UNITED STATES DEPARTMENT OF COMMERCE
Secretary of Commerce
Washington, D.C. 20230

May 9, 2023

Mr. Jake Sullivan
Assistant to the President for National Security Affairs
The White House
Eisenhower Executive Office Building
Washington, DC 20504

Dear Mr. Sullivan:

I am pleased to submit the annual report required in the October 25, 2018, Presidential Memorandum (PM) on *Developing a Sustainable Spectrum Strategy for America's Future*. Among other items, the PM directs the Secretary of Commerce to 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.

This report provides a snapshot of existing repurposing efforts through the end of December 2021, reflecting efforts of the Department, through the National Telecommunications and Information Administration, and the Federal Communications Commission. This report provides an update from last year's report regarding spectrum repurposing initiatives for bands under study and other activities related to statutory obligations.

The bulk of the report describes the status of efforts to repurpose specific bands. These ongoing efforts constitute a process that resembles a "pipeline" for continuous identification and assessment of bands and the resulting implementation of repurposing or other spectrum access mechanisms where needed and feasible.

Should you have any questions, please contact Alan Davidson, Assistant Secretary for Communications and Information, at (202) 482-4186.

Sincerely,

Gina M. Raimondo

Enclosure

Annual Report on the Status of Spectrum Repurposing and Other Initiatives

U.S. Department of Commerce

Gina M. Raimondo, Secretary

Alan Davidson, Assistant Secretary
for Communications and Information

March 2023

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EXECUTIVE SUMMARY

The United States has led the world in making spectrum available for wireless communications services, moving expeditiously to repurpose high- and low-band spectrum to support new advancements in technology, such as 5G. In 2021, the United States pushed that advantage even further with the auction of 100 megahertz of frequencies in the 3450-3550 MHz band, as part of a renewed focus on the valuable mid-band spectrum that will significantly contribute to 5G deployment. As this report from the National Telecommunications and Information Administration (NTIA) highlights, the United States continues to focus considerable effort on repurposing spectrum – either on an exclusive or shared basis – to support commercial wireless services and applications.[1] This report highlights spectrum repurposing activities through December 31, 2021, including those subject to statutory requirements. The report covers both repurposing of federal spectrum and repurposing of non-federal spectrum to enable new commercial uses. This report also summarizes the status of the federal agencies' key existing and planned near- to mid-term spectrum initiatives.

Importantly, the federal spectrum repurposing efforts described in this report could not have been accomplished without the important work of numerous federal agencies. Spectrum repurposing typically requires significant effort to replace or modify sophisticated equipment, to find suitable bands for relocation, and to coordinate with new commercial entrants – all while federal agencies carry out their primary, and typically critical, missions.

The table below provides a summary description of the status of current spectrum repurposing efforts of NTIA and the Federal Communications Commission (FCC), band by band. Bands shaded in green represent substantially completed repurposing activities. Bands shaded in yellow represent repurposing activities that are still ongoing.[2]

[1] 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.

[2] Department of Commerce and NTIA, *Annual Report on the Status of Spectrum Repurposing* (Aug. 2019), *available at* https://www.ntia.doc.gov/files/ntia/publications/spectrum_repurposing_report_august_2019.pdf ("*First Annual Report*").

TABLE 1

Frequency Band	***Repurposing Status – Through December 31, 2021***
MHz	**LOW-BAND**
512-698	In July 2020, the FCC announced the completion of the broadcast incentive auction, which cleared 70 megahertz of licensed spectrum in the 600 MHz band for repurposing from television broadcasting to commercial wireless operations.[3] The post-auction transition by repacked broadcast licensees is close to completion, with only a few repacked stations continuing to operate their new channels on interim facilities pending completion of construction of their permanent facilities.
809-817; 854-862	On March 5, 2021, the 800 MHz Transition Administrator (TA) notified the FCC that the 800 MHz rebanding program is complete and requested authorization to terminate all program agreements.[4] On April 22, 2021, the FCC adopted an order which accepted the TA's notice of program completion and terminated the 800 MHz rebanding program.[5]
896-901; 935-940	In May 2020, the FCC released an order reconfiguring the 900 MHz band to facilitate the development of broadband technologies and services, including for critical infrastructure. In May 2021, the FCC began accepting applications for 900 MHz broadband segment licenses, and the first such licenses were issued in August 2021.

[3] Press Release, FCC, Post-Incentive Auction Transition Successfully Meets 39-Month Deadline (July 13, 2020), https://docs.fcc.gov/public/attachments/DOC-365479A1.pdf (Post-Incentive Auction Transition Press Release).

[4] Notice of Program Completion and Request for Authorization to Terminate Program Agreements, WT Docket 02-55, (Mar. 5, 2021), *available at* https://ecfsapi.fcc.gov/file/10305346527305/FINAL_TA_Notice_of_Program_Completion%20-%20CLEAN%20030521.pdf.

[5] *Improving Public Safety Communications in the 800 MHz Band, Order Terminating Proceeding*, FCC 21-41 (Apr. 22, 2021), *available at* https://docs.fcc.gov/public/attachments/FCC-21-41A1.pdf.

Frequency Band	*Repurposing Status – Through December 31, 2021*
MHz	**MID-BAND**
1300-1350	Currently used primarily for federal radars, with some minimal non-federal radar use, this band remains under study by NTIA with the goal of repurposing at least 30 megahertz.[6] However, the Federal Aviation Administration (FAA), Department of Defense (DOD), and Department of Homeland Security (DHS) have significant concerns about impacts from various repurposing options on surveillance radars.
1526-1536; 1627.5-1637.5; 1646.5-1656.5	These three sub-bands 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)). In 2020, the FCC conditionally approved Ligado Networks LLC's deployment of a terrestrial network in these bands.[7] GPS industry interests and the federal government have submitted petitions for reconsideration.[8] The issue has received congressional attention, resulting in some language addressing DOD activities related to the bands and requiring further independent technical study from the National Academies of Science, Engineering, and Medicine in the FY2021 National Defense Authorization Act (NDAA),[9] and FY2022 NDAA.[10]

[6] Spectrum Efficient National Surveillance Radar (SENSR), *Fact Sheet*, https://www.faa.gov/air_traffic/technology/sensr/.

[7] *LightSquared Technical Working Group Report et al.,* Order and Authorization, IB Docket Nos. 11-109 and 12-340, 35 FCC Rcd 3772 (2020), *available at* https://docs.fcc.gov/public/attachments/FCC-20-48A1.pdf.

[8] NTIA filed petitions for stay and reconsideration of the decision, warning that Ligado's operations "will cause irreparable harms to federal government users of the Global Positioning System (GPS)." Petition for Stay of the National Telecommunications and Information Administration, IB Docket No. 11-109; *see also* Petition for Reconsideration or Clarification of the National Telecommunications and Information Administration, IB Docket Nos. 11-109 and 12-340 (filed May 22, 2020), *available at* https://www.ntia.doc.gov/fcc-filing/2020/ntia-petitions-stay-and-reconsideration-ligado-proceedings. In January 2021, the FCC denied NTIA's petition for stay of the Ligado decision. *LightSquared Technical Working Group et al.*, IB Docket No. 11-109, Order Denying Motion for Stay, 36 FCC Rcd 1262 (2021), *available at* https://docs.fcc.gov/public/attachments/FCC-21-22A1_Rcd.pdf.

[9] William M. (Mac) Thornberry National Defense Authorization Act for Fiscal Year 2021 (NDAA FY21), Pub. L. No. 116-283, 134 Stat. 3388, § 1663-64 (Jan. 1, 2021), *available at* https://www.congress.gov/bill/116th-congress/house-bill/6395.

[10] National Defense Authorization Act for Fiscal Year 2022 (NDAA FY22), Pub. L. No. 117-81, 135 Stat. 1541, § 1613 (Dec. 27, 2021), *available at https://www.congress.gov/bill/117th-congress/senate-bill/1605/text*.

Frequency Band	*Repurposing Status – Through December 31, 2021*
1675-1680	This band is under study as part of a Pipeline Plan by the National Oceanic and Atmospheric Administration (NOAA) and is the subject of an FCC rulemaking proceeding[11] to determine if the band could be shared with commercial terrestrial wireless services. Results from the NOAA study are being prepared for final release.
1695-1710; 1755-1780; 2155-2180	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 largely done and is expected to be completed by 2025.[12]
2483.5-2495	These frequencies are licensed to Globalstar; the FCC provided regulatory relief for a Terrestrial Low Power Service adjacent to the primary Wi-Fi band.[13]
2496-2690	The FCC adopted rules to provide greater flexibility for current Educational Broadband Service (EBS) licensees and create new opportunities for additional entities to obtain spectrum. The FCC in January 2021 sought comment on bidding procedures for an auction of licenses in the band, and bidding in the auction began in July 2022.[14]

[11] The FCC NPRM proposes a reallocation to non-federal flexible wireless use. *See Allocation and Service Rules for the 1675-1680 MHz Band*, WT Docket No. 19-116, Notice of Proposed Rulemaking and Order, 34 FCC Rcd 3552, 3553 (2019), *available at* https://ecfsapi.fcc.gov/file/05132467403342/FCC-19-43A1.pdf.

[12] NTIA, "Advanced Wireless Services in the 1695-1710 MHz, 1755-1780, 2155-2180 MHz Bands," https://www.ntia.doc.gov/category/aws-3-transition.

[13] See Terrestrial Use of the 2473-2495 MHz Band for Low-Power Mobile Broadband Networks; Amendments to Rules for the Ancillary Terrestrial Component of Mobile Satellite Service Systems, IB Docket No. 13-213, Report & Order (2016), https://ecfsapi.fcc.gov/file/122316206822/FCC-16-181A1.pdf.

[14] *Auction of Flexible-Use Service Licenses in the 2.5 GHz Band for Next Generation Wireless Services*, Public Notice, 36 FCC Rcd 645 (2021), *available at* https://docs.fcc.gov/public/attachments/FCC-21-14A1.pdf.

Frequency Band	*Repurposing Status – Through December 31, 2021*
3100-3550	NTIA in January 2020 released a technical feasibility study to determine if commercial services could operate without causing impact to incumbent operations. The report indicated that spectrum sharing may be possible. After an interagency effort that ensued throughout the remainder of 2020, the White House announced an auction of the 3450-3550 MHz band,[15] which the FCC began in October 2021, after close coordination and consultation with DOD and NTIA.[16] The auction was completed in January 2022 and raised over $22.5 billion in proceeds. On November 15, 2021, the President signed into law the Infrastructure Investment and Jobs Act, including Section 90008, which directed DoD to study reallocation of 3100-3450 MHz for shared Federal and non-Federal commercial licensed use. DOD is studying the 3100-3450 MHz band in collaboration with national policymakers, incumbent users, and industry.[17] The FCC is also evaluating potential sharing opportunities in the band.
3550-3700	An auction of Priority Access Licenses (PALs) in the Citizens Broadband Radio Service concluded on August 25, 2020, and the FCC has granted a majority of the license applications.[18] In addition, the FCC has authorized six Spectrum Access System (SAS) Administrators to facilitate the commercial spectrum usage by PALs and licensed-by-rule General Authorized Access (GAA) users.[19]

[15] Edward Drocella, Robert Sole & Nickolas LaSorte, NTIA Office of Spectrum Management, NTIA Technical Report 20-546: Technical Feasibility of Sharing Federal Spectrum with Future Commercial Operations in the 3450-3550 MHz Band (Jan. 27, 2020), *available at* https://www.ntia.gov/report/2020/technical-feasibility-sharing-federal-spectrum-future-commercial-operations-3450-3550 ("NTIA 3450-3550 MHz Technical Feasibility Report").

[16] *Auction of Flexible-Use Service Licenses in the 3.45-3.55 GHz Band for Next-Generation Wireless Service*, AU Docket No. 21-62, Public Notice, DA 21-655 (2021), *available at* https://docs.fcc.gov/public/attachments/DA-21-655A1.pdf.

[17] Infrastructure Investment and Jobs Act, Pub. L. 117-58, 135 Stat. 429, § 90008 (Nov. 15, 2021), *available at* https://www.congress.gov/bill/117th-congress/house-bill/3684/text.

[18] *Auction of Priority Access Licenses for the 3550-3650 MHz Band*, AU Docket No. 19-244, Public Notice, 35 FCC Rcd 2140 (2020), *available at* https://docs.fcc.gov/public/attachments/FCC-20-18A1.pdf; *Auction of Priority Access Licenses for the 3550-3650 MHz Band Rescheduled to Begin July 23, 2020*, AU Docket No. 19-244, Public Notice, DA 20-330 (WTB 2020), *available at* https://docs.fcc.gov/public/attachments/DA-20-330A1.pdf; FCC News, *FCC Starts First 5G Mid-Band Spectrum Auction Today* (2020), https://docs.fcc.gov/public/attachments/DOC-365702A1.pdf; *Auction of Priority Access Licenses in the 3550-3650 MHz Band Closes*, AU Docket No. 19-244, Public Notice, DA 20-1009 (WTB/OEA 2020), *available at* https://docs.fcc.gov/public/attachments/DA-20-1009A1.pdf.

[19] Wireless Telecommunications Bureau and Office of Engineering and Technology Approve Four Spectrum Access System Administrators for Full Scale Commercial Deployment in the 3.5 GHz Band and Emphasize Licensee

Frequency Band	*Repurposing Status – Through December 31, 2021*
3700-3980	The FCC made 280 megahertz of "C-band" spectrum available for commercial wireless services.[20] The auction of licenses in the band raised over $81 billion in proceeds, and the FCC granted a majority of the license applications in July 2021. The FCC has been working closely with the relocation payment clearinghouse, the relocation coordinator, and affected stakeholders to facilitate the transition of the band. Following the FAA's issuance of multiple Airworthiness Directives (AD) to address interference to radar altimeters, the FCC, FAA, and White House, with NTIA's technical support, came together to negotiate the safe and expeditious deployment of 5G services until June 30, 2023 through wireless provider voluntary mitigations and aircraft operational limitations. WRC-19 put into consideration identification of the frequency band 3.6-3.8 GHz for International Mobile Telecommunications (IMT)/5G on the agenda for the next Conference in 2023.[21]

Compliance Obligations in the 3650-3700 MHz Band Under Part 96, GN Docket No. 15-319, Public Notice, 35 FCC Rcd 117 (WTB/OET 2020), https://ecfsapi.fcc.gov/file/0127193875857/DA-20-110A1.pdf; Wireless Telecommunications Bureau and Office of Engineering and Technology Approve Spectrum Access System Administrator Amdocs for Full Scale Commercial Deployment in the 3.5 GHz Band, GN Docket No. 15-319, Public Notice, 35 FCC Rcd 3687, DA 20-437 (WTB/OET 2020), https://docs.fcc.gov/public/attachments/DA-20-437A1.pdf; Wireless Telecommunications Bureau and Office of Engineering and Technology Approve Spectrum Access System Administrator Key Bridge Wireless for Full Scale Commercial Deployment in the 3.5 GHz Band, GN Docket No. 15-319, Public Notice, DA 21-289 (WTB/OET Mar. 9, 2021), https://docs.fcc.gov/public/attachments/DA-21-289A1.pdf.

