

**Before the
Federal Communications Commission
Washington, D.C. 20554**

In the Matter of)	
)	
Report to Congress)	
Pursuant to Section 1008 of the Spectrum Pipeline)	
Act of 2015,)	
As Amended by the Ray Baum’s Act of 2018;)	
)	
Use of Spectrum Bands Above 24 GHz for)	GN Docket No. 14-177
Mobile Radio Services;)	
)	
3.5 GHz SAS and ESC Applications;)	GN Docket No. 15-319
)	
Expanding Flexible Use in Mid-Band Spectrum;)	GN Docket No. 17-183
Between 3.7 and 24 GHz;)	
)	
Promoting Investment in the 3550-3700 MHz)	GN Docket No. 17-258
Band)	
)	

REPORT

Adopted: November 2, 2018

Released: November 2, 2018

By the Wireless Telecommunications Bureau and the Office of Engineering and Technology:

I. INTRODUCTION

1. The Spectrum Pipeline Act of 2015 (Spectrum Pipeline Act), enacted on November 2, 2015, includes provisions focused on the repurposing of spectrum from federal uses to non-federal licensed and unlicensed uses. Section 1008 of the Spectrum Pipeline Act requires the Federal Communications Commission (FCC or Commission) to submit to Congress a report containing an analysis of the results of the rule changes made by the Commission when it adopted new rules for the 3550-3700 MHz band (3.5 GHz band) to open a path to commercial wireless use,¹ and an analysis of proposals to promote and identify at least 1 gigahertz in additional spectrum bands between 6 GHz and 57 GHz “that can be shared between incumbent uses and new licensed and unlicensed services under such rules.”² Today, the Wireless Telecommunications Bureau (WTB) and the Office of Engineering and Technology (OET) (collectively, WTB/OET), pursuant to their delegated authority, adopt this Report presenting their analysis and concurrently submit the Report to Congress as required by the Spectrum

¹ See *Amendment of the Commission’s Rules with Regard to Commercial Operations in the 3550-3650 MHz Band*, GN Docket No. 12-354, Report and Order and Second Further Notice of Proposed Rulemaking, 30 FCC Rcd 3959 (2015) (*2015 Report and Order* and *2015 FNPRM*); 47 CFR §§ 96.1 *et seq.* In the *2015 FNPRM*, the Commission sought comment on a few focused issues and later made additional rule changes in 2016. See *Amendment of the Commission’s Rules with Regard to Commercial Operations in the 3550-3650 MHz Band*, GN Docket No. 12-354, Order on Reconsideration and Second Report and Order, 31 FCC Rcd 5011 (2016) (*2016 Order on Reconsideration and Report and Order*, respectively).

² Spectrum Pipeline Act of 2015, Pub. L. No. 114-74, § 1008, 129 Stat. 621, 625 (2015), as amended by the Ray Baum’s Act of 2018, Pub. L. 115-141, § 614, 132 Stat. 1080, 1109 (2018).

Pipeline Act.³

2. The rule changes in the 3.5 GHz band were designed to advance a solution to a long-standing problem in spectrum policy—how to select the most appropriate commercial authorization or licensing mechanism for a newly repurposed band—by adopting a flexible regulatory framework that accommodates incumbent uses in the 3.5 GHz band while making the spectrum hospitable to a wide variety of new users, deployment models, and business cases featuring both licensed and unlicensed uses,⁴ providing economies of scale, and facilitating intensive use of this spectrum.⁵ The interest evinced in the Spectrum Pipeline Act with respect to spectrum repurposing reflects the growing need to increase flexible, shared access to spectrum.

3. Prior to the rule changes by the Commission in the *2015 Report and Order*, the 3550-3650 MHz band segment was reserved for use by Department of Defense (DoD) radar systems and commercial fixed satellite service (FSS) earth stations (with commercial FSS limited to the 3600-3650 MHz portion of the band); the 3650-3700 MHz portion of the band was shared by a limited number of DoD radar systems, FSS earth stations, and wireless radio services authorized under Part 90, subpart Z of the Commission's rules.⁶ In 2015, the Commission adopted technical and service rules for commercial use of the 3.5 GHz band and established a multi-tiered authorization framework to coordinate access to the band.⁷ Where local competition for spectrum access is low, users have a low-cost entry tier, similar to unlicensed access; and where rivalry is high, an auction resolves mutually exclusive applications in specific geographic regions for the rights to enjoy a higher priority of access.⁸ These uses are coordinated by Spectrum Access Systems (SASs) that protect higher tier users from harmful interference and facilitate

³ 47 CFR §§ 0.331 (WTB delegated authority) and 0.241 (OET delegated authority).

⁴ Unlicensed devices such as Wi-Fi and Bluetooth generally operate under the FCC's Part 15 rules for radio frequency devices.

⁵ *2015 Report and Order*, 30 FCC Rcd at 3962, paras. 5-6.

⁶ *Id.* at 3964-66, paras. 15-20.

⁷ See generally *id.*, 30 FCC Rcd 3959. The Commission released a notice of proposed rulemaking in December 2012 proposing to make an additional 100 megahertz (or up to 150 megahertz under a supplemental proposal) of spectrum available for shared wireless broadband use. See *Amendment of the Commission's Rules with Regard to Commercial Operations in the 3550-3650 MHz Band*, GN Docket No. 12-354, Notice of Proposed Rulemaking, 27 FCC Rcd 15594 (2012) (*2012 NPRM*). The Commission proposed a comprehensive regulatory scheme to promote development of innovative technologies and services in the 3.5 GHz band in order to make additional spectrum available to meet the growing consumer demand for spectrum in line with the "Fast Track" report released by the National Telecommunications and Information Administration (NTIA) in October 2010. See NTIA, *An Assessment of the Near-Term Viability of Accommodating Wireless Broadband Systems in the 1675-1710 MHz, 1755-1780 MHz, 3500-3650 MHz, 4200-4220 MHz, and 4380-4400 MHz Bands at 1-8 (2010) (Fast Track Report)*, http://www.ntia.doc.gov/files/ntia/publications/fasttrackevaluation_11152010.pdf. The Fast Track Report identified 3550-3650 MHz as one of several federal bands that could be made available for commercial wireless broadband by 2015. *Id.* The Commission proposed technical rules that focused on the use of low-powered small cells to drive increases in broadband capacity and spectrum reuse, and a spectrum access system that would coordinate multiple tiers of users. See *2012 NPRM*, 27 FCC Rcd at 15612-14, paras. 53-58. In April 2014, the Commission released a further notice of proposed rulemaking that proposed specific rules for a new Citizens Broadband Radio Service in the 3.5 GHz band to be codified in a new proposed Part 96. See generally *Amendment of the Commission's Rules with Regard to Commercial Operations in the 3550-3650 MHz Band*, GN Docket No. 12-354, Further Notice of Proposed Rulemaking, 29 FCC Rcd 4273 (2014) (*2014 FNPRM*); 47 CFR §§ 96.1 *et seq.* The *2014 FNPRM* also sought comment on various protection criterion for incumbent users and FSS earth stations in the 3700-4200 MHz band (C-Band), competitive bidding procedures for resolving mutually exclusive applications for secondary licenses, and the possible extension of the proposed rules to include the 3650-3700 MHz band. *2014 FNPRM*, 29 FCC Rcd at 4280, para. 17.

