

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

In the Matter of
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

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statements; Commissioners Pai and O'Rielly approving in part, concurring in part and issuing separate
statements.

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I. INTRODUCTION AND EXECUTIVE SUMMARY

1. With this *Report and Order* (*Report and Order* or *R&O*), we adopt rules for commercial use of 150 megahertz in the 3550-3700 MHz band (3.5 GHz Band), and in so doing open a new chapter in the history of the administration of one of our nation’s most precious resources—the electromagnetic radio spectrum.¹ Wireless broadband is transforming every facet of American life. We live in a world of wirelessly connected people, apps, and things. The 3.5 GHz Band has physical characteristics that make it particularly well-suited for mobile broadband employing small cell technology. The creation of our new Citizens Broadband Radio Service in this band will therefore add much-needed capacity to meet the ever-increasing demands of wireless innovation. As such, it represents a major contribution toward our collective goal of making 500 megahertz newly available for broadband use.

2. Advances in radio and computing technologies provide new tools to facilitate more intensive spectrum sharing. Our new rules use these tools to dissolve some age-old regulatory divisions, between commercial and federal users, exclusive and non-exclusive authorizations, and private and carrier networks. Starting from some of the recommendations of the President’s Council of Advisors on Science and Technology (PCAST), these rules incorporate a wide range of viewpoints and information collected through three rounds of notice and comment. Over time, some of the approaches we advance in the 3.5 GHz “innovation band” could lead to greater productivity in other parts of the radio spectrum.

3. The *R&O* establishes a roadmap for making the entirety of the 3.5 GHz Band available for commercial use in phases. The 3550-3650 MHz band segment is currently allocated for use by Department of Defense (DoD) radar systems. The National Telecommunications and Information Administration (NTIA) first proposed making the band available for shared use in its 2010 “Fast Track Report.” Based on technical assumptions available at the time, NTIA’s analysis showed that large exclusion zones would be required to protect the DoD radar systems. Last year’s *Further Notice of Proposed Rulemaking* (*FNPRM* or *3.5 GHz FNPRM*) sought comment on the Fast Track exclusion zones, but mentioned ongoing discussions among federal agencies on ways to reevaluate the zones.² On March 24, 2015, NTIA filed a letter recommending a framework that would reduce the geographic area of the zones by approximately 77 percent.³ NTIA’s letter also recommended the use of sensor technology to

¹ We note that the term 3.5 GHz Band was used to refer to the 3550-3650 MHz band in earlier phases of this proceeding. Since we have determined to include the 3650-3700 MHz band in the Citizens Broadband Radio Service, “3.5 GHz Band” refers to the entire 3550-3700 MHz for purposes of this *Report and Order*. Where rules apply to only a portion of the band (*i.e.*, 3650-3700 MHz), we address those band segments specifically.

² Amendment of the Commission’s Rules with Regard to Commercial Operations in the 3550-3650 MHz Band, GN Docket No. 12-354, FCC 14-49, *Further Notice of Proposed Rulemaking*, 29 FCC Rcd 4273, 4316 ¶ 141 (3.5 GHz FNPRM).

³ See Letter from Paige R. Atkins, Associate Administrator, Office of Spectrum Management, NTIA to Julius P. Knapp, Chief, Office of Engineering and Technology, FCC in GN Docket No. 12-354 (filed March 24, 2015) (NTIA Letter).

permit commercial use inside the zones, providing a roadmap to full nationwide commercial use of the band.

4. This federal/non-federal sharing arrangement is part of a broader three-tiered sharing framework enabled by a Spectrum Access System (SAS).⁴ Incumbent users represent the highest tier in this framework and receive interference protection from Citizens Broadband Radio Service users. Protected incumbents include the federal operations described above, as well as Fixed Satellite Service (FSS) and, for a finite period, grandfathered terrestrial wireless operations in the 3650-3700 MHz portion of the band. The Citizens Broadband Radio Service itself consists of two tiers—Priority Access and General Authorized Access (GAA)—both authorized in any given location and frequency by an SAS. As the name suggests, Priority Access operations receive protection from GAA operations. Priority Access Licenses (PALs), defined as an authorization to use a 10 megahertz channel in a single census tract for three years, will be assigned in up to 70 megahertz of the 3550-3650 MHz portion of the band. GAA use will be allowed, by rule, throughout the 150 megahertz band. GAA users will receive no interference protection from other Citizens Broadband Radio Service users.

5. Our new rules advance a potential solution to a long-standing problem in spectrum policy: how to select the most appropriate commercial authorization or licensing mechanism for a new band. The record has brought us back to first principles. We have considered ideas from three major traditions in spectrum management: flexible-use geographic licensing, site-based frequency coordination, and unlicensed authorization. Ultimately, we adopt a hybrid framework that selects, automatically, the best approach based on local supply and demand. Where competitive rivalry for spectrum access is low, the GAA tier provides a low-cost entry point to the band, similar to unlicensed access. Where rivalry is high, an auction resolves mutually exclusive applications in specific geographic areas for PALs. Finite-term licensing facilitates evolution of the band and an ever-changing mix of GAA and Priority Access bandwidth over time. The SAS serves as an advanced, highly automated frequency coordinator across the band. It protects higher tier users from those beneath and optimizes frequency use to allow maximum capacity and coexistence for both GAA and Priority Access users.

6. This regulatory adaptability should make the 3.5 GHz Band hospitable to a wide variety of users, deployment models, and business cases, including some solutions to market needs not adequately served by our conventional licensed or unlicensed rules. Carriers can avail themselves of “success-based” license acquisition, deploying small cells on a GAA basis where they need additional capacity and paying for the surety of license protection only in targeted locations where they find a demonstrable need for more interference protection. Real estate owners can deploy neutral host systems in high-traffic venues, allowing for cost-effective network sharing among multiple wireless providers and their customers. Manufacturers, utilities, and other large industries can construct private wireless broadband networks to automate processes that require some measure of interference protection and yet are not appropriately outsourced to a commercial cellular network. Smart grid, rural broadband, small cell backhaul, and other point-to-multipoint networks can potentially access three times more bandwidth than was available under our previous 3650-3700 MHz band rules. All of these applications could share common wireless technologies, providing economies of scale and facilitating intensive use of the spectrum.

7. In specifying rules for the SAS—the lynchpin of the Citizens Broadband Radio Service—we balance a need for clear definition of its role, purposes, and functions against a desire to allow market forces and industry standards to inform the specifics of implementation. We will open a process by which multiple entities can apply for certification to operate as SAS Administrators. Through this approval process, applicants will demonstrate their ability to perform the enumerated SAS functions. Because the regime depends on a high degree of interaction among different users, the approval process will be

⁴ Unless otherwise defined herein, capitalized terms have the definitions given them in section 96.3 of the rules. See Appendix A, § 96.3.

designed to confirm the ability of an SAS to ensure that lower tiers do not transgress the rights of higher tiers. This will be especially important with respect to incumbent military users of the band. A similar approach will also apply to the authorization and operation of the Environmental Sensing Capability (ESC).

8. This *Report and Order* initiates a comprehensive regulatory scheme to promote development of innovative technologies and services in the 3.5 GHz Band. Nonetheless, there are a few, highly technical areas where we have concluded that additional record development would provide beneficial clarity or consensus to shape some specific parts of the rules. With the *Second Further Notice of Proposed Rulemaking* we offer focused proposals, informed by the lengthy record to-date, for further comment. We encourage commenters to pay close attention to these proposals and, wherever possible, to work with other stakeholders to narrow points of difference.

II. BACKGROUND

A. Policy Context

9. America's appetite for wireless broadband service is surging. According to Cisco, North American mobile traffic grew 63 percent in 2014 and will continue to grow at a near-50 percent compound annual growth rate over the next five years.⁵ In this context, the FCC, NTIA, and federal agencies have worked collaboratively to make additional spectrum available to meet demand.

10. In March 2010, the *National Broadband Plan* recommended that the Commission make 500 megahertz available for broadband use by 2020, with 300 megahertz suitable for mobile use by 2015. It supported the development of opportunistic technologies to enable dynamic shared access to spectrum.⁶ The National Broadband Plan also recommended that the Commission and NTIA work together to identify spectrum that can be made available for wireless broadband use, on an exclusive, shared, licensed, and/or unlicensed basis.⁷

11. On June 28, 2010, President Obama released a Presidential Memorandum entitled "Unleashing the Wireless Broadband Revolution," which directed NTIA to collaborate with the FCC to make available 500 megahertz of spectrum available for commercial wireless services while ensuring no loss of critical government capabilities.⁸

12. Pursuant to this Presidential Memorandum, in October 2010, NTIA released its "Fast Track" Report, which identified 3550-3650 MHz as one of several federal bands that could be made available for commercial wireless broadband by 2015.⁹ As discussed below, this band has long been allocated for use by military radar systems. Based on a preliminary electro-magnetic compatibility

⁵ See Cisco Systems Inc., Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2014-2019 (Feb. 3, 2015), available at http://www.cisco.com/c/en/us/solutions/collateral/service-provider/visual-networking-index-vni/white_paper_c11-520862.pdf.

⁶ FCC, Connecting America: The National Broadband Plan at 75, 84-85, 94-96 (2010) (National Broadband Plan). See also Promoting More Efficient Use of Spectrum Through Dynamic Spectrum Use Technologies, ET Docket No. 10-237, FCC 10-198, *Notice of Inquiry*, 25 FCC Rcd 16632 (2010).

⁷ *Id.* at 96.

⁸ Memorandum for the Heads of Executive Departments and Agencies, Unleashing the Wireless Broadband Revolution, released June 28, 2010, 75 Fed. Reg. 38387 (July 1, 2010) (2010 Presidential Memorandum), available at <http://www.whitehouse.gov/the-press-office/presidential-memorandum-unleashing-wireless-broadband-revolution>.

⁹ 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 (rel. Oct. 2010) (Fast Track Report), available at http://www.ntia.doc.gov/files/ntia/publications/fasttrackevaluation_11152010.pdf at 1-8.

analysis, the Fast Track Report included significant restrictions on broadband use to protect existing DoD radars from commercial systems and vice-versa.¹⁰

13. In July, 2013, PCAST released its report. Given the increasing demand for commercial wireless spectrum and the continuing critical needs of federal users, the report concluded that the best way to increase the availability of broadband spectrum is to promote spectrum sharing between federal and commercial users through the use of new technologies.¹¹ PCAST recommended that shared spectrum be organized into three tiers.¹² The first tier would consist of incumbent federal users. These users would be entitled to full protection for their operations within their deployed areas, consistent with the terms of their assignments. The second tier would consist of users that would receive short-term priority authorizations to operate within designated geographic areas. Secondary users would receive protection from interference from third tier users but would be required to avoid interference with and accept interference from Federal Primary users. Third tier users would be entitled to use the spectrum on an opportunistic basis and would not be entitled to interference protection. Coordination among different tiers would be accomplished through a database-driven SAS. The use of low-power small cells for broadband would facilitate spectral reuse and sharing, increasing overall efficiency. PCAST recommended that the Federal Government identify 1,000 megahertz of federal spectrum for shared use under this system to create the first “shared use spectrum superhighways.”¹³

14. On June 13, 2013, President Obama released another Presidential Memorandum entitled “Expanding America’s Leadership in Wireless Innovation.” Echoing the PCAST report, this second Memorandum directed the executive branch to increase broadband access to spectrum through sharing with federal users.¹⁴

B. Spectrum Environment

1. 3550-3650 MHz Band

15. The 3550-3650 MHz band is allocated to the Radiolocation Service (RLS) and the Aeronautical Radionavigation Service (ARNS) (ground-based)¹⁵ on a primary basis for federal use.¹⁶ Footnote G59 states that all federal non-military RLS use of the 3500-3650 MHz band shall be on a secondary basis to military RLS operations.¹⁷ Footnote G110 states that federal ground-based stations in the ARNS may be authorized in the 3500-3650 MHz band when accommodation in the 2700-2900 MHz

¹⁰ *Id.* at 1-6 to 1-7, figures D-45 to D-55, and Appendix B.

¹¹ See PCAST, Report to the President: Realizing the Full Potential of Government-Held Spectrum to Spur Economic Growth (rel. July 20, 2012) (PCAST Report), available at http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast_spectrum_report_final_july_20_2012.pdf (PCAST Report).

¹² *Id.* at 23-24.

¹³ *Id.* at 50-52.

¹⁴ Memorandum for the Heads of Executive Departments and Agencies, Expanding America’s Leadership in Wireless Innovation, released June 14, 2013, 78 Fed. Reg. 37431 (June 20, 2013) (2013 Presidential Memorandum), available at <http://www.whitehouse.gov/the-press-office/2013/06/14/presidential-memorandum-expanding-americas-leadership-wireless-innovatio>.

¹⁵ 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 ARNS allocation is restricted to ground-based stations. 47 C.F.R. § 2.104(h)(4).

¹⁶ The RLS is a radiodetermination service for the purpose of radiolocation. The ARNS is a radionavigation service intended for the benefit and for the safe operation of aircraft. 47 C.F.R. § 2.1(c).

¹⁷ 47 C.F.R. § 2.106, note G59.

band is not technically and/or economically feasible.¹⁸

16. Both fixed and mobile high-powered DoD radar systems on ground-based, shipborne, and airborne platforms operate in this band. These radar systems are used in conjunction with weapons control systems and for the detection and tracking of air and surface targets. The U.S. Navy uses the band for radars on guided missile cruisers. The U.S. Army uses the band for a firefinder system to detect enemy projectiles.¹⁹ The U.S. Air Force 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.

17. The 3500-3600 MHz and 3600-3650 MHz bands are allocated to RLS on a secondary basis for non-federal use.²⁰ Survey operations, using transmitters with a peak power not to exceed five watts, may be authorized for federal and non-federal use on a secondary basis to other federal radiolocation operations.²¹ There are three non-federal RLS licensees, which are authorized to operate radiolocation land stations (station class LR) and radiolocation mobile stations (station class MR) using frequencies in the 3300-3500 MHz and 3500-3650 MHz bands.²²

18. The 3600-3650 MHz band is also allocated to the FSS (space-to-Earth) on a primary basis for non-federal use and, per footnote US245, use of this FSS downlink allocation is limited to international inter-continental systems and is subject to case-by-case electromagnetic compatibility analysis.²³ The Commission has licensed primary FSS earth stations to receive frequencies in the 3600-3650 MHz band in 35 cities. Airbus DS SatCom Government, Inc. operates two gateway earth stations (located northeast of Los Angeles and New York City) that provide feeder links for Inmarsat's L-band mobile-satellite service system.²⁴

2. 3650-3700 MHz Band

19. The 3650-3700 MHz band is also allocated for terrestrial non-federal use.²⁵ In March 2005, the Commission adopted a *Report and Order* that amended Part 90 by adding new Subpart Z – Wireless Broadband Services in the 3650-3700 MHz Band.²⁶ Such service is authorized through non-

¹⁸ 47 C.F.R. § 2.106, note G110.

¹⁹ See NTIA Office of Spectrum Management, Federal Spectrum Use Summary: 30 MHz – 3000 GHz (rel. June 21, 2010) (NTIA Federal Spectrum Use Summary), available at http://www.ntia.doc.gov/files/ntia/Spectrum_Use_Summary_Master-06212010.pdf.

²⁰ 47 C.F.R. § 2.106.

²¹ 47 C.F.R. § 2.106, note US108.

²² Specifically, call sign WQHK852 authorizes Mobile Data Solutions Ltd. to operate nationwide using two LR units transmitting in 3340-3600 MHz band (emission designators 64M0F3E and 16K0F3E) with a maximum ERP of 10 mW. Call sign WQLW310 authorizes Sage and Company, LLC to operate at a fixed location in Eldorado Springs, Colorado using 1 LR unit transmitting (on two antennas) in the 3500-3650 MHz band (emission designator 10M0D1D) with a maximum ERP of 50 W and to operate 1000 MR units within 113 km of that location transmitting in the 3300-3650 MHz band (emission designator 10M0D1D) with a maximum ERP of 30 W. Call sign WQPA798 authorizes Skandic to operate at a fixed location in Aspen, Colorado transmitting (on four antennas) in the 3300-3650 MHz band (emission designator 10M0D1D) using 1 LR unit with a maximum ERP of 50 W and 1000 MR units with a maximum ERP of 30 W.

²³ 47 C.F.R. § 2.106, note US245.

²⁴ It should be noted that commercial satellites are also authorized to operate and transmit in this band.

²⁵ 47 C.F.R. § 2.106.

²⁶ 47 C.F.R. Part 90 Subpart Z. See *Wireless Operations in the 3650-3700 MHz Band, Report and Order and Memorandum Opinion and Order*, 20 FCC Rcd 6502 (2005) (3.65 GHz Order); *3650-3700 MHz Report and Order and Memorandum Opinion and Order*; Amendment of the Commission's Rules with Regard to the 3650-3700 MHz (continued....)

exclusive nationwide licenses and requires the registration of individual fixed and base stations.²⁷ All stations operating in this band must employ a contention-based protocol.²⁸ Base and fixed stations are limited to 25 watts per 25 megahertz equivalent isotropically radiated power (EIRP) and the peak EIRP power density shall not exceed 1 watt in any 1 megahertz slice of spectrum; mobile and portable stations are limited to 1 watt per 25 megahertz EIRP and the peak EIRP density shall not exceed 40 mW in any 1 megahertz slice of spectrum.²⁹ Base and fixed stations may only be located within 150 kilometers of an FSS earth station if the licensee of the earth station agrees to such operation.³⁰ Requests for base or fixed station locations closer than 80 kilometers to three Federal Government radiolocation facilities are only approved upon successful coordination by the Commission with NTIA.³¹ Mobile and portable stations may operate only if they can positively receive and decode an enabling signal transmitted by a base station; airborne operations are prohibited.³²

20. The 3650-3700 MHz band is allocated for primary use by the federal RLS at three designated sites.³³ The 3650-3700 MHz band is also allocated for use by ship stations located at least 44 nautical miles from shore in offshore ocean areas on a non-interference-basis.³⁴

3. Adjacent Bands

21. *Below 3550 MHz.* Several of the allocations discussed above extend below 3550 MHz. Of particular relevance to this proceeding are the primary allocations for shipborne, airborne, and ground-based radars operated by DoD.

22. *Above 3700 MHz.* FSS, which has a co-primary allocation at 3600-3650 MHz, also makes extensive use of the 3700-4200 MHz band (C-Band) in the United States and globally in order to provide video distribution, mobile voice and data backhaul, retail services, aeronautical applications, and

(Continued from previous page) _____

Government Transfer Band, ET Docket No. 98-237, *Notice of Proposed Rule Making and Order*, 14 FCC Rcd 1295 (1999); Amendment of the Commission's Rules with Regard to the 3650-3700 MHz Government Transfer Band, ET Docket No. 98-237, *Memorandum Opinion and Order*, 15 FCC Rcd 9340 (2000); Amendment of the Commission's Rules with Regard to the 3650-3700 MHz Government Transfer Band, ET Docket No. 98-237, *First Report and Order and Second Notice of Proposed Rule Making*, 15 FCC Rcd 20488 (2000). *See also* Unlicensed Operation in the Band 3650-3700 MHz, ET Docket No. 04-151, *Notice of Proposed Rulemaking*, 19 FCC Rcd 7545 (2000); Wireless Operations in the 3650-3700 MHz Band, ET Docket No. 04-151, *Memorandum Opinion and Order*, 22 FCC Rcd 10421 (2007).

²⁷ A licensee cannot operate a fixed or base station before registering it under its license, and licensees must delete registrations for unused fixed and base stations. 47 C.F.R. § 90.1307.

²⁸ 47 C.F.R. § 90.1305. Contention-based protocol is a protocol that allows multiple users to share the same spectrum by defining the events that must occur when two or more transmitters attempt to simultaneously access the same channel and establishing rules by which a transmitter provides reasonable opportunities for other transmitters to operate. *See* 47 C.F.R. § 90.7.

²⁹ 47 C.F.R. § 90.1321.

³⁰ 47 C.F.R. § 90.1331. Pre-existing FSS earth stations are accorded geographic protection from terrestrial operations in the 3650-3700 MHz band. The coordinates of these stations are available at <http://www.fcc.gov/ib/sd/3650/>.

³¹ St. Inigoes, MD (38° 10' N, 76°, 23' W); Pascagoula, MS (30° 22' N, 88°, 29' W), and Pensacola, FL (30° 21' 28" N, 87°, 16' 26" W).

³² 47 C.F.R. § 90.1333.

³³ *See* 47 C.F.R. § 2.106, note US348. The FCC is required to coordinate any non-federal operations within 80 km of the designated sites with NTIA.

³⁴ 47 C.F.R. § 2.106, note US349.

other uses, to commercial and government customers. Terrestrial microwave services licensed under Part 101 of the Commission's rules also operate in this band.³⁵

C. Procedural History

1. 3.5 GHz NPRM

23. The *3.5 GHz NPRM* furthered the Commission's ongoing efforts to address the growing demand for fixed and mobile broadband capacity by proposing to make an additional 100 megahertz (or up to 150 megahertz under a supplemental proposal) of spectrum available for shared wireless broadband use. Specifically, the NPRM proposed to create a new Citizens Broadband Radio Service under Part 95 of the Commission's rules.³⁶ The proposed service built on our existing TVWS rules.³⁷ First, technical rules would focus on the use of low-powered small cells to drive increases in broadband capacity and spectrum reuse. Second, an SAS would coordinate multiple tiers of commercial use.³⁸

24. The *NPRM* proposed that the SAS would accommodate three service tiers: (1) Incumbent Access; (2) Priority Access; and (3) General Authorized Access. Incumbent Access users would include authorized federal and grandfathered FSS users currently operating in the 3.5 GHz Band.³⁹ These users would have protection from harmful interference from all other users in the 3.5 GHz Band.⁴⁰ In the Priority Access tier, the *NPRM* proposed that the Commission authorize certain users with critical quality-of-service needs (such as hospitals, utilities, and public safety entities) to operate with some interference protection in portions of the 3.5 GHz Band at specific locations.⁴¹ Finally, in the GAA tier, the *NPRM* proposed that users be authorized to use the 3.5 GHz Band opportunistically within designated geographic areas. GAA users would be required to not cause interference to, and accept interference from Incumbent and Priority Access tier users.⁴² The *NPRM* also included a supplemental proposal to expand the proposed licensing and authorization model to an additional adjacent 50 megahertz of spectrum in the 3650-3700 MHz band, making up to 150 megahertz available for shared wireless broadband access.⁴³

25. The *NPRM* noted that the technical characteristics of the 3.5 GHz Band and the existence of important incumbent operations in the band in many areas of the country make the band an ideal platform to explore innovative approaches to shared spectrum use and small cell technology.⁴⁴ NTIA's Fast Track Report recommended, based on technical assumptions typical of traditional macrocell deployments of commercial wireless broadband technology, that new commercial uses of the band occur outside of large "exclusion zones" to protect Federal Government operations.⁴⁵ Given that the exclusion zones would cover approximately 60 percent of the U.S. population and because of limited signal propagation in the band, the band did not appear to be well-suited for macrocell deployment.⁴⁶ However,

³⁵ See 47 C.F.R. §§ 101.17, 101.101.

³⁶ See *3.5 GHz NPRM*, 27 FCC Rcd at 15615-16, ¶¶ 61-63.

³⁷ See 47 C.F.R. §§ 15.701, *et seq.*

³⁸ See *3.5 GHz NPRM*, 27 FCC Rcd at 15612-14, ¶¶ 53-58.

³⁹ See *id.* at 15616-18, ¶¶ 65-69.

⁴⁰ See *id.*

⁴¹ See *id.* at 15618-20, ¶¶ 70-74.

⁴² See *id.* at 15620, ¶¶ 75-76.

⁴³ See *id.* at 15620-25, ¶¶ 77-92.

⁴⁴ See *id.* at 15601-03, ¶¶ 17-25.

⁴⁵ See Fast Track Report at 1-6 – 1-7 and Appendix D.

⁴⁶ See Fast Track Report at 1-6 – 1-7 and Appendix D and *3.5 GHz NPRM*, 27 FCC Rcd at 15597 and 15601, ¶¶ 6 and 17-18.

the *NPRM* stated that these very disadvantages could be turned into advantages if the band were used to explore spectrum sharing and small cell innovation.⁴⁷

26. We received 65 comments and 26 reply comments in response to the *NPRM*.⁴⁸ These comments, and those received in subsequent rounds, are summarized and referenced in this *Report and Order* where appropriate.

2. Licensing Public Notice

27. In November 2013, in response to record comments received up to that point, the Commission released the *Licensing PN*, which described a Revised Framework that elaborated upon some of the licensing concepts and alternatives set forth in the *NPRM*.⁴⁹ The Revised Framework retained the three-tier model proposed in the *NPRM* but expanded eligibility for access to the Priority Access tier with competitive bidding for assigning licenses within that tier.⁵⁰ Like the *NPRM*'s main proposal, the Revised Framework cited the unique capabilities of small cell and SAS technologies to enable sharing among users in the Priority Access and GAA tiers. Specifically, the Revised Framework contained the following core concepts:

- An SAS to dynamically manage frequency assignments and automatically enforce access to the Priority Access and GAA tiers;
- Expansive eligibility for Priority Access tier use;
- Granular, but administratively streamlined licensing of the Priority Access tier;
- Exclusive spectrum rights for Priority Access subject to licensing by auction in the event of mutually exclusive applications;
- A defined “floor” of GAA spectrum availability, to ensure that GAA access is available nationwide (subject to Incumbent Access tier use);
- Additional GAA access to unused Priority Access bandwidth, as identified and managed by the SAS, to maximize dynamic use of the unutilized portion of the band and ensure productive use of the spectrum;
- Opportunities for Contained Access Users to obtain targeted priority spectrum use within specific facilities (such as buildings) meeting certain requirements to mitigate the potential for interference to and from Incumbent Users and other Citizens Broadband Radio Service users; and
- A set of baseline technical standards to prevent harmful interference and ensure productive use of the spectrum.⁵¹

We received 35 comments and 27 reply comments in response to the *Licensing PN*.⁵²

3. Workshops

28. We convened two workshops to discuss technical issues related to this proceeding.⁵³ The

⁴⁷ See *3.5 GHz NPRM* at 15630-35, ¶¶ 113-23.

⁴⁸ A list of commenters is included in Appendix D.

⁴⁹ See *Licensing PN*, 28 FCC Rcd at 15301, ¶ 2.

⁵⁰ *Id.* at 15305-10, ¶¶ 10-27.

⁵¹ See *id.*

⁵² A list of commenters is included in Appendix D.

first workshop, held on March 13, 2013, explored broad issues that emanated from the original *NPRM*.⁵⁴ The second workshop, held on January 14, 2014, further explored the technical requirements, operational parameters, and architecture of the proposed SAS (SAS Workshop).⁵⁵ A group of engineers representing industry stakeholders, trade associations, and academia submitted technical papers in advance of the workshop and participated in panels throughout the day.⁵⁶

4. Further Notice of Proposed Rulemaking

29. In April 2014, the Commission released the *3.5 GHz FNPRM*, proposing specific rules for a new Citizens Broadband Radio Service in the 3.5 GHz Band to be codified in a new proposed Part 96.⁵⁷ The *FNPRM* built upon the concepts and proposals set forth in the *NPRM* and the *Licensing PN* and reflected the extensive record generated in the proceeding. Notably, the *3.5 GHz FNPRM* proposed to:

- Implement the three-tier authorization model proposed in the *NPRM*;
- Establish Exclusion Zones based on recommendations set forth in the Fast Track Report to ensure compatibility between incumbent federal operations and Citizens Broadband Radio Service users;
- Create an open eligibility authorization system for Priority Access and GAA operations;
- Establish granular, exclusive spectrum rights for the Priority Access tier, consistent with parameters discussed in the *Licensing PN*;
- Set a defined “floor” for GAA spectrum availability, to ensure that GAA access is available nationwide (subject to Incumbent Access tier use);
- Set guidelines to allow Contained Access Users to request up to 20 megahertz of reserved frequencies from the GAA pool for use within their facilities;
- Establish baseline technical rules for fixed or nomadic base stations operating in the 3.5 GHz Band;
- Set guidelines for the operation and certification of SASs in the band.⁵⁸

(Continued from previous page) _____

⁵³ FCC Wireless Telecommunications Bureau and Office of Engineering and Technology Announce Agenda for Workshop on the 3.5 GHz Notice of Proposed Rulemaking, GN Docket No. 12-354, *Public Notice*, 28 FCC Rcd 2251(2013) (*First 3.5 GHz Workshop PN*); FCC Wireless Telecommunications Bureau and Office of Engineering and Technology Announce Agenda for Workshop to Discuss the Creation of a Spectrum Access System in the 3.5 GHz Band, GN Docket No. 12-354, *Public Notice*, 29 FCC Rcd 174 (2014) (*SAS Workshop Agenda PN*); Workshop video and presentation materials available at: <http://www.fcc.gov/events/35-ghz-spectrum-access-system-workshop> and <http://www.fcc.gov/events/35-ghz-workshop>.

⁵⁴ See *First 3.5 GHz Workshop PN*, 28 FCC Rcd 2251; Video and presentation materials available at: <http://www.fcc.gov/events/35-ghz-workshop>.

⁵⁵ See Wireless Telecommunications Bureau and Office of Engineering and Technology Call for Papers on the Proposed Spectrum Access System for the 3.5 GHz Band, GN Docket No. 12-354, *Public Notice*, 28 FCC Rcd 15843 (2013) (*SAS Papers PN*); *SAS Workshop Agenda PN*, 29 FCC Rcd 174; Workshop video and presentation materials available at: <http://www.fcc.gov/events/35-ghz-spectrum-access-system-workshop>. The Commission also announced a two week online discussion to further explore topics addressed in the workshop. The results of that discussion were added to the record. See Wireless Telecommunications Bureau and Office of Engineering and Technology Submission for the Record in GN Docket No. 12-354 (filed March 31, 2014).

⁵⁶ See *SAS Workshop Agenda PN*, 29 FCC Rcd 174. See generally, SAS workshop submissions in GN Docket No. 12-354.

⁵⁷ See generally, *3.5 GHz FNPRM*, 29 FCC Rcd 4273.

⁵⁸ *3.5 GHz FNPRM*, 29 FCC Rcd at 4280, ¶ 17.

The *FNPRM* also sought comment on: (1) protection criteria for Incumbent Users; (2) potential protection of FSS earth stations in the C-Band; (3) competitive bidding procedures for resolving mutually exclusive applications for PALs; and (4) the possible extension of the proposed rules to include the 3650-3700 MHz band.⁵⁹

III. DISCUSSION

A. Allocation

30. *Background.* In the *NPRM*, the Commission requested comment on the allocation structure that should be used to accommodate the Citizens Broadband Radio Service at 3550-3650 MHz.⁶⁰ Specifically, the *NPRM* proposed to retain the primary allocation for existing federal radar systems, and also allocate that band for non-federal fixed and mobile use.⁶¹ In addition, the *NPRM* proposed to restrict primary non-federal FSS earth station use in the upper half of the band (3600-3650 MHz) to the FSS earth stations licensed or applied for as of the effective date of the *Report and Order* in this proceeding.⁶² The Commission noted the existence of primary federal allocations for aeronautical radionavigation service and ground-based radars, and stated that the Commission would work with NTIA regarding the continued need for those allocations.⁶³ The *NPRM* sought comment on the potential for interference to and from existing and future international FSS operations in the 3.5 GHz Band.⁶⁴ In the *NPRM*, the Commission noted its belief that its proposed framework met the requirements for allocation of flexible use spectrum under Section 303(y) of the Act.⁶⁵ In this regard, it noted that a non-federal Fixed and Mobile allocation is consistent with international allocations for use of the 3.5 GHz Band, that the proposed framework would spur innovation and investment in new wireless technologies with little to no impact on incumbent uses, and that the framework was structured to prevent interference between users through the SAS and technical and operational rules proposed therein.⁶⁶

31. In the *FNPRM*, the Commission refined the proposals initially made in the *NPRM*. The Commission proposed to add non-federal fixed and land mobile allocations to the 3550-3650 MHz band on a primary basis to permit commercial use of the band consistent with the Commission's accompanying licensing and service rule proposals. Additionally, the Commission proposed to remove the secondary radiolocation service allocation from the 3550-3650 MHz band in the non-Federal Table, and to add three US footnotes to: (1) permit non-federal stations in the radiolocation service that were licensed or applied for prior to the effective date of this *Report and Order* to continue to operate on a secondary basis until the end of the equipment's useful lifetime; (2)(a) limit primary FSS use of the 3600-3650 MHz band to

⁵⁹ *Id.*

⁶⁰ *3.5 GHz NPRM*, 27 FCC Rcd at 15623-25, ¶¶ 87-94. We note that the 3650-3700 MHz band is already allocated for fixed, fixed-satellite (space-to-Earth), and mobile (except aeronautical mobile) use. *See* 47 C.F.R. § 2.106; *3.65 GHz Order*, 20 FCC Rcd at 6505 ¶ 7, 6510 ¶¶ 21-22.

⁶¹ *3.5 GHz NPRM*, 27 FCC Rcd at 15624, ¶ 90. We observe that existing federal radar systems in this band are entirely Radiolocation systems. There is also a 3.5 GHz Band federal Aeronautical Radionavigation (ground-based) allocation, but it is currently unused.

⁶² *Id.* at 15625, ¶ 92. In connection with the *NPRM*, the Commission also issued an order freezing applications for new FSS earth stations more than 10 statute miles from a license earth station's coordinates. *Id.* at 15642-45, ¶¶ 154-55.

⁶³ *Id.* at 15625, ¶ 93.

⁶⁴ *Id.* at 15625, ¶ 94.

⁶⁵ *Id.* at 15624-25, ¶ 91, citing 47 U.S.C. § 303(y).

⁶⁶ *Id.* The Commission noted that in ITU Region 2, the 3500-3700 MHz band is allocated to the Fixed, Fixed Satellite (space-to-Earth), and Mobile (except aeronautical mobile) Services on a primary basis, and to RLS on a secondary basis. *Id.* at 15605, ¶ 29 & n.65.

earth stations authorized prior to, or granted as a result of an application filed prior to, the effective date of this *Report and Order* and constructed within 12 months of initial authorization; (2)(b) specify that FSS use of the 3600-3650 MHz band for all other earth stations will be on a secondary basis to non-federal stations in the fixed and land mobile services; and (3) specify provisions for federal use of the aeronautical radionavigation (ground-based) and radiolocation services and for non-federal use of the fixed and land mobile services in the 3550-3650 MHz band.⁶⁷ The Commission sought comment on these proposals. The *FNPRM* also sought comment on whether federal fixed and mobile operations should be permitted in the 3.5 GHz Band, and what the implications would be of such federal use on non-federal use of the band.⁶⁸

32. A small number of commenters addressed these allocation proposals. The Utilities Telecom Council, Edison Electric Institute, and National Rural Electrical Cooperative Association (Utility Groups) and Motorola Mobility support the proposals for non-federal fixed and mobile allocation of the 3550-3650 MHz band, and for the restrictions on the primary FSS earth station use to those earth stations licensed or applied for as of the effective date of the *Report and Order* in this proceeding.⁶⁹ Motorola Mobility argues that this limitation will result in more robust use of the band for the Citizens Broadband Radio Service, and for this same reason, argues that the Commission should not permit federal fixed and mobile operations in the 3.5 GHz Band.⁷⁰ On the other hand, the Satellite Industry Association (SIA) opposes a primary allocation for the Citizens Broadband Radio Service, but argues that if the Citizens Broadband Radio Service is granted primary status, such status should not preclude future FSS deployment because it would be contrary to the Commission's stated premise that the FSS and Citizens Broadband Radio Service can share spectrum.⁷¹ SIA contends that the proposal to relegate future FSS operations to secondary status would unnecessarily limit the much-needed flexibility of satellite network operators and strand existing investment in 3600-3650 MHz space stations, harming satellite operators, their customers, and their investors.⁷²

33. As detailed in section III(G)(1), NTIA generally supports the FCC's proposal to add a co-primary, non-federal fixed and mobile allocation to the band.⁷³ NTIA describes a phased approach to implementing protection criteria of federal operations, including the approval of an ESC to detect signals from federal radar systems. The ESC input would be used by the SAS to direct Priority Access licensees and GAA users to another portion of the 3.5 GHz Band or, if necessary, to cease transmissions to avoid potential interference to federal radar systems. NTIA also encourages the Commission to retain the federal allocation for airborne radar systems subject to the same type of approach used in the AWS-3 proceeding (*i.e.*, commercial operations will accept interference from federal airborne systems), including a clear statement in the rules that the airborne radars will not seek protection from Citizens Broadband Radio Service Devices (CBSD).⁷⁴ NTIA also requests that the Commission reinstate the protections for a site in Pascagoula, MS in the 3650-3700 MHz band. NTIA asserts that the DoD informed NTIA that it

⁶⁷ 3.5 GHz *FNPRM*, 29 FCC Rcd at 4308, ¶ 116.

⁶⁸ *Id.* at 4308, ¶ 117.

⁶⁹ See Utility Groups *NPRM* Comments at 19; see also Motorola Mobility *FNPRM* Comments at 15. The Utility Groups claim that such allocations will spur innovation and investment in new wireless technologies, with little or no impact on incumbent uses, including DoD radar systems. The Utility Groups also note similar to provisions restricting the FSS allocation apply in the 3650-3700 MHz band. See Utility Groups *NPRM* Comments at 19.

⁷⁰ Motorola Mobility *FNPRM* Comments at 16.

⁷¹ SIA *NPRM* Comments at 21; SIA *FNPRM* Comments at 19.

⁷² SIA *FNPRM* Comments at 19.

⁷³ See NTIA Letter.

⁷⁴ *Id.* at 7-8.

still has an active assignment in use at that location on a regular basis.⁷⁵

34. *Discussion.* After review of the record, we adopt allocation proposals largely consistent with the *FNPRM* proposals, as amended to reflect the NTIA Letter. The allocations are appropriate to permit both robust development of the Citizens Broadband Radio Service and protection of Incumbent Users. We believe that the Citizens Broadband Radio Service has the potential to provide a valuable new service to address broadband capacity shortages. Accordingly, we are adding primary fixed and mobile except aeronautical mobile allocations to the 3550-3650 MHz band in the non-federal table. We are also limiting the primary FSS operations in the band to those authorized prior to, or granted as a result of an application filed prior to the effective date of this *Report and Order*, and constructed within 12 months of the initial authorization. We are also removing the non-federal radiolocation allocation and agreeing to continued federal use of airborne radars in the band based on the NTIA Letter. Finally, we sunset the freeze we imposed on new earth station applications in the *NPRM*.⁷⁶ The freeze will expire on the effective date of this *Report and Order*, which replaces the freeze with a rule making such facilities secondary to non-federal stations in the fixed and land mobile services.⁷⁷

35. We also find that these changes to the Table of Allocations are made consistent with the Commission's authority under Section 303(y) of the Communications Act.⁷⁸ We adopt our tentative conclusion and find that: (1) the allocations are in the public interest; (2) new and revised uses of the band would not deter investments in communications services and systems or technology development; and (3) new and revised uses of the band would not result in harmful interference among users of the band.⁷⁹ Adding non-federal co-primary fixed and mobile (except aeronautical mobile) allocations in the 3550-3650 MHz band will add much needed capacity to meet the rapidly increasing demands of wireless innovation, and promote investment in new services and technologies for use in that band. In addition, the allocation plan we adopt today will create a system for shared use of the band with incumbent federal users in a way that maximizes efficient use of spectrum through the combination of small cell technology and more sophisticated spectrum management techniques through the SAS designed to prevent harmful interference. Moreover, we note that these allocations are consistent with the ITU Region 2 Allocation Table.

36. The non-federal co-primary fixed and mobile except aeronautical mobile allocations will allow for shared use of the band between Citizens Broadband Radio Service and incumbent federal Radiolocation and Aeronautical Radionavigation and non-federal FSS services. These allocations are consistent with prior Commission actions to repurpose certain bands for new broadband uses.⁸⁰ To ensure that essential federal radiolocation systems operating in the band continue their operations without impact from the sharing arrangements, we are prohibiting CBSDs from causing harmful interference to, or claiming protection from, federal stations aboard vessels (shipborne radars) and at designated ground-based radar sites.⁸¹ In addition, authorized users of CBSDs must not claim protection from airborne radars and airborne radar receivers must not claim protection from CBSDs operating in the Citizens

⁷⁵ *Id.* at 8-9.

⁷⁶ See *3.5 GHz NPRM*, 27 FCC Rcd at 15642-44, ¶¶ 154-55.

⁷⁷ Appendix A, § 2.106, note US107(b).

⁷⁸ 47 U.S.C. § 303(y).

⁷⁹ See *id.*

⁸⁰ See *3.5 GHz FNPRM*, 29 FCC Rcd at 4307-08, ¶ 114, n. 202 (citing to Reallocation of TV Channels 52-69; *Report and Order*, ET Docket No. 97-157 and *Report and Order*, GN Docket 01-74).

⁸¹ We note that additional federal ground radar sites operate adjacent to the 3550-3650 MHz band. Protection of those sites is addressed in section III(G)(1) See Appendix A, § 2.106, at footnote US433(a). We note that all coordinates specified in US433 are referenced to the North American Datum of 1983 (NAD 83). See 47 CFR 2.105(d)(6).

Broadband Radio Service. We therefore establish rules to protect federal radar systems from Citizens Broadband Radio Service operations as described below.⁸² These rules are reflected in footnote US433 to the Table of Allocations.⁸³ Also, we will take such actions as are necessary to amend the Commission's rules to reflect any modification to the list of sites designated by NTIA where federal radar systems will operate.

37. We will continue to permit primary operations in the 3600-3650 MHz band for those FSS earth stations authorized prior to, or granted as a result of an application filed prior to, the effective date of this *Report and Order*, and constructed within 12 months of their initial authorization. However, we will not accept applications for modifications to existing FSS earth station facilities after the effective date of the *Report and Order*, except for changes in polarization, antenna orientation, or ownership. We will also allow modifications to increase the antenna size to mitigate interference from new services. In addition, we will consider reasonable waiver requests from existing FSS licensees to accommodate additional modifications, including facility relocation, on a case-by-case basis. Any new FSS earth stations in the 3600-3650 MHz band, applied for following the effective date of the *Report and Order*, will be authorized on a secondary basis to non-federal stations in the fixed and land mobile services. These provisions are reflected in footnote US107 to the Table of Allocations.⁸⁴ We believe these changes to the Table of Allocations are necessary to ensure the ongoing stability of the band and ensure its availability for mobile broadband services. We will also coordinate with the border countries as necessary to ensure that the Citizens Broadband Radio Service does not cause harmful interference to international FSS operations in the band as set forth in section III(G)(3).

38. While we appreciate SIA's concerns that the proposed allocation changes may impact existing FSS growth and the investment in the band, these changes are consistent with Commission policies adopted more than 14 years ago for sharing in the adjacent 3650-3700 MHz band, wherein existing FSS earth stations were grandfathered on a primary basis and new FSS earth stations were permitted to operate on a secondary basis.⁸⁵ Further, as noted above, there is a co-primary FSS allocation in the 3700-4200 MHz band that can be used to accommodate future FSS earth station growth that cannot be accommodated in the 3600-3650 MHz band.⁸⁶ We also disagree with SIA that these changes are contrary to the Commission's stated premise that the FSS and Citizens Broadband Radio Service can share spectrum. The purpose of the 2012 freeze was to "ensure a stable spectral ecosystem for the proposed Citizens Broadband [Radio] Service."⁸⁷ Moreover, there will continue to be FSS use of the 3600-3650 MHz band, with grandfathered operations on a co-primary basis with the Citizens Broadband

⁸² See *infra* section III (G) (1) and Appendix A, §§ 96.15 and 96.67.

⁸³ See Appendix A, § 2.106, at footnote US433.

⁸⁴ See Appendix A, § 2.106, at footnote US107.

⁸⁵ See Amendment of the Commission's Rules With Regard to the 3650-3700 MHz Government Transfer Band, ET Docket No. 98-237, RM-9411; The 4.9 GHz Band Transferred from Federal Government Use, WT Docket No. 00-32; *First Report and Order and Second Notice of Proposed Rule Making*, 15 FCC Rcd 20488 at 20489-90, ¶¶ 1-2 (2000) (*3650-3700 MHz First R&O*) (allocating the 50 megahertz of spectrum in the 3650-3700 MHz band to fixed and mobile services on a primary basis to facilitate the provision of a broad range of services, including traditional voice telephony and broadband data and video services; while "grandfathering" existing primary FSS earth stations and permitting new secondary FSS earth station use of that band). While allowing existing sites to freely relocate could cause instability in the band and endanger spectrum access for Citizens Broadband Radio Service users, we acknowledge that such relocations may occasionally be necessary. Therefore, to accommodate what SIA represents would be the "quite rare" need for "[r]elocation or addition of an FSS earth station," as when a licensee is unable to extend its lease at any existing site or when that site is damaged, we will entertain applications for waivers for site relocations within 16.1 km of existing facilities. See SIA *FNPRM* Comments at 19-20.

⁸⁶ See 47 C.F.R. § 2.106.

⁸⁷ *3.5 GHz NPRM*, 27 FCC Rcd at 15642, ¶ 154.

Radio Service and new uses on a secondary basis to the Citizens Broadband Radio Service.

39. We emphasize that CBSDs are prohibited from causing harmful interference to any FSS earth stations authorized prior to the effective date of this *Report and Order*, as those earth stations will retain primary status. The approach we adopt in the 3600-3650 MHz band is similar to the one we adopted in the 3650-3700 MHz band and will permit the FSS to continue to make productive use of that band, without increasing impairments to the new Citizens Broadband Radio Service use.

40. In addition, we will eliminate the non-federal radiolocation allocation in the 3550-3650 MHz band. There are a number of other bands available for non-federal radiolocation use, and we see no need to continue to authorize use for such radiolocation services in the 3550-3650 MHz band, especially considering the impact of potential interference to Citizens Broadband Radio Service. However, we will continue to permit non-federal radiolocation stations that were licensed or had filed an application for authorization prior to the effective date of this *Report and Order* to continue to operate on a secondary basis until the end of the equipment's useful lifetime. These provisions are reflected in footnote US105 to the Table of Allocations.⁸⁸

41. No commenting party addressed the potential addition of a federal fixed and mobile allocation for the 3.5 GHz Band in response to the *NPRM* and *FNPRM*'s request for comment on federal Citizens Broadband Radio Service use of the band in addition to non-federal use. At this time we will not include a federal fixed and mobile allocation in the 3.5 GHz Band. However, if and when federal agencies determine they may benefit from use of Citizens Broadband Radio Service equipment, we will work with NTIA to ensure use by the federal agencies is consistent with the rules adopted herein.

42. We will continue to allow federal airborne radar use in the band, with some qualifications. As NTIA noted, in the AWS-3 proceeding, we allowed federal airborne radar use to continue in the band and required commercial systems to accept interference from these systems.⁸⁹ Unlike the AWS-3 band, there are no federal airborne radar systems currently operating in the 3550-3650 MHz band. However, NTIA recommends an approach that would allow federal incumbent users to retain the flexibility to deploy radar systems in the band.⁹⁰ We do not believe that the potential future deployment of federal airborne radar systems will significantly impact the commercial viability of the Citizens Broadband Radio Service. Accordingly, we adopt NTIA's recommendation for preserving the allocation allowing federal airborne radar systems in the 3550-3650 MHz band, with the proviso that such systems shall not be entitled to interference protection from Citizens Broadband Radio Service users in the band. As described below in Section III(G)(1)(b), Citizens Broadband Radio Service users will also have to accept the risk of interference from airborne systems.

43. Finally, in the 3650-3700 MHz band, footnote US 109 establishes an 80 kilometer protection zone around two federal government radiolocation facilities at Saint Indigoes MD and Pensacola FL.⁹¹ As specified in 47 CFR Part 90.1331, commercial fixed and mobile operations within the protection zone must be coordinated with NTIA.⁹² Prior to 2012, an additional site located in Pascagoula, MS had also been protected in the band. That site was removed in the 2012 *Notice of Proposed Rulemaking and Order* implementing the results of the 2007 WRC (WRC-07).⁹³ The NTIA

⁸⁸ See Appendix A, § 2.106, at footnote US105.

⁸⁹ See NTIA Letter at 7-8.

⁹⁰ See *id.* at 7-8.

⁹¹ See 47 C.F.R. § 2.106, footnote US 109.

⁹² See 47 C.F.R. § 90.1331.

⁹³ See Amendment of Parts 1, 2, 15, 74, 78, 87, 90, and 97 of the Commission's Rules Regarding Implementation of the Final Acts of the World Radiocommunication Conference (Geneva, 2007) (WRC-07), Other Allocation Issues, and Related Rule Updates, ET Docket No. 12-338, *Notice of Proposed Rulemaking and Order*, 27 FCC Rcd 14598, 14659 at ¶ 167 (2012).

Letter notes that DoD has an active frequency assignment at the Pascagoula, MS location that regularly uses the 3650-3700 MHz portion of the band.⁹⁴ Therefore, we revise footnote US 109 to include the Pascagoula, MS site and protect it from harmful interference consistent with other protected federal radiolocation sites in the band.

B. Access Model and Bandplan

44. We adopt an access model for the 3.5 GHz Band consistent with the proposals set forth in the *NPRM*, *Licensing PN*, and *FNPRM*.⁹⁵ We also adopt the supplemental proposal to include the 3650-3700 MHz band in the authorization framework. We will immediately effectuate three-tiered sharing, with Priority Access Licenses authorized in the bottom 100 megahertz of the combined band. By adopting a flexible access model across the entire band, we aim to create a versatile 150 megahertz band for shared wireless broadband use that can adapt to market and technological opportunities.

1. Three-Tier Access Model

45. *Background.* In the *FNPRM*, we proposed to implement the three-tier authorization framework originally described in the *NPRM* and further discussed in the *Licensing PN*.⁹⁶ Under this framework, existing primary operations – including authorized federal users and grandfathered FSS earth stations – would make up the Incumbent Access tier and would receive protection from harmful interference consistent with the proposed rules. The Citizens Broadband Radio Service would be divided into Priority Access and GAA tiers of service, each of which would be required to operate on a non-interference basis with the Incumbent Access tier. GAA users would also be required to operate on a non-interference basis with respect to Priority Access Licensees. We also proposed that any party that meets basic eligibility requirements under the Communications Act be eligible to hold a PAL or, when authorized, operate a CBSD on a GAA basis in the Citizens Broadband Radio Service. In addition, we proposed to apply the three-tier authorization model across the entire 3.5 GHz Band.⁹⁷ We sought comment on these proposals and encouraged commenters to consider the costs and benefits of any alternative proposals.

46. We received a varied record on this topic, with many commenters supporting the immediate implementation of the three-tier approach and others arguing for a “transitional” approach. Numerous commenters supported the use of a three-tier framework. This group included BLiNQ, Dynamic Spectrum Alliance, Federated Wireless, Google, Interdigital, Motorola Mobility, PISC, White Space Alliance, the Wireless Innovation Forum, and WISPA.⁹⁸ In a joint filing, PISC, the White Space Alliance, and the Dynamic Spectrum Alliance contend that immediate adoption of a three-tier framework would benefit the economy by enabling intensive use of the band, promoting additional broadband development in rural areas, and lowering the barriers to entry for a diverse range of users.⁹⁹

47. Federated Wireless asserts that delaying implementation of the three-tiered authorization model – even temporarily – would reduce spectral and economic efficiency and introduce uncertainty into

⁹⁴ See NTIA Letter at 8-9.

⁹⁵ See *3.5 GHz NPRM*, 27 FCC Rcd at 15612-14, ¶¶ 53-60; *Licensing PN*, 28 FCC Rcd at 15304-13, ¶¶ 10-40; *3.5 GHz FNPRM*, 29 FCC Rcd at 4281-82, ¶¶ 19-22.

⁹⁶ See *3.5 GHz NPRM*, 27 FCC Rcd at 15612-14, ¶¶ 53-60; *Licensing PN*, 28 FCC Rcd at 15304-13, ¶¶ 10-40; *3.5 GHz FNPRM*, 29 FCC Rcd at 4281-82, ¶¶ 19-22.

⁹⁷ See *3.5 GHz FNPRM*, 29 FCC Rcd at 4281-82, ¶¶ 19-22.

⁹⁸ See Wireless Innovation Forum *FNPRM* Comments at 2; Dynamic Spectrum Alliance, White Space Alliance, and PISC *FNPRM* Comments at 2; Motorola Mobility *FNPRM* Comments at 3-4; WISPA *FNPRM* Reply Comments at 5-8; Federated Wireless *FNPRM* Reply Comments at 13-15; Interdigital *FNPRM* Comments at 4; BLiNQ *FNPRM* Comments at 2.

⁹⁹ Dynamic Spectrum Alliance, White Space Alliance, and PISC *FNPRM* Comments at 2.

the band, reducing network deployments.¹⁰⁰ Federated also contends that SAS-based sharing between GAA and Priority Access users is conceptually no different than sharing between Priority Access and Incumbent Users. Therefore, according to Federated Wireless, the perceived risk of GAA interference should not pose an impediment to three-tier sharing or the development of a full functional SAS capable of managing three-tiers of users.¹⁰¹

48. Google agrees that the three-tier framework would meet the Commission's goals more effectively than the two-tier or "transitional" approaches advocated by other commenters.¹⁰² Google also argues that the SAS can effectively manage three-tiers of service without any negative effects on Priority Access networks and that some features of the SAS could help promote efficient use of the band by Priority Access Licensees.¹⁰³ Google contends that moving immediately to a three-tier sharing framework for the entire 3.5 GHz Band will promote investment and the deployment of innovative broadband technologies in the band.¹⁰⁴ Google recently demonstrated a prototype SAS, which it asserts is capable of managing three tiers of authorized users in the 3.5 GHz Band.¹⁰⁵

49. Other commenters, including 4G Americas, Alcatel-Lucent, AT&T, CTIA, Ericsson, Mobile Future, Qualcomm, PCIA, and Verizon argue for a "transitional" band plan that would divide the 3.5 GHz Band between two-tier and three-tier authorization models, at least initially, or phase in GAA use only after an SAS is tested and proven.¹⁰⁶ While these commenters differ on the specific bandplan that should be adopted, they generally argue that the SAS, as proposed, is a complex system that will require extensive testing and development prior to deployment. They believe that the inclusion of GAA use in the band increases this complexity significantly. They therefore argue in favor of more traditional exclusive licensing in a portion of the band before the eventual transition to a three-tier framework.¹⁰⁷

50. Verizon believes that moving to a three-tier framework is ultimately desirable, but that the Commission should designate a portion of the band for short-term deployment of existing technologies for a fixed period of time.¹⁰⁸ Verizon proposes that the band should initially be divided into three segments: (1) the "transitional band" for Priority Access and Incumbent Users only; (2) the "experimental" band for the Commission's three-tiered sharing approach; and (3) a portion of the band for GAA and Incumbent Use only.¹⁰⁹ According to Verizon, the two-tier model is a proven technology and designating a portion of the band for this use would promote near term investment and deployment of LTE networks while allowing industry to develop technology to support the three-tier framework in the "experimental" portion of the band.¹¹⁰ Verizon argues that its proposed framework would ultimately lead

¹⁰⁰ Federated Wireless *FNPRM* Reply Comments at 13-14.

¹⁰¹ *Id.* at 14.

¹⁰² Google *FNPRM* Reply Comments at 11.

¹⁰³ *Id.* at 10-14. *See also Ex Parte* Letter from Austin C. Schlick, Director of Communications Law, Google, Inc. to Marlene H. Dortch in Docket No. 12-354 (filed January 20, 2015) (Google January 2015 *Ex Parte*) at 1-4 and 7-21.

¹⁰⁴ Google *FNPRM* Reply Comments at 10-18.

¹⁰⁵ *See* Google January 2015 *Ex Parte*.