[20] *Expanding Flexible Use of the 3.7 to 4.2 GHz Band*, GN Docket No. 18-122, Report and Order and Order of Proposed Modification, 35 FCC Rcd 2343 (2020), *available at* https://docs.fcc.gov/public/attachments/FCC-20-22A1.pdf; *Auction of Flexible-Use Service Licenses in the 3.7-3.98 GHz Band for Next Generation Wireless Services*, AU Docket No. 20-25, Public Notice, 36 FCC Rcd 3318 (2020), *available at* https://docs.fcc.gov/public/attachments/FCC-20-110A1.pdf.

[21] *See* Final Acts of the World Radiocommunication Conference 2019 (WRC-19), Resolution 811 at p. 541, *available at* https://www.iata.org/contentassets/d7e421981aa64169af1a8d6b37438d4d/wrc-2019-final-acts.pdf. The International Telecommunications Union (ITU) uses the terminology International Mobile Telecommunications (IMT) for commercial wireless services with IMT-2020 representing 5G capabilities. For purposes of this report, 5G is synonymous with IMT-2020. An *identification* of spectrum is an international concept that provides guidance to countries internationally on a specific spectrum allocation that may be used by a large number of countries for a specified use.

Frequency Band	*Repurposing Status – Through December 31, 2021*
4940-4990	The FCC continues to explore ways to increase the use of the 4.9 GHz band.[22] In September 2020, the FCC adopted rules that would allow one entity in each state to lease up to 50 megahertz of spectrum in this band to third parties for fixed or mobile use, including for non-public safety operations.[23] However, the FCC stayed the order pending further review in May of 2021,[24] and reversed it thereafter.[25] At the same time, the FCC sought comment on the potential non-public safety use of the band.[26]
5850-5925	In November 2020, the FCC designated the lower 45 megahertz of the band for unlicensed use, which can include Wi-Fi, and the upper 30 megahertz for Long Term Evolution Cellular Vehicle to Everything (LTE C-V2X) Intelligent Transportation Systems (ITS) technology at the end of a transition period.[27]
5925-7125	In April 2020, the FCC issued a Report and Order expanding the types of devices that can operate on an unlicensed basis in this band.[28] WRC-23 will consider global identification of the top 100 MHz (7025-7125 MHz) for IMT/5G.[29] The conference will also consider identification of the frequency band 6425-7025 MHz for IMT/5G in ITU Region 1.[30]
GHz	**HIGH BAND**

[22] *See*, *e.g.*, *Amendment of Part 90 of the Commission's Rules*, WP Docket No. 07-100, Sixth Further Notice of Proposed Rulemaking, 33 FCC Rcd 3261 (2018), *available at* https://ecfsapi.fcc.gov/file/03231913715191/FCC-18-33A1.pdf.

[23] *Amendment of Part 90 of the Commission's Rules*, WP Docket No. 07-100, Sixth Report and Seventh Further NPRM (2020), *available at* https://docs.fcc.gov/public/attachments/FCC-20-137A1.pdf.

[24] *Amendment of Part 90 of the Commission's Rules*, WP Docket No. 07-100, Order, FCC-21-66 (2021), *available at* https://docs.fcc.gov/public/attachments/FCC-21-66A1.pdf.

[25] *Amendment of Part 90 of the Commission's Rules*, WP Docket 07-100, Order on Reconsideration and Eighth Further Notice of Proposed Rulemaking, FCC-21-106 (2021), *available at https://ecfsapi.fcc.gov/file/100196417863/FCC-21-106A1.pdf.*

[26] Id.

[27] *Use of the 5.850-5.925 GHz Band*, ET Docket No. 19-138, First Report and Order, Further Notice of Proposed Rulemaking, and Order of Proposed Modification, 35 FCC Rcd 13440, (2020), *available at* https://docs.fcc.gov/public/attachments/FCC-20-164A1.pdf.

[28] *Unlicensed Use of the 6 GHz Band*, ET Docket No. 18-295, Report and Order and Further Notice of Proposed Rulemaking, 35 FCC Rcd 3852 (2020), *available at* https://docs.fcc.gov/public/attachments/FCC-20-51A1.pdf.

[29] *See* Final Acts of the World Radiocommunication Conference 2019 (WRC-19), Resolution 245 at p. 361, *available at* https://www.iata.org/contentassets/d7e421981aa64169af1a8d6b37438d4d/wrc-2019-final-acts.pdf.

[30] Id.

Frequency Band	*Repurposing Status – Through December 31, 2021*
24.25-24.45; 24.75-25.25	The FCC made 700 megahertz of spectrum available through the auction of licenses and under flexible use rules in 2019.[31] WRC-19 identified these bands for 5G and unwanted emissions levels are under consideration.[32]
25.25-27.5	The FCC sought comment on potential shared use of the 26 GHz band.[33] The FCC issued notices of proposed rulemaking in exploring repurposing additional high band frequencies for flexible use in this band and other bands in the *Spectrum Frontiers* proceeding. WRC-19 identified this band for 5G.[34]
27.5-28.35	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 in 2019.[35]
37-37.6	The FCC sought comment on a mechanism for shared use of the Lower 37 GHz band by federal and non-federal entities.[36] WRC-19 identified the 37-43.5 GHz band for 5G.[37]

[31] *Auction of 24 GHz Upper Microwave Flexible Use Service Licenses Closes*, AU Docket No. 18-85, Public Notice, 34 FCC Rcd 4294 (OEA/WTB 2019), *available at* https://docs.fcc.gov/public/attachments/DA-19-485A1.pdf.

[32] *See* Final Acts WRC-19, Resolution 242 at p. 351, *available at* https://www.iata.org/contentassets/d7e421981aa64169af1a8d6b37438d4d/wrc-2019-final-acts.pdf.

[33] *Use of Spectrum Bands Above 24 GHz for Mobile Radio Services*, Third Report and Order, Memorandum Opinion and Order, and Third Further Notice of Proposed Rulemaking, 33 FCC Rcd 5576 (2018), *available at* https://docs.fcc.gov/public/attachments/FCC-18-73A1.pdf.

[34] *See* Final Acts WRC-19, Resolution 242 at p. 351, Resolution 243 at p. 355, *available at* https://www.iata.org/contentassets/d7e421981aa64169af1a8d6b37438d4d/wrc-2019-final-acts.pdf.

[35] *Auctions of Upper Microwave Flexible Use Licenses for Next-Generation Wireless Services*, AU Docket No. 18-85, Public Notice, 33 FCC Rcd 7575 (2018), *available at* https://docs.fcc.gov/public/attachments/FCC-18-109A1.pdf.

[36] *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 (2016), *available at* https://ecfsapi.fcc.gov/file/0714115429654/FCC-16-89A1.pdf.; *Use of Spectrum Bands Above 24 GHz For Mobile Radio Services, et al.,* Third Report and Order, Memorandum Opinion and Order, and Third Further Notice of Proposed Rulemaking, 33 FCC Rcd 5576 (2018), *available at* https://docs.fcc.gov/public/attachments/FCC-18-73A1.pdf..

[37] *See* Final Acts WRC-19, Resolution 243 at p. 355, *available at* https://www.iata.org/contentassets/d7e421981aa64169af1a8d6b37438d4d/wrc-2019-final-acts.pdf.

Frequency Band	*Repurposing Status – Through December 31, 2021*
37.6-38.6; 38.6-40; 47.2-48.2	The FCC made 3.4 gigahertz of spectrum available in the Upper 37 GHz, 39 GHz, and 47 GHz bands, and conducted an incentive auction to assign new licenses for contiguous spectrum in these bands while preserving incumbents' existing spectrum usage rights in the 39 GHz band.[38] WRC-19 identified several of these bands for 5G.[39]
42-42.5	The FCC sought comment on potential shared use of the 42 GHz band.[40] WRC-19 identified this band for 5G.[41]
50.4–52.6	The FCC sought comment on making this band available for flexible terrestrial use, and it adopted rules to allow fixed-satellite service providers to operate with individually licensed earth stations transmitting in the 50.4-51.4 GHz portion of this band.[42] WRC-19 maintained a "no change" status for 50.4-52.6 GHz and the band was not identified for 5G.
64-71	The FCC made 7 gigahertz of spectrum available for unlicensed use in the 64-71 GHz band, adjacent to another 7 gigahertz of spectrum available for unlicensed use in the 57-64 GHz band.[43] In July 2021, the FCC proposed rules that would expand operational flexibility for unlicensed field disturbance sensor devices (e.g., radars) to operate in the 57-64 GHz band segment.[44]

[38] Incentive Auction of Upper Microwave Flexible Use Service Licenses in the Upper 37 GHz, 39 GHz, and 47 GHz Bands for Next Generation Wireless Services Closes, Public Notice, 35 FCC Rcd 2015 (OEA/WTB 2020), https://docs.fcc.gov/public/attachments/DA-20-253A1.pdf.

[39] *See* Final Acts WRC-19, Resolution 243 at p. 355, *available at* https://www.iata.org/contentassets/d7e421981aa64169af1a8d6b37438d4d/wrc-2019-final-acts.pdf.

[40] *Use of Spectrum Bands Above 24 GHz for Mobile Radio Services*, GN Docket No. 14-177, Third Report and Order, Memorandum Opinion and Order, and Third Further Notice of Proposed Rulemaking, 33 FCC Rcd 5576 (2018), *available at* https://docs.fcc.gov/public/attachments/FCC-18-73A1.pdf.

[41] *See* Final Acts WRC-19, Resolution 242 at p. 351; Resolution 243 at p. 355, *available at* https://www.iata.org/contentassets/d7e421981aa64169af1a8d6b37438d4d/wrc-2019-final-acts.pdf.

[42] *Use of Spectrum Bands Above 24 GHz for Mobile Radio Services*, GN Docket No. 14-177, Fifth Report and Order, 34 FCC Rcd 2556 (2019), *available at* https://docs.fcc.gov/public/attachments/FCC-19-30A1.pdf.

[43] *Use of Spectrum Bands Above 24 GHz for Mobile Radio Services*, GN Docket No. 14-177, Report and Order and Further Notice of Proposed Rulemaking, 31 FCC Rcd 8014 (2016), *available at* https://ecfsapi.fcc.gov/file/0714115429654/FCC-16-89A1.pdf.

[44] *Amendment of Section 15.255 of the Commission's Rules*, ET Docket No. 21-264, Notice of Proposed Rulemaking, 36 FCC Rcd 11901 (2021), *available at* https://docs.fcc.gov/public/attachments/FCC-21-83A1.pdf.

Frequency Band	*Repurposing Status – Through December 31, 2021*
95-3000	The FCC created a new category of experimental licenses for use of frequencies between 95 GHz and 3 Terahertz (THz).[45] These licenses require coordination with existing passive users of the spectrum, such as radio astronomy which has multiple international primary allocations in this range.
116-123, 174.8-182, 185-190, and 244-246	The FCC made available just over 21 gigahertz of spectrum for unlicensed use in these bands with shared federal and non-federal allocations.[46]

[45] *Spectrum Horizons*, ET Docket No. 18-21, First Report and Order, 34 FCC Rcd 1605 (2019), *available at* https://ecfsapi.fcc.gov/file/0321900915630/FCC-19-19A1.pdf.

[46] *Id*.

BACKGROUND

Consistent with NTIA's mandate to foster the efficient and effective use of spectrum for its most beneficial uses in the public interest including ensuring federal users have access to adequate spectrum to meet mission requirements,[47] NTIA publishes an annual report on the status of existing efforts and planned near- to mid-term spectrum repurposing initiatives. This report is written in close coordination with the Office of Management and Budget (OMB) and the FCC. The Biden Administration has called for revitalizing America's digital infrastructure, and increasing broadband coverage across the country, and the President has since signed into law the IIJA, which directs NTIA to steward billions in broadband grants for this purpose. Spectrum is a critical element for building out high-speed network infrastructure.

This report addresses accomplishments and activities during the period between August 31, 2020, and December 31, 2021.[48] To date, most repurposing activities and statutory mandates for repurposing focus on accommodating non-federal uses. Recent repurposing efforts have resulted in sharing spectrum. NTIA is obliged, when evaluating a band of frequencies for possible reallocation, to prioritize options involving non-federal exclusive use and shall select sharing when exclusive use is not feasible because of technical or cost constraints.[49] Repurposing 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 that can meet high-capacity, low-latency, and high-speed requirements and unleash innovation across diverse sectors of the economy.

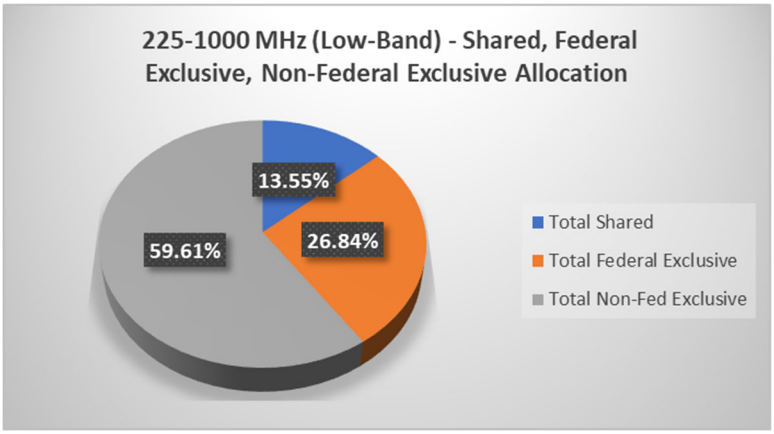

Figure A: Low-Band Shared, Federal Exclusive, Non-Federal Exclusive Allocation

The United States is making tremendous progress in repurposing spectrum for commercial wireless services. For

[47] 47 U.S.C. § 901(c).