⁸ *2015 Report and Order*, 30 FCC Rcd at 3962, para. 5.

coexistence between and among the various tiers of users.⁹

4. The licensing approach adopted by the Commission has already fostered significant investment by a wide range of commercial entities looking to develop a number of use cases and deployment models, many of which could prove useful in the race to implement 5G services. Likewise, interest in using elements of this spectrum access framework in other frequency bands between 6 GHz and 57 GHz to make more intensive use of spectrum continues to grow.

II. BACKGROUND

5. Prior to the rule changes in the *2015 Report and Order*, the 3550-3650 MHz band segment was reserved for use by DoD radar systems, FSS earth stations, and the non-federal Radiolocation Service (on a secondary basis).¹⁰ Specifically, the 3550-3650 MHz band was allocated to the Radiolocation Service and the Aeronautical Radionavigation Service (ground-based)¹¹ on a primary basis for federal use.¹² Both fixed and mobile high-powered DoD radar systems used in conjunction with weapons control systems and for the detection and tracking of air and surface targets on ground-based, shipborne, and airborne platforms operate in this band.¹³ At that time, the 3650-3700 MHz portion of the band was shared by a limited number of DoD radar systems, FSS earth stations, and wireless radio services authorized under Part 90, subpart Z of the Commission's rules. The 3650-3700 MHz band was allocated for primary use by the federal Radiolocation Service at three designated sites¹⁴ and allocated for use on a non-interference basis by ship stations located at least 44 nautical miles from shore in offshore ocean areas.¹⁵ The 3650-3700 MHz band also was allocated for terrestrial non-federal use, albeit subject to subpart Z, which governs wireless broadband services authorized via non-exclusive nationwide licenses and requires the registration of individual fixed and base stations.¹⁶ The specific technical characteristics of this band made it an ideal platform to explore innovative approaches to repurposing

⁹ *Id.*

¹⁰ The Radiolocation Service is a radiodetermination service for the purpose of radiolocation. Non-federal operation of land stations and mobile stations using frequencies in the 3500-3650 MHz bands was authorized on a secondary basis to other federal radiolocation operations. See 47 CFR § 2.106 (prior to 2015 amendment); *2015 Report and Order*, 30 FCC Rcd at 3965, para. 17 n.21. The Commission eliminated the non-federal radiolocation allocation for the 3550-3650 MHz band in the *2015 Report and Order*, although it permitted non-federal radiolocation stations to continue to operate on a secondary basis until the end of the equipment's useful lifetime, provided that the stations were licensed or had filed an application for authorization prior to July 23, 2015, the effective date of the *2015 Report and Order*. See *2015 Report and Order*, 30 FCC Rcd at 3974, para. 40; 47 CFR § 2.106, note US105.

¹¹ In the case where there is a parenthetical addition to an allocation in the International Table of Allocations, that service allocation is restricted to the type of operation so indicated, *i.e.*, federal use of this primary Aeronautical Radionavigation Service allocation is restricted to ground-based stations. 47 CFR § 2.104(h)(4).

¹² The Aeronautical Radionavigation Service is a radionavigation service intended for the benefit and for the safe operation of aircraft. 47 CFR § 2.1(c). Footnote G59 states that all federal non-military Radiolocation Service use of the 3500-3650 MHz band shall be on a secondary basis to military Radiolocation Service operations. 47 CFR § 2.106, note G59. Footnote G110 states that federal ground-based stations in the Aeronautical Radionavigation Service may be authorized in the 3500-3650 MHz band when accommodation in the 2700-2900 MHz band is not technically and/or economically feasible. 47 CFR § 2.106, note G110.

¹³ The U.S. Navy uses the band for radars on guided missile cruisers, while the U.S. Army uses the band for a firefinder system to detect enemy projectiles. See NTIA Office of Spectrum Management, Federal Spectrum Use Summary: 30 MHz-3000 GHz (2010), http://www.ntia.doc.gov/files/ntia/Spectrum_Use_Summary_Master-06212010.pdf. The U.S. Air Force also uses the band for airborne radar Station Keeping Equipment throughout the United States and Possessions to assist pilots in formation flying and to support drop-zone training.

¹⁴ See 47 CFR § 2.106, note US348. The FCC is required to coordinate any non-federal operations within 80 kilometers of the designated sites with NTIA.

¹⁵ 47 CFR § 2.106, note US349.

¹⁶ 47 CFR § 2.106 (non-federal terrestrial allocations); 47 CFR § 90.1307 (wireless broadband registration).

spectrum that accommodate the growing demand for fixed and mobile broadband capacity and balance the need to protect the important incumbent operations.¹⁷

A. Rule Changes

6. In 2015, the Commission adopted technical and service rules for commercial use of the 3.5 GHz band. Specifically, the *2015 Report and Order* created a three-tiered framework to coordinate shared federal and non-federal use of the band and established the Citizens Broadband Radio Service.¹⁸ Incumbents—including federal and certain existing non-federal users—comprise the highest tier and receive protection from all other users.¹⁹ Priority Access License (PAL) users, the second tier, receive protection from General Authorized Access (GAA) users, the third tier.²⁰ GAA is licensed-by-rule and must accept interference from all other users, including other GAA users.²¹ Automated frequency coordinators, known as SAs, will coordinate operations between and among users in different access tiers.²² In addition, an SA may incorporate information from an Environmental Sensing Capability (ESC)—a sensor network that detects transmissions from DoD radar systems and transmits that information to an SA—to ensure that federal incumbent users are protected from interference.²³

7. In the *2015 FNPRM*, which was released simultaneously with the *2015 Report and Order*, the Commission sought comment on a discrete set of issues that would benefit from further record development.²⁴ The Commission resolved issues regarding protections for PAL service areas, leasing parameters, and protection criteria for FSS sites in the *2016 Report and Order*.²⁵ Subsequently, the Commission issued the *2017 NPRM*, seeking comment on several proposed changes to the service rules governing PALs that will be issued in the 3.5 GHz band in addition to several changes to the technical rules to facilitate operations over wider bandwidths while ensuring that current and future incumbent operations continue to be protected from interference.²⁶ The Commission adopted the *2018 Report and*

¹⁷ See *2015 Report and Order*, 30 FCC Rcd at 3967-68, paras. 23-25.

¹⁸ See 47 CFR §§ 96.1 *et seq.*

¹⁹ Incumbent users include federal radiolocation users, FSS earth stations, and, for a finite period, certain grandfathered terrestrial wireless licensees in the 3650-3700 MHz band. See *2015 Report and Order*, 30 FCC Rcd at 3964-3967, paras. 15-22 (detailing incumbent use of the band); *id.* at 4075-4080, paras. 400-412 (adopting protections for grandfathered terrestrial wireless operations for five years or until the end of the license term, whichever is longer). Non-federal incumbents must register the parameters of their operations with the Commission and/or an SA to receive interference protection. See 47 CFR §§ 96.15, 96.17, 96.21.

²⁰ See *2015 Report and Order*, 30 FCC Rcd at 3962, para. 4.

²¹ See *id.* at 4009, para 156. GAA users may use only certified, Commission-approved devices and must register with the SA. *Id.* at 4012, para. 162.