¹⁰⁶ *See* Qualcomm *FNPRM* Comments at 6; Ericsson *FNPRM* Comments at 4-6; Mobile Future *FNPRM* Comments at 4-5; Verizon *FNPRM* Comments at 11-15; AT&T *FNPRM* Comments at 11-30; CTIA *FNPRM* Comments at 3-5; PCIA *FNPRM* Comments at 3; Alcatel-Lucent *FNPRM* Comments at 3-6; 4G Americas *FNPRM* Comments at 4-6,

¹⁰⁷ *See* Alcatel-Lucent *FNPRM* Comments at 4-6; AT&T *FNPRM* Comments at 11-30; CTIA *FNPRM* Comments at 3-5; Verizon *FNPRM* Comments at 11-15; 4G Americas *FNPRM* comments at 4-6; Ericsson *FNPRM* Comments at 4-6; Mobile Future *FNPRM* comments at 4-5.

¹⁰⁸ Verizon *FNPRM* Comments at 11.

¹⁰⁹ *Id.* at 11-13.

¹¹⁰ *Id.* at 11-13.

to a fully developed unified band without sacrificing short-term investment.¹¹¹

51. AT&T argues that the Commission should initially divide the band into licensed and unlicensed segments, with a significant amount of spectrum reserved for both types of users.¹¹² In its view, licensed users should be afforded longer license terms with a renewal expectation and reasonable performance requirements to provide licensees with the regulatory certainty necessary to encourage investment.¹¹³ During the “transition” period, AT&T argues that users should not be permitted to use channels assigned to licensed users on an opportunistic basis, though such use could be allowed after the “transition” window.¹¹⁴

52. Some network equipment and technology providers, including Nokia Solutions and Networks (NSN) and Qualcomm, continue to argue for the merits of a two-tier Licensed Shared Access (LSA) framework,¹¹⁵ whereby, in portions of the band assigned to Priority Access users, no GAA use would be allowed.¹¹⁶ They contend that two-tier sharing technology has already been proven to be effective in other markets and that adoption of a two-tier model would allow for rapid Priority Access development in the band.¹¹⁷ The proposals are consistent with the two-tier sharing model advocated by Verizon, AT&T, and others for the exclusively licensed portion of the band during the “transition” period.¹¹⁸

53. As described in detail in section III(J), the record divides over whether to include the 3650-3700 MHz band in the proposed Citizens Broadband Radio Service authorization framework. Many commenters support the proposal to create a 150 megahertz contiguous block of spectrum for the Citizens Broadband Radio Service.¹¹⁹ Others oppose changing the existing framework for the 3650-3700 MHz band.¹²⁰ Still others suggest that if we decide to include 3650-3700 MHz in the Citizens Broadband Radio Service we must do so in a manner that sufficiently protects existing investment in the band.¹²¹ These commenters propose that we adopt additional protections for 3650-3700 MHz band incumbents in order to mitigate any impact on existing operations.¹²²

¹¹¹ *Id.* at 11-15.

¹¹² AT&T *FNPRM* Comments at 23-24.

¹¹³ *Id.* at 24-27.

¹¹⁴ *Id.* at 23-24.

¹¹⁵ The two-tier sharing framework is referred to as Licensed Shared Access or Authorized Shared Access in different filings. For purposes of this *R&O*, Licensed Shared Access or LSA should be read to include both terms.

¹¹⁶ See Qualcomm *FNPRM* Comments at 6 and 8-11; NSN *FNPRM* Comments at 13-20.

¹¹⁷ See *id.* See also, Qualcomm *FNPRM* Reply Comments at 5-7.

¹¹⁸ See Verizon *FNPRM* Comments at 12-13; Alcatel-Lucent *FNPRM* Comments at 4-6; AT&T *FNPRM* Comments at 11-30; CTIA *FNPRM* Comments at 3-5; 4G Americas *FNPRM* comments at 4-6; Ericsson *FNPRM* Comments at 4-6; Mobile Future *FNPRM* comments at 4-5.

¹¹⁹ See *e.g.*, Google *Licensing PN* Comments at 13-16; NSN *Licensing PN* Comments at 8-15; T-Mobile *Licensing PN* Comments at 14; Verizon *Licensing PN* Comments at 4-5; Qualcomm *NPRM* Comments at 19.

¹²⁰ See *e.g.*, Neptuno Networks *Licensing PN* Comments at 8-9; UTC *Licensing PN* Comments at 6 (The Commission should only extend the Citizens Broadband Radio Service to the 3650-3700 MHz band if it adopts the licensing proposals set forth in the *NPRM*); KanOkla Communications *Licensing PN* Reply Comments at 1-2 (Arguing that the Commission should maintain the *status quo* in the 3650-3700 MHz band); Airspan Networks *FNPRM* comments at 1-2; Iberdrola USA Networks *FNPRM* Comments at 3-7; Sacred Wind Communications *FNPRM* Comments at 3-6; Telrad Networks *FNPRM* Comments at 3-5.

¹²¹ See WISPA *FNPRM* Comments at 34; UTC *FNPRM* Comments at 15-16.

¹²² See UTC *FNPRM* Comments at 15-16; WISPA *FNPRM* Reply Comments at 16-19.

54. *Discussion.* After thorough review of the record, we generally adopt the three-tier authorization model proposed in the *NPRM* and *FNPRM* for the 3550-3650 MHz band.¹²³ We conclude that moving immediately to a three-tier authorization model, rather than adopting a “transitional” approach to the band, is technologically feasible and will promote innovation and investment in the band. We also conclude that the 3650-3700 MHz band should be included in the Part 96 authorization regime, subject to the conditions set forth in sections 90.1307, 90.1311, 90.1338 and 96.21, but that the 3650-3700 MHz band should be reserved for GAA users and Grandfathered Wireless Broadband Licensees at this time. As we explain in detail in section III(J) below, we find that including the 3650-3700 MHz band for these uses and subject to these conditions will further the development of the Citizens Broadband Radio Service while respecting the investments that current licensees have made in the band.

55. We agree with numerous commenters that immediately adopting the three-tier access model for the 3550-3650 MHz band will best serve the public interest, encourage innovation, and spur investment in the band.¹²⁴ Indeed, as Federated Wireless notes, “[m]ovement away from the three tier model... will reduce spectral and economic efficiencies, and temporarily adopting two sets of rules for the band will introduce regime uncertainty, reducing deployments.”¹²⁵ Even commenters advocating “transition” plans agree that a three-tier access model would be advantageous as soon as it becomes technically feasible.¹²⁶ We believe that a three-tier framework is technically feasible in the near term, while adopting an “interim” plan could create more challenges to any eventual transition to a three-tier model. We also observe that we cannot predict with certainty what the demand for spectrum will be for use of the spectrum by PALs at any given location and over time. A three-tiered approach will better ensure that use of the spectrum can adapt to market and user demands. Therefore, the public interest will best be served by launching the Citizens Broadband Radio Service with the three-tier model in place from the outset.

56. While we appreciate the creative “transition plans” put forth by various commenters, we are not convinced that this approach is necessary or desirable. We disagree with commenters that argue that the three-tier framework entails untested and unproven sharing elements that will require significant testing and development – beyond that which would be required for two-tier sharing – prior to commercial deployment.¹²⁷ Rather, we agree with the Dynamic Spectrum Alliance, Federated Wireless, Google, PISC, Spectrum Bridge, the White Space Alliance, WISPA, and other commenters who have argued that the development of an SAS capable of managing three-tiers of authorized users will not be an impediment to rapidly deploying service across three tiers of service in the band.¹²⁸ Indeed, several current TVWS database providers support the Commission’s proposal and believe that, while the SAS will be a more complex system than the TVWS databases, the technology already exists to effectively

¹²³ See 3.5 GHz *NPRM*, 27 FCC Red at 15612-22, ¶¶ 53-82; 3.5 GHz *FNPRM*, 29 FCC Red at 4281-82, ¶¶ 19-22.

¹²⁴ See Wireless Innovation Forum *FNPRM* Comments at 2; Dynamic Spectrum Alliance, White Space Alliance, and PISC *FNPRM* Comments at 2; Motorola Mobility *FNPRM* Comments at 3-4; WISPA *FNPRM* Reply Comments at 5-8; Federated Wireless *FNPRM* Reply Comments at 13-15; Interdigital *FNPRM* Comments at 4; BLiNQ *FNPRM* Comments at 2.

¹²⁵ Federated Wireless *FNPRM* Reply Comments at 14.

¹²⁶ See, e.g., Alcatel-Lucent *FNPRM* Comments at 4-6; AT&T *FNPRM* Comments at 11-30; CTIA *FNPRM* Comments at 3-5; Verizon *FNPRM* Comments at 11-15; 4G Americas *FNPRM* comments at 4-6; Ericsson *FNPRM* Comments at 4-6; Mobile Future *FNPRM* comments at 4-5.

¹²⁷ CTIA *FNPRM* Comments at 3-5;

¹²⁸ See Wireless Innovation Forum *FNPRM* Comments at 2; Dynamic Spectrum Alliance, White Space Alliance, and PISC *FNPRM* Comments at 2; Motorola Mobility *FNPRM* Comments at 3-4; WISPA *FNPRM* Reply Comments at 5-8; Federated Wireless *FNPRM* Reply Comments at 13-15; Interdigital *FNPRM* Comments at 4; BLiNQ *FNPRM* Comments at 2. See *infra* III(H)(1)

manage the three tiers of users in the band.¹²⁹ Notably, as mentioned above, Google claims that it has already developed a prototype SAS capable of managing three tiers of users in the band to the specifications proposed by the *FNPRM*.¹³⁰

57. We believe that the technological development of an SAS capable of managing a “transitional” bandplan would not be significantly less burdensome than the development of a fully functional SAS. Even a two-tier or “transitional” approach would require Commission review and approval of some form of SAS to manage interactions between Incumbent Users and a variety of Priority Access Licensees prior to initial commercial deployment.¹³¹ Using the “proven” technologies available for two-tier sharing would entail some period of testing, development, and review prior to the issuance of PALs in the context of our proposed Citizens Broadband Radio Service. To ensure that a three-tier authorization model is developed, a two-tier sharing system would likely need to be designed from the outset to later accommodate a third tier after the transition period. Therefore, we adopt the three-tier approach for the entire 3550-3650 MHz band to encourage the development of fully functional SASs without delay. While we acknowledge that the development and approval of a fully functional SAS may take some time, as described in sections III(H)(1) and III(H)(3)(b), we are convinced that the technology to implement the three-tier authorization framework exists or is in late-stage development and that the public interest benefits of moving directly to this model significantly outweigh any possible risk of delay. These benefits include the promotion of wide-scale investment and deployment based on assured availability to both PAL and GAA users, as well as the critical need to provide for the most efficient use of the spectrum by providing users with the simultaneous option of bidding at auction for priority PAL use in areas where they need and are willing to pay for it, while obtaining shared use on a GAA basis in all other scenarios.

58. We are also unconvinced by arguments that a portion of the band must be, at least temporarily, set aside for more traditional licenses to encourage investment in the band.¹³² We address the specific elements of these licensing proposals in more detail below.¹³³ For now, we note that implementation of the “transition” plans advocated by AT&T, Verizon, Ericsson, CTIA, and others could effectively prevent the three-tier authorization model from ever taking hold in the “transitional” portion of the band.¹³⁴ The combination of fixed channel assignments for PALs and indefinite license renewals could permanently prevent GAA use of certain portions of the band, particularly in regions of high commercial interest, even after the “transition” period concludes. These proposals could also preclude investment from a newer generation of Priority Access Licensees in the future. Indeed, any plan that rests upon the assumption that a licensee will be able to renew a license for a fixed channel assignment in perpetuity can hardly be called “transitional.” In addition, the record includes substantial evidence from

¹²⁹ See Spectrum Bridge *FNPRM* Comments at 1-2; Google *FNPRM* Reply Comments at 11; Microsoft *FNPRM* Reply Comments at 2.

¹³⁰ See Google *FNPRM* Reply Comments at 11; Google January 2015 *Ex Parte*. See also Preston Marshall, Principal Wireless Architect, Google Inc., Spectrum Access System: Managing Three Tiers of Users in the 3550-3700 GHz Band at 2 (Jan. 14, 2014), available at http://wireless.fcc.gov/workshops/sas_01-14-2014/panel-1/Marshall-Google.pdf. We note that the Commission takes no position on whether Google’s prototype SAS would actually satisfy all of the requirements set forth in this Order in its current form.

¹³¹ See Google *FNPRM* Reply Comments at 15.

¹³² See Qualcomm *FNPRM* Comments at 6; Ericsson *FNPRM* Comments at 4-6; Mobile Future *FNPRM* Comments at 4-5; Verizon *FNPRM* Comments at 11-15; AT&T *FNPRM* Comments at 11-30; CTIA *FNPRM* Comments at 3-5; PCIA *FNPRM* Comments at 3; Alcatel-Lucent *FNPRM* Comments at 3-6; 4G Americas *FNPRM* Comments at 4-6.

¹³³ See *infra* sections III(B)(2)(c) and III(C)(2)(a).

¹³⁴ See Qualcomm *FNPRM* Comments at 6; Ericsson *FNPRM* Comments at 4-6; Mobile Future *FNPRM* Comments at 4-5; Verizon *FNPRM* Comments at 11-15; AT&T *FNPRM* Comments at 11-30; CTIA *FNPRM* Comments at 3-5; PCIA *FNPRM* Comments at 3; Alcatel-Lucent *FNPRM* Comments at 3-6; 4G Americas *FNPRM* Comments at 4-6,

commenters that are interested in investing in a three-tier band and, as such, we do not believe that it is in the public interest to delay or compromise its implementation. Moreover, our framework depends on providing potential PAL bidders with simultaneous economic choices of bidding for higher priority PAL licenses in areas where such priority is critical to their needs and relying on shared GAA use where it is not.

59. However, while we decline to subdivide the 3550-3650 MHz band, nothing in the rules we adopt should be read to preclude industry agreement on a common bandplan, so long as the bandplan complies with the rules, including the band-wide operability requirements described in section III(F)(2)(c). We acknowledge that SAS Administrators, potential licensees, and other industry stakeholders will need to develop various implementation details to facilitate development of the Citizens Broadband Radio Service. As described elsewhere in this *Report and Order*, we believe that many of these issues can be addressed during the SAS Approval Process and through the efforts of a multi-stakeholder group.¹³⁵ For example, a bandplan similar to the one shown in Figure 1 could promote efficient use of the band and simplify coordination between SAS Administrators. If industry stakeholders do not develop such a convention, the Commission may revisit this issue in the future.

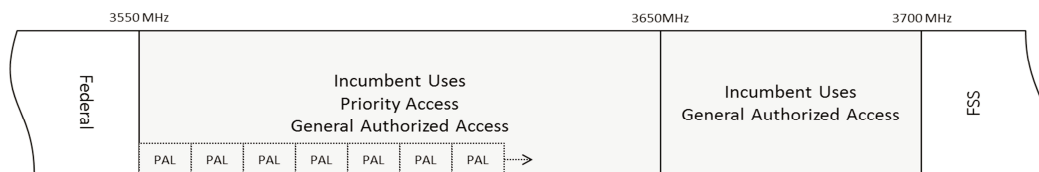


Figure 1: Potential Bandplan

2. Frequency Assignment

a. Apportionment Between Priority Access and GAA Tiers

60. *Background.* In the *FNPRM*, we proposed to adopt rules governing frequency assignments that would balance the needs of Priority Access Licensees and GAA users.¹³⁶ To foster a robust GAA ecosystem, a meaningful amount of the 3.5 GHz Band must be reserved for GAA use in any given geographic area. To that end, we proposed to reserve for GAA use a minimum of 50 percent of the 3.5 GHz Band in any given census tract – after accounting for any frequencies used by Incumbent Access tier operators in the area – with the remainder to be assigned as PALs. We sought comment on this proposed apportionment of spectrum between the GAA and Priority Access tiers.

61. Some commenters, including NSN and PCIA contend that the proposed GAA floor is too high.¹³⁷ NSN argues that the proposed 50 percent floor will not provide sufficient spectrum to encourage potential Priority Access Licensees to invest in the band.¹³⁸ T-Mobile argues that a minimum of 40 megahertz of spectrum should be reserved for Priority Access Licensees in each license area as well as 50 percent of any additional available spectrum.¹³⁹ Verizon asks that the Commission confirm that the 50 percent GAA floor will not remain static if Priority Access Licenses have been assigned in a given area and Incumbent Users later make use of a portion of the spectrum.¹⁴⁰ According to Verizon, in such cases,

¹³⁵ See *infra* sections III(H)(3)(b) and III(K).

¹³⁶ See *3.5 GHz FNPRM*, 29 FCC Rcd at 4283, ¶¶ 28-29.

¹³⁷ See NSN *FNPRM* Comments at 8; PCIA *FNPRM* Reply Comments at 2.

¹³⁸ See NSN *FNPRM* Comments at 8.

¹³⁹ T-Mobile *FNPRM* Comments at 5.

¹⁴⁰ Verizon *FNPRM* Comments at 19.

Priority Access Licensees should be assigned channels before GAA users.¹⁴¹

62. Others, including WISPA, the Wi-Fi Alliance, UTC, the American Petroleum Institute, Motorola Mobility, and Shared Spectrum Company support reserving at least 50 percent of available frequencies in any given area for GAA use.¹⁴² Motorola Solutions supports the proportional assignment approach proposed by the Commission but proposes that 60 percent of available frequencies be reserved for GAA use.¹⁴³ Others support the proposed GAA floor but contend that users should have at least a fixed minimum amount of the band available instead of utilizing a proportional approach. Notably, PISC and Microsoft ask that the Commission reserve the greater of 50 megahertz or 50 percent of available spectrum for GAA use.¹⁴⁴

63. *Discussion.* We continue to believe that ensuring that a stable and significant quantity of spectrum is available for both Priority Access Licensees and GAA will foster innovation, encourage efficient use of the band, and create an environment conducive to a wide array of potential users and uses. However, we modify the proposed approach to better serve the public interest in this band. We recognize that the proportional frequency assignment method proposed in the *FNPRM* could create uncertainty in the marketplace, particularly in areas where the band may be partially used by Incumbent Users. Therefore, we conclude that a maximum of 70 megahertz may be reserved for PALs in any given license area at any time and the remainder of the available frequencies should be made available for GAA use.

64. This approach will benefit Priority Access Licensees and GAA users alike. Priority Access Licensees will have more predictable access to spectrum. GAA users will potentially have access to all 150 megahertz in the band in areas where there are no PALs issued or in use and up to 80 megahertz where all PALs are in use.¹⁴⁵ We note, however, that both PAL and GAA spectrum access will necessarily be constrained by the need to protect Incumbent Users throughout the band. We believe that moving from proportional frequency reservations to fixed frequency reservations – coupled with opportunistic access to spectrum for GAA users across 150 megahertz – will increase band access, stability, and predictability for all Citizens Broadband Radio Service users.

65. We agree with those commenters who contend that a percentage-based reservation for GAA use in any given area could cause confusion and lead to uncertainty regarding the amount of available spectrum in any given area. As Verizon points out, under the *FNPRM* proposal, if the amount of available spectrum in a given area were to be reduced due to Incumbent Access use, Priority Access Licensees could lose access to capacity that they had been assigned through auction.¹⁴⁶ While the need to protect Incumbent Users makes it impossible to completely avoid this risk, moving to a non-proportional Priority Access reservation model should minimize it substantially.

66. While we agree with PISC and Microsoft that GAA users should have access to a significant amount of spectrum, we do not agree that 50 megahertz of the band should *always* be reserved for GAA use.¹⁴⁷ The presence of Incumbent Users could affect the amount of spectrum available for both GAA and PAL users. Circumstances may occur where incumbent use of the band leaves less than 50 megahertz available for GAA (or PAL) use in a given location. Nevertheless, we believe that the policies

¹⁴¹ *Id.* at 19-20.

¹⁴² See Wi-Fi Alliance *FNPRM* Comments at 6; Wi-Fi Alliance *FNPRM* Reply Comments at 5; Motorola Mobility *FNPRM* comments at 4; WISPA *FNPRM* Comments at 16; Shared Spectrum Company Comments at 9; UTC *FNPRM* comments at 2, 9; API *FNPRM* Comments at 10.

¹⁴³ Motorola Solutions *FNPRM* Comments at 2.

¹⁴⁴ See PISC *FNPRM* Reply Comments at 17; Microsoft *FNPRM* Comments at 3.

¹⁴⁵ See *infra* section III(B)(2)(b).

¹⁴⁶ See Verizon *FNPRM* Comments at 19-20.

¹⁴⁷ See PISC *FNPRM* Reply Comments at 17; Microsoft *FNPRM* Comments at 3.

we adopt in this order, including the ability to access “unused” channels assigned to Priority Access Licensees, will ensure that substantial spectrum capacity is available in all geographic areas for GAA use.

67. With regard to the amount of spectrum available for GAA and Priority Access use, we believe that reserving a maximum of 70 megahertz – *i.e.*, seven channels – for Priority Access Licensees in any given license area appropriately balances the needs of these two types of access. Seven PAL channels represent an increase from the five PAL channels that would have been available under the baseline *FNPRM* proposal (*i.e.*, 3550-3650 MHz) while providing a greater degree of certainty for potential licensees. This increase in Priority Access spectrum availability will likely encourage more licensees to enter the band in any given area or allow more licensees to pursue higher bandwidth applications (through channel aggregation). Considered alongside the inclusion of the 3650-3700 MHz band, the bandplan and frequency assignment model we adopt herein would generally provide all users with more and greater spectrum availability than they would have had under our proposal in the *FNPRM*. Where the band is not utilized by Incumbent Access users or Grandfathered Wireless Broadband Licensees,¹⁴⁸ GAA users will have access to a minimum of 80 megahertz, more than the proportional 50 percent of the band proposed in the *FNPRM*.¹⁴⁹ Thus, both Priority Access Licensees and GAA users will benefit from our revised approach to the assignment of frequencies in the band.

b. Opportunistic Access to Priority Access Licenses

68. *Background.* In the *NPRM* and *FNPRM* we proposed to allow GAA users access to frequencies not yet assigned to PALs - or where assigned bandwidth is not in actual use by Priority Access Licensees - on an opportunistic basis.¹⁵⁰ We sought comment on whether to allow opportunistic access to channels assigned to Priority Access Licensees and, if so, how to determine whether such channels are actually “in use.”¹⁵¹

69. Commenters offered varied opinions on whether opportunistic use of Priority Access channels should be permitted and proposed a variety of ways to determine whether such channels are actually “in use.” Commenters including the Dynamic Spectrum Alliance, Federated, Interdigital, Microsoft, PISC, Shared Spectrum Company, White Space Alliance, Wi-Fi Alliance, and WISPA support the proposal to allow opportunistic access to Priority Access channels by GAA users.¹⁵² Some others, like Ericsson, contend that opportunistic GAA use should not be permitted after network facilities have been deployed by Priority Access Licensees in a given channel and license area. CTIA contends that further study is needed before the Commission determines that it is feasible to allow opportunistic access to licensed spectrum.¹⁵³

70. Other commenters support opportunistic access, with certain caveats. AT&T argues that GAA use of channels assigned to Priority Access Licensees should only be permitted if, at the end of a license term, there is spectrum or geography not in actual use by the Priority Access Licensee.¹⁵⁴ According to AT&T, the Commission should utilize 3GPP standards for TD-LTE channel occupancy to

¹⁴⁸ See *infra* section III(J).

¹⁴⁹ See 3.5 GHz *FNPRM*, 29 FCC Red at 4283-84, ¶¶ 30-31.

¹⁵⁰ See *id.* at 4285, ¶¶ 36-37; 3.5 GHz *NPRM*, 27 FCC Red at 15620, ¶ 76; .

¹⁵¹ See 3.5 GHz *FNPRM*, 29 FCC Red at 4285, ¶¶ 36-37.

¹⁵² Federated Wireless *FNPRM* Comments at 19-20; Federated *Licensing PN* Comments at 36-38; Shared Spectrum Company *FNPRM* Comments at 10; White Space Alliance *FNPRM* Comments at 3; PISC *FNPRM* Reply Comments at 19-23; Microsoft *FNPRM* Comments at 5; Microsoft *FNPRM* Reply Comments at 4; Dynamic Spectrum Alliance *FNPRM* Comments at 2; Interdigital *FNPRM* Comments at 6-7, 21-22; WISPA *FNPRM* Comments at 27; WISPA *Licensing PN* Comments at 16; Wi-Fi Alliance *FNPRM* Comments at 6.

¹⁵³ CTIA *FNPRM* Comments at 9-10.

¹⁵⁴ AT&T *FNPRM* Comments at 12.

determine channel usage.¹⁵⁵ Verizon contends that the definition of “use” should not be limited to actual operations. For example, Priority Access Licensees should be permitted to use all or some of a given license area as a guard band to protect its network from interference.¹⁵⁶ T-Mobile asserts that GAA users should only be permitted to use channels assigned to PALs until the licensee notifies an SAS that such channels are in operation.¹⁵⁷ WISPA proposes a technical definition of use based on the specific number of data “packets” received by any CBSD within a five minute period.¹⁵⁸

71. TIA contends that the Commission’s proposal would effectively make GAA rights in the band superior to Priority Access rights by allowing GAA users to access channels assigned to Priority Access Licensees without allowing Priority Access Licensees to do the same.¹⁵⁹ The Wi-Fi Alliance counters that this is not the case since GAA users will always be prohibited from using channels assigned to Priority Access Licensees when they are in actual use and, as such, Priority Access rights will always be superior to GAA tier rights under the Commission’s proposed framework.¹⁶⁰

72. *Discussion.* We find that permitting opportunistic access to unused Priority Access channels would maximize the flexibility and utility of the 3.5 GHz Band for the widest range of potential users. By allowing GAA users to access bandwidth that is not used by Priority Access Licensees, we can ensure that the band will be in consistent and productive use. We believe the record demonstrates the benefits of allowing GAA users some degree of opportunistic access to “unused” Priority Access channels.¹⁶¹

73. We disagree with AT&T’s contention that GAA use of PAL channels should only be allowed if the licensee is not using a portion of its assigned spectrum or geography at the end of its license term.¹⁶² This proposed model is incompatible with the three-tier authorization framework adopted herein and would undermine the Commission’s objectives for more efficient spectrum use in this band. Under AT&T’s model, channels assigned to PALs would effectively lie fallow until the Priority Access Licensee chooses to deploy its network in a given area, precluding opportunistic use of the spectrum and limiting the scope of potential GAA deployments.¹⁶³ Thus, AT&T’s suggested policy could encourage spectrum warehousing and disincentivize efficient use of the band. We believe that it is in the public interest to ensure that the 3.5 GHz Band is made widely available to Citizens Broadband Radio Service users – regardless of their operational tier – and that Priority Access Licensees should not be permitted to exclude other authorized users unless and until their networks are in use.

74. We recognize a wide range of disagreement in the record about how to define “use” for the purpose of opportunistic access and therefore opt to seek additional comment in our *Second FNPRM*.

¹⁵⁵ *Id.* at 13-15.

¹⁵⁶ Verizon *FNPRM* Comments at 10-11.

¹⁵⁷ See *Ex Parte* Letter from Steve B. Sharkey, Chief Engineering and Technology Policy, Federal Regulatory Affairs, T-Mobile US Inc. to Marlene H. Dortch in GN Docket No. 12-354 (filed March 13, 2015) (T-Mobile March 2015 *ex Parte*) at 10.

¹⁵⁸ WISPA *FNPRM* comments at 16-17.

¹⁵⁹ TIA *FNPRM* Comments at 3.

¹⁶⁰ Wi-Fi Alliance *FNPRM* Reply Comments at 6.

¹⁶¹ Federated Wireless *FNPRM* Comments at 19-20; Federated Wireless *Licensing PN* Comments at 36-38; Shared Spectrum Company *FNPRM* Comments at 10; White Space Alliance *FNPRM* Comments at 3; PISC *FNPRM* Reply Comments at 19-23; Microsoft *FNPRM* Comments at 5; Microsoft *FNPRM* Reply Comments at 4; Interdigital *FNPRM* Comments at 6-7, 21-22; WISPA *FNPRM* Comments at 27; WISPA *Licensing PN* Comments at 16; Wi-Fi Alliance *FNPRM* Comments at 6.

¹⁶² See AT&T *FNPRM* Comments at 12.

¹⁶³ See *id.*

Many commenter concerns reflect uncertainty about how the implementation of the opportunistic access rules will protect Priority Access rights acquired at auction. We believe that additional input will help us determine the best strategy for implementing this policy. However we ultimately define “use,” we emphasize that Priority Access Licensees will always have the right to use the full 10 megahertz channel bandwidth within their license areas during their license terms. PAL channels may not be subdivided by an SAS without the licensee’s consent. We also observe that there is nothing in the rules to prevent a Priority Access Licensee from using the remainder of the band on a GAA basis under the same conditions that apply to all GAA users. Indeed, we expect that most, if not all, Priority Access Licensees will also be GAA users.

c. Frequency Assignment by SAS

75. *Background.* In the *FNPRM*, we proposed that, in place of fixed channel assignments, the SAS would assign bandwidth within given geographic areas to Priority Access Licensees and GAA users.¹⁶⁴ Under this proposal, the SAS would ensure that Priority Access Licensees have access to 10 megahertz channels and that GAA users would have access to the remaining portions of the band.¹⁶⁵ However, the exact frequencies defining any given authorization, whether Priority Access or GAA, would not be fixed. For example, a licensee might have Priority Access rights for a single PAL, but the specific channel location assigned to that user would be assigned by the SAS and could be reassigned from time to time (*e.g.*, from 3550-3560 MHz to 3630-3640 MHz). Individual GAA users would be assigned available bandwidth of a size and frequency range determined by the SAS. The SAS would assign and maintain appropriate frequency assignments and ensure that lower tier users do not interfere with higher tier users. To the extent that some level of regional or national consistency of assignment facilitates the provision of service, SAS providers would be free to agree upon a common assignment convention. However, such a convention was not specified in the proposed rules, in order to allow the greatest degree of operational flexibility.¹⁶⁶ We sought comment on these proposals.

76. The record reflects a sharp division between those who favor the assignment of frequencies by the SAS and those who prefer static frequency assignments. Commenters including PISC, White Space Alliance, Dynamic Spectrum Alliance, Federated Wireless, Interdigital, Google, Shared Spectrum Company, Spectrum Bridge, and the Wireless Innovation Forum support the Commission’s proposal to allow the SAS to dynamically assign frequencies in the band for both Priority Access Licensees and GAA Users.¹⁶⁷ Google asserts that SAS-directed spectrum sharing will ensure that Citizens Broadband Radio Service users will have access to the best available channel in any given spectral environment and that dynamic frequency assignment is a necessary component of any sharing regime that requires secondary users to change their operations in response to higher tier users.¹⁶⁸ Similarly, PISC states that frequency assignment through the SAS will confer a number of public interest benefits, including: (1) better accommodation of Incumbent Access Users; (2) more intensive and productive use of the band; and (3) improved coexistence of small cell and higher power uses.¹⁶⁹ Federated Wireless contends that static frequency assignments for PALs: (1) are inconsistent with the efficient, SAS-driven spectrum assignment model the Commission proposes; (2) would threaten

¹⁶⁴ See *3.5 GHz FNPRM*, 29 FCC Rcd at 4284, ¶¶ 32-35, Proposed Rules §§ 96.23, 96.33, and 96.46.

¹⁶⁵ See *id.*

¹⁶⁶ See *id.*

¹⁶⁷ Dynamic Spectrum Alliance, WhiteSpace Alliance, and PISC *FNPRM* Comments at 2; WhiteSpace Alliance *FNPRM* Comments at 3; Federated Wireless *FNPRM* Comments at 25; Wireless Innovation Forum *FNPRM* Comments at 5; Shared Spectrum Company *FNPRM* Comments at 9-10; Google *FNPRM* Comments at 28; Spectrum Bridge *FNPRM* Comments at 4 (suggesting that dynamic assignment with a fixed channel plan may be good intermediate step); Interdigital *FNPRM* Comments at 6.

¹⁶⁸ See Google *FNPRM* Comments at 28; Google January 2015 *Ex Parte* at 1-3.

¹⁶⁹ PISC *FNPRM* Reply Comments at 32-33.

interoperability in the band; and (3) are unnecessary for incumbent protection.¹⁷⁰

77. Other commenters, including AT&T, CTIA, Ericsson, 4G Americas, HKT Limited, NSN, and UK Broadband oppose the Commission's proposal and argue that Priority Access Licensees should be given static frequency assignments.¹⁷¹ Many of these commenters contend that static frequency assignments are the simplest and most effective way to license PALs to wireless broadband providers.¹⁷² AT&T and T-Mobile argue that dynamic frequency assignment would undermine carriers' essential network management functions, frustrate their ability to plan network deployments, and discourage investment in the band.¹⁷³ T-Mobile asserts that current network technology does not support dynamic frequency assignment.¹⁷⁴

78. Google disagrees and states that SAS management of frequency assignments is wholly compatible with LTE system architecture.¹⁷⁵ Indeed, Google asserts that dynamism in frequency assignment would provide greater certainty to Priority Access Licensees since the loss of any specific channel in a specific license area would not necessarily result in the loss of Priority Access functionality.¹⁷⁶ Google also stresses that reassignment should only be used to avoid situations where PALs might otherwise lose access to assigned PAL frequencies.¹⁷⁷

79. Seeking to balance concerns on both sides of the issue, Verizon notes that SAS-based frequency assignment has potential benefits and drawbacks. As a result, Verizon contends that additional information on incumbent frequency use is needed to perform a complete and accurate cost-benefit analysis of the Commission's proposals.¹⁷⁸

80. *Discussion.* After review of the record, we conclude that frequencies in the 3.5 GHz Band will be assigned by an SAS. This approach is consistent with the Revised Framework and the proposals set forth in the *FNPRM*. We believe that flexible band management is essential to effective spectrum sharing between the three tiers of authorized users in the band. However, we also acknowledge commenters' concerns about frequency predictability and stability. To address these concerns, we adopt provisions to ensure that Priority Access channel assignments remain as stable and consistent as possible for licensees holding multiple channels within the same license area or in contiguous license areas.

81. We agree with commenters who assert that SAS-controlled frequency assignment is an essential component of the three-tiered authorization framework adopted in this *Report and Order*.¹⁷⁹

¹⁷⁰ See *Ex Parte* Letter from Kurt Schaubach, Chief Technology Officer, Federated Wireless Inc. to Marlene H. Dortch, Secretary, FCC in GN docket No. 12-354 (filed Mar. 4, 2015) (Federated Wireless March 4, 2015 *Ex Parte*) at 2-5.

¹⁷¹ AT&T *FNPRM* Reply Comments at 13-15; T-Mobile *FNPRM* Comments at 10; CTIA *FNPRM* Comments at 8; 4G Americas *FNPRM* Comments at 5-6; UK Broadband *FNPRM* Comments at 3-4; HKT Limited *FNPRM* Comments at 3-4; NSN *FNPRM* Comments at 10-11; Ericsson *FNPRM* Comments at 6-7.

¹⁷² AT&T *FNPRM* Reply Comments at 13-15; T-Mobile *FNPRM* Comments at 10; CTIA *FNPRM* Comments at 8.

¹⁷³ AT&T *FNPRM* Reply Comments at 13-15; T-Mobile *FNPRM* Comments at 10.

¹⁷⁴ See T-Mobile March 2015 *Ex Parte* at 10.

¹⁷⁵ Google *FNPRM* Reply Comments at 13-14 and Marshall Declaration at ¶ 10.

¹⁷⁶ Google *FNPRM* Reply Comments at 13-14.

¹⁷⁷ *Id.* at 14.

¹⁷⁸ Verizon *FNPRM* Reply Comments at 10-11.

¹⁷⁹ Dynamic Spectrum Alliance, WhiteSpace Alliance, and PISC *FNPRM* Comments at 2; PISC *FNPRM* Reply Comments at 32; WhiteSpace Alliance *FNPRM* Comments at 3; Federated Wireless *FNPRM* Comments at 25; Wireless Innovation Forum *FNPRM* Comments at 5; Shared Spectrum Company *FNPRM* Comments at 9-10; Google *FNPRM* Comments at 28; Spectrum Bridge *FNPRM* Comments at 4 (suggesting that dynamic assignment

(continued....)

Notably, automated frequency assignment is necessary to ensure consistent spectrum access for Citizens Broadband Radio Service users and to ensure protection of Incumbent Users. Under the framework described in section III(B)(1), Incumbent Access users have superior spectrum rights at all times and in all areas over Priority Access Licensees and GAA Users. As such, all Citizens Broadband Radio Service users must be capable of discontinuing operation or changing frequencies at the direction of the SAS to protect Incumbent Users. If PAL assignments were entirely static, as AT&T and others propose, Priority Access Licensees would have no choice but to discontinue operations when an Incumbent User begins operating on its assigned channel in a given license area. Indeed, as PISC notes, the need to protect Incumbent Users coupled with static channel assignments could require Priority Access Users to shut down indefinitely or even permanently.¹⁸⁰ For example, assume that a Priority Access Licensee is given a fixed channel assignment of 3550-3560 MHz in a designated License Area. If an Incumbent User begins using those frequencies, the Priority Access Licensee would lose access to the channel. Without the ability to reassign channels dynamically, the Priority Access Licensee would lose the use of a channel it had acquired at auction for the duration of the Incumbent User's operations. Thus, static channel assignments for Priority Access Licensees would lead to unpredictable spectrum availability, undermining the very stability that commenters claim is needed to encourage investment in the band.¹⁸¹ However, with automated frequency assignment, Priority Access Licensees could be relocated to unencumbered channels and allowed to continue providing service.¹⁸²

82. We also find that SAS-based frequency assignments will increase the flexibility and utility of the 3.5 GHz Band. We agree with PISC's assertion that automated frequency assignment will allow more users to access spectrum in a given geography, leading to more productive and intense spectrum use by both Priority Access Licensees and GAA users.¹⁸³ Coupled with the requirement that CBSDs be capable of operating across the entire 3.5 GHz Band, SAS-controlled assignment will ensure that individual users are provided with flexible, stable access to the band and that Citizens Broadband Radio Service users as a whole are able to access as much spectrum as possible at any given time and place.¹⁸⁴

83. We are not convinced that frequency assignment by the SAS is incompatible with wireless broadband network planning as T-Mobile, AT&T, and CTIA claim.¹⁸⁵ We realize that operators traditionally have planned their networks with certain static assumptions about frequency assignments, reflecting the exclusive-use licenses they hold in other bands.¹⁸⁶ However, we do not agree that static assignments are always necessary to plan and operate a network – particularly a network with “islands” of small cell clusters – or that utilizing a flexibly assigned band would disrupt network deployments. To the contrary, as explained above, we believe that automated assignment will benefit wireless broadband providers by providing an additional measure of resiliency and flexibility.

(Continued from previous page) _____
with a fixed channel plan may be good intermediate step); Interdigital *FNPRM* Comments at 6; Federated Wireless March 4, 2015 *Ex Parte* at 2-5.

¹⁸⁰ See PISC *FNPRM* Reply Comments at 32.

¹⁸¹ See, e.g., AT&T *FNPRM* Reply Comments at 13-15; T-Mobile *FNPRM* Comments at 10; Ericsson *FNPRM* Comments at 6-7.

¹⁸² See PISC *FNPRM* Reply Comments at 32-33; WIN Forum *FNPRM* Comments at 5-6; Google *FNPRM* Comments at 28.

¹⁸³ See PISC *FNPRM* Reply Comments at 32-33.

¹⁸⁴ See *infra* section III(F)(2)(c).

¹⁸⁵ See AT&T *FNPRM* Reply Comments at 13-15; T-Mobile *FNPRM* Comments at 10; CTIA *FNPRM* Comments at 8.

¹⁸⁶ T-Mobile *FNPRM* Comments at 10.

84. We believe that our SAS rules will ensure a stable spectral environment for Priority Access Licensees and GAA users alike while providing the flexibility needed to accommodate and protect Incumbent Access users. To address the concerns raised by AT&T, Verizon, and others, the SAS will be responsible for ensuring that Priority Access Licensees are provided with consistent channel authorizations across contiguous geographic areas and contiguous channels within the same geographic area where feasible.¹⁸⁷ We address these rules in greater detail in sections III(H)(2)(c) and III(c)(2)(a).

85. Contrary to some of the arguments made in the record, SAS-based frequency assignment is compatible with international harmonization to achieve ecosystem scale and permit global roaming. In considering this issue, we believe it is necessary to distinguish air interface compatibility – the primary focus of international standards efforts, including those within 3GPP – from channel assignment. Indeed, irrespective of the method of channel assignment, we expect that any standardized device that uses the new 3.5 GHz Band would be able to tune across the band (and, in fact, we mandate such capability with a band-wide operability requirement).¹⁸⁸ Automated channel assignment by an SAS will simply involve instructions to these devices to use a specific channel, at a specific place and time, within this tuning range. As noted above, the rules contain provisions to promote stability of the spectral environment. Therefore, based on the record before us, it is our predictive judgment that SAS-mandated channel changes, guided by the requirement to preserve consistency and contiguity for PAL spectrum assignments where feasible, will generally occur relatively infrequently rather than on a millisecond-by-millisecond basis as some commenters fear.

86. This mode of automated frequency assignment is consistent with most prevalent networking standards. Indeed, modern networks typically have control features that allow for automated or managed channel selection. Finally, we note that unlike many other countries that have fully reallocated the 3.5 GHz Band for commercial broadband uses, we must accommodate a spectral environment that includes, and will continue to include, extensive use of the band by military radar systems.¹⁸⁹ Many of the policies we adopt in this *Report and Order* are intended to address this unique situation and ensure that the band is made available for commercial use while protecting important incumbent operations. As such, industry standards may need to evolve to accommodate some of the policies we adopt herein. We believe that standardization should be addressed, at least in part, during the SAS approval process and may be informed by the work of a multi-stakeholder group as described in sections III(K) and III(H)(3)(b).

C. Priority Access Tier

1. Eligibility

87. *Background.* Based on comments received in response to our original *NPRM* and *Licensing PN*, we proposed in the *FNPRM* to make eligibility for PALs open to any prospective licensee who meets basic FCC qualifications, rather than to a more limited group of “mission critical” users.¹⁹⁰ The record we received in this proceeding generally supports expanding eligibility to the Priority Access tier to a broader class of users than we proposed in the *NPRM*.¹⁹¹

¹⁸⁷ Appendix A, §§ 96.25(b); 96.59(b).

¹⁸⁸ See *infra* section III(F)(2)(c) and Appendix A, § 96.39(b).

¹⁸⁹ See, e.g., Industry Canada, *Decisions Regarding Policy Changes in the 3500 MHz Band (3475-3650 MHz) and a New Licensing Process*, DGSO-007-14 (Dec. 2014), available at <http://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf10914.html>.

¹⁹⁰ See *3.5 GHz FNPRM*, 29 FCC Rcd at 4286, ¶¶ 41-42.

¹⁹¹ See e.g., AT&T *Licensing PN* Comments at 3; T-Mobile *Licensing PN* Comments at 4; Alcatel Lucent *Licensing PN* Comments at 2; Spectrum Bridge *Licensing PN* Comments at 2; NSN *Licensing PN* Comments at 2; Google *Licensing PN* Comments at 5; OTI/PK *Licensing PN* Comments at 16-17; Coalition Letter at 1; TIA *Licensing PN* Comments at 7; Neptuno Networks *Licensing PN* Comments at 4, 5; WISPA *Licensing PN* Reply Comments at 12.

88. *Discussion.* The Commission has broad authority to prescribe “citizenship, character, and financial, technical, and other qualifications” for its licensees.¹⁹² Based on the record in this proceeding, and for the reasons we have previously outlined in a number of other wireless broadband services,¹⁹³ we determine that it is in the public interest to allow any entity that is eligible to hold an FCC license to also be eligible to apply for, and hold, a PAL.¹⁹⁴ All applicants for PALs must demonstrate their qualification to hold an authorization and demonstrate how a grant of authorization would serve the public interest.¹⁹⁵ Qualifications include those under Section 310 of the Act regarding foreign ownership,¹⁹⁶ as well as the bar on participation in spectrum auctions with respect to any person “who has been, for reasons of national security, barred by any agency of the Federal Government from bidding on a contract, participating in an auction, or receiving a grant.”¹⁹⁷

89. For the same reason that we have determined to expand the size of the tier, we conclude that expanded eligibility for access to the Priority Access tier will promote more intensive use of the 3.5 GHz Band. The increasing growth in demand for wireless broadband service has led to increasing demands for spectrum to accommodate that growth. As T-Mobile explains, many entities besides mission critical users seek access to the type of “quality assured” spectrum that PALs provide.¹⁹⁸ The Consumer Electronics Association notes that “[c]ommercial operations benefit from reliable, prioritized access to spectrum and a predictable quality of service, which will support investment and innovation in the 3.5 GHz Band.”¹⁹⁹ Google states that “[o]pening the Priority Access tier will encourage deployment of systems that require reliable access to spectrum to deliver higher quality service.”²⁰⁰ Accordingly, subject to the qualification rules discussed above, any entity, is eligible to be a Priority Access Licensee.²⁰¹

2. PAL Configuration

a. Frequencies

90. *Background.* We proposed to authorize PALs as 10 megahertz unpaired channels.²⁰²

¹⁹² 47 U.S.C. § 308(b).

¹⁹³ See, e.g., 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, 4656, ¶ 124 (2014) (*AWS-3 R&O*); Service Rules for Advanced Wireless Services H Block--Implementing Section 6401 of the Middle Class Tax Relief and Job Creation Act of 2012 Related to the 1915-1920 MHz and 1995-2000 MHz Bands, WT Docket No. 12-357, *Report and Order*, 28 FCC Rcd 9483, 9555, ¶ 186 (2013) (*H Block R&O*); Service Rules for Advanced Wireless Services in the 2000-2020 MHz and 2180-2200 MHz Bands, WT Docket No. 12-70, *Report and Order and Order of Proposed Modification*, 27 FCC Rcd 16102, 16193, ¶ 242 (2012) (*AWS-4 R&O*); Service Rules for the 698-746, 747-762 and 777-792 MHz Bands, WT Docket No. 06-150, *Second Report and Order*, 22 FCC Rcd 15289, 15381, 15383-84, ¶¶ 253, 256 (2007) (*700 MHz 2nd R&O*); Allocations and Service Rules for the 71-76 GHz, 81-86 GHz and 92-95 GHz Bands, WT Docket No. 02-146, *Report and Order*, 18 FCC Rcd 23318 at 23346-47, ¶ 70 (2003).

¹⁹⁴ See Appendix A, § 96.5.

¹⁹⁵ See 47 U.S.C. §§ 303, 307, 309, 310.

¹⁹⁶ See 47 U.S.C. § 310(b); Review of Foreign Ownership Policies for Common Carrier and Aeronautical Radio Licensees under Section 310(b)(4) of the Communications Act of 1934, as Amended, *Second Report and Order*, 28 FCC Rcd 5471 (2013).

¹⁹⁷ 47 U.S.C. § 1404; 47 C.F.R. § 1.2105(a)(2)(xii).

¹⁹⁸ T-Mobile *Licensing PN* Reply Comments at 3; T-Mobile *Licensing PN* Comments at 4.

¹⁹⁹ Consumer Electronics Association (CEA) *Licensing PN* Comments at 3.

²⁰⁰ Google *Licensing PN* Comments at 5.

²⁰¹ See Appendix A, § 96.5.

²⁰² See 3.5 GHz FNPRM, 29 FCC Rcd at 4287-88, ¶ 47..

With this proposal we intended to balance several objectives. First, as we have concluded in other services suitable for wireless broadband deployment,²⁰³ 10 megahertz channels are well suited for high data rate technologies both in terms of deployment and scalability. Second, 10 megahertz channels divide evenly into either the 100 megahertz (10 channels) or 150 megahertz of spectrum (15 channels) that would be available in either our main proposal or the supplemental proposal to include 3650-3700 MHz. Third, 10 megahertz channels will allow us to license multiple Priority Access users in each geographic area, particularly where protection of incumbents limits the amount of spectrum available for commercial use. Fourth, 10 megahertz licenses would provide useful “building blocks” for licensees that might wish to aggregate larger amounts of spectrum in a given area. We sought comment on the appropriate bandwidth for PALs.²⁰⁴

91. *Discussion.* Based on the general consensus in the record, we adopt our proposal to authorize PALs to operate over 10 megahertz unpaired channels. Ten megahertz channels provide a flexible, scalable, and practically deployable bandwidth for high data rate technologies, permitting multiple Priority Access Licensees to operate in the same geographic area. We agree with T-Mobile, that 10 megahertz blocks “strike the appropriate balance between permitting multiple entities access to licensed 3.5 GHz Band spectrum and ensuring that the blocks are large enough to support customer traffic.”²⁰⁵ Further, some commenters see beneficial consistency with the 3GPP Bands 42 and 43 channelization scheme.²⁰⁶ Such alignment should encourage investment in and development of new equipment for this innovation band.

92. Although a few commenters advocated for larger or smaller channels,²⁰⁷ the record generally supports our proposal to utilize 10 megahertz channels for PALs with the ability to aggregate multiple channels.²⁰⁸ Spectrum Bridge, for example, notes that 10 MHz channels are compatible with broadband technology and operations.²⁰⁹ NSN and T-Mobile also point out that 10 MHz licenses would harmonize with the worldwide use of existing global 3GPP Bands 42 and 43 for Long Term Evolution Time Division Duplex use.²¹⁰ As NSN further explains, “[b]and class harmonization helps achieve

²⁰³ See, e.g., *AWS-4 R&O*, 27 FCC Rcd at 16119, ¶ 42 (adopting 10 megahertz blocks as the block size for the AWS-4 band); *AWS-3 R&O*, 29 FCC Rcd at 4634, ¶¶ 51-52 (adopting a combination of 5 and 10 megahertz blocks for the AWS-3 band and noting that 10 MHz blocks afford carriers the ability to offer higher-bandwidth services); Service Rules for Advanced Wireless Services in the 1.7 GHz and 2.1 GHz Bands, WT Docket No. 02-353, *Report and Order*, 18 FCC Rcd 25162 (2003) (*AWS-1 R&O*) at 25177-79, ¶¶ 41-45 (adopting 5, 10, and 15 megahertz blocks for the AWS-1 band and noting that larger 10 and 15 MHz block should enable a broad range of broadband services).

²⁰⁴ See *3.5 GHz FNPRM*, 29 FCC Rcd at 4287-88, ¶ 47.

²⁰⁵ T-Mobile *NPRM* Reply Comments at 8-9.

²⁰⁶ See *NSN Licensing PN* Comments at 6-7; T-Mobile *NPRM* Reply Comments at 8.

²⁰⁷ See *Federated Wireless Licensing PN* Comments at 20-25 (Advocating the highest possible degree of granularity); *Ericsson Licensing PN* Comments at 8 (Advocating for an interim assignment of 60-80 megahertz spectrum blocks); *Salt River Agricultural Improvement and Power District FNPRM* Comments at 2 (stating a preference for “multiple channel sizes based on the standard channel plans for LTE and not just fixed 10 MHz channels.”).

²⁰⁸ See e.g., *AT&T Licensing PN* Comments at 3-5; *Google Licensing PN* Comments at 10-13; *Motorola Solutions Licensing PN* Comments at 4; *NSN Licensing PN* Comments at 5-8 (Stating a preference for larger blocks but agreeing that 10 megahertz blocks have some advantage); *OTI/PK Licensing PN* Comments at 20; *Qualcomm Licensing PN* Comments (Supporting 10 megahertz or 20 megahertz unpaired channels); *T-Mobile Licensing PN* Comments at 7; *WIPSA Licensing PN* Comments at 16-17; *Spectrum Bridge Licensing PN* Comments at 3; *FNPRM* Comments at 4.

²⁰⁹ *Spectrum Bridge Licensing PN* Comments at 3; *Spectrum Bridge FNPRM* Comments at 4.

²¹⁰ See *NSN Licensing PN* Comments at 6-7; T-Mobile *NPRM* Reply Comments at 8.

economies of scale, enables global roaming, reduces equipment design complexity and improves spectrum efficiency.”²¹¹

93. As discussed in section III(C)(2)(a), all channels will be assigned by the SAS. The exact frequencies of specific assigned channels, however, may be changed by the SAS, if necessary.²¹² To the extent feasible, we will require the SAS to assign multiple channels held by the same Priority Access Licensee to contiguous channels in the same license area.²¹³ The SAS may temporarily reassign individual PALs to non-contiguous channels only to the extent necessary to protect Incumbent Users from harmful interference or if necessary to perform its required functions. However, while a Priority Access Licensee may initially request a particular channel or frequency range, any particular request will not be guaranteed.²¹⁴ Nevertheless, SAS administrators would be required to maintain consistent and contiguous frequency assignments for licensees with multiple PALs in the same or adjacent license areas whenever feasible. Thus, our rules aim to create a flexible, responsive spectral environment while retaining much of the stability of traditional static channel assignments.

b. Area

94. *Background.* In the *FNPRM*, we proposed to authorize PALs at the census tract level and to permit geographic aggregation across license areas.²¹⁵ As we explained, census tracts offer a variety of benefits, including geographic sizes varying by population density, nesting into other political subdivisions including city lines, and aligning with other natural features that track population density.²¹⁶ Under our proposal, PAL applicants could target specific geographic areas in which they need additional coverage and avoid applying for areas that they do not intend to serve. Our proposal reflected the unique technical characteristics of small cells to promote a high degree of spectral and spatial reuse while facilitating flexible, targeted deployment of CBSDs.

95. We received a diverse record in response to our proposal to use census tracts as a licensing area. Some commenters agree with our proposal.²¹⁷ Others argue that census tracts are inappropriate because the borders of census tracts frequently divide streets and their relatively small size would make license administration and co-channel coordination between Priority Access Licensees more difficult.²¹⁸ Other commenters suggest that even smaller geographic areas, such as census block groups would allow for granular and demand-focused assignments.²¹⁹ Still others proposed larger, more

²¹¹ NSN *Licensing PN* Comments at 7.

²¹² See Appendix A, §§ 96.25(b).

²¹³ See Appendix A, § 96.25(b)(2)(i).

²¹⁴ See Appendix A, § 96.25(b)(2).

²¹⁵ See *3.5 GHz FNPRM*, 29 FCC Rcd at 4286, ¶ 44.

²¹⁶ See *id.*

²¹⁷ See *WISPA Licensing PN* Comments at 7; *WISPA FNPRM Reply* Comments at 10; *Spectrum Bridge Licensing PN* Comments at 2-3 (Supporting census tracts but arguing that a smaller grid may be preferable); *AT&T FNPRM* Comments at 27-28 (altering initial opposition to census tract licensing, but noting that census tracts also present certain challenges regarding frequency coordination, modification of census tract boundaries); *Cantor Telecom FNPRM* Comments at 3.

²¹⁸ See, e.g., *Verizon Licensing PN* Comments at 6-7; *T-Mobile Licensing PN Reply* Comments at 7-8; *Google Licensing PN* Comments at 5-8; *CTIA Licensing PN* Comments at 4-7.

²¹⁹ See *OTI/PK Licensing PN* Comments at 19 (suggesting census block groups); *Motorola Solutions Licensing PN* Comments at 8-9 (suggesting 100 meter x 100 meter grid spaces); *Microsoft Licensing PN* Comments at 6-7 (suggesting census block groups); *NCTA FNPRM* Comments at 2 (contending that census tracts may be too large to efficiently accommodate small cell deployments).

traditional license areas such as Economic Areas (EAs), Cellular Market Areas (CMAs), or counties.²²⁰ Google suggests license boundaries be based on proposed network parameters and actual contours, as determined and enforced by the SAS, rather than fixed geographic areas.²²¹ Google further maintains that small license areas which “track the radiofrequency characteristics of proposed deployments or rely on a pixel-based approach, will maximize use of the licensed spectrum in the 3.55 GHz band.”²²²

96. *Discussion.* We adopt census tracts as the appropriate geographic license size for PALs. Among our goals in this proceeding is to establish the geographic component of PALs in a way that allows flexible and targeted network deployments, promoting intensive and efficient use of the spectrum, but also allowing easy aggregation to accommodate a larger network footprint. We find that licensing PALs at the census tract level will serve the public interest and provide a middle ground between commenters who sought license areas larger than census tracts and those who supported even smaller license areas.