[48] NTIA's first such report was released in August 2019 and addressed activities from January 1, 2018, through June 30, 2019. *See First Annual Report.* Our second such report was released in September 2020 and addressed activities from June 30, 2019, through August 30, 2020. We note that a number of the actions discussed in this report were taken by the FCC, an independent agency, either exclusively or in coordination with other agencies in the Executive Branch.

[49] *See*, *e.g.*, 47 U.S.C. § 923(j).

low-band, 250 megahertz of spectrum have been made available.[50] As seen in *Figure A*, across low-band spectrum from 255-1000 MHz, roughly sixty percent is non-federal exclusive, roughly twenty-seven percent is federal exclusive, and the remaining thirteen percent is shared. Most recently, the TV Incentive Auction and 900 MHz realignment efforts have contributed another 90 megahertz of low-band spectrum for new commercial use. *Figure B* demonstrates recent low-band repurposing efforts, culminating in 210 megahertz of licensed spectrum made available and 40 megahertz of spectrum made available for unlicensed use.

Frequency Band	*Made Available*	*Spectrum Under Study*	**Legend** - Non-federal - Federal - Licensed - Unlicensed
Before MOBILE NOW Act	134	0	
	26	0	
TV Incentive auction	70	0	
	14	0	
900 MHz	6	0	
			Total
Sub-Totals (megahertz) for licensed :	210	0	210
Sub-Totals (megahertz) for unlicensed :	40	0	40

Figure B: Counting Low-Band Spectrum

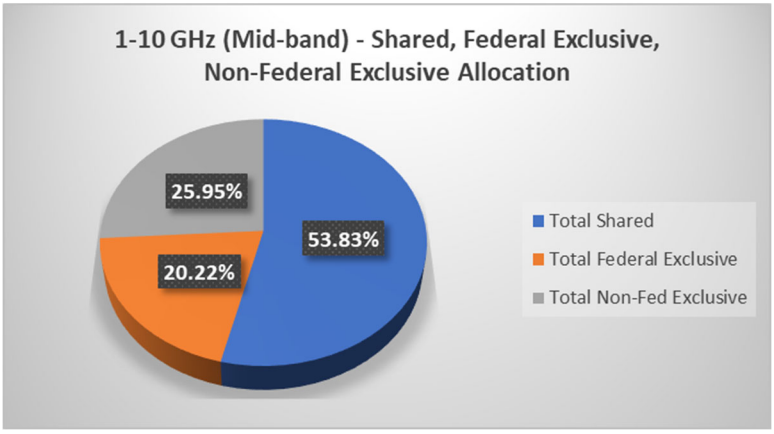

Figure C: Mid-Band Shared, Federal Exclusive, Non-Federal Exclusive Allocation

For mid-band spectrum, 3,014 megahertz have been made available.[51] *Figure C* demonstrates that roughly 54 percent of spectrum between 1-10 GHz is shared, with just over 20 percent federal exclusive and about 26 percent non-federal exclusive. Most recently, the FCC's C-band auction assigned 280 megahertz of mid-band spectrum, raising $81 billion in revenue in the process.[52] Following that was an auction of the 3450-3550 MHz band, which raised another $22.5 billion. Federal agencies, in coordination with NTIA and other stakeholders, are continuing to study additional mid-band spectrum (*e.g.*, 3100-3450 MHz and 1300-1350 MHz) for potential repurposing.

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[50] This total includes both licensed and unlicensed use, including repurposing from before the Mobile Now Act (160 megahertz), the UHF TV Incentive Auction (84 megahertz), and the 900 MHz reconfiguration (6 megahertz).

[51] This total includes both licensed and unlicensed use, including 1,178.5 megahertz from before the Mobile Now Act, part of the MSS ATC bands (11.5 megahertz), BRS/EBS (194 megahertz), the 3450-3550 MHz band (100 megahertz) the C-Band (280 megahertz), the 4.9 GHz band (50 megahertz), and the 6/7 GHz band (1,200 megahertz). *See also supra* note 4.

[52] *See, e.g.*, *Auction of Flexible-Use Service Licenses in the 3.7-3.98 GHz Band for Next Generation Wireless Services*, AU Docket No. 20-25, Public Notice, 36 FCC Rcd 3318 (2020), *available at* https://docs.fcc.gov/public/attachments/FCC-20-110A1.pdf.

Figure D shows mid-band repurposing totals, including 1,150.5 megahertz of licensed spectrum, 1,863.5 megahertz of spectrum for unlicensed use, and a further 485 megahertz under consideration for future repurposing.

Frequency Band	*Made Available*	*Spectrum Under Study*	**Legend**
Before MOBILE NOW Act (nonfederal):	280	0	- Non-federal
Before MOBILE NOW Act (federal):	235	0	- Federal
	663.5	0	- Licensed
MSS ATC bands: 1526-1536; 1627.5-1637.5; 1646.5-1656.5; 2483.5-2495 MHz	11.5	30	- Unlicensed
BRS/EBS	194	0	
1300-1350 MHz (SENSR)	0	50	
1675-1680 MHz (NOAA)	0	5	
2020-2025 MHz	0	5	
3100-3450 MHz	0	350	
3450-3550 MHz	100	0	
3.7-4.2 GHz: 3700-3980 MHz	280	0	
4.9 GHz: 4940-4990 MHz	50	0	
5 GHz Unlicensed: 5850-5925 MHz	0	45	
5925-7125 MHz (6/7 GHz)	1,200	0	
			Total
Sub-Totals (megahertz) for licensed :	1,150.5	440	1,590.5
Sub-Totals (megahertz) for unlicensed :	1863.5	45	1,908.5

Figure D: Counting Mid-Band Spectrum

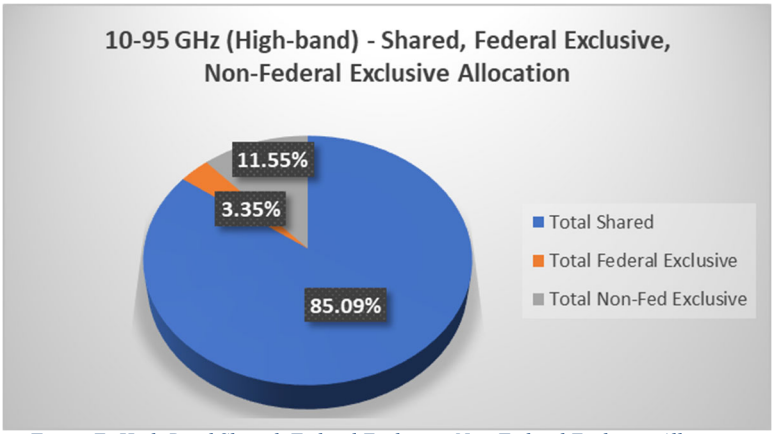

Figure E: High-Band Shared, Federal Exclusive, Non-Federal Exclusive Allocation

Additional efforts have been aimed at making high-band spectrum available, resulting in 11,950 megahertz of repurposed spectrum for licensed and unlicensed use. As *Figure E* demonstrates, the vast majority of high-band spectrum – roughly eighty-five percent – is shared, while roughly twelve percent is non-federal exclusive, and the remaining three percent is federal exclusive.

FCC rulemakings in recent years have made available large swaths of spectrum for commercial use including 5G. *Figure F* shows total repurposing efforts across all high-band spectrum, including 4,950 megahertz of licensed and 7,000 megahertz of spectrum made available for unlicensed use, and an additional 6,750 megahertz of spectrum under study for potential repurposing.

Frequency Band	*Made Available*	*Spectrum Under Study*	Legend
24 GHz (24.25-24.45 GHz)	200	0	- Non-federal
24 GHz (24.75-25.25 GHz)	500	0	- Federal
26 GHz (25.25-27.50 GHz)	0	2,250	- Licensed
28 GHz (27.50-28.35 GHz)	850	0	- Unlicensed
32 GHz (31.80-33.0 GHz)	0	1,200	
37 (37.0-37.6 GHz)		600	
37,39 GHz (37.60-40.0 GHz)	2,400	0	
42GHz (42.0-42.50 GHz)	0	500	
47 GHz (47.20-48.20 GHz)	1,000	0	
50 GHz (50.40-52.60 GHz)	0	2,200	
57-71 GHz	7,000	0	
			Total
Sub-Totals (megahertz) for licensed :	4,950	6,750	11,700
Sub-Totals (megahertz) for unlicensed :	7,000	0	7,000

Figure F: Counting High-Band Spectrum

Frequency Band	*Made Available*	*Spectrum Under Study*	Legend
Low-Band - licensed	210	0	- Licensed
Low-Band - unlicensed	40	0	- Unlicensed
Mid-Band - licensed	1,150.5	440	
Mid-Band - unlicensed	1,863.5	45	
High-Band - licensed	4,950	6,750	
High-Band - unlicensed	7,000	0	
			Total
Sub-Totals (megahertz) for licensed :	6,310.5	7,190	13,500.5
Sub-Totals (megahertz) for unlicensed :	8,903.5	45	8,948.5

Figure G: Spectrum Repurposing Totals

Through the hard work of many federal agencies, efforts across all bands have led to the repurposing of 15,214 megahertz of spectrum, shown in *Figure G*. This includes 6,310.5 megahertz of licensed spectrum, 8,903.5 megahertz available for unlicensed use, and an additional 7,235 megahertz across all bands currently under study. Further details of these repurposing efforts are provided in this report.

LEGISLATIVE MANDATES

Congress has been engaged substantially in spectrum repurposing. As policy evolved in the 1990s, Congress began a series of legislative actions that created a framework to support federal spectrum repurposing efforts.[53] These included the establishment of the Spectrum Relocation Fund (SRF) to reimburse certain federal costs associated with relocating federal operations to new bands.[54]

The Commercial Spectrum Enhancement Act requires that NTIA provide an annual report to the Committees on Appropriations and Energy and Commerce of the House of Representatives, the Committees on Appropriations and Commerce, Science, and Transportation of the Senate, and the Comptroller General on the progress made in relocating federal operations from spectrum designated under former section 118(d)(2)(A) of the NTIA Organization Act. NTIA has provided reports since federal agencies began relocating operations out of the 1710-1755 MHz band in March 2007. NTIA later expanded the report to include federal agency efforts to accommodate commercial use of the 1695-1710 MHz and 1755-1780 MHz bands, auctioned in 2014-2015. The last NTIA annual report covering the period January 2020 through December 2020 was published in August 2021.[55]

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 federal users to explore repurposing federal spectrum bands, including through spectrum sharing.[56] The Spectrum Pipeline Act established a method for federal agencies to obtain SRF resources to conduct studies to improve the efficiency and effectiveness of their spectrum use. This allows federal agencies that propose spectrum "Pipeline Plans" to receive some of this funding tied to the likelihood of future potential auctions for research, development, engineering studies, economic analyses, and other activities to make available frequencies for reallocation and auction, including for shared use.

Over the years, Congress has also directed a number of specific repurposing activities. NTIA is working with federal stakeholders to identify 30 megahertz below 3 GHz pursuant to the Spectrum Pipeline Act. Other Congressional directives included the Spectrum Pipeline Act's

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[53] 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, NTIA Special Publication 95-32 (Feb. 1995). Title III of the Balanced Budget Act of 1997 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, 258-70 (1997).

[54] Congress enacted the Commercial Spectrum Enhancement Act in 2004 (Title II of Pub. L. No. 108-494), creating the SRF and facilitating the initial AWS auction of the 1710-1755 MHz band (AWS-1).

[55] NTIA, *Commercial Spectrum Enhancement Act (CSEA) – Annual Progress Report for 2020* (Aug. 2021), https://www.ntia.doc.gov/files/ntia/publications/2020-csea-report.pdf.

[56] *See* Middle Class Tax Relief and Job Creation Act of 2012, Pub. L. No. 112-96, Title VI, Subtitle G, 126 Stat. 245-55 (Feb. 22, 2012); Spectrum Pipeline Act of 2015, Pub. L. No. 114-74, Title X, 129 Stat. 621-24 (Nov. 2, 2015).

requirement that NTIA and the FCC identify an additional 100 megahertz of federal and non-federal spectrum below 6 GHz for repurposing. The MOBILE NOW Act of 2018 required the identification of spectrum for repurposing and called for studies and reports related to spectrum repurposing.[57] Specifically, section 603(a) of the Act required NTIA and the FCC to identify 255 megahertz of federal and non-federal spectrum for mobile and fixed wireless broadband use by December 31, 2022. The Act required that these 255 megahertz meet the following specifications: 100 megahertz below 8 GHz (unlicensed), 100 megahertz below 6 GHz (exclusively licensed for commercial mobile use), and 55 megahertz below 8 GHz (licensed or unlicensed). Any spectrum made available on or after February 11, 2016, otherwise satisfying the aforementioned requirements was counted towards the Act's 255-megahertz identification requirement.[58] Currently, 711.5 megahertz of licensed spectrum has been identified[59] since passage of the MOBILE NOW Act — with up to another 385 megahertz under assessment and slated for potential identification as licensed commercial spectrum[60] — as well as 1,259 megahertz of spectrum for unlicensed operations identified in FCC proceedings that also will play a part in mobile broadband access.[61] As summarized in Table 2 below, the Spectrum Pipeline Act and the MOBILE NOW Act generally required NTIA or the FCC either to study the feasibility of, or develop rules for, new spectrum sharing in specific frequency bands, or to identify for repurposing spectrum bands meeting certain criteria or amounts specified in the legislation.

