as is widely predicted, the forward auction does not sell enough licenses to cover all costs, the FCC will set a new target for the amount of spectrum to be released and establish new prices for broadcasters that may remain eligible to participate. The FCC had anticipated multiple stages for the forward auction and has nine separate targets for released spectrum and accompanying band plans.

The FCC's auction rules call for the FCC to repeat the auction process with modifications of the spectrum band plan until either the market clears at an equilibrium point between supply and demand, or demand by wireless carriers for licenses is insufficient to meet the price at which broadcasters are willing to sell. If the auction fails, the FCC may consider a new proceeding to reallocate broadcast spectrum, within limitations established by the act.[45]

One hundred eight companies completed applications to bid in Auction 1002.[46] Of these, 62 qualified applicants submitted good faith payments by July 1, 2016.[47] The auction is scheduled to begin August 16, 2016.

Spectrum Pipeline Act of 2015

The Spectrum Pipeline Act of 2015 passed as part of the Bipartisan Budget Act of 2015 (P.L. 114-74, Title X). The act requires the NTIA to make available 30 MHz of spectrum currently used by federal agencies for licensing on an exclusive or shared basis to nonfederal users. The frequencies must be located below 3 GHz on the spectrum chart;[48] must be available in bandwidths of at least 10 MHz; and may not be within the 1675-1695 MHz range (primarily used for weather forecasting). Not later than January 2022, the NTIA must identify suitable spectrum and begin the

[43] FCC Blog, "Setting Sights on the Forward Auction," July 1, 2016, https://www.fcc.gov/news-events/blog/1638.

[44] Howard Buskirk and Monty Taylor, "Reverse Auction Clearing Cost Over $86 Billion; Second Stage Expected," *Communications Daily*, June 30, 2016; Ryan Knutson, "FCC Acquires Large Swath of TV Airwaves in Auction," *Wall Street Journal*, June 29, 2016; John Eggerton,"Ryvicker: Spectrum Auction Likely to See Multiple Stages," *Broadcasting & Cable*, June 29, 2016; Todd Shields and Scott Moritz, "Auction Pledge to Broadcasters May be Too High for Wireless," *Bloomberg News*, June 29, 2016.

[45] P.L. 112-96, §6403 (e), (f), and (g) 126 Stat. 229 - 230.

[46] FCC, "Forward Auction (Auction 1002) Upfront Payment Instructions," June 8, 2016, https://www.fcc.gov/document/forward-auction-auction-1002-upfront-payment-instructions.

[47] FCC, "62 Applicants Qualified to Bid.... " July 15, 2016, DA 16-796, http://transition.fcc.gov/Daily_Releases/Daily_Business/2016/db0715/DA-16-796A1.pdf.

[48] NTIA, *United States Frequency Allocations*, https://www.ntia.doc.gov/files/ntia/publications/spectrum_wall_chart_aug2011.pdf.

process of reallocation. The FCC must commence the auction proceedings for released federal spectrum by July 2024.[49]

Two additional tranches of spectrum, of 50 MHz each, must be identified by the FCC for nonfederal use, either licensed or unlicensed, in frequencies below 6 GHz. The FCC is to provide corresponding reports to congressional committees by January 1, 2022, and January 1, 2025. The reports are to include an assessment of federal use of these frequencies, where applicable; a timeline for competitive bidding; and a proposed plan for balancing licensed and unlicensed use.[50] The act extends the FCC's auction authority to the end of FY2025 exclusively for the purpose of conducting auctions required by the act.[51]

As regards the federal Spectrum Relocation Fund, the act provides new criteria for the administration of the fund and for eligible uses of the fund. In particular, the act expands the availability of funding for research and development, engineering studies, economic analysis, and other planning activities that facilitate the efficiency and availability of federal spectrum, among other purposes.[52]

Other provisions require reports to Congress from the FCC analyzing (1) the impact of rules changes governing radio frequencies at 3550-3650 MHz and (2) "proposals to promote and identify additional spectrum bands that can be shared between incumbent uses and new licensed, and unlicensed services under such rules and identification of at least 1 gigahertz between 6 gigahertz and 57 GHz for such use."[53]

Release of Federal Spectrum under the Spectrum Pipeline Act

The Spectrum Pipeline Act requires three tranches for identification of auctionable spectrum as well as spectrum for unlicensed use.