97. Census tracts will provide a number of other benefits. Currently, there are over 74,000 census tracts in the United States targeted to an optimum population of 4,000.²²³ Census tracts vary in size depending on the population density of the region, with tracts as small as one square mile or less in dense urban areas and up to 85,000 square miles in sparsely populated rural regions.²²⁴ Census tracts generally nest into counties and other political subdivisions.²²⁵ In turn, they nest into the standardized license areas commonly used by the Commission (e.g., CMAs, EAs, and Partial Economic Areas).²²⁶ Census tracts also generally align with the borders of political boundaries (e.g., city lines) and often to natural features, which may affect population density (e.g., rivers).²²⁷ Census tracts, therefore, may

²²⁰ See Qualcomm *Licensing PN* Comments at 3-4; Qualcomm *FNPRM* Comments at 6; Ericsson *Licensing PN* Comments at 7-8; Ericsson *FNPRM* Comments at 9-10; NSN *Licensing PN* Comments at 5; NSN *FNPRM* Comments at 12; T-Mobile *Licensing PN* Comments at 6-7; T-Mobile *FNPRM* Comments at 3-4; Mobile Future *FNPRM* Comments at 6; Verizon *FNPRM* Comments at 14; CTIA *Licensing PN* Comments at 7; PCIA *Licensing PN* Comments at 4. See also API *FNPRM* Comments at 9 (proposing using service contours or a point/radium methodology); WiMax Forum *FNPRM* Comments at 6; UTC *Licensing PN* Reply Comments at 3; UTC *FNPRM* Comments at 8 (proposing a mix of large and small geographic areas tailored to meet the needs of critical infrastructure users).

²²¹ Google *Licensing PN* Comments at 5-8; Google *FNPRM* Comments at 10.

²²² *Ex Parte* Letter from Aparna Sridhar, Counsel, Google Inc., to Marlene H. Dortch, Secretary, Federal Communications Commission in GN Docket No. 12-354 at 1 (filed Nov. 24, 2014) (Google November 2014 *Ex Parte*).

²²³ See United States Census Bureau, *Geographic Terms and Concepts – Census Tract*, available at: http://www.census.gov/geo/reference/gtc/gtc_ct.html (last visited September 5, 2013); Some information Calculated using Geolytics Population estimates 2012 from U.S. Geography obtained from United States Census Bureau, *Tiger/Line Shapefiles and Tiger/Line Files*, available at: <https://www.census.gov/geo/maps-data/data/tiger-line.html> (Last visited September 5, 2013).

²²⁴ The 85,000 square mile census tract is in Alaska. The largest census tract in the continental United States is approximately 40,000 square miles. Calculated using Geolytics Population estimates 2012 from U.S. Geography obtained from United States Census Bureau, *Tiger/Line Shapefiles and Tiger/Line Files*, available at: <https://www.census.gov/geo/maps-data/data/tiger-line.html> (Last visited August 15, 2013).

²²⁵ See United States Census Bureau, *Geographic Terms and Concepts – Census Tract*, available at: http://www.census.gov/geo/reference/gtc/gtc_ct.html (last visited September 5, 2013).

²²⁶ See *id.* (“Census tract boundaries generally follow visible and identifiable features. They may follow nonvisible legal boundaries, such as minor civil division (MCD) or incorporated place boundaries in some states and situations, to allow for census-tract-to-governmental-unit relationships where the governmental boundaries tend to remain unchanged between censuses. State and county boundaries always are census tract boundaries in the standard census geographic hierarchy.”).

²²⁷ See *id.*

naturally mirror key considerations in targeted deployment by service providers, such as tracking existing customers, plant, and permits or rights-of-way. In addition, the inclusion of census tracts in census geospatial databases may ease the incorporation of geographic and demographic data into an SAS.

98. Census tract-level licensing also aligns well with small cell deployment. Due to their low power and small size, small cells can provide broadband coverage and capacity in targeted geographic areas.²²⁸ This applies whether small cells are used to offer independent broadband service, supplemental coverage for a macrocell network, or private network functions. PAL authorization in a highly localized fashion, *i.e.*, at the census tract level, will promote the use of the band for clusters of small cells.

99. In our view, other proposals in the record have limitations. Like Spectrum Bridge, we believe that geographic license areas significantly smaller than census tracts will “significantly increase the complexity and data management requirements [in the band], with diminishing and no obvious improvement in spectral efficiency.”²²⁹ Regarding Google’s proposal to assign licenses according to interference protection requirements rather than by fixed geographic areas, we believe that such a proposal adds unnecessary uncertainty and complexity to the licensing process and would complicate the competitive bidding process by creating irregular “lots” for auction. Google subsequently proposed a “pixel-based” approach to Priority Access licensing but we believe the enormous volume of licenses that would result would be challenging to administer.²³⁰ We agree with WISPA that proposals to assign licenses based on point/radius methodology will result in license areas that do not conform to natural boundaries and will “complicate[] mutual exclusivity determinations.”²³¹

100. As noted above, some commenters argue that to encourage investment in this shared band, we should license PALs in larger geographic areas such as those used in other licensed mobile bands.²³² These commenters argue that introducing a new license scheme in the band will create uncertainty and delay deployment in the band.²³³ We disagree. As noted above, the mandate of Section 309(j) strongly supports our goal, particularly in “prescrib[ing] area designations,”²³⁴ of providing economic opportunity to a wide variety of applicants. That mandate is particularly compelling in light of the opportunities for participation with much lower capital investment requirements associated with smaller service areas, as we have previously recognized in other services in trying to address the substantial challenges faced by new entrants.²³⁵ The larger, traditional license areas favored by some commenters are inconsistent with our desire to promote innovative, low power uses in this band, such as

²²⁸ See 3.5 GHz NPRM, 27 FCC Rcd at 15606-06, ¶¶ 30-32.

²²⁹ Spectrum Bridge *FNPRM* Comments, Appendix, at 1.

²³⁰ See Google November 2014 *Ex Parte*.

²³¹ WISPA *FNPRM* Reply Comments at 11-12.

²³² See Qualcomm *Licensing PN* Comments at 3-4; Qualcomm *FNPRM* Comments at 6; Ericsson *Licensing PN* Comments at 7-8; Ericsson *FNPRM* Comments at 9-10; NSN *Licensing PN* Comments at 5; NSN *FNPRM* Comments at 12; T-Mobile *Licensing PN* Comments at 6-7; T-Mobile *FNPRM* Comments at 3-4; Mobile Future *FNPRM* Comments at 6; Verizon *FNPRM* Comments at 14; CTIA *Licensing PN* Comments at 7; PCIA *Licensing PN* Comments at 4.

²³³ See, e.g., Qualcomm *FNPRM* Comments at 6.

²³⁴ 47 U.S.C. § 309(j)(4)(C).

²³⁵ See *AWS-1 R&O* (adopting a mix of smaller and larger geographic license areas – EAs, REAGs, and CMAs – in order to provide entry opportunities for a wide variety of applicants including smaller carriers, new entrants, and rural telephone companies); *AWS-3 R&O*, 29 FCC Rcd at 4632-33, ¶¶ 48-49 (adopting hybrid licensing plan of EAs and CMAs strikes the appropriate balance between the needs of large and small carriers and will encourage dissemination of licenses among a variety of applicants).

²³⁵ WISPA *Licensing PN* Reply Comments at 15. See also PISC *FNPRM* Reply Comments at 29 (“census tracts could represent a workable ‘middle ground’ compromise”).

small cells, which align well with small, targeted geographic areas such as census tracts. Further, traditional licensing areas will not allow users of the band to acquire PALs only for those specific geographic areas they intend to serve. Divesting large, unwanted swaths through secondary markets transactions could impose significant transactions costs. On the other hand, should users of the band desire to provide service within traditional geographic license areas, they can aggregate multiple contiguous census tracts, which as discussed above, nest into the standardized license areas commonly used by the Commission.

101. We continue to believe that census tracts are the appropriate middle ground among the competing proposals developed in the record and provide an equitable means of achieving the Commission's public interest goals consistent with our statutory mandates. As WISPA stated, "[t]he range of views suggests that, while not perfect, census tracts probably strike the appropriate balance with regard to size and are therefore the best alternative."²³⁶ Census tracts are sufficiently granular to promote intensive use of the band and are large enough, either on their own or in aggregate, to support a variety of use cases, including small cell base stations and backhaul. As Cantor Telecom states, "census tracts may offer certain benefits such as geographic sizes varying by population densities which would allow PAL applicants to target specific areas that they intend to serve."²³⁷ Moreover, by defining license areas in a granular fashion and allowing geographic aggregation, operators should be able to acquire enough PALs to cover their desired network footprint without having to over-acquire licenses. Accordingly, each PAL shall consist of a single census tract as defined, initially, in the 2010 census.²³⁸

c. Term

102. *Background.* In the *FNPRM*, we proposed that PALs would have a one year, non-renewable term.²³⁹ PALs would automatically terminate after one year and would not be renewed. We reasoned that a one-year term, while shorter than the 10- or 15-year terms typically associated with geographic area-licensed wireless services, would be appropriate for this band. First, licensees would be permitted to aggregate up to 5 consecutive 1-year terms to replicate the predictability of a longer-term license while providing the flexibility inherent in shorter-term spectrum authorizations.²⁴⁰ Second, the use of a shorter, non-renewable license term could simplify the administration of the Priority Access tier by obviating the need for renewal, discontinuance, and performance requirements typically associated with longer-term licenses. Third, shorter terms would allow for a wider variety of innovative uses and encourage efficient use of spectrum resources. Fourth, short term licenses could promote greater fungibility and liquidity in the secondary market. Finally, allowing applications for multiple years of PALs would provide Priority Access Licensees with the certainty they may need to make capital investment in PALs. We sought comment on the appropriate duration of PALs and our aggregation proposal and invited commenters to suggest other proposals.

103. Commenters differed on the appropriate term for PALs. Some commenters supported one-year terms for PALs with the option to aggregate multiple years.²⁴¹ Others argued for license terms

²³⁶ WISPA *Licensing PN* Reply Comments at 15.

²³⁷ Cantor Telecom *FNPRM* Comments at 3.

²³⁸ See Appendix A, § 96.3 (Census Tract definition). To the extent some commenters raised concerns that census tracts will change over time, we fix initial census tract boundaries according to the 2010 Census. See WISPA *FNPRM* Comments at 13-14; WISPA *FNPRM* Reply Comments at 11 n.31.

²³⁹ See *3.5 GHz FNPRM*, 29 FCC Rcd at 4288, ¶ 49.

²⁴⁰ See *id.*; *Licensing PN*, 28 FCC Rcd at 15306, at ¶ 13.

²⁴¹ See WISPA *Licensing PN* Comments at 14-15, WISPA *Licensing PN* Reply Comments at 19 (one-year terms with a four-year aggregation limit); OTI/PK *Licensing PN* Comments at 16-18 (one-year terms with a three-year aggregation cap); Spectrum Bridge *Licensing PN* Comments at 2-3 (supporting one year "leases" but advocating a mix of fixed and variable length lease times); See also AT&T *Licensing PN* Comments at 3-5 (supporting one-year (continued....))

shorter than one year,²⁴² while Microsoft agreed with the one-year proposal but argued for a prohibition on term aggregation.²⁴³ Alternatively, numerous commenters including Ericsson, NSN, and Qualcomm supported a more traditional licensing model with longer license terms.²⁴⁴ These commenters argue that short, one-year licenses will not provide operators with sufficient certainty to invest the necessary resources in the band.²⁴⁵ Instead, commenters argue, longer, more traditional license terms will make the spectrum more attractive for investment.²⁴⁶ AT&T for example states that “a one-year, non-renewable license is insufficient assurance to spark investment in the 3.5 GHz band [and may] raise the possibility of stranded investment.”²⁴⁷

104. Commenters also differed on the appropriate temporal aggregation limit for PALs. For example, WISPA suggests a four-year aggregation cap, Public Knowledge and the New America Foundation suggest a three-year cap, Motorola Solutions suggests only two years, and Microsoft suggests we not permit term aggregation (effectively a one-year availability in the licensing window).²⁴⁸ AT&T, by contrast, suggests that licensees be permitted to retain their authorizations indefinitely for areas in which they have deployed equipment and provided service within one year.²⁴⁹

105. *Discussion.* Based on the record in this proceeding, and in the context of our particular regulatory scheme for this band, we adopt a longer license term than originally proposed: three-year rather than one-year terms.²⁵⁰ At the end of its three-year license term, a PAL will automatically terminate and may not be renewed.²⁵¹ However, solely during the first application window, we will permit an applicant to apply for up to two consecutive three-year terms for any given PAL available

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terms but arguing for a “keep what you use” approach to renewals); Federated *Licensing PN* Comments at 17-25 (supporting one-year terms as a nominal level but advocating for finer temporal granularity with usage fees); Motorola Mobility *FNPRM* Comments at 5 (supporting one-year terms with ability to aggregate up to five years); Cantor Telecom *FNPRM* Comments at 3-4 (supporting one-year terms with ability to aggregate up to five years).

²⁴² See Motorola Solutions *Licensing PN* Comments at 7-8 (quarterly terms with a two-year aggregation cap); Wireless Innovation Forum *FNPRM Comments* at 35 (minimum terms of less than one year to support specialized events such as disaster recovery). See also InterDigital *FNPRM* Comments at 21 (PA licensees should only be allowed to reserve a PAL for the time they will be in actual use).

²⁴³ Microsoft *Licensing PN* Comments at 6.

²⁴⁴ See Ericsson *Licensing PN* Comments at 7-8; NSN *Licensing PN* Comments at 4-5; NSN *FNPRM* Comments at 11-12; Qualcomm *Licensing PN* Comments at 7-8; Qualcomm *FNPRM* Comments at 6; Qualcomm *FNPRM* Reply Comments at 3, 7; WiMax Forum *FNPRM* Comments at 6-7; 4G Americas *NPRM* Reply Comments at 8; American Petrol Institute *FNPRM* Comments at 9 (supports 10-year license term with renewal expectancy); Google *NPRM* Comments at 8-10 (supports two-year initial term with one-year renewals thereafter); AT&T *FNPRM* Comments at 25 (supports three-year initial term coupled with first renewal of two years); PCIA *FNPRM* Reply Comments at 2 (supports license terms longer than one year).

²⁴⁵ See Alcatel Lucent *NPRM* Comments at 2-4; T-Mobile *Licensing PN* Comments at 6, 8, 12; T-Mobile *Licensing PN* Reply Comments at 5-6; NSN *FNPRM* Comments at 4.

²⁴⁶ See, e.g., NSN *FNPRM* Comments at 4; WiMax Forum *FNPRM* Comments at 6-7 (one-year license terms are inconsistent with the buildout timeframes for utilities’ infrastructure).

²⁴⁷ AT&T *FNPRM* Comments at 25.

²⁴⁸ See OTI/PK *Licensing PN* Comments at 16-18; WISPA *Licensing PN* Comments at 15; Motorola Solutions *Licensing PN* Comments at 7-9; Microsoft *Licensing PN* Comments at 6.

²⁴⁹ AT&T *Licensing PN* Comments at 5.

²⁵⁰ See Appendix A § 96.25(b)(3).

²⁵¹ See Appendix A § 96.25(b)(3).

during such first application window, for a total of six years.²⁵² During subsequent regular application windows, only the next three-year license term will be made available for any given PAL.²⁵³ If sufficient interest is expressed by prospective Priority Access Licensees, we will also open interim filing windows for unassigned PALs, in which case any newly auctioned PAL term will expire at the end of the three-year period associated with previously auctioned PALs, so that all PALs will be made available for bidding in the next regular window. This practice will avoid staggered PAL terms.²⁵⁴

106. Among our goals in this proceeding is to promote more efficient wireless network architectures and innovative approaches to spectrum management. To this end, we identified the 3.5 GHz Band as “an ideal ‘innovation band,’ well suited to exploring the next generation of shared spectrum technologies, to drive greater productivity and efficiency in spectrum use.”²⁵⁵ In our view, the flexibility inherent in shorter license terms should allow for a wider variety of innovative uses in the band and encourage efficient use of scarce spectrum resources. Commenters in this proceeding, however, hold widely varying views on the appropriate license terms for PALs. While some commenters support our initial proposal for one-year terms,²⁵⁶ many others argue that longer license terms will best spur investment in this repurposed band.²⁵⁷

107. We believe that three-year non-renewable license terms – with the ability to aggregate up to six years up-front – strike a balance between some commenters’ desire for flexibility with other commenters’ need for certainty. This belief is consistent with our goal of creating greater opportunities for new and innovative uses to secure the priority benefits associated with PAL licenses governed by the mandates of Section 309(j) described above. As recognized by OTI/PK, shorter, non-renewable licenses “will promote deployments by a wide range of service providers.”²⁵⁸ Further, OTI/PK reasons that the cost of such short duration licenses covering small geographic areas “will dramatically lower the barriers to entry for innovation and competition in the band.”²⁵⁹ At the same time, we acknowledge that a license

²⁵² See Appendix A § 96.27(b). Even if the same licensee purchases two PALs in the same license area during the first auction, the second license will not be considered a renewal. Rather, the two licenses will be considered independent initial licenses that automatically terminate at the end of their respective terms.

²⁵³ See Appendix A § 96.27(b).

²⁵⁴ We recognize the possibility that not all auction winners will be issued initial three-year licenses on the same date, depending on any need to review their qualifications in light of issues that may be raised in any particular case. Therefore, we will endeavor to conclude any auctions with sufficient lead time to allow licenses to issue at the same time.

²⁵⁵ *3.5 GHz FNPRM*, 29 FCC Rcd at 4275, ¶ 3.

²⁵⁶ See *WISPA Licensing PN* Comments at 14-15, *WISPA Licensing PN* Reply Comments at 19 (one-year terms with a four-year aggregation limit); *OTI/PK Licensing PN* Comments at 16-18 (one-year terms with a three-year aggregation cap); *Spectrum Bridge Licensing PN* Comments at 2-3 (supporting one year “leases” but advocating a mix of fixed and variable length lease times); See also *AT&T Licensing PN* Comments at 3-5 (supporting one-year terms but arguing for a “keep what you use” approach to renewals); *Federated Licensing PN* Comments at 17-25 (supporting one-year terms as a nominal level but advocating for finer temporal granularity with usage fees); *Motorola Mobility FNPRM* Comments at 5 (supporting one-year terms with ability to aggregate up to five years); *Cantor Telecom FNPRM* Comments at 3-4 (supporting one-year terms with ability to aggregate up to five years).

²⁵⁷ See *Ericsson Licensing PN* Comments at 7-8; *NSN Licensing PN* Comments at 4-5; *NSN FNPRM* Comments at 11-12; *Qualcomm Licensing PN* Comments at 7-8; *Qualcomm FNPRM* Comments at 6; *Qualcomm FNPRM* Reply Comments at 3, 7; *WiMax Forum FNPRM* Comments at 6-7; *4G Americas NPRM* Reply Comments at 8; *American Petrol Institute FNPRM* Comments at 9 (supports 10-year license term with renewal expectancy); *Google NPRM* Comments at 8-10 (supports two-year initial term with one-year renewals thereafter); *AT&T FNPRM* Comments at 25 (supports three-year initial term coupled with first renewal of two years); *PCIA FNPRM* Reply Comments at 2 (supports license terms longer than one year).

²⁵⁸ *OTI/PK Licensing PN* Comments at 16-17.

²⁵⁹ *Id.* at 17.

term longer than one year “will foster more robust deployment and strengthen innovation.”²⁶⁰ We believe our rule appropriately addresses the competing public interest concerns expressed in the record.

108. We believe that, as part of the overall set of rules established for the Citizens Broadband Radio Service, time-limited PAL terms will promote investment by traditional and non-traditional providers of wireless broadband service. We are not persuaded by arguments put forth by AT&T, T-Mobile, and others that non-renewable PALs will diminish investment in the band.²⁶¹ Several considerations jointly and severally weigh in this determination. In our view, these considerations applicable to the 3.5 GHz Band do not support traditional justifications for renewal expectancies appropriate in exclusively licensed bands.²⁶²

109. First, we expect that Citizens Broadband Radio Service users will have similar incentives to invest under the GAA rules as unlicensed users in other bands. Ample experience with tens of millions of unlicensed wireless devices deployed under our non-exclusive Part 15 rules demonstrates that significant investment can occur under a non-exclusive use authorization. Moreover, unlike the traditional exclusive licensing regime in which the Commission has established renewal expectancies, even a PAL licensee who does not obtain PAL rights for the succeeding three-year term retains the ability to use the same equipment in the same area as a GAA licensee. The investment is thus not stranded. In this context, PALs simply provide additional economic incentives, over and above GAA authorizations, for those users seeking greater interference protection in specific locations for a specific three-year period.

110. Second, return-on-investment determinations for PALs in the 3.5 GHz Band likely involve a lower cost hurdle than in other bands permitting higher-power transmissions. The economics and upgrade cycles for the (predominant) small cell use case, applied in the context of census tract license areas over three-year license terms, may resemble those for enterprise and carrier Wi-Fi deployments rather than traditional macro cell deployments common to other bands.²⁶³

111. Third, where a prospective user of the band does require a PAL as a predicate to investment, our rules do permit the user to bid for and acquire, as a condition to its investment, at the time of the initial PAL auctions, two successive three-year licenses. A Priority Access Licensee would also have subsequent opportunities to participate in auctions assigning PALs for subsequent three-year terms, or secondary market transactions. Moreover, the non-fixed frequency assignment model and band-wide equipment operability rule we adopt herein increase the substitutability of PALs in a given area.²⁶⁴ This model also substantially reduces the risk to a Priority Access Licensee of not winning a comparable license in a subsequent auction. Additionally, it is possible that a Priority Access Licensee with a proven business case that depends on access to Priority Access tier channels could value a subsequent PAL in the same license area more highly than a new entrant in that area, further increasing the incumbent’s odds of winning a new PAL.²⁶⁵ In a service in which we have determined to permit shared (albeit prioritized)

²⁶⁰ AT&T *FNPRM* Comments at 27.

²⁶¹ See, e.g., AT&T *FNPRM* Comments at 25; Alcatel Lucent *NPRM* Comments at 2-4; T-Mobile *Licensing PN* Comments at 6, 8, 12; T-Mobile *Licensing PN* Reply Comments at 5-6; NSN *FNPRM* Comments at 4.

²⁶² Such justifications include: (1) rewarding proven performance over much longer license terms; (2) encouraging investment; or (3) avoiding haphazard restructuring of the industry. See generally *Central Florida Enterprises, Inc. v. FCC*, 683 F.3d 503, 507 (D.C. Cir. 1982).

²⁶³ See, e.g., Andrew Mackay, Manager Mobile Solutions, Cisco Systems, “Cost Optimised Indoor Coverage,” at <https://communities.cisco.com/community/solutions/sp/mobility/blog/2014/09/13/cost-optimised-indoor-coverage> (last visited April 2, 2015).

²⁶⁴ See *infra* sections III(F)(2)(c) and III(C)(2)(a); Appendix A, §§ 96.39 (b), 96.13 (c), and 96.25 (b)(2).

²⁶⁵ We recognize that a new entrant using new technologies or business practices may outbid an incumbent Priority Access Licensee. Such an instance is precisely when it makes economic sense for a new licensee to replace the old.

(continued....)

uses of the same technology, it seems more appropriate to tie prioritized use to the ongoing desire to pay for it at auction.

112. Finally, industry structure may adapt in ways that obviate any remaining perceived risks associated with term-limited licensing in this band. For example, “neutral host” business models common to the distributed antenna systems (DAS) industry may also apply to small cell networks operating in the 3.5 GHz Band.²⁶⁶ A venue network operator (*e.g.*, an enterprise, facilities owner, or their agent) could install small cell equipment and provide service directly or pursuant to agreements with several different wireless carriers. In this situation, this venue operator may be the lowest-cost provider of service, as it brings to the table some of the key inputs (mounting points, backhaul, etc.) and the ability to coordinate network sharing inside its facility (which further reduces costs). A venue operator inhabiting the underlying real estate will therefore likely be a party to any provision of small cell service in the area. As a consequence, it has incentives to invest in network infrastructure regardless of who holds the local PALs at any given time.

113. For similar reasons, we believe our rules prescribing three-year, non-renewable license terms for PALs, coupled with the absence of a renewal expectancy, will operate in combination with our rules permitting opportunistic GAA use and the relatively inexpensive deployment costs in this band to ensure that winning bidders for PAL licenses at auction will have sufficient incentive to deliver service so as to avoid the need for prescribing any further performance requirements. Bidders who purchase PALs at auction will likely have an interest in putting the spectrum into productive use.

3. Spectrum Aggregation Limits

114. *Background.* In the *FNPRM*, we proposed to allow licensees to hold up to three out of an anticipated five PALs in one census tract at one time (*i.e.*, 30 megahertz in one census tract at any time).²⁶⁷ We indicated that, given the unique circumstances of this band, a specific aggregation limit applicable to all PAL licensees would promote access to the band.²⁶⁸

115. Several commenters advocate for the adoption of a spectrum aggregation limit on the number of PALs that can be held in each license area. WISPA and Cantor Telecom support the proposed limit of 30 megahertz of PALs in each license area, with caveats.²⁶⁹ Motorola Mobility suggests that the actual cap should be the larger of either the 30 megahertz fixed limit or a percentage of Priority Access spectrum, such as 55 percent.²⁷⁰ PISC, Sony Electronics, and Motorola Solutions contend that a 20 megahertz limit on PALs would be more appropriate to allow future entrants and new competitors to enter the marketplace.²⁷¹

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Moreover, we believe that combining term-limited PALs with the kind of renewal expectancy traditionally awarded to commercial wireless licenses (with longer terms and higher capital costs) would not be consistent with our statutory responsibility to promote “efficient and intensive use of the electromagnetic spectrum.” 47 U.S.C. § 309(j)(3)(D).

²⁶⁶ See PCIA *NPRM* Comments at 5.

²⁶⁷ See 3.5 GHz *FNPRM*, 29 FCC Red at 4290, ¶ 55.

²⁶⁸ See *id.*

²⁶⁹ WISPA *FNPRM* Comments at 25-26 (asserting that grandfathered 3650-3700 MHz licensees should be allowed to exceed the aggregation limit); Cantor Telecom *FNPRM* Comments at 4 (suggesting that waivers of the limit should be permitted to avoid spectrum lying fallow).

²⁷⁰ See Motorola Mobility *FNPRM* Comments at 5. See also Wireless Innovation Forum *FNPRM* Comments at 35.

²⁷¹ PISC *FNPRM* Reply Comments at 31; Sony Electronics *FNPRM* Comments at 2; Motorola Solutions *FNPRM* Comments at 3. See also OTI/PK *Licensing PN* Comments at 20.

116. Verizon Wireless and AT&T oppose any cap on Priority Access channel aggregation.²⁷² Verizon argues that adopting a spectrum cap will harm consumers by impeding the development and deployment of innovative services in the 3.5 GHz Band, particularly given that providers require large contiguous blocks of spectrum to deliver broadband service.²⁷³ AT&T also claims that the Commission has not identified any public interest harm associated with allowing licensees to aggregate as much spectrum as they require.²⁷⁴

117. *Discussion.* In this *Report and Order*, we adopt an aggregation limit, as proposed, but increase the limit to allow licensees to hold no more than four PALs in one census tract at one time (*i.e.*, 40 megahertz out of 70 megahertz allocated to PALs in one census tract at any time).²⁷⁵ We find that, on balance, the potential public interest benefits of adopting a limitation on the aggregation of PALs outweigh the potential public interest harms of such limits.²⁷⁶ In particular, we conclude that a limit of 40 out of the maximum of 70 megahertz of PALs that may be available in each license area will facilitate competition, innovation, and the efficient use of the 3.5 GHz Band, ensuring that it is assigned in a manner that serves the public interest, convenience, and necessity.²⁷⁷

118. We evaluate the potential benefits and costs of a spectrum aggregation limit in the context of the licensing framework that we adopt for the 3.5 GHz Band, which would make available up to 80 megahertz of GAA spectrum when PALs are assigned and accordingly, up to 70 megahertz of PAL spectrum. In considering whether to adopt a mobile spectrum holdings limit for the licensing of a particular band through competitive bidding, as well as what type of limit to apply, the Commission assesses how such a limit would likely affect the quality of communications services or result in the provision of new or additional services to consumers.²⁷⁸ In its consideration, the Commission evaluates whether the public interest could potentially be negatively affected if multiple licensees would not have

²⁷² Verizon Wireless *FNPRM* Comments at 21-22; AT&T *FNPRM* Reply Comments at 18-19; Verizon Wireless *FNPRM* Reply Comments at 9.

²⁷³ See Verizon *FNPRM* Comments at 21-22. See also T-Mobile *Licensing PN* Comments at 7.

²⁷⁴ See AT&T *FNPRM* Reply Comments at 18-19.

²⁷⁵ See Appendix A, § 96.31.

²⁷⁶ While we adopt a band-specific limit on the aggregation of PALs, we do not find that PALs are suitable and available for the provision of mobile telephony/broadband services in the same manner as other spectrum bands that currently are included in the Commission's spectrum screen as applied to secondary market transactions. See *Policies Regarding Mobile Spectrum Holdings Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions*, WT Docket No. 12-269, GN Docket No. 12-268, Report and Order, 29 FCC Rcd 6133 at 6169, ¶ 70 (2014) ("*Mobile Spectrum Holdings Report and Order*"). at 6169 ¶ 70. We make this finding based on the combination of the unique characteristics of this band – multiple tiers of many users including Federal incumbents, sophisticated rules for sharing that include dynamic access for PALs, the short license terms and very small license areas for PALs, and the range of technologies and heterogeneous business models that may operate in this environment. Accordingly, we do not include 3.5 GHz spectrum in the spectrum screen, and we will not evaluate secondary market acquisitions of this spectrum relative to existing holdings of other spectrum bands included in the screen.

²⁷⁷ Section 309(j)(3) of the Communications Act provides that, in designing systems of competitive bidding, the Commission must "include safeguards to protect the public interest in the use of the spectrum," and must seek to promote various objectives, including "promoting economic opportunity and competition and ensuring that new and innovative technologies are readily accessible to the American people by avoiding excessive concentration of licenses and by disseminating licenses among a wide variety of applicants," and promoting the "efficient and intensive use" of spectrum. *Communications Act*, § 309(j)(3) codified at 47 U.S.C. § 309(j)(3).

²⁷⁸ See *Mobile Spectrum Holdings Report and Order*, 29 FCC Rcd at 6192-93, ¶ 143 (*Mobile Spectrum Holdings Report and Order*).

access to sufficient spectrum to be able to compete robustly.²⁷⁹ The framework adopted in this *Report and Order* is designed to facilitate spectrum sharing and innovation in an environment with many tiers of users, including commercial and private users with heterogeneous business models.

119. A spectrum aggregation limit of 40 megahertz will ensure availability of PAL spectrum to at least two users in those geographic areas where there is the greatest likelihood of high demand for such spectrum. We recognize that in geographic areas where PALs are issued, multiple users may wish to try out different business models or technologies in this unique and highly innovative marketplace. And while the census tracts used to license PALs are small by comparison to most commercial wireless license areas in other bands, multiple small cell users may want to pursue different business models in census tracts covering densely populated areas or areas with significant commercial activity. Allowing one licensee to acquire all seven PALs would limit choices to users interested in applications that would benefit from PAL access. Given the many potential scenarios and the nature of demand for PALs, as described, we believe the spectrum aggregation limit is appropriate, as it will likely foster competition and innovation in both PAL and GAA uses.

120. This spectrum aggregation limit provides a minimum degree of diversity among commercial and private users that likely will be operating in this band. Such diversity is important to encourage innovation in technologies and business models that include access to shared spectrum in a multi-user environment. The 3.5 GHz Band will provide a very significant opportunity for the development of innovative approaches to spectrum sharing. We believe that some of the resulting business models and technologies developed in the 3.5 GHz Band may well lead to positive spillovers in the development of other spectrum bands in the future.

121. We anticipate that the potential costs of such a spectrum aggregation limit will be low. We disagree with AT&T and Verizon Wireless that such a limitation will impede the development of innovative services to consumers.²⁸⁰ On the contrary, as explained above, we believe this spectrum aggregation limit will promote competition and innovation by ensuring at least two parties have access to PALs in those areas where sophisticated approaches to sharing are most needed and most likely to develop. In addition, we note that, in Census tracts where seven PALs are issued, one entity would have access to up to 40 megahertz of PAL spectrum, as well as up to 80 megahertz of GAA spectrum – or 120 megahertz out of the total of 150 megahertz of spectrum available in the 3.5 GHz Band. Under these circumstances, we find it unlikely that this spectrum aggregation limit would curtail potential business models and use cases in the band. We also disagree with those commenters who suggest a smaller aggregation limit, such as 20 megahertz as opposed to 40 megahertz, due primarily to the nascent state of the marketplace and the need in these circumstances to balance the foregoing goals against the potential benefits of developing innovative services with larger contiguous blocks.²⁸¹ For all the reasons discussed, the 40 megahertz limit strikes the appropriate balance between ensuring a diversity of users and allowing for applications that require larger blocks of spectrum.

4. Competitive Bidding Procedures

122. Under the licensing scheme we adopt, PALs will be assigned by competitive bidding. The geographic area licensing approach we adopt for PALs will permit the filing and acceptance of

²⁷⁹ This evaluation is based on several factors, including, but not limited to, the total amount of spectrum to be assigned, the extent to which competitors have opportunities to gain access to alternative bands that would serve the same purpose as the spectrum licenses at issue, the characteristics of the spectrum to be assigned, the timing of when the spectrum could be used, and the specific rights being granted to licensees of the spectrum. *See Mobile Spectrum Holdings Report and Order*, 29 FCC Rcd at 6193, ¶ 144.

²⁸⁰ *See* Verizon Wireless *FNPRM* Comments at 21-22; AT&T *FNPRM* Reply Comments at 18-19; Verizon Wireless *FNPRM* Reply Comments at 9.

²⁸¹ *See* PISC *FNPRM* Reply Comments at 31; Sony Electronics *FNPRM* Comments at 2; Motorola Solutions *FNPRM* Comments at 3.

mutually exclusive applications, which we are required to resolve through competitive bidding. Thus, as detailed below, we adopt rules to govern the use of a competitive bidding process for assigning PALs in the 3550-3650 MHz band.

123. We will conduct any auction of PALs in the 3550-3650 MHz band in conformity with the general competitive bidding rules set forth in Part 1, Subpart Q of the Commission's rules,²⁸² and substantially consistent with the competitive bidding procedures that have been employed in previous auctions, except as otherwise provided in this *Report and Order*. Below, we explain that PALs will be assigned through competitive bidding only where we receive multiple competing applications in a geographic area that seek PALs that exceed the available supply. If PAL applicants for a specific geographic area do not seek PALs that exceed the available supply, we will not assign any PALs in that license area. Instead, we will cancel the auction with respect to that license area and the spectrum will remain available for GAA use under our license-by-rule framework until the next application filing window for PALs in the 3.5 GHz Band is opened either for unassigned PALs or otherwise in advance of the expiration of the prior three-year license term.

124. We also discuss in this section our decision not to offer bidding credits to small businesses or Critical Infrastructure Industry (CII) entities due to the unique characteristics and nature of the Citizens Broadband Radio Service. In addition, we discuss our public notice process by which we will develop the auction design and procedures for an auction of PALs. Finally, we note that in the *Second Further Notice*, we seek additional comment on whether the approach we adopt to the spectrum use by a PAL would require revision of any of our Part 1 rules governing applications, payments, or default as they pertain to auctions of licenses in this band.

a. PAL Applications Subject to Competitive Bidding

125. *Background.* In the *NPRM*, the Commission proposed a license-by-rule framework for assigning licenses in the Citizens Broadband Radio Service, including the Priority Access tier.²⁸³ The Commission suggested that a license-by-rule licensing framework would allow rapid deployment of small cells by a wide range of users, including consumers, enterprises, and service providers, at low cost and with minimal barriers to entry.²⁸⁴ Commenters were divided on whether a license-by-rule regime was appropriate for PALs.²⁸⁵

126. Under the Revised Framework outlined in the Commission's *Licensing PN*, and in response to many comments, we proposed to open eligibility for PALs for flexible use, beyond only "mission critical" uses.²⁸⁶ We sought comment on "approaches to spectrum assignment and auction that could be used to productively manage use of the Priority Access tier while allowing SAS authorized opportunistic use of the GAA tier as described in the *NPRM*."²⁸⁷ In proposing auctions to assign PALs "where there are mutually exclusive applications pending," the Commission sought comment on its

²⁸² See 47 C.F.R. Part 1, Subpart Q.

²⁸³ *3.5 GHz NPRM*, 27 FCC Rcd at 15598, ¶ 11.

²⁸⁴ *Id.* at 15615, ¶ 61.

²⁸⁵ Some commenters agreed with the proposal to use a license-by-rule framework for PALs. See InterDigital *NPRM* Comments at 17-18; SITA *NPRM* Comments at 3; WISPA *NPRM* Comments at 5; Utility Groups *NPRM* Comments at 11; WiMAX Forum *NPRM* Comments at 7; Great River Energy *NPRM* Comments at ¶ 11; PISC *NPRM* Comments at 13; Exelon *NPRM* Reply Comments at 4. Some commenters opposed a license-by-rule framework. See AT&T *NPRM* Comments at 13; T-Mobile *NPRM* Comments at 8; Telecommunications Industry Association *NPRM* Comments at 5; Xchange Telecom Corp. *NPRM* Reply Comments at 4-5. One commenter asked for clarification. See Spectrum Bridge, Inc. *NPRM* Comments at 5-6.

²⁸⁶ *Licensing PN*, 28 FCC Rcd at 15305, ¶ 11.

²⁸⁷ *Id.* at 15308, ¶ 22.

proposed auction and licensing mechanisms, including their economic and technical viability, and in particular on whether its approach “[w]ould . . . properly incentivize targeted use of the Priority Access tier by a diverse group of users,” as well as on alternative licensing and authorization mechanisms.²⁸⁸

127. In the *FNPRM*, the Commission proposed to open an application window for PALs annually, with each PAL authorized at the census tract level.²⁸⁹ This approach would permit the filing and acceptance of mutually exclusive applications for PALs and would require the Commission “to resolve such applications through competitive bidding consistent with the mandate of Section 309(j) of the Communications Act.”²⁹⁰ The *FNPRM* proposed that “[c]onsistent with the Commission’s approach in other spectrum auctions, mutual exclusivity would be triggered when more applications are submitted than can be accommodated geographically, temporally, and spectrally.”²⁹¹

128. AT&T, PISC, Wireless Innovation Forum, and WISPA agree that if the Commission adopts its geographic area licenses for the Priority Access tier, it would have to resolve mutually exclusive applications through competitive bidding.²⁹² Google argues that the Commission can avoid mutual exclusivity in the Citizens Broadband Radio Service band by limiting the number of PAL licenses available in the relevant geographic area, giving priority to spectrally efficient operators, and SAS-based interference avoidance could minimize mutually exclusive applications.²⁹³

129. A number of utilities oppose the Commission’s proposal to adopt a licensing scheme that could result in mutually exclusive applications for PALs. Several utilities express concern that CII entities have not been successful at competing with commercial carriers for spectrum.²⁹⁴ UTC/EEI said that its members are concerned about the “cost and difficulty of competing with commercial carriers for Priority Access Licenses.”²⁹⁵ They also express concern about the uncertainty of PAL renewals year-to-year, potential interference to GAA operations, and interference with utilities’ incumbent systems.²⁹⁶ ENTELEC suggested that the Commission utilize a lottery-based system should “two or more applicants file applications on the same day and request the same PAL frequency block.”²⁹⁷

130. *Discussion.* The Communications Act, as amended, requires the Commission to use competitive bidding to assign licenses when “mutually exclusive applications are accepted for any initial license,” subject to specified exemptions not applicable here.²⁹⁸ Section 309(j)(1) provides the Commission with the obligation to conduct competitive bidding when all applicants to participate in bidding on particular licenses cannot be granted the subject licenses because at the time of application submission, the applicants seek the same license or different licenses that would interfere with each

²⁸⁸ *Id.* at 15309, 15310, ¶¶ 23, 26, 27.

²⁸⁹ 3.5 GHz *FNPRM*, 29 FCC Rcd. at 4286-87, 4289, ¶¶ 44, 53.

²⁹⁰ *Id.* at 4308, ¶ 118.

²⁹¹ *Id.* at 4309, ¶ 120.

²⁹² See Wireless Innovation Forum *FNPRM* Comments at 26; WISPA *FNPRM* Comments at 23; AT&T *FNPRM* Comments at 30; PISC *FNPRM* Reply Comments at 8.

²⁹³ Google Nov. 24, 2014 Ex Parte.

²⁹⁴ Oncor Electric Delivery Company LLC *FNPRM* Comments at 2-3; see also American Petroleum Institute *FNPRM* Comments at 12-13 (“Critical infrastructure companies historically have not been successful at competing for auctioned spectrum against commercial carriers.”).

²⁹⁵ UTC/EEI *FNPRM* Reply Comments at 12.

²⁹⁶ *Id.*

²⁹⁷ ENTELEC *FNPRM* Comments at ¶ 8.

²⁹⁸ 47 U.S.C. §§ 309(j)(1)-(2),(j)(6)(E).

other,²⁹⁹ or when the requests for interchangeable channels exceed the available supply.³⁰⁰ The Commission has such authority irrespective of whether each of the parties applying to bid for a license subsequently bids for the subject license.³⁰¹

131. As an initial matter, we disagree with ENTELEC's proposal to utilize a simple lottery-based system to resolve mutually exclusive applications. This would violate the Commission's mandate under the Communications Act.³⁰² Nor do we believe that the public interest will be served by avoiding mutual exclusivity in the manner advocated by Google.

132. In awarding initial PALs in the 3.5 GHz Band, when multiple applicants select to bid on more licenses than are available in a geographic area, we find that mutual exclusivity exists.³⁰³ When the mutually exclusive applications are accepted the Commission will, consistent with its statutory authority, assign the licenses through competitive bidding. Consistent with previous spectrum auctions, mutual exclusivity will be determined based upon the Commission's acceptance of competing applications. Also consistent with our previous spectrum auctions, applicants to participate in an auction of PALs in the 3.5 GHz Band, will have an opportunity to select across some or all of the available license areas the lesser of the maximum number of PALs that may be available in a license area or the maximum number of PALs they are permitted to hold in a license area under our spectrum aggregation limit. Once mutual exclusivity has been established by competing accepted applications seeking to acquire more PALs than are available in a particular geographic area, the PALs in that area will be assigned by competitive bidding, without regard to the number of applicants that ultimately decide to bid or the actual number of PALs for which they place bids.³⁰⁴

133. Under this approach, when there are two or more applicants for PALs in a given census tract for a specific auction, we will make available one less PAL than the total number of PALs in that tract for which all applicants have applied, up to a maximum of seven. Determining availability in this way is in the public interest because it promotes the underlying principle for this band that while GAA should be easy to access and sufficient for many applications in this service, PALs should be available for applications that require greater certainty as to interference protection because they would suffer in a congested use environment. We therefore conclude that we should make available one less PAL, up to a maximum of seven, than the total selected by two or more applicants to assure that our licensing scheme for PALs meets the needs of such potential users.

134. Because of the "generic" nature of PAL frequency assignments, when total PAL applications exceed the PAL bandwidth available in a license area, PAL applications are mutually exclusive because granting one application would create conflict with another application. This will assure that there is mutual exclusivity between any two applications in the same license area and enable us to assign PALs by competitive bidding. As we explain further below, we conclude that assigning PAL

²⁹⁹ *Benkelman Tel. Co. v. FCC*, 110 F.3d 601, 603 n.2 (D.C. Cir. 2000).

³⁰⁰ *DIRECTV v. FCC*, 110 F.3d 816, 822 (D.C. Cir. 1997).

³⁰¹ See *Benkelman Tel. Co.*, 220 F.3d at 605-606 (upholding the Commission's findings of mutual exclusivity where applicants merely reserved the option to bid on all available licenses, where "necessary to effectively implement the new [license by auction] scheme"); see also *DIRECTV*, 110 F.3d at 827-28.

³⁰² ENTELEC *FNPRM* Comments at ¶ 8. The use of lotteries to issue initial licenses is prohibited by the Communications Act. See 47 U.S.C. § 309(i)(5).

³⁰³ See *Benkelman Tel. Co.*, 220 F.3d at 605-606.

³⁰⁴ See *DIRECTV*, 110 F.3d at 827-28. Although our determination that mutual exclusivity exists within a particular geographic area will not be based on the number of applicants for PALs in that area, because we adopt an aggregation limit that allows licensees to hold no more than four PALs (i.e., 40 megahertz) in one census tract at one time, see *supra* Section III.C.2.a, this necessarily means that for mutual exclusivity to exist we will have accepted at least two applications for PALs in a given census tract.

licenses in the 3.5 GHz Band on a non-auctioned basis would not result in as efficient an assignment of the spectrum as licensing the spectrum for shared GAA use. However, by reducing the available PAL inventory when there are competing demands for less than the maximum number of PALs, interested applicants may bid for PALs to ensure access to exclusive usage rights. In contrast, when there is only one applicant for one or more PALs in a given census tract, we will neither proceed to an auction nor assign any PAL for that license area.

135. This determination is consistent with Commission precedent. In establishing its competitive bidding rules in 1994, the Commission recognized that the Act does not permit the award of initial licenses through competitive bidding in the absence of mutually exclusive applications.³⁰⁵ Thus, if the Commission receives only one application acceptable for filing with respect to a particular license, “mutual exclusivity would be lacking and the Commission would be prohibited from using competitive bidding to award the license.”³⁰⁶ The Commission noted that to handle such situations it “[g]enerally” would intend to adopt procedures for conducting auctions that provided in such a situation for “cancelling [of] the auction for this license and establishing a date for the filing of a long-form application [by the lone applicant], the acceptance of which would trigger the relevant procedures permitting petitions to deny.”³⁰⁷ However, it noted that the Commission “may decide in the future to alter some or all of the procedures” detailed therein, “or to tailor them to specific service rules, after we have had an opportunity to assess their effectiveness.”³⁰⁸

136. Additionally, we conclude that, with respect to Priority Access licensing, where there is only a single applicant seeking PALs in a geographic area, and therefore no mutual exclusivity (and hence we have no auction authority),³⁰⁹ the best way to discharge our statutory mandate to “encourage the larger and more effective use of radio in the public interest”³¹⁰ is to provide access to such spectrum via shared GAA use. If we do not accept competing applications seeking in total more PALs than the number of PALs available in a particular geographic area, we will not assign any PAL for that license area. Instead, we will cancel the auction with respect to that geographic area and allow the spectrum to remain accessible solely for shared GAA use under a license-by-rule framework until the next filing window for competitive bidding of PALs.

137. While we could issue PALs for these areas on a non-auctioned basis, we conclude that doing so in this band would not result in as efficient an assignment of the spectrum as licensing the spectrum for shared GAA use. Given the fact of more than 74,000 census tracts throughout the country, we believe there is a substantial likelihood that in many of these areas, at least initially, there would not be applicants for more than seven PALs – thereby precluding mutual exclusivity for these initial licenses. Because it does not appear that the incidence of areas without mutually exclusive applications under the approach we describe above for the 3.5 GHz Band will be isolated events, we predict that licensing at most a handful of PAL licenses would likely have the widespread effect of substantially restricting extensive deployment of a wide range of innovative GAA uses in the 70 megahertz reserved for PALs.

138. We do not believe that using a “first come, first served giveaway”³¹¹ as a licensing

³⁰⁵ Implementation of Section 309(j) of the Communications Act – Competitive Bidding, PP Docket No. 93-253, *Second Report and Order*, 9 FCC Rcd 2348, 2350-51 ¶ 12 (1994) (*Competitive Bidding Second Report and Order*).

³⁰⁶ *Id.* at 2376, ¶ 165.

³⁰⁷ *Id.*

³⁰⁸ *Id.* at 2376, ¶ 164 & n.120.

³⁰⁹ As explained above, our rules will permit up to seven PAL licensees in each census tract. Thus, up to seven PAL licenses may be granted in any one census tract without creating any mutual exclusivity.

³¹⁰ 47 U.S.C. § 303(g).

³¹¹ *See Kay v. FCC*, 393 F.3d 1339, 1344 (D.C. Cir. 2005) (declining to award license based on pioneer preference).

mechanism in this scenario would ensure the most efficient and intensive use of the spectrum, or be consistent with the goals served by more extensive GAA use as demonstrated by the record. The 3.5 GHz Band is designed to allow new, innovative operations access to flexible, fungible spectrum. The small cell deployment envisioned for the 3.5 GHz Band should enable tremendous spatial reuse and coexistence among users. The small license size will allow for targeting of network deployments, with GAA users able to coordinate actual use of the spectrum through the SAS. In areas where genuine local scarcity exists, interested applicants may apply for PALs to ensure access to exclusive usage rights. This reliance on economic incentives, and not performance requirements, will prevent spectrum warehousing and ensure continued innovation. By ensuring widespread GAA use of any spectrum for which we have not received mutually exclusive PAL applications, we ensure that the spectrum will be put to a use for which we have identified a clear public interest need, including by those who have filed PAL applications as well as others.

139. At the same time, we note that the determination of mutual exclusivity of PAL applications is not a one-time event for this band. Because PALs are licensed for three-year, non-renewable terms, we will periodically open application windows for new PALs that take effect upon expiration of previously assigned PALs. Additionally, if sufficient interest is expressed by prospective PAL users, we will open interim filing windows to accept applications for unassigned PALs, *i.e.*, PALs that could be made available for auction, before the expiration of an ongoing three-year PAL term. In the pre-auction public notice process by which the Commission first seeks comment on and subsequently announces the procedures for the first auction of PALs in the 3.5 GHz Band, we will consider the process by which we will determine whether there is sufficient interest by prospective Priority Access Licensees in participating in an interim auction of PALs prior to expiration of an ongoing three-year PAL term. These procedures are designed to ensure that we continue to provide opportunities to satisfy any further demand for higher priority PAL use as the 3.5 GHz Band service matures.

140. In accordance with Section 309(j), we have established an auction process that promotes “efficient and intensive use” of this spectrum and the “development and rapid deployment of new technologies, products, and services for the benefit of the public, including those residing in rural areas,” that “recover[s] for the public . . . a portion of the value of the public spectrum resource made available for commercial use, and achieves the other goals of the statute described above.”³¹² Providing for both GAA and PAL operations allows the Commission to create a band “well suited to exploring the next generation of shared spectrum technologies, to drive greater productivity and efficiency in spectrum use.”³¹³

141. Our licensing approach to address any absence of mutually exclusive applications is supported by the commenters urging greater reliance on shared use in the particular circumstances of this 3.5 GHz Band. We have employed shared use rather than exclusive licensing as a spectrum management approach in other services where appropriate, both licensed³¹⁴ and unlicensed,³¹⁵ even without any initial reliance on a competitive bidding mechanism for assignments from among mutually exclusive applicants. Accordingly, we exercise our established rulemaking authority to enable GAA uses of the entire 3.5 GHz Band in any census tract where we are unable to use our auction authority to issue PAL licenses from

³¹² See 47 U.S.C. §§ 309(j)(3), 309(j)(4).

³¹³ *3.5 GHz FNPRM*, 29 FCC Rcd at 4275, ¶ 3.

³¹⁴ See *3.65 GHz Order*, 20 FCC Rcd at 6510-13, ¶¶ 23-30; see also *Allocations and Service Rules for the 71-76 GHz, 81-86 GHz, and 92-95 GHz Bands*, WT Docket No. 02-146, *Report and Order*, 18 FCC Rcd 23318, 23337-39, ¶¶ 43-47 (2003).

³¹⁵ See, e.g., *Amendment of the Commission’s Rules to Provide for Operation of Unlicensed NII Devices in the 5 GHz Frequency Range*, ET Docket No. 96-102, *Report and Order*, 12 FCC Rcd 1576, 1579-85, ¶¶ 7-18 (1997).

among mutually exclusive applicants.³¹⁶ Nothing in the auction provisions of the Communications Act was intended to affect this broad spectrum management authority,³¹⁷ particularly where we conclude our licensing approach will best serve the public interest.³¹⁸ We conclude that our decision best accords with the Communications Act, as amended, while still affording the flexibility needed for the three-tiered spectrum sharing framework.

b. Application of Part 1 Competitive Bidding Rules

142. *Background.* For those mutually exclusive applications that will be subject to competitive bidding, the Commission proposed to employ its general competitive bidding rules to conduct an auction of PALs in the 3.5 GHz Band.³¹⁹ Commenters generally support the Commission's proposed use of its general competitive bidding rules. WISPA supports our proposal to adopt our general competitive bidding rules.³²⁰ AT&T cautions that the Commission's traditional auction framework "may not be appropriate with respect to PALs."³²¹ AT&T warns that the Commission's section 1.2105(c) prohibited communications rule would be inappropriate due to the "high-volume of auction activity on a regular basis."³²² Other commenters express views on topics that are generally considered after the adoption of service rules, during the pre-auction process for establishing procedures for conducting a PAL auction. For example, some parties state their positions on auction design and the use of package bidding for any auction of PALs, with some in favor and some opposed.³²³ Likewise, other commenters recommend that the Commission make certain changes to its auction procedures concerning payment and default issues.³²⁴

143. *Discussion.* Except as noted below, we adopt our proposal to conduct any auction of PALs in conformity with the general competitive bidding rules in Part 1, Subpart Q, including any modifications that the Commission may adopt for its Part 1 general competitive bidding rules in the future. We believe that the Commission's general competitive bidding rules are suitable to conduct auction of PALs. These rules have proven successful in previous spectrum auctions, and will enable the Commission to meet its goals for the Citizens Broadband Radio Service.

144. We proposed to apply any future modifications made to the Part 1 general competitive

³¹⁶ See 47 U.S.C. § 307; 47 C.F.R. § 1.945. The Commission is also not precluded "from establishing threshold standards to identify qualified applicants." *Hispanic Information & Telecommunications Network, Inc. v. FCC*, 865 F.2d 1289, 1294 (D.C. Cir. 1989). See also *United States v. Storer Broadcasting Co.*, 351 U.S. 192, 202, 205 (1956).

³¹⁷ See 47 U.S.C. § 309(j)(6)(A), (B), (C), (E).

³¹⁸ See *DIRECTV, Inc. v. FCC*, 110 F.3d 816 (D.C. Cir. 1997) (upholding determination to change prior policy to assign specific orbital positions on a first come, first served basis); *M2Z Networks, Inc. v. FCC*, 558 F.3d 554, 563-64 (D.C. Cir. 2009) (citing Improving Public Safety Communications in the 800 MHz Band, *Report and Order, Fifth Report and Order, Fourth Memorandum Opinion and Order, and Order*, 19 FCC Rcd 14969 ¶ 72 n.236 (2004)) (discussing Commission's undisputed authority to "consider the public interest in deciding whether to forgo an auction").

³¹⁹ *3.5 GHz FNPRM*, 29 FCC Rcd at 4308-09, ¶ 119.

³²⁰ WISPA *FNPRM* Reply Comments at 23 ("WISPA generally supports use of the Commission's existing rules combined with a streamlined competitive bidding process for mutually exclusive applications for PALs.").

³²¹ AT&T *FNPRM* Comments at 30.

³²² AT&T *FNPRM* Comments at 30-31.

³²³ See Verizon *FNPRM* Comments at 18. See also UTC/EEI *FNPRM* Reply Comments at 12-13. But see WISPA *FNPRM* Reply Comments at 12-13.

³²⁴ See Federated Wireless, Inc. *FNPRM* Reply Comments at 3. See also Open Technology Institute *et al.* *FNPRM* Reply Comments at 37.

bidding rules to an auction of PALs in the 3.5 GHz Band. We received no comment on this proposal.³²⁵ Specifically, we noted the Commission's proposal, in the Broadcast Incentive Auction proceeding, to revise the list of auction design options in section 1.2103 of the competitive bidding rules. The Commission has since adopted its proposed revisions in the *Broadcast Incentive Auction Report & Order*, which provide for the establishment of specific auction procedures governing bid collection, assignment of winning bids, and the determination of payment amounts in spectrum license auctions, and these provisions will be generally applicable as we consider procedures for future spectrum auctions, including auctions of PALs in the 3.5 GHz Band.³²⁶ The Commission also adopted its proposed amendments to section 1.2104, which permit the Commission to establish stopping rules in order to terminate multiple round auctions within a reasonable time and in accordance with the goals, statutory requirements, and rules for the incentive auction, including the reserve price or prices.³²⁷ In the absence of comments establishing a record, we do not adopt any additional revisions to sections 1.2103 or 1.2104. Our decision to conduct competitive bidding for PALs subject to the Commission's most current Part 1 rules, including any modifications that the Commission may adopt in the future,³²⁸ will ensure that the rules applied to auctions of licenses in the 3.5 GHz Band are up-to-date and will avoid uncertainty for prospective applicants if changes are made to the Part 1 competitive bidding rules.