More recently, the Consolidated Appropriations Act of 2021, incorporating language from the Beat China by Harnessing Important, National Airwaves for 5G Act, mandated an FCC commercial auction of the 3450-3550 MHz band which the FCC initiated in October of 2021.[62] The IIJA directed the Office of Management and Budget to transfer $50 million from the SRF to DOD "for the purpose of research and development, engineering studies, economic analyses, activities with respect to systems, or other planning activities to improve efficiency and effectiveness of the spectrum use of the Department of Defense in order to make available

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[57] *See* Consolidated Appropriations Act, 2018, Pub. L. No. 115-141, Division P, the Repack Airwaves Yielding Better Access for Users of Modern Services (RAY BAUM'S) Act, Title VI (the Making Opportunities for Broadband Investment and Limiting Excessive and Needless Obstacles to Wireless Act or MOBILE NOW Act), § 603 (Mar. 23, 2018).

[58] MOBILE NOW Act § 603. It additionally precluded the already identified frequencies of 1695-1710 MHz, 1755-1780 MHz, 2155-2180 MHz, and 3550-3700 MHz from satisfying the 255-megahertz requirement. *Id.*

[59] Combining the licensed portion of the UHF TV Incentive Auction (70 megahertz), 900 MHz (6 megahertz), Educational Broadcasting Service (194 megahertz), the C-Band spectrum to be auctioned in December 2020 (280 megahertz), 3450-3550 MHz (100 megahertz), the Ancillary Terrestrial Component (ATC) of the MSS L-Band and S-band (11.5 megahertz), and 4.9 GHz (50 megahertz).

[60] Combining the 1675-1680 MHz band (5 megahertz), the 3100-3450 MHz band (350 megahertz), and the remaining portion of the MSS L-Band (30 megahertz).

[61] Combining the 1200 megahertz use of the 6 GHz band (*Unlicensed Use of the 6 GHz Band*, ET Docket No. 18-295, Report and Order and Further Notice of Proposed Rulemaking, 35 FCC Rcd 3852, FCC 20-51 (rel. Apr. 24, 2020), *available at* https://docs.fcc.gov/public/attachments/FCC-20-51A1.pdf, the UHF TV Incentive Auction band (14 megahertz), and the potentially unlicensed portion of the 5.9 GHz band (45 megahertz).

[62] Consolidated Appropriations Act, 2021, Pub. L. 116-260, Division FF, Title IX, § 905.

electromagnetic spectrum in the covered band."[63] Subsequently, DOD must provide the results of this report to the Secretary of Commerce, who, in coordination with the Secretary of Defense, Director of the White House Office of Science and Technology Policy (OSTP), and relevant Congressional committees, must determine which frequencies could be made available on a shared basis. The Secretary of Commerce must submit to the President and the FCC a report identifying such frequencies by August 15, 2023.

[63] Infrastructure Investment and Jobs Act, Pub. L. 117-58, 135 Stat. 429, § 90008 (Nov. 15, 2021).

TABLE 2

Summary of Statutory Provisions Related to Spectrum Repurposing

In Progress Provisions

- *Spectrum Pipeline* § 1004(a): Department of Commerce report to the 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 the auction
- *IIJA* § 90008(b)(2): Department of Commerce report to the President and FCC regarding frequencies identified for repurposing in the 3100-3450 MHz band.
    - Due Date: August 15, 2023 (IIJA + 21 months) for DOC report; not earlier than November 30, 2024 for FCC to begin the auction.

Satisfied and Exceeded Provisions

- *Consolidated Appropriations Act of 2021* § 905: FCC 3.45-3.55 GHz auction
    - Due date: for NTIA to begin withdrawing and modifying Federal Government assignments (Consolidated Appropriations + 180 days); 30 days after completing withdrawal for notifying the FCC; December 31, 2021, for the FCC auction to begin.
- *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)
- *FAA Reauthorization Act of 2018* § 374: FCC, NTIA, and FAA joint report on UAS operations on the L-band and C-band
    - Due Date: July 1, 2019 (FAA Act + 270 days)
- *Spectrum Pipeline* § 1006(c)(1): FCC report for at least 50 megahertz of additional spectrum below 6 GHz for reallocation to non-federal use (licensed or shared) (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 for reallocation to non-federal use (licensed or shared) (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

REPURPOSING INITIATIVES BY SPECTRUM BAND

Below are details about repurposing efforts for specified bands.

Low-Band Spectrum

512-698 MHz UHF TV Incentive Auction

The FCC repurposed this band from television broadcasting; as of August 2020, all of the broadcast television stations that were assigned new channels in order to repurpose the band for wireless services had vacated their pre-auction channels and thereby cleared the new wireless band, and wireless services had commenced in some markets even before the full band was cleared. The two-part 2016-2017 FCC auction repurposed a total of 84 megahertz of spectrum, including 70 megahertz for licensed use and 14 megahertz for licensed and unlicensed wireless microphones as well as other unlicensed use, meeting the requirements to partially satisfy Section 603(a)(5) of the MOBILE NOW Act.

- Current Status: All of the 987 full power and Class A repacked TV stations have vacated their pre-auction channels and the new wireless band has been cleared for wireless services. Virtually all of the repacked stations are now operating their new channels on permanent facilities, and the few remaining stations that have not yet completed construction of their final facilities have received FCC authorization to continue to operate their new channels on interim facilities for a limited time pending completion of construction.
- Next Steps: The FCC is continuing to reimburse the repacked stations, certain multichannel video service providers and FM radio stations affected by the repack, and certain Low Power Television (LPTV) and TV Translator stations displaced by the repack, from the $2.7 billion TV Broadcaster Relocation Fund for their costs associated with the transition.

800 MHz Band - Interstitial Channel Allocation

The rebanding process in this band has substantially alleviated interference risk to public safety licensees, and the process was completed on April 22, 2021.[64] On October 22, 2018, the Commission released the PLMR Report and Order[65] which updated its part 90 rules to provide new spectrum capacity and eliminate unnecessary restrictions on private land mobile radio (PLMR) services. The PLMR Report and Order created 318 new "interstitial" channels in the

[64] *Improving Public Safety Communications in the 800 MHz Band*, WT Docket No. 02-55, Order Terminating Proceeding, (rel. Apr. 22, 2021), *available at* https://docs.fcc.gov/public/attachments/FCC-21-41A1.pdf.

[65] *Creation of Interstitial 12.5 Kilohertz Channels in the 800 MHz Band Between 809-817/854-862 MHz*, WP Docket No. 15-32, Report and Order and Order, 33 FCC Rcd 10222 (rel. Oct. 22, 2018), *available at* https://www.fcc.gov/ecfs/search/search-filings/filing/1022268519037.

800 MHz Mid-Band to accommodate increased demand for spectrum capacity from public safety and other PLMR users.

- Current Status: The dispute resolution process under the 800 MHz rebanding orders, and the docket itself, is terminated. The TA has removed its email address from service and discontinued website resources.[66]
- Next Steps: Certified frequency coordinators may file applications in the Universal Licensing System (ULS), on behalf of eligible applicants, for interstitial channels beginning July 7, 2022.

900 MHz Band

In March 2019, the FCC proposed a reconfiguration of the 900 MHz band (896-901/935-940 MHz) to facilitate the development of broadband technologies and services.[67] In October 2019, the FCC issued an Order[68] modifying the September 2018 FCC freeze on applications for new or expanded use of the 900 MHz band. The FCC announced this action was being taken to provide "greater flexibility" for incumbents to be able to relocate from the proposed broadband segment. In May 2020, the FCC adopted a Report and Order reconfiguring the 900 MHz band to facilitate the development of broadband technologies and services, including for critical infrastructure uses.[69] The FCC established a broadband segment in the band, and adopted a transition mechanism based primarily on negotiations between prospective broadband licensees and existing narrowband incumbent licensees. On January 4, 2021, the private company Anterix, acting in accordance with the FCC's negotiation process, announced the first successfully negotiated lease agreement in the band.[70]

- Current Status: In May 2021, the FCC began accepting 900 MHz broadband segment applications.[71] In August 2021, the FCC granted the first and second round of 900 MHz

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[66] 800 MHz Transition Administrator, Landing Page *800TA* (Dec. 31, 2020), http://www.800ta.org/.

[67] *Review of the Commission's Rules Governing the 896-901/935-940 MHz Band*, WT Docket No. 17-200, Notice of Proposed Rulemaking, 34 FCC Rcd 1550 (2019), *available at* https://docs.fcc.gov/public/attachments/FCC-19-18A1.pdf.

[68] *Review of the Commission's Rules Governing the 896-901/935-940 MHz Band*, WT Docket No. 17-200, Order, 34 FCC Rcd 9369 (WTB 2019), *available at* https://ecfsapi.fcc.gov/file/1009391605766/DA-19-1025A1.pdf.

[69] *Review of the Commission's Rules Governing the 896-901/935-940 MHz Band*, WT Docket No. 17-200, Report and Order, Order of Proposed Modification, and Orders, 35 FCC Rcd 5183, FCC 20-67 (2020), *available at* https://docs.fcc.gov/public/attachments/FCC-20-67A1.pdf.

[70] DeGrasse, Martha, "Anterix Announces First Major 900 MHz Lease Agreement." *Fierce Wireless* (January 4, 2021), https://www.fiercewireless.com/private-wireless/anterix-announces-first-major-900-mhz-lease-agreement.

[71] *See Wireless Telecommunications Bureau to Accept 900 MHz Broadband Segment Applications Beginning May 27, 2021*, WT Docket 17-200, Public Notice, 36 FCC Rcd 7377, DA 21-450 (WTB 2021) *available at* https://docs.fcc.gov/public/attachments/DA-21-450A1.pdf.

broadband segment licenses.[72] Potential applicants continue negotiating with incumbent licensees to implement the repurposing pursuant to the rules adopted by the FCC.

- Next Steps: The FCC will review and evaluate the success of the negotiation process and consider whether additional mechanisms for transition are necessary.[73]

Mid-Band Spectrum

1300-1350 MHz Band

The Spectrum Efficient National Surveillance Radar (SENSR) program and participating agencies are studying the development of a SENSR capability that could enable vacating certain long-range air surveillance systems from the 1300-1350 MHz band, to determine the feasibility of making available at least 30 megahertz for commercial wireless broadband.[74] The band is currently under study by the FAA, DOD, and DHS for sharing with wireless services. In 2019, DOD also received SRF funding to assess sharing between incumbent DOD systems that are expected to remain in the band and potential new commercial systems. The National Science Foundation (NSF) noted follow-on impacts to spectrum in and near the critical 1400-1427 MHz band, as well as potential direct impacts to radio astronomy operations in the 1300-1350 MHz range.

- Current Status: The band remains under study by NTIA. However, federal agencies have significant concerns about impacts from various repurposing options on surveillance radars. NTIA continues efforts to address these concerns.
- Next Steps: NTIA is working with federal stakeholders in the band to respond to the obligation in Section 1004 of the Spectrum Pipeline Act to identify 30 megahertz of spectrum below 3 GHz that could be repurposed for commercial use.

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

In April 2020, the FCC approved, with conditions, modification applications of Ligado with respect to the ancillary terrestrial component 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

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[72] *See Wireless Telecommunications Bureau Grants First Round of 900 MHz Broadband Segment Applications*, WT Docket No. 17-200, Public Notice, DA 21-954 (rel. August 4, 2021) *available at* https://docs.fcc.gov/public/attachments/DA-21-954A1.pdf; *see also Wireless Telecommunications Bureau Grants 900 MHz Broadband Segment Applications*, WT Docket No. 17-200, Public Notice, DA 21-985 (rel. August 16, 2021) *available at* https://docs.fcc.gov/public/attachments/DA-21-985A1.pdf.

[73] *Review of the Commission's Rules Governing the 896-901/935-940 MHz Band*, WT Docket No. 17-200, Report and Order, Order of Proposed Modification, and Orders, 35 FCC Rcd 5183, FCC 20-67 (2020), *available at* https://docs.fcc.gov/public/attachments/FCC-20-67A1.pdf.

[74] The band is currently being studied by FAA, DOD, DHS, and NOAA (in an advisory role). Spectrum Efficient National Surveillance Radar (SENSR). *Fact Sheet*, https://www.faa.gov/air_traffic/technology/sensr/.

band.[75] There has been extensive analysis and testing focused on potential harmful interference to the Global Positioning System (GPS).[76] In the FY2021 NDAA, Congress responded to concerns raised by federal agencies by adopting several measures to address DOD activities in relation to the order and to request further independent technical analysis from the National Academies of Science, Medicine, and Engineering.[77] In the FY2022 NDAA, Congress further called for the Secretary of Defense to provide a briefing regarding the potential for harmful interference to GPS, mobile satellite services, or other tactical or strategic DOD systems from Ligado's operations in the band.

- Current Status: The FCC in January 2021 denied a petition to stay the decision approving the Ligado applications.[78]
- Next Steps: Petitions seeking reconsideration of the FCC's decision remain pending and the National Academies report is pending completion.

1675-1680 MHz Band

In a May 2019 Notice of Proposed Rulemaking (NPRM), the FCC proposed to reallocate the 1675-1680 MHz band for shared use between incumbent federal operations and non-federal

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[75] *See* Ligado Amendment to License Modification Applications IBFS File Nos. SES-MOD-20151231-00981, SAT-MOD-20151231-00090, and SAT-MOD-20151231-00091, IB Docket No. 11-109, Order and Authorization, 35 FCC Rcd 3772, FCC 20-48 (2020), *available at* https://docs.fcc.gov/public/attachments/FCC-20-48A1.pdf.

[76] *See*, *e.g.*, Dep't of Transp., *Global Positioning System (GPS) Adjacent Band Compatibility Assessment*, Final Report (Apr. 2018), https://www.transportation.gov/sites/dot.gov/files/docs/subdoc/186/dot-gps-adjacent-band-final-reportapril2018.pdf ("*DoT ABC Final Report*"); NIST Technical Note 1952, *LTE Impacts on GPS*, Final Test Report (Feb. 15, 2017), https://nvlpubs.nist.gov/nistpubs/TechnicalNotes/NIST.TN.1952.pdf; *FCC GPS Technical Working Group Final Report*, IB Docket No. 11-109 (Jun. 30, 2011), *available at* https://ecfsapi.fcc.gov/file/7021690471.pdf; National Space-Based Positioning, Navigation, and Timing Systems Engineering Forum (NPEF), *Assessment of LightSquared Terrestrial Broadband System Effects on GPS Receivers and GPS-dependent Applications* (Jun. 1, 2011), https://www.ntia.doc.gov/files/ntia/publications/ligtsquared_assessment_report_07062011.pdf; NPEF, *Follow-On Assessment of LightSquared Ancillary Terrestrial Component Effects on GPS Receivers* (Jan. 19, 2012), https://www.ntia.doc.gov/files/ntia/publications/npef_lsq_follow-on_test_report_final_public_release.pdf; Roberson and Associates, LLC, *Final Report: GPS and Adjacent Band Co-Existence Study* (Jun. 10, 2016), https://ecfsapi.fcc.gov/file/60002112686.pdf; *Letter from Deputy Assistant Secretary for Communications and Information Douglas Kinkoph to FCC Chair Ajit Pai re Ligado Networks LLC, License Modification Applications* (Dec. 6, 2019), *available at* https://www.ntia.doc.gov/files/ntia/publications/ntia_letter_to_fcc_chairman_re_ligado_mss_atc_applications_dec._6_2019.pdf.

