Annual Report on the Status of Spectrum Repurposing

U.S. Department of Commerce

Wilbur L. Ross, Secretary

Douglas W. Kinkoph, Acting Deputy Assistant Secretary for Communications and Information

August 2019

TABLE OF CONTENTS

INTRODUCTION

On October 25, 2018, President Donald J. Trump issued a *Presidential Memorandum* establishing a national policy for the efficient and effective use of radiofrequency spectrum "to help meet our economic, national security, science, safety, and other federal mission goals now and in the future."[1] Among other things, the *Presidential Memorandum* required the Secretary of Commerce, working through National Telecommunications and Information Administration (NTIA), and in coordination with the Office of Management and Budget (OMB), the Office of Science and Technology Policy (OSTP), and the Federal Communications Commission (FCC), to submit an annual report "on the status of existing efforts and planned near- to mid-term spectrum repurposing initiatives."[2] This is the initial report; it addresses activities and events during a period beginning on January 1, 2018 and running through June 30, 2019.

This report begins with some historical background and a description of the legislative and Executive Branch mandates to identify and assess spectrum bands for possible repurposing. The bulk of the report describes the status of efforts to repurpose specific bands and other non-band-specific initiatives to explore repurposing. Within the context of the *Presidential Memorandum*, the repurposing efforts and initiatives summarized in this initial report are those policy and regulatory activities aimed at implementing recent statutory requirements and achieving the policy objectives the President laid out. [3] We note that the FCC is an independent agency and that many of the actions discussed in this report are taken by the FCC either exclusively or in coordination with the Executive Branch. These activities include ongoing regulatory proceedings and feasibility studies that address, for example, the reallocation of federal and non-federal spectrum bands to enable "wireless technologies capable of meeting the high-capacity, low-latency, and high-speed requirements that can unleash innovation broadly across diverse sectors of the economy and the public sector."[4] To date, most repurposing

[1] Memorandum for the Heads of Executive Departments and Agencies, *Developing a Sustainable Spectrum Strategy for America's Future* (rel. Oct. 25, 2018) *published at* 83 Fed. Reg. 38387 (Oct. 30, 2018), *available at* https://www.whitehouse.gov/presidential-actions/presidential-memorandum-developing-sustainable-spectrum-strategy-americas-future/ (*Presidential Memorandum*), at Section 1.

[2] "Within 180 days of the date of this memorandum, and annually thereafter, the Secretary, working through the NTIA, and in coordination with the Office of Management and Budget (OMB), OSTP, and the Federal Communications Commission (FCC), shall submit to the President, through the Director of the National Economic Council and the Assistant to the President for National Security Affairs, a report (to be made public to the extent practicable and consistent with applicable law) on the status of existing efforts and planned near- to mid-term spectrum repurposing initiatives." *Id.* at Section 3.

[3] In the context of this report "spectrum repurposing" means changing the allocation of specific frequencies from one radiofrequency service or set of services to another, or changing the service rules associated with an allocation, such that the frequencies can be used by different entities and in different ways than previously. The repurposed spectrum may be allocated for either federal or non-federal use, or both, and the repurposing may involve relocating legacy systems to other spectrum bands, requiring legacy and new systems to share spectrum, or, in rare cases, discontinuing legacy systems altogether.

[4] *Presidential Memorandum*, Section 1.

activities and the statutory mandates for repurposing focus on accommodating non-federal uses and have not directed the repurposing of spectrum to new federal uses; they also prioritize exclusive non-federal use over sharing.

This report is part of a broader effort to maintain the U.S. position as a global leader in pioneering and sustaining technological and economic leadership in developing and deploying spectrum-dependent products and services, from 5G wireless systems to innovative satellite and space applications. A significant component of this effort is the construction and execution of the National Spectrum Strategy called for by the *Presidential Memorandum*. The U.S. Government will continue to support this leadership in ground-breaking wireless technologies, including those that greatly improve the spectrum efficiency and effectiveness of federal operations. This is being accomplished through ongoing efforts to assess the Nation's spectrum needs and to identify additional bands with federal and non-federal allocations to serve those needs. This will entail examining and implementing effective protective measures for incumbent services and managing the transitions as spectrum uses shift and new spectrum-sharing tools and techniques are developed and implemented. These ongoing efforts constitute a process that resembles a "pipeline" for continuous identification and assessment of bands, followed by repurposing or implementing other spectrum access mechanisms wherever needed and feasible.

SUMMARY

Table 1 provides a summary description of the status of current spectrum repurposing efforts of NTIA and the FCC, during the period covered by this report (Jan. 1, 2018 through June 30, 2019), band by band.

TABLE 1

Status of Current Repurposing Efforts, by Band

Frequency Band	*Repurposing Status*
512-698 MHz	This band with non-federal allocations (84 megahertz) was repurposed from UHF television broadcasting to licensed wireless broadband (70 megahertz) and unlicensed devices and wireless microphones (14 megahertz). New wireless licenses were awarded and incumbent full power and Class A TV station licensees were assigned new channels through the Broadcast Incentive Auction. The post-auction transition to repack broadcast licensees into a smaller band and clear the 600 MHz band for new wireless licensees is underway.
809-817 MHz 854-862 MHz	The FCC updated its rules to provide public safety organizations and other private land mobile radio users with access to as many as 318 new "interstitial" channels in the 800 MHz band.[5]
896-901 MHz 935-940 MHz	In March 2019, the FCC issued a Notice of Proposed Rulemaking (NPRM) proposing to reconfigure the 900 MHz band to facilitate the development of broadband technologies and services, including for critical infrastructure.
1300-1350 MHz	This band (50 megahertz) is used for both federal and non-federal radar and is under study for sharing with wireless services, with a goal of auctioning at least 30 megahertz by July 1, 2024, if relocation, sharing, or a combination thereof proves feasible.
1526-1536 MHz 1627.5-1637.5 MHz 1646.5-1656.5 MHz	These three sub-bands (30 megahertz) are within the 1525-1559 MHz and 1626.5-1660 MHz bands allocated for federal and non-federal mobile satellite services (including an ancillary terrestrial component (ATC)). The current licensee has asked the FCC for a modification to its license to authorize stand-alone terrestrial wireless operations.
1675-1680 MHz	This band (5 megahertz) is currently allocated for federal and non-federal meteorological aids and satellite services; it is under study by the National Oceanic and Atmospheric Administration (NOAA) and is the subject of an FCC rulemaking proceeding to determine if the band could be shared with commercial terrestrial wireless services. Results from the NOAA study are expected in 2020.
1695-1710 MHz 1755-1780 MHz 2155-2180 MHz	The FCC auctioned these "AWS-3" bands (65 megahertz) in 2015 to accommodate licensed wireless services, with some continued federal sharing at selected locations. The transition is ongoing and is slated to be completed by 2025.
2020-2025 MHz	This band with a non-federal allocation (5 megahertz) is currently allocated on a co-primary basis to the fixed and mobile services.

[5] FCC, Creation of Interstitial 12.5 kilohertz Channels in the 800 MHz Band Between 809-817/854-862 MHz, *Report and Order and Order*, 31 FCC Rcd 9431 (2018).

2496-2690 MHz	The FCC released a public draft Report and Order (R&O) that would provide greater flexibility to current Educational Broadband Service (EBS) licensees and create new opportunities for additional entities, including Tribal Nations, to obtain unused 2.5 GHz band spectrum.
3100-3550 MHz	This band (450 megahertz), with a primary federal allocation for radiolocation, is under study to determine the feasibility of sharing the band, or a portion thereof, with commercial wireless services. A report is due to the Commission and the appropriate committees of Congress by March 2020. Portions of this band are used for non-federal radiolocation, space research, earth exploration satellites, and amateur services (on a secondary basis).
3550-3650 MHz	This band with both federal and non-federal allocations (100 megahertz), together with the 3650-3700 MHz band, has been made available for the Citizens Broadband Radio Service (or CBRS) under an innovative sharing approach that allows ongoing federal radar use. The FCC has enacted a tiered licensing structure to repurpose this band for use by commercial wireless services. The FCC and the NTIA have taken a number of actions towards implementing this sharing approach.
3700-4200 MHz	This is a band with a non-federal allocation that is currently used primarily by commercial satellite systems. The FCC has commenced a rulemaking proposing to make some or all of the band available for terrestrial wireless. The FCC also must report to Congress in September 2019 on the feasibility of making the band available for licensed or unlicensed commercial wireless services.
4940-4990 MHz	The Commission is exploring ways to expand investment in and the use of the 4.9 GHz band.
5850-5925 MHz	This band is allocated for federal radars on a primary basis. FCC authorized Dedicated Short Range Communications (DSRC) in the co-primary mobile service, under Part 95, Sub-Part L and 90.371 of the FCC rules. The FCC, NTIA, Department of Defense, and the Department of Transportation are studying the potential for unlicensed use of this band (or a portion of it), and whether this use, or expansion of the DSRC to other vehicular services, would be compatible with each other and incumbent operations. Phase I of a multi-phase testing plan was completed in 2018; Phase II will commence in Summer 2019.
5925-6425 MHz 6425-7125 MHz	The FCC has proposed rules under which these bands with non-federal allocations would be made available to address the expected growth of Wi-Fi and Internet of things (IoT) devices. In addition, federal agencies and NTIA have a pending proposal at the FCC to implement the results of WRC-07 and make the 5925-6700 MHz band available for aeronautical mobile telemetry (flight testing).