²² The three-tier access framework adopted in the *2015 Report and Order* is generally consistent with proposals in the *2014 FNPRM*. See generally *2014 FNPRM*, 29 FCC Rcd 4273. See also *Commission Seeks Comment on Licensing Models and Technical Requirements in the 3550-3650 MHz Band*, GN Docket No. 12-354, Public Notice, 28 FCC Rcd 15300 (2013).

²³ See 47 CFR §§ 96.15, 96.67.

²⁴ See generally *2015 FNPRM*, 30 FCC Rcd 3959.

²⁵ *2016 Report and Order*, 31 FCC Rcd at 5014, para. 6.

²⁶ See generally *Promoting Investment in the 3550-3700 MHz Band*, GN Docket Nos. 17-258 *et al.*, Notice of Proposed Rulemaking and Order Terminating Petitions, 32 FCC Rcd 8071 (2017) (*2017 NPRM* or *Termination Order*, respectively). The Commission simultaneously adopted the *Termination Order*, in which it declined to seek comment on discrete proposals from a petition for rulemaking filed by T-Mobile that would have fundamentally altered the sharing framework of the band. *Termination Order*, 32 FCC Rcd at 8092-95, paras. 59-62.

Order on October 23, 2018.²⁷ Notably, the Commission adopted counties as the geographic license area for each PAL, extended PAL license terms to ten years, and made such licenses renewable.²⁸ The Commission revised its rules to adopt new end-of-term performance requirements for PALs;²⁹ eliminated the rule that made available one less PAL than the total number of PALs for which all applicants had applied in a given geographic license area, adopting the Commission's standard approach to determining whether accepted applications with respect to initial geographic area licenses are mutually exclusive applications subject to competitive bidding;³⁰ and adopted its proposal to assign PAL(s) even when there is only one application in a given geographic area, assuming the applicant is otherwise qualified.³¹ The Commission also adopted in the *2018 Report and Order* its proposal from the *2017 NPRM* to allow partitioning and disaggregation of PALs,³² amended the rules to prohibit an SAS from disclosing Citizens Broadband Service Device (CBSD)³³ registration data to the public except where such disclosure is authorized by the registrant, and required SAS Administrators to make aggregated spectrum usage data for any particular geographic area available to the public.³⁴ Finally, the Commission adopted a revised emission mask and an adjacent channel leakage requirement of -30 dBc for End User Devices.³⁵

B. Implementation of the Rule Changes

8. WTB/OET have taken multiple actions to facilitate the testing and development of SASs and ESCs.³⁶ All SAS Administrators and ESC operators must complete a two-stage review process that involves conditional certification of an application prior to public testing and a submission of the reports generated from those tests before final certification and approval by the Commission.³⁷ WTB/OET, in conjunction with DoD and the National Telecommunications and Information Administration (NTIA), have worked throughout the review process with the industry, including members of the Wireless

²⁷ *Promoting Investment in the 3550-3700 MHz Band*, GN Docket No. 17-258, Report and Order, FCC 18-149 (Oct. 24, 2018), 2018 WL 5311439 (*2018 Report and Order*).

²⁸ *Id.* at *6, para. 19 (geographic licensing area) and *16, para. 46 (license term and renewal); *see* 47 CFR § 96.25(b)(3).

²⁹ *Id.* at *21, para. 60. Specifically, the Commission requires PALs to provide a bona fide communications service that meets a "substantial service" standard of performance, and it adopted two specific safe harbors to meet this standard, one for mobile or point-to-multipoint services and a second for point-to-point services. *Id.* Licensees may fulfill their performance requirements by showing that they meet at least one of these safe harbors, or they may make an individualized showing of substantial service by relying, for example, on a combination of different services for which there is a safe harbor or on services for which there is no defined safe harbor. *Id.*

³⁰ *Id.* at *27-28, paras. 76-77.

³¹ *Id.* at *28, para. 78.

³² *Id.* at *35, para. 97; *see* 47 CFR § 96.32(b); *2017 NPRM*, 32 FCC Rcd at 8083, para. 31.

³³ CBSDs are fixed stations, or network of such stations, that operate on a Priority Access or General Authorized Access basis in the Citizens Broadband Radio Service. Category A CBSDs operate at lower power levels, while Category B CBSDs operate at higher levels and may operate outdoors only. *See* 47 CFR §§ 96.3, 96.41, 96.43, 96.45. Under the current rules, prior to the deployment of an ESC, an SAS may only authorize lower-power (Category A) CBSDs outside of Exclusion Zones, and the SAS may not authorize higher-power (Category B) CBSDs prior to the certification and deployment of ESCs. *See* 47 CFR §§ 96.7(a), 96.15(a)(2)-(3), 96.15(b)(2)-(3), 96.45(b), 96.53(g), 96.57(d).

³⁴ *2018 Report and Order* at *40, para. 112.

³⁵ *Id.* at *47, para. 137.

³⁶ *See 2015 Report and Order*, 30 FCC Rcd at 4067, paras. 369-373; *see also* 47 CFR §§ 0.241(j), 0.331(f).

³⁷ *See 2015 Report and Order*, 30 FCC Rcd at 4070, para. 386; *see also Wireless Telecommunications Bureau and Office of Engineering and Technology Establish Procedure and Deadline for Filing Spectrum Access System (SAS) Administrator(s) and Environmental Sensing Capability (ESC) Operator(s) Applications*, Public Notice, 30 FCC Rcd 14170 (WTB/OET 2015) (*SAS/ESC Proposal Public Notice*).

Innovation Forum (WinnForum), the multi-stakeholder group developing industry standards for SAS operations in the 3.5 GHz band, to simultaneously preserve necessary protections for incumbents and facilitate the certification and commercial deployment of SASs and ESCs.³⁸

9. On October 23, 2015, WTB released a public notice seeking comment on the appropriate methodology and relevant technical parameters for determining the Grandfathered Wireless Protection Zones.³⁹ WTB/OET released a public notice on August 19, 2016, announcing the methodology for determining the protected contours for grandfathered 3650-3700 MHz band licensees.⁴⁰ On April 7, 2017, WTB released a public notice that announced a four-month filing window for incumbent 3560-3700 MHz licensees to file the supplemental information required to define their Grandfathered Wireless Protection Zone within the framework for deployment of the Citizens Broadband Radio Service and provided the relevant filing procedures.⁴¹ This information is now available on the Commission's website at: <https://opendata.fcc.gov/Wireless/ULS-3650-Locations-Default-View/dpvg-tvcx> (list of the registered Grandfathered Wireless Protection Zones by site); and at <https://us-fcc.app.box.com/v/3650-contours> (GEOJSON file containing the Grandfathered Wireless Protection Zones contours).

10. On December 21, 2017, WTB/OET and IB released a public notice describing the FSS earth station registration process for licensees eligible for protection from Citizens Broadband Radio Service users.⁴² This identified the specific types of earth stations that are eligible for registration and informed the public that the agency would establish the window for initial registrations and communicate to earth station licensees the detailed registration instructions once the registration system became operational.⁴³ On July 27, 2018, WTB/OET subsequently announced the opening of the filing window for initial registration of FSS earth stations entitled to protection from Citizens Broadband Radio Service

³⁸ See, e.g., Letter from Julius P. Knapp, Chief, OET, FCC, and Donald K. Stockdale, Jr., Chief, WTB, FCC, to Paige R. Atkins, Associate Administrator, Office of Spectrum Management, NTIA (filed Apr. 20, 2018) (on file in GN Docket Nos. 15-319 and 17-258) (requiring SASs to effectively coordinate operations around the Table Mountain Radio Receiving Zone consistent with Section 1.924 of the Commission's rules).