[77] William M. (Mac) Thornberry National Defense Authorization Act for Fiscal Year 2021 or NDAA FY21, Pub. L. No. 116-283, 134 Stat. 3388, § 1663-64 (Jan. 1, 2021); *see also* National Academies of Sciences, Engineering, and Medicine, *Review of FCC Order 20-48 Authorizing Operation of a Terrestrial Radio Network Near the GPS Frequency Bands*, *available at* https://www.nationalacademies.org/our-work/review-of-fcc-order-20-48-authorizing-operation-of-a-terrestrial-radio-network-near-the-gps-frequency-bands.

[78] *LightSquared Technical Working Group et al.*, IB Docket No. 11-109, Order Denying Motion for Stay, 36 FCC Rcd 1262 (2021), *available at* https://docs.fcc.gov/public/attachments/FCC-21-22A1_Rcd.pdf/.

fixed or mobile (except aeronautical mobile) operations on a co-primary basis and sought comment on proposals for reallocation.[79]

- Current Status: NOAA has completed a study, funded via the Spectrum Pipeline Act, on sharing with commercial wireless services in the band without compromising NOAA's mission to obtain and distribute meteorological data.[80]
- Next Steps: NOAA is developing courses of action to address the issues identified. The FCC will evaluate the NOAA study along with other information supplied in its record on the proposed rules.

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 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.[81] Federal agency systems continue to operate in the lower two bands where the broadband licensees will share the spectrum either temporarily until the federal incumbents vacate the band (*i.e.*, early entry) or indefinitely with certain federal systems in a limited number of locations.

The early-entry coordination, per the framework developed by NTIA and FCC, has been successful in enabling carrier deployments in the 1755-1780 MHz band in advance of most federal systems vacating the band.[82] Because federal systems are not relocating from the 1695-1710 MHz band, the sharing will be indefinite.

Several agencies modified their initial transition plans for vacating the spectrum to request additional funding, change their technical solutions, and/or request an extension in the time required to vacate the spectrum. Some 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

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[79] *Allocation and Service Rules for the 1675-1680 MHz Band*, Notice of Proposed Rulemaking and Order, GN Docket No. 19-116, 34 FCC Rcd 3552 (2019), *available at* https://docs.fcc.gov/public/attachments/FCC-19-43A1.pdf.

[80] *See, e.g.*, NOAA, *Spectrum Reallocation Study: Solicitation Number SP-133E-17-RF-SpectrumReallocationStudy* (Apr. 13, 2017), https://govtribe.com/opportunity/federal-contract-opportunity/spectrum-reallocation-study-sp133e17rfspectrumreallocationstudy.

[81] 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 (2014), https://docs.fcc.gov/public/attachments/FCC-14-31A1.pdf.

[82] FCC and NTIA, Coordination Procedures in the 1695–1710 MHz and 1755–1780 MHz Bands, *Notice*, 79 Fed. Reg. 54710 (Sept. 12, 2014), *available at* https://www.ntia.doc.gov/files/ntia/publications/fr_aws3_notice_09122014.pdf.

non-interference basis for the period beyond that identified in the initial transition plan.[83] 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.[84]

- Current Status: These bands have been repurposed via auction; transition is under way and 90% complete.
- Next Steps: NTIA will continue to oversee the transition process.

2483.5-2495 MHz Band

In December 2016, the FCC adopted rules permitting Globalstar to deploy a terrestrial low-power broadband network using 11.5 megahertz of the company's 2.4 GHz spectrum. This authority provided increased capacity for the nation's terrestrial broadband spectrum inventory and furthers the FCC's continued policy to increase spectrum efficiency.[85] In March of 2020, the 3GPP approved a 5G variant of Globalstar's Band 53 at 2483.5-2495 MHz. Band 53 can be integrated into user equipment and cellular infrastructure; it can provide a single coast-to-coast contiguous license across the United States.

- Current Status: Repurposed for industry.
- Next Steps: No further regulatory action seen.

2496-2690 MHz ("2.5 GHz") Band

In June 2019, the FCC expanded the types of entities eligible to hold 2.5 GHz licenses and eliminated educational use requirements so that incumbent and future licensees have more flexibility in use of the spectrum.[86] A public notice released in January 2020 announced procedures for rural tribal nations to obtain 2.5 GHz spectrum licenses for the communications needs of their communities *via* a priority filing window through September 2, 2020.[87]

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[83] NTIA, *Commercial Spectrum Enhancement Act (CSEA)—Annual Report for 2018* (Oct. 2019), at p. II-2, https://www.ntia.doc.gov/files/ntia/publications/3397-ntia_2018_csea_report102819final.pdf.

[84] *See* NTIA, *Commercial Spectrum Enhancement Act (CSEA)—Annual Report for 2020* (Aug. 2021), https://www.ntia.doc.gov/files/ntia/publications/2020-csea-report.pdf.

[85] *See* Terrestrial Use of the 2473-2495 MHz Band for Low-Power Mobile Broadband Networks; Amendments to Rules for the Ancillary Terrestrial Component of Mobile Satellite Service Systems, IB Docket No. 13-213, Report & Order,31 FCC Rcd 13801 (2016) https://ecfsapi.fcc.gov/file/122316206822/FCC-16-181A1.pdf.

[86] *Transforming the 2.5 GHz Band*, WT Docket No. 18-120, Report and Order, 34 FCC Rcd 5446 (2019), *available at* https://ecfsapi.fcc.gov/file/0711901905298/FCC-19-62A1.pdf.

[87] *Wireless Telecommunications Bureau Announces Procedures for 2.5 GHz Rural Tribal Priority Window*, WT Docket No. 18-120, Public Notice, 35 FCC Rcd 308, DA 20-18 (2020), *available at* https://ecfsapi.fcc.gov/file/01062185814033/DA-20-18A1.pdf; *Transforming the 2.5 GHz Band*, GN Docket No. 18-120, Memorandum Opinion and Order, DA 20-819 (WTB 2019), *available at* https://docs.fcc.gov/public/attachments/DA-20-819A1.pdf.

The radio astronomy service has footnote US 385 in this range and operates as primary in the adjacent 2690-2700 GHZ range.

- Current Status: The FCC has granted 335 licenses as part of the Rural Tribal Priority Window and is considering the remaining applications.
- Next Steps: Bidding in the auction for any remaining spectrum licenses began on July 29, 2022.

3100-3550 MHz Band

NTIA evaluated the 3100-3550 MHz band both as part of ongoing efforts to identify candidate bands for repurposing and in response to the directions of the MOBILE NOW Act. Early in the analysis, and as described in a technical report released in January 2020, NTIA, in coordination with DOD, determined that the 3450-3550 MHz portion of this mid-band spectrum held the greatest promise for quicker repurposing and focused efforts accordingly.[88] The report indicated that spectrum sharing providing both sufficient protection to incumbent operations and an attractive business case to prospective commercial operations was possible, and that further analysis was warranted — including studying time-based sharing mechanisms. An NTIA report on the full 3100-3550 MHz band, conducted with federal users including DOD, indicated that further sharing below 3450 MHz may be possible, particularly as mechanisms for dynamic, time-based sharing are developed and tested.[89]

Building upon these efforts, DOD, the FCC, and NTIA expeditiously developed arrangements to make the 3450-3550 MHz band available to commercial wireless services for 5G deployment while still protecting military readiness and national security. In October 2020, the FCC issued a Further Notice of Proposed Rulemaking (FNPRM) proposing to auction licenses for use of the 3450-3550 MHz band[90] and adopted rules in March 2021.[91] The FCC ultimately began an auction of the band in October of 2021 which raised over $22.5 billion in proceeds, making it the third highest-grossing auction of all time.

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[88] *See* NTIA, *3450-3550 MHz Technical Feasibility Report* (Jan. 2020), https://www.its.bldrdoc.gov/publications/details.aspx?pub=3236.

[89] NTIA, *Feasibility of Commercial Wireless Services Sharing with Federal Operations in the 3100-3550 MHz Band* (July 2020), https://www.ntia.doc.gov/files/ntia/publications/ntia_3100-3550_mhz_mobile_now_report_to_congress.pdf.

[90] *Facilitating Shard Use in the 3.1-3.55 GHz Band*, WT Docket No. 19-348, Report and Order and Further Notice of Proposed Rulemaking, 35 FCC Rcd 11078 (2020), *available at* https://docs.fcc.gov/public/attachments/FCC-20-138A1.pdf.

[91] *Auction of Flexible-Use Service Licenses in the 3.45-3.55 GHz Band for Next-Generation Wireless Service*, AU Docket No. 21-62, Public Notice, DA 21-655 (2021), *available at* https://docs.fcc.gov/public/attachments/DA-21-655A1.pdf.

At Congress' direction, $50 million was allocated to DOD from the SRF to study opportunities for additional sharing in the remaining 3100-3450 MHz portion of the band.[92] DOD, which is working with industry and government stakeholders, including NTIA, will offer its assessment to the Secretary of Commerce, who, in coordination with the Secretary of Defense, Director of the White House OSTP, and relevant Congressional committees, must determine which frequencies could be made available on a shared basis. The Secretary of Commerce must submit to the President and the FCC a report identifying such frequencies by August 15, 2023.

Meanwhile, an agenda item at WRC-23 will consider identifying 3300-3400 MHz for IMT in Regions 1 (Europe, the Middle East, Russia, and Africa) and 2 (the Americas).[93]

NSF, cognizant of radio astronomy usage in this band per US 342, is studying for potential impacts.

- Current Status: The FCC successfully auctioned the 3450-3550 MHz portion of the band, and industry will deploy 5G services throughout 2022 and beyond. The remaining 3100-3450 MHz portion of the band is under study by DOD.
- Next Steps: DOD and NTIA will continue to study the feasibility of additional sharing within the remaining 3100-3450 MHz portion of the band, offering a report identifying such frequencies by August 23, 2023. Subsequently, the FCC will conduct an auction not earlier than November 30, 2024. Internationally, the United States will engage with the WRC-23 study group as it studies the bands, including conducting feasibility studies.

3550-3700 MHz (CBRS Band)

Spectrum access in the Citizens Broadband Radio Service (CBRS) band is facilitated by a novel spectrum sharing methodology consisting of a three-tiered licensing and access framework that places incumbent users in the highest tier (receiving protection from every other user), Priority Access License (PAL) users in the second tier (receiving protection from GAA users), and General Authorized Access (GAA) users in the final tier.[94] SASs are "automated frequency coordinators" that coordinate operations between the different user tiers.[95] After close consultation with NTIA, the FCC has certified that the following six SAS Administrators complied with Part 96 rule requirements and authorized them to make their SAS available for commercial use over a five-year term: Amdocs, CommScope, Federated Wireless, Google,

[92] Infrastructure Investment and Jobs Act, Pub. L. 117-58, 135 Stat. 429, § 90008 (Nov. 15, 2021).

[93] *See* Final Acts WRC-19, Resolution 245 at p. 363, Resolution 811 at p. 541, *available at* https://www.iata.org/contentassets/d7e421981aa64169af1a8d6b37438d4d/wrc-2019-final-acts.pdf.

[94] *Promoting Investment in the 3550-3700 MHz Band*, GN Docket No. 17-258, Order, 33 FCC Rcd 4987 (WTB/OET 2018), *available at* https://ecfsapi.fcc.gov/file/0522188222724/DA-18-538A1.pdf.

[95] *Id*.

Sony, and Key Bridge.[96] On August 25, 2020, the FCC concluded the auction of PALs.[97] The FCC then performed post-auction activities, including awarding PALs to successful auction winners. DOD Chief Information Officer (CIO) currently serves as the single point of contact for all DOD transition activities in the band and has committed to leading "active coordination with industry and Priority Access License holders for continued refinement of the CBRS sharing structure as commercial deployment evolves."[98]

- Current Status: CBRS deployments and usage in both the GAA and PAL tiers are well underway. Six SASs are commercially operational.
- Next Steps: NTIA and the FCC will continue to monitor the success of the novel sharing framework and oversee the transition of DOD operations in the band.[99]

3700-3980 MHz Band (C-Band)

The FCC reallocated and auctioned licenses for commercial wireless services in the lower 280 megahertz (3700-3980 MHz) of the C-Band, consolidating the incumbent satellite operations in the 4000-4200 MHz band. The new commercial wireless licensees are to pay the relocation costs of the C-band satellite operations as well as "accelerated relocation payments" to the satellite incumbents who voluntarily choose to clear the band on an expedited basis.[100] The auction, which concluded in January 2021, ultimately raised over $81 billion in revenue.[101] The FAA, other Federal stakeholders, and the aviation community have raised safety concerns regarding potential harmful interference to radar altimeters from the new commercial wireless

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[96] Wireless Telecommunications Bureau and Office of Engineering and Technology Approve Four Spectrum Access System Administrators for Full Scale Commercial Deployment in the 3.5 GHz Band and Emphasize Licensee Compliance Obligations in the 3650-3700 MHz Band Under Part 96, GN Docket No. 15-319, Public Notice, 35 FCC Rcd 117 (WTB/OET 2020), https://ecfsapi.fcc.gov/file/0127193875857/DA-20-110A1.pdf; Wireless Telecommunications Bureau and Office of Engineering and Technology Approve Spectrum Access System Administrator Amdocs for Full Scale Commercial Deployment in the 3.5 GHz Band, GN Docket No. 15-319, Public Notice, 35 FCC Rcd 3687, DA 20-437 (WTB/OET 2020), https://docs.fcc.gov/public/attachments/DA-20-437A1.pdf; Wireless Telecommunications Bureau and Office of Engineering and Technology Approve Spectrum Access System Administrator Key Bridge Wireless for Full Scale Commercial Deployment in the 3.5 GHz Band, GN Docket No. 15-310, Public Notice, 36 FCC Rcd 4880, DA 21-289 (WTB/OET 2021), https://docs.fcc.gov/public/attachments/DA-21-289A1.pdf.