24.25–24.45 GHz 24.75–25.25 GHz*	The FCC made 700 megahertz of spectrum available in the 24 GHz band under flexible-use rules and conducted an auction of licenses in this band.[6]
27.5–28.35 GHz*	The FCC made 850 megahertz of spectrum available in the 28 GHz band under flexible-use rules and completed an auction of 28 GHz licenses.
25.25-27.5 GHz 42-42.5 GHz	The FCC sought comment on potential shared use of the 26 GHz and 42 GHz bands.
37-37.6 GHz	The FCC sought comment on a mechanism for shared use of the Lower 37 GHz band by federal and non-federal entities.
37.6-38.6 GHz 38.6-40 GHz 47.2-48.2 GHz*	The FCC made 3.4 gigahertz of spectrum available in the Upper 37 GHz, 39 GHz, and 47 GHz bands, and established an incentive auction mechanism to assign new licenses for contiguous spectrum in these bands while preserving incumbents' existing spectrum usage rights in the 39 GHz band.[7]
50.4–52.6 GHz	The FCC sought comment on making this band available for flexible terrestrial use, and it adopted rules to allow fixed-satellite service operators to operate with individually licensed earth stations transmitting in the 50.4-51.4 GHz portion of this band.
64-71 GHz	The FCC made 7 gigahertz of unlicensed spectrum available in the 64-71 GHz band, adjacent to another 7 gigahertz of unlicensed spectrum in the 57-64 GHz band.
95-3000 GHz	The FCC created a new category of experimental licenses for use of frequencies between 95 GHz and 3 Terahertz (THz).
116-123 GHz 174.8-182 GHz 185-190 GHz 244-246 GHz	The FCC made available just over 21 gigahertz of spectrum for unlicensed use in these shared bands with federal and non-federal allocations.[8]
* Indicates that a band, or a portion of a band, has recently been made available (*e.g.*, through adoption of final rules or by auction) and no further repurposing activities are required.	

[6] On April 17, 2019, bidding concluded in the clock phase of the auction of 24 GHz licenses. Bidding in the assignment phase began on May 3, 2019, and concluded on May 28, 2019.

[7] Bidding on licenses in the Upper 37 GHz, 39 GHz, and 47 GHz bands is scheduled to begin on December 10, 2019.

[8] On March 15. 2019, the FCC approved the Spectrum Horizons First Report and Order that created a new category of experimental licenses for spectrum between 95 GHz and 3 THz. Spectrum Horizons, ET Docket No. 18-21, *First Report and Order*, 34 FCC Rcd 1605 (2) (2019), *available at* https://docs.fcc.gov/public/attachments/FCC-19-19A1.pdf (*Spectrum Horizons First Report & Order*). The item also made 21.2 GHz of spectrum available for unlicensed use.

Table 1 identifies bands recently repurposed or currently being considered for repurposing, most of which would accommodate commercial wireless services. Meanwhile, a total of 5,863 megahertz (about 5.9 gigahertz) already has been made available in bands that can be licensed and used to advance Fifth-Generation ("5G") technologies. In terms of spectrum range, this includes 204 megahertz of low-band spectrum (under 1 GHz), 709 megahertz of mid-band spectrum (above 1 GHz and under 6 GHz), and 4,950 megahertz of high-band spectrum (above 24 GHz) that has been made available.[9]

Moreover, a further 7,250 megahertz (7.25 gigahertz) of potential licensed spectrum is under active consideration or study. This includes 10 megahertz of low-band spectrum, 1,090 megahertz of mid-band spectrum, and 6,150 megahertz of high-band spectrum that is in the pipeline (under consideration or study).[10] This would yield a potential 13,113 megahertz (13 gigahertz) that ultimately could be available for licensed 5G networks (including the spectrum that already has been repurposed).

In addition, more spectrum is being made available for unlicensed wireless usage, which likely will be adjunct to licensed 5G spectrum usage. A full 14,689.5 megahertz (14.7 gigahertz) of unlicensed spectrum has been made available across low-band (26 megahertz), mid-band (663.5 megahertz) and high-band (14,000 megahertz) ranges.[11] In addition, a further 1,200 megahertz is being proposed for mid/high-band unlicensed usage (predominantly in the 6-7 GHz range).[12]

---

[9] For the purposes of this report, the ranges for the low, mid, mid/high, and high bands are taken from the White House Office of Science And Technology Policy (OSTP) Report, *Emerging Technologies And Their Expected Impact On Non-Federal Spectrum Demand* (May 2019), which states the low-band range as spectrum below 1 GHz, the mid-band range as spectrum between 1-6 GHz, the mid/high-band range between 6-24 GHz, and the high-band range as spectrum above 24 GHz. Furthermore, we recognize there are variations of these ranges depending on the source of information (*e.g.*, FCC, service providers, manufacturers).

[10] Licensed spectrum under consideration (Low-band – 10 megahertz [896-901/935-940 MHz]; Mid-band – 1090 megahertz [50 megahertz in 1300-1350 MHz, 10 megahertz in 1526-1536 MHz, 10 megahertz in 1627.5-1637.5 MHz, 10 megahertz in 1646.5-1656.5 MHz, 5 megahertz in 1675-1680 MHz, 5 megahertz in 2020-2025 MHz, 350 megahertz in 3100-3450 MHz, 100 megahertz in 3450-3550 MHz, 500 megahertz in 3700-4200 MHz, and 50 megahertz in 4940-4990 MHz]; High-band – 6150 megaherz [2250 megahertz in 25250-27500 MHz, 1200 megahertz in 31800-33000 MHz, 500 megahertz in 42000-42500 MHz, and 2200 megahertz in 50400-52600 MHz]).

[11] Unlicensed spectrum amounts (Low-band – 26 megahertz in 902-928 MHz; Mid-band – 663.5 megahertz [83.5 megahertz in 2400-2483.5 MHz and 580 megahertz in 5 GHz (U-NII)]; High-band – 14,000 megahertz [57-71 GHz]).

[12] FCC, Unlicensed Use of the 6 GHz Band; Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz, *Notice of Proposed Rulemaking*, FCC 18-147 (rel. Oct 24, 2018). Note that for purposes of this report, the sub-band 5925-6000 MHz has been included in the mid/high-band category with the rest of the 6-7 GHz range (*i.e.,* 5925-7125 MHz), for consistency and to avoid confusion.

In addition, several initiatives are underway that are not band-specific pursuant to the MOBILE NOW Act of 2018.[13] These include a study of opportunities for increasing federal use of non-federal spectrum (sometimes referred to as "bi-directional sharing"); the development of a national plan for additional spectrum for unlicensed or licensed-by-rule operation; a study of incentives for federal agencies to increase their repurposing of federal spectrum to facilitate the provision of commercial wireless broadband; and the development of new rules to increase unlicensed use of guard bands.

BACKGROUND

Efforts to repurpose spectrum have been ongoing for decades in response to the growth of commercial wireless and satellite services. The policy of examining whether federal spectrum could be repurposed for non-federal uses became salient during the 1990s. For example, the 1710-1755 MHz band was identified by NTIA for transfer from federal use to federal and non-federal use in conjunction with the Omnibus Budget Reconciliation Act of 1993 (OBRA-93).[14] A more recent example is the repurposing of federal spectrum auctioned for Advanced Wireless Services (AWS-3) licenses in the 1695-1710 MHz, 1755-1780 MHz, and 2155-2180 MHz bands.[15] That effort, which involved development and coordination of a combined relocation and sharing approach, netted the U.S. Treasury more than $41 billion and made available spectrum to expand wireless broadband services. Another recent example is the FCC's incentive auction of UHF television spectrum in the 600 MHz band.[16] Repurposing has been a facet of federal spectrum policy through multiple presidential administrations over the past 25 years.

Legislative and Executive Branch Mandates

As this policy evolved in the 1990s,[17] Congress took a series of legislative actions over the following decades, creating a framework to effect federal spectrum reallocations and to

---

[13] MOBILE NOW Act, Division P, Title VI (pp. 750-768) of the Consolidated Appropriations Act of 2018, Pub. L. No. 115-141, *available at* https://www.congress.gov/115/plaws/publ141/PLAW-115publ141.pdf (*MOBILE NOW Act*).

[14] Pub. L. No. 103-66, 107 Stat. 312 (1993).

[15] NTIA and the FCC, respectively, maintain AWS-3 Transition websites at https://www.ntia.doc.gov/category/aws-3-transition and https://www.fcc.gov/auction/97.

[16] *See* FCC Post-Auction Transition website at https://www.fcc.gov/about-fcc/fcc-initiatives/incentive-auctions/post-auction-transition.

[17] Title VI of the Omnibus Budget Reconciliation Act of 1993 required that the Secretary of Commerce identify at least 200 megahertz of spectrum below 5 GHz used by the Federal Government for reallocation to new spectrum-based technologies. *See* Pub. L. No. 103-66, Title VI, 107 Stat. 312, 380 (1993). In response, NTIA published a plan identifying twelve bands and a reallocation schedule for each. *See* NTIA, Spectrum Reallocation Final Report,

repurpose spectrum with non-federal allocations for flexible use. These included the establishment of the Spectrum Relocation Fund (SRF) to defray the costs of relocating federal spectrum uses to new bands.[18] More recently, the Middle Class Tax Relief and Job Creation Act of 2012 and the Spectrum Pipeline Act of 2015 refined the tools available for NTIA and the federal users to explore repurposing of federal spectrum bands, including spectrum sharing.[19] The Spectrum Pipeline Act appropriated funds for federal agencies to conduct studies to improve the efficiency and effectiveness of their spectrum use in order to make it available for auction. This allowed federal agencies to propose spectrum "Pipeline Plans" to receive some of this funding tied to potential auctions. The Spectrum Pipeline Act also required NTIA and the FCC to identify certain amounts of federal and non-federal spectrum for repurposing.