³⁹ See *Wireless Telecommunications Bureau Seeks Comment on an Appropriate Method for Determining the Protected Contours for Grandfathered 3650-3700 MHz Band*, GN Docket No. 12-354, Public Notice, 30 FCC Rcd 11557 (WTB 2015). The Commission provided that Grandfathered Wireless Protection Zones will be defined using methodology determined by WTB/OET. 47 CFR § 96.3. The Commission adopted rules in the *2015 Report and Order* to protect incumbent licensees' registered base stations in the 3650-3700 MHz band from harmful interference from CBSD users for a fixed transition period. *2015 Report and Order*, 30 FCC Rcd at 4075-80, paras. 400-412. Existing licensees will receive protection for operations that are within their Grandfathered Wireless Protection Zone for either five years after the *3.5 GHz Order* adoption date of April 17, 2015, or for the remainder of the license term, whichever is longer, with the exception that Part 90 incumbents licensed after January 8, 2013, will be limited to a protection period of five years after the 3.5 GHz Order adoption date. *Id.* at 4075-76, para. 400. These licensees are eligible for protection provided that: (1) the stations were registered in the Commission's Universal Licensing System on or before April 17, 2015; and (2) as of a year later (April 17, 2016) the stations were constructed, in service, and fully compliant with the relevant operating rules. *Id.* at 4078, para. 406.

⁴⁰ See *Wireless Telecommunications Bureau and Office of Engineering and Technology Announce Methodology for Determining the Protected Contours for Grandfathered 3650-3700 MHz Band Licensees*, GN Docket No. 12-354, Public Notice, 31 FCC Rcd 9037 (WTB/OET 2016).

⁴¹ *Wireless Telecommunications Bureau Announces Filing Window and Procedures for 3650-3700 MHz Band Licensees to File Supplemental Information Necessary for Creating Grandfathered Wireless Protection Zones*, GN Docket No. 12-354, Public Notice, 32 FCC Rcd 2977 (WTB 2017).

⁴² See *Wireless Telecommunications Bureau, Office of Engineering and Technology, and International Bureau Announce Procedures for Registration of Fixed Satellite Service Earth Stations Entitled to Protection from the 3.5 GHz Citizens Broadband Radio Service*, GN Docket No. 17-258, Public Notice, 32 FCC Rcd 10419 (WTB/OET/IB 2017).

⁴³ *Id.* at 10420-21.

users and provided detailed registration instructions for earth station licensees.⁴⁴

11. WTB/OET released a public notice on December 16, 2015, establishing a “first wave” deadline for proposals from prospective SAS Administrators and ESC operators and describing the application submission process and path to final certification.⁴⁵ WTB/OET conditionally approved the first wave of SAS Administrators on December 21, 2016⁴⁶ and conditionally approved the first wave of ESC operators on February 21, 2018.⁴⁷ On April 7, 2017, WTB/OET released a public notice establishing a “second wave” deadline for another round of proposals for prospective SAS Administrators and ESC operators, which the Commission currently is reviewing.⁴⁸

12. On July 27, 2018, WTB/OET released a public notice seeking proposals for short-term, limited geographic commercial deployment (Initial Commercial Deployment or ICD) by those SASs that had been conditionally approved.⁴⁹ The *ICD Public Notice* provides a summary of the requirements for Initial Commercial Deployment and an outline of the review process that WTB/OET will use to evaluate ICD proposals. ICD will complement the testing done in a controlled laboratory setting by providing a real-world environment to assess certain aspects of compliance with the Commission’s rules.⁵⁰ On September 10, 2018, six of the conditionally approved first wave SAS Administrators submitted their ICD proposals, which WTB/OET currently are reviewing.⁵¹

13. WTB/OET also acted on May 22, 2018, to support commercial deployment by releasing an order granting waiver of several Part 96 rules to permit SASs to implement a protection methodology

⁴⁴ *Wireless Telecommunications Bureau, Office of Engineering and Technology, and International Bureau Announce the Initial Filing Window and Procedures for Registration of Fixed Satellite Service Earth Stations Entitled to Protection from the 3.5 GHz Citizens Broadband Radio Service*, GN Docket No. 15-319, Public Notice, DA 18-783 (Jul. 27, 2018 WTB/OET/IB), 2018 WL 3629334.

⁴⁵ *See Wireless Telecommunications Bureau and Office of Engineering and Technology Establish Procedure and Deadline for Filing Spectrum Access System (SAS) Administrator(s) and Environmental Sensing Capacity (ESC) Operator(s) Applications*, GN Docket No. 15-319, Public Notice, 30 FCC Rcd 14170 (WTB/OET 2015).

⁴⁶ *Wireless Telecommunications Bureau and Office of Engineering and Technology Conditionally Approve Seven Spectrum Access System Administrators for the 3.5 GHz Band*, GN Docket No. 15-319, Public Notice, 31 FCC Rcd 13355 (WTB/OET 2016). Although seven SAS Administrators received conditional approval, CTIA later withdrew its proposal. *See* Letter from Paul Anuskiewicz et al., Vice President, Spectrum Planning, CTIA, to Marlene H. Dortch, Secretary, FCC (Nov. 20, 2017) (on file in GN Docket No. 15-319).

⁴⁷ *Wireless Telecommunications Bureau and Office of Engineering and Technology Conditionally Approve Four Environmental Sensing Capability Operators for the 3.5 GHz Band*, Public Notice, 33 FCC Rcd 1942 (WTB/OET 2018) (conditionally approving CommScope, Google Inc., Federated Wireless, and Key Bridge).

⁴⁸ *Wireless Telecommunications Bureau and Office of Engineering and Technology Establish “Second Wave” Deadline for Proposals from Prospective Spectrum Access System (SAS) Administrator(s) and Environmental Sensing Capacity (ESC) Operator(s)*, GN Docket No. 15-319, Public Notice, 32 FCC Rcd 2973 (WTB/OET 2017).

⁴⁹ *Wireless Telecommunications Bureau and Office of Engineering and Technology Establish Procedure and Deadline for Filing Spectrum Access System Initial Commercial Deployment Proposals*, GN Docket No. 15-319, Public Notice, DA 18-783 (Jul. 27, 2018 WTB/OET), 2018 WL 3629334 (*ICD Public Notice*).

⁵⁰ *See ICD Public Notice* at *2, para. 6; 47 CFR §§ 96.1 *et seq.* and all other applicable rules.