[97] *Auction of Priority Access Licenses in the 3550-3650 MHz Band Closes*, AU Docket No. 19-244, Public Notice, 35 FCC Rcd 9287 (WTB/OEA 2020), *available at* https://docs.fcc.gov/public/attachments/DA-20-1009A1.pdf.

[98] Releasable Bands, NTIA, (Dec. 20, 2019), https://www.ntia.doc.gov/files/ntia/releasable_dod_ocio_3550-3650_rev-_sufficient_3_3_2020.pdf.

[99] NTIA, Transition Plans for 3550-3650 MHz Auction (Oct. 21, 2020), https://www.ntia.doc.gov/category/3550-3650-mhz.

[100] *Expanding Flexible Use of the 3.7 to 4.2 GHz Band*, GN Docket No. 18-122, Report and Order and Order of Proposed Modification, 35 FCC Rcd 2343 (2020), *available at* https://docs.fcc.gov/public/attachments/FCC-20-22A1.pdf.

[101] *Auction of Flexible Use Service Licenses in the 3.7-3.98 GHz Band Closes*, Public Notice, 36 FCC Rcd 4318 (2021), https://docs.fcc.gov/public/attachments/DA-21-207A1.pdf..

services.[102] AT&T and Verizon voluntarily delayed initial 5G deployments to enable time to further investigate these concerns and, following extensive collaboration between federal agencies and the wireless and aviation industries, agreed to preventative mitigation measures for these initial deployments. In addition, to reduce the potential for harmful interference from 5G C-band operations and prevent aircraft accidents, the FAA issued a series of Airworthiness Directives (AD) that prohibit certain aircraft operations in geographic areas where C-band frequencies may compromise proper functioning of radar altimeters.[103] The FAA also collaborated with wireless providers and aviation stakeholders to develop Alternative Methods of Compliance to the ADs to minimize the impact to flight operations. The parties continue to work together to review and adjust the restrictions on wireless deployment around airports as upgrades to aircraft are incrementally implemented. There is ongoing work to design and approve modifications for certain aircraft that will improve performance in the radio frequency environment as restrictions on wireless deployment are lifted. WRC-19 put into consideration identification of the frequency band 3.6-3.8 GHz for IMT/5G on the agenda for the next Conference in 2023.[104]

- Current Status: The FCC granted a majority of the license applications in July 2021 and has been working closely with the relocation payment clearinghouse, the relocation coordinator, and affected stakeholders to facilitate the transition of the band. Incumbent operators cleared the lower 120 megahertz of the band as of December 5, 2021. The FCC continues to monitor the band transition, with all major satellite incumbents reporting that transition activities are on track.[105] The FAA issued a series of Airworthiness Directives (AD) that prohibit certain aircraft operations in low visibility weather. The FAA also

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[102] *See*, *e.g.*, RTCA, *Assessment of C-Band Mobile Telecommunications Interference Impact on Low Range Radar Altimeter Operations*, (October 7, 2020), *available at* https://www.rtca.org/wp-content/uploads/2020/10/SC-239-5G-Interference-Assessment-Report_274-20-PMC-2073_accepted_changes.pdf.

[103] Airworthiness Directive 2021-23-13, Transport and Commuter Category Airplanes, Department of Transportation (Dec. 7, 2021), available at https://www.faa.gov/sites/faa.gov/files/2021-12/FRC_Document_AD-2021-01169-T-D.pdf; Airworthiness directive 2021-23-13, Various Helicopters (Dec. 7, 2021), available at https://www.faa.gov/sites/faa.gov/files/2021-12/FRC_Document_AD-2021-01170-R-D.pdf.

[104] *See* Final Acts of the World Radiocommunication Conference 2019 (WRC-19), Resolution 811 at p. 541, *available at* https://www.itu.int/dms_pub/itu-r/opb/act/R-ACT-WRC.14-2019-PDF-E.pdf. The International Telecommunications Union (ITU) uses the terminology International Mobile Telecommunications (IMT) for commercial wireless services with IMT-2020 representing 5G capabilities. For purposes of this report, 5G is synonymous with IMT-2020. An *identification* of spectrum is an international concept that provides guidance to countries internationally on a specific spectrum allocation that may be used by a large number of countries for a specified use.

[105] Vorwig, Petra A., SES Quarterly Report, SES Networks, (Mar. 26, 2021), https://ecfsapi.fcc.gov/file/10326094891198/2021%20March%20Quarterly%20Report.pdf, Bocquet, Wladimir, Eutelsat Quarterly Status Report, Eutelsat, (Mar. 31, 2021), , Intelsat: Bryan, Michelle, V., (Mar. 31, 2021) https://ecfsapi.fcc.gov/file/1033146816460/March%202021%20Quarterly%20Report%20-%20Intelsat%203-31-2021.pdf, Telesat, Telesat C-Band Transition Quarterly Report, Telesat, (Mar. 30, 2021), https://ecfsapi.fcc.gov/file/1033197694292/Telesat%20Q1%202021%20Report%20for%20FCC%20C-band%20Transition.pdf.

collaborated with wireless providers and aviation stakeholders to develop Alternative Methods of Compliance to the ADs to minimize the impact to flight operations. The FAA has been engaged with NTIA and FCC and are interfacing regularly with the wireless industry, the aviation community, and the radar altimeter manufacturers.

- Next Steps: Incumbent operators have committed to clearing the entirety of the 3700-3980 MHz band in the contiguous United States by December 5, 2023. Efforts are ongoing between DOT, FAA, other stakeholders, NTIA, and FCC to identify potential mitigations to ensure there will be no safety impacts to the national airspace system.

4940-4990 MHz Band

The FCC allocated 50 megahertz (4940-4990 MHz) of spectrum in the 4.9 GHz band for fixed and mobile services and designated the band for public safety support, adopting service rules in 2003 to encourage state and local agencies to benefit from high-speed applications like real-time video, data downloads, and short-range wireless networking at emergency incidents. Under this framework, public safety entities could enter into sharing agreements with utilities, federal government agencies, and others in support of public safety and homeland security. The FCC has an ongoing rulemaking proceeding open to examine the 4.9 GHz band and potentially modify the service rules to expand usage of the band. In March 2018, the FCC released a Sixth FNPRM,[106] followed by a September 2020 decision to allow one entity in each state to lease some or all of the 50 megahertz of spectrum to third parties for fixed and mobile services, including for non-public safety operations.[107] However, the FCC stayed the order pending further review in May of 2021[108] and reversed course in September 2021.[109] In the FCC's September 2021 action, it vacated the leasing rules that were adopted in the 2020 Report and Order.[110] Going forward, the FCC has sought comment on new ways to share the band and add

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[106] *Amendment of Part 90 of the Commission's Rules*, Sixth Further Notice of Proposed Rulemaking, 33 FCC Rcd 3261 (2018), *available at* https://ecfsapi.fcc.gov/file/03231913715191/FCC-18-33A1.pdf.

[107] *Amendment of Part 90 of the Commission's Rules*, WP Docket No. 07-100, Sixth Report and Seventh Further NPRM, 36 FCC Rcd 1958 (2020), *available at* https://docs.fcc.gov/public/attachments/FCC-20-137A1.pdf.

[108] *Amendment of Part 90 of the Commission's Rules*, WP Docket No. 07-100, Order, FCC-21-66 (2021), *available at* https://docs.fcc.gov/public/attachments/FCC-21-66A1.pdf.

[109] *Amendment of Part 90 of the Commission's Rules*, WP Docket 07-100, Order on Reconsideration and Eighth Further Notice of Proposed Rulemaking, FCC-21-106 (2021), *available at* *https://ecfsapi.fcc.gov/file/100196417863/FCC-21-106A1.pdf.*

[110] *Amendment of Part 90 of the Commission's Rules*, WP Docket 07-100, Order on Reconsideration and Eighth Further Notice of Proposed Rulemaking, FCC-21-106 (2021), *available at* *https://ecfsapi.fcc.gov/file/100196417863/FCC-21-106A1.pdf;* Public Safety and Homeland Security Bureau and Wireless Telecommunications Bureau Modify Temporary Filing Freeze on the Acceptance and Processing of Certain Part 90 Applications for the 4940-4990 MHz Band, WP Docket No. 07-100, *Public Notice* (2021) *https://ecfsapi.fcc.gov/file/1021103895772/DA-21-1320A1.pdf.*

mobile capabilities while protecting public safety operations.[111] The entire 4800-4990 MHz band is now the subject of increased global attention as a potential band for wireless commercial broadband. An agenda item for WRC-23 will consider possible measures to address protection of stations of the Aeronautical and Maritime Mobile Services (AMS/MMS) located in international airspace and waters.[112]

NSF is considering impacts on the band per US 342 and US 246.

- Current Status: The FCC has reaffirmed the importance of public safety operations in the band and is considering the record to determine whether the band should be made available only for public safety, or for other purposes as well. Internationally, several administrations have identified the entire 4800-4990 MHz band as a prime candidate for 5G, while other administrations expect to continue operating AMS and MMS systems in this band.
- Next Steps: The FCC is reviewing comments submitted in response to the 2021 FNPRM and assessing its next steps in 4940-4990 MHz band proceeding. Simultaneously, the United States will engage in the WRC-23 study group as it studies the 4800-4990 MHz band to determine the technical and regulatory conditions for the protection of stations of the AMS and MMS.

5850-5925 MHz Band

The FCC adopted new rules in November 2020, partitioning the band with the lower 45 megahertz designated for unlicensed use and the upper 30 megahertz for LTE C-V2X technology (and for existing Dedicated Short Range Communications (DSRC) on an interim basis for systems that move to the upper 30 megahertz prior to transitioning to LTE C-V2X).[113] Unlicensed National Information Infrastructure (U-NII) devices currently operate in four frequency bands in the 5 GHz range, totaling 580 megahertz of spectrum.[114] The 5850-5925 MHz band is allocated on a primary basis to the non-federal mobile service. Currently in the 5850-5895 MHz band, unlicensed use is permitted indoors only and DSRC service for ITS applications were able to operate in the lower 45 MHz until July 5, 2022; and can continue operations in the upper 30 MHz until FCC provides a cessation date in an upcoming Second

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111 *Amendment of Part 90 of the Commission's Rules*, WP Docket 07-100, Order on Reconsideration and Eighth Further Notice of Proposed Rulemaking, FCC-21-106 (2021), *available at* *https://ecfsapi.fcc.gov/file/100196417863/FCC-21-106A1.pdf*.

[112] *See* Final Acts WRC-19, Resolution 811 at p. 541, *available at* https://www.iata.org/contentassets/d7e421981aa64169af1a8d6b37438d4d/wrc-2019-final-acts.pdf.

[113] *Use of the 5.850-5.925 GHz Band*, ET Docket No. 19-138, First Report and Order, Further Notice of Proposed Rulemaking, and Order of Proposed Modification, 35 FCC Rcd 13440, (2020), *available at* https://docs.fcc.gov/public/attachments/FCC-20-164A1.pdf.

[114] *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 (Jun. 1, 2016), *available at* https://apps.fcc.gov/edocs_public/attachmatch/FCC-16-68A1.pdf.

Report and Order (date not yet determined for this Report and Order). The band is also allocated on a primary basis to the Federal Radiolocation service, so roadside DSRC units must accept any interference from and be coordinated with Federal Radiolocation operations within 75 kilometers of a number of military installations. In conjunction with the Report and Order, the FCC issued an FNPRM proposing technical rules for LTE C-V2X operations and seeking comment on measures for unlicensed devices to protect Federal Radiolocation operations.[115] The FNPRM also proposed that all DSRC operations in the upper 30 megahertz of the band either convert to LTE C-V2X or cease operation within two years of the forthcoming Second Report and Order. DOT is presently evaluating LTE C-V2X device radio performance for transportation safety purposes. Simultaneously, certain automotive and transportation infrastructure stakeholders have filed a court challenge to the FCC order in the Circuit Court for the District of Columbia.[116]

Pursuant to the November 2020 First Report and Order, on August 6, 2021, the FCC issued a Public Notice which provided guidance to current and prospective ITS licensees that wish to obtain waivers of the existing DSRC-based rules to deploy C-V2X operations in the upper 30-megahertz portion (5895-5925 MHz) of the 5850-5925 MHz Band prior to adoption of the final rules which will ultimately govern ITS operations in the band.

On September 12, 2021, the Department of Transportation of the State of Georgia requested that the FCC waive its rules applicable to ITS operations in the upper 30-megahertz portion of the 5850-5925 MHz Band to permit them to operate roadside units (RSUs) with C-V2X-based technology in the upper 30-megahertz portion of the band.

Also, on December 13, 2021, a coalition of automakers, state departments of transportation, and equipment manufacturers requested a nationwide waiver of the FCC's ITS rules to allow them to deploy C-V2X technology in the upper 30 megahertz of the 5850-5925 MHz Band prior to adoption of the final rules which will govern ITS operations in the band.

- Current Status: The FCC repurposed 45 megahertz of the band for unlicensed use, including Wi-Fi. DOT is testing LTE C-V2X device radio performance as well as the potential for UNII-4 or UNII-5 interference to ensure the remaining 30 megahertz can achieve transmitting and receiving transportation safety-of-life messages and other connected and automated transportation public benefits.[117] The FCC is currently defending its November 2020 order from a court challenge in the D.C. Circuit.[118]

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[115] *Use of the 5.850-5.925 GHz Band*, ET Docket No. 19-138, First Report and Order, Further Notice of Proposed Rulemaking, and Order of Proposed Modification, 35 FCC Rcd 13440, (2020), *available at* https://docs.fcc.gov/public/attachments/FCC-20-164A1.pdf.

[116] *Intelligent Transp. Soc., et al, v. FCC,* Case Number 21-1130, (D.C. Cir. 2021), *available a*t https://dockets.justia.com/docket/circuit-courts/cadc/21-1130.