Federal Spectrum Below 3 GHz

The first requirement is for the release of 30 MHz of federal spectrum below 3 GHz.[54] Possible bands for reallocation include

- 1300-1390 MHz, allocated for Aeronautical Radionavigation, used for radar by the Federal Aviation Administration and other federal agencies; the 1300-1370 MHz bands may be evaluated by the NTIA for sharing and the 1370-1390 MHz band for relocation.
- 2200-2290 MHz, allocated and used primarily for space research and communications, including Tracking and Data Relay Satellite Systems.
- 2700-2900 MHz, allocated for Meteorological Aids and Aeronautical Radionavigation, used notably for Air Traffic Control and Next Generation Weather Radar; identified by NTIA for study to repurpose.
- 2900-3100 MHz, allocated for Radiolocation and Maritime Radionavigation, uses include Next Generation Weather Radio and by DOD for defense purposes.

[49] P.L. 114-74, §1004, "Identification, Reallocation, and Auction of Federal Spectrum."

[50] P.L. 114-74, §1006, "Plans for Auction of Certain Spectrum."

[51] P.L. 114-74, §1007, "FCC Auction Authority."

[52] P.L. 114-74, §1005, "Additional Uses of Spectrum Relocation Fund."

[53] P.L. 114-74, §1008, "Reports to Congress."

[54] P.L. 114-74, §1004, "Identification, Reallocation, and Auction of Federal Spectrum."

Clearing of identified spectrum is to begin no later than January 1, 2022. The FCC is to reallocate the frequencies for nonfederal use or shared use for assignment through competitive bidding. The bidding process is to commence no later than July 1, 2024.

Federal Spectrum Below 6 GHz

The Spectrum Pipeline Act further requires that the NTIA provide information to the FCC so that it may identify additional spectrum for reallocation and assignment to nonfederal or shared use.[55] The FCC is to issue two reports to Congress, each identifying 50 MHz of spectrum below 6 GHz suitable for licensed or unlicensed use, including an assessment of federal operations on identified spectrum and a timeline for competitive bidding. The first report is to be submitted not later than January 1, 2022; the second report is to be delivered by January 1, 2024. Additional possible bands for reallocation include bands within:

- 3100-3500 MHz, shared federal and nonfederal uses, allocated for Radiolocation for federal use, used by DOD for national defense; in the private sector used primarily for earth-exploration satellites and space research.
- 3500-3650 MHz, federal allocation for Radiolocation and Aeronautical Radionavigation used by DOD for radar; nonfederal uses are for Radiolocation in 3500-3600 MHz and Fixed Satellite for 3600-3650 MHz; as noted above, the FCC is overseeing a proceeding that would allow nonfederal users to share with military radar systems within the 3550-3650 MHz band, and extends into the 3650-3700 band.
- 3700-4200 MHz, used by federal and civilian agencies for satellites, carries space-to-Earth signals and is paired with 5925-6425 MHz for Earth-to-space transmissions.
- 4200-4400 MHz, globally reserved for altimeters on federal and nonfederal aircraft; the NTIA has recommended studying the release of two 20 MHz bands within these frequencies.

Federal Spectrum Use and Reallocation

The Spectrum Act and the Spectrum Pipeline Act address 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.[56] To facilitate the transfer of spectrum rights to commercial purchasers from the agencies relinquishing spectrum, the Commercial Spectrum Enhancement Act of 2004 (P.L. 108-494, Title II) was amended by the Spectrum Act, and further amended by the Spectrum Pipeline Act. In general the amendments deal with describing reimbursable costs and providing guidelines to the Office of Management and Budget, which approves transfers. The Spectrum Pipeline Act expands the types of reimbursable plans to include agency expenditures not previously considered eligible for reimbursement.

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

[55] P.L. 114-74, §1006, "Plans for Auction of Certain Spectrum."

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

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[57] by the Commercial Spectrum Enhancement Act but the law was written to apply to any federally used frequencies scheduled for reallocation and possible auction.[58]

The Spectrum 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.[59] The Spectrum Pipeline Act added specific criteria for the Technical Panel to consider in approving plans, including whether a plan will "increase the net expected auction proceeds in an amount not less than the time value of the amount of the payment.... "[60]

Making Federal Spectrum Available for Commercial Use

In 2010, the NTIA, with input from the Policy and Plans Steering Group (PPSG),[61] has produced a 10-year plan and timetable that identifies bands of spectrum that might be available for commercial wireless broadband service.[62] As part of its planning efforts, the NTIA prepared a "Fast Track Evaluation" of spectrum that might be made available in the near future.[63] Annual reports of progress for the 10-year plan are available on the NTIA website.[64]

[57] 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.