More recently, the MOBILE NOW Act of 2018 required the identification of spectrum for repurposing and called for studies and reports related to spectrum repurposing.[20] Specifically, section 603(a) of the Act requires NTIA and the FCC to prepare a report identifying 255 megahertz of federal and non-federal spectrum for mobile and fixed wireless broadband use. The various requirements of the Spectrum Pipeline Act and the MOBILE NOW Act fall into three categories:

1. Requirements to study the feasibility of, or develop rules for, new spectrum sharing in specific frequency bands;
2. Requirements to identify, for repurposing, spectrum bands meeting certain criteria or amounts specified in the legislation; and
3. Other, non-band-specific spectrum repurposing activities and studies.

NTIA Special Publication 95-32 (Feb. 1995). Title III of the Balanced Budget Act of 1997 (Budget Act) required the FCC to identify 15 megahertz from the 1990-2110 MHz band for assignment by competitive bidding, but also provided a process for spectrum substitution to protect incumbent federal systems from interference if determined to better serve the public interest. *See* Pub. L. No. 105-33, Title III, 111 Stat. 251, 258-270 (1997).

[18] Congress enacted the Commercial Spectrum Enhancement Act (CSEA) in 2004 (Title II of Public Law 108-494), creating the SRF and paving the way for the initial AWS auction of the 1710-1755 MHz band (AWS-1).

[19] *See* Middle Class Tax Relief and Job Creation Act of 2012, Pub. L. No. 112-96, Title VI, Subtitle G, 126 Stat. 245-255 (Feb. 22, 2012); Spectrum Pipeline Act of 2015, Pub. L. No. 114-74, Title X, 129 Stat. 621-624 (Nov. 2, 2015) (Spectrum Pipeline Act).

[20] *MOBILE NOW Act*.

Table 2 below summarizes the requirements for each of these categories.

TABLE 2

Summary of Statutory Provisions Related to Spectrum Repurposing, by Category

Requirements regarding Specific Bands To Be Repurposed:

- *MOBILE NOW* §605(b)—FCC 3700-4200 MHz sharing feasibility study
  - Due date: September 23, 2019 (MOBILE NOW Act + 18 months)
- *MOBILE NOW* §604—FCC 42-42.5 GHz service rules NPRM
  - Due date: March 23, 2020 (MOBILE NOW Act + 2 years)
- *MOBILE NOW* §605(a)—NTIA 3100-3550 MHz sharing feasibility report
  - Due Date: March 23, 2020 (MOBILE NOW Act + 24 months)

Requirements to Identify Spectrum Meeting Certain Criteria or Amounts:

- *Spectrum Pipeline* §1004(a)—DOC must report to President and FCC identifying 30 megahertz below 3 GHz for reallocation to non-federal or shared or both (excludes 1675-1695 MHz)
  - Due date: January 1, 2022, for report and to begin withdrawing or modifying federal assignments; July 1, 2024 for the FCC to begin auctioning spectrum
- *Spectrum Pipeline* §1006(c)(1)—FCC report for at least 50 megahertz of additional spectrum below 6 GHz (excludes §1004(a) spectrum)
  - Due date: January 1, 2022
- *Spectrum Pipeline* §1006(c)(2)—FCC report for at least 50 megahertz of additional spectrum below 6 GHz (excludes §1006(c)(1) spectrum and §1004(a) spectrum)
  - Due date: January 1, 2024
- *MOBILE NOW* §603(a)—NTIA and FCC must identify 255 megahertz for mobile and fixed broadband use
  - 100 megahertz below 8 GHz for unlicensed
  - 100 megahertz below 6 GHz for licensed
  - 55 megahertz below 8 GHz for licensed or unlicensed or both
    - Due date: December 31, 2022

Provisions for Other Related Activities and Studies:

- *Spectrum Pipeline* §1008(1)—FCC report on results of 3550-3650 MHz rule changes
  - Released: November 2, 2018[21]
- *Spectrum Pipeline* §1008(2)—FCC report analyzing "1 gigahertz in 6-57 GHz" sharing
  - Released: November 2, 2018[22]
- *MOBILE NOW* §610—FCC Bidirectional sharing study
  - Due date: September 23, 2019 (MOBILE NOW Act + 18 months)

[21] Report to Congress Pursuant to Section 1008 of the Spectrum Pipeline Act of 2015, as amended by the Ray Baum's Act of 2018, et al., *Report*, 33 FCC Rcd 11033 (2018).

[22] *Id*.

- *MOBILE NOW* §618(b)—FCC national plan for additional unlicensed or licensed-by-rule spectrum
    - Due date: September 23, 2019 (MOBILE NOW Act + 18 months)
- *MOBILE NOW* §618(d)—NTIA appendix to above plan, to reform the Spectrum Relocation Fund
    - Due date: September 23, 2019 (MOBILE NOW Act + 18 months)
- *MOBILE NOW* §609—NTIA Federal Sharing Incentives report
    - Due date: March 23, 2020 (MOBILE NOW Act + 24 months)
- *MOBILE NOW* §611—FCC rules for unlicensed use of guard bands
    - No Deadline

Over the past couple of decades, the White House has issued directive documents regarding spectrum repurposing. More recently, the Trump Administration has established spectrum policy as a top priority, issuing the October 25, 2018 *Presidential Memorandum* calling for development of a comprehensive, long-term National Spectrum Strategy. In addition to the strategy and this report, the *Presidential Memorandum* calls for several other, near-term Executive Branch actions that are relevant to carrying out many of the provisions outlined above. Specifically, by the end of April 2019:

- Executive Branch agencies must report to the Secretary of Commerce on their anticipated future requirements for spectrum (Section 2(a) of the *Presidential Memorandum*);
- The agencies must initiate a review of their current spectrum assignments and quantification of their spectrum usage (Section 2(a) of the *Presidential Memorandum*);
- The Office of Science and Technology Policy (OSTP) must submit a report to the President on emerging technologies and their expected impact upon demand for non-federal spectrum access (Section 2(b) of the *Presidential Memorandum*); and
- OSTP also must deliver a report on recommendations for research and development priorities to advance spectrum access and efficiency (Section 2(c) of the *Presidential Memorandum*).

Further, by July 22, 2019 (270 days after release of the *Presidential Memorandum*), NTIA must submit a National Spectrum Strategy with legislative, regulatory, or other policy recommendations (Section 4 of the *Presidential Memorandum*). Among the objectives of the Strategy is one to "increase spectrum access for all users, including on a shared basis, through transparency of spectrum use and improved cooperation and collaboration between federal and non-federal stakeholders."[23] While the *Presidential Memorandum* does not specifically call for repurposing of spectrum, its implementation will help inform policy-makers' decisions and add

[23] *Presidential Memorandum*, Section 4(a).

to the spectrum management and planning tools they can use in considering potential repurposing.

CURRENT SPECTRUM REPURPOSING ACTIVITIES

NTIA and the FCC share responsibility for managing the nation's radio spectrum resources in the public interest. NTIA manages spectrum and assigns frequencies to federal stations, while the FCC has regulatory authority, including licensing, over non-federal stations.[24] NTIA and the FCC, working with other federal agencies, have undertaken a comprehensive and systematic effort to implement these various statutory provisions. This has entailed facilitating the process or "pipeline" to systematically analyze potential bands for possible repurposing, identify appropriate bands for more intensive study, and then engage in cooperative and cross-governmental efforts to develop specific spectrum-sharing or relocation approaches. Throughout this process, NTIA has worked closely with the FCC, the federal agencies, and industry groups to carefully identify and coordinate additional commercial access to spectrum while preserving the vital spectrum access that federal agencies require to fulfill their statutory missions. The following subsection is a discussion of all the various bands currently undergoing repurposing (including transitioning) or being assessed for potential repurposing during this reporting period.

Repurposing Initiatives by Spectrum Band

NTIA and the FCC recognize that future wireless services for both federal and non-federal users will require a diversity of radio-frequency spectrum in the low, mid, mid/high, and high ranges, distinguished by such factors as capacity, latency, coverage, and building penetration. To best respond to evolving commercial demand, NTIA and the FCC have sought to make spectrum available in all of these ranges, from the 512-698 MHz UHF Television Band to the 95 GHz band and beyond.

Low-Band Spectrum

512-698 MHz UHF TV Incentive Auction

From March 2016 to April 2017, the FCC conducted its first incentive auction, to repurpose spectrum for new uses in the UHF television broadcasting band. The incentive auction consisted of a reverse auction, which set the price at which broadcasters would voluntarily relinquish some or all of their spectrum rights, followed by a forward auction to determine the prices commercial entities would pay for flexible-use wireless licenses in the spectrum the broadcasters vacated. The auction generated $10.05 billion in payments to the

[24] The FCC is an independent agency headed by a Chairman and four additional Commissioners, while NTIA is an Executive Branch agency administered the Assistant Secretary for Communications and Information on authority delegated by the President of the United States. *See* 47 U.S.C. §§ 301, 305(a).

winning broadcast bidders (the "incentive" payment) and more than $7 billion for the U.S. Treasury. The two-part auction repurposed a total of 84 megahertz of spectrum, including 70 megahertz for licensed use and another 14 megahertz for wireless microphones and other unlicensed use. This 84 megahertz meets the requirements to partially satisfy §603(a)(5) of the MOBILE NOW Act. In 2018, the FCC completed the process of granting 600 MHz license applications filed by winning wireless bidders; continued the post-auction repacking process in which 987 full power and Class A television stations received new channel assignments in a smaller TV band; reimbursed full-power and Class A TV stations for expenses incurred as a result of the repacking as required by the 2012 Middle Class Tax Relief and Job Creation Act; and began implementing the 2018 Reimbursement Expansion Act, which added low power television, TV translator and FM broadcast stations to the category of stations eligible for reimbursement of expenses incurred as a result of the post-auction transition.