145. We nonetheless recognize that the Commission could greatly benefit from a more fully developed record regarding limited rule revisions that may be necessary to accommodate payment, application and default issues that are unique to the service rules we adopt for the Citizens Broadband Radio Service. These issues will therefore be considered in the context of the *Second Notice of Proposed Rulemaking* discussed fully below.

146. Finally, we decline to adopt AT&T's proposal to eliminate the Commission's section 1.2105(c)'s prohibited communications rule in auctions for PALs in the Citizens Broadband Radio Service. We disagree with AT&T's contention that the prohibition would impair secondary markets and reduce participation in the 3.5 GHz Band. The plain text of the rule makes clear that business discussions and negotiations that are unrelated to bids or bidding strategies or to post-auction market structure are not prohibited by the rule.³²⁹ The rule's prohibition has always been aimed at the specific content of an applicant's communication to a competing applicant regardless of the context or situation in which such content is communicated, and applies only during a limited window.³³⁰

³²⁵ 3.5 GHz FNPRM, 29 FCC Rcd at 4310, ¶¶ 123-25.

³²⁶ See Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions, GN Docket No. 12-268, *Report and Order*, 29 FCC Rcd 6567, 6775, ¶ 504 (2014) (*Broadcast Incentive Auction Report & Order* or *BIA R&O*).

³²⁷ See *id.* at 6781-82, ¶¶ 522-23.

³²⁸ The Commission recently adopted changes to its Part 1 rules in its Broadcast Incentive Auction proceeding will apply to the 3.5 GHz Band. See *id.* at 6781-82, ¶¶ 522-23. The Commission also has an ongoing proceeding regarding its Part 1 rules and any changes will also apply to the 3.5 GHz Band. See In the Matter of Updating Part 1 Competitive Bidding Rules, WT Docket No. 14-170, GN Docket No. 12-268, RM-11395, WT Docket No. 05-211, *Notice of Proposed Rulemaking*, 29 FCC Rcd 12426 (2014).

³²⁹ 47 C.F.R. § 1.2105(c).

³³⁰ The Wireless Telecommunications Bureau has previously issued guidance explaining that, although auction applicants competing for licenses in the same geographic areas, or competing for licenses in the same areas in competing services, must affirmatively avoid all communications with each other that affect, or have the potential to affect, their bids or bidding strategy, this does not mean that all business negotiations between such applicants are prohibited. See Wireless Telecommunications Bureau Responds to Questions About the Local Multipoint Distribution Service Auction, *Public Notice*, DA 98-37, 13 FCC Rcd 341, 347 (1998). The public notices issued by the Bureau establishing the procedures for each auction have also provided detailed guidance to auction applicants and bidders regarding section 1.2105(c), including its application to particular types of communications. See, e.g., Auction of Advanced Wireless Services (AWS-3) Licenses Scheduled for November 13, 2014; Notice and Filing

(continued....)

c. Bidding Process Options

147. *Competitive Bidding Design Options.* We solicited comment on a number of issues regarding competitive bidding design options for PALs. Here too we received limited comment. WISPA proposes a two-step auction process.³³¹ AT&T asked that the Commission clarify its PAL competitive bidding rules.³³² Consistent with the Commission's practice in past spectrum license auctions, the rules we adopt allow subsequent determination of specific final auction procedures.³³³ The process will be initiated by the release of the *Auction Comment PN*, which will solicit public input on final auction procedures, and which will include specific proposals for auction components such as minimum opening bids. Thereafter, the *Auction Procedures PN* will specify final procedures, including dates, deadlines, and other final details of the applications and bidding processes. We believe the Commission's practice of finalizing auction procedures in the pre-auction process provides time for interested participants to both comment on the final procedures and to develop business plans in advance of the auction.³³⁴ Maintaining flexibility in the implementation of final procedures is a prudent approach to assuring that the PAL auction will fulfill the goals we have established by this *Report and Order*.

148. *Payment, Application and Default Rules.* We solicited comment on our general competitive bidding rules regarding payments, including upfront payments, down and final payments, default and disqualification. We received a limited number of comments on these payment issues. Federated Wireless proposes a two-step payment process.³³⁵ WISPA asks that the Commission "revise its payment rules to require payment for winning bids on an annual basis after the competitive bidding process is complete[]."³³⁶ Open Technology Institute at the New America Foundation and Public Knowledge argue that payment should be "due annually prior to the license start date and a license would terminate automatically if the payment is not made."³³⁷ We believe that it is in the public interest to develop a more complete record on payment, application and default issues. The *Second Further Notice of Proposed Rulemaking* addresses some of these interrelated issues below. We believe that any service-specific deviation from our general competitive bidding rules should be made once the record is complete.

149. *Bidding Credits.* We solicited comment on the use of bidding credits in the 3.5 GHz Band. In the *FNPRM*, we explained that in authorizing the Commission to use competitive bidding, Congress mandated that the Commission "ensure that small businesses, rural telephone companies, and businesses owned by members of minority groups and women are given the opportunity to participate in the provision of spectrum-based services."³³⁸ We further discussed that one of the principal means by

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Requirements, Reserve Prices, Minimum Opening Bids, Upfront Payments, and Other Procedures for Auction 97, *Public Notice*, 29 FCC Rcd 8386, 8392-99, ¶¶ 11-36 (2014).

³³¹ WISPA *FNPRM* Comments at 23-24.

³³² AT&T *FNPRM* Comments at 30.

³³³ See Amendment of Part 1 of the Commission's Rules – Competitive Bidding Procedures, *Third Report and Order and Second Further Notice of Proposed Rule Making*, 13 FCC Rcd 374, 447-49 ¶¶ 124-25 (1997); Amendment of Part 1 of the Commission's Rules – Competitive Bidding Proceeding, *Order, Memorandum Opinion and Order and Notice of Proposed Rule Making*, 12 FCC Rcd 5686, 5697-98 ¶ 16 (1997).

³³⁴ See 47 U.S.C. § 309(j)(3)(E).

³³⁵ Federated Wireless *FNPRM* Reply Comments at 3.

³³⁶ WISPA *FNPRM* Comments at 25.

³³⁷ OTI/PK *Licensing PN* Comments at 18.

³³⁸ *3.5 GHz FNPRM*, 29 FCC Rcd at 4312-13, ¶ 131 *citing* 47 U.S.C. § 309(j)(4)(D). Such entities are collectively described as "designated entities." See 47 C.F.R. § 1.2110(a). In addition, section 309(j)(3)(B) of the Act provides that in establishing eligibility criteria and bidding methodologies, the Commission shall promote "economic opportunity and competition . . . by avoiding excessive concentration of licenses and by disseminating licenses

(continued....)

which the Commission furthers these statutory goals is the award of bidding credits to small businesses.

150. For the 3.5 GHz Band, the Commission specifically asked whether the flexible and dynamic auction and licensing mechanisms, shorter license term, and size of the license area would limit the barriers to participate in PAL auctions.³³⁹ Six CII entities filed comments, requesting that the Commission provide bidding credits “for entities that would use the spectrum for ‘mission critical’ communications³⁴⁰ systems, such as utilities.”³⁴¹ API also suggests that the Commission could “provide bidding credits to current licensees who demonstrate they are using their licenses in the public interest.”³⁴² WISPA objects to CII-specific bidding credits, arguing that “[b]idding credits add a layer of complexity that would make conducting competitive bidding for potentially thousands of census blocks much more difficult, especially considering that the Commission has proposed one-year license terms.”³⁴³ Mobile Future opposes “restrictive spectrum set-asides and preferential rules including bidding credits.”³⁴⁴ We also solicited comment regarding bidding credits for serving a qualifying tribal land.³⁴⁵ We received no comment regarding tribal land bidding credits.

151. We conclude that given the unique characteristics of the service, bidding credits are not necessary to ensure the participation by small businesses in competitive bidding for PALs. We also conclude that the unique characteristics of the Citizens Broadband Radio Service are sufficient to promote greater use of the spectrum over tribal lands, making bidding credits unnecessary for tribal lands. As we noted in the *FNPRM*, “the Commission takes into account both the nature of the service and the nature of the parties most likely to be interested in using the spectrum.”³⁴⁶ The Citizens Broadband Radio Service licensing scheme is designed to encourage participation from a wide variety of users and a broad range of operations. The GAA tier already allows low cost access to the 3.5 GHz Band, both in the at least 80 megahertz of spectrum in which there is no PAL use, and in the remaining portion of the band on an opportunistic basis. While mutually exclusive applications for PALs in up to 70 megahertz of the band are subject to competitive bidding, the short term of the license and small geographic area should work to keep costs affordable to acquire PALs. Because the nature of the Citizens Broadband Radio Service already gives designated entities the opportunity to access 3.5 GHz spectrum, we will not offer small business nor tribal land bidding credits in auctions of PALs. For the same reason, we decline to adopt bidding credits for CII entities.

152. *Commission Notices.* In the *FNPRM*, we proposed to follow our established practice of issuing a public notice upon the conclusion of a PAL auction declaring the bidding closed and identifying the winning bidders.³⁴⁷ We received no comment on this proposal, and accordingly, we will follow this

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among a wide variety of applicants, including small businesses, rural telephone companies, and businesses owned by members of minority groups and women.” 47 U.S.C. § 309(j)(3)(B).

³³⁹ 3.5 GHz *FNPRM*, 29 FCC Rcd at 4313, ¶ 132.

³⁴⁰ The Commission sought comment on restricting the Priority Access tier for operations “with an urgent need for uninterrupted spectrum access to support ‘mission critical’ uses,” includes medical body area networks, public safety, and the critical infrastructure industry. See 3.5 GHz *NPRM*, 27 FCC Rcd at 15618 and n.162.

³⁴¹ Exelon *FNPRM* Comments at 5. See also API *FNPRM* Comments at 13; Oncor *FNPRM* Comments at 3; UTC *FNPRM* Comments at 8; API *FNPRM* Comments at 1; UTC/EEI *FNPRM* Reply Comments at 12; Xcel Energy *FNPRM* Reply Comments at 6.

³⁴² API *FNPRM* Comments at 9.

³⁴³ WISPA *FNPRM* Reply Comments at 12-13.

³⁴⁴ Mobile Future *FNPRM* Comments at 8.

³⁴⁵ 3.5 GHz *FNPRM* at 29 FCC Rcd 4313-14, ¶ 133.

³⁴⁶ *Id.* at 4312-13, ¶ 131.

³⁴⁷ *Id.* at 4314, ¶ 134.

process for notifying auction participants and the public of the auction results.

153. As noted above, after adoption of all of the necessary service rules for the Citizens Broadband Radio Service, consistent with the Commission's longstanding approach, the Commission will initiate a public notice process to solicit public input on certain details of auction design and the auction procedures. This public notice will address auction-specific matters such as the competitive bidding design and mechanisms, minimum opening bids and/or reserve prices, and payment procedures. In advance of the auction, the Commission will issue another public notice to announce the auction procedures and provide detailed instructions for potential auction participants. Because we expect the first auction to raise new and novel considerations with respect to the auction procedures, we will vote the public notices for the initial auction at the Commission level.

154. As discussed above, procedures regarding minimum opening bids and upfront payments will be announced via the public notice process. In determining these amounts, we expect we will have to balance our twin objectives of satisfying applicant demand for PALs and the possibility of shared GAA use where no PALs are issued. We recognize that this balance may vary in different geographic areas. In addition, given the very high volume of licenses that will be available in an auction of PALs, it may be necessary to implement measures that will allow the auction to close within a reasonable time. Therefore, we will consider establishing other auction procedures that will encourage targeted bidding on specific PAL licenses. To further that objective, we may consider various procedures, including, among others, establishing an upfront payment process that requires qualified bidders to make upfront payments on a license-by-license basis, *i.e.* for a PAL in a specific license area, rather than for general bidding eligibility on any one of a set number of PALs. If bidding eligibility is nontransferable to other PALs, this would limit a bidder's ability to change the geographic area of the PALs for which it bids during the auction.³⁴⁸ We may also consider whether such license-specific upfront payments should also serve as an applicant's opening bid for that PAL, constituting a binding commitment to purchase the PAL at that price.

D. General Authorized Access

155. The GAA-tier is intended to provide a low-cost entry point into the Citizens Broadband Radio Service for a wide array of users. GAA users will have no expectation of interference protection from Incumbent Users and other Citizens Broadband Radio Service users. Further, GAA users must comply with the instructions of the SAS and avoid causing harmful interference to Priority Access Licensees and Incumbent Access tier users. We believe that GAA availability will promote competition, encourage flexible network deployments, and facilitate the efficient use of available spectrum. The same technical rules will apply to devices operated in both the Priority Access and GAA tiers of service to maximize flexible and efficient use of the band. Therefore, as discussed below and consistent with the proposals set forth in the *NPRM* and *FNPRM*, we adopt a license-by-rule authorization framework under Section 307 of the Communications Act for GAA users.³⁴⁹

1. Authorization Methodology

156. *Background.* We proposed to establish the Citizen's Broadband Radio Service (including the GAA tier) by rule under Section 307(e) of the Communications Act.³⁵⁰ We reasoned that a license-by-rule licensing framework would allow for rapid deployment of small cells by a wide range of users, including consumers, enterprises, and service providers, at low cost and with minimal barriers to entry. As we explained, much wireless broadband use occurs indoors or in other enclosed facilities. Typically, the owners or users of such facilities already have access to the siting permissions, backhaul facilities,

³⁴⁸ Under our current Part 1 competitive bidding rules, a bidder is permitted to submit an upfront payment providing it with bidding eligibility that only allows it to bid on a smaller number of licenses at one time than it selected on its short-form application. Requiring upfront payments that are license-specific would not change that.

³⁴⁹ See 47 U.S.C. § 307(e)(1); Appendix A §§ 95.401(h) and 96.33.

³⁵⁰ 47 U.S.C. § 307(e).

electrical power, and other key non-spectrum inputs for the provision of service. Moreover, small cell operation in the 3.5 GHz Band would generally tend to contain service within such facilities, allowing for a high degree of spectrum reuse. Therefore, authorizing these end users to have direct access to the 3.5 GHz Band in the physical locations that they otherwise are able to access would seem to facilitate expeditious and low-cost provision of service. Accordingly, we concluded that a license-by-rule framework was very compatible with and conducive toward these aims.³⁵¹

157. A number of commenters endorsed the license-by-rule approach.³⁵² The Utility Groups, for example, agree that the Citizens Broadband Radio Service should be licensed by rule. The Utility Groups note that a license-by-rule model for this band is consistent with the Commission's decision to license the Wireless Medical Telemetry Service by rule because both services facilitate the accelerated deployment of mission critical services.³⁵³ In addition, UTC notes that the license-by-rule model promotes economies of scale, minimizes administrative burdens, and provides a unified licensing model in the band.³⁵⁴ WISPA argues that a license-by-rule approach coupled with SAS requirements "represents an evolution of *ad hoc* unlicensed systems where spectrum coordination often occurs after deployment, an inefficient and outdated approach for avoiding interference."³⁵⁵ The WiMAX Forum states that a license-by-rule approach "would streamline deployment as compared to the 'light licensing' scenario of the current 3650-3700 MHz band."³⁵⁶

158. Other commenting parties express a preference for an unlicensed (Part 15) framework, rather than the *FNPRM's* proposed license-by-rule framework.³⁵⁷ AT&T specifically opposes license-by-rule authorizations and asserts that the Commission's statutory authority under Section 307(e) is narrower than the Commission claims. AT&T argues that the Commission should authorize GAA users under Part 15 instead.³⁵⁸ Microsoft likewise argues that an unlicensed regime would facilitate the rapid deployment of new technologies in the band "because of the relatively low regulatory barriers to entry and because the technical rules governing Part 2 and 15 devices have proven effective in protecting incumbent users from interference."³⁵⁹ TIA, by contrast, argues that license-by-rule and unlicensed approaches are too unpredictable to support the Commission's service expectations, as envisioned by the National Broadband

³⁵¹ See *3.5 GHz NPRM* at 15615, 15620, ¶¶ 61, 76; *Licensing PN*, 28 FCC Rcd at 15309, ¶ 23; *3.5 GHz FNPRM*, 29 FCC Rcd at 4291-92, 4308, ¶¶ 56-57, 115.

³⁵² See, e.g., Great River Energy *NPRM* Comments at 2 ("GRE agrees with Commission in that a license-by-rule approach would be preferred above unlicensed operation in the Priority Access and GAA tiers. If utilities are to make use of the 3.5 GHz band for mission critical communications, protection from interference is of paramount importance."); Interdigital *NPRM* Comments at 18 ("InterDigital agrees with the use of the license-by-rule approach for both the Priority Access and GAA tiers. We believe that the license-by-rule approach helps in implementing a more dynamic use of spectrum than traditional licensing or temporary licensing, thus increasing the spectrum availability at a given time."); and Public Interest Spectrum Coalition *NPRM* Comments at 14 ("The Commission is also correct to choose a license-by-rule framework where, as here, the public interest purposes of the band can be achieved without more restrictive licensing.")

³⁵³ Utility Groups *NPRM* Comments at 11.

³⁵⁴ *Id.* at 18.

³⁵⁵ WISPA *NPRM* Comments at 6; WISPA *FNPRM* Comments at 26-27.

³⁵⁶ WiMAX Forum *NPRM* Comments at 7.

³⁵⁷ See, e.g., *See, e.g., AT&T Licensing PN* Comments at 2; Microsoft *Licensing PN* Comments at 5; Google *Licensing PN* Reply Comments at 3-5; OTI/PK *Licensing PN* Reply Comments at 3.

³⁵⁷ Microsoft *FNPRM* Comments at 10.

³⁵⁸ See *AT&T Licensing PN* Comments at 6-7.

³⁵⁹ Microsoft *FNPRM* Comments at 10.

Plan.³⁶⁰

159. *Discussion.* After careful consideration of the record in this proceeding, we adopt a licensed-by-rule framework for the GAA tier of the new Citizens Broadband Radio Service, pursuant to Section 307(e) of the Communications Act, as amended, and subject to applicable technical rules.³⁶¹ Section 307(e) states in part that, “[n]otwithstanding any license requirement established in this Act, if the Commission determines that such authorization serves the public interest, convenience, and necessity, the Commission may by rule authorize the operation of radio stations without individual licenses in the following radio services: (A) citizens band radio service;”³⁶² Section 307(e) further states that, “[f]or purposes of this subsection, the terms ‘citizens band radio service’ ... shall have the meanings given them by the Commission by rule.”³⁶³

160. We conclude that a license-by-rule framework is the appropriate methodology for authorizing users in the 3.5 GHz Band consistent with the tiers of service proposed herein. This proposed framework will facilitate the rapid deployment of compliant small cell devices while minimizing administrative costs and burdens on the public, licensees, and the Commission.

161. We disagree with AT&T’s assertion that the Commission does not have authority to license GAA users by rule under Section 307(e) of the Communications Act.³⁶⁴ As noted above, the Act expressly delegates to the Commission the discretion to define the scope of the term “citizens band radio service.” The Commission has repeatedly exercised that authority to license new services by rule under Section 307.³⁶⁵ Indeed, the Commission has licensed an array of beneficial services by rule by defining the Citizens Band Radio Services to include the Family Radio Service, the Low Power Radio Service, the Medical Device Radiocommunication Service, the Wireless Medical Telemetry Service, and the Dedicated Short-Range Communications Service On-Board Units.³⁶⁶ Accordingly, we establish a new Citizen’s Broadband Radio Service under Part 96 of the Commission’s Rules, and define the GAA tier as a Citizens Band Radio Service pursuant to the Commission’s authority under Sections 307(e)(1) and (e)(3) of the Act.³⁶⁷ We find that the creation of a wireless Citizens Broadband Radio Service under the license-by-rule framework of Section 307 will serve the public interest, convenience, and necessity and is consistent with Commission precedents creating new services with flexible assignments for any number of users.³⁶⁸

³⁶⁰ TIA *NPRM* Comments at 5. Instead, TIA favors an exclusive licensed spectrum model for the band. *Id.*

³⁶¹ *See supra* III(F).

³⁶² 47 U.S.C. § 307(e)(1).

³⁶³ 47 U.S.C. § 307(e)(3).

³⁶⁴ *See* 47 U.S.C. § 307(e); AT&T *NPRM* Comments at 13-15; AT&T *Licensing PN* Comments at 6-7.

³⁶⁵ *See, e.g.*, Amendment of Parts 1, 2, 22, 24, 27, 90 and 95 of the Commission’s Rules, WT Docket No. 10-4, *Notice of Proposed Rulemaking*, 26 FCC Rcd 5490, ¶¶ 29-32 (2011); Amendment of Parts 1 and 95 of the Commission’s Rules to Eliminate Individual Station Licenses in the Remote Control (R/C) Radio Service and the Citizens Band (CB) Radio Service, PR Docket No. 82-799, *Report and Order*, 48 Fed. Reg. 24884 ¶ 25 (1983).

³⁶⁶ *See* 47 C.F.R. §§ 95.401(a)-(g). While the plain language of Section 309(e)(3) provides for such authority, we also note that GAA use of the Citizens Broadband Radio Service fits well within the category of licenses that are “granted to virtually any person who files an application,” that are non-exclusive, and for which the high cost of licensing so many eligible users is not justified in light of the public interest benefits. H.R. Conf. Rep. No. 97-765, at 36 (1982).

³⁶⁷ *See* 47 U.S.C. § 307(e)(1), (e)(3).

³⁶⁸ *See, e.g.*, Amendment of Parts 2 and 95 of the Commission’s Rules to Create a Wireless Medical Telemetry Service, ET Docket No. 99-255, PR Docket No. 92-235, *Report and Order*, 15 FCC Rcd 11206, at 11216 ¶ 27 (2000) (adopting rules to license the wireless medical telemetry service by rule under Part 95).

162. Under the license-by-rule framework we adopt today, GAA users may use only certified, Commission-approved CBSDs and must register with the SAS.³⁶⁹ Consistent with our new rules governing CBSDs, devices operating on a GAA basis must provide the SAS with all information required by the rules – including operator identification, device identification, and geo-location information – upon initial registration and as required by the SAS.³⁷⁰ GAA users must also comply with the instructions of the SAS and must avoid causing harmful interference to Priority Access Licensees and Incumbent Access tier users.³⁷¹ Similar to unlicensed operations, GAA users have no expectation of interference protection from Incumbent Users and other Citizens Broadband Radio Service users.³⁷²

163. We decline to adopt an unlicensed regime for this band as suggested by certain commenters in the proceeding. Instead, we adopt a primary fixed and land mobile allocation across the entire band. A co-primary allocation for the entire 3.5 GHz Band will ensure that GAA operations are prioritized over existing secondary users in the band. Moreover, this authorization framework will serve the public interest, aiding enforcement and promoting a more stable and predictable spectral environment through affirmative authorization of CBSDs by the SAS. Further, authorizing GAA as a licensed radio service will facilitate its integration into the broader Part 96 framework, including SAS-governed frequency assignment, and simplify administration and oversight of the Citizens Broadband Radio Service.

2. Contained Access Facilities

164. *Background.* In the *FNPRM*, we proposed to allow Contained Access Users, such as hospitals, public safety organizations, and local governments to request up to 20 megahertz of reserved frequencies from the GAA pool for indoor use within their facilities. These frequencies would be used only for private internal radio services and could not be made available to the general public. Other GAA users would not be permitted to utilize the reserved frequencies within designated CAFs. We also proposed that Contained Access Users must accept interference from GAA transmissions originating outside the CAF and undertake reasonable efforts to safeguard against harmful interference from those transmissions. Potential Contained Access Users would be required to receive approval from the Commission to be eligible to utilize reserved frequencies. We sought comment on these proposals.³⁷³

165. Some commenters, including Verizon, Mobile Future, PISC, Wi-Fi Alliance, and others oppose the Commission’s proposal to set aside frequencies for CAF use.³⁷⁴ Verizon contends that the Commission should not “earmark” spectrum for a particular class of users.³⁷⁵ WiMAX Forum argues that the Commission’s CAF proposal is incompatible with SmartGrid technology.

166. PISC opposes the Commission’s CAF proposal and notes that it could have the effect of limiting or eliminating GAA availability in some areas.³⁷⁶ PISC argues that, if the Commission wishes to provide exclusive access spectrum to critical access facilities, it should assign them finely tailored

³⁶⁹ See Appendix A, §§ 96.35 and 96.39.

³⁷⁰ See Appendix A, §§ 96.35 and 96.39. We require that all information provided by the CBSD to the SAS be true, complete, correct, and made in good faith.

³⁷¹ See Appendix A, §§ 96.35, 96.53, and 96.59.

³⁷² See 47 C.F.R. §15.5; Appendix A, § 96.35.

³⁷³ See *3.5 GHz FNPRM*, 29 FCC Red at 4291-2, ¶ 60.

³⁷⁴ See Wi-Fi Alliance *FNPRM* Comments at 7-8; Verizon *FNPRM* Comments at 20; Sony *FNPRM* Comments at 2; Mobile Future *FNPRM* Comments at 7-8; PISC *FNPRM* Reply Comments at 23-24.

³⁷⁵ See Verizon *FNPRM* Comments at 20.

³⁷⁶ See PISC *FNPRM* Reply Comments at 23.

PALs.³⁷⁷ PISC also argues that, if the Commission does adopt its CAF proposal, eligible users should be narrowly tailored to include only “public safety agencies, hospitals, local governments and possibly public utilities for only indoor and internal, noncommercial communication in support of core public service functions.”³⁷⁸

167. Other commenters, including Exelon and Interdigital, support the proposal.³⁷⁹ Still others support CAF use in principle with some key changes. Microsoft argues that prospective CAF users should be required to demonstrate a clear need for exclusive use of frequencies within their facilities and qualified applicants should be assigned frequencies from the Priority Access spectrum pool.³⁸⁰ WISPA argues that CAF frequencies should be taken from Priority Access channels and not GAA frequencies.³⁸¹ Motorola Solutions contends that CAFs should be permitted for campuses that include outdoor areas and that CAF authorizations should be made available on a temporary basis at emergency incident scenes.³⁸² The American Petroleum Institute, UTC, and other utility companies also argue that CAFs should include outdoor areas.³⁸³

168. Federated Wireless supports the Commission’s CAF proposal but urges the Commission to expand access to the CAF designation and incorporate additional commercial uses into its rules.³⁸⁴ Specifically, Federated suggests that the class of eligible users should be expanded beyond the “critical users” that the Commission proposed.³⁸⁵ Federated argues that the CAF should be defined as any “any contiguous boundary that encompasses both indoor and outdoor locations” and should include additional conditions such as a minimum size requirement. Federated suggests 500 square meters. Federated believes that instead of being limited to 20 megahertz, a CAF rule should apply to all GAA frequencies.³⁸⁶ Several commenters also opined on the types of entities that should be eligible to be CAF users. For instance, the American Petroleum Institute, UTC, and others contend that the definition of CAF should be clearly defined to include critical infrastructure entities.³⁸⁷ WISPA argues that qualified users should be limited to hospitals, utilities, public safety organizations, and local governments.³⁸⁸

169. *Discussion.* After review of the record, we decline to adopt the CAF proposal. The final rules only allow fixed CBSDs – as opposed to the fixed and portable CBSDs proposed in the FNPRM. Thus, there will be limited opportunities for Citizens Broadband Radio Service users to deploy and utilize CBSDs in indoor areas without the permission of facility owners, even without CAFs available. In these circumstances, we conclude that the need for additional protection is outweighed by the additional costs

³⁷⁷ *Id.* at 24.

³⁷⁸ *Id.* at 24.

³⁷⁹ See Exelon *FNPRM* Comments at 5;

³⁸⁰ See Microsoft *FNPRM* Comments at 5.

³⁸¹ See WISPA *FNPRM* Comments at 28.

³⁸² See Motorola Solutions *FNPRM* Comments at 3-4

³⁸³ See e.g., API *FNPRM* Comments at 7-8; UTC *FNPRM* Comments at 9-11; Siemens Industry *FNPRM* Comments at 7; Oncor Electric Utility *FNPRM* Reply Comments at 4-6

³⁸⁴ See *Ex Parte* Letter from Kurt Schaubach, Chief Technology Officer, Federated Wireless, to Marlene H. Dortch Secretary, Federal Communications Commission in GN Docket No. 12-354 (filed Feb. 3, 2015) (*Federated Wireless February 2015 Ex Parte*).

³⁸⁵ *Id.* at 2-3.

³⁸⁶ *Id.* at 3-4.

³⁸⁷ See API *FNPRM* Comments at 7-8; Oncor Electric Utility *FNPRM* Reply Comments at 4-6; Lockard and White *FNPRM* Reply Comments at 2; EWA *FNPRM* Reply Comments at 3; UTC *FNPRM* Comments at 9-10.

³⁸⁸ WISPA *FNPRM* Comments at 29.

and burdens of implementing this special priority within GAA use. We remain optimistic that the Citizens Broadband Radio Service can be used support a wide variety of indoor operations, including private networks. We will monitor the development of the band and we may take action if we believe that such vital use cases are not being supported.

E. Regulatory Status

170. *Background.* In the *FNPRM*, we proposed to allow Citizens Broadband Radio Service users to select whether to provide service on a common carrier or non-common carrier basis, regardless of whether they operate in the Priority Access tier, GAA tier, or both. Users that elect to offer services on a common carrier basis would be required to comply with all of the Commission's rules applicable to common carriers.³⁸⁹ This is consistent with our approach in other licensed services.³⁹⁰ We sought comment on this proposal.³⁹¹

171. Verizon supports the Commission's proposal.³⁹² WISPA argues that Priority Access Licensees should be permitted to select whether to provide service on a common carrier or non-common carrier basis on their license applications. However, WISPA contends that GAA users should not be permitted to select common carrier status since GAA users are not required to file an application and the Commission does not have an established process to accept and track submissions by GAA users.³⁹³

172. *Discussion.* After review of the record, we adopt our proposal to allow GAA users and Priority Access Licensees to select whether they will provide service on a common carrier or non-common carrier basis. We agree with Verizon that "[a]n entity's decision to operate as either a Priority Licensee or as a GAA user should not affect how it is regulated or the services it can provide."³⁹⁴ Moreover, this approach is consistent with Commission precedent in other bands.³⁹⁵

173. We do not agree with WISPA's contention that GAA users should not be permitted to provide common carrier services.³⁹⁶ We believe that it is in the public interest for Citizens Broadband Radio Service users to be able to utilize the same equipment interchangeably – in both Priority Access and GAA tiers – to provide the same service. Not allowing GAA users to provide common carrier service would undercut this interchangeability. We believe that any administrative effort needed to establish an application process for GAA users wishing to provide common carrier services will be far outweighed by the public interest benefits of allowing licensees to offer these services.

F. Technical Rules

174. We effectuate technical rules for the 3.5 GHz Band that will allow for a wide range of usage scenarios, while also encouraging spectral efficiency and orderly co-existence with other users of the radio spectrum. Our technical rules are the same for devices operating on a Priority Access or GAA basis to allow Citizens Broadband Radio Service users to effectively access both tiers using the same equipment. We also observe that the public interest requires us to balance opportunities for greater

³⁸⁹ See 3.5 GHz *FNPRM*, 29 FCC Red at 4282, ¶ 26.

³⁹⁰ See e.g., 47 C.F.R. § 90.1309 (3650-3700 MHz Service) and 47 C.F.R. § 27.10 (Miscellaneous Wireless Communications Services).

³⁹¹ See 3.5 GHz *FNPRM*, 29 FCC Red at 4282, ¶ 26.

³⁹² See Verizon *FNPRM* Comments at 20-21.

³⁹³ See WISPA *FNPRM* Comments at 15.

³⁹⁴ See Verizon *FNPRM* Comments at 20-21.

³⁹⁵ See e.g., 47 C.F.R. § 90.1309 (3650-3700 MHz Service) and 47 C.F.R. § 27.10 (Miscellaneous Wireless Communications Services).

³⁹⁶ See WISPA *FNPRM* Comments at 15.

engineering efficiency against other goals. For example, we understand that in many cases it may be most efficient to define interference protection with respect to aggregations of signals received by a protected receiver. At the same time, this type of approach raises questions of equity and complexity. While we have endeavored to accommodate as much technical flexibility and use-case diversity as possible in the initial rules (in some respects, more than other “flexible use” radio services), we necessarily have had to simplify in ways that we believe will accelerate use of the band. We recognize that innovation requires iteration. We expect that as the band develops, we will occasionally revisit the rules in ways that increase the technical flexibility – and therefore the economic productivity – of the Citizens Broadband Radio Service.

1. General Radio Requirements

a. Digital Modulation

175. In the *FNPRM* we proposed that systems operating in the Citizens Broadband Radio Service use digital modulation techniques and sought comment on this proposed rule.³⁹⁷ There was no objection to this proposed rule. Digital modulation technology has become an embedded and essential component of today’s wireless broadband devices. Therefore, we adopt the requirement that CBSDs use digital modulation techniques.³⁹⁸

b. Emissions and Interference Limits

176. *Background.* In the *FNPRM*, we sought comment on specific out-of-band emission (OOBE) power levels for CBSDs and End User Devices. We proposed applying the long-standing OOBE attenuation requirement of $43 + 10 \log(P)$ dB (equivalent to -13 dBm / MHz), to all emissions from CBSDs and End User Devices outside of any channel assigned by the SAS.³⁹⁹ We also proposed a 30 megahertz transition gap above 3650 MHz and below 3550 MHz with an OOBE limit of no more than -40 dBm / MHz for emissions above 3680 MHz and below 3520 MHz.

177. We sought comment on whether the proposed transition gap is in the range of existing filter technology and whether the gap could be smaller. We also noted in the *FNPRM* that there has been considerable technological advancement in transmitter and receiver technologies deployed in the mobile broadband industry over recent years, such that more stringent out-of-band emission limits may be practical without undue burden to manufacturers and operators.⁴⁰⁰

178. In the *FNPRM*, we noted that a more stringent OOBE limit would enable closer proximity of neighboring service operations while still protecting the operations of earth stations in the C-Band and DoD systems. We sought comment as to whether the OOBE limit at greater offsets than 30 megahertz above or below the band edge should be more stringent, such as to a level below -50 dBm / MHz, and whether the in-band emission limits outside of any channel assignment should be more stringent (*i.e.*, at a lower power spectral density) than -13 dBm / MHz.⁴⁰¹

179. The record reflects divergent views regarding appropriate OOBE limits. Some commenters support the proposed OOBE attenuation requirement of $43 + 10 \log(P)$ dB (-13 dBm / MHz) adjacent to and outside the band, as well as a $70 + 10 \log(P)$ dB (-40 dBm / MHz) OOBE level 30 megahertz outside of the Citizens Broadband Radio Service operating band.⁴⁰² Motorola Mobility

³⁹⁷ See *3.5 GHz FNPRM*, 29 FCC Rcd at 4294, ¶¶ 69; Proposed Rules, § 96.38(a)

³⁹⁸ See Appendix A, § 96.41(a).

³⁹⁹ The *FNPRM* proposal was specific to the 3550 – 3650 MHz band, and the *FNPRM* also asked about what changes would be needed if the Commission were to extend the band to 3700 MHz.

⁴⁰⁰ See *3.5 GHz FNPRM*, 29 FCC Rcd at 4298, ¶¶ 82-83; Proposed Rules, § 96.38(d).

⁴⁰¹ See *id.* at 4298, ¶ 83.

⁴⁰² See Motorola Solutions *FNPRM* Comments at 7 and Alcatel-Lucent *FNPRM* Comments at 12.

supports the overall proposed OOB limits and argues that 10 and 20 megahertz LTE channels should not encounter any problems in meeting such limits. Motorola Mobility urges the Commission to refrain from adopting any limit more stringent than proposed in the *FNPRM* (e.g., -50 dBm / MHz).⁴⁰³

180. On the other hand, NSN and AT&T state that the Commission should harmonize its OOB rules with the existing 3GPP standard.⁴⁰⁴ NSN points out that the use of -40 dBm / MHz at a frequency offset of 30 megahertz would not comply with 3GPP TS 36.101 Out-of-Band Emission limits of -25 dBm / MHz for 10 megahertz channels beyond a 10 megahertz frequency offset for End User Devices. According to NSN, this would imply that Band 42 and Band 43 user equipment would not be able to operate under the emission limits proposed by the Commission.⁴⁰⁵ Qualcomm states that while NSN's proposal to reuse 3GPP Band 42 and 43 plans is not unreasonable, the better path forward would be to define a new 3GPP band class for the 3.5 GHz Band because doing so would offer more flexibility for purposes of setting OOB limits.⁴⁰⁶ AT&T states that the Commission's proposed OOB rules differ considerably from those for other bands used for mobile broadband service.⁴⁰⁷ AT&T argues that the Commission's proposed OOB limits are too extreme because, unlike AWS-4, receivers and transmitters in the 3.5 GHz Band will not be in extremely close proximity to one another.⁴⁰⁸

181. BLiNQ Networks filed a 3.5 GHz Band co-existence study with a proposal to allow higher conducted CBSD transmit power and limit adjacent channel leakage by defining a power ratio relative to the authorized carrier power.⁴⁰⁹ BLiNQ proposes to limit adjacent channel power to -30 dBm / MHz beyond 2.5 times the channel bandwidth offset and proposes to limit out-of-band emissions outside the 3.5 GHz Band to -40 dBm / MHz beyond 40 megahertz offset and to -50 dBm / MHz beyond 60 megahertz offset. BLiNQ presents calculations, for base station radii (i.e., CBSDs), of protection distances to C-band earth stations for various combinations of propagation path models and OOB levels, resulting in large variations in computed protection distances and poor spectrum utilization for worst case assumptions.⁴¹⁰ Importantly, BLiNQ, and others, conclude that limiting OOB is more critical to protecting incumbent services, than minimum geographic distance separation to limit receiver (low noise block downconverter, or LNB) saturation.⁴¹¹

182. Google argues that OOB rules should not adopt a one-size-fits-all limit to protect adjacent services from harmful interference. Instead, Google states that the rules should recognize that device performance may result in lower emissions than the -13 dBm / MHz standard and enable SASs to take improved performance into account when determining which spectrum is available for a device in a

⁴⁰³ See Motorola Mobility *FNPRM* Comments at 9. We note that Motorola Mobility did not address the effect that different OOB would have on the ability of CBSDs and End User devices to operate more closely to neighboring incumbent services.

⁴⁰⁴ See NSN *FNPRM* Comments at 19; AT&T *FNPRM* Reply Comments at 19. To this end, noting that 3GPP recommends a -25 dBm / MHz OOB limit, they assert that the OOB limit below 3520 MHz and above 3680 MHz must be changed from $70 + 10 \text{ Log (P)}$ dB attenuation (-40 dBm / MHz) to $55 + 10 \text{ Log (P)}$ dB attenuation (-25 dBm / MHz).

⁴⁰⁵ See NSN *FNPRM* Comments at 19.

⁴⁰⁶ Qualcomm *FNPRM* Reply Comments at 9.

⁴⁰⁷ See AT&T *FNPRM* Reply Comments at 19.

⁴⁰⁸ *Id.*

⁴⁰⁹ See *Ex Parte* Letter from Trey Hanbury, Counsel to BLiNQ Networks, to Marlene H. Dortch, Secretary, Federal Communications Commission in GN Docket No. 12-354 (filed Dec. 23, 2014) (BLiNQ December 2014 *Ex Parte*).

⁴¹⁰ See *id.*

⁴¹¹ See BLiNQ December 2014 *Ex Parte* at 10; See SIA *FNPRM* Comments at 19; Comsearch Report.

given operating environment.⁴¹² NTIA lab measurements of emission spectra for several commercial devices that operate within the 3.5 GHz Band demonstrate emission performance and OOB power levels significantly below the levels proposed in the *FNPRM*, and with transition bandwidths narrower than 30 megahertz to achieve OOB levels below -40 dBm / MHz.⁴¹³

183. On the other hand, SIA advocates for significant separation distances and OOB limits to prevent harmful adjacent band interference.⁴¹⁴ SIA observes that the Commission's "choice of 'band edges' and the frequency ranges in which it proposes to impose a stricter OOB limit (beyond 3550 MHz and 3650 MHz) do not make a great deal of sense if the goal is to protect adjacent band FSS earth station receivers operating at 3600 MHz and above."⁴¹⁵ However, SIA agrees with the Commission's observation that "a more stringent limit would enable closer proximity of neighboring service operations."⁴¹⁶ SIA presents an engineering study by RKF Engineering, including an analysis of the required line-of-sight separation distances between a CBSD and an FSS earth station as a function of OOB limit (-13, -40, and -50 dBm / MHz) and the earth station off-axis angle.⁴¹⁷ The study shows separation distances of tens of kilometers required to control aggregate interference with an OOB limit of -13 dBm / MHz, while the required separation distances with a tighter OOB limit of -50 dBm / MHz are between 100 m and 1 km, depending on the off-axis angle to the FSS earth station.⁴¹⁸

184. *Discussion.* After review of the record, we adopt emissions and interference limits that will further the Commission's goals and promote effective coexistence of different users in the band. Specifically, we adopt the following:

- -13 dBm/MHz from 0 to 10 megahertz from the SAS assigned channel edge
- -25 dBm/MHz beyond 10 megahertz from the SAS assigned channel edge down to 3530 MHz and up to 3720 MHz
- -40 dBm/MHz below 3530 MHz and above 3720 MHz

⁴¹² See Google *FNPRM* Comments at 26.

⁴¹³ See NTIA Technical Report TR 14-506, Effects of Radar Interference on LTE (FDD) eNodeB and UE Receiver Performance in the 3.5 GHz Band, Section 4, and NTIA Technical Report TR 15-512, Emission Spectrum Measurements of a 3.5 GHz LTE Hotspot.

⁴¹⁴ See SIA *FNPRM* Comments at 15.

⁴¹⁵ *Id.* at 17.

⁴¹⁶ *Id.* at 15-19.

⁴¹⁷ See *id.* at Technical Annex.

⁴¹⁸ *Id.* at Figure 12.

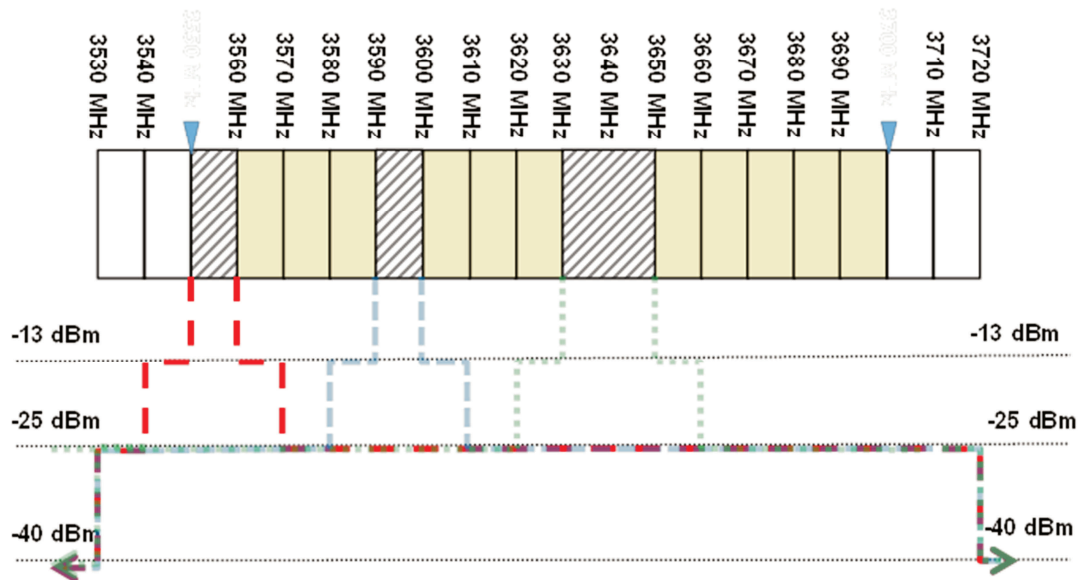


Figure 2

We recognize that these emission limits are more stringent than what we proposed in the *FNPRM*. However, we also observe that these limits are a logical extension of multiple proposals in the record, which reflects more stringent requirements at greater offsets from the band, and are consistent with the capabilities of the equipment and services likely to be deployed in this band. Some commenters suggest that the Commission should harmonize with the existing 3GPP standards. Industry standards typically cover many radio options and variations (e.g., many bandwidths, base station types, user equipment types, modulation types), resulting in many different OOB power level specifications.⁴¹⁹ We believe that the Commission's rules can simultaneously be supportive of such flexible and evolving standards, while also being technology neutral, and not overly prescriptive.

185. We agree with Google that the approach to interference limits and service protection should recognize that device performance may exceed industry standards and baseline regulations.⁴²⁰ However, the baseline standards and rules must be balanced and sufficiently stringent to ensure that spectrum sharing between diverse radio services and license types will work. They should also address a wide range of technologies, standards, and radio types (e.g., end user devices, access points, small cells, base stations, etc.) without being excessively complicated or stifling innovation. BLiNQ proposes an adjacent channel leakage ratio (ACLR)⁴²¹ for first and second adjacent channels. However, BLiNQ's proposal appears to only address base station radios and not end-user devices.⁴²² We recognize that end-user device radios may have different adjacent channel performance requirements as compared to base station requirements in industry standards (e.g., 30-33 dB ACLR for end user equipment versus 45 dB ACLR for base stations⁴²³). However, because we are adopting conducted power limits for end-user

⁴¹⁹ See 3GPP TS 36.101, TS 36.104; *Ex Parte* Letter from Douglas A. Gray, WiMAX Forum, to Marlene H. Dortch, Secretary, Federal Communications Commission in GN Docket No. 12-354 (filed Jan. 27, 2015).

⁴²⁰ See Google *FNPRM* Comments at 26.

⁴²¹ Adjacent Channel Leakage Ratio (ACLR) is the ratio of the filtered mean power centered on the assigned channel frequency to the filtered mean power centered on an adjacent channel frequency.

⁴²² See BLiNQ December 2014 *Ex Parte* at 3.

⁴²³ 3GPP TS 36.101 Section 6.6.2.3.

devices that are similar to the rules for CBSD conducted power limits, we can adopt one set of OOBEm rules to cover both CBSDs and End User Devices thereby avoiding adding more complexity to the emission rules.

186. Additionally, we must consider the OOBEm limits in context of our decision to include the 3650-3700 MHz band as part of the 3.5 GHz Band.⁴²⁴ The existing Part 90 rules for that band segment specify a -13 dBm / MHz OOBEm limit above 3700 MHz, while the proposed OOBEm limits in the *FNPRM* above 3700 MHz were -40 dBm / MHz.⁴²⁵

187. As an initial matter, we note that adopting a -13 dBm / MHz OOBEm limit for the first 10 megahertz beyond the SAS assigned channel edge is reasonably supported by industry standards and existing technologies, it is consistent with the limits for other Commission regulated services, and it is non-controversial among commenters.⁴²⁶ Similarly, based on the NTIA measurements, the 3GPP emission mask for user devices and base stations, and the WiMAX spectrum emission mask for 10 megahertz bandwidth equipment, we find that an emission limit of -25 dBm / MHz at frequency offsets beyond 10 megahertz from the SAS assigned channel edge up to 3530 MHz and 3720 MHz is also reasonably supported by industry standards and existing technologies. We acknowledge that this is more stringent than the proposed limit which did not have such an intermediate limit. However, based on our review of the record, existing standards, and the NTIA measurements, we believe that adopting this limit will allow for greater spectrum efficiency through shorter coupling distances and reduced interference potential while not having a significant impact on equipment cost.

188. We also address the size of the transition gap. While some commenters supported the proposed 30 megahertz transition gap from the upper edge of an authorized CBSD channel to an out-of-band emission limit of -40 dBm / MHz,⁴²⁷ there would be a significant impact on the required separation distance between CBSDs operating just below 3700 MHz, and C-Band earth station receivers operating between 3700-3730 MHz, where the higher (-13 dBm / MHz) OOBEm limit applied.⁴²⁸

189. We disagree with AT&T that our proposed OOBEm limit is too stringent.⁴²⁹ NTIA measurements show that the OOBEm of commercial products can be lower than -40 dBm / MHz at offsets higher than 20 megahertz. Based on these measurements, we adopt a 20 megahertz transition gap instead of our proposed 30 megahertz transition gap.⁴³⁰ This more stringent requirement appears to be practically realizable with existing state-of-the-art products at little or no added cost and will provide superior protection to FSS and DoD systems as compared to our original proposal.⁴³¹ We therefore adopt -40 dBm / MHz as the OOBEm limit for End User Devices and CBSDs, at frequencies above 3720 MHz and below 3530 MHz. Motorola Mobility argues that larger aggregated channels above 20 megahertz up to 40 megahertz in bandwidth may not be possible because a 30 megahertz transition gap would be too narrow

⁴²⁴ See *3.5 GHz FNPRM*, 29 FCC Rcd at 4297-99, ¶¶ 80-84. See *infra* section III(J).

⁴²⁵ *3.5 GHz FNPRM*, 29 FCC Rcd at 4298, ¶ 83; 47 C.F.R. § 90.1323(a).

⁴²⁶ The emission limits are defined with respect to the SAS assigned channel edge to accommodate the ability of licensees to aggregate multiple channels. In these cases, the emission limits only need to be met at the edges of those aggregated channels.

⁴²⁷ See Qualcomm *FNPRM* Comments at 9; Motorola Mobility *FNPRM* Comments at 9; and Motorola Solutions *FNPRM* Comments at 7.

⁴²⁸ See Comsearch Report at 6.

⁴²⁹ See AT&T *FNPRM* Reply Comments at 19-20.

⁴³⁰ See NTIA Technical Report TR 15-512, Emission Spectrum Measurements of a 3.5 GHz LTE Hotspot.

⁴³¹ See NTIA Technical Report TR 15-512, Emission Spectrum Measurements of a 3.5 GHz LTE Hotspot. See also, NTIA Technical Report 14-506, Effects of Radar Interference on LTE (FDD) eNodeB and UE Receiver Performance in the 3.5 GHz Band.

to meet the -40 dBm / MHz limit outside of the 3.5 GHz Band.⁴³² We are not convinced that OOB limits should be raised or the transition gap should be wider, at the expense of less spectral efficiency and increased risk of interference to incumbent systems.

190. Finally, we encourage industry to establish improved emission standards and reception performance for both the protection of incumbent and future radio services. Improved performance in these areas, could allow for denser deployment of CBSDs closer to Incumbent Users, and more efficient use of the 3.5 GHz Band.

c. Received Signal Strength Limits

191. *Background.* In the *FNPRM*, we indicated that the SAS should have a baseline threshold for the maximum permitted aggregate signal level from all CBSDs at the borders of PALs. We stated that Citizens Broadband Radio Service users should ensure that the aggregate signal level from their CBSDs as well as the aggregate transmissions from their associated End User Devices at the edge of their authorized service boundaries remain at levels that would not harm other CBSDs in the same or adjacent service areas. For small cell networks, industry standards and studies have shown, so long as interference rise over noise (IoT) remains at or below 20 dB and 55 dB for picocells and femtocells, respectively, performance is not impaired.⁴³³ Based on the industry studies, and taking into account reasonable distance between authorized user operations, we proposed a maximum aggregate signal level threshold of -80 dBm with reference to a 0 dBi antenna in any 10 megahertz bandwidth, at a height of 1.5 meters above the ground level, anywhere along the boundary of a PAL license area.⁴³⁴ Furthermore, we proposed a minimum adjacent channel and in-band blocking interference threshold not to exceed -30 dBm / 10 megahertz with greater than 99% probability. We also proposed to allow neighboring PALs to coordinate and mutually agree on higher or lower signal level thresholds. We sought comment on these proposals.⁴³⁵

192. Commenters offered a range of positions on what would constitute an acceptable signal level at the boundary of each service area. Notably, WISPA and Federated Wireless support the Commission's proposal to establish a signal strength limit along the borders of individual license areas.⁴³⁶ Motorola Solutions agrees and states that a -80 dBm limit would be an acceptable initial starting level.⁴³⁷ Some commenters believe using 3GPP standards for Band 42 and 43 and a reference sensitivity limit of -96 dBm over a 10 megahertz channel bandwidth would be appropriate.⁴³⁸ Commenters including AT&T, Motorola Solutions, and WISPA agree that, regardless of the maximum signal level set at the border, individual licensees should be allowed to agree on alternate signal levels appropriate to their network

⁴³² See Motorola Mobility *FNPRM* Comments at 9.

⁴³³ See *3.5 GHz FNPRM*, 29 FCC Rcd at 4297, ¶ 79; See also 3GPP, Technical Specification Group Radio Access Network, Evolved Universal Terrestrial Radio Access (E-UTRA), Radio Frequency (RF) requirements for LTE Pico Node B (release 11), 3GPP TR 36.931 version 11.0.0 (2012-09), available at: <http://www.3gpp.org/DynaReport/36931.htm> at section 6.1.2.3.1; and 3GPP, Technical Specification Group Radio Access Network, Evolved Universal Terrestrial Radio Access (E-UTRA), TDD Home eNodeB (HeNB) Radio Frequency (RF) requirements analysis (release 11), 3GPP TR 36.922 v11.0.0 (2012-09), available at: <http://www.3gpp.org/DynaReport/36922.htm>.

⁴³⁴ See *3.5 GHz FNPRM*, 29 FCC Rcd at 4297, ¶ 79.

⁴³⁵ See *id.*

⁴³⁶ See WISPA *FNPRM* Comments at 31, Federated Wireless *FNPRM* Reply Comment at 11.

⁴³⁷ See Motorola Solutions *FNPRM* Comment at 7.

⁴³⁸ See AT&T *FNPRM* Comments at 46; Pierre de Vries *FNPRM* Reply Comment at 4-5.

configurations.⁴³⁹

193. Verizon argues that rather than using a one-size-fits-all specification, a multilevel interference framework with different regimes (areas, channel sets) for managing the allowed frequency reuse density to achieve different IoT targets would advance the Commission's objectives.⁴⁴⁰ Google contends that a fixed maximum signal level of -80 dBm along license area boundaries does not reflect actual network deployment parameters and could lead to inefficient use of the band. It argues that it would be more efficient for the SAS to assign a PAL's boundaries based on the actual characteristics of a licensee's proposed network equipment, CBSD locations, and the physical characteristics of the area where that network will operate.⁴⁴¹ Similarly, Wireless Innovation Forum contends that the appropriate signal threshold should be network dependent and that a general received signal strength limit should be determined by PAL and GAA service providers. It contends that a multi-stakeholder working group is the proper forum for determining the appropriate maximum signal threshold along license area borders.⁴⁴²

194. With regard to adjacent reception limits, Pierre de Vries, Senior Fellow and Co-Director of the Spectrum Policy Initiative at the Silicon Flatirons Center at the University of Colorado at Boulder, argues that such limits will facilitate productive coexistence among Priority Access Licensees, whereby dynamic frequency assignment requires an explicit statement of the interference rights and responsibilities of receivers.⁴⁴³ NSN states that systems likely to operate in this band should follow the technical specifications of standards bodies such as 3GPP, and the Commission should not specify minimum receiver standards.⁴⁴⁴ Motorola Mobility states that receiver limits should be set by standards organizations and the adoption of any guidance by the Commission should be voluntary.⁴⁴⁵ Motorola Mobility also argues that, if the Commission concludes that a mandated receiver requirement is necessary, it should not be more stringent than 3GPP in-band blocking specifications and the Commission should define separate requirements for in-band and out-of-band blocking.⁴⁴⁶ Pierre De Vries states that -30 dBm per 10 megahertz is reasonable and conservative, and cites drive test field data that suggests that -30 dBm per 10 megahertz, 99th percentile, could be lowered by 5 dB or more, leading to more operational flexibility for licensees.⁴⁴⁷ Furthermore, Motorola Solutions believes that -30 dBm per 10 megahertz is too burdensome and implies more adjacent channel selectivity than is feasible in typical broadband system designs, and would limit CBSD system (weak signal) coverage in areas with strong adjacent channel signals. Motorola Solutions recommends an interference requirement no higher than -40 dBm per 10 megahertz if a general fixed interference power spectral density level is enforced by rule for adjacent and alternate channels.⁴⁴⁸

195. *Discussion.* After a thorough review of the record, we believe that establishing a baseline maximum signal level along license area boundaries will help foster effective coexistence in the 3.5 GHz Band. We also find that licensees should be permitted to agree to lower or higher acceptable maximum

⁴³⁹ See Motorola Solutions *FNPRM* Comment at 7, WISPA *FNPRM* Comments at 31, AT&T *FNPRM* Comments at 46.