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

[59] 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.

[60] P.L. 114-74, §1005, "Additional Uses of Spectrum Relocation Fund."

[61] 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.

[62] NTIA, *Plan and Timetable to Make Available 500 Megahertz of Spectrum for Wireless Broadband*, October 2010, https://www.ntia.doc.gov/files/ntia/publications/tenyearplan_11152010.pdf.

[63] 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, http://www.ntia.doc.gov/report/2010/assessment-near-term-viability-accommodating-wireless-broadband-systems-1675-1710-mhz-17.

[64] The most recent progress report is *Sixth Interim Progress Report of the Ten-Year Plan and Timetable*, June 17, 2016, https://www.ntia.doc.gov/files/ntia/publications/ntia_6th_interim_progress_report_on_ten-year_timetable_june_2016.pdf.

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 Wi-Fi communications. Wi-Fi 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.

Unlicensed Spectrum at 5 GHz

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 Wi-Fi capacity, the Spectrum Act required new studies and evaluations of frequencies at 5 GHz.[65] The FCC was required to commence a proceeding that might open access for some unlicensed devices in the 5350-5470 MHz band.[66] The NTIA was required to prepare an evaluation of spectrum-sharing technologies for the 5350-5470 MHz and 5850-5925 MHz bands.[67] Pursuant to the findings of the two agencies, the FCC has issued a Report and Order[68] 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.

FCC Measures to Improve Competition

Implementation of the Spectrum Act and the Spectrum Pipeline Act raises a number of policy issues such as allocation of spectrum between licensed and unlicensed use and how to structure competitive bidding systems to maximize both competition and innovation. 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.

---

[65] P.L. 112-96, §6406.

[66] 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.

[67] 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.

[68] FCC, "Revision of Part 15 of the Commission's Rules to Permit Unlicensed National Information Infrastructure (U-NII) Devices in the 5 GHz Band," April 1, 2014, http://www.fcc.gov/document/5-ghz-u-nii-ro.

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 created Partial Economic Area licenses within Economic Areas, to allow for a greater choice between urban and rural coverage among bidders for licenses.[69]

Spectrum Caps and Screens

The history of spectrum caps as a policy to promote competition dates to preparations for the first spectrum license auctions in the 1990s. 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.[70] 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.

The FCC will apply new criteria for the Broadcast Incentive Auction intended to limit the ability of Verizon and AT&T to acquire licenses in certain areas, noting their substantial holdings of licenses below 1000 MHz. These criteria will limit the amount of spectrum that any one carrier may hold, by placing restrictions on bidding activity.[71] The majority of the 700 MHz band commercial licenses were purchased at auction in 2008 (Auction 73) by Verizon and AT&T,[72]

---

[69] "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.

[70] 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.

[71] "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, 2014, 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.

[72] The major auction of licenses for the 700 MHz band was Auction 73. Some information about the top ten successful

which together also hold approximately 70% of commercial spectrum licenses below 1000 MHz.[73] 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 T-Mobile is generally viewed by observers as the primary beneficiary 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 bidders 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. T-Mobile and smaller carriers, among others, have unsuccessfully pressed the FCC to increase the amount of spectrum reserved for priority bidding. Although some would like to see Verizon and AT&T excluded entirely from participation in the Broadcast Incentive Auction, the Spectrum Act prohibits exclusion of any qualified bidder.[74]

How spectrum caps might be implemented and how limitations might affect auction revenue have been topics of spirited debate. Numerous position papers have argued 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.[75] 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.[76]

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.[77] 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).

bidders in Auction 73 is available at Wireless Strategy, FCC Auctions, http://www.wirelessstrategy.com/700auction.html.

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

[74] 47 U.S.C. §309 (j) (17) (A).

[75] 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.

[76] For example, *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.

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

The FCC has reconsidered the rules for designated entities in a Notice of Proposed Rulemaking.[78] Among the rules reevaluated are those for AMR, which the FCC believes may be discriminating against entrepreneurs that have formed partnerships with larger companies.[79] 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 & Telecom Council (MMTC).[80]

Issues for the 114th Congress: Planning for Future Needs

The Spectrum Act and the Spectrum Pipeline Act focus on three key policy tools for increasing the availability of radio frequency spectrum for wireless broadband: allocating additional spectrum through competitive auctions; reassigning federal spectrum for commercial use; and opening up spectrum for unlicensed use.