- Current Status: This band has been repurposed; broadcast station transition is underway; wireless services have commenced in some markets.
- Next Steps: Completion of transition, allowing licensees to begin operation nationwide.

800 MHz Band - Interstitial Channel Allocation

In 2015, the FCC sought comment on expanding use of the 800 MHz band by creating 12.5 kilohertz interstitial channels in frequencies between existing channels.[25] Introduction of these "interstitial" channels facilitates the reuse of spectrum that could not otherwise be used without causing interference. The mid-segment of the 800 MHz band consists of the Interleaved Band (809-815/854-860 MHz, 240 channels), the Expansion Band (815-816/860-861 MHz, 40 channels), and the Guard Band (816-817/861-862 MHz, 40 channels). This portion of the band is licensed on an exclusive basis, assigned using 25 kilohertz bandwidth channels with 25 kilohertz separation between channels. In November 2018, the FCC allowed Public Safety, Business/Industrial/Land Transportation (B/ILT), Specialized Mobile Radio, and General Pool users access to as many as 318 new interstitial channels for use with very-narrowband equipment.

- Current Status: This band plan has been adopted, but interstitial licensing has not begun.
- Next Steps: The FCC will announce the date on which interstitial channels are available for licensing in each region.

[25] FCC, Creation of Interstitial 12.5 Kilohertz Channels in the 800 MHz Band Between 809-817/854-862 MHz, *Notice of Proposed Rulemaking*, 30 FCC Rcd 1663 (2015) (*800 MHz Interstitial NPRM*).

900 MHz Band

In March 2019, the FCC adopted an NPRM to propose a reconfiguration of the 900 MHz band (896-901/935-940 MHz) to facilitate the development of broadband technologies and services.[26] This action followed a 2017 Notice of Inquiry (NOI) that examined reconfiguring the band to create a broadband service, and allowing Specialized Mobile Radio (SMR) systems on B/ILT channels.[27] The 900 MHz band is currently designated for narrowband private land mobile radio (PLMR) communications by licensees and for SMR providers, with deployed systems primarily used for two-way communication by land transportation, utility, manufacturing, and petrochemical companies. The FCC is proposing to designate 897.5-900.5 MHz/936.5-939.5 MHz for broadband segments, which would leave two separate narrowband segments: a 1.5/1.5 megahertz segment (896-897.5/935-936.5 MHz) below the broadband segment, and a 0.5/0.5 megahertz segment (900.5-901/939.5-940 MHz) above the broadband segment.

- Current Status: The FCC is reviewing public comments.
- Next Steps: The FCC will issue a final determination on NPRM.

Mid-Band Spectrum

1300-1350 MHz Band

Plans for studying whether to make 30 to 50 megahertz of this federal band available for commercial use began in 2017 with the inception of the Spectrum Efficient National Surveillance Radar (SENSR) program, which would relocate the long-range federal radars from the 1300-1350 MHz band by combining the long-range detection requirement with radar functions of multiple agencies into a range of surveillance solutions that would operate in spectrum other than 1300-1350 MHz. The Federal Aviation Administration (FAA), Department of Defense (DoD), Department of Homeland Security (DHS), and NOAA developed a cross-agency team for the program. OMB provided SRF funding authorized under the Spectrum Pipeline Act for the SENSR analysis and planning study. NOAA later withdrew the meteorological functions from the SENSR program, although it continues to participate in the studies, since meteorological systems will likely share spectrum with SENSR. DoD also submitted a plan for pipeline funding for its "Non-SENSR" studies to assess sharing between the incumbent DoD systems that are expected to remain in the band and potential new commercial systems. The Non-SENSR pipeline plan was approved by the Technical Panel and was sent to OMB for funding approval. Thirty megahertz of this band would satisfy the requirement of

[26] FCC, Review of the Commission's Rules Governing the 896-901/935-940 MHz Band, *Notice of Proposed Rulemaking*, 34 FCC Rcd 1550 (2019).

[27] FCC, Review of the Commission's Rules Governing the 896-901/935-940 MHz Band, *Notice of Inquiry*, 32 FCC Rcd 6421 (2017) (*900 MHz NOI*).

Section 1004(a) of the Spectrum Pipeline Act to identify "30 megahertz of electromagnetic spectrum [below 3 GHz] for reallocation from federal use to non-federal use or shared federal and non-federal use, or a combination thereof."

- Current Status: The band is actively being studied, using SRF funding via the Spectrum Pipeline Act, for possible repurposing.
- Next Steps: The Pipeline studies are expected to be completed by 2021, in time for a repurposing decision by January 2022 and an auction by July 2024, as required by the Spectrum Pipeline Act.

1526-1536 MHz, 1627.5-1637.5 MHz and 1646.5-1656.5 MHz MSS L-Band

In December 2015, Ligado Networks LLC filed license modification applications to change the ancillary terrestrial component (ATC) of its mobile satellite service (MSS) license in three band segments: base stations in the 1526-1536 MHz portion of the MSS downlink band, user equipment in the 1627.5-1637.5 MHz, and 1646.5-1656.5 MHz portions of the MSS uplink band.[28] The applicant abandoned its predecessor-company's efforts to use a fourth band segment (1545-1555 MHz) for any ATC or terrestrial base station use. It also proposed technical and operational parameters, including base station and user equipment power limits and out-of-band emission limits. These limits were based on the terms of agreements reached with certain Global Positioning System (GPS) device manufacturers.[29]

Throughout the pendency of these applications, various federal agencies and interagency groups have worked diligently to evaluate the difficult technical and regulatory issues raised by these applications and their potential impact on GPS, if granted by the FCC. One of these related activities was the significant efforts by the Department of Transportation (DOT) to develop tolerable interference levels in bands adjacent to spectrum used by GPS. This could inform proposals for non-space commercial uses of bands adjacent to GPS signals, so that any such proposals could be implemented in a way that would not affect current and evolving uses of space-based Positioning, Navigation & Timing (PNT) services vital to economic, public safety, scientific, and national security needs. Over the last several years, DOT conducted six public workshops around the country, and developed test plans and use cases, culminating in laboratory measurements of 80 GPS receivers in an anechoic chamber in April 2016. DOT tested civilian GPS devices and antenna equipment used for non-certified aviation, cellular, general

[28] *See* Letter from Gerald J. Waldron, New LightSquared, to Ms. Marlene Dortch, Secretary, FCC, at 1 (filed Dec. 31, 2015) (*Ligado December 2015 Letter*), *available at* https://ecfsapi.fcc.gov/file/60001396811.pdf.

[29] *See id.* at 1-2; *see also* "Comments Sought on Ligado Modification Applications," 31 FCC Rcd 3802 (Apr. 22, 2016).

location/navigation, high-precision, timing, and space-based applications. The DOT released a final report in April, 2018 (the *DOT ABC Assessment*) that specified acceptable emissions limits for a variety of GPS receivers. On parallel tracks, the Air Force and FAA focused on military GPS receivers and certified GPS avionics, respectively.[30]

In addition to the DOT compatibility assessment, the PNT Executive Committee (ExCom) requested its National Space-Based PNT Systems Engineering Forum (NPEF) to conduct an assessment of the testing methodologies used in five different tests conducted from 2011 through 2017 to analyze the impacts of adjacent-band interference on GPS receivers.[31] The NPEF concluded that the results from three of the tests (NPEF in 2011, FCC's Technical Working Group from 2011, and the DOT adjacent-band assessment) were sufficient and appropriate to inform spectrum policy-makers on the major impacts of the applicant's proposed terrestrial network on GPS receivers.

Following the release of *the DOT ABC Assessment* in April 2018, the applicant amended its pending applications in May 2018 to reduce the maximum transmitter power of its terrestrial base stations operating in the 1526-1536 MHz from 32 dBW to 9.8 dBW (*i.e.*, 39.8 dBm/10 MHz).[32] This reduced power level is in excess of the limits established in the *DOT ABC Assessment*,[33] but the applicant also stated that it would agree to conditions on its license that would: (a) prohibit any base station transmitter antenna in this band from operating within specified distances of any FAA-established obstacle clearance surface; and (b) impose specific reporting, notification, and monitoring obligations.[34] Although the applicant committed to address concerns about potential adverse effects of its operations on U.S. Government GPS devices – "including but not limited to upgrading or replacing government devices" – it did not

[30] *See* U.S. Dep't of Transportation, *Global Positioning System (GPS) Adjacent Band Compatibility Assessment: Final Report* (Apr. 2018) (*DOT ABC Assessment*), *available at* https://go.usa.gov/xPQPt; *see also* U.S. Dep't of Transportation, *Global Positioning System Adjacent Band Compatibility Assessment Workshops I through VI*, *available at* https://www.transportation.gov/pnt/adjacent-band-workshops-federal-register-public-notices.