⁴⁴⁰ See Verizon *FNPRM* Comments at 8-9.

⁴⁴¹ See Google *FNPRM* Comments at 15-16.

⁴⁴² See Wireless Innovation Forum *FNPRM* Comments at 41.

⁴⁴³ See Pierre de Vries *FNPRM* Comments at 3-5.

⁴⁴⁴ See Nokia Solutions and Networks US LLC *FNPRM* Comments at 18.

⁴⁴⁵ See Motorola Mobility *FNPRM* Comments at 10.

⁴⁴⁶ *Id.* at 11.

⁴⁴⁷ See Pierre de Vries *FNPRM* Comments at 5-6.

⁴⁴⁸ See Motorola Solutions *FNPRM* Comments at 7-8.

signal levels appropriate to their particular network configurations. We believe that the aggregate -80 dBm per 10 megahertz signal threshold at the service boundaries proposed in the *FNPRM* is wholly appropriate for the dense cell deployments and relatively small license areas that we expect in this band. Therefore, we adopt our proposal for aggregate received signal level at a PAL license boundary to be at or below an average (rms) power level of -80 dBm when integrated over a 10 MHz reference bandwidth with the measurement antenna placed at a height of 1.5 meters above ground level. We also recognize that the PAL licensees may agree to an alternative limit besides -80 dBm at their service boundaries and communicate it to an SAS. Moreover, these signal level requirements will not apply to adjacent license areas held by the same Priority Access Licensee. We recognize that ensuring compliance with this limit at the boundary is likely challenging on a real-time basis and there are legitimate questions relative to how to develop appropriate predictive models. We also recognize that the use of an aggregate metric could be challenging in a multi-user environment.⁴⁴⁹ We encourage any multi-stakeholder group formed to address technical issues raised by this proceeding to consider how this limit should be applied.⁴⁵⁰ As an initial matter, we will apply the limit through measurements at the license area boundary at times of peak activity.

196. Furthermore, we believe that efficient use of the band by both Priority Access Licensees and GAA users requires not only the specification of emission limits but also the protection limits that should be afforded to PAL receivers, without mandating receiver performance specifications. We agree with Pierre de Vries that a baseline reception limit lower than -30 dBm per 10 megahertz is appropriate and will lead to more operational flexibility to licensees.⁴⁵¹ We also agree with Motorola Solutions' recommendation of a threshold no higher than -40 dBm per 10 megahertz.⁴⁵² Therefore, we adopt the rule that Priority Access Licensees must accept adjacent channel and in-band blocking from other Priority Access or GAA radios in the band, up to a power spectral density level not to exceed -40 dBm per 10 megahertz with greater than 99% probability.⁴⁵³

197. We also acknowledge that licensees may have a legitimate need for flexibility in their network deployments, which may not all fit into the dense small cell category and therefore may tolerate lower or higher levels of interference. It is our policy to encourage technical flexibility wherever possible and it is clear from the record that several commenters desire such flexibility here. By leveraging the capabilities of the SAS, licensees will hopefully be able to reach agreement on maximum signal thresholds that will maximize the utility of the band, promote spectral reuse, and facilitate efficient network planning. As such, we find that holders of geographically and spectrally adjacent licenses may mutually consent to different thresholds than the mandatory baseline. Such agreements must be communicated to an SAS Administrator. The SAS Administrator shall enforce these agreements to the extent that such agreements do not conflict with its other responsibilities under the rules or cause impermissible interference to other Citizens Broadband Radio Service users of the same or higher tier.

2. CBSD Requirements

a. CBSD Categories and Power Requirements

198. *Background.* In the *FNPRM*, we defined CBSD categories based on multiple use cases. We proposed a baseline maximum conducted power of 24dBm per 10MHz (Power Spectral Density of 14dBm/MHz) and, maximum EIRP of 30dBm for CBSDs.⁴⁵⁴ We noted that this proposal was consistent

⁴⁴⁹ See *infra* section IV (C).

⁴⁵⁰ See *infra* section III (K).

⁴⁵¹ See Pierre de Vries *FNPRM* Comments at 5-6.

⁴⁵² See Motorola Solutions *FNPRM* Comments at 7-8.

⁴⁵³ See Appendix A, § 96.41(f).

⁴⁵⁴ See 3.5 GHz *FNPRM*, 29 FCC Rcd at 4296, ¶ 74; Proposed Rules, § 96.38

with the values commonly assumed in various studies for small cell base stations. We also proposed higher power limits for rural CBSDs. Specifically, we proposed that rural CBSDs have flexibility to transmit a maximum conducted power of 30dBm per 10 megahertz (Power Spectral Density of 20dBm/MHz) and EIRP of 47dBm.⁴⁵⁵ For purposes of this rule part, we proposed that a rural area be defined as a county (or equivalent) with a population density of 100 persons per square mile or less, based upon the most recently available Census data.⁴⁵⁶ The *FNPRM* also proposed a third category of CBSD deployment for fixed point-to-point (PTP) CBSDs with maximum conducted power not to exceed 30dBm per 10 MHz (Power Spectral Density of 20dBm/MHz) and EIRP of 53dBm.⁴⁵⁷ We also indicated that the maximum operational EIRP of individual base stations might be reduced by the SAS to prevent interference and promote efficient network operation.⁴⁵⁸

199. Commenters diverged greatly with regard to the maximum allowable power for devices operating in the band, with many supporting variable power limits for different use cases. For instance, AT&T, Google, Motorola Solutions, and NSN support a 36dBm maximum EIRP for baseline CBSDs.⁴⁵⁹ CTIA also argues that the power levels proposed in the *FNPRM* are too low for effective small cell deployment.⁴⁶⁰ Verizon advocates up to 46dBm EIRP for baseline CBSDs.⁴⁶¹ Alcatel-Lucent argues for 30dBm maximum power for indoor CBSDs and greater than 30dBm for outdoor CBSDs. Alcatel-Lucent also contends that for outdoor cells, allowing greater than the proposed 30dBm (1W) limit could foster rapid deployment in the 3.5 GHz Band.⁴⁶²

200. Sony supports the Commission's proposed maximum power of 30dBm.⁴⁶³ Shure contends that 20dBm EIRP would be sufficient to characterize devices with low interference potential.⁴⁶⁴

201. NTIA states that 30 dBm per 10 MHz channel maximum EIRP would be appropriate for CBSD deployment during the first phase of the proposed commercial-federal sharing proposal described in section III (G) (1). In subsequent phases, NTIA indicates that higher power CBSDs could be permitted provided that relevant CBSD parameters required to protect radar operations at higher power levels are determined through the SAS and ESC approval and authorization process.⁴⁶⁵

202. For rural CBSD deployments, Qualcomm and Motorola Solutions support maximum EIRP of 47dBm and believe the FCC should allow the band to be used at higher power levels for cellular deployments away from the coast.⁴⁶⁶ Along the same lines, Verizon asserts that 58dBm EIRP would be appropriate for non-baseline use cases.⁴⁶⁷

⁴⁵⁵ *Id.*

⁴⁵⁶ See Proposed Rules, § 96.3 (Rural Area definition).

⁴⁵⁷ See *3.5 GHz FNPRM*, 29 FCC Red at 4296, ¶ 74; Proposed Rules, § 96.38

⁴⁵⁸ *Id.* at 4295, ¶ 70.

⁴⁵⁹ See NSN *FNPRM* Comments at 20, AT&T *FNPRM* Reply Comment at 21; Motorola Solutions *FNPRM* Comments at 5; Google *FNPRM* Comments at 26.

⁴⁶⁰ See CTIA *FNPRM* Comments at 9.

⁴⁶¹ See Verizon *FNPRM* Comments at 8.

⁴⁶² See Alcatel-Lucent *FNPRM* Comments at 12.

⁴⁶³ See Sony *FNPRM* Comments at Annex 6.

⁴⁶⁴ See Shure *FNPRM* Comments at 6.

⁴⁶⁵ See *infra*, section III(G)(1)(a).

⁴⁶⁶ See Motorola Solutions *FNPRM* Comments at 5; Qualcomm *FNPRM* Comments at 13; Qualcomm *FNPRM* Reply Comments at 8.

⁴⁶⁷ See Verizon *FNPRM* Comments at 8.

203. WISPA supports higher power operations in rural areas and argues that the Commission should define “rural area” in the same manner that the Rural Utilities Service defines it for its Community Connect program. This definition deems an area “rural” if it “ is not located within: (i) A city, town, or incorporated area that has a population of greater than 20,000 inhabitants; or (ii) An urbanized area contiguous and adjacent to a city or town that has a population of greater than 50,000 inhabitants.”⁴⁶⁸

204. We also received transmit power recommendations from parties who would like to utilize the 3.5 GHz Band for point-to-point and point-to-multipoint services. BLiNQ provided a range of EIRP limits and argued that by adopting intermediate power limits between the baseline 30dBm EIRP limit and the 53dBm EIRP point-to-point limit, the Commission can enable innovative use cases, including non-line-of-sight (NLOS) point-to-multipoint backhaul.⁴⁶⁹ For fixed PTP systems, AT&T and Motorola Solutions both advocate for a 53 dBm EIRP allowable power limit.⁴⁷⁰

205. *Discussion.* We believe that it is vitally important to establish flexible, yet simple, rules that would allow for a wide variety of innovative services to be deployed in the 3.5 GHz Band and we are encouraged that many commenters share this view. Ensuring that the band is available for multiple use cases should encourage rapid network deployment, promote the development of a robust device ecosystem, and help to ensure the long-term viability of the band. It is also important that we provide interference protection to Incumbent Users and Priority Access Licensees. To advance these goals, we define two categories of CBSDs. Category A and Category B CBSDs will be defined mainly by their maximum conducted power and deployment conditions. Both CBSD categories will be available for GAA and Priority Access use (with certain caveats, described below). This commonality of technical rules throughout the Citizens Broadband Radio Service will ensure that equipment can switch between GAA and PA authorizations over time without changing network coverage footprint.

206. Category A represents a lower-power use (small cells being the paradigmatic example) that we expect will be widely prevalent in the 3.5 GHz Band. Category A CBSDs will be limited to a maximum conducted transmit power of 24 dBm and a maximum EIRP of 30 dBm in 10 megahertz, but will be required to operate in accordance with instructions from the SAS, which for interference prevention reasons, may authorize a lower power level (*see* sections 96.41 and Subpart F of the rules).⁴⁷¹ These parameters are consistent with the baseline small cell use case proposed in the *FNPRM* and with NTIA’s phased federal-commercial sharing plan.⁴⁷² We believe that the lower power limit for Category A CBSDs will facilitate coordination with existing federal operations – particularly before an ESC is developed and made commercially available – while allowing Citizens Broadband Radio Service users to deploy a variety of small cell applications.

207. In addition, to facilitate coordination with neighboring Citizens Broadband Radio Service users, and to avoid potential interference into the incumbent services, Category A CBSDs shall not be deployed or operated outdoors with antennas exceeding 6 meters Height above Average Terrain.⁴⁷³ We believe that the majority of Category A devices will likely be deployed indoors or at street level. As discussed in greater detail below, Category B devices may be used for outdoor uses in other configurations such as non-line-of-sight backhaul.⁴⁷⁴

208. Category A CBSDs must also provide certain essential information about their

⁴⁶⁸ *See* WISPA *FNPRM* Comments at 14-15.

⁴⁶⁹ *See* BLiNQ *FNPRM* Comments at 7 and 9.

⁴⁷⁰ *See* Motorola Solutions *FNPRM* Comments at 5, AT&T *FNPRM* Reply Comments at 21.

⁴⁷¹ *See* Appendix A, § 96.41 and Subpart F.

⁴⁷² *See* NTIA Letter at 4-5.

⁴⁷³ *See* Appendix A, § 96.43(a).

⁴⁷⁴ *See e.g.*, BLiNQ December 2014 *Ex Parte*.

configuration, location, and operation (e.g., EIRP) when registering with an SAS.⁴⁷⁵ However, due to their relatively small footprint, information about antenna configuration (other than EIRP) need not be transmitted to the SAS. Assuming a relatively large number of Category A CBSDs, this will simplify frequency coordination in the band. Category A CBSDs do not have to be professionally installed. However, as described in section III(F)(2)(b), geo-location data must be provided by a professional installer if this information cannot be automatically reported by the CBSD. Once registered with an approved SAS, Category A CBSDs may operate throughout the entire 3550-3700 MHz range, provided they respect protections for Incumbent Users.

209. Category B CBSDs will be authorized to operate at higher power than Category A, providing greater flexibility and ensuring ongoing compatibility with existing 3650-3700 MHz operations. In non-rural areas, the conducted power limit is the same as Category A (24 dBm), but the EIRP limit is 40 dBm. In rural areas, the conducted power limit is increased to 30dBm per 10 MHz and EIRP to 47 dBm EIRP per 10 MHz.⁴⁷⁶ As implied by the difference between low conducted and higher radiated power limits, Category B CBSDs can make use of more directional, higher-gain antennas to achieve increased range. Compared to an approach that merely specifies a higher EIRP, our rule should promote efficient use of the spectrum and facilitate greater coexistence with neighboring CBSDs. The higher rural power limits reflect challenges for deploying wireless coverage in rural areas as well as decreased contention for spectrum resources due to lower population density in those areas.

210. In order to realize these efficiencies, we require Category B CBSDs to provide the SAS with additional information about antenna configuration, including the antenna gain, beamwidth, azimuth, downtilt angle, and antenna height above ground level.⁴⁷⁷ Such information can help SASs more accurately estimate the signal transmissions from such high power nodes and avoid harmful interference. In addition, as described in section III(F)(2)(b), Category B CBSDs will be limited to outdoor deployments and – due to their higher maximum transmit power – they are required to be installed professionally. Crucially, as discussed below in section III(G)(1), Category B operations in the 3550-3650 MHz band segment will only be permitted pursuant to authorization of an appropriately calibrated ESC, and consistent with system parameters required to protect federal incumbent operations.⁴⁷⁸

211. We believe that this approach addresses many of the concerns raised by commenters that support higher power operations in the band. Commenters supporting higher power CBSDs typically express interest in using such devices for outdoor backhaul, coverage, or capacity for managed networks.⁴⁷⁹ While we acknowledge that some commenters, including Alcatel-Lucent, AT&T, BLiNQ, CTIA, and Verizon requested higher maximum power levels for outdoor operations than we adopt in this *Report and Order*, we believe that the Category B criteria we adopt will allow a wide range of network deployments, including point-to-point and point-to-multipoint transmissions, while maximizing coexistence between and within different tiers of user.⁴⁸⁰ Thus, we are not adopting specific rules for point-to-point deployments as we proposed. Moreover, these criteria are consistent with permissible power levels and deployment characteristics in the 3650-3700 MHz band and should allow current 3650-

⁴⁷⁵ See Appendix A, §§ 96.39(c) and 96.43(b). See *infra* section III(H)(2)(b).

⁴⁷⁶ See Appendix A, § 96.41(b).

⁴⁷⁷ See Appendix A, § 96.45(d).

⁴⁷⁸ See sections III(I) and III(G)(1).

⁴⁷⁹ See e.g., *Ex Parte* Letter from Trey Hanbury, Counsel to BLiNQ Networks, Inc, to Marlene H. Dortch, Secretary, Federal Communications Commission in GN Docket No. 12-354 (filed Nov. 20, 2014), AT&T *FNPRM* Reply Comments at 20-21, Verizon *FNPRM* Reply Comments at 6-7, T-Mobile *FNPRM* Comments at 11-13.

⁴⁸⁰ See Alcatel-Lucent *FNPRM* Comments at 12; AT&T *FNPRM* Reply Comments at 21; BLiNQ *FNPRM* Reply Comments at 2; CTIA *FNPRM* Comments at 9; and Verizon *FNPRM* Comments at 8.

3700 MHz licensees to continue to provide service within their existing network footprints.⁴⁸¹

212. Finally, we agree with WISPA’s proposed definition of “rural area.”⁴⁸² Accordingly, for purposes of the Citizens Broadband Radio Service, “rural area” will be defined as any census tract which is not located within, or overlapping: (i) a city, town, or incorporated area that has a population of greater than 20,000 inhabitants; or (ii) an urbanized area contiguous and adjacent to a city or town that has a population of greater than 50,000 inhabitants.⁴⁸³ We direct WTB to promulgate a machine-readable list of census tracts that meet the “rural area” definition.

213. The table below summarizes the main technical and operational characteristics of Category A and Category B CBSDs:

CBSD Category	Maximum Conducted Power (dBm/10 MHz)	Maximum EIRP (dBm/10 MHz)	Maximum Conducted PSD (dBm/MHz)	CBSD Installations	Operations in 3550-3650 MHz	Operations in 3650-3700 MHz
Category A	24	30	14	- Indoor - Outdoor max 6m HAAT	Everywhere Outside DoD Protection Zone	Everywhere Outside FSS and DoD Protection Zone ⁴⁸⁴
Category B (Non-Rural)	24	40	14	- Outdoor only - Professional Installation	Outside DoD Protection Zone & requires ESC approval	Everywhere Outside FSS Protection Zone and DoD Protection Zone
Category B (Rural)	30	47	20	- Outdoor only - Professional Installation	Outside DoD Protection Zone & requires ESC approval	Everywhere Outside FSS Protection Zone and DoD Protection Zone

214. We are cognizant that the determination of power limits must reflect consideration of several different public interest objectives with respect to the new Citizens Broadband Radio Service. On the one hand, higher limits may provide more technical flexibility for users of the band to increase coverage with sparser network topologies, potentially reducing deployment costs. On the other hand, lower power limits may lead to greater spatial reuse of the band, reduced coexistence challenges, and increased aggregate network capacity. In establishing the power limits herein, we strive to strike a practical balance of these different considerations based on the existing record. Nonetheless, we remain open to the possibility that we may allow higher power limits for Category B non-rural use at a future point in time, either through our usual waiver process or through modification of our initial rules. In

⁴⁸¹ See WISPA FNPRM Comments at 7.

⁴⁸² *Id.* at 13-14.

⁴⁸³ See Appendix A, § 96.3 (Rural Area definition).

⁴⁸⁴ DoD Protection Zones for the 3650-3700 MHz bands include only those sites listed at 47 C.F.R. § 2.106, note US 109.

making this consideration, we will place consideration on the extent to which demonstrable advances in technology, such as advanced SAS coordination capabilities or use of contention-based protocols in CBSDs (or both), would mitigate concerns about spectrum congestion in urban areas. For example, it might be possible that instead of the bright-line urban/rural distinction implemented in these initial rules, industry stakeholders (perhaps working through a multi-stakeholder forum) could agree on a “congestion metric” and associated methodology for SASs to reduce CBSD power levels in high-demand areas. We intend to continue an informal dialog with stakeholders on this topic and welcome the submission of additional technical analysis or reports of technological developments that can inform us going forward.

b. Geo-location and Reporting Capability

215. *Background.* In the *FNPRM*, we stated that for the SAS to accurately predict and evaluate potential interference and channel availability, it must receive and store accurate location information for all CBSDs. We proposed that all CBSDs must accurately report the location coordinates (referenced to the North American Datum of 1983, NAD83) of each of their antennas to within ± 50 meters (horizontal) and ± 3 meters (vertical).⁴⁸⁵ The proposed horizontal geo-location requirement is consistent with a similar requirement in the TVWS rules.⁴⁸⁶ Such geographic coordinates shall be reported to SAS at the time of first activation from a power-off condition. We also propose that CBSDs report their location to the SAS within 60 seconds of a change in location exceeding the accuracy requirement.⁴⁸⁷ This capability is used by a SAS to determine frequency availability and maximum power limits for CBSDs.

216. AT&T asserts that the geo-location requirements proposed in the *FNPRM* are not feasible.⁴⁸⁸ AT&T suggests that the Commission require that CBSDs report their location but defer on specific location accuracy requirements until the SAS is developed and agreed upon by a multi-stakeholder group.⁴⁸⁹ T-Mobile also requests that the Commission re-evaluate the proposals for ± 50 meters horizontal, ± 3 meters vertical location accuracy, and CBSDs to report their location to the SAS within 60 seconds of a change in location particularly as they pertain to PALs.⁴⁹⁰

217. In its comments, Google also questioned ± 3 meters vertical accuracy and stated that such accuracy is not technologically reasonable today and need to be revisited.⁴⁹¹ Google also submitted an *ex parte* filing arguing that “consumer devices should be able to report their location to a SAS either through an automated capability or through the services of a trusted installer.”⁴⁹² Google contends that this approach is consistent with Commission precedent in the TVWS proceeding.⁴⁹³

218. Google agrees that the Commission’s rules should require communication with the SAS whenever a controlling access point device (CBSD) moves more than 50 meters.⁴⁹⁴ AT&T contends that the proposed 60-second reporting requirement may not provide sufficient time for a CBSD to obtain an

⁴⁸⁵ See 3.5 GHz *FNPRM*, 29 FCC Rcd at 4293, ¶ 63.

⁴⁸⁶ See 47 C.F.R. § 15.711(b).

⁴⁸⁷ See 3.5 GHz *FNPRM*, 29 FCC Rcd at 4293, ¶ 63.

⁴⁸⁸ See AT&T *FNPRM* Comments at 5 and 40.

⁴⁸⁹ *Id.* at 42.

⁴⁹⁰ See T-Mobile *FNPRM* Comments at 13.

⁴⁹¹ See Google *FNPRM* Comments at 25.

⁴⁹² See Google January 2015 *Ex Parte* at 5.

⁴⁹³ See 47 C.F.R. § 15.711(b) (allowing location of a fixed device to be determined either through the device’s geolocation capability or by a professional installer); Google January 2015 *Ex Parte* at 5.

⁴⁹⁴ See Google *FNPRM* Comments at 18.

accurate location fix, particularly indoors.⁴⁹⁵ On the other hand, SIA claims that a 60-second interval for geo-location reporting is too long and notes that a shorter interval may be necessary to enforce incumbent protection criteria.⁴⁹⁶

219. *Discussion.* After thorough review of the record, we adopt the location accuracy requirements set forth in the *FNPRM*. We will allow location information to be captured and reported to SAS as part of a CBSD's initial registration either via automated geolocation technologies or by a professional installer. This approach allows for deployment in the band to proceed as new automated new technologies evolve to achieve the capability to automatically and accurately meet our geolocation requirements in different environments.⁴⁹⁷

220. Accurate CBSD location is essential for coordinating interactions between and among users in the band and for protecting Incumbent Users from harmful interference. Indeed, NTIA noted that CBSDs should transmit geo-location information to the SAS and SASs should use that information to determine permissible operational parameters.⁴⁹⁸ Without accurate location data, SASs will be unable to effectively determine where and at what power levels CBSDs should be authorized or effectively discontinue their operations to protect Incumbent Users. To this end, we also note that our rules require authentication of CBSDs with an SAS and require that SAS Administrators maintain the accuracy of stored data, including CBSD records. The latter requirement places a duty on SAS Administrators to take reasonable steps to validate newly entered data and to purge obsolete data. We believe that, in some conditions (*e.g.*, outdoors with clear line of site to GPS), automated reporting of geolocation to our location accuracy requirements is achievable. Other conditions, particularly indoors, may prove to be more challenging.

221. We will therefore permit professional installers to report accurate CBSD location information in lieu of automated reporting measures. Any subsequent CBSD movement must be reported by a professional installer as well. Since CBSDs will be fixed installations, the professional installation option should allow for network deployment in the near term while automatic geo-location technologies are tested and developed that meet our accuracy requirements.⁴⁹⁹

222. Given the importance of accurate reporting by professional installers, we strongly encourage the SAS and user community, through multi-stakeholder fora or industry associations, to develop programs for accrediting professional installers who receive training in the relevant Part 96 rules and associated technical best practices. We note that industry-led professional accreditation processes have proven successful in other similar situations. In fact, Section 154(f)(4)(D) of the Communications Act authorizes the Commission to “to endorse certification of individuals to perform transmitter installation, operation, maintenance, and repair duties in the private land mobile services and fixed services (as defined by the Commission by rule) if such certification programs are conducted by organizations or committees which are representative of the users in those services and which consist of

⁴⁹⁵ See AT&T *FNPRM* Comments at 40-41.

⁴⁹⁶ See SIA *FNPRM* Comments at 8,12.

⁴⁹⁷ The Commission recently addressed similar but distinguishable geo-location issues in an order that strengthened the Commission's E911 location accuracy rules to improve location determination for indoor and outdoor calls using CMRS providers. However, while some of the issues addressed in the *E911 Fourth Report and Order* are similar to those addressed herein, that proceeding dealt with determining the precise location of mobile devices in real time. CBSDs will be fixed devices and may be moved only intermittently, if at all, simplifying the process of determining and reporting the location of individual devices. See In the Matter of Wireless E911 Location Accuracy Requirements, PS Docket No. 07-114, *Fourth Report and Order*, FCC 15-9 (2015) (*E911 Fourth Report and Order*).

⁴⁹⁸ See NTIA Letter at 2.

⁴⁹⁹ Iposi Inc. claims that the accuracy required by our rules is feasible for almost all indoor and outdoor sites that use assisted GPS solutions. See Iposi, Inc. *FNPRM* Comments at 9.

individuals who are not officers or employees of the Federal Government.”⁵⁰⁰ Following the amendment of the Act to include this Section, the Commission eliminated the licensing requirement and “strongly endorse[d] and encourage[d] organizations or committees representative of users in the Private Land Mobile Radio and Private Operational-Fixed Microwave Services to establish a national industry certification program or programs for technicians,” but left the development of and details concerning such a program to the private sector.⁵⁰¹

c. Band-wide Operability

223. *Background.* In the *FNPRM*, we proposed to require that CBSDs have the ability to operate across all frequencies from 3550-3700MHz.⁵⁰² We noted that this proposal would ensure that all CBSDs and End User Devices certified to operate in the band would be capable of utilizing any frequencies assigned by the SAS. We sought comment on this proposal.⁵⁰³

224. Many commenters also support band-wide device operability because it would open a wider range spectrum for commercial use and give flexibility to the SAS to tune within the band to select the best available frequency.⁵⁰⁴ Some commenters, including existing 3650-3700 MHz band licensees, express concerns about extending the Citizens Broadband Radio Service framework into the 3650-3700 MHz band. As described in detail in section III(J), these commenters claim that compelling existing licensees to change or replace existing equipment to comply with the Part 96 licensing framework would undermine the substantial investments that licensees have made in the band.⁵⁰⁵ Specifically, UTC contends that compliance with band-wide operability requirements will necessitate equipment upgrades and changes which will impose significant additional costs on existing licensees.⁵⁰⁶

225. Commenters also express mixed opinions as to whether CBSDs and End User Devices should be required to be capable of operating in the 3.5 GHz Band on a two-way, stand-alone basis. CTIA, T-Mobile, and Verizon support rules that would allow Citizens Broadband Radio Service users to utilize either one-way or two-way technology in the 3.5 GHz Band. These commenters contend that the Commission should adopt technologically agnostic rules that would not require or restrict particular

⁵⁰⁰ 47 U.S.C. § 154 (f) (4) (D).

⁵⁰¹ Requirement for Licensed Operators in Various Radio Services, *Report and Order*, Gen. Docket No. 83-222, 96 FCC 2d 1123, 1141-45 paras. 36-43 (1984).

⁵⁰² See *3.5 GHz FNPRM*, 29 FCC Red at 4293, ¶ 64.

⁵⁰³ See *id.*

⁵⁰⁴ See *e.g.*, Motorola Mobility *FNPRM* Comments at 7; Verizon *FNPRM* Comments at 3; T-Mobile *FNPRM* Comments at 12; AT&T *FNPRM* Comments at 43; 4G Americas *FNPRM* Comments at 6. See also *Ex Parte* Letter from Scott K. Bergmann, Vice President, Regulatory Affairs, CTIA to Marlene H. Dortch, Secretary, Federal Communications Commission in GN Docket No. 12-354 (filed Mar. 24, 2015) at 2 (CTIA March 2015 *Ex Parte*); *Ex Parte* Letter from Patrick Welsh, Assistant Vice President, Federal Regulatory Affairs, Verizon Wireless to Marlene H. Dortch, Secretary, Federal Communications Commission in GN Docket No. 12-354 (filed Mar. 24, 2015) at 1 (Verizon March 2015 *Ex Parte*).

⁵⁰⁵ See *e.g.*, Lockard & White *FNPRM* Comments at 2-3; American Petroleum *FNPRM* Comments at 5-6; American Petroleum *FNPRM* Reply Comments at 2-5; WiMax Forum *FNPRM* Comments at 3-8; UTC *FNPRM* Comments at 5, 10; Neptuno Networks *Licensing PN* Comments at 3; SIA *NPRM* Comments at 18; SIA *NPRM* Reply Comments at 21-2; WISPA *FNPRM* Reply Comments at 15.

⁵⁰⁶ See UTC *FNPRM* Comments at 13. See also American Petroleum *FNPRM* Reply Comments at 3 (noting that “a major concern for 3.65 GHz band users is that recently deployed equipment will need to be replaced” if 3.5 GHz frame is extended to the band); WiMax Forum *FNPRM* Comments at 4.

technologies in the 3.5 GHz Band.⁵⁰⁷ CTIA contends that the Commission should adopt rules that are independent of the type of air interface technology deployed in the band. Specifically, CTIA argues that there is no reason for the Commission to prohibit technologies, such as LTE-Unlicensed (LTE-U), that rely on bonded channels in licensed bands.⁵⁰⁸ Verizon states that it intends to deploy equipment and devices that are capable of bi-directional operation in the 3.5 GHz Band but urges the Commission to avoid any mandate that would restrict how the spectrum is used.⁵⁰⁹

226. A number of commenters, including Federated Wireless, Google, NCTA, Open Technology Institute, and Public Knowledge have expressed concern that the use of LTE-U/Licensed Assisted Access (LAA) technology in the 3.5 GHz Band could negatively affect competition and innovation in the band.⁵¹⁰ NCTA contends that LAA's reliance on licensed spectrum would raise barriers to access for new entrants and give carriers with existing licensed spectrum an advantage in the band.⁵¹¹ As such, NCTA argues that the Commission should prohibit tying access to GAA frequencies to the use of a control channel in a licensed band.⁵¹² Google and Federated wireless argue that devices should be capable of operating across the entirety of the 3.5 GHz Band in a stand-alone manner, without relying on any other band.⁵¹³ Public Knowledge and the Open Technology Institute agree and contend that all equipment operated in the 3.5 GHz Band should be capable of operating on a standalone basis and that no standard incorporating 3.5 GHz frequencies should require access to exclusively licensed frequencies to function. They also urge the Commission to require any technology standard adopted for use in the 3.5 GHz Band to be licensed on fair and reasonable (FRAND) terms identical to those adopted by the IEEE and that the Commission adopt a spectrum etiquette rule, similar to the requirement for a contention-based protocols in the 3650-3700 MHz band.⁵¹⁴

227. *Discussion.* After review of the record, we conclude that all CBSDs must be capable of two-way transmissions on any frequency from 3550-3700 MHz as instructed by the SAS. Ensuring that all devices in the band are able to operate on any assigned frequency will promote innovation and flexibility in the band. Indeed, this rule is necessary to make full use of the frequency assignment capabilities of the SAS described in section III(H)(2)(c). Band-wide operability will also help to establish a consistent certification process for the entire band.⁵¹⁵ We also clarify that this rule requires all CBSDs

⁵⁰⁷ See T-Mobile March 2015 *ex parte* at 8; Letter from Scott K. Bergmann, Vice President, Regulatory Affairs, CTIA to Marlene H. Dortch, Secretary, Federal Communications Commission in GN Docket No. 12-354 (filed Mar. 24, 2015)CTIA January 2015 *ex parte* at 4; CTIA March 2015 *Ex Parte* at 1-2; Verizon March 2015 *Ex Parte* at 2.

⁵⁰⁸ See CTIA March 2015 *Ex Parte* at 1-2.

⁵⁰⁹ See Verizon March 2015 *Ex Parte* at 2.

⁵¹⁰ See *Ex Parte* Letter from Michael Calabrese, Director, Wireless Future Project, Open Technology Institute and Harold Feld, Senior Vice President, Public Knowledge to Marlene H. Dortch, Secretary, Federal Communications Commission (filed February 18, 2015) at 3-4 (OTI/PK February 18, 2015 *Ex Parte*) (OTI and PK filed two *ex parte* notices on February 18, 2015. This citation references the notice regarding OTI and PK's meeting Paul Powell and John Leibovitz of WTB); *Ex Parte* Letter from Rick Chessen, Senior Vice President, Law and Regulatory Policy, NCTA to Marlene H. Dortch, Secretary, Federal Communications Commission in GN Docket No. 12-354 (filed February 27, 2015) at 1-2 (NCTA February 2015 *Ex Parte*); *Ex Parte* Letter from Aparna Sridhar, Counsel, Google, Inc. to Marlene H. Dortch, Secretary, Federal Communications Commission in GN Docket No. 12-354 (filed January 12, 2015) at 9 (Google March 3, 2015 *Ex Parte*); Federated Wireless March 4, 2015 *Ex Parte* at 7-10.

⁵¹¹ NCTA February 2015 *Ex Parte* at 1-2.

⁵¹² *Id.* at 1-2.

⁵¹³ Google March 3, 2015 *Ex Parte* at 9; Federated Wireless March 4, 2015 *Ex Parte* at 7-10.

⁵¹⁴ See OTI/PK February 18, 2015 *Ex Parte* at 3-4.

⁵¹⁵ See Motorola Mobility LLC *FNPRM* Comments at 7, Verizon *FNPRM* Comments at 3, T-Mobile *FNPRM* Comments at 12, AT&T *FNPRM* Comments at 43, 4G Americas *FNPRM* Comments at 6.

and End User Devices in the band to be capable of two-way operations across the entire band. It does not require adherence to, or interoperability with, a particular transmission technology or air interface.

228. We agree with commenters that argue that devices in the 3.5 GHz Band should be *capable* of two-way operation.⁵¹⁶ We believe that this rule is crucial to promote competitive access to the band, encourage innovation, foster the development of a diverse equipment ecosystem, and ensure that the band is made available for a wide variety of innovative uses by an array of potential users, including standalone private networks that do not have recourse to mobile networks in other bands for signaling and control. However, we also conclude that CBSDs and End User Devices using the 3.5 GHz Band should not be required to *operate* in a two-way mode.⁵¹⁷ We believe that adopting this flexible rule, which allows licensees to elect whether to make use of a device's two-way functionality, will provide public interest benefits for the 3.5 GHz Band. This rule is consistent with the Commission's longstanding policies promoting technological neutrality and competition in emerging bands. We believe that the 3.5 GHz Band could potentially engender a wide diversity of network deployments, including by some non-traditional entrants that do not operate mobile networks in other spectrum. To this end, we will observe the development of technology standards for this band, with an eye toward ensuring they include, rather than preclude, a wide variety of uses and users.

229. In addition, as described in greater detail in section III(J), we exempt existing Part 90 equipment used by Grandfathered Wireless Broadband Licensees from the band-wide operability requirement and provide such licensees with a reasonable transition period during which their existing operations will be protected. After the transition period, such equipment will continue to be exempt from the band-wide operability requirement but must otherwise comply with the rules applicable to CBSDs, including SAS registration. These rules address some of the concerns raised by 3650-3700 MHz band licensees and their representatives regarding the threat to existing investment posed by a band-wide operability requirement.⁵¹⁸ This rule will facilitate the development of a robust device ecosystem and promote new investment in the band, and protect investments made by existing 3650-3700 MHz band licensees.

d. Registration Requirements

230. *Background.* In the *FNPRM*, we proposed that a CBSD must register and receive authorization from an approved SAS prior to its initial service transmission.⁵¹⁹ We also proposed to define a CBSD as "Fixed or Portable Base stations, or networks of such base stations..."⁵²⁰ We therefore intended that registration could occur directly between a CBSD and an SAS or between a network of CBSDs (In the latter instance, an intermediary network management element/proxy would be required). Specifically, we proposed that a CBSD must provide the SAS its geographic location, antenna height above ground level, requested authorization status whether it is Priority Access or General Authorized Access, unique FCC identification number, user contact information, and unique serial number.⁵²¹ We also proposed that the CBSDs update the SAS if any of the original registration parameters changes. CBSDs would be permitted to operate only if authorized by the SAS and if they follow frequency assignments and power limitations set by an SAS. We sought comment on these proposals.

⁵¹⁶ See OTI/PK February 18, 2015 *Ex Parte* at 3-4; NCTA February 2015 *Ex Parte* at 1-2; Google March 2015 *Ex Parte* at 9; Federated Wireless March 4, 2015 *Ex Parte* at 7-10.

⁵¹⁷ See OTI/PK February 18, 2015 *Ex Parte* at 3-4; NCTA February 2015 *Ex Parte* at 1-2.

⁵¹⁸ See e.g., UTC *FNPRM* Comments at 13; American Petroleum *FNPRM* Reply Comments at 3; WiMax Forum *FNPRM* Comments at 4.

⁵¹⁹ 3.5 GHz *FNPRM*, 29 FCC Rcd at 4292-93, ¶ 62.

⁵²⁰ See Proposed Rules, § 96.3 (CBSD definition).

⁵²¹ See 3.5 GHz *FNPRM*, 29 FCC Rcd at 4292-93, ¶ 62.

231. Many commenters generally agree with the concept of CBSDs registering with the SAS.⁵²² Microsoft suggests that there should be limits on the information the SAS collects and the time it maintains records for CBSDs.⁵²³ Sony also recommends that to better manage coexistence among PAL licensees and GAA users, each SAS should store the actual operational information of CBSDs and End User Devices registered with it.⁵²⁴ Some commenters expressed concern about the SAS having information on detailed operational parameters of mobile networks as well maintaining the confidentiality of sensitive information.⁵²⁵ Motorola Solutions also asserts that, similar to the TVWS rules, if a CBSD cannot successfully query an SAS within a designated period of time it should cease its operation in the band.⁵²⁶

232. *Discussion.* The Citizens Broadband Radio Service framework depends on SAS authorization of commercial use and protection of incumbents. In order to perform this function, it is essential for the CBSD to provide the SAS with necessary information about its operations prior to transmission. We therefore require that as part of registration, the CBSD should provide the SAS with a number of operational parameters, including geographic location, antenna height above ground level (meters), CBSD operational category (Category A/Category B), requested authorization status, unique FCC identification number, user contact information, air interface technology, unique serial number, and additional information on its deployment profile (*e.g.*, indoor/outdoor operation). All information provided by the CBSD to the SAS must be true, complete, correct, and made in good faith, and failure to provide such information will void the user's authority to operate the CBSD.⁵²⁷

233. We adopt additional registration requirements for Category B CBSDs. Pursuant to section 96.45, Category B CBSDs must register all information required under section 96.39 as well as antenna gain, antenna beamwidth, antenna azimuth for sector site, and antenna height above ground level.⁵²⁸ These additional requirements could provide the SAS with information necessary to perform effective propagation and interference mitigation analyses on these higher power devices. This will help ensure the effective coexistence of all tiers of user operating in the band. If any of the required registration information changes, the CBSD shall update the SAS within 60 seconds of such change.⁵²⁹

234. We encourage multi-stakeholder groups to consider the issues raised by the registration rules described in this section, including acceptable contact intervals between CBSDs and SASs, and to suggest appropriate operational parameters. We also acknowledge concerns raised by commenters about the security of information that will be retained by the SAS and the desire to keep certain sensitive information confidential. These issues are addressed in detail in section III(H)(2)(a).

e. Interference Reporting

235. *Background.* It was suggested in the *FNPRM* that, to help an SAS tune or update its predictive propagation models and detect realistic interference issues once CBSDs are deployed, the CBSDs should be able to provide signal strength and interference level measurements. This capability is

⁵²² See *e.g.*, Motorola Solutions *FNPRM* Comments at 3; AT&T *FNPRM* Comments at 33; Microsoft *FNPRM* Comments at 12; Ericsson *FNPRM* Comments at 21; Shared Spectrum Company *FNPRM* Reply Comments at 6; and Google *FNPRM* Comments at 22.

⁵²³ See Microsoft *FNPRM* Comments at 11.

⁵²⁴ See Sony *FNPRM* Comments at 4.

⁵²⁵ See Ericsson *FNPRM* Comments at 20; AT&T *FNPRM* Comments at 31-32.

⁵²⁶ See Motorola Solutions *FNPRM* Comments at 4.

⁵²⁷ See Appendix A, § 96.39(c).

⁵²⁸ See Appendix A, § 96.45(d).

⁵²⁹ See Appendix A, § 96.39(c).

already widely used to facilitate interference and radio resource management within cellular networks. It could be used in the 3.5 GHz Band to help promote coexistence between different users.

236. The record generally supports the proposal to incorporate interference reporting into CBSDs.⁵³⁰ However, some commenters contend that the details of such measurement/reporting should be specified by industry forums.⁵³¹

237. *Discussion.* We require that CBSDs be able to measure and report on their local interference levels and issues as set forth in the proposed rules. We encourage industry to develop detailed metrics regarding issues like received signal strength, packet error rate, and technology specific parameters of signal and interference metrics. These metrics could be developed by an industry multi-stakeholder group. Such guidance could be incorporated in the SAS Approval process described in section III(H)(3)(b) or incorporated independently by authorized SAS Administrators, subject to Commission review. This requirement is separate from sensing requirements associated with ESC, discussed in section III(I).

f. Security

238. *Background.* The *FNPRM* emphasized the importance of data security and end-to-end security for communications among CBSDs, End User Devices, and the SAS. To that end, we proposed a security requirement for all communications between authorized SASs and CBSDs. We also proposed to adopt comprehensive procedures to test and certify CBSDs and associated End User Devices for operation in this band and to require the SAS to disconnect any device whose proper operation has been compromised.⁵³² As described in section III(H)(2)(d), we also proposed to require that the SAS employ protocols and procedures to ensure that all communications and interactions between the SAS and CBSDs are accurate and secure and that unauthorized parties cannot access or alter the SAS or the list of frequencies sent to a CBSD.⁵³³

239. The record strongly supports the inclusion of robust security protocols for CBSDs and for communications between CBSDs and SASs.⁵³⁴ The record regarding secure communications between CBSDs and SASs is described in detail in section III(H)(2)(d).

240. *Discussion.* Data security is fundamental to the successful implementation of the Citizens Broadband Radio Service. To this end, as described in section III(H)(2)(d), we codify the requirement for secure communications between authorized SASs and CBSDs. We also adopt comprehensive procedures to test and certify CBSDs and associated End User Devices for operation in this band.⁵³⁵ Notably, all CBSDs and End User Devices must contain security features sufficient to protect against modification of software and firmware by any unauthorized parties. Applications for certification of CBSDs and End User Devices must include an operational description of the technologies and measures that are incorporated in the device to comply with the security requirements indicated in section 96.39.⁵³⁶ In addition, CBSDs and End User Devices should be able to protect the communication

⁵³⁰ See Motorola Solutions *FNPRM* Comments at 3, Shared Spectrum *FNPRM* Comments at 9, Federated Wireless *FNPRM* Comments at 20-21, Ericsson *FNPRM* Comments at 7-10, Microsoft *FNPRM* Comments at 11-12, AT&T *FNPRM* Comments at 43-44, Wireless Innovation Forum *FNPRM* Comments at 32.

⁵³¹ See *infra* III(K).

⁵³² See 3.5 GHz *FNPRM*, 29 FCC Red at 4294, ¶ 67; Proposed Rules, § 96.36(e).

⁵³³ See *Id.* at 4304, ¶ 104; Proposed Rules, § 96.47.

⁵³⁴ See e.g., Ericsson *FNPRM* Comments at 22; iconective *FNPRM* Comments at 7-8; Federated Wireless *FNPRM* Reply Comments at 20-21; Google *FNPRM* Comments at 31-32; WIN Forum *FNPRM* Comments at 10-11; Verizon *FNPRM* Comments at 17-18.

⁵³⁵ See *infra* sections III(H)(2), III(F)(4), and III(H)(3)(b).

⁵³⁶ Appendix A, § 96.39 (g).

data that are exchanged between these elements. SAS Administrators and CBSD operators who, in good faith, implement duly approved/certified SAS or CBSD security capabilities will be presumed, for enforcement purposes, to be compliant with the rules pertaining to those capabilities.⁵³⁷ Any subsequently identified security vulnerabilities will need to be resolved on a going-forward basis. We are mindful, however, of the limitations inherent in mandating any particular security technology or protocol through regulation. We encourage the industry to develop best practices for end-to-end security that can be validated in the equipment and SAS certification processes.⁵³⁸

3. End User Device Requirements

241. *Background.* In the *FNPRM*, we proposed that End User Devices must be authorized and controlled by an SAS-authorized CBSD. These devices may not be used as intermediate service access links or to provide service to other End User Devices. We also proposed that the End User Device transmit at an EIRP not to exceed 23dBm per 10MHz.⁵³⁹ End User Devices would operate only if they could positively receive and decode an authorization signal transmitted by a CBSD, including the frequency channels and power limits for their operation. This requirement would effectively prevent End User Devices from unauthorized operation in the 3.5 GHz Band and ensure that such devices operate only according to the instructions transmitted from the SAS to the CBSD.⁵⁴⁰ As discussed above, we proposed that all CBSDs along with all End User Devices must contain security features sufficient to protect against modification of software by unauthorized parties.

242. Some commenters support the idea of user devices transmitting power levels based on the latest 3GPP standards and believe that making this adjustment will promote global harmonization.⁵⁴¹ NSN and Motorola Mobility recommend user device transmit power to be at maximum 25dBm (23dBm +2/-3).⁵⁴² On the other hand, WISPA argues that the user device power level should agree with the three different power levels for CBSDs defined in the *FNPRM*. WISPA's view is that, the Commission should set the maximum conducted power to be 30dBm/10 MHz with maximum EIRP of 47dBm/10 MHz for end user devices in rural areas. In WISPA's view a lower EIRP limit would neutralize any benefits intended by the higher maximum power level proposed for CBSDs in rural area.⁵⁴³

243. *Discussion.* Based on industry standard power levels for end user devices and comments received we maintain the proposed maximum EIRP of 23dBm per 10 megahertz for end user equipment.⁵⁴⁴ We also conclude that End User Devices must only operate if they can receive and decode an authorization signal sent by a CBSD, including the frequencies and power limits for their operation.⁵⁴⁵ We agree with WISPA and BLiNQ that End User Devices should operate under power control of an associated CBSD.⁵⁴⁶ This requirement is necessary to ensure that interference levels can be effectively

⁵³⁷ See Appendix A, §§ 96.39 (g) and 96.61.

⁵³⁸ See Google *FNPRM* Comments at 31.

⁵³⁹ See *3.5 GHz FNPRM*, 29 FCC Rcd at 4296, ¶ 76.

⁵⁴⁰ See Proposed Rules, § 96.47.

⁵⁴¹ In their comments, Nokia Solutions and Motorola Mobility refer to 3GPP TS 36.101 V12.1.0 (Release 12). See NSN *FNPRM* Comments at 17-18; Motorola Mobility *FNPRM* Comments at 8-9. See also HKT *FNPRM* Comments at 4 (noting that 3GPP LTE and LTE-Advanced are becoming the dominant standard in the 3.5 GHz Band).

⁵⁴² See Nokia Solutions *FNPRM* Comments at 17-18 and Motorola Mobility Comments at 8-9.

⁵⁴³ See WISPA *FNPRM* Comments at 10.

⁵⁴⁴ See *3.5 GHz FNPRM*, 29 FCC Rcd at 4296, ¶ 76.

⁵⁴⁵ See Appendix A, § 96.47 (a).

⁵⁴⁶ See WISPA *FNPRM* Comments at 10, and BLiNQ *FNPRM* Reply Comments at 2.

managed in the band to protect Incumbent Access and Priority Access Licensees from harmful interference.

244. We do not agree with WISPA's assertion that End User Devices should be permitted to operate at power levels equal to CBSDs.⁵⁴⁷ Adopting such a rule would effectively authorize the deployment of innumerable higher power fixed and mobile devices in the band not subject to direct SAS authorization. As stated previously, SAS-enabled coordination is essential to the success of the Citizens Broadband Radio Service and is necessary to ensure a stable and secure spectral environment for Incumbent Access users. As such, we find that devices that need to operate at a higher EIRP than 23dBm will be considered to be CBSDs and subject to all CBSD requirements, including SAS registration.⁵⁴⁸

245. As described above, all End User Devices and CBSDs must also include necessary security features to protect against modification of software and firmware by any unauthorized parties. Applications for certification of CBSDs and End User Devices must include an operational description of the technologies and methods that are incorporated in the device to comply with the security requirements of this proceeding.⁵⁴⁹

4. Other Technical Issues

246. In the *FNPRM*, we proposed to apply our Part 1 RF Safety and Part 2 Equipment Authorization rules to CBSDs.⁵⁵⁰ The record did not raise objections, so we adopt these proposals.⁵⁵¹ We also emphasize that our equipment authorization process is essential to ensuring that CBSDs and End User Devices implement the various technical requirements in Part 96 that are essential to the overall integrity of the Citizens Broadband Radio Service framework.

G. Incumbent Protections

1. Federal Incumbent Protection

a. Multi-Phase Approach

247. *Background.* As we detailed in section II(B), the 3.5 GHz Band is currently used by a number of federal agencies for radiolocation operations. Federal operations in the band include high-powered DoD radar systems using ground-based and shipboard platforms.⁵⁵² In its Fast Track Report, NTIA concluded that geographic separation and frequency offsets could be used to minimize interference between commercial networks and radar systems operating in the 3.5 GHz Band. However, NTIA's analysis at the time indicated that it would be necessary to put in place exclusion zones around the coast to prevent incumbent operations and broadband wireless systems from causing interference to one another. NTIA concluded that effective exclusion zone distances around ground-based radar systems would extend approximately one to 60 kilometers, coupled with frequency offsets of 40 or 50 megahertz.⁵⁵³ Exclusion zones around certain high-power shipborne Naval radars would require over-land separation distances of several hundred kilometers.⁵⁵⁴

⁵⁴⁷ See WISPA *FNPRM* Comments at 10

⁵⁴⁸ See Appendix A, § 96.47 (b).

⁵⁴⁹ See Appendix A, § 96.39 (g).

⁵⁵⁰ See *3.5 GHz FNPRM*, Proposed Rules, § 96.39 and § 96.41.

⁵⁵¹ See Appendix A, § 96.51.

⁵⁵² See Fast Track Report at 3-30 – 3-33. See also *3.5 GHz NPRM*, 27 FCC Red at 15602-15605, ¶¶ 22-28 (discussion of entities operating in the 3.5 GHz Band and adjacent bands); *supra* section II(B),

⁵⁵³ *Id.* at 5-3 – 5-4.

⁵⁵⁴ *Id.* at 5-6, Table 5-4. See also *3.5 GHz NPRM*, 27 FCC Red at 15633 ¶ 118.

248. In the *FNPRM*, we proposed to adopt the geographic Exclusion Zones described in the Fast Track Report as a starting point for further updates and analysis.⁵⁵⁵ In the *FNPRM*, we noted that preliminary studies had been performed on the potential effects of small cells on radar operations, with additional studies planned, that could lead to a reduction in Exclusion Zones in the near future.⁵⁵⁶ We also noted that the rules proposed in the *FNPRM* contemplate additional uses other than small cells, with varying maximum transmit power levels and antenna gains, which must factor into the consideration of Exclusion Zones. We unambiguously stated that we would continue our dialogue with NTIA and other federal agencies regarding reduction of the Exclusion Zones and noted that various in-progress technical studies could yield information that would allow us to provide greater access to commercial users in the band.⁵⁵⁷ We asked commenters to submit data and studies that could help with the analysis.

249. We also stated that we would explore the topic of dynamic coordinated access within the Exclusion Zones in future phases of this proceeding. We sought comment on allowing Citizens Broadband Radio Service operations within Exclusion Zones and encouraged commenters to submit technical analyses to support their positions.⁵⁵⁸

250. Commenters overwhelmingly support reducing or eliminating the Exclusion Zones presented in the Fast Track Report and proposed as a starting point in the *FNPRM*.⁵⁵⁹ Qualcomm claims that Exclusion Zones based on actual small cell use cases could be less than 10 kilometers along the coastlines.⁵⁶⁰ Other commenters contend that, regardless of their size, exclusion zones should be reclassified as “coordination zones” to allow licensees to establish coordination agreements with incumbent users.⁵⁶¹

251. Some commenters propose that the Commission permit CBSDs to operate closer to the coastline when no federal radar systems are in use in the area.⁵⁶² Google and Federated Wireless contend that the Commission should adopt an engineering-based protection standard rather than relying on static exclusion zones.⁵⁶³ In addition, several commenters contend that sensing technologies could play a role in

⁵⁵⁵ See 3.5 GHz *FNPRM*, 29 FCC Red at 4315-16, ¶ 140; Fast Track Report at 5-6, Table 5-4

⁵⁵⁶ See Qualcomm *NPRM* Comments at 16-18; Jeffrey H. Reed, Charles Clancy, Virginia Tech (sponsored by NSWC Dahlgren Division), Measurement Results for Radar and Wireless System Coexistence at 3.5 GHz, (presented January 14, 2014), available at: http://wireless.fcc.gov/workshops/sas_01-14-2014/end/Reed-VA_TECH.pdf; Frank Sanders, Robert Sole, and John Carroll, NTIA, Effects of Pulsed Radar Waveforms on LTE (TDD) Receiver Performance (presented January 14, 2014), available at: http://wireless.fcc.gov/workshops/sas_01-14-2014/end/Sanders-NTIA.pdf.

⁵⁵⁷ See 3.5 GHz *FNPRM*, 29 FCC Red at 4315-16, ¶ 140-42.

⁵⁵⁸ See *Id.* at 4315-16, ¶ 140-42.

⁵⁵⁹ See e.g., Qualcomm *FNPRM* Comments at 7-8; PISC *FNPRM* Reply Comments at 26; NCTA *FNPRM* Comments at 6-8; Wi-Fi Alliance *FNPRM* Comments at 14-15; CTIA *FNPRM* Comments at 11; Google *FNPRM* Comments at 2-3; WISPA *FNPRM* Comments at 17-20; Microsoft *FNPRM* Comments at 2-4, 10; Motorola Mobility *FNPRM* Comments at 12-13; NSN *FNPRM* Comments at 5; Verizon *FNPRM* Reply Comments at 5-6; T-Mobile *FNPRM* Comments at 6-8; Ericsson *FNPRM* Comments at 10-12.

⁵⁶⁰ See Qualcomm *FNPRM* Comments at 7-8.

⁵⁶¹ See Verizon *FNPRM* Reply Comments at 6; T-Mobile *FNPRM* Comments at 7-8; Ericsson *FNPRM* Comments at 12.

⁵⁶² See, e.g., Google *FNPRM* Comments at 7-10; Federated *FNPRM* Comments at 15; Alcatel-Lucent *FNPRM* Comments at 8; Shared Spectrum Company *FNPRM* Comments at 6-9; WIN Forum *FNPRM* Comments at 5-6.