[117] DOT, The Safety Band #SafetyBand, https://www.transportation.gov/content/safety-band.

[118] *Intelligent Transp. Soc., et al, v. FCC,* Case Number 21-1130, (D.C. Cir. 2021), *available at* https://dockets.justia.com/docket/circuit-courts/cadc/21-1130.

- Next Steps: ITS including LTE C-V2X and DSRC are required to vacate the lower 45 megahertz, to utilize only the upper 30 megahertz, and the FCC is expected to act on the issues raised in the FNPRM relative to Federal Radiolocation systems and determine whether mitigation is required.[119] DOT continues to test the LTE C-V2X device radio performance and test results are expected in 2022.[120]

5925-7125 MHz Band

In April 2020 the FCC adopted rules for unlicensed use of the 6 GHz band (5925-7125 MHz).[121] Under these rules, in the 5.925-6.425 GHz and 6.525-6.875 GHz sub-bands unlicensed access points can transmit both indoors and outdoors under the control of an automated frequency coordination (AFC) system. Across the entire 6 GHz band, unlicensed access points may operate at lower power restricted to indoor use, without an AFC system. Client devices may connect to either type of access point. These new rules are expected to be instrumental in meeting the growing need for wireless connectivity and address the expected growth of Wi-Fi and IoT devices. The new rules are designed to allow this spectrum to be more intensively used by unlicensed devices, while protecting existing licensed services (including microwave links, mobile news gathering (BAS), satellite uplinks, and a limited number of satellite downlinks). In November 2021, the FCC began the process of accepting applications for Automated Frequency Coordinators, drawing on a similar process in the CBRS band with Spectrum Access Systems.[122] Meanwhile, an agenda item at WRC-23 will consider identification of 7025-7125 MHz globally as spectrum appropriate for IMT.[123]

- Current Status: The FCC has adopted rules allowing unlicensed use across the entire 6 GHz band for low-power indoor use as well as standard-power in the 5.925-6.425 GHz and 6.525-6.875 GHz bands for both indoor and outdoor devices using AFC systems.
- Next Steps: The FCC will consider further expanding unlicensed use of the band by a new class of very-low-power devices as well as by client-to-client device

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[119] *Use of the 5.850-5.925 GHz Band*, ET Docket No. 19-138, First Report and Order, Further Notice of Proposed Rulemaking, and Order of Proposed Modification, 35 FCC Rcd 13440, (2020), *available at* https://docs.fcc.gov/public/attachments/FCC-20-164A1.pdf.

[120] DOT, *Test Plan and Test Procedures Summary: Testing Long Term Evolution Vehicle to Everything (LTE-V2X) Radio Performance Capabilities within the 5.9 GHz Band*, (December 8, 2021), https://www.transportation.gov/sites/dot.gov/files/2021-12/DOT%20LTE%20V2X%20Summary%20Overview%2007cDEC2021%20vFINAL.pdf.

[121] *Unlicensed Use of the 6 GHz Band*, ET Docket No. 18-295, Report and Order and Further Notice of Proposed Rulemaking, 35 FCC Rcd 3852, FCC 20-51 (2020), *available at* https://docs.fcc.gov/public/attachments/FCC-20-51A1.pdf.

[122] The Commission Begins the Process for Authorizing 6 GHz Band Automated Frequency Coordination Systems, ET Docket No. 21-352, *Public Notice* (2021), https://ecfsapi.fcc.gov/file/09281454120568/FCC-21-100A1.pdf.

[123] *See* Final Acts WRC-19, Resolution 245 at p. 363, Resolution 811 at p. 541, *available at* https://www.iata.org/contentassets/d7e421981aa64169af1a8d6b37438d4d/wrc-2019-final-acts.pdf.

communications.[124] It will also begin certifying AFC systems.[125] Internationally, the United States will engage with the WRC-23 study group as it studies the bands for IMT identification, including conducting feasibility studies.

High-Band Spectrum

24.25-25.45; 24.75-25.25 GHz Bands

In March 2019, 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.[126] WRC-19 identified these bands for 5G.[127] In April 2021, the FCC sought comment on aligning its rules with decisions of WRC-19 regarding the 24.25-27.5 GHz band, posing questions about out-of-band emission limits and passive sensing, among other things.[128]

- Current Status: The FCC concluded its auction of the band in 2019, awarding over 2,909 licenses over 700 megahertz of spectrum.[129]
- Next Steps: The FCC will evaluate responses to the April 2021 Public Notice seeking comment on unwanted emission levels in the band and consider next steps for the 24 GHz band.

25.25-27.5 GHz Band

In 2018, the FCC sought comment on potential shared use of the 26 GHz band.[130] WRC-19 identified this band for 5G.[131] The FCC announced notices of proposed rulemaking to explore

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[124] The Office of Engineering & Technology Seeks Additional Information Regarding Client-to-Client Device Communications in the 6 GHz Band, Public Notice (OET rel. Jan. 11, 2021), https://ecfsapi.fcc.gov/file/0111778905671/DA-21-7A1.pdf.

[125] The Commission Begins the Process for Authorizing 6 GHz Band Automated Frequency Coordination Systems, ET Docket No. 21-352, *Public Notice* (2021), https://ecfsapi.fcc.gov/file/09281454120568/FCC-21-100A1.pdf.

[126] *Auction of 24 GHz Upper Microwave Flexible Use Service Licenses Closes*, AU Docket No. 18-85, Public Notice, 34 FCC Rcd 4294 (OEA/WTB 2019), *available at* https://docs.fcc.gov/public/attachments/DA-19-485A1.pdf.

[127] *See* Final Acts WRC-19, Resolution 242 at p. 351, *available at* https://www.iata.org/contentassets/d7e421981aa64169af1a8d6b37438d4d/wrc-2019-final-acts.pdf.

[128] The Office of Engineering & Technology and the Wireless Telecommunications Bureau Seek Comment on Emission Limits for the 24.25-27.5 GHz Band, OET Docket No. 21-186, Public Notice, DA 21-482 (rel. Apr. 26, 2021), *available at* https://ecfsapi.fcc.gov/file/0426169205434/DA-21-482A1.pdf.

[129] *Auction 102: Spectrum Frontiers* – 24 GHz, FCC, *available at* https://www.fcc.gov/auction/102.

[130] *Use of Spectrum Bands Above 24 GHz for Mobile Radio Services*, Third Report and Order, Memorandum Opinion and Order, and Third Further Notice of Proposed Rulemaking, 33 FCC Rcd 5576 (2018), *available at* https://docs.fcc.gov/public/attachments/FCC-18-73A1.pdf.

[131] *See* Final Acts WRC-19, Resolution 242 at p. 351, Resolution 243 at p. 355, *available at* https://www.iata.org/contentassets/d7e421981aa64169af1a8d6b37438d4d/wrc-2019-final-acts.pdf.

repurposing additional high band frequencies for wireless use in this band and others in the *Spectrum Frontiers* proceeding. Internationally, the United States supported identification for 5G in three frequency ranges at WRC-19 based on existing domestic decisions.[132]

- Current Status: The FCC has received and is considering comments on potential service rules for the 26 GHz band.
- Next Steps: The FCC, in consultation with NTIA and relevant federal stakeholders, will determine if, when, and how the band is suitable for repurposing.

27.5-28.35 GHz Band

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.[133]

- Current Status: The FCC concluded an auction of licenses in the 28 GHz band in January 2019.[134]
- Next Steps: Winning bidders will continue to deploy new technologies in the band, including 5G services.

37-37.6 GHz Band

The FCC sought comment on a mechanism for shared use of the Lower 37 GHz band by federal and non-federal entities.[135] WRC-19 identified the 37-43.5 GHz band for 5G.[136] The United States supported identification[137] for 5G in three frequency ranges at WRC-19 based on existing domestic decisions.

- Current Status: The FCC received comments on sharing in the Lower 37 GHz band and continues to consider them.
- Next Steps: NTIA, DOD, and the FCC will continue discussion on the methodology for

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[132] An *identification* of spectrum is an international concept that provides guidance to countries internationally on a specific spectrum allocation that may be used by a large number of countries for a specified use.

[133] *Auctions of Upper Microwave Flexible Use Licenses for Next-Generation Wireless Services*, AU Docket No. 18-85, Public Notice, 33 FCC Rcd 7575 (2018), *available at* https://docs.fcc.gov/public/attachments/FCC-18-109A1.pdf.

[134] The FCC 28 GHz Auction, Auction 101, netted $700,309,809. *Winning Bidders Announced for Auction of 28 GHz Upper Microwave Flexible Use Service Licenses (Auction 101)*, AU Docket No. 18-85, Public Notice, 34 FCC Rcd 4279 (2019), *available at* https://docs.fcc.gov/public/attachments/DA-19-484A1.pdf.

[135] *Use of Spectrum Bands Above 24 GHz for Mobile Radio Services*, GN Docket No. 14-177, Third Report and Order, Memorandum Opinion and Order, and Third Further Notice of Proposed Rulemaking, 33 FCC Rcd 5576 (2018), *available at* https://docs.fcc.gov/public/attachments/FCC-18-73A1.pdf.

[136] *See* Final Acts WRC-19, Resolution 243 at p. 355, *available at* https://www.iata.org/contentassets/d7e421981aa64169af1a8d6b37438d4d/wrc-2019-final-acts.pdf.

[137] An *identification* of spectrum is an international concept that provides guidance to countries internationally on a specific spectrum allocation that may be used by a large number of countries for a specified use.

sharing the Lower 37 GHz band between Federal and non-Federal users.

37.6-38.6; 38.6-40; 47.2-48.2 GHz Band

In March of 2020 the FCC conducted Auction 103, making 3.4 gigahertz of spectrum available in the Upper 37 GHz, 39 GHz, and 47 GHz bands, and conducted an incentive auction to assign new licenses for contiguous spectrum in these bands while preserving incumbents' existing spectrum usage rights in the 39 GHz band.[138] WRC-19 identified several of these bands for 5G.[139]

- Current Status: The FCC concluded its auction of these bands in 2020, repurposing 3,400 megahertz of spectrum.
- Next Steps: Winning bidders will continue to deploy new technologies in these bands, including 5G services.

42-42.5 GHz Band

This band has been allocated to fixed, mobile, broadcasting and broadcasting-satellite operations on a primary basis for non-Federal use. In 2018, the FCC sought comment on potential shared use of the 42 GHz band.[140] The FCC also sought comment on whether to add a Federal fixed and mobile allocation in the band. The FCC has declined to add a domestic FSS allocation in the band. In 2019, WRC-19 identified the band for 5G while supporting development of a recommendation to protect radio astronomy observations in adjacent 42.5-43.5 GHz band via geographic separation and power limits.[141]

- Current Status: The FCC received comments on service rules for the 42 GHz band and continues to consider them.
- Next Steps: The band remains under consideration for flexible use licensing. NTIA will continue to work with federal agency spectrum users to assess and study potential impacts to in-band and adjacent-band operations, existing and planned, to avoid interrupting critical missions.

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[138] Incentive Auction of Upper Microwave Flexible Use Service Licenses in the Upper 37 GHz, 39 GHz, and 47 GHz Bands for Next Generation Wireless Services Closes, Public Notice, 35 FCC Rcd 2015 (OEA/WTB 2020), *available at* https://docs.fcc.gov/public/attachments/DA-20-253A1.pdf.

[139] *See* Final Acts WRC-19, Resolution 243 at p. 355, *available at* https://www.iata.org/contentassets/d7e421981aa64169af1a8d6b37438d4d/wrc-2019-final-acts.pdf.

[140] *Use of Spectrum Bands Above 24 GHz for Mobile Radio Services*, GN Docket No. 14-177, Third Report and Order, Memorandum Opinion and Order, and Third Further Notice of Proposed Rulemaking, 33 FCC Rcd 5576 (2018), *available at* https://docs.fcc.gov/public/attachments/FCC-18-73A1.pdf.

[141] *See* Final Acts WRC-19, Resolution 242 at p. 351; Resolution 243 at p. 355, *available at* https://www.iata.org/contentassets/d7e421981aa64169af1a8d6b37438d4d/wrc-2019-final-acts.pdf.

50.4-52.6 GHz Band

The FCC sought comment on making this band available for flexible terrestrial use and adopted rules to allow fixed-satellite service providers to operate with individually licensed earth stations transmitting in the 50.4-51.4 GHz portion of the band.[142] At WRC-19 the band was not identified for 5G.

- Current Status: An FCC rule change allows fixed satellite service providers to operate individually licensed earth stations in the 50.4-51.4 GHz segment of the band.
- Next Steps: The remaining aspects of the FCC's rulemaking remain pending.

64-71 GHz Band

The FCC made 7 gigahertz of spectrum available for unlicensed use in the 64-71 GHz band, adjacent to an existing 7 gigahertz of spectrum already available for unlicensed use in the 57-64 GHz band.

- Current Status: The FCC adopted rules to allow for unlicensed operations in the band, subject to the technical standards in Section 15.255, which created a 14-gigahertz contiguous spectrum segment.
- Next Steps: Operators will continue to deploy unlicensed operations in the band. The FCC is also considering proposed modifications to its unlicensed rules that would permit expanded radar operations in the 57-64 GHz segment.

95-3000 GHz Band

In 2019, the FCC released a Report and Order that created a new class of experimental licenses for use of spectrum above 95 GHz (and below 3 THz) that provide for increased flexibility.[143]

- Current Status: The FCC has created a new class of experimental licenses for spectrum between 95 GHz and 3 THz. These licenses require coordination with existing passive users of the spectrum, such as radio astronomy which has multiple international primary allocations in this range. WRC-19 supported the continued study of this range for sharing and compatibility with the passive services and active services.
- Next Steps: The Commission deferred action on implementing licensed service rules and a rulemaking remains pending.[144]

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[142] *Use of Spectrum Bands Above 24 GHz for Mobile Radio Services*, GN Docket No. 14-177, Fifth Report and Order, 34 FCC Rcd 2556 (2019), *available at* https://docs.fcc.gov/public/attachments/FCC-19-30A1.pdf.

[143] *Spectrum Horizons*, ET Docket No. 18-21, First Report and Order, 34 FCC Rcd 1605 (2019), *available at* https://docs.fcc.gov/public/attachments/FCC-19-19A1.pdf.