The MOBILE NOW Act

These policies dominate provisions of the MOBILE NOW[81] Act (S. 2555), which was approved by the Senate Committee on Commerce, Science, and Transportation on March 3, 2016.[82] The act would address a range of issues related to the deployment of mobile broadband including providing infrastructure and minimizing regulatory hurdles. It would expand on provisions in the Spectrum Pipeline Act to make additional federal spectrum available for commercial use by 2020. In referring to the Administration goal of repurposing 500 MHz of federal and nonfederal spectrum for mobile broadband, the act would require that at least 225 MHz of new spectrum be released below 6 GHz. Of this, at least 100 MHz would be made available for unlicensed use and 100 MHz would, where possible, be auctioned as exclusive use licenses. Where exclusive use is not deemed feasible, spectrum might be shared using procedures similar to those for the AWS-3 auction. Some bands of federal spectrum, where discussions on possible reassignment or sharing have commenced, would be excluded from consideration.[83] The act also includes several provisions that would facilitate the release of federal spectrum.

Several provisions would expedite the deployment of communications facilities, including requirements governing placement of sites on federal land, and mandated action by the FCC regarding deployment of small cell networks.[84] For example, the bill would require the Office of

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

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

[80] Now the Multicultural Media Telecom and Internet Council; MMTC, *Digital Déjà vu: A Road Map for Promoting Minority Ownership in the Wireless Industry*, S. Jenell Trigg and Jeneba Jalloh Ghatt, February 25, 2014, http://mmtconline.org/mmtc-white-paper-wireless-ownership-02-24-14/.

[81] Making Opportunities for Broadband Investment and Limiting Excessive and Needless Obstacles to Wireless.

[82] "Commerce Approves MOBILE NOW Act and Nominations," Press Release, March 3, 2016, http://www.commerce.senate.gov/public/index.cfm/pressreleases?ID=C4B031EF-FE5A-42F0-9D6D-3C4C10B7B268.

[83] Spectrum bands that are exempt from the provisions of the act are 1695-1710 MHz; 1755-1780 MHz; 2155-2180 MHz; and 3550-3700 MHz.

[84] FCC, "Wireless Telecommunications Bureau Seeks Comment on Revising the Historic Preservation Review Process for Small Facility Deployments," WT Docket No. 15-180, DA 15-865, July 28, 2015, https://apps.fcc.gov/edocs_public/attachmatch/DA-15-865A1_Rcd.pdf.

Science and Technology Policy to establish a database to provide information on communications facilities installed on federal property or where communications equipment might be installed, including new properties when acquired. In general the database would be available to states and localities, which would be encouraged to include comparable data for properties under their jurisdiction.

The law also provides for an exception to the Miscellaneous Receipts Act (31 U.S.C. §3302 (b)), thereby allowing federal agencies to accept funds from commercial carriers to assist them in expediting release of spectrum that has been designated for clearance.

Congressional Budget Office Cost Estimate[85]

The Congressional Budget Office (CBO) has estimated that implementing the bill would cost $85 million over the 2017-2021 period if funds were appropriated. These expenditures would be primarily to develop new data systems ($71 million) although the cost could be less or greater depending on what data is collected for analysis and the degree of participation by state and local governments.

The impact on spending would be $135 million for the period 2017-2026 because of accelerated spending related to clearing federal spectrum for commercial use.

There are no provisions for generating revenue in the bill and pay-as-you go provisions apply.

Preparation for the Future

The MOBILE NOW Act also recognizes the needs of future technologies with requirements to evaluate millimeter wave[86] spectrum bands. Communications technology for transmission over millimeter waves is generally expected to be a key component in developing fifth-generation (5G)[87] commercial mobile broadband and the Internet of Things.[88]

The act identifies bands that would be evaluated by the NTIA, in consultation with affected agencies, for possible impacts on existing federal users of commercial mobile operations within those bands.[89] The NTIA would have 18 months from date of enactment to complete its assessment, and another 30 days to report its finding to the appropriate congressional committees.

Similarly, the FCC would be required, within two years, to publish a notice of proposed rulemaking for service rules in high band frequencies. Other millimeter wave bands were included in an FCC Notice of Inquiry (NOI),[90] covering high-band and millimeter wave

[85] Congressional Budget Office Cost Estimate, S. 2555, https://www.cbo.gov/publication/51515.