⁵⁶³ See Google *FNPRM* Comments at 7-10; Google *FNPRM* Reply Comments at 5; Federated Wireless *FNPRM* Reply Comments at 9-13.

enabling dynamic access to the 3.5 GHz Band.⁵⁶⁴ Notably, Google, Federated Wireless, and Virginia Tech submitted a joint filing that argues that a network of “dedicated listening devices” could eliminate the need for permanent fixed exclusion zones entirely.⁵⁶⁵

252. On January 12, 2015, CTIA and several of its member companies filed an *ex parte* presentation advocating an approach to the protection of federal incumbents that would incorporate sensing technologies to promote dynamic access to spectrum in the 3.5 GHz Band.⁵⁶⁶ In CTIA’s proposed approach, federal incumbents would be able to choose between an “informing” (*i.e.*, incumbent notification driven) or non-informing (*i.e.*, sensor-based) solution – to be developed and managed by private industry - for protection of their radar systems. CTIA also proposes technical solutions based on LTE network deployments.⁵⁶⁷

253. The NTIA Letter recommends, among other things: (1) changes to the regulatory framework of the spectrum sharing model described in the *3.5 GHz FNPRM*; (2) a phased implementation and approval process for the SAS and ESC; and (3) protection of commercial operations in the 3.5 GHz Band from federal radar systems. NTIA also supplements the technical information presented in the Fast Track Report and provides an explanation of its recent technical work on these issues.⁵⁶⁸

254. The phased approach described by NTIA relies on an SAS and ESC approved by the Commission to protect federal incumbent operations. NTIA asserts that these approval processes could take place simultaneously or separately.⁵⁶⁹

255. In the first phase, as recommended by NTIA, geographic exclusion zones would be established along the coastlines and around designated ground-based radar locations. CBSDs with an EIRP up to 30 dBm as measured in a 10 megahertz bandwidth would be authorized to operate outside of the Exclusion Zones during this phase but higher power operations would not be permitted. Approved SASs would manage Citizens Broadband Radio Service users outside of the Exclusion Zones during this phase. Phase two would begin after an ESC that meets all of the requirements set forth by the Commission is approved and synchronized with at least one approved SAS. With the SAS and ESC in place, the Exclusion Zones for the coastal areas and the ground-based radars would be converted to Protection Zones. ESC deployment near the borders of protection zones (*i.e.*, not nationwide) would protect radars from interference. NTIA indicates that the rules may authorize CBSDs at higher EIRP levels than 30 dBm provided that the relevant system parameters required to protect DoD operations at

⁵⁶⁴ Wireless Innovation Forum *NPRM* Comments at 3; Spectrum Bridge *NPRM* Comments at 19; Shared Spectrum Company *NPRM* Comments at 8-10; White Space Alliance *NPRM* Comments at 2; InterDigital Inc. *NPRM* Comments at 9, 16, and 17; Wireless Internet Service Provider Association *NPRM* Reply Comments at 16; Ericsson *FNPRM* Comments at 25; Telcordia Technologies Inc. *FNPRM* Comments at 7; Federated Wireless *FNPRM* Comments at 24-28; Verizon and Verizon Wireless *FNPRM* Comments at 15; Federated Wireless *FNPRM* Reply Comments at 2, 6, and 7; BLiNQ Networks *FNPRM* Reply Comments at 8 and 9; *Ex Parte* Letter from Trey Hanbury, Counsel to BLiNQ Networks, to Marlene H. Dortch, Secretary, Federal Communications Commission in Docket No. 12-354 (filed Sept. 6, 2013) at 7, 11, 12, and 18; Google *FNPRM* Reply Comments at 5 and 6; and PISC *FNPRM* Reply Comments at 32 and 33.

⁵⁶⁵ See *Ex Parte* Letter from Jeff Reed, Professor, Virginia Polytechnic Institute and State University, to Marlene H. Dortch, Secretary, Federal Communications Commission in Docket No. 12-354 (filed Sept. 3, 2014) (Google, Federated Wireless, and Virginia Tech September 2014 *Ex Parte*).

⁵⁶⁶ Participating CTIA members included Alcatel-Lucent, AT&T, Ericsson, NSN, Qualcomm, Sprint, T-Mobile, and Verizon. See CTIA January 2015 *Ex Parte*.

⁵⁶⁷ CTIA January 2015 *Ex Parte* at 7.

⁵⁶⁸ See NTIA Letter.

⁵⁶⁹ *Id.* at 4-5.

these higher levels are determined through the ESC approval process.⁵⁷⁰ NTIA also indicates that the phased approach could be used to protect the three protected federal radiolocation facilities in the 3650-3700 MHz band.⁵⁷¹

256. In addition to the coastal exclusion zones, NTIA identifies a need to protect short-duration, non-emergency use of shipborne radars during scheduled visits to ports along inland waterways. NTIA suggests that, given the advance notice associated with these types of events, shipborne radars could be protected by temporarily extending the Exclusion (or Protection) Zones to include these port areas. NTIA offers to work with the FCC and DoD to develop the necessary procedures to adequately protect these types of temporary shipborne radar operations.⁵⁷²

257. NTIA also states that a limited number of facilities used by DoD and its contractors for the development and testing of shipborne radars in the 3.5 GHz Band must be protected from harmful interference.⁵⁷³ NTIA suggests that Exclusion Zones be established around these sites using the same methodology used to establish the coastal Exclusion Zones but notes that site-specific characteristics may be employed to reduce the impact of these Zones on the Citizens Broadband Radio Service. NTIA indicates that additional time will be needed to calculate these zones and offers to work with DoD and the Commission to develop appropriate protection criteria.⁵⁷⁴

258. *Discussion.* Federal use of the radio spectrum is generally governed by NTIA while non-federal use is governed by the Commission.⁵⁷⁵ As such, we adopt the phased approach to federal Incumbent User protection generally described in NTIA's letter. We believe this approach properly balances the need to protect current and future federal operations in the band with the need to make the band available for commercial use in the near future. During phase one, a large portion of the country will be available for Citizens Broadband Radio Service use as soon as a commercial SAS is approved and made commercially available. During phase two, much of the rest of the country – including major coastal cities – will be made available for commercial use when no federal incumbent use is detected in a given area by the ESC. This approach addresses the concerns of commenters and federal users in an equitable manner and provides a clear path toward dynamic sharing of spectrum in the band.

259. We will establish Exclusion Zones along the coast and around designated ground-based radar facilities, consistent with NTIA's recommendations.⁵⁷⁶ These Exclusion Zones are the product of further analysis by NTIA engineers to reevaluate the Exclusion Zone distances with technical assistance from Commission staff and DoD experts. The zones are 77 percent smaller than the Exclusion Zones described in the Fast Track Report and more accurately reflect the types of devices and network deployments that are likely to be used in the 3.5 GHz Band.⁵⁷⁷ In addition, Exclusion Zones around ground-based radar sites have been reduced to a 3 km contour around the borders of protected locations from the 50-60 km Exclusion Zones recommended by the Fast Track Report.⁵⁷⁸

260. During the first phase, no Citizens Broadband Radio Service operations will be permitted in the 3550-3650 MHz band within the Exclusion Zones. Outside of the Exclusion Zones, Citizens

⁵⁷⁰ *Id.* at 4-5.

⁵⁷¹ *Id.* at 8. *See supra* section III (A).

⁵⁷² *Id.* at 6.

⁵⁷³ *Id.* at 6.

⁵⁷⁴ *Id.*

⁵⁷⁵ *See* 47 U.S.C. §§ 305(a), 902(b)(2)(A)

⁵⁷⁶ *See* NTIA Letter.

⁵⁷⁷ *Id.* at 5.

⁵⁷⁸ *Id.* at 5.

Broadband Radio Service Licensees will be permitted to deploy and utilize Category A CBSDs in the 3550-3650 MHz band, consistent with the Commission's rules. Phase one deployments may begin once an SAS is approved and made available for commercial use as set forth in section III(H)(3)(b).

261. Phase two will begin when an ESC is developed, approved, and deployed as described in section III(I). The ESC will consist of a network of sensors – infrastructure-based, device-based, or a combination of both – that will detect federal radars operating in and around the 3.5 GHz Band and relay information regarding those transmissions to the SAS in order to protect incumbent federal users. Sensors must be deployed in or near Exclusion Zones and near federal ground-radar facilities to detect federal spectrum use. Approved SASs will process the information communicated by the ESC and instruct associated CBSDs to cease operations or move to unencumbered frequencies in geographic areas where federal use has been detected. The ESC will be managed and operated by one or more commercial entities and will not require day-to-day input or oversight from DoD or NTIA.

262. As a consequence of ESC deployment in phase two, the Exclusion Zones will be converted to Protection Zones. Citizens Broadband Radio Service operations in the 3550-3650 MHz band will be permitted within Protection Zones, including major coastal cities, except when the ESC reports federal use in the area. Availability of an ESC will also allow use of Category B CBSDs in the 3550-3650 MHz band portion, provided that the relevant system parameters required to protect federal Incumbent User operations at these higher levels are determined and implemented through the ESC approval process. DoD may also add additional radar sites in the future through the usual NTIA spectrum assignment processes, and the Commission will provide appropriate notice of any such additions and make the necessary ministerial amendments to its Table of Allocations.⁵⁷⁹ Once assigned, these new sites will be accorded the same protections as other radar sites in the band.

263. This two-phase approach will also apply to the protection of the existing federal sites operating in the 3650-3700 MHz band and listed in 47 C.F.R. § 90.1331. During phase one, these sites will be protected from commercial operations in the 3650-3700 MHz band consistent with the static protection contours set forth in 47 C.F.R § 2.106, US 109. During phase 2, these sites will be protected by the ESC in the same manner as federal sites in the 3550-3650 MHz band.

264. After the ESC and SAS are approved, spectrum availability will be determined and conveyed automatically, promoting efficient use of the band and ensuring that federal Incumbent Users are protected. We believe that this approach is superior to the “coordination zone” approach proposed by Verizon, Ericsson, and T-Mobile since it relies on technology to automatically provide information on federal frequency use to an SAS for the benefit of all of its associated CBSDs.⁵⁸⁰ This approach will be more efficient and will advance our goals for the band more effectively than requiring individual licensees and federal Incumbent Users to attempt to reach *ad hoc* coordination agreements and implement the terms of such agreements. It will avoid burdening military operators with significant new spectrum coordination obligations and will protect operational security.

265. It should also be noted that operators may skip phase one entirely if they develop an ESC simultaneously with the SAS. However, while the approval processes for these systems will be similar, they may be developed separately. If an SAS is approved and made commercially available before an ESC is available, the rules governing phase one deployments will apply until an ESC is approved and connected to an approved SAS.

266. We acknowledge that there are several inland radar testing facilities that will require

⁵⁷⁹ 47 C.F.R. § 2.106 note US433.

⁵⁸⁰ See Verizon *FNPRM* Reply Comments at 6; T-Mobile *FNPRM* Comments at 7-8; Ericsson *FNPRM* Comments at 12.

protection.⁵⁸¹ We will work with NTIA and DoD to determine appropriate phase one protection criteria for these sites based on the engineering methodology used to determine the revised coastal Exclusion Zones and taking into account any site-specific factors that may serve to minimize the impact of these Zones on Citizens Broadband Radio Service users. During phase two, these sites will be protected by the ESC consistent with the procedures described in this section and sections 96.15 and 96.67 of the rules.⁵⁸² We will release a Public Notice detailing these protection criteria.

267. We will implement a coordination procedure to protect temporary federal naval radars – including visits to non-homeports – from interference. Under this procedure, federal Incumbent Users will provide the Commission with notice of the location and scope of temporary operations before such operations commence. This requirement will ensure that federal Incumbent Users may receive protection when they (infrequently) visit locations not covered by the coastal Exclusion Zones. We will work with NTIA and DoD to develop appropriate coordination procedures.⁵⁸³

268. We also require SAS Administrators to implement protocols to respond to directions from the President of the United States or another designated federal entity to manually discontinue operations of its associated CBSDs in a given area pursuant to 47 U.S.C. § 606.⁵⁸⁴ SAS Administrators must also implement protocols to manually discontinue operations of their associated CBSDs in response to enforcement actions taken by the Commission. These requirements are consistent with the Commission’s enforcement responsibilities and its statutory obligation to comply with Presidential orders to suspend or amend the rules and regulations governing designated transmitters during times of war or national emergency.⁵⁸⁵

b. Protection of CBSDs from Radar Interference

269. *Background.* In the *Fast Track Report*, NTIA considered interference to and from commercial systems in establishing the exclusion zones.⁵⁸⁶ The distances used to establish the Exclusion Zones were based on the protection of commercial systems from federal radar systems and were considerably larger than the distances deemed necessary to protect federal radars from commercial systems. The analysis performed by NTIA in the *Fast Track Report* considered small-signal interference (e.g., degradation of receiver noise floor, reduction of data throughput rates, increases in block error rates) and high-power interference effects to commercial receivers.⁵⁸⁷ These effects include permanent electrical damage that may occur to receiver components (often referred to as receiver “burnout”), as well as temporary performance degradation such as receiver overload and receiver saturation.⁵⁸⁸

270. In the *FNPRM*, we stated that Citizens Broadband Radio Service users should take reasonable measures to protect their CBSDs from high-power radar interference effects.⁵⁸⁹ We also sought comment on whether and to what degree CBSDs should be protected – geographically or

⁵⁸¹ These sites include: St. Inigoes, MD; Wallops Island, VA; Yuma, AZ; White Sands, NM; China Lake, CA; Dahlgren, VA; McKinney, TX; Sudbury, MA; and Moorestown, NJ. See NTIA Letter at 6.

⁵⁸² Appendix A, §§ 96.15 and 96.67.

⁵⁸³ See Appendix A, § 96.15.

⁵⁸⁴ See 47 U.S.C. § 606(c).

⁵⁸⁵ See 47 U.S.C. § 606(c).

⁵⁸⁶ 3.5. *GHz FNPRM*, 29 FCC Rcd at 4315, ¶ 138; *Fast Track Report* at 5-6.

⁵⁸⁷ See *Fast Track Report* at Appendix G.

⁵⁸⁸ See NTIA Letter at 7.

⁵⁸⁹ See 3.5 *GHz FNPRM*, 29 FCC Rcd at 4317, ¶ 143.

otherwise – from radar interference.⁵⁹⁰

271. Commenters overwhelmingly assert that the Commission should only consider protection of federal radar systems from commercial devices in devising protection criteria for incumbent systems.⁵⁹¹ Notably, the Wireless Innovation Forum contends that modern small cell devices can successfully operate in the presence of interference that is several orders of magnitude stronger than the -6 dB I/N considered in the NTIA Fast Track Report.⁵⁹² In addition, some commenters claim that commercial devices, particularly LTE devices, can provide viable service in close proximity to radar transmitters.⁵⁹³ One set of lab tests showed that LTE and Wi-Fi devices could operate as close as 0.6 km from incumbent radars under favorable conditions and as close as 20.7 km under worst-case scenarios.⁵⁹⁴

272. NTIA states that Citizens Broadband Radio Service users should be required to accept harmful interference from federal radar operations and take all practical measures to design their systems to overcome or avoid the interference in the event that it occurs.⁵⁹⁵ NTIA recommends that all Citizens Broadband Radio Service licensees be required to accept harmful interference from the federal radar operations in and near the 3.5 GHz Band and design their systems to overcome such interference effects. NTIA also agrees with the FCC that Citizens Broadband Radio Service users should take reasonable measures to protect themselves from high-power radar interference since such interference can cause damage to CBSD receivers under certain conditions. NTIA offers to work with the FCC and the DoD to analyze where high-power interference effects to CBSD receivers could potentially occur based on current and future radar operations.⁵⁹⁶

273. *Discussion.* After review of the record, we agree with commenters that argue that Exclusion and Protection Zones should only account for the protection of federal radar systems from harmful interference and not protection of CBSDs from federal radar transmissions. Analyses submitted on the record indicate that CBSDs can operate in close proximity to active radar sites, even on a co-channel basis, without interrupting commercial transmissions.⁵⁹⁷ We note that NTIA's latest analysis effort, performed in conjunction with Commission and DoD, to reduce the Exclusion Zones did not consider the potential interference impact to CBSDs from federal radar systems.⁵⁹⁸ We encourage device manufacturers to design equipment that overcomes or avoids harmful interference from federal radar systems.

274. Consistent with NTIA's recommendation, Citizens Broadband Radio Service users will be required to accept interference – including potentially harmful interference – from federal radar systems as a condition of their authorization. We require Citizens Broadband Radio Service users to acknowledge that they understand and accept the risk of interference from federal radar systems. This

⁵⁹⁰ See *Id* at 4317, ¶ 143-44.

⁵⁹¹ See e.g., PISC *FNPRM* Reply Comments at 25; WIN Forum *FNPRM* Comments at 4-5; Google *FNPRM* Reply Comments at 3.

⁵⁹² See Wireless Innovation Forum *FNPRM* Comments at 4. See also Google *FNPRM* Comments at 8 and Clegg Declaration at 3-4.

⁵⁹³ See Google *FNPRM* Reply Comments at 4 and Appendix A at 13 (claiming that, at distances as small as 4 km, co-channel operation of an LTE base station and a shipborne federal radar would not have a discernible impact on LTE performance); See also NSN *FNPRM* Reply Comments at 5-9.

⁵⁹⁴ See Google, Federated Wireless, and Virginia Tech September 2014 *Ex Parte*. See also Google *FNPRM* Reply Comments at 4 and Appendix A at 13.

⁵⁹⁵ See NTIA Letter at 7.

⁵⁹⁶ *Id.* at 7.

⁵⁹⁷ See generally Google, Federated Wireless, and Virginia Tech September 2014 *Ex Parte*.

⁵⁹⁸ See NTIA Letter.

requirement is consistent with the approach we adopted in the recent AWS-3 proceeding and will apply to all Citizens Broadband Radio Service users regardless of their area of operation or their status as a Priority Access Licensee or GAA user.⁵⁹⁹ Such acknowledgements may be made through the SAS upon registering a CBSD. SAS Administrators must develop policies and procedures to ensure that such acknowledgements are properly recorded and maintained.

275. We will also continue to work with NTIA and DoD to study the effects of federal radars on CBSDs, including the effects of high-powered radar interference. As new devices are developed and made available for use in the 3.5 GHz Band, we hope to gain a better understanding of the effects of radar signals on device performance. We hope that this work can proceed collaboratively with SAS Administrators and Citizens Broadband Radio Service users going forward.

2. Protection of Incumbent FSS Earth Stations

a. FSS Earth Stations in the 3.5 GHz Band

276. *Background:* As noted in this proceeding, the Commission has licensed primary FSS earth stations to receive on frequencies in the 3600-3650 MHz band (Extended C-Band).⁶⁰⁰ Currently, FSS earth station facilities in 35 cities are authorized to receive in the 3625-3650 MHz sub-band, and Airbus DS SatCom Government, Inc. operates two gateway earth stations (located northeast of Los Angeles and New York City) that provide feeder links for Inmarsat's L-band mobile-satellite service system.⁶⁰¹

277. The *NPRM and FNPRM* sought comment on appropriate interference protection and mitigation strategies for incumbent FSS earth stations.⁶⁰² We asked about the use of advanced analytic approaches to modeling interference from Citizens Broadband Radio Service devices into FSS earth stations. We also asked whether the SAS could effectively implement such a model, ensuring FSS earth stations are protected while maximizing the areas available for Citizens Broadband Radio Service operations. We sought comment on what SAS functionalities would need to be required by rule and what functionalities could be specified through other means (*e.g.*, industry standards). For example, we asked whether field strength, power-flux density, or some other technical metric, measured in relation to the earth station's technical configuration (look angle, antenna characteristics, etc.), could provide FSS earth stations with adequate protections while maximizing the available geographic area and bandwidth for Citizens Broadband Radio Service users. We also asked about mitigation techniques, such as the use of filters to reduce or eliminate harmful interference.⁶⁰³

278. Commenters offered a variety of perspectives on these questions in the record. A number of technical reports and analyses have been provided using different assumptions about geographic protection zones that may be required to protect earth stations, both in-band and in the adjacent C-Band. Filings in response to the *NPRM* included submissions from media companies,⁶⁰⁴ Comsearch and Alion

⁵⁹⁹ See Auction of Advanced Wireless Services (AWS-3) Licenses Scheduled for November 13, 2014, Notice and Filing Requirements, Reserve Prices, Minimum Opening Bids, Upfront Payments, and Other Procedures for Auction 97, *Public Notice*, 29 FCC RCD 8386 paras. 76-78, attach. G (WTB 2014).

⁶⁰⁰ See *3.5 GHz NPRM*, 27 FCC Rcd at 15642-43 and 15647-48, ¶¶ 154-55 and Appendix A;

⁶⁰¹ See *id.* at 15647-48. A current list of protected FSS earth station locations is available at <http://fcc.gov/cbrs-protected-fss-sites>. See Appendix A, § 96.17.

⁶⁰² See *id.* at 15635-36, ¶¶ 124-127; *3.5 GHz FNPRM*, 29 FCC Rcd at 4319, ¶¶ 150-51.

⁶⁰³ See *3.5 GHz FNPRM*, 29 FCC Rcd at 4319, ¶¶ 150-51.

⁶⁰⁴ See *Ex Parte* Letter from National Association of Broadcasters, News Corporation, Time Warner Inc., Viacom Inc., CBS Corporation, and The Walt Disney Company, to Marlene H. Dortch, Secretary, Federal Communications Commission (Content Interests May 2013 *Ex Parte*) and Attachment A, Comsearch, "Estimating the Required Separation Distances to Avoid Interference from Citizens Broadband Radio Service Transmitters into C-Band Earth Stations" (Comsearch Report) in GN Docket no. 12-354 (filed May 8, 2013); CBS Corporation, the National

(continued....)

Science,⁶⁰⁵ SIA,⁶⁰⁶ Google,⁶⁰⁷ and others.

279. We received a number of responses concerning the need for protection zones around FSS earth stations. SIA states that protection zones must be established to prevent both in-band and adjacent-band interference to FSS earth stations. SIA claims that these zones must be based on ITU interference criteria and take into account the aggregate effect of multiple Citizens Broadband Radio Service devices. According to SIA, the size of the zones will depend on the technical parameters of Citizens Broadband Radio Service operations – in particular, power density levels and OOB limits – and these parameters are still in dispute.⁶⁰⁸ NPR contends that preventing adjacent-band interference requires a combination of appropriate emission mask limits from devices in the band and geographic separation based on a conservative estimate of path-loss between such devices and an FSS earth station.⁶⁰⁹ WISPA argues that the Commission should avoid the arbitrary circular zones that currently overprotect FSS earth stations in the 3650-3700 MHz band. According to WISPA, the SAS should also be informed on an annual basis that the earth stations are in actual use.⁶¹⁰ CTIA references earlier Qualcomm comments that argued that exclusion zones could be reduced to less than 10 miles.⁶¹¹ The Wireless Innovation Forum disagrees with the use of fixed geographic exclusion zones for FSS spectrum. Rather, the Forum argues that a roadmap for better receivers is appropriate for FSS earth stations. The Wireless Innovation Forum also contends that the roadmap proposal should be addressed by a multi-stakeholder group.⁶¹²

280. Several parties argue that the geographic protection zones around FSS earth stations may be adjusted through coordination. Both NSN and Motorola Solutions assert that Priority Access Licensees should be permitted to negotiate with individual FSS earth station licensees for smaller protection zones.⁶¹³ SIA disagrees, stating “[I]t is not clear how or even whether such an option would work as a practical matter when it comes to large numbers of mobile Citizens Broadband Radio Service devices, or how such agreements would be incorporated into an SAS.”⁶¹⁴ Other commenters argue that coordination zones would increase the utility of the spectrum. For example, T-Mobile asserts that coordination zones maximize the potential use of spectrum.⁶¹⁵ ICONECTIV states that coordination zones could allow more efficient sharing of this spectrum with commercial users.⁶¹⁶ WISPA agrees that

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Association of Broadcasters, Fox Entertainment Group Inc., Time Warner Inc., Viacom Inc., and The Walt Disney Company *NPRM* Reply Comments (Content Interests *NPRM* Reply Comments) and Attachment A, Alion Science and Technology, “Effects of the Proposed Citizens Broadband Radio Service to C-Band Domsat Earth Stations” (Alion Report).

⁶⁰⁵ See Alion Report and Comsearch Report.

⁶⁰⁶ See SIA *NPRM* Comments at 18-20; SIA *NPRM* Reply Comments at 22-24; *Ex Parte* Letter from Patricia Cooper, President, SIA, to Marlene H. Dortch, Secretary, Federal Communications Commission in GN Docket No. 12-354 (filed Aug. 20, 2013); *Ex Parte* Letter from Patricia Cooper, President, SIA, to Marlene H. Dortch, Secretary, Federal Communications Commission in GN Docket No. 12-354 (filed Feb. 1, 2014).

⁶⁰⁷ See Google Letter and Marshall Declaration.

⁶⁰⁸ See SIA *FNPRM* Comments at i.

⁶⁰⁹ See NPR *FNPRM* Comments at 4.

⁶¹⁰ See WISPA *FNPRM* Comments at 19.

⁶¹¹ See CTIA *FNPRM* Comments at 12.

⁶¹² See Wireless Innovation Forum *FNPRM* Comments at 55. See *infra* III(K).

⁶¹³ See NSN *FNPRM* Comments at 11; Motorola Solutions *FNPRM* Comments at 10.

⁶¹⁴ See SIA *FNPRM* Reply Comments at 7-8.

⁶¹⁵ See T-Mobile *FNPRM* Comments at 8.

⁶¹⁶ See ICONECTIV *FNPRM* Comments at 6.

operation inside FSS protection zones should be permitted upon agreement between CBSD licensees and FSS licensees.⁶¹⁷ SIA asserts that significant work remains to be done to develop and validate SAS-based coordination functionality and that existing technology would not be capable of making such determinations.⁶¹⁸ Google presented an *ex parte* demonstration of a system it claims is capable of performing the SAS functions of Priority Access and GAA authorization, protecting Priority Access, FSS users, and federal radar operation from PA and GAA users.⁶¹⁹

281. Several parties opine on appropriate methods for FSS earth station protection. SIA provides an engineering analysis using non-rural and point-to-point transmit power. SIA also supports the use of I/N criteria listed in ITU Recommendations for the protection of FSS earth stations. From these I/N criteria, SIA claims that a received power limit at the FSS earth station can be calculated, taking into account the FSS earth station and Citizens Broadband Radio Service system characteristics and deployment scenarios. SIA asserts that whether this received power limit is exceeded should be determined using an aggregate Equivalent Power Flux Density (EPFD) calculation.⁶²⁰ SIA uses I/N criteria set forth in Recommendations ITU-R S.1432 and ITU-R SF.1006 for interference from non-primary (including adjacent band) sources and interference from co-primary sources into FSS earth stations for its analysis.⁶²¹ SIA recommends the following aggregate interference criteria for in-band FSS earth stations:

- Long Term I/N=-13 dB, not to be exceeded for more than 20% of the time
- Short Term I/N=-1.3 dB, not to be exceeded for more than 0.001667% of the time⁶²²

SIA also contends that the aggregate power emitted by CBSDs at an FSS earth station receiver will be a function of multiple factors: (i) the EIRP density of each CBSD transmitter in the direction of the FSS earth station receiver (which in turn depends on the CBSD's maximum EIRP density and its antenna pattern and orientation); (ii) the FSS earth station's receive gain in the direction of each CBSD transmitter (which depends on the FSS receiver's antenna pattern and orientation); (iii) the distance between the FSS earth station receiver and each CBSD transmitter; and (iv) the intervening terrain between each CBSD transmitter and the FSS earth station receiver.⁶²³ SIA notes that, since the FSS earth stations do not transmit, the Commission cannot rely on sensing by CBSDs to help the SAS protect these stations from harmful interference.⁶²⁴

282. Google claims that, by allowing devices with better OOB performance to take advantage of smaller protection zones around FSS earth stations, the Commission would create a market incentive for innovation that would be self-adjusting to actual band usage and conditions.⁶²⁵ Google asserts that the methodology for determining interference to C-Band downlinks from in-band operation described in the *3.65 GHz Report and Order* can be used to compute both adjacent channel interference and out-of-band emissions to FSS operations above 3.7 GHz.⁶²⁶

⁶¹⁷ See WISPA *FNPRM* Comments at 19.

⁶¹⁸ See SIA *FNPRM* Comments at 9-13.

⁶¹⁹ See Google January 2015 *Ex Parte*.

⁶²⁰ See SIA *FNPRM* Comments at 4.

⁶²¹ See *id.* at 5.

⁶²² See *id.* at 6; SIA *FNPRM* Reply Comments at 4.

⁶²³ See SIA *FNPRM* Comments at 8.

⁶²⁴ See *id.* at 21.

⁶²⁵ See Google *FNPRM* Comments at 21.

⁶²⁶ See Google *FNPRM* Reply Comments at 21.

283. Google also claims that SIA's analysis fails to account for the effects of actual antenna gain, directionality, and elevation angles that are specific to each site.⁶²⁷ According to Google, in most locations in the United States, elevation angles are high enough that the antenna gain will be no more than the front-to-back ratio of the antenna.⁶²⁸ Therefore, Google argues that relying on these front-to-back ratios reduces the power received by the FSS earth station by more than 30 dB as compared to SIA's analysis. As a result, Google claims that, even in locations with low elevation angles, the resulting geographic restrictions are minimal because the excluded area is likely to be long but very narrow in shape as a result of the directionality.⁶²⁹

284. Google also asserts that numerous filter vendors have developed "radar elimination filters" that are designed to protect FSS earth stations from existing high-powered military radar systems in the 3500 -3700 MHz band.⁶³⁰ According to Google, this equipment, which is widely available for less than \$500, can be used to filter out interference from small cell operations. Google opines that the Commission should take account of available filter performance when creating final rules to protect FSS operations that might reduce the value of the Citizens Broadband Radio Service band.⁶³¹

285. Sony provides a study on the protection of FSS earth stations using the proposed maximum output power levels of CBSDs, taking aggregate interference into account.⁶³² Sony calculates protection distances at various CBSD frequency offsets to C-Band earth stations, with and without RF filters, considering different earth station elevation angles, different I/N threshold and different CBSD installation heights.⁶³³ SIA claims that Sony's parameter choices tend to unrealistically downplay the interference susceptibility of FSS earth stations.⁶³⁴

286. The Wireless Innovation Forum argues that the Commission should focus on comprehensive interference analysis rather than static component elements of a system such as antenna angle, terrain, etc. The Forum contends that the issue of FSS user protection should be addressed by a multi-stakeholder group. Such a group should consider how and when to apply SAS control behavior associated with FSS earth stations.⁶³⁵

287. *Discussion.* The record broadly recognizes the need to protect incumbent FSS earth stations from harmful interference. There is also significant agreement about many of the technical factors that contribute to the interference equation, such as: (1) the actual EIRP density of CBSD and End User Device transmitters; (2) the location, antenna pattern, and orientation of those transmitters; (3) the FSS earth station receiver characteristics (including location, antenna gain, elevation and azimuth of the main antenna beam); and (4) the relative distance, mutual orientation, surrounding terrain and the propagation channel(s) between an FSS earth station and potential interfering transmitters. However, the record contains large variations in computed protection parameters and differing opinions among commenters about the efficacy of SAS-based interference mitigation techniques.

288. We believe it is possible to balance the protection of incumbent FSS sites and greater

⁶²⁷ See *id.* at 23.

⁶²⁸ The front-to-back ratio of an antenna is defined as the difference in dB between the maximum gain in front of the antenna (usually 0 degrees) and a point exactly 180 degrees behind the front.

⁶²⁹ See Google *FNPRM* Reply Comments at 23.

⁶³⁰ See *id.* at 24.

⁶³¹ See *id.* at 24-25.

⁶³² See Sony *FNPRM* Comments, Appendix.

⁶³³ See *id.*

⁶³⁴ See SIA *FNPRM* Reply Comments at 7.

⁶³⁵ See Wireless Innovation Forum *FNPRM* Comments at 32.

Citizens Broadband Radio Service spectrum utilization instead of relying on a one-size-fits-all approach to protecting incumbent FSS sites using worst-case interference assumptions. The existing rules for the 3650-3700 MHz Wireless Broadband Service define a 150 km default separation distance with a circular contour around any grandfathered satellite earth stations, separating them for protection from base and fixed stations.⁶³⁶ In a number of cases, coordination with incumbent FSS licensees resulted in deployment of sites within the default protection area.⁶³⁷ In the context of the Citizens Broadband Radio Service, we find these protections to be excessively large, overly simplistic, and inefficient given the capabilities of SASs to predict realistic path loss in the 3.5 GHz Band. In general, we expect that realistic and predictable path loss between CBSDs and FSS earth stations will be substantially higher than (near) line-of-sight free space path loss, resulting in smaller protection distances than 150 km and a protection contour similar to the butterfly-like pattern shown in the *3.65 GHz Order*.⁶³⁸ We conclude that an analytic framework similar to what the Commission offered in Part 90, Subpart Z for Wireless Broadband Service in the 3650-3700 MHz Band, for determining interference to C-Band downlink earth stations from in-band operations, is applicable in the 3.5 GHz Band.⁶³⁹ We therefore establish reasonable protection criteria for in-band FSS earth stations and, in the *Second FNPRM* below, seek comment on additional protection criteria for these stations.⁶⁴⁰

289. As discussed in greater detail in section III(K), we agree with Federated Wireless, Google, Motorola Solutions, SIA, the Wireless Innovation Forum, and others, that a multi-stakeholder process could provide insight into the technical factors and interference limits between coexisting services in the 3.5 GHz Band. While there are many technical implementation details to be worked out prior to equipment certification and deployment, we agree that an SAS-based system of frequency coordination and CBSD authorization can be effective in protecting in-band FSS earth stations, using characteristic parameters of incumbent systems and potential interfering systems. We therefore adopt rules that require CBSDs to protect specific incumbent in-band FSS earth stations from interference using power levels authorized and enforced by SAS.⁶⁴¹ We seek comment on specific protection methodologies in section IV(C).

290. We adopt rules to protect FSS earth stations in the 3.5 GHz Band, by allowing the FSS earth stations to register with the Commission annually, or upon making changes to any of the parameters listed in section 96.17(d).⁶⁴² This registration information will be made available to all approved SASs and may be used to determine appropriate protection criteria for such earth stations. Annual registration for each earth station shall include, at a minimum, the earth station's geographic location, antenna gain, horizontal and vertical antenna gain pattern, antenna azimuth relative to true north, and antenna elevation angle.⁶⁴³ This information must be made available to SAS Administrators and maintained consistent with section 96.55 of the rules.⁶⁴⁴

291. We also adopt a rule that CBSDs may operate within areas that are predicted to

⁶³⁶ See 47 C.F.R. §90.1331.

⁶³⁷ A search of records in ULS indicates that as of March 10, 2015, more than 5,500 applications for new site registration have been filed within 150 km of an existing grandfathered earth station, and the applicants have certified as part of the application that an agreement with the earth station was negotiated.

⁶³⁸ See *3.65 GHz Order*, 20 FCC Rcd at Appendix D.

⁶³⁹ *Id.*

⁶⁴⁰ See *infra* section IV(C).

⁶⁴¹ See Appendix A, §§ 96.17 and 96.53.

⁶⁴² Appendix A, § 96.17 (d).

⁶⁴³ See Appendix A, § 96.17 (d).

⁶⁴⁴ Appendix A, § 96.55.

potentially cause interference to FSS earth stations provided that the licensee of the FSS earth station, the authorized user of the CBSD, and an SAS Administrator mutually agree to such operation at specified CBSD location(s) and the terms of any such agreement are provided to, and can be enforced by, an SAS. The terms of any such agreement shall be communicated promptly to all SAS Administrators.

b. Out-of-Band FSS Protection

292. *Background:* The Commission also licenses FSS earth stations in the C-Band. In contrast to the Extended C-Band, the C-Band is highly utilized for FSS. As discussed above, the C-Band is used for a number of different applications, including distribution of multi-channel video content. FSS providers value the C-Band because its propagation characteristics allow for greater service reliability compared to other bands, especially in adverse weather conditions. The C-Band is one of the oldest and most mature FSS bands in-use. Preventing harmful interference into the C-Band from Citizens Broadband Radio Service has been one of our goals throughout this proceeding.⁶⁴⁵

293. C-Band FSS currently operates adjacent to two sources of signals emitting from below the 3700 MHz band edge: high-powered military radars and the current Wireless Broadband Service operating in the 3650-3700 MHz band. With respect to the former, FSS operators benefit from over 50 megahertz of frequency separation, but otherwise receive no regulatory out-of-band protections. Indeed, it is with the purpose of mitigating interference from military radars that the “radar elimination filters” described by Google were developed. For the latter, the “standard” emissions limit of $43 + 10 \log(P)$ dB, equivalent to -13 dBm / MHz, regulates emissions from the 3650-3700 MHz band into the C-Band. We are not aware of any formal complaints by C-Band FSS operators of harmful interference from over 45,000 wireless broadband site locations.⁶⁴⁶

294. We sought comment in the *FNPRM* about establishing out-of-band emissions limits to protect C-Band earth stations from Citizens Broadband Radio Service operations below 3700 MHz. Specifically, we proposed a stringent limit of -40 dBm / MHz for emissions into the C-Band. However, this proposal did not assume adoption of the “supplemental proposal” to include 3650-3700 MHz in the Citizens Broadband Radio Service.

295. *Discussion:* The Commission has taken action in this *R&O* that we believe will significantly reduce the potential for interference into FSS earth stations in the adjacent C-Band.⁶⁴⁷ We also believe that with modern high-performance and low-cost digital and RF transmit filters, Citizens Broadband Radio Service devices will be able to make extensive use of the spectrum close to the band edge, especially at lower power levels.

296. In our *Second FNPRM*, below, we seek comment on use of the SAS to permit a more flexible approach to out-of-band protections for FSS. As commenters point out, additional measures may provide more assurance to incumbent C-Band FSS licensees, while increasing spectrum access for Citizens Broadband Radio Service users.⁶⁴⁸ We therefore seek comment on steps we can take over and

⁶⁴⁵ 3.5 GHz NPRM, 27 FCC Rcd at 15637-38, ¶¶ 136-138; 3.5 GHz FNPRM, 29 FCC Rcd at 4276, ¶ 7.

⁶⁴⁶ As of April 17, 2015, more than 2,750 licenses have been granted and more than 45,800 sites have been registered (an additional 9215 sites have pending registrations).

⁶⁴⁷ The OOB limit of -40 dBm/MHz is 500 times lower than the current -13 dBm/MHz limit for Wireless Broadband Service in the 3650-3700 MHz band, and FSS earth station licensees requesting protection under this Part may register with the Commission to receive protection afforded by a Spectrum Access System in accordance with Part 96.17 and 96.53.

⁶⁴⁸ See National Public Radio *FNPRM* Comments at 3-14; Wireless Innovation Forum *FNPRM* Comments at 8-10; SIA *FNPRM* Comments at 11-13 and 15-19; SIA *FNPRM* Reply Comments at 11-16; *Ex Parte* Letter from Patricia Cooper, President, SIA, to Marlene H. Dortch, Secretary, Federal Communications Commission, in GN Docket No. 12-354 (filed Oct. 15, 2014) at 4-6; Google *FNPRM* Reply Comments at 20-25; Federated Wireless *FNPRM* Reply Comments at 11-13; and Comsearch *FNPRM* Reply Comments at 2-7.

above those we've already taken to preempt and mitigate the potential for interference. We recognize that our baseline emission performance rule necessarily involves tradeoffs that might be avoided through a more advanced SAS-coordinated approach.⁶⁴⁹ Such an approach might provide greater protection to FSS receivers and increase the usability of spectrum near the band edge for Citizens Broadband Radio Service devices not in proximity to those receivers. We believe the record could benefit from further development of and consensus around this concept.

3. Operations Near International Borders

297. *Background:* In the *FNPRM*, we proposed that Citizens Broadband Radio Service operations along the Canadian and Mexican borders would be subject to international agreements with Mexico and Canada. The SAS would be required to implement these requirements. We sought comment on these proposals.⁶⁵⁰

298. In its comments, SIA agrees with the importance of ensuring that FSS earth stations in Canada and Mexico are protected from Citizens Broadband Radio Service users in the United States.⁶⁵¹ However, SIA contends that there is no indication of how the SAS will protect cross-border sites that are not included in the Commission's licensing databases.⁶⁵²

299. *Discussion.* We adopt the rule proposed in the *FNPRM* and commit to working with Canadian and Mexican authorities to determine how best to coordinate in-band and adjacent band frequency use in the 3.5 GHz Band near international borders. This approach is consistent with our usual practice for new services. SAS Administrators will be required to demonstrate that their systems can and will enforce agreements between the U.S., Canadian, and Mexican governments regarding commercial operations in the 3.5 GHz Band. The specific methods of enforcement will be determined and implemented by SAS administrators, with appropriate Commission oversight, after the agreements are in place.

300. In addition, Industry Canada recently completed a consultation on the 3475-3650 MHz band which will allow the introduction of mobile services in the band.⁶⁵³ We will work with Canadian officials to ensure effective cross-border coordination of new devices or services introduced in the band.

H. Spectrum Access System

301. As we stated in the *NPRM*, *FNPRM*, and *Licensing PN*, the effectiveness of the Citizens Broadband Radio Service depends largely on the development and implementation of one or more robust SASs to coordinate use of the 3.5 GHz Band.⁶⁵⁴ In this section, we reaffirm our commitment to the expeditious development of a fully functional SAS, capable of protecting Incumbent Users from interference and facilitating coexistence among and between Priority Access Licensees and GAA users in the band. We also adopt high-level requirements to govern the authorization and operation of SASs in the band. In addition, we expect that industry participants will take it upon themselves to develop technical implementations of these requirements during the course of the SAS approval process and, where applicable, to develop industry-wide standards. This section addresses: (1) the general scope of an SAS's

⁶⁴⁹ For example, the SAS could employ a validated standard propagation model that employs not only terrain data, but also building and urban clutter.

⁶⁵⁰ See 3.5 GHz *FNPRM*, 29 FCC Rcd at 4286, ¶ 40.

⁶⁵¹ See SIA *FNPRM* Reply Comments at 16-17.

⁶⁵² See *id.*

⁶⁵³ See Industrie Canada, Decisions Regarding Policy Changes in the 3500 MHz Band (3475-3650 MHz) and a New Licensing Process, DGSO-007-14 (2014), available at: <http://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf10914.html>.

⁶⁵⁴ See 3.5 GHz *NPRM*, 27 FCC Rcd at 15625-26, ¶ 95; *Licensing PN*, 28 FCC Rcd at 15313, ¶ 43; 3.5 GHz *FNPRM*, 29 FCC Rcd at 4300, ¶ 90.

responsibilities; (2) high-level SAS requirements; (3) specific responsibilities relating to frequency assignment, security, and information retention; and (4) the SAS approval processes.

1. General SAS Functions

302. *Background.* Throughout this proceeding, we have acknowledged that the SAS is essential to commercial use of the 3.5 GHz Band. We sought comment on the appropriate scope and functions of the SAS in the *Licensing PN*, *NPRM*, and *FNPRM*.⁶⁵⁵ In addition, OET and WTB held a workshop to discuss the operational and functional parameters of the SAS.⁶⁵⁶ The workshop and associated technical papers were organized according to the following focus areas: (1) General Responsibilities and Composition of the SAS; (2) SAS Functional Requirements; (3) SAS Monitoring and Management of Spectrum Use; and (4) Issues related to the Initial Launch and Evolution of the SAS and Band Plan.⁶⁵⁷

303. While commenters and workshop presenters submitted a diverse set of positions regarding the necessary features of the SAS, most agreed that an effective SAS would need to be more dynamic and responsive than the current TVWS database.⁶⁵⁸ Moreover, many commenters agreed that the FCC should set only baseline parameters and guidelines for the SAS and should allow industry stakeholders to develop detailed policies and standards to facilitate operation consistent with the Commission's rules.⁶⁵⁹

304. After thorough review of the record received in response to the *Licensing PN*, *SAS Workshop*, and *NPRM*, we proposed rules that would encourage the rapid development of a robust SAS, capable of managing the proposed three-tier authorization framework.⁶⁶⁰ We sought comment on these proposed rules and on the overall scope and functions of the SAS.⁶⁶¹

305. Some commenters express concern about the complexity of the SAS and argue that the Commission should adopt rules to facilitate Priority Access licensing without the development of a fully functional SAS.⁶⁶² These concerns are frequently linked to commenters' proposals for transitional band plans or LSA licensing frameworks discussed in section III(B) above.⁶⁶³ Advocates of LSA tend to support SASs capable of managing their preferred two-tier framework.⁶⁶⁴ Other commenters support

⁶⁵⁵ See *3.5 GHz NPRM* 27 FCC Rcd at 15625-28, ¶¶ 95-108; *Licensing PN*, 28 FCC Rcd at 15313, ¶¶ 41-43; See *3.5 GHz FNPRM*, 29 FCC Rcd at 4301-03, ¶¶ 93-98.

⁶⁵⁶ See *SAS Workshop Agenda PN*, 29 FCC Rcd 174.

⁶⁵⁷ See *SAS Papers PN*, 28 FCC Rcd 15843.

⁶⁵⁸ See e.g., *BLiNQ Licensing PN* Comments at 14-16; *WISPA Licensing PN* Comments at 18-19; Google SAS Paper.

⁶⁵⁹ See Spectrum Bridge Response to FCC Call for Papers on Proposed 3.5 GHz Spectrum Access System in GN Docket No. 12-354 (filed December 20, 2013) (Spectrum Bridge SAS Paper); Google SAS Paper at 2-3.

⁶⁶⁰ See *3.5 GHz FNPRM*, 29 FCC Rcd at 4300-03, ¶¶ 90-98.

⁶⁶¹ See *id.* at 4300-03, ¶¶ 90-98.

⁶⁶² See Alcatel-Lucent *FNPRM* Comments at 4-6; AT&T *FNPRM* Comments at 11-30; CTIA *FNPRM* Comments at 3-5; Verizon *FNPRM* Comments at 11-15; 4G Americas *FNPRM* comments at 4-6; Ericsson *FNPRM* Comments at 4-6; Mobile Future *FNPRM* comments at 4-5.

⁶⁶³ See *supra* III(B). See e.g., Qualcomm *FNPRM* Comments at 6; Ericsson *FNPRM* Comments at 4-6; Mobile Future *FNPRM* Comments at 4-5; Verizon *FNPRM* Comments at 11-15; AT&T *FNPRM* Comments at 11-30; CTIA *FNPRM* Comments at 3-5; PCIA *FNPRM* Comments at 3; Alcatel-Lucent *FNPRM* Comments at 3-6; 4G Americas *FNPRM* Comments at 4-6.

⁶⁶⁴ See Qualcomm *FNPRM* Comments at 8-11; Ericsson *FNPRM* Comments at 14-16; NSN *FNPRM* Reply Comments at 3-4.

transitional plans and contend that the SAS is not yet fully developed and could be deployed to support two-tier sharing immediately with a portion of the band reserved for experimenting with three-tier sharing. These commenters contend that development of a fully functional SAS should not delay the assignment of Priority Access Licenses in the band or the deployment of robust Priority Access networks. Under the proposed transitional frameworks, the SAS could move from relatively basic functionality to more robust capabilities over time.⁶⁶⁵

306. AT&T argues that there are significant issues to be resolved in the development and implementation of an SAS capable of managing three-tiers of authorized users.⁶⁶⁶ These issues include: (1) implementation of appropriate security protocols; (2) interference coordination; (3) protocols to prevent the operation of rogue GAA devices; and (4) other, unforeseen complications.⁶⁶⁷ According to AT&T, the Commission should adopt a phased approach to licensing and SAS development to bring PALs to market quickly while working towards the future implementation of three-tiered sharing across the entire band.⁶⁶⁸

307. Verizon argues that the Commission should only prescribe the minimum functions that an SAS would have to follow. According to Verizon, these core functions must include: (1) access to a database with information about Incumbent Users' locations; and (2) frequency uses and access to the results of PAL auctions and subsequent PAL frequency assignments.⁶⁶⁹ CTIA agrees with this basic premise, arguing that the SAS should focus on core, high level functions.⁶⁷⁰

308. Some commenters also caution against allowing the SAS to manage the operations of wireless networks directly. Specifically, WISPA, T-Mobile, NSN, and CTIA argue that the SAS should not directly manipulate the EIRP and other functions of attached CBSDs.⁶⁷¹ T-Mobile asserts that SAS management of PALs is inconsistent with a licensee's obligation to manage its own network and that the SAS should be limited to managing GAA devices.⁶⁷²

309. Dynamic Spectrum Alliance, Federated Wireless, Google, Microsoft, PISC, Spectrum Bridge, WISPA and other commenters support the Commission's proposal to expeditiously authorize and approve a robust SAS, capable of managing three-tiers of service across the entire 3.5 GHz Band.⁶⁷³ Notably, Google argues that the Commission should authorize fully functional SASs quickly to ensure that the band is put to productive use in the near future.⁶⁷⁴ According to Google, from the outset, the SAS

⁶⁶⁵ See Alcatel-Lucent *FNPRM* Comments at 4-6; AT&T *FNPRM* Comments at 11-30; CTIA *FNPRM* Comments at 3-5; Verizon *FNPRM* Comments at 11-15; 4G Americas *FNPRM* comments at 4-6; Ericsson *FNPRM* Comments at 4-6; Mobile Future *FNPRM* comments at 4-5.

⁶⁶⁶ AT&T *FNPRM* Reply Comments at 4-8.

⁶⁶⁷ *Id.* at 5-6.

⁶⁶⁸ AT&T *FNPRM* Comments at 4-8.

⁶⁶⁹ Verizon *FNPRM* Comments at 15.

⁶⁷⁰ CTIA *FNPRM* Comments at 13-15.

⁶⁷¹ See WISPA *FNPRM* Comments at 31-32; T-Mobile *FNPRM* Comments at 14; CTIA *FNPRM* Comments at 14-15; NSN *FNPRM* Reply Comments at 4; Verizon *FNPRM* Comments at 9-10.

⁶⁷² T-Mobile *FNPRM* Comments at 14-15.

⁶⁷³ See Microsoft *FNPRM* Reply Comments at 5-6, Wireless Innovation Forum *FNPRM* Comments at 2; Dynamic Spectrum Alliance, White Space Alliance, PISC *FNPRM* Comments at 2; PISC *FNPRM* Reply Comments at 11-16; Motorola Mobility *FNPRM* Comments at 3-4; WISPA *FNPRM* Reply Comments at 5-8; Federated Wireless *FNPRM* Reply Comments at 13-15; Interdigital *FNPRM* Comments at 4; Google *FNPRM* Reply Comments at 10-14.

⁶⁷⁴ Google *FNPRM* Comments at 27-33.

should be capable of: (1) managing three tiers of authorized users; (2) accepting and applying detailed information from CBSDs; and (3) setting and modifying maximum power levels and permissible operational frequencies for CBSDs.⁶⁷⁵ SASs could also provide valuable additional services, including recognizing coexistence agreements between PAL licensees, at their option⁶⁷⁶

310. Federated Wireless also supports implementation of a fully functional SAS, capable of managing the proposed three-tier framework. According to Federated Wireless, moving away from the three-tiered authorization model – even temporarily – would reduce spectral and economic efficiency and introduce uncertainty into the band, reducing network deployments.⁶⁷⁷ Federated Wireless also contends that SAS-based sharing between GAA and Priority Access users is conceptually no different than sharing between Priority Access and Incumbent Users. Therefore, according to Federated Wireless, perceived risks of GAA interference should not pose an impediment to the rapid development and deployment of a fully functional SAS.⁶⁷⁸ However, Federated Wireless did suggest that the Commission should clarify that the role of the SAS with regard to device management is to determine the maximum permissible operational parameters for CBSDs to protect the spectrum rights of Citizens Broadband Radio Service Users and not to exercise the level of operational control over networks that some commenters fear.⁶⁷⁹

311. *Discussion.* After thorough review of the record, we continue to believe that developing a fully functional SAS capable from the outset of managing three tiers of authorized users would benefit the public interest, spur innovation, and encourage investment in the 3.5 GHz Band. As we stated in Section III(B), we believe that immediately implementing the three-tier sharing framework originally set forth in the PCAST Report and proposed in the *NPRM* and *FNPRM*, will promote the development of a robust device ecosystem and facilitate rapid network deployment in the band. Thus, the SAS must be capable of coordinating operations among and between Priority Access, GAA, and Incumbent Access Users in the band as a condition of authorization.

312. While we acknowledge the concerns expressed by some commenters regarding complexity, we believe that the immediate use of the SAS to coordinate three tiers of service in the 3.5 GHz Band will best serve the public interest.⁶⁸⁰ As the Dynamic Spectrum Alliance noted, “There is no need to phase in three-tier spectrum management as under the transitional plan proposed by some commenters; database technology can implement a three-tier system, and the approaches required to protect first-tier incumbents can be applied equally effectively to secondary user protection.”⁶⁸¹ Indeed, we believe that delaying the development of an SAS capable of managing three tiers of users in the band could cause spectrum to lie fallow and discourage deployment in the band. In addition, as noted above, simultaneous availability of PAL and GAA use is critical to the design of our auction framework, which is intended to provide potential auction bidders for PALs to have the choice of bidding for PAL priority rights where truly needed to implement their networks or relying on free, shared GAA use of the same frequencies in other situations, thus promoting more efficient use of the spectrum. Moreover, providing Priority Access Licensees with exclusive access to the band, even on a temporary basis, could provide an advantage to certain uses while hampering the development of other innovative uses for the band.

⁶⁷⁵ *Id.*

⁶⁷⁶ *Id.* at 30-31.

⁶⁷⁷ Federated Wireless *FNPRM* Reply Comments at 13-14.

⁶⁷⁸ *Id.* at 14.

⁶⁷⁹ *Id.* at 18-20.

⁶⁸⁰ See e.g., Alcatel-Lucent *FNPRM* Comments at 4-6; AT&T *FNPRM* Comments at 11-30; CTIA *FNPRM* Comments at 3-5; Verizon *FNPRM* Comments at 11-15; 4G Americas *FNPRM* comments at 4-6; Ericsson *FNPRM* Comments at 4-6; Mobile Future *FNPRM* comments at 4-5.

⁶⁸¹ Dynamic Spectrum Alliance Comments at 2.

313. Given the dynamic nature of the SAS that was proposed in the *FNPRM*, it is understandable that some commenters are concerned about the degree to which the SAS would manage the power levels, frequencies, and other operational features of CBSDs in the 3.5 GHz Band.⁶⁸² We agree that the SAS should not micromanage the moment-to-moment operations of CBSDs in the band and we note that the *FNPRM* did not propose to allow the SAS this level of control. We also agree with T-Mobile that operators are in the best position to manage their own networks, and coordinate their own internal operations.⁶⁸³ However, we disagree with T-Mobile's assertion that the SAS should have no role in managing Priority Access users.⁶⁸⁴ As Google noted, the SAS must be able to direct Priority Access users to change their frequencies of operation to protect Incumbent User operations.⁶⁸⁵ We conclude that, to effectively coordinate Priority Access and GAA users in the band, the SAS must be responsible for authenticating and authorizing CBSDs in both tiers of service and ensuring that those CBSDs operate within permissible technical parameters. In essence, we see the SAS's role as akin to frequency coordination, a familiar concept in spectrum management,⁶⁸⁶ but with a high degree of automation.

314. Under the rules we adopt herein, the SAS will be responsible for setting the maximum permissible power levels for CBSDs – within the maximum permissible power limits established in the rules – and authorizing them to operate over available frequencies in authorized locations, and other responsibilities consistent with the rules set forth in Part 96.⁶⁸⁷ As Google accurately notes, these capabilities will not affect operators' abilities to manage their networks so long as their preferences do not run counter to the requirements of the Citizens Broadband Radio Service.⁶⁸⁸ We continue to believe that the SAS should be responsible for setting and enforcing these high level parameters and for maintaining a stable spectral environment in the 3.5 GHz Band. We agree with Federated Wireless that, "the ability of the SAS to set maximum power levels and assign frequencies is critical to Citizens Broadband Radio Service band interference management."⁶⁸⁹

315. In place of the manual processes that have characterized some other frequency coordination regimes, the SAS would respond quickly to ensure effective coexistence between and among the three tiers of users in the band. As shown in Figure 3, the SAS would obtain information about registered or licensed commercial users in the band from the Commission and information about federal incumbent users of the band from ESC. The SAS could also interact directly or indirectly through a proxy – such as a network manager – with CBSDs operating in the band to ensure that Citizens Broadband Radio Service users operate in a manner consistent with their authorizations and promote efficient use of the spectrum resource. SAS-to-SAS synchronization will ensure coordination occurs even between CBSDs that use different SAS providers.

⁶⁸² T-Mobile *FNPRM* Comments at 14; Verizon *FNPRM* Comments at 9-10.

⁶⁸³ T-Mobile *FNPRM* Comments at 14.

⁶⁸⁴ *Id.* at 3, 14-15.

⁶⁸⁵ Google *FNPRM* Comments at 28.

⁶⁸⁶ *See e.g.*, 47 C.F.R. § 101.103 (Describing frequency coordination procedures for Fixed Microwave Services).