[144] *Id.* at para. 2.

116-123; 174.8-182; 185-190 and 244-246 GHz Bands

The FCC Report and Order released in 2019 made available over 21 gigahertz of spectrum for unlicensed use in these bands with shared federal and non-federal allocations. The FCC crafted the bands selected to permit large numbers of unlicensed devices to use the spectrum, while limiting the potential for harmful interference to existing governmental and scientific operations in the above-95 GHz bands, such as space research and atmospheric sensing.

- Current Status: The FCC has opened up 21.2 gigahertz of spectrum in these bands for unlicensed devices.
- Next Steps: The FCC will continue to work with industry, NTIA, and Federal stakeholders on equipment authorization of unlicensed devices for these bands.

OTHER RELATED SPECTRUM INITIATIVES

The future of spectrum repurposing is closely tied to spectrum sharing. NTIA, through the Office of Spectrum Management (OSM), is actively pursuing initiatives designed to facilitate more efficient and effective use of spectrum, which, among other outcomes, may provide opportunities for federal and non-federal spectrum sharing. These efforts are also advanced by NTIA's research laboratory the Institute for Telecommunication Sciences (ITS).

The sections below reflect two key initiatives in progress. These include: (1) NTIA's Spectrum IT Modernization, which, among other things, will provide more reliable, accessible, and up-to-date information on agency spectrum use; and (2) the NSF's Spectrum Innovation Initiative (SII), which aims to solve spectrum-related problems with a combination of research, development, education, and workforce development. In addition, NTIA is exploring important spectrum sharing methodologies, including a uniform spectrum sharing solution called Incumbent Informing Capability (IIC).[145]

Spectrum IT Modernization

NTIA's current spectrum IT systems are becoming inadequate to successfully execute the Department of Commerce's Primary Mission Essential Function to ensure the continuity of operations of Federal radio communications systems and manage Federal use of the radio frequency spectrum. New communications, radar, satellite, and unmanned system technologies are increasingly complex and evolving quickly, while current spectrum management IT systems are antiquated, disconnected, and ineffective, limiting the ability to keep pace with these advanced technologies. NTIA's IT Modernization effort is key for managing federal spectrum and for future spectrum sharing and repurposing efforts. It will provide OSM and the Federal

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[145] NTIA, "NTIA Pursues Innovative Spectrum Sharing Plan That Could Deliver Boost to 5G," (Dec. 15, 2020), https://www.ntia.doc.gov/blog/2020/ntia-pursues-innovative-spectrum-sharing-plan-could-deliver-boost-5g.

Di Francisco, et al., "Incumbent Informing Capability (IIC) for Time-Based Spectrum Sharing," 10, (Dec. 17, 2020), https://www.ntia.doc.gov/files/ntia/publications/iic_for_time-based_spectrum_sharing.pdf.

agencies the automation and technical foundation to transform our ability to manage federal spectrum more efficiently and effectively in a spectrum-sharing environment to enable essential government services and spur commercial wireless innovation and economic growth. In September of 2021, NTIA published its IT modernization plan, in accordance with Section 9203 of the FY2021 NDAA.[146]

NTIA plans to work collaboratively with Federal agencies to evolve its IT systems in ways that improve efficiency and information gathering for all involved. NTIA's planned architecture is composed of three main sections:

1. Operational needs – defines the goals from a business process or operational perspective. These encompass a wide variety of needs, including spectrum certification, Interdepartment Radio Advisory Committee (IRAC) functions,[147] spectrum sharing, reallocation, and general information gathering.
2. The system component – defines the elements necessary to meet operational needs. This encompasses a wide variety of applications for daily use built on top of the Master Data Repository, an aggregated pool of spectrum data.
3. Technology – describes the technologies used to implement system components. Here NTIA plans to use stable and mature technologies guaranteed to work seamlessly together and receive security support over an extended time horizon.

The Spectrum Innovation Initiative

Begun in 2020, the NSF's SII presents opportunities to address the pressing challenges arising from the growing demand for usage of the electromagnetic spectrum, including passive and active applications. In 2021, NSF, NTIA, and the FCC signed a Memorandum of Agreement to collaborate and provide subject matter expertise to help ensure that SII operations are aligned with U.S. spectrum regulatory and policy objectives, principles, and strategies.

The goal of the SII is to promote dynamic and agile spectrum utilization, while ensuring innovation and security for all users. Reaching this goal will require basic research, infrastructure development, new collaborations, and education and workforce development.

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[146] NTIA, Plan to Modernize and Automate the Infrastructure of NTIA Related to Managing Federal Spectrum Use, (Sep. 2021), available at https://www.ntia.doc.gov/report/2021/plan-modernize-and-automate-infrastructure-ntia-related-managing-federal-spectrum-use.

[147] IRAC assists the Assistant Secretary in assigning frequencies to U.S. Government radio stations and advises on issues of policy, programs, procedures, and technical criteria. *See* Interdepartment Radio Advisory Committee (IRAC), NTIA (last visited July 24, 2021), https://www.ntia.doc.gov/page/interdepartment-radio-advisory-committee-irac.

NSF, through SII, is focused on cultivating research and innovation in spectrum usage in the following ways:

National Radio Dynamic Zones

To facilitate the ongoing research and development of enhanced, next-generation spectrum management and to promote the nation's leadership in the efficient use of the electromagnetic spectrum, NSF supports the development and establishment of National Radio Dynamic Zones (NRDZ)[148] as test beds in a few geographic areas. Through the SII, the NSF NRDZ effort intends to foster the testing and implementation of state-of-the-art wireless and spectrum-use technologies through the use of national test beds. NRDZ test beds should build and expand upon experience with existing national quiet zones, innovation zones, and coordination zones, for example the National Radio Quiet Zone,[149] the ITS-managed Table Mountain Field Site and Radio Quiet Zone, the Puerto Rican Coordination Zone, and the NSF-funded Platforms for Advanced Wireless Research (PAWR) in Salt Lake City,[150] New York City,[151] Boston, Raleigh (which are designated as FCC Innovation Zones),[152] and Central Iowa.[153] The long-term goal of the NSF NRDZ is to provide enhanced spectrum usability and access for both passive and active users of the spectrum, piloting the technology in a few limited, yet diverse, geographic areas, to enable wider future deployments.

National Center for Spectrum Innovation and Workforce Development - SpectrumX

On September 14, 2021, NSF announced a $25 million investment over five years to launch SpectrumX, an NSF Spectrum Innovation Center that will address the growing demand for usage of the radio spectrum.[154] SpectrumX is a coalition of 29 institutions[155] led by the

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[148] Kidd, Thomas. "National Radio Quiet and Dynamic Zones." *CHIPS: The Department of the Navy Information Technology Magazine*, June 2018. https://www.doncio.navy.mil/CHIPS/ArticleDetails.aspx?ID=10299.

[149] *See* Paulette Woody, *National Radio Quiet Zone*, National Radio Astronomy Observatory, (Jun. 2, 2016), https://science.nrao.edu/facilities/gbt/interference-protection/nrqz.

[150] *See* PAWR, Platforms for Advanced Wireless Research; https://www.advancedwireless.org.

[151] *See* FCC Establishes First Two Innovation Zones, *News Release* (Sep. 18, 2019), *available at* https://www.fcc.gov/document/fcc-establishes-first-two-innovation-zones.

[152] *See* FCC Announces Two New Innovation Zones and Amends One Existing Innovation Zone for Program Experimental Licenses, *Public Notice* (August 6, 2021), *available at* https://www.fcc.gov/document/fcc-established-two-new-innovation-zones-boston-and-raleigh-0.

[153] *See* ARA: Wireless Living Lab for Smart and Connected Rural Communities, PAWR, https://advancedwireless.org/central-iowa/.

[154] NSF, "NSF Announces the Launch of SpectrumX, an NSF Spectrum Innovation Center," Press Release, Sept. 14, 2022, https://www.nsf.gov/news/news_summ.jsp?cntn_id=303454.

[155] SpectrumX partners include Agnes Scott College, Clemson University, Florida Agricultural and Mechanical University, Massachusetts Institute of Technology, Morehouse College, Morgan State University, the National

University of Notre Dame working to develop new ways to share and manage the radio spectrum; act as a hub for collaboration among researchers, industry, government agencies, and others; and develop the diverse workforce needed for future growth. The overall goal of SpectrumX is to maximize the benefits of the radio spectrum for society. The investment in SpectrumX is part of the SII collaboration between NSF, NTIA, and the FCC to promote dynamic and agile spectrum utilization while ensuring innovation and security. This represents the first federal investment in a national center focused on the transformation of wireless spectrum management for the benefit of active and passive users of the spectrum, including 5G cellular networks. The SII-Center is also expected to educate and develop an agile workforce needed to support industries of the future which will rely heavily on wireless technologies and will require new advanced and automated spectrum management techniques.

Spectrum Research Activities

NSF is promoting and developing the means for increased and more effective use of spectrum for passive and active applications, especially activities of a cross-disciplinary nature. Other programs of note underway during this reporting period involving multiple awardees include:

- ***Spectrum and Wireless Innovation Enabled by Future Technologies (SWIFT):*** This program has a focus on effective spectrum utilization and/or coexistence techniques, especially with passive uses, which have received less attention from researchers. The goal of these research projects may be the creation of new technology or significant enhancements to existing wireless infrastructure, with an aim to improve spectrum utilization beyond mere spectrum efficiency.
- ***NSF/Intel Partnership on Machine Learning for Wireless Networking Systems (MLWiNS):*** This program seeks to accelerate fundamental, broad-based research on wireless-specific machine learning techniques, towards a new wireless system and architecture design, which can dynamically access shared spectrum, efficiently operate with limited radio and network resources, and scale to address the diverse and stringent quality-of-service requirements of future wireless applications.
- ***Resilient & Intelligent NextG Systems Program (RINGS):*** The RINGS program focuses on emerging Next Generation (NextG) wireless and mobile communication, networking, sensing, and computing systems. In this program, NSF is partnering with the Office of the Under Secretary of Defense for Research and Engineering (OUSD R&E), the National Institute of Standards and Technology, and several industry partners. The

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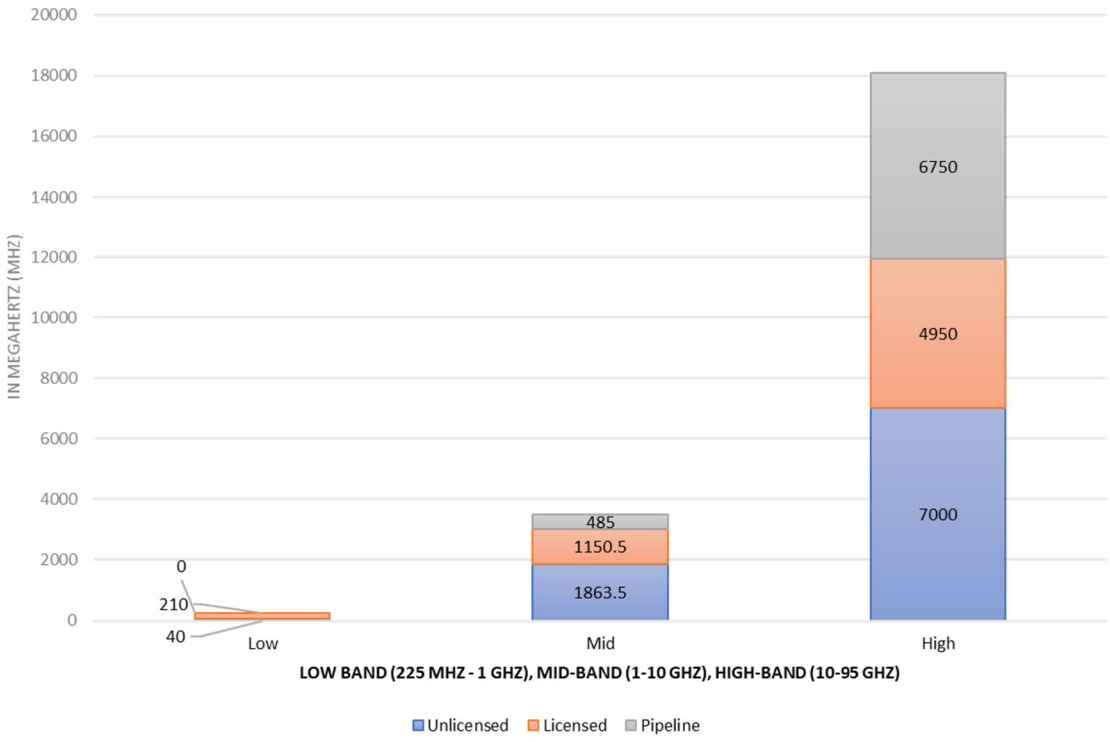
Radio Astronomy Observatory, New Mexico Institute of Mining and Technology, New York University, Norfolk State University, Northwestern University, Olin College of Engineering, South Carolina State University, Spelman College, Stanford University, Texas Tech University, University at Albany, University of California Berkeley, University of California Los Angeles, University of California Santa Cruz, University of Colorado Boulder, University of Pittsburgh, University of Puerto Rico de Mayaguez, University of Texas at San Antonio, University of the Virgin Islands, University of Virginia, University of the West Indies and Virginia Diodes Inc. SpectrumX, "Notre Dame to Lead $25 Million SpectrumX Project; First NSF Spectrum Innovation Initiative Center," Press Release, Sept. 14, 2021, https://www.spectrumx.org/notre-dame-to-lead-25-million-spectrumx-project-first-nsf-spectrum-innovation-initiative-center/.

goals of the program include the design and analysis of resilient communications systems that can operate over multiple frequency bands and evolving spectrum-use constraints.

CONCLUSION

The United States continues to make tremendous progress in repurposing spectrum to support commercial wireless services while ensuring the protection of critical federal missions (*See Figure I*).



The ongoing efforts have successfully met and exceeded the statutory reallocation requirements thus far. Going forward, NTIA will identify candidate spectrum bands for potential repurposing in collaboration with the FCC, other federal partners, and non-federal stakeholders. NTIA will work with the FCC and other stakeholders to understand the value of repurposing choices to the nation when making these critical decisions, while still preserving federal capabilities.