[31] *See* National Space-Based Positioning, Navigation, and Timing Systems Engineering Forum, Final Report: Assessment to Identify Gaps in Testing of Adjacent Band Interference to the Global Positioning System (GPS) L1 Frequency Band (Mar. 2018), *available at* https://go.usa.gov/xPQE8. In addition to the DOT assessment, studies were conducted by a Commission-mandated Technical Working Group (2011), NPEF (2012), Roberson and Associated on behalf of Ligado (2016), and the National Advanced Spectrum and Communications Test Network (2017). *See id.* at 3.

[32] *See* Letter from Gerald Waldron, Ligado, to Ms. Marlene Dortch, Secretary, FCC, at 1 (May 31, 2018) (*Ligado May 31 Letter*), *available at* https://ecfsapi.fcc.gov/file/1053120688074/Ligado%20License%20Modification%20Cover%20Letter%20and%20Amendment%20(5-31-2018).pdf.

[33] *See DOT ABC Assessment* at Table ES-1.

[34] *See Op. Cit.*

propose that as a license condition, stating only that "it expects a requirement to this effect."[35] The revised application did not address GPS devices not owned by the U.S. Government in this regard.

In August 2018, the PNT Advisory Board (PNTAB) recommended that the PNT ExCom oppose the applicant's proposal based on the need to protect all GPS devices over 90 percent of the area surrounding the applicant's base station transmitters using a 1 dB rise in the carrier-to-noise density ratio (C/N_0), one of the criterion recommended by the PNTAB and also specified by the PNT EXCOM in the NPEF Gap Analysis tasking.[36] The PNTAB letter specifically addressed the applicant's May amendment to its modification application, finding further fault in the applicant's failure to specify "transmitter spacing" or "a feasible scheme for monitoring their interference levels, expecting the GPS user to contact them instead."[37]

- Current Status: Ligado filed an amendment in May 2018.
- Next Steps: The FCC will issue a determination on the applicant's pending modification applications.

1675-1680 MHz Band

In 2012 and again in 2016, the FCC sought comment on a petition for rulemaking that proposed rules to enable terrestrial mobile operations in the 1675-1680 MHz band on a shared basis with incumbent meteorological services.[38] Since 2013, OMB's budget proposals submitted

---

[35] *See id*. at 2. The Commission provided public notice of the application's filing on June 8, 2018. Space Station Applications Accepted for Filing, *Public Notice*, Report No. SAT-01321, at 1 (rel. June 8, 2018), *available at* https://docs.fcc.gov/public/attachments/DOC-351419A1.pdf. In response to that notice, several parties contended that the applicant had not adequately addressed GPS interference issues. *See, e.g.*, Comments of Aviation Spectrum Resources, Inc., at 3-5 (filed Jul. 9, 2018), *available at* https://ecfsapi.fcc.gov/file/1070990738110/ASRI%20Ligado%20Amendment%20Comments%20(FINAL%207-9-18).pdf; Comments of The Boeing Company, at 2-3 (filed Jul. 9, 2018), *available at* https://ecfsapi.fcc.gov/file/107091154000514/Boeing%20Comments%20on%20Ligado%20Further%20Modification%20PN%207%209%202018%20final.pdf.

[36] *See* Letter from Bradford W. Parkinson, 1st Vice-Chair, PNT Advisory Board, to Patrick M. Shanahan, Deputy Secretary of Defense, and Jeffrey A. Rosen, Deputy Secretary of Transportation (Aug. 10, 2018) (*PNTAB August 2018 Letter*), *available at* https://www.gps.gov/governance/advisory/recommendations/2018-08-letter-to-excom.pdf; *see also* PNTAB Meeting Minutes for Intersession Meeting 21A, Aug. 6, 2018 (posted Sept. 20, 2018), *available at* https://www.gps.gov/governance/advisory/meetings/2018-08/minutes.pdf); Letter from John Stenbit, Chair, PNT Advisory Board, to Robert O. Work, Deputy Secretary of Defense, and Jeffrey A. Rosen, Deputy Secretary of Transportation (July 5, 2017), *available at* https://www.gps.gov/governance/advisory/recommendations/2017-07-letter-to-excom.pdf.

[37] *See PNTAB August 2018 Letter* at 1.

[38] *See* Petition of LightSquared Subsidiary LLC for Rulemaking (Nov. 2, 2012); Petition for Rulemaking Filed, RM No. 11681, Public Notice, Report No. 2967 (Nov. 9, 2012); Comment Sought to Update the Record on Ligado's

for Fiscal Years 2014 through 2019 proposed that the FCC reallocate the 1675-1680 MHz band for non-federal shared use.[39] It would require the FCC to either auction or use fee authority to assign spectrum frequencies between 1675-1680 megahertz for flexible use by 2020, subject to sharing arrangements with federal weather satellites.[40] The proposal would also expect NOAA to "establish limited protection zones for the remaining weather satellite downlinks and develop alternative data broadcast systems for users of its data products."[41]

Under a study funded via the Spectrum Pipeline Act, NOAA is evaluating whether and how such a proposal could be implemented without compromising NOAA's mission to obtain and distribute meteorological data.[42]

In May 2019, the FCC proposed to reallocate the 1675-1680 MHz band for shared use between incumbent federal operations and non-federal fixed or mobile (except aeronautical mobile) operations on a co-primary basis and sought comment on proposals for reallocation.[43]

- Current Status: NOAA is studying this band under a Spectrum Pipeline Plan.
- Next Steps: NOAA is expected to complete its spectrum pipeline study by March 2020. As a result, NOAA's input in response to the NPRM may be limited until the Spectrum Pipeline Plan has been completed. The FCC may issue a final determination on the NPRM.

1695-1710 MHz, 1755-1780 MHz and 2155-2180 MHz (AWS-3) Bands

In January 2015, the FCC completed an auction of new, commercial AWS-3 licenses in

---

Request That the Commission Initiate a Rulemaking to Allocate the 1675-1680 MHz Band for Terrestrial Mobile Use Shared with Federal Use, RM-11681, Public Notice, 31 FCC Rcd 3813 (2016).

[39] *See* Fiscal Year 2014 Analytical Perspectives, Budget of the U.S. Government, Office of Management and Budget, at 228-229; Fiscal Year 2015 Analytical Perspectives, Budget of the U.S. Government, Office of Management and Budget, at 199; Fiscal Year 2016 Analytical Perspectives, Budget of the U.S. Government, Office of Management and Budget, at 215; Fiscal Year 2017 Analytical Perspectives, Budget of the U.S. Government, Office of Management and Budget, at 220; FCC Fiscal Year 2018 Budget in Brief at 7 (May 2017), FCC Fiscal Year 2019 Budget in Brief at 9 (Feb. 2018).

[40] Most recently, the FCC's Fiscal Year 2020 budget included the same proposal. *See* FCC, Fiscal Year 2020 Budget in Brief, at 10 (Mar. 2019), *available at* https://docs.fcc.gov/public/attachments/DOC-356607A2.pdf.

[41] *Id.*

[42] *See, e.g.*, NOAA, *Spectrum Reallocation Study: Solicitation Number SP-133E-17-RF-SpectrumReallocationStudy* (Apr. 13, 2017), *available at* https://www.fbo.gov/notices/49c5770f499de8d04fe9267745785e2f.

[43] Fact Sheet: Allocation and Service Rules for the 1675–1680 MHz Band, *Draft Notice of Proposed Rulemaking and Order*, GN Docket No. 19-116 (rel. Apr. 17, 2019), *available at* https://docs.fcc.gov/public/attachments/DOC-357088A1.pdf.

the 1695-1710 MHz band, and in the paired 1755-1780 MHz and 2155-2180 MHz bands, based on rules the FCC had adopted to facilitate commercial access to bands through spectrum-sharing arrangements with incumbent federal users.[44] Federal agency systems currently operate in the lower two bands where the new broadband licensees will share the spectrum temporarily until the federal incumbents vacate the band (*i.e.*, early entry); or will share the spectrum indefinitely with certain federal systems.

Early in Fiscal Year 2016, federal agencies and broadband licensees began coordination for early entry, pursuant to a framework that NTIA and the FCC had developed.[45] To facilitate coordination, NTIA and DoD established online "portals" through which licensees can initiate coordination of sharing with federal agencies operating incumbent systems. By the end of 2018, licensees had sent approximately 900 formal coordination requests for early access to the 1755-1780 MHz band to federal agencies, either through the DoD's early-entry portal or directly to the agency point of contact by other means. In all cases, the federal agencies provided timely formal responses, and the parties continued the formal coordination process to resolve any issues. There have not been any coordination requests from licensees in the 1695-1710 MHz band. NOAA is currently negotiating a coordination agreement for future sharing with licensees.

Several agencies have modified their initial transition plans for vacating the spectrum to request additional funding, reduce funding requirements, and/or request an extension in the time required to vacate the spectrum. Several of these requests have been approved, and several are still pending decision. Extensions in time may be approved; however, the agency must operate on a non-interference basis (NIB) for the time period beyond that identified in the initial transition plan. Further information and status on AWS-3 transition can be obtained from the annual report generated by NTIA in accordance with Commercial Spectrum Enhancement Act (CSEA).[46]

- Current Status: These bands have been repurposed via auction; transition is under way.
- Next Steps: NTIA will continue to oversee the transition process.