⁶⁸⁷ Appendix A, §§ 96.53 *et seq.* *See infra* III(H)(2).

⁶⁸⁸ Google *FNPRM* Reply Comments at 12-13.

⁶⁸⁹ Federated Wireless *FNPRM* Reply Comments at 19.

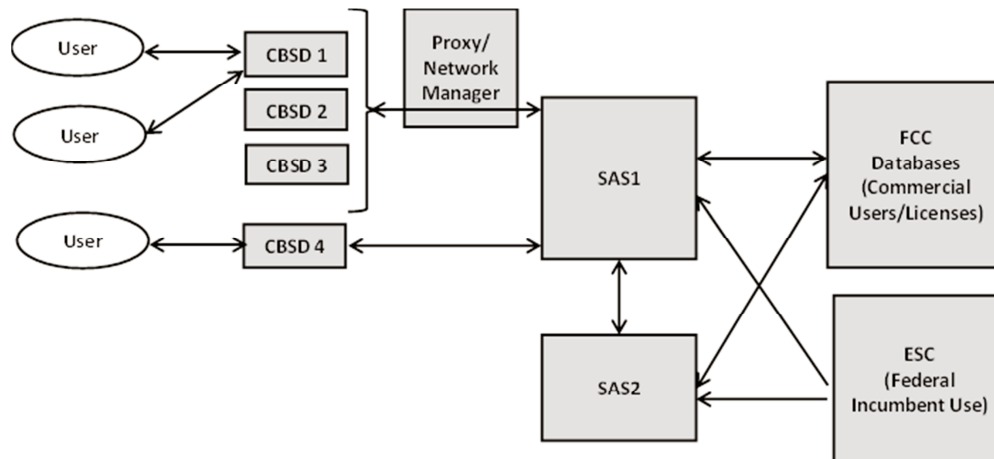


Figure 3 – Illustrative End-to-End Citizens Broadband Radio Service Architecture

2. High Level SAS Requirements

316. *Background.* After thorough review of the record generated in response to the *NPRM, Licensing PN, and SAS Workshop*, we proposed that the SAS should perform a variety of high level functions to facilitate the implementation of the Citizens Broadband Radio Service. Specifically, we proposed that authorized SASs would perform the following core functions:

- Determine the available frequencies at a given geographic location and assign them to CBSDs;
- Determine the maximum permissible radiated transmission power level for CBSDs at a given location and communicate that information to the CBSDs;
- Register and authenticate the identification information and location of CBSDs;
- Enforce Exclusion Zones to ensure compatibility between Citizens Broadband Radio Service users and incumbent federal operations;
- Protect Priority Access Licensees from harmful interference from General Authorized Access Users;
- Reserve the use of GAA channels for use in a CAF;
- Ensure secure transmission of information between the SAS and CBSDs.⁶⁹⁰

In addition, we proposed that multiple SASs could be authorized by the Commission and that each SAS would provide nationwide service.⁶⁹¹ The proposed rules outlined the essential requirements for a successful SAS and would promote innovation and productive use of the 3.5 GHz Band. We sought comment on these proposals and requested input regarding alternative or additional SAS guidelines.⁶⁹²

317. Numerous commenters submitted their views on the scope and functionality of the SAS,

⁶⁹⁰ See *3.5 GHz FNPRM*, 29 FCC Rcd at 4302, ¶ 95.

⁶⁹¹ See *id.* at 4300, 4302, ¶¶ 91, 96.

⁶⁹² See *id.* at 4302-03, ¶¶ 97-98.

offering widely divergent opinions on the scope and necessary requirements for the system.⁶⁹³ Commenters generally support the authorization of multiple SASs on a nationwide basis.⁶⁹⁴ Some commenters also contend that the Commission should adopt a “light touch” regulatory approach towards the SAS and allow SAS Administrators, individual licensees, and the rest of the industry to work together to implement procedures to meet the Commission’s regulations.⁶⁹⁵

318. Some commenters request that SASs be required or permitted to perform functions beyond those enumerated in the proposed rules. For example, Google proposes that SASs be permitted to honor coexistence agreements between Priority Access Licensees to operate CBSDs at higher power levels than the rules allow.⁶⁹⁶ Others, including Wireless Innovation Forum, Federated Wireless, and Google argue that the SAS should accept information from sensor networks to further develop advanced spectrum management practices.⁶⁹⁷

319. *Discussion.* We continue to believe that a “light touch” regulatory approach is appropriate for this band and that the rules should include only the high-level requirements necessary to ensure the effective development and operation of fully functional SASs. We agree with commenters that support collaborative, industry-wide efforts to create standards and best practices governing SAS operations.⁶⁹⁸ The Commission will assist these efforts through the SAS Administrator approval process, as set forth in III(H)(3)(b). We also believe that an active multi-stakeholder group could help develop industry consensus around the best methods of meeting the SAS requirements.⁶⁹⁹

320. After review of the record, we conclude that the SAS should perform the high level functions generally set forth in the *FNPRM* as well as certain additional functions needed to address changes to the rules governing CBSDs and Incumbent Users. We also agree with the commenters who contend that the SAS should provide nationwide service.⁷⁰⁰ The core functions that an SAS must perform are as follows:

- Determine the available frequencies at a given geographic location and assign them to CBSDs;
- Determine the maximum permissible transmission power level for CBSDs at a given location and communicate that information to the CBSDs;
- Register and authenticate the identification information and location of CBSDs;

⁶⁹³ Some commenters sought to limit the role of the SAS in connection with their proposals to implement a two-tier or transitional authorization framework. Those comments are addressed in detail in sections III(B)(1).

⁶⁹⁴ See Motorola Solutions *FNPRM* Comments at 8-9; Microsoft *FNPRM* Reply Comments at 6; Ericsson *FNPRM* Comments at 16; Google *FNPRM* Reply Comments at 8; Spectrum Bridge *FNPRM* Comments at 8; AT&T *FNPRM* Comments at 33. *But see* Wireless Innovation Forum *FNPRM* Comments at 9-10 and Federated Wireless *FNPRM* Comments at 21-22 (The Commission should establish multiple regional SASs instead of multiple nationwide SASs)

⁶⁹⁵ See Wireless Innovation Forum *FNPRM* Comments at 9; AT&T *FNPRM* Comments at 47-52.

⁶⁹⁶ Google *FNPRM* Comments at 30-31.

⁶⁹⁷ See Wireless Innovation Forum *FNPRM* Comments at 10; Federated Wireless *FNPRM* Reply Comments at 7; Google *FNPRM* Comments at 27; Shared Spectrum Company *FNPRM* Comments at 7-9; BLiNQ SAS Paper at 6.

⁶⁹⁸ See e.g., AT&T *FNPRM* Comments at 47-52, Wireless Innovation Forum *FNPRM* Comments at 9.

⁶⁹⁹ See *infra*, section III(K) See also Wireless Innovation Forum *FNPRM* Comments at 9; AT&T *FNPRM* Comments at 47-52.

⁷⁰⁰ See Motorola Solutions *FNPRM* Comments at 8-9; Microsoft *FNPRM* Reply Comments at 6; Ericsson *FNPRM* Comments at 16; Google *FNPRM* Reply Comments at 8; Spectrum Bridge *FNPRM* Comments at 8; AT&T *FNPRM* Comments at 33

- Enforce Exclusion and Protection Zones, including any future changes to such Zones, to ensure compatibility between Citizens Broadband Radio Service users and incumbent federal operations;
- Communicate with the ESC and ensure that CBSDs operate in a manner that does not interfere with federal users;
- Ensure that CBSDs protect non-federal incumbent users consistent with the rules;
- Protect Priority Access Licensees from impermissible interference from other Citizens Broadband Radio Service users;
- Facilitate coordination between GAA users to promote a stable spectral environment;
- Ensure secure and reliable transmission of information between the SAS, ESC, and CBSDs;
- Provide an approved ESC with any sensing information reported by CBSDs if available;
- Protect Grandfathered Wireless Broadband Licensees until the end of the grandfather period; and
- Facilitate coordination and information exchange between SASs.

This revised list of functions is necessary to enforce the rules governing protection of Incumbent Users and of Grandfathered Wireless Broadband Licensees.⁷⁰¹ We address public interest rationales for these rules in sections III(G) and III(J). Authorization of multiple SASs and SAS Administrators is addressed in section III(H)(3).

321. We also adopt a policy to ensure that the SAS facilitates coordination among GAA users to promote a stable spectral environment in the band.⁷⁰² This requirement includes any coordination agreements entered into by users of Category B CBSDs pursuant to section 96.35(e).⁷⁰³ It also entails a general responsibility for SASs to promote spectral efficiency and non-discriminatory coexistence among GAA users. This policy is consistent with our adoption of a three-tier access model and is essential to the development of a robust GAA device ecosystem and will foster innovation and investment in the band. It is also consistent with the recommendations of commenters that SASs be capable of integrating information from sensor networks or CBSDs regarding the interference environment and local spectrum usage to promote efficient use of the band.⁷⁰⁴ We further note that the specific policies and protocols needed to enforce this general requirement may be developed as part of the SAS approval process and may be informed by the work of an industry-led multi-stakeholder group. While the SASs assign GAA users with a goal of minimizing harmful interference among those users, we recognize that enabling flexibility to deploy whatever technologies meet the standards in the rules can pose difficulties to completely manage interference. The SAS will help to minimize interference such as by avoiding assignment of the same frequency to multiple GAA users at the same location to the extent possible. However, our rules provide no assurance of interference protection between GAA users. To minimize interference, we encourage, but do not require, manufacturers to incorporate spectrum sharing features, much like those commonly employed in unlicensed uses. Contrary to Google's suggestion that SASs be permitted to honor coexistence agreements between Priority Access Licensees to operate CBSDs at

⁷⁰¹ See Appendix A, §§ 90.1338, 96.15, 96.17, 96.19, 96.21.

⁷⁰² This requirement could include coordinating frequency assignments, CBSD power levels, or overall network plans, as appropriate.

⁷⁰³ See Appendix A, § 96.35(e).

⁷⁰⁴ See Wireless Innovation Forum *FNPRM* Comments at 10; Federated Wireless *FNPRM* Reply Comments at 7; Google *FNPRM* Comments at 27; Shared Spectrum Company *FNPRM* Comments at 7-9; BLiNQ SAS Paper at 6.

higher power levels than the rules allow, our rules supersede any private agreements, unless otherwise specified.⁷⁰⁵

a. Information Gathering and Retention

322. *Background.* In the *FNPRM* we proposed high-level information gathering and retention requirements consistent with the responsibilities of the SAS, the security concerns of Citizens Broadband Radio Service users and Incumbent users, and the Commission's oversight and enforcement responsibilities. To protect Incumbent Users and effectively coordinate Citizens Broadband Radio Service users, we proposed that the SAS retain information on all operations within the 3.5 GHz Band. For CBSDs, such information would include all data that they are required to transmit to the SAS.⁷⁰⁶ For incumbent FSS operators, the SAS would maintain a record of the location of protected earth stations as well as the direction and look angle of all earth station receivers and any other information needed to perform its functions. For incumbent federal users, the SAS would include only the geographic coordinates of the Exclusion Zones. We sought comment on these proposed rules and alternative approaches.⁷⁰⁷

323. Some parties express concern about the type of information that the SAS would gather and maintain from Citizens Broadband Radio Service users and whether that information would be secure and confidential.⁷⁰⁸ Notably, AT&T argues that the Commission should clarify that information gathered by the SAS is for registration purposes only and that licensees need not submit information about network performance. AT&T also contends that, since spectrum assignment is an FCC function and the SAS will be acting as the FCC's agent, all data collected by the SAS should be confidential.⁷⁰⁹

324. The Public Interest Spectrum Coalition supports the Commission's proposal and argues that it is critical that the informational inputs and outputs of the SAS, including exclusion zone coordinates and notifications of "actual use" by Priority Access Licensees, be available to the public.⁷¹⁰ According to PISC, transparency is essential for the credibility and accountability of the SAS.⁷¹¹

325. NTIA contends that SASs should not retain information on federal operations, radar usage, or fleet movements. NTIA asserts that such restrictions are necessary to protect the operational security of military operations and installations in the United States.⁷¹²

326. *Discussion.* After review of the record, we conclude that an SAS must be capable of gathering and retaining information submitted by registered CBSDs necessary to perform its essential tasks under Part 96. Information not pertaining to federal incumbent operations must be retained for a minimum of 60 months.⁷¹³ SASs must also obtain essential licensing information from Commission

⁷⁰⁵ Google *FNPRM* Comments at 30-31.

⁷⁰⁶ See *3.5 GHz FNPRM*, 29 FCC Rcd at 4303, ¶¶ 99-101; Proposed Rules, § 96.36.

⁷⁰⁷ See *3.5 GHz FNPRM*, 29 FCC Rcd at 4303, ¶ 99; Proposed Rules, §§ 96.44 and 96.48.

⁷⁰⁸ See Ericsson *FNPRM* Comments at 20; Verizon *FNPRM* Comments at 17-18; Google *FNPRM* Comments at 31-32.

⁷⁰⁹ AT&T *FNPRM* Comments at 31-32.

⁷¹⁰ See PISC *FNPRM* Reply Comments at 33-34.

⁷¹¹ *Id.* at 33-34.

⁷¹² See NTIA Letter.

⁷¹³ See Appendix A, § 96.55. The 60 month information retention requirement mirrors the limitations period imposed on the Department of Justice to bring suit for collection of a forfeiture assessed by the Commission for violation of its rules. See 28 U.S.C. § 2462. The 60 month information retention requirement ensures the preservation of information that may be relevant in future collection actions brought by the Department of Justice on

(continued....)

databases, maintain accurate records of the parameters of Protection Zones, and enforce additional federal Incumbent User protections based on information received from the ESC.⁷¹⁴ Absent access to and retention of such essential information, SASs will be unable to effectively manage coexistence between and among the different tiers of users in the band.

327. We acknowledge the concerns raised by commenters about disclosure of confidential business information to the public. To some extent, the tension in the comments reflects different traditions of spectrum management, which are intertwined in the Citizens Broadband Radio Service rules we adopt today. Site-based radio services, for instance, typically require all site-based licensing information to be disclosed and available in various FCC databases. The flexible-use and unlicensed rules, however, do not require users to disclose information about specific sites. We agree with PISC that transparency is a key element of the authorization framework and that certain information must be made available to the public – and other SAS Administrators – consistent with usual Commission practices.⁷¹⁵ We also understand that network owners may not desire release of information related to network deployments and configurations to the public in a manner that could compromise personal privacy or affect competitive interests. Regardless, some of this information may need to be shared, confidentially, with other SAS Administrators to effectively coordinate frequency assignments and avoid interference between CBSDs.

328. Therefore, we find make two findings with respect to SAS Administrator disclosure of CBSD information. First, SAS Administrators must make all information necessary to effectively coordinate operations between and among CBSDs available to other SAS Administrators. Second, SAS Administrators must make CBSD registration information available to the general public, but they must obfuscate the identities of the licensees providing the information for any public disclosures.

329. We also note that, contrary to PISC's assertions, the Commission is not "effectively delegating its enforcement authority to privately-operated SASs to enforce exclusions from the public airwaves."⁷¹⁶ Based on the record before us, we have concluded that approved SAS will be capable of effectively coordinating operations between and among a wide variety of Citizens Broadband Radio Service Users and preventing disputes before they arise. However, as described in section III(H)(2)(e), the Commission will retain ultimate responsibility for enforcing its rules, overseeing and approving SASs and SAS Administrators, resolving disputes between licensees, and addressing consumer complaints.

330. With regard to information on federal Incumbent Users communicated from the ESC to the SAS and retention of that information, we adopt several safeguards. We require that the SAS and the ESC must not have any connectivity to any military or other sensitive federal database or system. Nor shall they store, retain, transmit, or disclose operational information on the movement or position of any federal systems. The Commission will work with NTIA and DoD to establish the information the ESC would need to transmit to the SAS as necessary to manage connected CBSDs. For example, this data could be limited to the ESC's detection of protected radar signals, their approximate locations, and the protection zone coordinates as required for the SAS to instruct CBSDs to move off of a channel. We will restrict the storage and retention of this data and any other operational information to ensure only the effective operation of the SAS and ESC, and for no other purposes. The SAS shall only retain records of information or instructions received from the ESC in accordance with information retention policies established as part of the ESC approval process.⁷¹⁷ These policies will include appropriate safeguards for

(Continued from previous page) _____
the Commission's behalf. *See* 47 U.S.C. § 504(a) (requiring any collection action to enforce a Commission forfeiture be brought by the Department of Justice in a civil suit).

⁷¹⁴ *See* Appendix A, § 96.55.

⁷¹⁵ *See* PISC *FNPRM* Reply Comments at 33-34.

⁷¹⁶ *Id.* at 33-34.

⁷¹⁷ *See* Appendix A, 96.55(c)

classified and other sensitive data and will be developed by the Commission in coordination with NTIA and DoD. These rules implement the recommendations set forth in the NTIA Letter.⁷¹⁸

b. Registration, Authentication, and Authorization of CBSDs

331. *Background.* We proposed that the SAS would confirm and verify the identity of any CBSD seeking to use the 3.5 GHz Band prior to authorizing its operation. The SAS would also prevent CBSDs from operating within any Exclusion Zones.⁷¹⁹ We also proposed that registration information from multiple CBSDs could be communicated by a central network controller device.⁷²⁰ We sought comment on these proposed rules.⁷²¹

332. As detailed in section III(F)(2)(d), many commenters generally agree with the registration requirements for CBSDs.⁷²² AT&T expresses concern about the security of data collected by the SAS and argues that the Commission should clearly state that such information is collected for registration purposes only and that licensees are not required to submit information about network performance.⁷²³ Microsoft suggests that there should be limits on the information the SAS collects and the time it maintains records for CBSDs.⁷²⁴

333. *Discussion.* We find that registering, authenticating, and authorizing CBSDs is an essential component of the SASs responsibilities. As described in section III(F)(2)(b), CBSDs must report information on their technical specifications, location, and the identity of their authorized operators or licensees to the SAS.⁷²⁵ The SAS must, in turn, verify this information to ensure that CBSDs are used only by authorized users in accordance with the Commission's rules. The SAS must also verify that the FCC ID of any CBSD seeking to provide Citizens Broadband Radio Services is valid prior to authorizing it to begin providing service.⁷²⁶ We reiterate that individual CBSDs are not required to interface with the SAS so long as the required information is communicated by an aggregation point or network control device. We also note that these requirements do not apply to End User Devices. SASs must not collect, track, or store information on End User Devices or their users without user consent. The precise methods used to register, authenticate, and authorize CBSDs may be determined during the SAS approval process described in section III(H)(3)(b).

c. Frequency Assignment

334. *Background.* In the *FNPRM*, we proposed to dynamically assign PAL channels and GAA frequencies in the 3.5 GHz Band.⁷²⁷ Under that proposal, the SAS would be responsible for determining the available and appropriate frequencies at a given location using the location information supplied by CBSDs, Exclusion Zone parameters, the authorization status and operating parameters of CBSDs in the surrounding area, and such other information necessary to ensure the lawful operation of CBSDs. The

⁷¹⁸ See NTIA Letter.

⁷¹⁹ See *3.5 GHz FNPRM*, 29 FCC Red at 4303, ¶ 102; Proposed Rules § 96.45.

⁷²⁰ See *id.* at 4292-93, ¶ 62; Proposed Rules § 96.3 (Definition of Citizens Broadband Radio Service Device).

⁷²¹ See *id.* at 4303, ¶ 102.

⁷²² See of Motorola Solutions *FNPRM* Comments at 3, AT&T *FNPRM* Comments at 33, Microsoft *FNPRM* Comments at 12, Ericsson *FNPRM* Comments at 21, Shared Spectrum Company *FNPRM* Reply Comments at 6, and Google *FNPRM* Comments at 22.

⁷²³ See AT&T *FNPRM* Comments at 31-32.

⁷²⁴ See Microsoft *FNPRM* Comments at 11.

⁷²⁵ See *supra* III(F)(2)(b).

⁷²⁶ See Appendix A, § 96.57(c).

⁷²⁷ See *3.5 GHz FNPRM*, 29 FCC Red at 4284, ¶¶ 32-35.

SAS would also take into consideration any channel or frequency requests submitted by CBSDs as well as geographic and spectral efficiency considerations. We also proposed that the SAS be able to provide a list of available frequencies in a given area and confirm that any CBSDs causing harmful interference to an Incumbent User have been deactivated or reassigned upon request. We sought comment on these proposals.⁷²⁸

335. As set forth in detail in section III(B), the record was divided over whether the SAS should be permitted to assign frequencies and channels to Citizens Broadband Radio Service users in the proposed manner. Commenters including Dynamic Spectrum Alliance, Federated Wireless, Google, Interdigital, PISC, Shared Spectrum Company, Spectrum Bridge, the WhiteSpace Alliance, and the Wireless Innovation Forum support the Commission's proposal to allow the SAS to assign frequencies in the band for both Priority Access Licensees and GAA Users.⁷²⁹ Other commenters, including AT&T, CTIA, NSN, 4G Americas, Ericsson, HKT Limited, and UK Broadband oppose the Commission's proposal and argued that Priority Access Licensees should be given static frequency assignments.⁷³⁰

336. In addition, Verizon stresses the importance of strong security protocols – dubbed “channel use surety” – to ensure that GAA devices operate only on frequencies assigned by the SAS. According to Verizon, these protocols must be designed to prevent modifications of GAA devices or their firmware that would allow them to operate on unauthorized frequencies. Verizon stresses that such protocols are necessary to protect Priority Access Licensees and promote a stable spectral ecosystem.⁷³¹

337. *Discussion.* As we detailed in section III(B)(2)(c), it is in the public interest to establish a SAS-automated frequency assignment model for the 3.5 GHz Band.⁷³² This method of frequency assignment is consistent with the Revised Framework and the proposals set forth in the *FNPRM*.⁷³³ The record clearly reflects that automated coordination by a robust SAS is essential to effective spectrum sharing between the three tiers of authorized users in the band.

338. We also acknowledge the concerns raised by various commenters regarding frequency predictability and stability in an SAS-assigned frequency management regime.⁷³⁴ As detailed in section III(C)(2)(a), we adopt appropriate provisions to ensure that PAL assignments remain as stable and consistent as possible across different channels and geographic boundaries. The SAS must respect and enforce these provisions to create a stable spectral environment for all Citizens Broadband Radio Service users.

339. In assigning frequencies for Priority Access and GAA use, the SAS must take appropriate

⁷²⁸ See *id.* at 4304, ¶ 103.

⁷²⁹ Dynamic Spectrum Alliance, WhiteSpace Alliance, and PISC *FNPRM* Comments at 2; WhiteSpace Alliance *FNPRM* Comments at 3; Federated Wireless *FNPRM* Comments at 25; Wireless Innovation Forum *FNPRM* Comments at 5; Shared Spectrum Company *FNPRM* Comments at 9-10; Google *FNPRM* Comments at 28; Spectrum Bridge *FNPRM* Comments at 4 (suggesting that dynamic assignment with a fixed channel plan may be good intermediate step); Interdigital *FNPRM* Comments at 6.

⁷³⁰ AT&T *FNPRM* Reply Comments at 13-15; T-Mobile *FNPRM* Comments at 10; CTIA *FNPRM* Comments at 8; 4G Americas *FNPRM* Comments at 5-6; UK Broadband *FNPRM* Comments at 3-4; HKT Limited *FNPRM* Comments at 3-4; NSN *FNPRM* Comments at 10-11; Ericsson *FNPRM* Comments at 6-7.

⁷³¹ See Verizon *FNPRM* Comments at 17-18.

⁷³² See *supra*, section III(B)(2)(c).

⁷³³ *Licensing PN*, 28 FCC Rcd at 15310-11, ¶¶ 30-32 and 3.5 GHz *FNPRM*, 29 FCC Rcd at 4283, 4304, ¶¶ 28-29, 103.

⁷³⁴ See AT&T *FNPRM* Reply Comments at 13-15; T-Mobile *FNPRM* Comments at 10; CTIA *FNPRM* Comments at 8; 4G Americas *FNPRM* Comments at 5-6; UK Broadband *FNPRM* Comments at 3-4; HKT Limited *FNPRM* Comments at 3-4; NSN *FNPRM* Comments at 10-11; Ericsson *FNPRM* Comments at 6-7.

steps to ensure that CBSDs operate only on authorized frequencies at all times. As Verizon noted, ensuring that devices operate only on assigned frequencies is essential to maintaining stability in the band and protecting network investments.⁷³⁵ However, while Verizon focuses on GAA users, we find that the SAS should take appropriate steps to ensure that all Citizens Broadband Radio Service users operate only on their assigned frequencies. As one element of this process, we require that, when an SAS deauthorizes a CBSD or changes its permissible operational frequencies, it may require that CBSD to confirm that it has complied with the SAS's instructions.⁷³⁶ As described below, we impose end-to-end security requirements that will prevent tampering with devices to circumvent SAS control or otherwise defeating the purposes of our rules.

340. As detailed in section III(H)(2)(e) the Commission will address any issues concerning unauthorized frequency use or unauthorized equipment that arise in the band. We believe that applying these requirements to all users will help prevent interference, assist in network planning, and promote network investment in the 3.5 GHz Band.

341. We acknowledge that our new framework for the 3.5 GHz Band raises technological challenges that will likely require novel and collaborative solutions. Detailed implementation strategies for the frequency management rules we adopt herein will be addressed during the SAS Administrator approval process described in section III(H)(3)(b). These discussions may also be informed by the outputs of any industry multi-stakeholder groups that are formed to address issues in the 3.5 GHz Band.⁷³⁷ Through these processes, we hope to gather insight from potential SAS administrators, future licensees, and other industry stakeholders regarding the most effective techniques for implementing these rules.

d. Security

342. *Background.* In the *FNPRM*, we proposed that the SAS employ protocols and procedures to ensure that all communications and interactions between the SAS and CBSDs are accurate and secure and that unauthorized parties cannot access or alter the SAS or the list of frequencies sent to a CBSD. These protocols and procedures would be reviewed and approved by the Commission before the SAS Administrator could be certified. We sought comment on these proposed rules and on any additional safeguards needed to protect sensitive federal information.⁷³⁸

343. The record strongly supports the inclusion of robust security protocols for communications between CBSDs and SASs.⁷³⁹ For instance, Ericsson supports a system wherein communications between CBSDs are protected using standard Internet security procedures.⁷⁴⁰ Federated Wireless agrees that secure Internet-based communications should be the minimum requirement for CBSD-to-SAS interactions but contends that SAS Administrators should be permitted to offer additional interfaces beyond the minimum requirements to meet the unique needs of various users.⁷⁴¹ Google contends that the Commission should not require manufacturers and operators to adopt specific security measures but should instead require that devices and services in the 3.5 GHz Band reflect “contemporary

⁷³⁵ See Verizon *FNPRM* Comments at 17-18.

⁷³⁶ See Appendix A, § 96.59(a)(3).

⁷³⁷ See *infra* III(K).

⁷³⁸ See *3.5 GHz FNPRM*, 29 FCC Rcd at 4304, ¶ 104.

⁷³⁹ See e.g., Ericsson *FNPRM* Comments at 22; iconective *FNPRM* Comments at 7-8; Federated Wireless *FNPRM* Reply Comments at 20-21; Google *FNPRM* Comments at 31-32; WIN Forum *FNPRM* Comments at 10-11; Verizon *FNPRM* Comments at 17-18.

⁷⁴⁰ Ericsson *FNPRM* Comments at 22.

⁷⁴¹ Federated Wireless *FNPRM* Reply Comments at 20-21.

industry best practices for security.”⁷⁴²

344. AT&T argues that, to ensure security of information in the SAS, the Commission should contract with a vendor approved by DoD, NTIA, and the General Services Administration to create the SAS software as a “work for hire” and ensure that the Commission retains control over the system. They argue that this would give licensees a greater degree of certainty that their information will be secure and confidential.⁷⁴³

345. *Discussion.* After review of the record, we adopt our proposal to require secure and reliable communications among and between CBSDs and SASs. We will also require SASs to protect themselves from unauthorized data input or alteration of stored data.⁷⁴⁴ Secure and reliable communication pathways between SASs and CBSDs and between different SASs are essential for the success of the Citizens Broadband Radio Service. Due to the nature of the Citizens Broadband Radio Service, sensitive information relating to network configuration and operations will be routinely sent between CBSDs and SASs. This information must be protected from interception or modification – during transmission and while stored in an SAS - to ensure that the proprietary and confidential information provided by licensees is not compromised.

346. However, while communications security in the band is paramount, we do not believe that mandating specific security protocols would serve the public interest at this time. Instead, we require potential SAS Administrators to develop and demonstrate that their systems include robust communications and information security features during the SAS Approval process.⁷⁴⁵ CBSDs shall demonstrate compliant security features during the equipment authorization process.⁷⁴⁶ These security protocols will be subject to the Commission’s review and approval, with input from NTIA and DoD. We anticipate that given the immense value of industry-wide interoperability, groups – such as the types of multi-stakeholder groups discussed in section III(K) – will develop security models that SAS Administrators may consider, subject to Commission review. We also expect that security mechanisms will be updated on an ongoing basis to reflect state-of-the-art protection against ever-evolving security threats.

347. We do not agree with AT&T’s argument that the SAS software should be created for the Commission as a “work for hire.”⁷⁴⁷ We believe that allowing applicants to develop multiple SASs within the parameters set by the Commission’s rules will foster innovation, competition, and lead to a higher quality of service for all Citizens Broadband Radio Service users. Indeed, this development path could lead to even more effective security features than could be created under the more restrictive approach suggested by AT&T. Moreover, as Federated Wireless notes, federal ownership of the software could lock the Commission into an expensive support system and hinder competition-driven innovation in the band.⁷⁴⁸

348. In addition, federal Incumbent Users have unique security concerns related to information that will be transmitted from the ESC to the SAS. SAS Administrators and potential ESC Operators are required to develop security protocols that meet the standards set by the Commission in collaboration with NTIA. Issues related to the ESC, including security policies, are addressed in greater detail section III(I).

⁷⁴² Google *FNPRM* Comments at 31-32.

⁷⁴³ AT&T *FNPRM* Comments at 32.

⁷⁴⁴ See Appendix A, § 96.61(b). See *supra* section III(F)(2)(f).

⁷⁴⁵ See *infra* section IIIH)(3)(b).

⁷⁴⁶ See *supra* section III(F)(2)(f).

⁷⁴⁷ AT&T *FNPRM* Comments at 32.

⁷⁴⁸ See Federated Wireless *FNPRM* Reply Comments at 22-23.

e. Enforcement

349. *Background.* In the *FNPRM* we noted that many of our proposals could raise novel enforcement issues for the Commission.⁷⁴⁹ Many of the proposals in the *FNPRM*, including the SAS specifications, CBSD technical requirements, and security protocols were designed to address these issues and facilitate secure and consistent access to the 3.5 GHz Band for all authorized users. We sought comment on additional techniques and protocols that could be implemented, inside or outside the SAS, to address the unique enforcement concerns raised by the proposals in the *FNPRM*.⁷⁵⁰

350. Commenters that addressed enforcement issues mostly raised concerns about the perceived complexity and unproven nature of the SAS. For instance, commenters including CTIA, SIA, and Verizon express concerns about the ability of the SAS to manage three tiers of authorized users and effectively protect Incumbent and Priority Access tier operations.⁷⁵¹ SIA questions the SAS's ability to prevent interference from CBSDs into existing FSS earth stations, especially given the complexity of the management functions under consideration.⁷⁵² CTIA argues that an SAS capable of managing three tiers of operations has not been tested and that, until such a system is vetted, Incumbent and Priority Access tier users would run a serious risk of interference from GAA users.⁷⁵³

351. *Discussion.* We note that many of the issues raised by commenters regarding enforcement mechanisms are addressed in sections III(H)(1) and III(H)(3). In addition to the rules proposed in the *FNPRM*, after review of the record, we also adopt additional requirements for the SAS to help manage access to the band and assist the Commission in performing its enforcement responsibilities. Specifically, to assist with the Commission's oversight responsibilities, we have added a requirement that SAS Administrators adopt procedures to immediately respond to requests from Commission personnel for information stored or maintained by the SAS and to discontinue CBSD operations as directed by the Commission.⁷⁵⁴ We also require SAS Administrators to establish and follow protocols to comply with enforcement instructions from the Commission, including discontinuance of CBSD operations in designated geographic areas.⁷⁵⁵ These requirements are necessary to ensure that the Commission is able to ascertain the accuracy of information stored in the SAS, obtain the information necessary to enforce the Commission's rules, and ensure that CBSDs that do not comply with the Commission's rules are shut down in a timely manner.

352. We expect that the SAS will be a valuable tool for spectrum management and enforcement and that SAS Administrators, in cooperation with individual licensees, will be able to resolve many of the issues that will arise in the band. We address concerns raised about the SAS's ability to manage and protect multiple tiers of authorized users elsewhere in this *Report and Order*.⁷⁵⁶ We expect many of the detailed enforcement mechanisms and procedures employed by SASs to be developed during the SAS Administrator approval process described in section III(H)(3)(b). However, we reiterate that, regardless of the scope of the SAS, the Commission retains the ultimate responsibility for and authority over licensees in the band. In the event that the SAS is unable to resolve disputes between licensees or identify and address the sources of harmful interference in the band, we will address these issues, as well as any issues concerning unauthorized frequency use or unauthorized equipment.

⁷⁴⁹ See *3.5 GHz FNPRM*, 29 FCC Red at 4322, ¶ 162.

⁷⁵⁰ See *id.* at 4322, ¶ 162.

⁷⁵¹ Verizon *FNPRM* Comments at 13; SIA *FNPRM* Comments at 11-13; CTIA *FNPRM* Comments at 3-5.

⁷⁵² See SIA *FNPRM* Comments at 11-13.

⁷⁵³ See CTIA *FNPRM* Comments at 3-5.

⁷⁵⁴ Appendix A, § 96.63(k).

⁷⁵⁵ Appendix A, § 96.63(m).

⁷⁵⁶ See *supra* sections III(B) and III(H)(2).

3. SAS Administrators

353. In the *FNPRM*, we proposed that only designated SAS Administrators that have been approved by the Commission could operate an SAS.⁷⁵⁷ We proposed to authorize multiple SAS Administrators, though each Administrator would be responsible for a single SAS. SAS Administrators would have to demonstrate, in detail, how their SASs will comply with the Commission's rules and establish detailed protocols to enforce the responsibilities set forth in Part 96.⁷⁵⁸ We hereby adopt many of the proposals described in the *FNPRM*, set forth general guidelines for SAS Administrators, and provide details regarding the SAS Approval process.

354. We intend to foster a diverse, competitive marketplace of SAS providers. We believe that the rules we adopt will promote technological innovation and encourage the development of market based solutions to the challenges involved with effective spectrum management in the 3.5 GHz Band. We believe that competition among multiple SAS providers is essential to the success of the 3.5 GHz Band. Indeed, we believe our rules will provide much leeway for competitive SAS Administrators to provide differentiated, value-added services in the course of fulfilling the core regulatory obligations. We hope that such competition will create a "race to the top" that yields advances in technology, at reasonable cost, as SAS Administrators vie to serve different parts of the market. We have seen this dynamic begin to emerge in TV White Spaces, with the approval of multiple database providers to-date, as well as in more conventional frequency-coordinated radio services.

355. At the same time we understand that network effects and technological "lock-in" can also sometimes present dynamics that hinder, rather than help, competition. Were this to occur in the 3.5 GHz Band, an SAS Administrator might use its position not only to facilitate a particular use of the band, but also to control access to the band. Let us be clear: we do not intend to create a back-door "license", which vests exclusionary power in one or a few SAS Administrators (separate from any licenses assigned pursuant to our Part 96 rules). We will carefully review SAS Administrator applications – and will revise the rules, if necessary – to ensure that the SASs develop in a way that achieves the positive goals set forth in this *Report and Order*.

a. SAS Administrator Requirements

356. Background. In the *FNPRM* we proposed that SAS's be operated only by approved SAS Administrators. Those SAS Administrators would be authorized for a five-year term, renewable at the Commission's discretion. We proposed that the SAS Administrators establish protocols and procedures to manage Citizens Broadband Radio Service Users in the band, protect Incumbent Users from harmful interference, and perform the other proposed SAS functions set forth in the Proposed Rules.⁷⁵⁹ We also proposed that SAS Administrators be required to:

- maintain a regularly updated database that contains the information described in the proposed rules;
- establish a process for acquiring and storing in the database necessary and appropriate information from the Commission's databases;
- respond in a timely manner to verify, correct or remove, as appropriate, data in the event that the Commission or a party brings claim of inaccuracies in the SAS to its attention;
- securely transfer the information in the SAS to another designated entity in the event it does not continue as an SAS Administrator at the end of its term;

⁷⁵⁷ See *3.5 GHz FNPRM*, 29 FCC Rcd at 4304-05, ¶¶ 105-108.

⁷⁵⁸ See *id.* at 4305, ¶¶ 107-108.

⁷⁵⁹ See *id.* at 4304-05, ¶¶ 105-108.

- cooperate with other SAS Administrators to develop a standardized process for coordinating and exchanging required information;
- provide a means to make public information available to the public in an accessible manner.⁷⁶⁰

357. The record shows general support for authorizing multiple SAS Administrators in the band.⁷⁶¹ Commenters emphasize that authorizing multiple SAS Administrators will promote competition and innovation in the band.⁷⁶² Google also cautions against overly proscriptive rules, noting that SAS Administrators should be able to differentiate themselves based on the technologies and services they offer.⁷⁶³

358. The record was split on the issue of whether SAS Administrators should be permitted to act as Priority Access Licensees. Some commenters, including Verizon and Google, support allowing SAS Administrators to also hold Priority Access Licenses.⁷⁶⁴ Google argues that preventing SAS Administrators from holding PALs would discourage parties from investing in SAS development, reducing overall competition in the band.⁷⁶⁵ Microsoft disagrees, and argues that SAS Administrators should not be permitted to hold PALs to prevent conflicts of interest.⁷⁶⁶

359. *Discussion.* The primary function of any SAS Administrator will be to develop protocols, procedures, and systems to enforce the Commission's rules governing SAS operations. We will require each SAS Administrator to provide services for a five-year term, which, at the Commission's discretion, may be renewed.⁷⁶⁷ In the event that an SAS Administrator does not wish to continue at the end of its term, or if its term is not renewed, it will be required to transfer its database along with the information necessary to access the database to another designated SAS. The SAS administrator would be permitted to charge a reasonable fee for conveyance of that resource.⁷⁶⁸

360. If the Commission approves multiple SAS Administrators, we must ensure that each SAS contains consistent, accurate information. Because a CBSD will only be required to contact a single SAS, there is a need for SASs to share accurate registration information so that each SAS has the same, current view of the radio environment. Therefore, we will require SAS Administrators to cooperate with one another to develop a standardized process for coordinating their operations, avoiding any conflicting assignments, maximizing shared use of available frequencies, ensuring continuity of service to all registered CBSDs, and sharing the data collected from registered CBSDs.⁷⁶⁹ We will also require SAS Administrators to coordinate with each other to facilitate non-interfering use by CBSDs connected to

⁷⁶⁰ See *id.* at 4304-05, ¶ 106, Proposed Rules, § 96.48.

⁷⁶¹ See e.g., Google *FNPRM* Comments at 32-33; Verizon *FNPRM* Comments at 15-16; AT&T *FNPRM* Comments at 33-34; PISC *FNPRM* Reply Comments at 35; Motorola Solutions *FNPRM* Comments at 8-9; Microsoft *FNPRM* Reply Comments at 6; Ericsson *FNPRM* Comments at 16; WISPA *FNPRM* Comments at 32; iconectiv *FNPRM* Comments at 2; *But see* Wireless Innovation Forum *FNPRM* Comments at 9-10 and Federated Wireless *FNPRM* Comments at 21-22 (The Commission should establish multiple regional SASs instead of multiple nationwide SASs)

⁷⁶² See Google *FNPRM* Comments at 32-33; Verizon *FNPRM* Comments at 15-16.

⁷⁶³ See Google *FNPRM* Comments at 32-33.

⁷⁶⁴ See Google *FNPRM* Reply Comments at 27-28; Verizon *FNPRM* Comments at 15-16.

⁷⁶⁵ See Google *FNPRM* Reply Comments at 27-28.

⁷⁶⁶ See Microsoft *FNPRM* Comments at 12; Microsoft *FNPRM* Reply Comments at 7.

⁷⁶⁷ See Appendix A, § 96.63e.

⁷⁶⁸ See Appendix A, § 96.63(g).

⁷⁶⁹ See Appendix A, § 96.63(h).

other SASs, maximize available GAA frequencies by assigning PALs to similar channels in the same geographic regions, and perform such other functions necessary to ensure that available spectrum is used efficiently.⁷⁷⁰ SAS Administrators must share information on the CBSDs and licensees managed by their SAS to the extent necessary to facilitate the effective coordination of all approved SASs.

361. In addition, an SAS will obtain much of the information on licensed use of the 3.5 GHz Band from Commission databases. This information will include information on Priority Access Licensees and licensed in-band FSS users. This information may be stored in the Commission's Universal Licensing System database or another system. Each SAS will be required to synchronize itself with Commission databases at least once a day so that the information in the SAS remains current.⁷⁷¹

362. SAS Administrators must also establish protocols and procedures to protect Incumbent operations consistent with information received from an approved ESC. SAS Administrators will be responsible for ensuring that all information transmitted by the ESC is acted upon and protected consistent with any additional requirements imposed during the SAS and ESC approval processes.⁷⁷² SAS Administrators may themselves provide an ESC (if approved) or work with another approved ESC provider.

363. We will expect SAS Administrators to respond quickly to verify and correct or remove data in the event that a party or the Commission brings claims of inaccuracies in the SAS to its attention.⁷⁷³ This obligation to remedy inaccuracies applies to information entered into or omitted from the SAS, whether willfully or through operator error. Further, SAS Administrators must ensure that the SAS is able, at all times, to promptly respond to requests from Commission personnel for any information stored in the SAS.⁷⁷⁴ SAS Administrators must ensure that there is a capability in place to respond to emergency instances that require CBSDs to cease operation in a geographic area or during a specified time period.⁷⁷⁵

364. Finally, we permit SAS Administrators to hold PALs and act as GAA users. We disagree with Microsoft's contention that allowing SAS Administrators to hold or lease PALs would necessarily lead to discriminatory conduct based on potential conflicts of interest.⁷⁷⁶ So long as an approved SAS Administrator complies with all of our rules, coordinates fairly with other SAS Administrators, and is one of several options available to end users in a competitive market for SAS services, we believe that the public interest should be well served by the SAS community. However, we include in our rules a requirement that SAS Administrators discharge their frequency assignment functions, whether involving their own users or those served by a different SAS Administrator, in a non-discriminatory manner, consistent with the priority accorded to PAL users vis-à-vis GAA users under our rules.

365. In addition, in determining whether to approve applicants to serve as SAS Administrators, we will require a demonstration of their intent and ability to comply with all of our rules, including this nondiscrimination requirement as well as the requirement that they cooperate with other SAS Administrators in coordinating and exchanging required information. Moreover, the Commission will monitor the behavior of SAS Administrators and will take enforcement action if necessary to ensure that SAS Administrators comply with all applicable rules. The Commission will also monitor the competitive balance in the 3.5 GHz Band and may take action to rectify any anti-competitive behavior

⁷⁷⁰ See Appendix A, § 96.63(i).

⁷⁷¹ See Appendix A, § 96.63(b).

⁷⁷² See Appendix A, §§ 96.63(n) and 96.67.

⁷⁷³ See Appendix A, § 96.63(f).

⁷⁷⁴ See Appendix A, § 96.63(k).

⁷⁷⁵ NTIA Letter; Appendix A, § 96.63(l).

⁷⁷⁶ See Microsoft *FNPRM* Comments at 12; Microsoft *FNPRM* Reply Comments at 7.

that could be attributed to SAS Administrators holding or leasing PALs or GAA licenses or operating CBSDs (under PAL or GAA authorization) in the band.

366. In the past, we have recognized the need to avoid conflicts of interest in connection with frequency coordination.⁷⁷⁷ We believe the foregoing protections are sufficient to guard against such conflicts in the discharge of SAS duties. First, as noted above, we contemplate approval of a number of SAS Administrators, to ensure that 3.5 GHz Band licensees have sufficient choices and thereby promote competition as to fees and service quality. We believe that establishment of a competitive market for these services will help ensure against discriminatory conduct based on potential conflicts of interest. Second, we have designed the SAS function to be a highly automated one that minimizes the potential for such discriminatory conduct, and will review applications during the approval process in the light of that goal. In these circumstances, we believe the foregoing protections should be adequate.⁷⁷⁸

b. SAS and SAS Administrator Approval Process

367. *Background.* In the *FNPRM*, we proposed to authorize multiple SASs for five-year terms. We also proposed that the Bureau review applications for SAS certification and establish procedures for reviewing the qualifications of prospective SAS Administrators. We sought comment on this approach and on the appropriate process for selecting, reviewing, and approving SAS Administrators.⁷⁷⁹

368. Several commenters, including AT&T, Ericsson, Google, and PISC supported the Commission's proposal to require prospective SAS administrators to complete a thorough review and approval process.⁷⁸⁰ AT&T notes that the approval process, coupled with the SAS Administrator requirements, strikes a balance between Commission oversight of the SAS and the need to avoid adopting overly prescriptive rules about the SAS.⁷⁸¹ While Google supports rigorous requirements to ensure that SAS Administrators have the technical expertise and financial security to operate an SAS, it urges the Commission not to mandate specific technology that SAS Administrators must use.⁷⁸² Instead, Google asks that we "establish basic functional requirements that will protect both incumbent users and the rights of PAL holders."⁷⁸³

⁷⁷⁷ See, e.g., Wireless Telecommunications Bureau Opens Filing Window for Requests to be the Frequency Coordinator for Medical Body Area Networks, *Public Notice*, 29 FCC Rcd 13750 (WTB 2014) (requiring applicant to demonstrate "how it will prevent any conflict of interest"); Wireless Telecommunications Bureau Opens Filing Window for Requests to Be a Frequency Coordinator in the Wireless Medical Telemetry Service, *Public Notice*, 15 FCC Rcd 19038 (WTB 2000) (same); Wireless Telecommunications Bureau Opens Filing Window for Proposals to Develop and Manage Independent Database of Site Registrations by Licensees in the 71-76 GHz, 81-86 GHz and 92-95 GHz Bands, *Public Notice*, 19 FCC Rcd 4597 (2004) (database manager applicants must show how they would prevent conflict of interests or alternatively certify that neither they nor any affiliate would be a licensee); Wireless Telecommunications Bureau Certifies Additional Frequency Coordinator for 800/900 MHz Business/Industrial/Land Transportation Pool, *Public Notice*, 29 FCC Rcd 9599 (WTB 2014) (certifying Association of American Railroads as a frequency coordinator but precluding it as a license holder from coordinating applications on its own behalf).

⁷⁷⁸ We note that the Commission has "propose[d] to make Cellular licensees ineligible to be certified as Cellular frequency coordinators." Amendments of Parts 1 and 22, *Report and Order and Further Notice of Proposed Rulemaking*, 29 FCC Rcd 14100 ¶ 102 (2014). For the reasons stated above, our action here with respect to SAS Administrators does not bear on that question.

⁷⁷⁹ See *3.5 GHz FNPRM*, 29 FCC Rcd at 4304-05, ¶¶ 105-108.

⁷⁸⁰ See Google *FNPRM* Comments at 32-33; AT&T *FNPRM* Comments at 33-34; Ericsson *FNPRM* Comments at 16-17; PISC *FNPRM* Reply Comments at 35.

⁷⁸¹ AT&T *FNPRM* Comments at 33-34.

⁷⁸² Google *FNPRM* Comments at 32.

⁷⁸³ *Id.* at 32.

369. *Discussion.* We will designate one or more private sector administrators to create and operate an SAS, following a thorough approval and review process. We believe that a comprehensive process for SASs and SAS Administrators will foster competition, promote the development of innovative technologies, and further the public interest. An approval process that builds upon the TVWS experience should facilitate the testing and development of multiple SASs to oversee the Citizens Broadband Radio Service. We adopt the proposed delegation of authority to WTB and OET and instruct them to take such actions as authorized by sections 0.241(j) and 0.331(f).⁷⁸⁴

370. As stated previously, the rules governing SASs and SAS Administrators are high-level guidelines that describe the minimum requirements for any authorized SAS.⁷⁸⁵ We expect that applicants will develop specific policies, procedures, and technologies to show compliance with, implement and enforce the rules during the approval process. We agree with Google that our rules should “provide a framework to enable efficient spectrum use” without mandating “the specific technical means by which SAS administrators achieve them.”⁷⁸⁶ All stages of the process, including review of applications and system compliance testing, will be overseen by WTB and OET, in close consultation with NTIA and DoD.

371. After the release of this *Report and Order*, WTB and OET will issue a Public Notice requesting proposals from entities desiring to administer an SAS. Applicants will be required to, at a minimum, demonstrate how they plan to meet the Commission’s rules governing SAS operations, demonstrate their technical qualifications to operate an SAS, and provide any additional information requested by WTB and OET.⁷⁸⁷ Based on these applications, WTB and OET will determine whether to conditionally approve any of the applicants. If an application is not accepted, the applicant may file an Application for Review with the Commission.⁷⁸⁸

372. Any applicants that receive conditional approval must demonstrate, to the satisfaction of WTB and OET, that their SASs meet all of the requirements set forth in the Commission’s rules and any other conditions that these offices deem necessary. WTB and OET will provide detailed instructions to applicants throughout the process. At a minimum, applicants will be required to allow their systems to be tested and analyzed by FCC staff prior to making their systems available for a period of public testing prior to release. Applicants may also be required to attend workshops and meetings as directed by the offices. NTIA will provide input and guidance as needed to ensure that the concerns of federal incumbents are properly addressed during the approval process.

373. We expect that this process will facilitate the rapid development and deployment of multiple fully functional SASs. We also expect that, through the approval process, applicants and other stakeholders will work collaboratively to develop standards, procedures, and industry best practices in several key areas, including SAS coordination and information exchange, communications between CBSDs and SASs, and information security. We believe that these collaborative efforts will yield flexible, innovative solutions to these, and other, technical issues. However, if satisfactory solutions are not reached through industry consensus, the Commission may address these issues in the future.

c. SAS Administrator Fees

374. *Background.* In the FNPRM, we proposed that SAS Administrators be permitted to

⁷⁸⁴ See Appendix A, §§ 0.241(j) and 0.331(f).

⁷⁸⁵ See *supra* section III(H)(2).

⁷⁸⁶ Google *FNPRM* Comments at 33.

⁷⁸⁷ See Office of Engineering and Technology Invites Proposals from Entities Seeking to be Designated TV Band Device Database Managers, *Public Notice*, ET Docket No. 04-186, 24 FCC Rcd 14136 (OET 2009) (describing the application procedures for TVWS database administrators).

⁷⁸⁸ See 47 C.F.R. § 1.115.

collect reasonable fees from Priority Access Licensees and General Authorized Access users for use of the SAS and associated services.⁷⁸⁹ We based this proposal on a similar rule adopted for TVWS database administrators.⁷⁹⁰ We sought comment on this proposal and on whether SAS Administrators should be permitted to collect fees from all Citizens Broadband Radio Service users.

375. Many commenters, including Federated Wireless, Ericsson, Verizon, and PISC support our proposal to allow SAS Administrators to collect reasonable fees from both Priority Access Licensees and GAA users.⁷⁹¹ T-Mobile contends that SAS administrators should not be permitted to collect fees from Priority Access Licensees since the Commission proposes to assign PALs via competitive bidding.⁷⁹² However, T-Mobile maintains that if fees are necessary to recover SAS costs, they should only be collected from GAA users.⁷⁹³

376. *Discussion.* We find that permitting SAS Administrators to charge reasonable fees to Priority Access Licensees and GAA users is in the public interest. Our review of the record shows that there is widespread support for allowing SAS Administrators to collect reasonable fees from both Priority Access Licensees and GAA users.⁷⁹⁴ As Ericsson notes, allowing SAS Administrators to collect fees from PAL and GAA users in a manner similar to users of the TVWS databases is “reasonable and appropriate.”⁷⁹⁵ Ericsson explains that the collection of fees will give SAS Administrators the flexibility to develop individual business models.⁷⁹⁶ We agree; allowing SAS Administrators the option of whether and which users to charge for use of an SAS will give Administrators the greatest possible flexibility and facilitate the development of various competitive business models. Accordingly, SAS Administrators may charge any Citizens Broadband Radio Service user a reasonable fee for provision of its services.⁷⁹⁷

377. We do not agree with T-Mobile’s assertion that SAS Administrators should not be permitted to charge fees to Priority Access Licensees since those licensees will have already paid for spectrum access at auction.⁷⁹⁸ We believe that allowing SAS Administrators the freedom to determine whether to charge users for their valuable services – and which users to charge – will promote competition in the band. The choice to acquire spectrum access and bear the costs associated with managing access to the spectrum, including whether to pay an SAS Administrator, is a business decision to be made by the potential licensee.⁷⁹⁹ This approach is wholly consistent with Commission precedent in other services, including Land Mobile Services authorized under part 90 of the Commission’s rules,

⁷⁸⁹ See 3.5 GHz FNPRM, 29 FCC Red at 4305, ¶ 109.

⁷⁹⁰ See 47 C.F.R. § 47.1514.

⁷⁹¹ See Federated Wireless FNPRM Reply Comments at 21-22; Ericsson FNPRM Comments at 17; Verizon FNPRM Comments at 16; WISPA FNPRM Comments at 32; PISC FNPRM Reply Comments at 36; iconectiv FNPRM Comments at 3; Motorola Solutions FNPRM Comments at 8-9; InterDigital FNPRM Comments at 14; Google FNPRM Comments at 33-34; Spectrum Bridge FNPRM Comments at 8; AT&T FNPRM Comments at 33-34.

⁷⁹² See T-Mobile FNPRM Comments at 15.

⁷⁹³ *Id.* at 15.

⁷⁹⁴ See Federated Wireless FNPRM Reply Comments at 21-22; Ericsson FNPRM Comments at 17; Verizon FNPRM Comments at 16; WISPA FNPRM Comments at 32; PISC FNPRM Reply Comments at 36; iconectiv FNPRM Comments at 3; Motorola Solutions FNPRM Comments at 8-9; InterDigital FNPRM Comments at 14; Google FNPRM Comments at 33-34; Spectrum Bridge FNPRM Comments at 8; AT&T FNPRM Comments at 33-34.

⁷⁹⁵ Ericsson FNPRM Comments at 17.

⁷⁹⁶ *Id.* at 17.

⁷⁹⁷ See Appendix A, § 96.65(a).

⁷⁹⁸ See T-Mobile FNPRM Comments at 15.

⁷⁹⁹ See PISC FNPRM Reply Comments at 36-37.

wherein licensees pay the Commission to obtain a license and a third party for coordination services.⁸⁰⁰

378. Our determination is based on the expectation that a competitive market for SAS services will emerge. We intend to allow the market to determine the appropriate rates to be charged to Citizens Broadband Radio Service users. However, if SAS Administrators engage in anti-competitive or collusive practices resulting in excessive fees, or if a competitive market for SAS services otherwise fails to materialize, the Commission may take steps to address such issues.⁸⁰¹

I. Environmental Sensing Capability

379. *Background.* In the *FNPRM*, we proposed that the SAS retain information on all operations within the 3.5 GHz Band, including, for incumbent federal users, the geographic coordinates of the Exclusion Zones.⁸⁰² We also noted that some commenters have argued that the SAS should be required to incorporate spectrum sensing information from CBSDs or other remote beaconing and sensing sites to accurately detect incumbent usage models and respond to the interference environment.⁸⁰³ In addition, we stated that we would explore the possibility of allowing dynamic coordinated access to spectrum within Exclusion Zones.⁸⁰⁴ We sought comment on allowing Citizens Broadband Radio Service operations within Exclusion Zones as well as the use of sensors for frequency management and incumbent protection.⁸⁰⁵

380. Several commenters support allowing Citizens Broadband Radio Service users to dynamically access areas within the Exclusion Zones proposed in the *FNPRM*. In addition, as set forth in section III(G), many commenters supported using spectrum sensing technology to protect federal users from harmful interference and facilitate more widespread commercial use of the 3.5 GHz Band.⁸⁰⁶ Some commenters also contend that the Commission should authorize the use of a federal SAS to securely maintain information on federal incumbent operations and accelerate the process for reducing exclusion zones.⁸⁰⁷

381. In its March 24, 2015 letter, NTIA suggested that sensors could be used to protect federal operations using an ESC. NTIA suggests that the ESC could consist of one or more commercially operated networks of device-based or infrastructure-based sensors that would be used to detect signals

⁸⁰⁰ See 47 C.F.R. §90.171, *et seq.*

⁸⁰¹ See Appendix A, §96.65(b). Federated Wireless contends that implicit in our rule to review SAS fees upon request and change such fees if they are found to be unreasonable is an intent to set prices for SAS services. Federated Wireless *FNPRM* Comments at 27. We disagree. As stated above we intend to allow the market to develop competitive prices for SAS services, but reserve the right to review such fees if necessary.