[86] Millimeter waves occupy the frequency spectrum from 30 GHz to 300 GHz. They're found in the spectrum between microwaves (1 GHz to 30 GHz) and infrared waves.

[87] The progression of cellular technology is often referred to in terms of generations. 2G, for example, referred generally to digital technologies that replaced analog systems. The improvements in speed and efficiency of 3G networks were quickly replaced by 4G technologies that support the demands of smartphones and similar digital devices. Among the advantages expected of 5G technologies are speed increases 200 times greater than what is available on 4G, higher quality of images, and more efficient battery use.

[88] For example, the National Institute of Standards and Technology (NIST) has created a 5G Millimeter Wave Channel Model Alliance to support the development of accurate, consistent and predictive models of channels for 5G millimeter wave transmissions, http://www.nist.gov/ctl/wireless-networks/5gmillimeterwavechannelmodel.cfm.

[89] The bands are 31.8 -33.4 GHZ; 71.0-76.0 GHz; 81.0-86.0 GHz.

[90] FCC, Notice of Inquiry, "Use of Spectrum Bands Above 24GHz for Mobile Radio Services," GN Docket No. 14-177 *et al*., released October 23, 2015, https://apps.fcc.gov/edocs_public/attachmatch/FCC-15-138A1_Rcd.pdf.

frequencies.[91] On July 14, 2016, the FCC followed up on the NOI by proposing rules that would make high-band spectrum available for 5G. The proposed rules, referred to as the "Spectrum Frontier Order"[92] would make a total of 10.85GHz of high-band spectrum available for licensed, unlicensed, and shared use. Spectrum in the 28 GHz, 37 GHz, and 39 GHz totaling 10.85 GHz would be allocated for flexible use licenses. [93]

Overall, the provisions of the MOBILE NOW Act appear to provide leeway for accommodating new technology in its requirements for licensed, unlicensed, and shared use of spectrum resources. There is no measure that would create additional revenue for the Treasury. It seems likely that, either on the Senate floor or in the House Committee on Energy and Commerce, provisions will be added that identify new bands of spectrum for auction. These provisions may impinge on forward-looking parts of the MOBILE NOW Act by constraining the power of the FCC to propose new forms of spectrum access.

The DIGIT Act

The Developing Innovation and Growing the Internet of Things Act, or DIGIT Act (S. 2607), and its companion bill (H.R. 5117) seek to ensure appropriate spectrum planning and interagency coordination in support of the Internet of Things. The DIGIT Act would direct the FCC to prepare a report assessing spectrum needs required to support the Internet of Things. It would also convene a working group of both federal and private entity stakeholders to provide recommendations to Congress. These recommendations would focus on how to plan for, and encourage, the growth of the Internet of Things in the United States.

The 114th Congress has passed resolutions that call for strategic planning at the national level for the Internet of Things (S.Res. 110, H.Res. 195). The Senate passed their Internet of Things resolution on March 24, 2015, supporting a strategy to maintain U.S. global competitiveness in the digital age. It also called for a modern framework around innovation, recognizing the importance of consensus-based best practices and the need for innovators to drive the future development of the Internet of Things.

Congressional Budget Office Cost Estimate[94]

The CBO has estimated that it would cost $3 million to create the working group and fund the reports required by the DIGIT Act. These costs would be spread among the federal agencies participating in the working group and would be subject to the availability of appropriated funds. This would not affect direct spending or revenues. Therefore, pay-as-you-go procedures do not apply.

[91] The bands are 27.5-28.35 GHZ (28 GHZ band); 37.0 -38.6 GHz (37 GHz band); 38.6-40.0 GHz (39 GHz band); and 64.0-71.0 GHz.

[92] FCC Blog, "A Busy Summer Continues," by Tom Wheeler, FCC Chairman, July 14, 2016, https://www.fcc.gov/news-events/blog/2016/07/14/busy-summer-continues.

[93] FCC, "Fact Sheet: Spectrum Frontiers Rules Identify, Open Up Vast Amounts of New High-Band Spectrum for Next Generation (5G) Wireless Broadband," July 14, 2016, http://transition.fcc.gov/Daily_Releases/Daily_Business/2016/db0714/DOC-340310A1.pdf.

[94] Congressional Budget Office Cost Estimate, S. 2607, https://www.cbo.gov/publication/51776.