---

[44] Amendment of the Commission's Rules with Regard to Commercial Operations in the 1695-1710 MHz, 1755-1780 MHz, and 2155-2180 MHz Bands, GN Docket No. 13-185, *Report and Order*, 29 FCC Rcd 4610 (Mar. 31, 2014), *available at* https://docs.fcc.gov/public/attachments/FCC-14-31A1.pdf (*AWS-3 Report and Order*).

[45] Coordination Procedures in the 1695-1710 MHz and 1755-1780 MHz Bands, GN Docket No. 13-185, *Joint Public Notice*, 29 FCC Rcd 8527 (2014), *available at* http://www.ntia.doc.gov/files/ntia/publications/pn-aws3-procedures.pdf, *and* https://apps.fcc.gov/edocs_public/attachmatch/DA-14-1023A1.pdf (*AWS-3 Joint PN*).

[46] NTIA, *Commercial Spectrum Enhancement Act (CSEA)—Annual Report for 2017* (2018), *available at* https://www.ntia.doc.gov/files/ntia/publications/csea_2017_report_june_2018.pdf.

2020-2025 MHz Band

On June 1, 2016, DISH Network Corporation (DISH) filed a letter with the FCC electing to use its licenses in the 2000-2020 MHz band (adjacent to the 2020-2025 MHz band) for downlink operations.[47] No further action related to this five megahertz, unpaired band has been taken. The FCC is currently considering the next steps to accommodate fixed and mobile broadband services in that band.

- Current Status: The FCC is currently considering how best to accommodate fixed and mobile broadband services in this band.
- Next Steps: The FCC will determine the next action.

2496-2690 MHz "2.5 GHz" Band

In a May 2018 NPRM, the FCC proposed to provide greater flexibility to EBS licensees and to provide new opportunities for additional entities to obtain unused 2.5 GHz spectrum.[48]

In June 2019, the FCC released a public draft of an R&O that gives incumbent users more flexibility in how they use the spectrum, but also provides opportunities for additional entities, including Tribal Nations, to obtain access to unused 2.5 GHz spectrum. The order rolls back restrictions on the types of entities that are eligible to hold 2.5 GHz licenses and eliminates the educational use requirements for 2.5 GHz licenses, so that incumbent and future licensees have more flexibility. Further, the order establishes a priority filing window for rural Tribal Nations to provide them with an opportunity to obtain unassigned 2.5 GHz spectrum to address the communications needs of their communities. The remaining unassigned spectrum will be available for commercial use via competitive bidding immediately following the completion of the Tribal priority filing window. The order identifies counties as the appropriate geographic area size for new overlay licenses and a band plan with three blocks of licenses: two 50 megahertz blocks and a 16.5 megahertz block.

- Current Status: The FCC will make a decision on the R&O at its July 2019 meeting.
- Next Steps: Pending adoption of the R&O, establish priority filing window for rural Tribal Nations.

[47] Letter from Jeffrey H. Blum, Senior Vice President & Deputy General Counsel, DISH Network Corporation to Marlene H. Dortch, Secretary, FCC (June 1, 2016).

[48] Transforming the 2.5 GHz Band, WT Docket No. 18-120, *Notice of Proposed Rulemaking*, 33 FCC Rcd 4687 (2018), *available at* https://docs.fcc.gov/public/attachments/FCC-18-59A1.pdf (*2.5 GHz NPRM*).

3100-3550 MHz Band

Section 605(a) of the MOBILE NOW Act requires NTIA – in consultation with FCC and each affected agency – to develop, by March 2020, a report on the feasibility of sharing between commercial wireless services, licensed or unlicensed, and federal agency systems operating in the 3100-3550 MHz band. NTIA had conducted a high-level assessment of this band, among others, in the summer of 2017 while implementing the NTIA's Strategic Frequency Band Selection and Prioritization (SFBSP) process. It was determined that the top 100 megahertz (*i.e.*, 3450-3550 MHz band) was the most promising portion of the band for sharing; therefore, that band should undergo a detailed sharing feasibility assessment. NTIA has been collaborating with DoD, the agency with systems in the band, to document required technical and operational characteristics, gain agreement on the analysis methodology and criteria, coordinate on the outcome of in-band and adjacent-band analyses, and develop sharing options and recommendations for each category of systems in the band.

- Current Status: The 3450-3550 MHz portion of the band is undergoing a detailed sharing feasibility study.
- Next Steps: NTIA will complete the study of the 3450-3550 MHz band and document the results along with a description of the SFBSP process used to focus the analysis on the upper portion of the band. Consideration will be given to extending the detailed studies to the remainder of the band (*i.e.*, 3100-3450 MHz) upon completion of the report.

3550-3650 MHz CBRS Band

In April 2015, the FCC adopted rules for commercial use of 150 megahertz in the 3.5 GHz band (3550-3700 MHz).[49] Repurposing the lower two-thirds of this band—the 3550-3650 MHz portion, which broadband systems will now share with incumbent DoD radars—made 100 megahertz of spectrum available for commercial mobile services. The *First Report and Order* created a three-tiered framework to coordinate shared federal and non-federal use of the band. Incumbents (including federal radiolocation users, fixed satellite service (FSS) earth stations, and, for a finite period, certain grandfathered terrestrial wireless licensees in the 3650-3700 MHz band) comprise the highest tier and will receive protection from all other users, followed by Priority Access Licenses (PALs), the second tier, and General Authorized Access (GAA), the third tier. PALs will receive protection from GAA operations and must accept interference from incumbent tier users. GAA is licensed-by-rule and must accept interference from all other users (including other GAA users). Automated frequency coordinators, known as

[49] Amendment of the Commission's Rules with Regard to Commercial Operations in the 3550-3650 MHz Band, GN Docket No. 12-354, *Report and Order and Second Further Notice of Proposed Rulemaking*, 30 FCC Rcd 3959 (2015), *available at* https://apps.fcc.gov/edocs_public/attachmatch/FCC-15-47A1.pdf (*3.5 GHz R&O and Second FNPRM*).

Spectrum Access Systems (SASs), will coordinate operations between and among users in different access tiers. Environmental Sensing Capability (ESC) operators will manage a sensor system designed to detect the presence of federal incumbent radar transmissions and communicate that information to one or more SASs. The service and technical rules governing the 3.5 GHz Band were adopted as the new Part 96 of the Commission's rules.

In October 2018, the FCC updated the licensing and technical rules for PALs—which will be assigned by competitive bidding—to promote investment and encourage rapid deployment of wireless broadband services, including 5G.[50] The Spectrum Pipeline Act required the FCC to submit a report to Congress analyzing the results of rule changes in the 3.5 GHz band. After notice and public comment,[51] the FCC developed its report and released it on November 2, 2018.[52]

- Current Status: A sharing approach has been developed to repurpose this band.
- Next Steps: FCC and NTIA will complete testing and validation of SAS and ESC equipment, followed by FCC certification, FCC approval of requests for initial commercial deployments, availability of frequencies for GAA use, and preparation and execution of an FCC auction for PALs.

3700-4200 MHz Band

Section 605(b) of the *MOBILE NOW Act* directs the FCC to complete, by September 23, 2019, in consultation with NTIA and the federal agencies, a report to Congress evaluating the feasibility of licensed or unlicensed commercial wireless services using the 3700-4200 MHz band exclusively or through sharing with federal systems. In July 2018, the FCC released an Order and NPRM seeking to identify potential opportunities for additional terrestrial use of mid-

[50] *See Promoting Investment in the 3550-3700 MHz Band,* GN Docket No. 17-259, *Report and Order*, 33 FCC Rcd 10598 (2018).

[51] Wireless Telecommunications Bureau and Office of Engineering and Technology Seek Comment Pursuant to the Spectrum Pipeline Act of 2015, GN Docket Nos. 14-177 et al., *Public Notice*, DA 18-841 (WTB/OET Aug. 10, 2018), 2018, WL 3854030, *available at* https://docs.fcc.gov/public/attachments/DA-18-841A1.pdf (*Spectrum Pipeline Report Public Notice*).

[52] Report to Congress Pursuant to Section 1008 of the Spectrum Pipeline Act of 2015, As Amended by the Ray Baum's Act of 2018, of the Commission's Rules with Regard to Commercial Operations in the 3550-3650 MHz Band, GN Docket No. 14-177, *Report*, 33 FCC Rcd [TBD] (2018), *available at* https://docs.fcc.gov/public/attachments/DA-18-1128A1.pdf (*Pipeline Act Reports*). Paragraphs 6-18 pertain to the 3.5 GHz rule changes. *Id*. at ¶¶ 19-23.

band spectrum in the 3700-4200 MHz band, particularly for wireless broadband services.[53] The Order establishes a collection of additional information about existing earth and space station operations in the band that will inform the Commission's decision-making in this proceeding. The NPRM proposes to make more spectrum available for terrestrial wireless uses by adding a mobile allocation to all 500 megahertz in this band. The FCC also sought comment on potential methods, including a market-based mechanism, auction-based approaches, and hybrid proposals. On April 11, 2019, following approval of the information collection requirements by the Office of Management and Budget, the FCC issued a public notice that announced the deadline and other details for filing the certifications and information required by the Order.[54]

- Current Status: Pending FCC action.
- Next Steps: FCC will receive and evaluate information collections, and analyze options for repurposing current uses, including satellite operations; FCC will submit the MOBILE NOW Act report to Congress.