⁵¹ The conditionally approved SAS Administrators that submitted their ICD proposals include Amdocs, Inc.; CommScope; Federated Wireless, Inc.; Google; Key Bridge; and Sony, Inc. We note that, while the filing window established in the *ICD Public Notice* was for the benefit of the first wave SAS Administrators, which having received conditional approval prior to the release of that public notice, were seeking concurrent review with other ICD proposals submitted prior to the deadline on September 10, 2018, the general requirements and review process for ICD proposals will also apply to future rounds of proposals. *See ICD Public Notice* at *4, para. 9.

developed by NTIA that is based on Dynamic Protection Areas (DPAs).⁵² DPAs are pre-defined protection areas—extending from the coastline out into the ocean or enclosing a protected terrestrial radar facility—which may be activated or deactivated as necessary to protect DoD radar systems.⁵³ As a result, SASs now have the option to use DPA-based protection instead of Exclusion Zones in coastal areas and around federal facilities protected by DPAs.⁵⁴ Pursuant to the *DPA Waiver Order*, a DPA-enabled SAS may authorize both Category A and Category B CBSDs on a nationwide basis and will not be required to enforce Exclusion Zones in areas protected by DPAs prior to the certification of an ESC.⁵⁵ This waiver will permit operators in the 3.5 GHz band to operate both Category A and Category B CBSDs in a larger portion of the country more quickly than anticipated and thereby will promote efficient spectrum use and rapid commercial deployment in the band, encourage investment, and facilitate the expeditious provision of new products and services to the public while still protecting federal operations (including those used for defense purposes) against harmful interference.⁵⁶

14. WTB/OET released a public notice on October 16, 2018, to announce the beginning of ESC sensor registrations and the procedures to be followed by ESC operators.⁵⁷ ESC operators must register—and receive approval of—sensor configurations and locations before they can be used as part of an approved ESC.⁵⁸

15. *Summary of the Record.* On August 10, 2018, WTB/OET gave notice and sought public comment as directed by Congress in the Spectrum Pipeline Act, as amended by the Ray Baum’s Act.⁵⁹ Comments were due by September 11, 2018; twelve comments were filed by a diverse set of commercial

⁵² *Promoting Investment in the 3550-3700 MHz Band*, GN Docket Nos. 17-258 et al., Order, DA 18-538 (WTB/OET May 22, 2018), 2018 WL 2387489 (*DPA Waiver Order*).

⁵³ Letter from Paige R. Atkins, Assoc. Admin., Office of Spectrum Mgt., NTIA, to Julius P. Knapp, Chief, OET, FCC, and Donald Stockdale, Chief, WTB, FCC (May 17, 2018) at 2-3.

⁵⁴ Exclusion Zones are “geographic area[s] wherein no CBSD shall operate.” See 47 CFR § 96.3 (Exclusion Zone).

⁵⁵ *DPA Waiver Order* at *1, para. 1.

⁵⁶ *Id.* at para. 2.

⁵⁷ *Wireless Telecommunications Bureau and Office of Engineering and Technology Establish Procedure for Registering Environmental Sensing Capability Sensors*, GN Docket No. 15-319, Public Notice, DA 18-1054 (Oct. 16, 2018 WTB/OET), 2018 WL 5023300 (*ESC Sensor Registration Public Notice*).

⁵⁸ See *2015 Report and Order*, 30 FCC Rcd at 4070, para. 372.

⁵⁹ *Wireless Telecommunications Bureau and Office of Engineering and Technology Seek Comment Pursuant to the Spectrum Pipeline Act of 2015*, GN Docket Nos. 14-177 et al., Public Notice, DA 18-841 (WTB/OET Aug. 10, 2018), 2018 WL 3854030 (*Spectrum Pipeline Report Public Notice*). The Spectrum Pipeline Act became public law on November 2, 2015, prior to its amendment by the Ray Baum’s Act of 2018, which did not alter the deadline originally imposed by Congress, which was “no later than three years after the date of the enactment of the Spectrum Pipeline Act.” Pub. L. No. 114-74, § 1008, 129 Stat. 625. The Ray Baum’s Act amended the Spectrum Pipeline Act by adding a notice requirement on the Commission that mandates that the Commission seek comment with respect to this report. Pub. L. 115-141 § 614, 132 Stat. 1080, 1109.

entities, industry advocacy groups, and public interest advocates.⁶⁰ The Commission received three reply comments on September 26, 2018.⁶¹ The majority of the comments focused on analyzing changes in the 3.5 GHz band and reported on the Commission's role in enabling investment and commercial deployment in the band.⁶² Commenters also discussed various proposals before the Commission that identify certain frequencies for spectrum reallocation as described in the Spectrum Pipeline Act; the majority of these comments focused on the 6 GHz band and other spectrum identified in the *Spectrum Frontiers* proceeding.⁶³

III. ANALYSIS OF RULE CHANGES ON 3.5 GHZ BAND

16. *Overview.* The Commission has worked diligently—in close cooperation with NTIA, DoD, and industry stakeholders—to encourage investment, promote technological innovation, and facilitate the provision of new commercial services in the 3.5 GHz band. As reflected in the comments, the licensing approach adopted by the Commission, which is intended to protect incumbent uses while encouraging innovative technologies and services, already has fostered significant investment in the 3.5 GHz band.⁶⁴ A wide range of commercial entities, including the members of multi-stakeholder industry groups like the WinnForum and the CBRS Alliance, have developed a number of deployment models that permit both incumbent and new uses.⁶⁵

17. Multiple entities—mobile wireless service providers, Wireless Internet Service Providers (WISPs) and other fixed mobile providers, cable providers, Internet of Things (IoT) providers, and energy

⁶⁰ The following entities filed comments timely on Sept 11, 2018: Federated Wireless, Inc.; Apple Inc.; Broadcom Inc.; Cisco System, Inc.; Facebook, Inc.; Google LLC; Hewlett Packard Enterprise; Intel Corporation; Marvell Technology Group; Microsoft Corporation; Qualcomm Incorporated; Ruckus Networks; EchoStar Satellite Operating Company; Hughes Network Systems, LLC; Elefante Group, Inc.; CTIA; Dynamic Spectrum Alliance; Wireless Internet Service Providers Association (WISPA); Wi-Fi Alliance; National Public Safety Telecommunications Council (NPSTC); Open Technology Institute at New America; American Library Association; Benton Foundation; Consumer Federation of America; Consumers Union; Institute for Local Self-Reliance; National Hispanic Media Coalition; Next Century Cities; Public Knowledge; Schools, Health, & Libraries Broadband Coalition; WinnForum; and X-Lab. *See, e.g.*, Wi-Fi Alliance Comments, GN Docket Nos. 14-177 et al. (Sept 11, 2018) (Wi-Fi Alliance). Contour Networks Inc. also filed its comments timely, but did so only in one docket. *See* Contour Networks Inc. Comments, GN Docket No. 17-258 (Sept. 11, 2018).

⁶¹ *See* Federated Wireless, Inc. Reply Comments, GN Docket Nos. 14-177 et al. (Sept. 26, 2018); Utilities Technology Council Reply Comments, GN Docket Nos. 14-177 et al. (Sept. 26, 2018) (UTC Reply Comments); WISPA Reply Comments, GN Docket Nos. 14-177 et al. (Sept. 26, 2018). Because the Commission adopted the *2018 Report and Order* and the *6 GHz NPRM* (discussed *infra* at paragraphs 21 and 23) after the public notice comment cycle closed on September 26, 2018, these actions are therefore not considered in the analysis below. This same principle holds for the *ESC Sensor Registration Public Notice* released by WTB/OET.

⁶² *See, e.g.*, Open Technology Institute et al. Comments, GN Docket Nos. 14-177 et al. (Sept. 11, 2018) at 14-17 (OTI Comments) (discussing a diversity of uses and a large amount of investment in the band spurred by the rules changes in the 3.5 GHz band).