Introduction of 5G and the Internet of Things

The introduction of 5G is expected to develop from current trials to rapid commercial expansion in the period 2020-2025. Trials for early 5G technologies are scheduled to begin in late 2016.[95] Initial standards for transitioning existing LTE and LTE Advanced technologies to 5G may be ready as early as 2018.[96]

Expansion plans of the major wireless carriers in general appear to assume an orderly progression in existing technologies for mobile broadband. However, a number of new spectrum-dependent industries are emerging that include much of the Internet of Things (IoT),[97] such as advanced robotics, autonomous vehicles, cloud computing, and machine-to-machine communications. Many industry experts expect that new—possibly disruptive—technologies will emerge as 5G develops. Many of these technologies are expected to be based on new concepts for network organization and communications and not on existing cellular technology. In other words, 5G is seen by many as including IoT solutions outside mobile broadband.

A recent study[98] estimated that projected worldwide demand for IoT in 2020 can be largely met by Wi-Fi (67%) and by the current development plans for Long Term Evolution (LTE)[99] and related technologies (13%), but that 19% cannot be met by current or projected network development plans. To address this gap between demand and supply, the study concludes that network operators must accelerate the existing trend to 5G as defined by their plans for investment in LTE.

An alternative interpretation, using the above projections, is that 19% of the near-term (2020) market for IoT network technologies, therefore, is open for entrepreneurial solutions that may produce an entirely new business model for competition in communications technologies. It is conceivable that this approximately 20% slice may in the future provide the platform for exponential growth. This leads to a possibility for a surge in innovation and technological change similar to what experts often attribute to the introduction, development, and commercialization of Internet technologies.

Next Steps

Assuming that the MOBILE NOW or DIGIT acts are enacted, there would still remain a number of gaps in national planning and preparation for the communications technologies of the future.

[95] Recode.net, "A&T, Like Verizon, to Begin Testing 5G Wireless This Year, As US Aims to Stay Ahead of the Pack," by Ina Fried, February 11, 2016.

[96] Remarks of Tom Keathley, Senior Vice President, Wireless Network Architecture and Design, AT&T, at "The Next Generation of Wireless: 5G Leadership in the U.S.," program sponsored by CTIA, February 9, 2016.

[97] The Internet of Things refers to the interconnection of things and sentient beings using communications networks, such as the Internet, and advanced software to collect, manage, store, analyze, and act upon data gathered by a variety of sensors and through other information sources. The Internet of Things is one of a number of applications of Cyber-physical systems. See, for example, the work of the National Institute of Standards and Technology, http://www.nist.gov/cps/.

[98] Juan Pedro Tomas, "Study Urges Operators to Accelerate Investments in 5G, Cloud," RCR Wireless News, April 15, 2016, http://www.rcrwireless.com/20160415/internet-of-things/study-urges-operators-accelerate-investments-5g-cloud-tag23. The study was released by Bell Labs Consulting.

[99] LTE is a standard for fourth-generation mobile broadband that is being expanded to provide 5G services.

The DIGIT Act, for example, would create a temporary working group that would be required to examine specific policy questions related to the Internet of Things: spectrum needs; regulatory

environment; consumer protection; privacy and security; and preparedness of federal agencies to adapt future technologies. The MOBILE NOW Act would provide mechanisms for the FCC and the NTIA to work with federal agencies in identifying federal spectrum that can be licensed or otherwise made available to the commercial sector for mobile broadband. Neither bill provides the framework for public-private collaboration on important factors that might influence the continued success of the United States and its current leadership in technology. These factors include investment in IoT infrastructure; international negotiations; programs for technology transfer; processes to identify, support, and coordinate basic research in 5G for emerging technologies; consideration of how current FCC rules for auctions might be changed to allow access for new entrants; protection of intellectual property; and many other aspects important to competition and innovation.

Author Information

Linda K. Moore
Specialist in Telecommunications Policy

Disclaimer

This document was prepared by the Congressional Research Service (CRS). CRS serves as nonpartisan shared staff to congressional committees and Members of Congress. It operates solely at the behest of and under the direction of Congress. Information in a CRS Report should not be relied upon for purposes other than public understanding of information that has been provided by CRS to Members of Congress in connection with CRS's institutional role. CRS Reports, as a work of the United States Government, are not subject to copyright protection in the United States. Any CRS Report may be reproduced and distributed in its entirety without permission from CRS. However, as a CRS Report may include copyrighted images or material from a third party, you may need to obtain the permission of the copyright holder if you wish to copy or otherwise use copyrighted material.