5850-5925 MHz Band

Unlicensed National Information Infrastructure (U-NII) devices currently operate in four frequency bands in the 5 GHz range, totaling 580 megahertz of spectrum.[55] Using wideband digital modulation techniques, these devices provide short-range, high-speed unlicensed wireless connections for, among other applications, Wi-Fi-enabled radio local networks, cordless telephones, and fixed outdoor broadband transceivers used by wireless internet providers.[56]

The 5850-5925 MHz band is allocated on a primary basis to the non-federal Mobile and Fixed Satellite (earth-to-space) services, and also on a primary basis to the federal Radiolocation service. The Mobile allocation is authorized for the Dedicated Short Range Communications (DSRC) service, and roadside units must accept any interference from and be coordinated with

[53] Expanding Flexible Use of the 3.7-4.2 GHz Band, GN Docket No. 18-122, *Order and Notice of Proposed Rulemaking*, 33 FCC Rcd 6915 (2018), *available at* https://docs.fcc.gov/public/attachments/FCC-18-91A1.pdf (*3.7-4.2 GHz Order and NPRM*).

[54] FCC, Deadline for Submission of Information on Earth Station and Satellite Use of the 3.7-4.2 GHz Band, GN Docket No. 18-122, DA 19-278, *Public Notice* (Apr. 11, 2019), *available at* https://docs.fcc.gov/public/attachments/DA-19-278A1.pdf.

[55] The Commission Seeks to Update and Refresh the Record in the "Unlicensed National Information Infrastructure (U-NII) Devices in the 5 GHz Band" Proceeding, ET Docket No. 13-49, *Public Notice*, 31 FCC Rcd 6130, 6131-32 (2016), *available at* https://apps.fcc.gov/edocs_public/attachmatch/FCC-16-68A1.pdf (*5 GHz U-NII Refresh PN*). The current band plan includes the bands 5150-5250 MHz (U-NII 1), 5250-5350 MHz (U-NII 2A), 5470-5725 MHz (U-NII 2C), and 5725-5850 MHz (U-NII 3). *Id*.

[56] *Id*. at 6130.

federal Radiolocation operations within 75 kilometers of a number of military installations per current FCC rules (Part 95, Sub-Part L and 90.371). The band is also allocated on a secondary basis to the non-federal Amateur Radio service.

The FCC has sought sharing solutions between the proposed U-NII devices and DSRC in the U-NII-4 band at 5850-5925 MHz. To evaluate sharing possibilities, the FCC is working with the DOT, NTIA/Institute for Telecommunication Sciences, and the automotive and communications industries on a three-phase test plan. The FCC has concluded laboratory testing using prototype U-NII devices for Phase I of the Test Plan. Phase I focused on performing laboratory tests intended to collect empirical data that can be used in a technical evaluation of the electromagnetic compatibility (EMC) between proposed 5.9 GHz U-NII-4 transmitters and DSRC Basic Safety Message (BSM) reception. On October 29, 2018, the FCC released a public notice requesting comment on the Phase I testing results.[57] Phase II will involve field tests of the techniques used to avoid interference to DSRC in a few vehicles. Phase III will expand the tests to more vehicles, more test devices, and real-world scenarios.[58]

- Current Status: Phase I testing is complete. Devices required for Phase II testing have been requested and one set of devices has been received from vendors.
- Next Steps: DOT-led team will conduct Phase II and Phase III testing. Phase II will commence in the summer of 2019.

Mid/High-Band Spectrum

5925-6425 MHz and 6425-7125 MHz Bands

In 2017, the FCC opened an NOI exploring ways to make parts of the 5925-6425 and 6425-7125 MHz bands available to address the expected growth of Wi-Fi and Internet of things (IoT) devices.[59] In October 2018, the FCC proposed rules to make 1200 megahertz of spectrum

[57] Office of Engineering and Technology Requests Comment on Phase I Testing of Prototype U-NII-4 Devices, ET Docket No. 13-49, *Public Notice,* 19 FCC Rcd 13020 (2018), *available at* https://docs.fcc.gov/public/attachments/DA-18-1111A1.pdf (*U-NII-4 Testing PN*).

[58] The Commission Seeks to Update and Refresh the Record in the "Unlicensed National Information Infrastructure (U-NII) Devices in the 5 GHz Band" Proceeding, ET Docket No. 13-49, *Public Notice,* 31 FCC Rcd 6130 (2016), *available at* https://www.fcc.gov/document/59-ghz-public-notice.

[59] Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz, GN Docket No. 17-183 *Notice of Inquiry*, 32 FCC Rcd 6373 (2017), *available at* https://docs.fcc.gov/public/attachments/FCC-17-104A1.pdf (*Mid-Band Spectrum NOI*).

in the 5925- 7125 MHz (6 GHz) band available for unlicensed use.[60] Two band segments were identified for unlicensed use: 5925-6425 MHz and 6425-7125 MHz. Within those segments, two classes of uses were proposed, based on compatibility with incumbent services operating in the bands. One class of devices would operate in the 5925-6425 MHz and 6525-6875 MHz bands using power levels of the 5 GHz U-NII-1 and U-NII-3 bands on frequencies determined by automated frequency coordination (AFC). The other class would operate in the 6425-6525 MHz and 6875-7125 MHz bands for indoor "low-power access point" operation using 5 GHz U-NII-2 power levels.[61]

In April 2015, after allocations in the 4400-4940 and 5925-6700 MHz bands for aeronautical mobile telemetry (AMT) for flight testing were added at the 2007 World Radiocommunication Conference, the FCC sought public comment through an NPRM on sharing between AMT and other incumbent systems in the 4400-4940 and 5925-6700 MHz bands.[62] That matter remains pending.

- Current Status: Pending.
- Next Steps: Decision on proposed FCC rule provisions for unlicensed.

High-Band Spectrum

Spectrum above 24 GHz: the FCC's Spectrum Frontiers Proceeding

The FCC, through its *Spectrum Frontiers* proceeding, is taking significant steps—building on successful spectrum policies, including flexible use and unlicensed access—to take advantage of largely co-primary spectrum above 24 GHz. Technological advances allow this spectrum, historically used for satellite and terrestrial point-to-point applications, to bring very high speeds and low latency to advanced wireless services, particularly for 5G services. This proceeding establishes a framework that enables greater spectrum access and increased

[60] Unlicensed Use of the 6 GHz Band, ET Docket 18-295, *Notice of Proposed Rulemaking,* 33 FCC Rcd 10496 (2018), *available at* https://www.fcc.gov/document/fcc-proposes-more-spectrum-unlicensed-use-0 (*Unlicensed 6 GHz NPRM*)

[61] Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz, GN Docket No. 17-183 *Notice of Inquiry*, 32 FCC Rcd 6373 (2017), *available at* https://transition.fcc.gov/Daily_Releases/Daily_Business/2017/db0713/FCC-17-104A1.pdf (*Mid-Band Spectrum NOI*).

[62] Amendment of Parts 2, 15, 80, 90, 97, and 101 of the Commission's Rules Regarding Implementation of the Final Acts of the World Radiocommunication Conference (Geneva, 2012)(WRC-12), Other Allocation Issues, and Related Rule Updates, ET Docket No. 15-99, *Report and Order*, 30 FCC Rcd 4183 (2015), *available at* https://docs.fcc.gov/public/attachments/FCC-15-50A1.pdf (*5 GHz NPRM*).

flexibility for both federal and non-federal uses, including satellite, while encouraging innovation that will ensure continued U.S. leadership in wireless broadband. A 600-megahertz block of spectrum in the 37 GHz band, set aside for sharing, makes possible the exploration of a new paradigm for federal and non-federal sharing, with potential for application to other bands as the technology advances, pending completion of sharing rules.

Since July 14, 2016, the FCC has adopted several actions in its *Spectrum Frontiers* proceeding, making millimeter-wave spectrum available for flexible use under a new service, the Upper Microwave Flexible Use Service (UMFUS) rules.[63] The first R&O made nearly 4 gigahertz of licensed spectrum available in the 28 GHz, 37 GHz, and 39 GHz bands; and 7 gigahertz of unlicensed spectrum available in the 64-71 GHz band. In the co-primary 37 GHz band, the FCC, working with NTIA, made 37.0-37.6 GHz available on a co-primary basis for shared access between and among federal and non-federal users.[64] The Second R&O made an additional 1700 megahertz in the 24 GHz and 47 GHz bands available for use, while noting the need to protect passive services in adjacent bands.[65]

The Third FNPRM sought comment on potential shared use of the federal 26 GHz and non-federal 42 GHz bands for commercial wireless broadband service.[66] It also sought information on the possibility of granting federal access to the non-federal 42 GHz band.[67] The Third FNPRM also sought comment on coordinating access to the lower 37 GHz band between federal and non-federal entities,[68] and on allowing a limited number of individually licensed satellite earth stations in the 50.4-51.4 GHz band.[69] This Third FNPRM satisfied the requirement in Section 604 of the MOBILE NOW Act for the FCC to publish an NPRM "to consider service rules to authorize mobile or fixed terrestrial wireless operations, including for

---

[63] *See* Use of Spectrum Bands Above 24 GHz For Mobile Radio Services, *et al*., *Report and Order and Further Notice of Proposed Rulemaking*, 31 FCC Rcd 8014, 8043-44, para. 74 (2016) (*Spectrum Frontiers R&O*); Use of Spectrum Bands Above 24 GHz For Mobile Radio Services, *et al*., *Third Report and Order, Memorandum Opinion and Order, Third Further Notice of Proposed Rulemaking*, 83 FCC Rcd 34478 (2018) (*Spectrum Frontiers 3rd R&O or Spectrum Frontiers 3rd FNPRM*); Use of Spectrum Bands Above 24 GHz For Mobile Radio Services, *Fourth Report and Order*, FCC 18-180 (rel. Dec. 12, 2018), *available at* https://docs.fcc.gov/public/attachments/FCC-18-180A1.pdf (*Spectrum Frontiers 4th R&O*).