⁶³ *See e.g.*, Apple et al. Comments, GN Docket Nos. 14-177 et al. (Sept. 11, 2018) (Apple Comments) (focusing on the 6 GHz band); Federated Wireless, Inc. Comments, GN Docket Nos. 14-177 et al. (Sept 11, 2018) at 16 (Federated Comments) (discussing the frequencies between 37 GHz and 37.6 GHz).

⁶⁴ *See, e.g.*, Baicells Technologies North America, Inc. Comments, GN Docket No. 17-258, at 3 (Dec. 27, 2017) (Baicells Comments); *infra* discussion at paragraphs 18-19.

⁶⁵ Upwards of 60 companies have participated in the WinnForum, expending tens of thousands of hours to research and develop the technical standards enabling use by a variety of incumbent and new users. WinnForum Comments, GN Docket Nos. 14-177 et al., at 9, Figure 2 (Sept. 11, 2018); *see also* Open Technology Institute and Public Knowledge Comments, GN Docket No. 17-258, at 13 (Dec. 28, 2017). The CBRS Alliance, which has over 100 members, supports the common interest of implementers, operators, and its members for the development, commercialization, and adoption of LTE solutions for the 3.5 GHz band. *See* CBRS Alliance, About Us, <https://www.cbrrsalliance.org/about-us/> (last visited Oct. 29, 2018).

and utility associations—encouraged by the rule changes in the 3.5 GHz band, actively made significant investments to take the first steps towards providing commercial services in the band.⁶⁶ For example, the CBRS Alliance reported in August that twelve devices have been submitted for certification to its approved test laboratories; as of October 11, 2018, four of these devices successfully completed laboratory testing and have been certified for authorized operation in the 3.5 GHz band by the Commission.⁶⁷ On April 5, 2018, after participating in end-to-end system testing to determine the feasibility of Citizens Broadband Radio Service spectrum deployment with multiple equipment manufacturers and SAS Administrators, Verizon reported that it expects to begin commercial deployment of LTE in the 3.5 GHz band in the near future.⁶⁸ Several companies have invested in the development of live private LTE networks for deployment in the 3.5 GHz band; Nokia, Alphabet (Google’s parent company), and Qualcomm Technologies recently partnered to demonstrate a private LTE network at the Las Vegas Motor Speedway.⁶⁹ Federated Wireless, with Accelleran and Athonet, also have demonstrated an end-to-end commercial LTE network that is self-deployable on shared spectrum.⁷⁰ Many investments have been made to bring high-speed internet and wireless broadband to rural areas, as well.⁷¹

18. The Commission’s rule changes to the 3.5 GHz band have set the stage to: (1) promote investment in the band; (2) encourage rapid and robust network deployment; and (3) protect federal and non-federal incumbent users.⁷² As the Commission moves toward the future auction of PAL licenses, we hope to see the development of new licensed protected commercial uses in the 3.5 GHz band that further encourages intense spectrum usage by a diversity of users. We also note that the level of communication and cooperation that has taken place throughout this proceeding among WTB/OET, DoD, and NTIA, along with industry members, has played a key role in encouraging new investment and fostering new commercial usage of this spectrum. As a result, the conditionally approved SAS Administrators currently

⁶⁶ See, e.g., Baicells Comments at 3; Federated Comments at 5-8 (significant interest and investment by industry stakeholders); WISPA Comments, GN Docket Nos. 14-177 et al. (Sept. 11, 2018) at 4-5 (WISPA Comments) (industry stakeholder actions furthering the provision of a wide variety of use cases such as rural broadband, neutral host networks, and IoT); OTI Comments at 14-17 (diversity of uses and a large amount of investment in the band).

⁶⁷ See Letter from David A. Wright, President, CBRS Alliance, to Marlene H. Dortch, Secretary, FCC, GN Docket No. 15-319 (filed Aug. 22, 2018), Attach. at 5-6; see also Ruckus Networks Comments, GN Docket Nos. 14-177 et al. (Sept. 11, 2018) at 2 (noting its receipt of the first CBSD authorization on September 6, 2018, for its Q710 and Q910 small cell products); Press Release, CBRS Alliance and WinnForum, CBRS Alliance and Wireless Innovation Forum Celebrate First Generation of Certified Devices (Oct. 9, 2018), <https://globenewswire.com/news-release/2018/10/09/1618570/0/en/CBRS-Alliance-and-Wireless-Innovation-Forum-Celebrate-First-Generation-of-Certified-Devices.html> (commending Ericsson, Nokia, Sercomm and Ruckus Networks for achieving certification of their CBSDs).

⁶⁸ Press Release, Verizon, Verizon Takes Industry Lead in Working with Key Partners to Drive Advancements on CBRS Spectrum (Apr. 5, 2018), <https://www.verizon.com/about/news/verizon-takes-industry-lead-working-key-partners-drive-advancements-cbrs-spectrum>.

⁶⁹ See Press Release, Nokia, Nokia, Alphabet’s Access Group and Qualcomm Showcase First Live Demo of a Private LTE Network Over CBRS Shared Spectrum Providing a 360° Race Car Experience (Feb. 7, 2018), https://www.nokia.com/en_int/news/releases/2017/02/07/nokia-alphabets-access-group-and-qualcomm-showcase-first-live-demo-of-a-private-lte-network-over-cbrs-shared-spectrum-providing-a-360deg-race-car-experience.

⁷⁰ Press Release, IssueWire, “Plug & Play” Private LTE for CBRS Launched by Accelleran, Federated Wireless and Athonet (May 9, 2018), <https://www.issuewire.com/plugin-play-private-lte-for-cbrs-launched-by-accelleran-federated-wireless-and-athonet-1599981309367039>.

⁷¹ See, e.g., WISPA Comments at 8-10 (discussing numerous investments made to deploy broadband services in the 3.5 GHz band in order to provide wireless broadband services to unserved rural Americans); Frontier Communications Corporation et al. Comments, GN Docket No. 17-258, at 3-5; see also General Electric Company, GN Docket No. 17-258, at 13 (importance of PAL spectrum to IoT and other innovative use of spectrum in suburban and urban areas).

⁷² See *supra* discussion at paragraphs 5-15.

are working to complete lab testing of their SASs. The first wave ESCs, having received conditional approval of their ESC operator proposals, also have entered the lab testing phase.

IV. ANALYSIS OF SPECTRUM PROPOSALS

19. Congress required the Commission to analyze “proposals to promote and identify additional spectrum bands that can be shared between incumbent uses and new licensed, and unlicensed services under [the rules in the 3.5 GHz band]” that identify at least 1 gigahertz between 6 GHz and 57 GHz for such use. Our analysis of the following fulfills that requirement: the proposals originated by the Commission and the comments and reply comments submitted in response to our call for public comment that identify spectrum within the specified frequency range and discuss approaches under consideration for both licensed and/or unlicensed use that may be based on elements of the concepts developed in the 3.5 GHz band. As directed by Congress, WTB/OET sought comment on August 10, 2018.⁷³ Twelve comments and three reply comments were filed by a diverse set of industry members and public interest advocates.⁷⁴ The majority of the comments and reply comments dealt with the impact of the then-proposed rule changes in the 3.5 GHz band, the Commission’s proposal for providing access for licensed fixed and mobile service in the 3700-4200 GHz band and the Commission’s inquiry to consider providing access to spectrum in the 5.925-7.125 GHz band for unlicensed use. Commenters generally did not suggest other frequency bands within the frequency range of 6 GHz through 57 GHz specified in the Spectrum Pipeline Act. Commenters were divided on whether the framework for the Citizens Broadband Radio Service in the 3.5 GHz band is suitable for use in other bands and whether particular spectrum bands should be made available for new licensed or unlicensed use.⁷⁵ We note the identification by Elefante Group, Inc. (Elefante) of spectrum that is the subject of a pending rulemaking proceeding where the Commission will later address the relevant portions of Elefante’s proposal as appropriate, and therefore do not incorporate an analysis of that proposal into this report.⁷⁶

20. *6 GHz Band.* In 2017, the Commission began an evaluation of whether spectrum in between 3.7 GHz and 24 GHz could be made available for flexible use, particularly for wireless broadband services.⁷⁷ The *Mid-Band NOI* sought comment on three particular mid-range bands, two containing frequencies specified by the Spectrum Pipeline Act (5.925-6.425 GHz and 6.425-7.125 GHz, collectively, the 6 GHz band). The *NOI* also asked commenters to identify other mid-range frequencies that may be suitable for expanded flexible use.⁷⁸ In response, commenters proposed various approaches for expanding wireless broadband use in the 6 GHz band and identified several challenges presented by

⁷³ See *supra* discussion at paragraph 16.

⁷⁴ See *supra* discussion at paragraph 16.

⁷⁵ See, e.g., Ruckus Comments at 10 (strongly supporting unlicensed operations in the 6 GHz band provided incumbents can be adequately protected); National Public Safety Telecommunications Council, GN Docket Nos. 14-177 et al. (Sept. 11, 2018) at 7-8 (NPSTC Comments) (expressing significant concern that the spectrum use by incumbents in these bands must be fully evaluated prior to any importation of spectrum sharing rules such as those adopted in the 3.5 GHz band).

⁷⁶ Elefante Group, Inc., Comments, GN Docket Nos. 14-177 et al. (Sept. 11, 2018) (referencing its petition to modify Part 2 and 101 of the Commission’s rules to modify the rules governing the 21.5-23.6, 25.25-27.5, 71-76, and 81-86 GHz bands, pending in Docket No. RM-11809). We also note several commenters, like Elefante, identified bands outside the range of frequencies identified in the Spectrum Pipeline Act—6 GHz through 57 GHz—so we decline to address them here as outside the bounds of the statute.

⁷⁷ *Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz*, GN Docket No. 17-183, Notice of Inquiry, 32 FCC Rcd 6373 (2017) (*Mid-Band NOI*).

⁷⁸ *Id.* at 6374, para. 2. The Commission noted that, consistent with established coordination practices, any viable proposals for flexible use in spectrum allocated for both federal and non-federal use would need to be carefully evaluated by both the Commission and NTIA, taking into consideration the resources necessary to study such bands. *Id.* at 6385, para. 37.

the current incumbent ecosystem.⁷⁹ On October 23, 2018, the Commission issued the *6 GHz NPRM* seeking comment on several proposed changes to the service rules governing the 6 GHz band.⁸⁰

21. With respect to 5.925-6.425 GHz, which currently is allocated in the United States exclusively for non-federal use on a primary basis for FSS and the terrestrial Fixed Service,⁸¹ commenters identified several challenges related to the heavy usage of this spectrum, which overlap with those previously noted by the Commission in the *Mid-Band NOI*.⁸² We note that the 5.925-6.425 GHz Band also is heavily used for Fixed Service;⁸³ the Commission's licensing records reflect that more than 27,000 licenses are issued for point-to-point operations in this band.⁸⁴ FS operations support a variety of critical services such as public safety (including backhaul for police and fire vehicle dispatch), coordination of railroad train movements, control of natural gas and oil pipelines, regulation of electric grids, and backhaul for commercial wireless traffic.

22. Commenters generally considered the entire range of frequencies between 5.925-7.125 GHz when proposing new ways to repurpose spectrum licensed or unlicensed use.⁸⁵ Several commercial entities, including Google and Microsoft, filed comments expressing a broad interest in this spectrum for unlicensed uses, asserting that this can be accomplished while protecting existing microwave services against harmful interference.⁸⁶ However, other commenters, including AT&T, recommended caution when considering whether to import the sharing regime adopted by the Commission in the 3.5 GHz band with respect to spectrum bands above 7 GHz given the occupancy and societally beneficial use in the 6 GHz band.⁸⁷ The *Mid-Band NPRM* issued by the Commission on October 23, 2018, seeks comment on

⁷⁹ See generally *2017 NPRM*, 32 FCC Rcd. 8071. The Commission simultaneously adopted the *Termination Order*, in which it declined to seek comment on discrete proposals from a petition for rulemaking filed by T-Mobile that would have fundamentally altered the sharing framework of the band. *Termination Order*, 32 FCC Rcd at 8092-95, paras. 59-62.

⁸⁰ *Unlicensed Use of the 6 GHz Band*, GN Docket No. 17-183, Notice of Proposed Rulemaking, FCC 18-187 (Oct. 24, 2018), 2018 WL 5311438 (*Mid-Band NPRM*).

⁸¹ See *Mid-Band NOI*, 32 FCC Rcd at 6381, para. 24. There are about 1,535 earth station licenses in the 5.925-6.425 GHz band. While most of the earth stations operate at fixed locations, earth stations on vessels also operate in this band on a primary basis. 47 CFR § 2.106 footnote NG181. Additionally, one licensee, Higher Ground, has been granted a waiver to operate mobile devices that transmit to geostationary satellites to provide consumer-based text messaging/light email and IoT, protecting terrestrial operations by using a database-driven, permission-based, self-coordination authorization system. See *Higher Ground LLC Application for Blanket Earth Station License*, IBFS File No. SES-LIC-20150616-00357, Order and Authorization, 32 FCC Rcd 728 (IB/WCB/OET 2017) (Applications for Review pending).

⁸² See *infra* discussion at paragraph 23.

⁸³ *Mid-Band NOI*, 32 FCC Rcd at 6382, para. 25.

⁸⁴ Each of these licenses authorizes one or multiple point-to-point links. A small number of these licenses (71) authorize temporary fixed stations to use the 5.925-6.425 GHz band in a large geographic area, e.g., multi-state areas.

⁸⁵ See, e.g., AT&T Services, Inc., Comments, GN Docket No. 17-183 (Oct. 2, 2017) (AT&T Mid-Band Comments) at 4; Ruckus Comments at 2 and 10.

⁸⁶ See, e.g., Apple Comments at 1-2; The Internet & Television Association (NCTA) Comments, GN Docket No. 17-183, at 10 (Oct. 2, 2017); Ruckus Comments at 10. See also OTI Comments at 21-25 (advocating for unlicensed, low-power use in the 6 GHz band to fuel the next generation of Wi-Fi services and enable 5G deployment).