[64] *Spectrum Frontiers R&O*, 31 FCC Rcd at 8059, para. 111.

[65] Use of Spectrum Bands Above 24 GHz For Mobile Radio Services, et al., *Second Report and Order, Second Further Notice of Proposed Rulemaking, Order on Reconsideration, and Memorandum Opinion and Order*, 32 FCC Rcd 10988 (2017) (*Spectrum Frontiers 2nd R&O*).

[66] *Spectrum Frontiers 3rd FNPRM*, 33 FCC Rcd at 5595-5600, 5605-10, paras. 47-57, 75-91.

[67] *Id.* at 5598, para. 53.

[68] *Id*. at 5600-05, paras. 58-74.

[69] *Id*. at 5610-12, paras. 92-94.

advanced mobile service operations," in the 42-42.5 GHz band by March 23, 2020.[70]

The Fourth R&O established a framework to auction spectrum in the Upper 37 GHz (37.6-38.6 GHz), 39 GHz, and 47 GHz bands. This innovative incentive auction mechanism will offer new licenses of contiguous spectrum in these bands while preserving incumbents' existing spectrum usage rights in the 39 GHz band.[71] The Fifth R&O established rules to allow fixed-satellite service operators to operate with individually licensed earth stations transmitting in the 50.4–51.4 GHz band, and established a process for the DoD to operate on a shared basis in the Upper 37 GHz band in limited circumstances.[72]

On November 14, 2018, the Commission began an auction of licenses in the 28 GHz band that concluded on January 24, 2019.[73] On March 14, 2019, the FCC began an auction of licenses in the 24 GHz band. On April 17, 2019, bidding concluded in the clock phase of the auction of 24 GHz licenses; bidding in the assignment phase began on May 3, 2019 and concluded on May 28, 2019. Bidding for licenses in the Upper 37 GHz, 39 GHz, and 47 GHz bands is scheduled to begin on December 10, 2019.

In preparation for potential proliferation of UMFUS operations in the millimeter wave bands, NTIA is working with federal agency spectrum users to assess and study the potential impact to in-band and adjacent-band existing and planned operations to establish any reasonable protection limits necessary to avoid interrupting critical missions.

- Current Status: The bidding in the auction of 28 GHz licenses and 24 GHz licenses has concluded.
- Next Steps: Bidding for licenses in the Upper 37 GHz, 39 GHz, and 47 GHz bands is scheduled to begin on December 10, 2019. The FCC and NTIA are working to establish sharing rules for the Lower 37 GHz band. Issues related to access to 26 GHz, 42 GHz, and 50 GHz bands remain under consideration.

[70] *See* MOBILE NOW Act § 604(b).

[71] *See* Spectrum Frontiers 4th R&O.

[72] Use of Spectrum Bands Above 24 GHz For Mobile Radio Services, et al., *Fifth Report and Order*, FCC 19-30 (rel. Apr. 15, 2019).

[73] The FCC 28 GHz Auction, Auction 101, netted $702,572,410. Auction 102 for the 24 GHz band began March 14, 2019.

Above 95 GHz: the FCC's Spectrum Horizons Proceeding

In March 2019, the FCC released a First Report and Order providing additional access to spectrum above 95 GHz for new experimental operations.[74] To enable innovators and entrepreneurs to most readily access this spectrum, the Order creates a new category of experimental licenses for use of frequencies between 95 GHz and 3 THz. These licenses will give innovators the flexibility to conduct experiments lasting up to 10 years, and to more easily market equipment during the experimental period.

The Order also made a total of 21.2 gigahertz of spectrum available for use by unlicensed devices. The Commission selected bands with propagation characteristics that will permit large numbers of unlicensed devices to use the spectrum, while limiting the potential for interference to existing governmental and scientific operations in the above-95 GHz bands, such as space research and atmospheric sensing.

The FCC is still considering opportunities for licensed commercial operation in this spectrum.

- Current Status: FCC has created a framework for experimental operations.
- Next Steps: Further FCC action pending.

Other Spectrum Repurposing Initiatives

In addition to repurposing initiatives focused on particular bands, NTIA and the FCC (with cooperation from the federal agencies) are pursuing more general initiatives that could support needed spectrum repurposing or otherwise increase spectrum access in the future — while safeguarding federal user access to needed spectrum resources. Importantly, the MOBILE NOW Act included several provisions requiring various activities in support of spectrum repurposing, as described in the following subsections.

Bidirectional Sharing Study

Section 610 of the MOBILE NOW Act requires that, by September 23, 2019 (and after a period of public comment) the FCC submit a report to Congress regarding the best means of giving federal entities flexible access to non-federal spectrum on a shared basis.[75] In

[74] In the Matter of Spectrum Horizons, *First Report and Order*, ET Docket No. 18-21, (rel. Mar. 21, 2019, *available at* https://docs.fcc.gov/public/attachments/FCC-19-19A1.pdf At the March 15, 2019, FCC Commission meeting, the FCC approved a Report and Order that made 21.2 gigahertz of spectrum above 95 GHz available for unlicensed operations. The Report and Order also created a new class of experimental licenses for spectrum between 95 GHz and 3 THz. The FCC will collaborate with NTIA, the agencies, and industry to refine use cases, study compatibility, and develop methodologies for sharing, where sharing is appropriate.

[75] The term "bidirectional sharing" herein refers to shared access of federal entities to non-federal spectrum.

collaboration with NTIA, the FCC is conducting a bidirectional sharing study that considers such sharing scenarios over short-, mid-, and long-range timeframes, including shared use for intermittent purposes such as emergency communications.

In conducting the study, the FCC is considering the commercial spectrum users' and federal agencies' requirements for regulatory certainty to make longer-term investment decisions for shared access to be viable. The FCC is also evaluating any barriers to voluntary commercial arrangements in which non-federal users could provide federal entities access to shared spectrum.

National Plan for Additional Unlicensed or Licensed-by-Rule Spectrum

Also, by September 23, 2019, Section 618(b) of the MOBILE NOW Act requires that the FCC, in consultation with NTIA, develop a national plan for making additional bands available for unlicensed or licensed-by-rule operations. Under Subsection 618(d), NTIA, by the same date, will generate recommendations to the FCC on how to reform the Spectrum Relocation Fund to address the sufficiency of funds to address agency costs of sharing with unlicensed or licensed-by-rule operations.

Incentives for Federal Spectrum Sharing

Section 609 of the MOBILE NOW Act requires that by March 23, 2020, NTIA, in consultation with the FCC, OMB, and the federal agencies (and after notice and an opportunity for public comment) must submit a report to Congress with legislative or regulatory recommendations to incentivize federal entities to relinquish or share federal spectrum, allowing commercial services to operate on that federal spectrum. The report will also consider whether SRF payments to agencies could expedite non-federal or shared use of the spectrum.

FCC Rules for Unlicensed Use of Guard Bands

Although it does not specify a deadline, Section 611 of the MOBILE NOW Act requires that the FCC, in consultation with NTIA and the federal agencies, adopt rules to permit unlicensed services to use frequencies designated as guard bands, where feasible, to protect frequencies allocated by competitive bidding after the enactment of the MOBILE NOW Act. The FCC may not permit such use if it would cause harmful interference to a licensed service or a federal service.

CONCLUSIONS

As demonstrated herein for the annual report, in 2018 and into the second quarter of 2019, NTIA continued to work diligently and collaboratively with the FCC and the federal agencies toward implementing legislative mandates and achieving the policy objectives of the

Trump Administration, which were clearly articulated in the October 2018 *Presidential Memorandum*. The ongoing efforts to identify and explore potential bands for repurposing are an integral part of the *Presidential Memorandum*'s mandate to pursue policies that maximize the potential of the nation's spectrum resources for both economic growth and national security, and support U.S. leadership in 5G and in the frontiers of space. Moreover, these efforts to pursue potential repurposing directly address statutory requirements in the Spectrum Pipeline Act and MOBILE NOW Act.

Looking ahead to the remainder of 2019, NTIA will continue its collaborative efforts with its federal partners and non-federal stakeholders to meet the growing federal and non-federal spectrum requirements. Ongoing efforts to identify, analyze, and study specific bands for potential repurposing, including bi-directional sharing, along with broader initiatives to support more efficient use of spectrum, are core elements of NTIA's spectrum activities. NTIA will facilitate federal and industry stakeholder engagement in the ongoing transition to shared use of the 1695-1710 MHz and 1755-1780 MHz (AWS-3) bands. Employing innovative technology in spectrum access systems and environmental sensing, NTIA and the FCC will continue to work to build an infrastructure to support sharing in the 3550-3700 MHz band. Moreover, NTIA and the FCC will continue to implement the Spectrum Pipeline and MOBILE NOW provisions applicable to spectrum repurposing, including reviewing potential bands for repurposing, such as portions of 3100-3550 MHz.

With the activities described in this report, along with new efforts sure to emerge, the U.S. Government is taking concrete and aggressive steps to ensure that the utilization of our spectrum resources benefits the American people.