⁸⁷ See, e.g., AT&T Mid-Band Comments at 4; see also Apple Comments at 6-8 (asserting that the Commission should avoid applying the sophisticated sharing regime governing the 3.5 GHz band to the 6 GHz band given the significant differences between the sharing needs and incumbent populations of the two bands).

several proposed changes to the service rules to permit unlicensed operations in the 5.925-7.125 band.⁸⁸ The amount of spectrum identified under the proposal totals 1.2 gigahertz and is broken into four segments based on the incumbent services in each segment.⁸⁹ One feature of this proposal involves the use of an automated frequency control system that would include a database of incumbent services that require interference protection.⁹⁰ While the details remain to be determined, the concept of using a database of protected services to enable sharing spectrum by unlicensed devices is similar to that used in the 3.5 GHz band. We note that this proceeding has not been finalized and may not ultimately require use of automated frequency control systems throughout the band or involve a full one gigahertz of spectrum, but we believe it falls within the statutory scope as currently proposed.

23. *Spectrum Frontiers Proceedings*. The Commission has taken several actions to make spectrum available for licensed and unlicensed use in its *Spectrum Frontiers* proceeding.⁹¹ Recently in this proceeding, the Commission invited comment on a wide variety of frequency bands, including which bands might be suitable for licensed or unlicensed use.⁹² The Commission has made spectrum available for unlicensed use of the 64-71 GHz band and licensed fixed and mobile use in the 24 GHz, 28 GHz, 37 GHz, 39 GHz, and 47 GHz bands.⁹³ Access to this spectrum did not warrant use of techniques similar to those in the 3.5 GHz band. However, the Commission identified the 37-37.6 GHz band for sharing between federal systems and licensed non-federal operations.⁹⁴ In the *Spectrum Frontiers Third FNPRM*, the Commission invited further comment on how this sharing should be accomplished, including whether use of something like a spectrum access system might be appropriate, if not initially, in the longer term.⁹⁵ Twenty-five comments were filed by September 10, 2018, by a diverse set of entities, including mobile wireless broadband providers, public interest and industry advocacy groups, and equipment manufacturers.⁹⁶ The Commission later received seventeen reply comments by September 28, 2018.⁹⁷ Commenters generally supported the adoption of spectrum sharing rules much like those in the 3.5 GHz

⁸⁸ *Mid-Band NPRM*, 2018 WL 5311438.

⁸⁹ *See id.* at *1, paras. 1-2 and *6, para. 20.

⁹⁰ *Id.* at *9, para. 25.

⁹¹ *See, e.g., 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) (*Spectrum Frontiers Report and Order* and *Spectrum Frontiers FNPRM*, respectively).

⁹² *See generally 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, FCC 18-73 (Jun. 8, 2018), 2018 WL 2932188 (*Spectrum Frontiers Third Report and Order*, *Spectrum Frontiers Memorandum Opinion and Order*, and *Spectrum Frontiers Third FNPRM*, respectively).

⁹³ *See Use of Spectrum Bands Above 24 GHz for Mobile Radio Services*, GN Docket No. 14-177, Second Report and Order, Second Further Notice of Proposed Rulemaking, Order on Reconsideration, and Memorandum Opinion and Order, 32 FCC Rcd 10988, 10990, para. 2 (2017). In total, the amount of spectrum that the Commission has made available through this proceeding is approximately 13 gigahertz. *Id.*

⁹⁴ *Spectrum Frontiers Report and Order*, 31 FCC Rcd at 8059-61, paras. 111-17.

⁹⁵ *Spectrum Frontiers Third FNPRM* at *21-24, paras. 62-73.

⁹⁶ *See, e.g., Verizon Comments*, GN Docket No. 14-177 (Sept. 10, 2018); National Academy of Sciences' Committee on Radio Frequencies Comments, GN Docket No. 14-177 (Sept. 10, 2018); WISPA Comments, GN Docket No. 14-177 (Sept. 10, 2018); Qualcomm Incorporated Comments, GN Docket No. 14-177 (Sept. 10, 2018) (Qualcomm Comments).

⁹⁷ *See, e.g., T-Mobile USA, Inc. Reply Comments*, GN Docket No. 14-177 (Sept. 28, 2018); Space Exploration Technologies Corp. Reply Comments, GN Docket No. 14-177 (Sept. 28, 2018); Federated Wireless, Inc. Reply Comments GN Docket No. 14-177 (Sept. 28, 2018); CTIA Reply Comments, GN Docket No. 14-177 (Sept. 28, 2018).

band for the 37-37.6 GHz band proposed by the Commission in the *Spectrum Frontiers Third FNPRM*.⁹⁸ This matter remains pending.

V. CONCLUSION

24. We note that, in analyzing these proposals to enable access to spectrum for new licensed services and unlicensed uses, we generally examine different circumstances in every instance. Determining what is the best approach for any given spectrum band must be evaluated on a case-by-case base. In some cases, the best approach is to clear spectrum for exclusive use, possibly for licensing through an auction. In others, more conventional techniques for sharing spectrum on the basis of geographic separation or engineering analyses may be the best approach. In the case of unlicensed uses, spectrum sharing can sometimes be accomplished via overlay licensing and limiting operation to low power levels, such as was done in the 64-71 GHz band in the *Spectrum Frontiers* proceeding.⁹⁹ Dynamic spectrum access techniques have been developing over the past twenty years, perhaps longer, and are becoming viable as a result of technological developments such as software defined radios that can adapt to the available spectrum and adjust their power levels to avoid interference, the ability to develop databases of protected services and have devices capable of accessing them over the Internet, and advanced antennas that can steer signals in ways to avoid causing harmful interference to incumbent services. Notably, dynamic spectrum access techniques formed the basis for unlicensed access to spectrum in the TV white spaces. This in turn was the precursor to the development of the more sophisticated sharing techniques that are manifest in the Citizens Broadband Radio Service.

25. We are making great progress towards the establishment of commercial operations in the Citizens Broadband Radio Service in the 3.5 GHz band. The rules have been finalized. We have granted conditional approval for six SAS Administrators.¹⁰⁰ The testing of the SASs is well under way.¹⁰¹ We have granted conditional approval for four ESC operators and have announced the process towards final approval of those systems.¹⁰² We have established a process for Initial Commercial Deployments and received proposals for the same.¹⁰³ The Commission has certified equipment for use in this spectrum.¹⁰⁴ Collaboration among all of the stakeholders is excellent.

26. While the Commission and industry stakeholders are confident and excited about the Citizens Broadband Radio Service and use of dynamic sharing techniques to enable sharing by licensed and unlicensed use with incumbent services, most comments in response to the *Spectrum Pipeline Report Public Notice* coalesced around the adoption of a wait-and-see-approach before the Commission decides to apply these techniques elsewhere. Dynamic spectrum access will continue to develop; we are also aware that entities such as the WinnForum, which conducted a multi-stakeholder process for developing many of the implementation details for the 3.5 GHz band, are actively considering whether other bands may be appropriate for the application of similar techniques. It is too soon to know whether other bands may be suitable for licensed or unlicensed use based on the techniques used in the 3.5 GHz band. The Commission will continue to monitor and consider relevant developments.

⁹⁸ See, e.g., Qualcomm Comments at 8 (recommending the implementation of technology neutral rules to enable spectrum sharing for 5G deployment by a mix of licensed and unlicensed uses).

⁹⁹ See *Spectrum Frontiers Report and Order*, 31 FCC Rcd at 8064-65, paras. 130-131.

¹⁰⁰ See *supra* note 46.

¹⁰¹ *Supra* discussion at paragraph 19.

¹⁰² *Supra* note 47.

¹⁰³ *Supra* discussion at paragraph 13.

¹⁰⁴ See *supra* note 67 and supporting text.