⁸⁰² See 3.5 GHz *FNPRM*, 29 FCC Rcd at 4303, ¶ 99.

⁸⁰³ See *id.* at 4303, ¶ 101. Federated SAS Paper at 3-4; Shared Spectrum Company *Licensing PN* Comments at 3-6.

⁸⁰⁴ See 3.5 GHz *FNPRM*, 29 FCC Rcd at 4316, ¶ 142.

⁸⁰⁵ See *id.* at 4303, 4316, ¶¶ 101, 142.

⁸⁰⁶ See *supra* section III(G). See also Wireless Innovation Forum *NPRM* Comments at 3; Spectrum Bridge Inc. *NPRM* Comments at 19; Shared Spectrum Company *NPRM* Comments at 8-10; White Space Alliance *NPRM* Comments at 2; InterDigital Inc. *NPRM* Comments at 9, 16, and 17; WISPA *NPRM* Reply Comments at 16; Ericsson *FNPRM* Comments at 25; Telcordia Technologies Inc. *FNPRM* Comments at 7; Federated Wireless *FNPRM* Comments at 24-28; Verizon and Verizon Wireless *FNPRM* Comments at 15; Federated Wireless *FNPRM* Reply Comments at 2, 6, and 7; BLiNQ Networks *FNPRM* Reply Comments at 8 and 9; *Ex Parte* Letter from Trey Hanbury, Counsel to BLiNQ Networks, to Marlene H. Dortch, Secretary, Federal Communications Commission in Docket No. 12-354 (filed Sept. 6, 2013) at 7, 11, 12, and 18; Google *FNPRM* Reply Comments at 5 and 6; and PISC *FNPRM* Reply Comments at 32 and 33.

⁸⁰⁷ See Microsoft *FNPRM* Comments at 6-7; Motorola Solutions *NPRM* Comments at 6; InterDigital *SAS Workshop* Paper at 11; Ericsson *SAS Workshop PN* Comments at 4.

from federal radar systems. According to NTIA, based on ESC inputs, the SAS could instruct commercial users to vacate a channel when proximity to federal operations (in frequency, location, or time) presents a risk of harmful interference to federal radar systems. The information communicated by the ESC could then be used by the SAS to direct Citizens Broadband Radio Service users to another channel or, if necessary, to cease transmissions to avoid potential interference to federal radar systems. NTIA also asserts that ESC sensors would only be required in the vicinity of the Exclusion Zones established to protect federal radar systems.⁸⁰⁸

382. *Discussion.* We agree with NTIA's suggestion to allow the use of one or more ESCs to detect federal frequency use in and adjacent to the 3.5 GHz Band. As NTIA, Google, Federated Wireless, and others have noted, spectrum sensing technologies – in conjunction with management of CBSDs by an approved SAS – would allow Citizens Broadband Radio Service users to operate near the coastline on a channel or frequency not being used by federal radar systems.⁸⁰⁹ This would allow for more efficient and widespread commercial use of the spectrum while ensuring that federal use of the band is protected. Moreover, sensing technology would allow federal users to deploy next generation radar systems without fear of interference from commercial operators.

383. We also agree with NTIA that the ESC should be developed, managed, and maintained by a non-governmental entity and should not require oversight or day-to-day input from NTIA or DoD. We note that the rules governing the ESC are technologically neutral and, as such, ESC developers may utilize different sensing techniques that yield the desired result. The sensors comprising an authorized ESC may be infrastructure-based, device-based, or a combination of the two, as long as the ESC complies with the rules and guidelines set forth by the Commission. These sensors shall be deployed in the vicinity of the Exclusion Zones described in section III(G) to ensure that all federal radar use in and adjacent to the 3.5 GHz Band is accurately detected and reported to an SAS.

384. In addition and as noted above, our rules protect the security and confidentiality of federal operations by ensuring that the ESC does not store, retain, transmit, or disclose any information on the locations or movements of any federal systems. The ESC will not provide any insights into the operations, locations, parameters, or features of federal radar and other systems that could potentially affect their security posture. This is consistent with NTIA's recommended approach to providing information on federal systems that is necessary for the effective implementation of the ESC.

385. While some commenters support establishing a federal SAS to retain and manage federal spectrum use data, given the sensitivity of the information in question, we do not think it would be in the public interest to retain this data.⁸¹⁰ Moreover, given the large number of commenters who opined on the positive benefits and technological feasibility of using sensing technology in the band, we believe that retaining information on federal operations will not be necessary to share the band effectively.⁸¹¹

386. Prospective ESC operators must have their systems reviewed, certified, and approved through the approval process used to approve SASs and SAS Administrators described in section III(H)(3)(b). While the processes are the same, ESCs and SASs shall be evaluated, tested, and approved separately. However, these processes may be concurrent and the ability to communicate with an SAS will be a key component of ESC approval. The approval process will be overseen by the Commission in close consultation with NTIA and DoD. To be approved, an ESC must meet the following requirements:

- be managed and maintained by a non-governmental entity;
- accurately detect federal frequency use in the 3550-3700 MHz band and adjacent

⁸⁰⁸ See NTIA Letter at 3-4.

⁸⁰⁹ See *id.* at 3-4; Federated *FNPRM* Comments at 14; Google January 2015 *Ex Parte* at 5.

⁸¹⁰ See Federated Wireless *FNPRM* Reply Comments at 8-9.

⁸¹¹ See Federated Wireless *FNPRM* Comments at 16-18 and Federated Wireless *FNPRM* Reply Comments at 7.

frequencies;

- communicate information about detected frequency use to an approved SAS;
- maintain security of detected and communicated signal information;
- comply with all Commission rules and guidelines governing the construction, operation, and approval of ESCs;
- be available at all times to immediately respond to requests from authorized Commission personnel for any information collected or communicated by the ESC;
- ensure that the ESC operates without any connectivity to any military or other sensitive federal database or system;
- ensure that the ESC does not store, retain, transmit, or disclose operational information on the movement or position of any federal system or any information that reveals other operational information of any federal system that is not required to effectively operate the ESC by Part 96.

Following ESC approval, approved SAS Administrators making use of an approved ESC may dynamically authorize CBSDs nationwide, consistent with section III(G). We also direct WTB and OET to submit a report to the Commission on the status of the development, review, and approval of SASs and ESCs at nine month intervals. The first such report will be due on January 17, 2016. Overall, we believe that the development of an ESC – in conjunction with an approved SAS - will maximize efficient commercial use of the 3.5 GHz Band while protecting important federal incumbent operations.

J. 3650-3700 MHz Band

387. *Background.* In the *NPRM*, the Commission sought comment on a supplemental proposal to include the adjacent 3650-3700 MHz band in the proposed Citizens Broadband Radio Service regulatory regime.⁸¹² As we noted in the *NPRM*, incorporating this additional 50 megahertz would create a 150 megahertz contiguous block of spectrum that could be used by existing licensees in the 3650-3700 MHz band – as well as new licensees – to expand the services that they are already providing. Subsequently, in the *Licensing PN* the Commission specifically sought comment on extending the Revised Framework to the 3650-3700 MHz band, and asked what provisions would need to be made for existing operators and how much transition time would be required.⁸¹³

388. In the *FNPRM*, we reaffirmed our supplemental proposal to extend our proposed rules for the 3.5 GHz Band to the 3650-3700 MHz band.⁸¹⁴ The Commission stated that, if it decided to include the latter band segment in the Citizens Broadband Radio Service, the existing 3650-3700 MHz operations would be grandfathered for a period of five years after the effective date of the proposed rules.⁸¹⁵ During the transition period, existing licensees would be permitted to operate stations in accordance with the technical rules in Part 90, Subpart Z, if any had been authorized.⁸¹⁶ During this period, Grandfathered Wireless Broadband Providers would be required to avoid causing harmful interference to the federal sites listed in 47 C.F.R. § 90.1331 and grandfathered FSS earth stations, in accordance with existing Part 90 rules.⁸¹⁷ At the end of the transition period, Grandfathered Wireless Broadband Providers would have the

⁸¹² *3.5 GHz NPRM*, 27 FCC Rcd at 15620-22, ¶¶ 77-82.

⁸¹³ *Licensing PN*, 28 FCC Rcd at 15315-16, ¶ 51.

⁸¹⁴ *See 3.5 GHz FNPRM*, 29 FCC Rcd at 4323, ¶ 166.

⁸¹⁵ *See id.*

⁸¹⁶ *See id.*

⁸¹⁷ We note that operators in the 3650-3700 MHz band currently operate without restriction within the Exclusion Zones we propose. As such, we do not propose to exclude Citizens Broadband Radio Service operations from these
(continued....)

option, available to all eligible 3.5 GHz Band users, to apply for PALs in the 3550-3650 MHz band or to operate on a GAA basis consistent with Part 96 rules.⁸¹⁸ The Commission sought comment on the current equipment upgrade cycles for equipment in the band, and the incremental cost to Part 90 incumbents of complying with Part 96 requirements weighed against the benefits of obtaining access to an additional 100 megahertz of spectrum on a PAL or GAA basis.⁸¹⁹

389. Many commenters support the proposal to create a 150 megahertz contiguous block of spectrum for the 3.5 GHz Band.⁸²⁰ T-Mobile, for example, observes that by extending the Citizens Broadband Radio Service licensing framework to the 3650-3700 MHz band, we will “increase the utility of the band, benefitting existing operators, attracting new providers, and fostering a large, innovative equipment market.”⁸²¹ Similarly, Motorola Mobility asserts that including 3650-3700 MHz will meet the Commission’s policy goals of making additional spectrum available for mobile broadband service to the public, while promoting interference mitigation techniques and spectral efficiency.⁸²² Google similarly supports extension of the Citizens Broadband Radio Service framework to the 3650-3700 MHz band, but notes that current users should only be grandfathered to use the band for a period of time based on their actual current use.⁸²³

390. Some commenters oppose changing the existing framework for the 3650-3700 MHz band.⁸²⁴ These commenters assert that given existing investment in the band, 3650-3700 MHz should not be integrated with the Citizens Broadband Radio Service framework.⁸²⁵ WISPA notes that Wireless Internet Service Providers (WISPs) currently use the 3650-3700 MHz band to provide fixed wireless broadband services.⁸²⁶ Cloud Alliance in Vermont and Neptuno Networks in Puerto Rico, for example, use their 3650 MHz licenses to provide WiMAX service.⁸²⁷ Exelon and Ameren Services Inc. state that

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areas. However, operators in the 3650-3700 MHz band would be required to continue to protect grandfathered FSS earth stations and the grandfathered federal radiolocation facilities listed in Section 90.1331 of the Commission’s Rules. 47 C.F.R. § 90.1331.

⁸¹⁸ See *3.5 GHz FNPRM*, 29 FCC Rcd at 4323, ¶ 167.

⁸¹⁹ *Id.* at 4323-24 ¶ 168.

⁸²⁰ See e.g., PISC *FNPRM* Reply Comments at 39-40; AT&T *FNPRM* Comments at 21-22; Google *FNPRM* Comments at 19-20; Google *Licensing PN* Comments at 13-16; Microsoft *FNPRM* Comments at 9-10; NSN *FNPRM* Comments at 11; NSN *Licensing PN* Comments at 8-15; Wi-Fi Alliance *FNPRM* Comments at 10-11; Motorola Mobility *FNPRM* Comments at 3-4; Shared Spectrum Company *FNPRM* Comments at 9; T-Mobile *Licensing PN* Comments at 14; Verizon *Licensing PN* Comments at 4-5; Qualcomm *NPRM* Comments at 19.

⁸²¹ T-Mobile *Licensing PN* Comments at 14.

⁸²² Motorola Mobility *Licensing PN* Comments at 7.

⁸²³ Google January 2015 *Ex Parte* at 4-5.

⁸²⁴ See e.g., Neptuno *Licensing PN* Comments at 8-9; UTC *Licensing PN* Comments at 6 (The Commission should only extend the Citizens Broadband Radio Service to the 3650-3700 MHz band if it adopts the licensing proposals set forth in the *NPRM*); KanOkla Communications *Licensing PN* Reply Comments at 1-2 (Arguing that the Commission should maintain the *status quo* in the 3650-3700 MHz band); Airspan Networks *FNPRM* Comments at 1-2; Iberdrola USA Networks *FNPRM* Comments at 3-7; Sacred Wind Communications *FNPRM* Comments at 3-6; Telrad Networks *FNPRM* Comments at 3-5.

⁸²⁵ See, e.g., Lockard & White *FNPRM* Comments at 2-3; API *FNPRM* Comments at 5-6; American Petroleum *FNPRM* Reply Comments at 2-5; WiMAX Forum *FNPRM* Comments at 3-8; UTC *FNPRM* Comments at 5, 10; Neptuno Networks *Licensing PN* Comments at 3; SIA *NPRM* Comments at 18; SIA *NPRM* Reply Comments at 21-22; SIA *FNPRM* Reply Comments at 25-28.

⁸²⁶ WISPA *FNPRM* Comments at 7.

⁸²⁷ Cloud Alliance *FNPRM* Comments at 1; Neptuno Networks *NPRM* Comments at 3.

they use 3650 MHz licenses as part of their communications networks for the management of utility grids.⁸²⁸ UTC similarly notes that utilities have used their licenses to deploy and support smart grid applications including supervisory control and data acquisition (SCADA) and advanced metering infrastructure (AMI) systems.⁸²⁹ UTC maintains that extending the proposed Part 96 rules to the 3650-3700 MHz band would increase congestion in the band and impose undue costs on incumbents.⁸³⁰

391. Alternatively, some commenters suggest that if we decide to apply the proposed Part 96 rules to the 3650-3700 MHz band, we must do so by adopting sufficient protections to safeguard existing investment in the band and to mitigate any impact on incumbent operations.⁸³¹ Neptuno argues for a grandfathering period of five years or the remainder of the licensee's ten-year term, whichever is longer, with the ability to continue using current equipment.⁸³² UTC, pointing to CenterPoint's investment to support a smart grid system, proposes that incumbent operators be (1) grandfathered permanently; (2) protected from PAL and GAA operations in the band; and (3) have the first option to access PALs in their area.⁸³³ WISPA asks that incumbent operators be given priority access protection⁸³⁴ and be permitted to permanently retain and operate their existing equipment.⁸³⁵

392. *Discussion.* We conclude that it is in the public interest to adopt our supplemental proposal and include the 3650-3700 MHz band in the Citizens Broadband Radio Service framework, creating a 150 megahertz contiguous band for flexible, shared uses. We have tailored the 3.5 GHz Band rules in response to commenter concerns that incumbent 3650-3700 MHz licensees should be able to continue operations after transition to the broader Citizens Broadband Radio Service framework. We also provide for a transition period – longer, for many licensees, than was proposed in the *FNPRM* – in which incumbent 3650-3700 MHz licensees will enjoy interference protections that ease the transition to the new rules.

393. Including the 3650-3700 MHz band will serve the public interest by promoting spectrum availability, efficiency, and usability for all 3.5 GHz Band users, including prior 3650-3700 MHz licensees. There is substantial support in the record for extending the Citizens Broadband Radio Service rules to the 3650-3700 MHz band.⁸³⁶ As Google notes, “[m]ore contiguous spectrum can support more uses, attract more services, and encourage expansion of the equipment market – all of which will increase the intensity and diversity of 3.5 GHz operations.”⁸³⁷ PISC adds that common technical rules for PAL

⁸²⁸ Exelon *FNPRM* Comments at 2; Ameren Services Inc *FNPRM* Comments at 2-3.

⁸²⁹ UTC *FNPRM* Comments at 12.

⁸³⁰ *Id.* at 2, 12. See also FWCC *FNPRM* Reply Comments at 4; API *FNPRM* Comments at 3.

⁸³¹ See WISPA *FNPRM* Comments at 34; UTC *FNPRM* Comments at 15-16; FWCC *FNPRM* Reply Comments at 4 (Proposing permanent grandfathering for existing Part 90 links in order to mitigate effect on incumbent licensees).

⁸³² Neptuno Networks *FNPRM* Reply Comments at 4.

⁸³³ UTC *FNPRM* Comments at 15-16.

⁸³⁴ WISPA *Licensing PN* Comments at 19.

⁸³⁵ WISPA *FNPRM* Comments at 34. See also *Ex Parte* Letter from Alex Phillips, WISPA FCC Committee Chair, and Brett Kilbourne, General Counsel, UTC, to Marlene H. Dortch, Secretary, Federal Communications Commission at 1 (Dec. 5, 2014) (arguing that grandfathering must account for long lifespans of existing equipment and must not delay or strand investment through the forced upgrade of equipment).

⁸³⁶ See e.g., PISC *FNPRM* Reply Comments at 39-40; AT&T *FNPRM* Comments at 21-22; Google *FNPRM* Comments at 19-20; Google *Licensing PN* Comments at 13-16; Microsoft *FNPRM* Comments at 9-10; NSN *FNPRM* Comments at 11; NSN *Licensing PN* Comments at 8-15; Wi-Fi Alliance *FNPRM* Comments at 10-11; Motorola Mobility *FNPRM* Comments at 3-4; Shared Spectrum Company *FNPRM* Comments at 9; T-Mobile *Licensing PN* Comments at 14; Verizon *Licensing PN* Comments at 4-5; Qualcomm *NPRM* Comments at 19.

⁸³⁷ Google *Licensing PN* Comments at 13; Google *FNPRM* Comments at 19-20.

and GAA devices for the entire 3550-3700 MHz Band will promote “a mass market ecosystem of devices that can operate on either licensed (PAL) or unlicensed (GAA) spectrum.”⁸³⁸ The Wi-Fi Alliance maintains that extension of the rules will “promote the availability and efficient use of the spectrum band” and “provide economies of scale for equipment across the full 150-megahertz contiguous block of spectrum, thereby facilitating the realization of a robust small-cell market.”⁸³⁹ The Shared Spectrum Company contends that the expanded bandwidth available for GAA use will result in the deployment of innovative technologies such as sensing systems, which might not be financially attractive under “the traditional capital and planning restrictions imposed on auction licensing paradigms.”⁸⁴⁰ Our band-wide operability requirement for CBSDs will ensure that the benefits of equipment scale and spectrum access described above inure to all users. This scale should be far greater scale than available under the current Part 90 regime, due in large part to the relatively small size of the incumbents’ band (only 50 megahertz of spectrum).

394. We have also endeavored with the Citizens Broadband Radio Service to create a regulatory environment that will preserve, encourage, or even accelerate network deployments, including those providing smart grid and WISP services, which have taken root under the existing rules governing the 3650-3700 MHz band.⁸⁴¹ In making our supplemental proposal to include the 3650-3700 MHz band, we recognized that there were currently over 2,000 Part 90 incumbent licensees in this band with more than 25,000 registered sites.⁸⁴² As noted above, many of these Part 90 incumbents have made substantial investments in equipment deploying various services in the band. These investments were made under a non-exclusive licensing regime and subject to their statutory waiver against any claim to use of the spectrum “as against the regulatory power of the United States.”⁸⁴³ Still, we strive to minimize the adverse effects of rule changes on incumbents to the extent possible without compromising the public interest benefits that we believe such rules changes will produce.

395. We have therefore modified our proposal in four important ways to preserve existing 3650-3700 MHz investment. First, our decision not to allow Priority Access use in the 3650-3700 MHz band segment means that this portion of the band will continue to be licensed on a non-exclusive basis, and thus will continue to be available on a non-exclusive basis to former Part 90 incumbents.⁸⁴⁴

⁸³⁸ PISC *FNPRM* Reply Comments at 37.

⁸³⁹ Wi-Fi Alliance *FNPRM* Comments at 11.

⁸⁴⁰ Shared Spectrum Company *FNPRM* Comments at 9.

⁸⁴¹ See 47 C.F.R. § 90.1301, *et seq.*

⁸⁴² *3.5 GHz NPRM*, 27 FCC Rcd at 4296, ¶ 77.

⁸⁴³ 47 U.S.C. § 304. It is also “undisputed that the Commission always retain[s] the power to alter the term of existing licenses by rulemaking.” *Celtronix Telemetry, Inc. v. FCC*, 272 F.3d 585, 589 (D.C. Cir. 2001). *Accord, Cellco Partnership v. FCC*, 700 F.3d 534, 543 (D.C. Cir. 2012). See also *Committee for Effective Cellular Rules v. FCC*, 53 F.3d 1309, 1318-20 (D.C. Cir. 1995); *WBEN, Inc. v. United States*, 396 F.2d 601, 617-18 (2d Cir. 1968) (upholding rules resulting in increased interference during term of fulltime AM stations’ licenses resulting from operations of daytime licensees); *California Citizens Band Ass’n v. United States*, 375 F.2d 43, 50-52 (9th Cir. 1967). While such modifications may not extend to making “fundamental changes” to the terms of existing licenses, *Cellco*, 700 F.3d at 534, here as noted below we have taken steps to ensure that Part 90 incumbents may continue to provide those same services [using the same technologies], over the same as well as substantially additional spectrum. See *Community Television, Inc. v. FCC*, 216 F.3d 1133, 1140-41 (D.C. Cir. 2000).

⁸⁴⁴ We emphasize that the existing Part 90 rules provide for non-exclusive spectrum access only. See 47 C.F.R. § 90.1307. See also *Wireless Operations in the 3650-3700 MHz Band, Memorandum Opinion and Order*, 22 FCC Rcd 10421, 10430 ¶ 25 (2007): “In contrast to an exclusive licensing model in which a licensee may exclude others from a particular license area, the non-exclusive licensing model adopted in the 3650 MHz Order requires a potential entrant to consider that the presence of other licensees will require cooperative use and may, at times, restrict the amount of spectrum and/or time that spectrum is available to any particular licensee.”

396. Second, our technical rules for Category B CBSDs will accommodate existing 3650-3700 MHz network deployments and, in fact, will increase technical flexibility in rural areas. In urban areas, the power level authorized for Category B CBSDs is the same as allowed under the existing Part 90 rules. In rural areas, the levels are even higher. These rules therefore address a principal concern of Part 90 incumbents about the potential for substantial decreases in coverage areas due to lower power levels.⁸⁴⁵

397. Third, while we believe our band-wide operability rule will ultimately benefit prior existing users of the 3650-3700 MHz band by expanding equipment availability and spectrum access, we exempt equipment deployed under these preexisting rules from the operability requirement.⁸⁴⁶ We believe that this exemption will allow 3650-3700 MHz users to continue operating under the new 3.5 GHz Band rules, without need to retrofit or abandon their existing equipment.⁸⁴⁷

398. Fourth, defining a CBSD in a flexible way to encompass a *network* of base stations should allow legacy network equipment to interact with the SAS at relatively low cost, through the addition of a proxy controller device. The vast majority of equipment deployed in the 3650-3700 MHz band uses the WiMAX technology standard. We note that this standard, like most carrier-grade managed network technologies, defines network management interfaces that allow for operator control of network operating parameters.⁸⁴⁸ These interfaces provide software “hooks” that can enable deployment of a network proxy controller that intermediates between the legacy network and the SAS, effectively translating between the SAS and network management layer to ensure compatibility with our Part 96 rules.

399. In short, we believe that we have made necessary and appropriate rule accommodations to allow prior existing 3650-3700 MHz licensees to continue operations in the band under a framework that provides access to greater spectrum that may better meet their needs in the long run.⁸⁴⁹ To the extent that we may have overlooked any technical obstacles to achieving this goal, we note that Part 90 incumbents may avail themselves of our waiver process on a case-by-case basis.

400. Nevertheless, recognizing the potential challenges that may come with any regulatory transition, and in light of the significant investment many incumbent 3650-3700 MHz licensees have

⁸⁴⁵ *Ex Parte* Letter from Brett Kilbourne, Vice President and Deputy General Counsel, Utilities Telecom Council to Marlene H. Dortch, Secretary, Federal Communications Commission in GN Docket No. 12-354 (filed Sept. 18, 2014) at 1; *Ex Parte* Letter from WiMAX Forum, UTC, API, Ameren Corporation, Centerpoint Energy Houston, Exelon Corporation, Iberdrola USA, GE Digital Energy, Siemens Industry, and Telrad Networks to Marlene H. Dortch, Secretary, Federal Communications Commission in GN Docket No. 12-354 (filed Feb. 23, 2015) at 7; UTC *FNPRM* Comments at 13; UTC/EEI *FNPRM* Reply Comments at 10; *Ex Parte* Letter from Brett Heather Freedson, CenterPoint Energy Houston Electric LLC to Marlene H. Dortch, Secretary, Federal Communications Commission in GN Docket No. 12-354 (filed Oct. 16, 2014), at 3 (*CenterPoint Ex Parte*) (reduction of current coverage area by 80 to 90 percent). See also AT&T *FNPRM* Reply Comments at 23; BLiNQ Networks Reply Comments at 12-14.

⁸⁴⁶ See *supra* section III (F)(2)(c).

⁸⁴⁷ See CenterPoint *Ex Parte* at 4; UTC *FNPRM* Comments at 14; FWCC *FNPRM* Reply Comments at 5.

⁸⁴⁸ See, e.g., WMF-T31-119-R016v01: “WiMAX Forum® Network Requirements, WiMAX Network Management, NMS to EMS Interface” at http://resources.wimaxforum.org/sites/wimaxforum.org/files/technical_document/2013/04/WMF-T31-119-R016v01_-Network-Management-Requirements.pdf

⁸⁴⁹ UTC is concerned that the Commission “is expecting too much too soon from the SAS,” with “too great a risk” of interference and congestion to Part 90 incumbents. UTC *FNPRM* Comments at 14. As noted below, the Commission’s approval process for SAS Administrator applicants is designed to ensure reliable interference management, including protections with respect to DoD, FSS, and Part 90 incumbents. While we have concluded that the SAS can be a feasible approach to interference management based on the record and our past experience with TVWS operations, we will continue to work with all users in the band and encourage their coordination through the existing multi-stakeholder group to ensure such feasibility.

made in the band, we provide *additional* protections for these incumbent operations during a reasonable transition period. In place of the strict five-year term proposed in our *FNPRM*,⁸⁵⁰ we will protect incumbent 3650-3700 MHz nationwide licensees (Grandfathered Wireless Broadband Providers) for five years after the *R&O* Adoption Date or for the remainder of the license term, whichever is longer⁸⁵¹ with one exception. We do not believe it would be appropriate to extend a transition period of more than five years to those Part 90 incumbents licensed after the January 8, 2013 Federal Register publication date of the *NPRM*.⁸⁵² Such licensees were on notice of our supplemental proposal to integrate the 3650-3700 MHz band into the Citizens Broadband Radio Service regulatory regime before obtaining their licenses, and we believe according them more than a five-year priority over GAA users of the band would unnecessarily curtail the spectral efficiencies contemplated by our rules.

401. The grandfathering period “allows incumbent licensees to benefit from the original term of the license they possess while giving them sufficient time to decide whether to seek a new license under a modified regime or look for other alternatives” that may be available at that time.⁸⁵³ We are mindful of some commenters’ concerns that existing licensees in the 3650-3700 MHz band entered the band with the expectation of a ten-year license term under the prior existing rules.⁸⁵⁴ As noted above, we believe our technical and licensing rules will allow for continued operation in the band for the indefinite future. The transition period will provide incumbent licensees with the benefit of operating under the existing Part 90 framework for the remainder of their full licensed term, or in some cases substantially longer.⁸⁵⁵ At the end of the transition period, these licensees may continue to operate their networks under the GAA rules, but without the priority accorded them during the transition.⁸⁵⁶

402. During the transition period, grandfathered licensees will receive interference protection from other 3.5 GHz Band users operating in the 3650-3700 MHz band segment (*i.e.*, GAA users) for network operations and frequencies that are in use at registered sites as of April 17, 2016. We agree with

⁸⁵⁰ See 3.5 GHz *FNPRM*, 29 FCC Rcd at 4323, ¶ 166.

⁸⁵¹ See Neptuno Networks *FNPRM* Comments at 4-6; Neptuno Networks *FNPRM* Reply Comments at 4; WISPA *FNPRM* Comments at 35-36. See also Service Rules for the 698-746, 747-762 and 777-792 MHz Bands, *Second Report and Order*, 22 FCC Rcd 15289, 15388-89 (2007) (preserving PTPMS II operations pursuant to terms of existing license only through end of license term). We note that if a non-exclusive nationwide license expires between April 17, 2015 and April 17, 2020, a licensee may request a one-time renewal and the Commission may renew that license for a term ending no later than April 17, 2020. Appendix A, § 90.1307(c).

⁸⁵² See Appendix A, § 90.1338.

⁸⁵³ Neptuno Networks *FNPRM* Comments at 6.

⁸⁵⁴ See, *e.g.*, WISPA *FNPRM* Comments at 34, 36 (“Grandfathered Wireless Broadband Providers obtained their licenses in the expectation that the term would last a full ten years”); Neptuno *FNPRM* Comments at 4-6.

⁸⁵⁵ See WISPA *FNPRM* Comments at 36.

⁸⁵⁶ As noted above, our rules preserve the opportunity for continued use of Part 90 equipment rather than stranding investment in it even after the transition. We also note that, in response to our request for comment on the question, commenters have not provided any consistent or definitive estimates as to the *remaining* life of equipment used by Part 90 incumbents. UTC asserts only that utilities’ equipment “may” be subject to extended depreciated cycles “far longer” than five years. UTC *FNPRM* Comments at 16. See also Xcel *FNPRM* Reply Comments at 3 (previously proposed five-year transition period not appropriate “given the long lifecycle of existing Smart Grid equipment and the typical network planning period”); API *FNPRM* Comments at 5-6 (such equipment “has not been in existence long enough to accurately judge expected lifecycles,” but “any reasonable estimate is closer to 15 years than five”). CenterPoint notes an anticipated life span of between 10 and 15 years, with infrastructure currently in the field deployed from two and five years ago, leading to potential remaining life of between five and 13 years. CenterPoint *Ex Parte* at 2 & n.5. Blooston 3.65 GHz Coalition cites to IRS Publication 946, which establishes a permissible 7 to 13 year recovery period for certain radio equipment, but this publication notes (at 30-31) that the shorter period under the General Depreciation System (GDS) is generally required. Blooston 3.65 GHz Coalition *FNPRM* Comments at 6 & n.3.

Google's comment that "[c]onsistent with the logic of grandfathering, protection should be provided only for the channels and locations where operations currently are deployed, rather than categorically granting incumbents exclusive rights to a full 50 MHz of spectrum they may not be using (and may not be authorized to use)."⁸⁵⁷ In defining the Grandfathered Wireless Protection Zone, we intend to distinguish between "real" networks that have received substantial investment and provide socially productive service from "paper networks" whose only effect is to restrict spectrum accessible by the Citizens Broadband Radio Service.

403. The Grandfathered Wireless Protection Zone therefore represents the exclusions, in geographic area and frequency range, needed to reasonably protect *registered* networks that are *constructed, in service*, and in *compliance* with the prior existing rules for the 3650-3700 MHz band. We elaborate on these concepts as follows:

- *Registered* means that any fixed or base stations defining the extent of the network have been properly registered with ULS.
- *Constructed* means that all of the requisite infrastructure elements are in-place and operational. These include siting, FCC-certified radio equipment, backhaul, power, etc.
- *In service* means that the network provides ongoing service to unaffiliated, paying subscribers (*e.g.*, broadband service from a WISP) or for *bona fide* private uses (*e.g.*, utility networks, network backhaul).
- *Compliance* means that to receive protection, licensees must be in compliance with all other applicable FCC rules (or operating pursuant to a waiver of those rules).

404. We will determine a Grandfathered Wireless Protection Zone, after issuing a Public Notice seeking comment on the appropriate methodology and relevant technical parameters. In conducting our technical analysis, we will use realistic modeling assumptions, reflecting the equipment, technical configuration, and propagation environment of real-world deployments authorized by the Part 90 rules. Alternatively, a simplified metric (*e.g.*, distance from a base station) that sufficiently approximates such a technical analysis may be appropriate instead. We also emphasize that the Grandfathered Wireless Protection Zone shall only protect frequencies in use by a Grandfathered Wireless Broadband Provider at a given site.⁸⁵⁸

405. The Grandfathered Wireless Protection Zone will be defined based on fixed or base stations registered by applications filed in ULS on or before April 17, 2015, the adoption date of this *Report and Order*.⁸⁵⁹ The use of the adoption date is necessary to prevent a speculative "land rush" in site

⁸⁵⁷ Google January 2015 *Ex Parte* at 5.

⁸⁵⁸ To the extent existing licensees reasonably employ a frequency reuse pattern that extends across several sites with contiguous coverage, the contour may apply to the frequency range for the entire re-use pattern at each site within that pattern. To the extent that Grandfathered Wireless Broadband Licensee use of the band is highly intermittent or periodic, we may in a future phase of this proceeding consider whether sensing could increase efficient use of the band, while protecting incumbents, during the transition period.

⁸⁵⁹ Under the current Part 90 rules, stations that operate above the power limits specified in 47 C.F.R. § 90.1333 are required to be registered. We note that many subscriber units/customer premise equipment/ remote terminals operate above the mobile/portable power limits. However, we believe that it is appropriate to define the Grandfathered Wireless Protection Zones based on the contour of base and fixed access points that define the network. As such, in this context, "fixed or base station" does not include subscriber units, customer premise equipment, or remote terminals that communicate with base stations or access points. We will rely on information provided in the equipment certification to distinguish base stations and fixed access points from customer premise equipment. Grandfathered Wireless Protection Zones will not be specifically defined for subscriber units operated by Grandfathered Wireless Broadband Licensees, regardless of whether they have been registered in ULS. We expect, however, that the methodology for defining the Grandfathered Wireless Protection Zone around based and fixed

(continued....)

registrations during the period between the adoption date and the effective date of the new and revised rules. This approach will also help prevent the protection of “paper” networks and ensure that the 3650-3700 MHz band is put to its most productive use. Additionally, we note that for any assignments or transfers of control of Grandfathered Wireless Broadband licenses or registered sites that occur following the effective date of this *Report and Order*, the applicable transition period will run with the original license date, on a site-by-site basis.

406. Under current procedures, “we will generally consider a fixed or base station to be ‘unused’ if it has not operated for one year or more.”⁸⁶⁰ We believe this establishes an expectation that any sites registered in ULS will be constructed within one year of registration. Therefore, we will establish the Grandfathered Wireless Protection Zone around only those base and fixed stations that are registered by applications filed in ULS on or before April 17, 2015 and are *constructed, in service*, and in *full compliance* with the rules by April 17, 2016. Additionally, the Grandfathered Wireless Protection Zone will be reduced should any portions of the protected network fail to meet the above criteria after April 17, 2016. Any registrations filed after April 17, 2015 will only be afforded protection from harmful interference under our rules within the licensee’s Grandfathered Wireless Protection Zone, *i.e.*, a Grandfathered Wireless Broadband Provider may not expand its protected contour using sites registered after April 17, 2015.⁸⁶¹ Modifications to ULS site registrations after the April 17, 2015 will not have the effect of increasing the Grandfathered Wireless Protection Zone.

407. In order to be afforded Grandfathered Wireless Broadband Provider protections, we require incumbent operators to register their frequency usage with approved SAS Administrators.⁸⁶² Existing licensees must register their fixed and base stations as well as their service contours with the SAS. In addition, existing licensees must indicate the specific frequencies and channel bandwidth in use at each site. Subsequently, any Grandfathered Wireless Broadband Provider protections will only apply in the frequency range registered by the incumbent. Registration with the SAS will promote spectrum efficiency by identifying precisely which spectrum is reserved for Grandfathered Wireless Broadband Providers and which spectrum may be available for GAA use under rules governing the Citizens Broadband Radio Service.

408. Grandfathered Wireless Broadband Licensees will be deemed incumbent users within their registered service contours for the duration of the transition period. During this transition period, Grandfathered Wireless Broadband Providers must avoid causing harmful interference to authorized federal users and grandfathered FSS earth stations, in accordance with our rules.⁸⁶³ Thus, existing FSS sites will be protected under Part 90, Subpart Z until the last Grandfathered Wireless Broadband Licensee within a given protected area is transitioned to the new Part 96 regime. After the transition period, such facilities shall be protected from harmful interference consistent with the protections afforded similarly situated facilities as set forth in sections 96.15 and 96.17.⁸⁶⁴ Consistent with current practice, during the

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access points will provide appropriate protections for the subscriber units, customer premise equipment, and remote terminals associated with registered base and fixed stations.

⁸⁶⁰ Wireless Telecommunications Bureau Announces Start Date for Licensing and Registration Process for the 3650-3700 MHz Band, ET Docket No. 04-151, WT Docket No. 05-96, *Public Notice*, 22 FCC Rcd 19802, 19812.

⁸⁶¹ Appendix A, § 90.1338. Where the service contours of Grandfathered Wireless Broadband Licensees overlap, the licensees must continue to comply with section 90.1319(d).

⁸⁶² Appendix A, § 90.1338.

⁸⁶³ Going forward, operators in the 3650-3700 MHz band must continue to protect grandfathered FSS earth stations and the grandfathered federal radiolocation facilities listed in Section 90.1331 of the Commission’s Rules. 47 C.F.R. § 90.1331.

⁸⁶⁴ See Appendix A, §§ 96.15 and 96.17. These protection criteria were developed in conjunction with NTIA, DoD, and other stakeholders.

transition period, Grandfathered Wireless Broadband Providers with overlapping service contours must coordinate with one another as currently required by Part 90, Subpart Z.⁸⁶⁵

409. Grandfathered Wireless Broadband Licensees may register sites outside of their Grandfathered Wireless Protection Zones, but these sites will not be entitled to any interference protection from Citizens Broadband Radio Service users. We strongly encourage Grandfathered Wireless Broadband Licensees to procure equipment with an eye toward complying with the Part 96 technical rules once the transition period is completed. We expect all Grandfathered Wireless Broadband Licensees to comply with the Part 96 rules once their transitions are complete. At that point, use of legacy equipment that does not operate across the entire 150 megahertz band could hinder a former Part 90 licensee's flexibility with respect to other GAA operations in the band. On the other hand, the use of technology that is capable of, or can be upgraded to, operation throughout the band will provide for the possibility of much greater spectrum access. Grandfathered Wireless Broadband Licensees, and their vendors, should plan accordingly.

410. As described in section III(B)(1), we conclude that it is in the public interest to limit 3650–3700 MHz use to GAA operations. GAA operation closely aligns with the current licensing regime in the band where licenses are awarded on a non-exclusive basis and licensees must share spectrum and coordinate operations. Similarly, GAA operators will have shared use of the entire 3.5 GHz Band and access will be coordinated by the SAS. We believe that limiting the 3650–3700 MHz band to GAA use post-transition, rather than adopting our original proposal to allow both PALs and GAA use, will minimize disruption to incumbent operators. By eliminating the availability of PALs in the 3650–3700 MHz portion of the band, incumbent operators will continue to have access to the entire 50 MHz, post-transition. Grandfathered Wireless Broadband Providers thus will have the option, available to all eligible 3.5 GHz Band users, to operate on a GAA basis consistent with Part 96 rules throughout the 3650–3700 MHz band.

411. We disagree with commenters who maintain that the existing licensing regime should be retained for the 3650-3700 MHz band specifically because the spectrum is used for critical infrastructure applications such as Smart Grid.⁸⁶⁶ While we acknowledge the federal policy of supporting such modifications of the electrical transmission and distribution system,⁸⁶⁷ our new framework does not preclude such continued use of the band. Instead, the new framework promotes flexible, shared use of the band for any suitable purpose, including critical infrastructure use. Further, by extending the band from 3550–3700 MHz, we increase the contiguous, interoperable spectrum available for critical infrastructure use. Critical infrastructure users will now have access to up to 80 MHz of GAA spectrum in each census tract with the ability to use an additional 70 MHz of PAL spectrum on an opportunistic basis. The framework we adopt today increases, rather than limits, the spectrum available for critical infrastructure use. Moreover, we note that existing licenses in the 3650–3700 MHz band are nationwide, *non-exclusive* licenses. Thus, licensees in this band were never afforded exclusive use of the spectrum for any period of time.⁸⁶⁸ By limiting Citizens Broadband Radio Service use in the band to GAA uses at the end of the transition period, we retain the non-exclusive, shared characteristic of this spectrum.

412. We decline to adopt additional protections for Grandfathered Wireless Broadband Providers beyond those that we adopt today. The additional protections suggested by commenters will only serve to delay the ultimate integration of 3650-3700 MHz into the Citizens Broadband Radio

⁸⁶⁵ 47 C.F.R. § 90.1319.

⁸⁶⁶ See e.g., API *FNPRM* Comments at 3-6; Xcel Energy Services *FNPRM* Reply Comments at 1-5; UTC *FNPRM* Comments at 1-2, 11-15; Great River Energy *FNPRM* Comments at 2-5;

⁸⁶⁷ Energy Independence and Security Act of 2007, Pub. L. No. 110-140, 121 Stat. 1492, codified at 15 U.S.C. §§ 17381, *et seq.*

⁸⁶⁸ CenterPoint *Ex Parte* at 3.

Service. In addition, we note that incumbent licensees had no expectation of exclusive access to the spectrum in the 3650-3700 MHz band as all licenses issued in the band were non-exclusive. We conclude that the modified protections for incumbent licensees that we adopt today will maximize the benefits to all potential licensees, while minimizing the costs to incumbent licensees. Based on careful consideration of the record in this proceeding, we adopt modified rules for transitioning the 3650-3700 MHz band into the Citizens Broadband Radio Service as provided in Appendix A.

K. Multi-Stakeholder Group

413. *Background.* In the *FNPRM*, we noted that the TAC recommends that the Commission consider forming one or more multi-stakeholder groups to study receiver standards and interference limits policy at service boundaries in the 3.5 GHz Band.⁸⁶⁹ In addition, the Wireless Innovation Forum recommends that the FCC encourage the formation of industry led multi-stakeholder groups, proposes key characteristics of such a process, and commits to establishing such a multi-stakeholder process to develop recommendations for the 3.5 GHz Band and other band opportunities.⁸⁷⁰ Consistent with the recommendations of the TAC, we encouraged action to charter a technical group of stakeholders to develop industry coordination agreements and protocols, including technical options and methods for managing spectrum access that would improve access to and make efficient use of the 3.5 GHz Band. We sought comment on the appropriate scope and structure of such a group.⁸⁷¹

414. The record generally supports the formation of an industry led multi-stakeholder group to study technical issues in the 3.5 GHz Band.⁸⁷² The Wireless Innovation Forum asserts that a technically focused multi-stakeholder group should address a variety of outstanding SAS issues, including inter-SAS communications, communications security, protections of higher tier users, and CBSD-to-SAS communications. The Wireless Innovation Forum argues that the Commission should establish certification procedures to ensure that SASs and CBSDs conform to the procedures and methods developed by this multi-stakeholder group.⁸⁷³ They also propose a detailed organizational framework for the working group, including a process for the group to provide proposals to the Federal Government and for government agencies to act on such proposals within a limited period of time.⁸⁷⁴ Indeed, on February 12, 2014, the Wireless Innovation Forum announced the approval of a charter for a new Spectrum Sharing Committee focused on developing industry standards for the 3.5 GHz Band.⁸⁷⁵

415. The Wi-Fi Alliance states that, while industry groups may play an important role in guiding coexistence matters in the 3.5 GHz Band, the Commission should take an active role in developing spectrum management tools for the band.⁸⁷⁶

416. *Discussion.* As we stated in the *FNPRM*, we believe that a multi-stakeholder group focused on the complex technical issues raised by this proceeding could provide us with a wealth of

⁸⁶⁹ See TAC *White Paper* at ¶ 50; *3.5 GHz FNPRM*, 29 FCC Rcd at 4300, ¶ 89.

⁸⁷⁰ See Wireless Innovation Forum *Licensing PN* Comments.

⁸⁷¹ See *3.5 GHz FNPRM*, 29 FCC Rcd at 4300, ¶ 89.

⁸⁷² See Wireless Innovation Forum *FNPRM* Comments at 9; Motorola Mobility *FNPRM* Comments at 9; SIA *Licensing PN* Comments at 10; SIA *Licensing PN* Reply Comments at 9; SIA *FNPRM* Reply Comments at 28-29 (noting that multi-stakeholder group must fairly represent all interests); Motorola Solutions *FNPRM* Comments at 5; AT&T *FNPRM* Comments at 47-52; CEA *Licensing PN* Comments at 4-5.

⁸⁷³ See Wireless Innovation Forum *FNPRM* Comments at 9.

⁸⁷⁴ See *id.* at 12-20.

⁸⁷⁵ See Wireless Innovation Forum Announces Approval of New Spectrum Sharing Committee, Press Release (February 12, 2015), available at: http://groups.winnforum.org/press_room.

⁸⁷⁶ See Wi-Fi Alliance *FNPRM* Comments at 9.

valuable insights and useful information. A broad-based group incorporating wireless carriers, network equipment manufacturers, potential SAS Administrators, satellite operators, existing 3650-3700 MHz band licensees, and other parties with an interest in the 3.5 GHz Band could be instrumental in developing answers to some of the novel technical questions raised by the Citizens Broadband Radio Service rules. We hope that any such group would work collaboratively towards innovative solutions that would encourage the rapid development of the Citizens Broadband Radio Service, protect valuable incumbent operations, and benefit all potential stakeholders in the band. We do not, however, take a position on the exact scope, makeup, or organizational structure of any such working group.

417. At this time, we also decline to adopt a specific process for reviewing and responding to recommendations made by such a forum. We encourage working group participants to share their findings with the Commission and to incorporate their work, to the extent feasible, into the development of CBSDs, SASs, and ESC components. We also believe that the insights provided by any such working group could be informative during the SAS Administrator approval process.

IV. SECOND FURTHER NOTICE OF PROPOSED RULEMAKING

418. While we have endeavored in the *Report and Order* to adopt a complete set of rules and policies related to the establishment of the Citizens Broadband Radio Service, there remain a few focused issues that would benefit from further record development. For the most part, we view these issues as opportunities to optimize the rules we have already established. We believe that the *R&O* provides a solid foundation for industry stakeholders to accelerate multi-stakeholder discussions and standardization efforts necessary to launch service in the 3.5 GHz Band. Therefore, while we plan to move expeditiously toward resolution of the issues raised in this *Second Further Notice of Proposed Rulemaking*, we do not expect that our further consideration of these issues will have a material effect on the timing of band deployment. Additionally, we believe that necessary follow-on actions required to implement the Citizens Broadband Radio Service (*e.g.*, the SAS/ESC authorization process and the consideration of auction procedures) can proceed apace while this *Second FNPRM* is pending. With this context in mind, we urge commenters to focus responses to the specific proposals and questions discussed below. At this stage of the proceeding we encourage parties to converge on practical, multi-stakeholder solutions. While achieving consensus can be difficult – particularly across multiple industry sectors – we believe that everyone will benefit from a “big tent” resolution of these issues.

A. Defining “Use” of PAL Frequencies

419. In the *Report and Order* above, we determined that allowing opportunistic access to unused Priority Access channels would serve the public interest by maximizing the flexibility and utility of the 3.5 GHz Band for the widest range of potential users.⁸⁷⁷ When Priority Access rights have not been issued (*e.g.*, due to lack of demand) or the spectrum is not actually in use by a Priority Access licensee, the SAS will automatically make that spectrum available for GAA use on a local and granular basis.⁸⁷⁸ While there is substantial support in the record for an opportunistic use approach generally,⁸⁷⁹ we see wide divergence in the record to-date regarding specific implementation of our “use-it-or-share-it” rule.⁸⁸⁰ We therefore seek focused comment on specific options, rooted in the record, for defining “use” by Priority Access licensees.

420. *Engineering Definition.* Several commenters provided versions of an approach that would rely on an engineering definition of “use,” effectively leveraging the SAS to define a boundary that would forbid GAA access near Priority Access CBSDs. Google maintains that an SAS can enforce Priority

⁸⁷⁷ See *supra* Section III(B)(2)(b).

⁸⁷⁸ See Appendix A, § 96.25(c).

⁸⁷⁹ See *supra* Section III(B)(2)(b).

⁸⁸⁰ See *id.*

Access user protection areas based on information such as the Priority Access device's location and technical characteristics.⁸⁸¹ According to Google, the SAS can protect the Priority Access device from nearby GAA operations including the aggregate effect of multiple devices operating in the vicinity.⁸⁸² Google, at various points in the record, suggests versions of this approach with differing levels of complexity, ranging from use of simple distance-based metrics to methods based on site-specific propagation modeling.⁸⁸³ Pierre de Vries offers another variation of this concept, based on "interference limits policy," specifically the use of defined "reception limits" to specify GAA operation that does not degrade the performance of Priority Access systems.⁸⁸⁴ According to Pierre de Vries, the Commission could specify the "maximum allowed resulting signal strength at the protected receiver and let an SAS calculate the allowed GAA transmit power."⁸⁸⁵ AT&T suggests that 3GPP standards for TD-LTE channel occupancy could be used to determine channel usage.⁸⁸⁶ Federated Wireless proposes that GAA devices could provide the SAS with "spectrum sensing data" upon initial operation and at regular intervals as directed by the SAS.⁸⁸⁷ Federated Wireless recommends that an industry group be convened to develop the details of such a sensing framework, including the measurement procedure, reporting protocol, and occupancy and evacuation times.⁸⁸⁸ WISPA proposes that "any CBSD that has not received 300 end-user packets within each five-minute interval would be deemed by the SAS to be not 'in use.'"⁸⁸⁹ Other commenters, including Microsoft, PISC, and Shared Spectrum Company suggest that GAA use be permitted in PAL spectrum until a Priority Access licensee affirmatively requests access to its PAL from the SAS.⁸⁹⁰ InterDigital suggests that evacuation commands be signaled to GAA users via the SAS, which will allow for flexible channel evacuation times.⁸⁹¹

421. We seek comment on whether we should adopt an engineering definition of "use." We ask proponents of this approach to develop, in detail, an engineering methodology along with technical criteria and metrics that could be readily implemented by multiple, coordinated SASs. We also ask proponents to address some specific concerns about the engineering approach.

422. First, we note Verizon's observation that there may be occasions when a vacant channel performs a productive use, for example by serving as a guard band. Is this claim valid given the technical rules we have adopted in the *R&O* (e.g., for Category A and Category B CBSDs)? In cases where a vacant channel is serving as a guard band for high or full power use, could it be usable for localized communications at lower powers (e.g., a few milliwatts) or indoor operations?

423. Second, we speculate that it might be possible for Priority Access licensees to deploy low-cost CBSDs whose main purpose is to trigger SAS protections. We further observe that policing "license savers" has historically been a very challenging and administratively costly endeavor for the

⁸⁸¹ Google Jan. 20, 2015 *Ex Parte* Letter 3.

⁸⁸² *Id.* at 3-4.

⁸⁸³ Google *NPRM* Comments at 17-18; Google *NPRM* Reply Comments at 9-10; Google *Licensing PN* Comments at 13; Google *FNPRM* Reply Comments at 11, Appendix B (Declaration of Preston B. Marshall).

⁸⁸⁴ Pierre de Vries *FNPRM* Comments at 22.

⁸⁸⁵ *Id.*

⁸⁸⁶ AT&T *FNPRM* Comments at 13-15.

⁸⁸⁷ Federated *FNPRM* Comments at 20.

⁸⁸⁸ *Id.*

⁸⁸⁹ WISPA *FNPRM* Comments at 17.

⁸⁹⁰ SSC *FNPRM* Comments at 10; Microsoft *FNPRM* Comments at 5, *FNPRM* Reply Comments at 4; PISC *FNPRM* Reply Comments at 21.

⁸⁹¹ InterDigital *FNPRM* Comments at 8-9.

Commission. How could we prevent such gaming of the use-or-share rules, while maintaining our goals of technological flexibility, administrative simplicity, and light-touch regulation?

424. Third, the prospect of basing determinations of “use” on aggregate interference metrics raises equitable and coordination challenges with respect to the GAA tier. As discussed above, reliance on aggregate interference begs the question of which GAA user will be denied access when the aggregate threshold is exceeded. Therefore, we are not comfortable delegating this decision to third parties absent the adoption of an equitable and non-discriminatory methodology. We seek comment on whether and how aggregate metrics could be used to facilitate coordination among multiple SASs? Would the use of aggregate metrics introduce complexities that would outweigh the potential benefits of using such metrics? If we were to utilize an approach based on aggregate interference, how could we overcome these significant concerns? Alternatively, are there simpler, non-aggregate engineering metrics available that sidestep our concerns, perhaps with slightly less optimal spectrum utilization?

425. *Economic Definition.* An alternative approach presented in the record is to define “use” from an economic perspective for the purposes of determining GAA access to PAL spectrum. William Lehr, an economist at the Massachusetts Institute of Technology, proposes that we “view the PAL as an option to exclude GAA usage. PAL licensees would acquire the right to exclude GAA access.”⁸⁹² Under this approach, actual operation as a PAL licensee would not be a trigger for excluding GAA use. A PAL licensee would have the right, but not the obligation, to exercise its option and thus exclude GAA access from the PAL. The amount ultimately paid by the licensee would depend on whether the option is exercised and GAA access is correspondingly restricted. Lehr elaborates that in a simple implementation, “A winning bidder (with a bid of P for a PAL) would expect to owe $\frac{1}{2}$ P when the license is awarded and $\frac{1}{2}$ P when the licensee elects to exercise the option to exclude. The opportunity to delay payment would provide winning bidders with an economic incentive to avoid excluding GAA users unless the benefits of such exclusion outweigh the costs of exercising.”⁸⁹³ Lehr argues that the options approach offers multiple benefits, including: more efficient spectrum usage and expanded access for commercial users; increased participation of PAL and GAA commercial users by enabling better matching of PAL costs with network investment requirements and by expanding access for GAA; simple and low-cost implementation; reduced potential risk of PAL spectrum hoarding by PAL; and, flexibility and consistency with future dynamic shared spectrum policy.⁸⁹⁴ He also addresses some potential concerns, including: enforceability; auction revenue impact; foreclosure of GAA use; and mispricing of options payments.⁸⁹⁵ Lehr concludes by addressing some additional implementation details such as the “reversibility” of license payments and the possibility of trading option rights on a secondary market.⁸⁹⁶

426. We seek comment on whether Lehr’s economic construction of “use” would be appropriate for determining GAA admission to PAL frequencies as the concept may provide a potential way to avoid some of the concerns raised above with respect to an engineering approach. At the same time, the proposal raises other issues, some of which, as noted above, Lehr discusses in his comments. We seek comment on these concerns.

427. First, we seek comment on hoarding. Would the option framework encourage or discourage hoarding of PAL spectrum? How does the risk of hoarding using options compare against the risk of hoarding through deployment of low-cost CBSDs (discussed above) in an engineering-based approach?

⁸⁹² William Lehr *FNPRM* Comments at 1.

⁸⁹³ *Id.* at 6.

⁸⁹⁴ *Id.* at 8, *et seq.*

⁸⁹⁵ *Id.* at 13, *et seq.*

⁸⁹⁶ *Id.* at 15, *et seq.*

428. Second, how should we think about the payments and pricing of PALs? In the *FNPRM*, the Commission sought comment on employing its existing rules to address upfront,⁸⁹⁷ down and final payments by winning bidders,⁸⁹⁸ applications for licenses by winning bidders,⁸⁹⁹ as well as the processing of such applications and default by and disqualification of winning bidders.⁹⁰⁰ The Commission sought comment on whether its existing rules required any revisions in connection with the conduct of an auction of PALs.⁹⁰¹ We did not receive a sufficient record to determine what payment, application, and default rule revisions are necessary in adopting a less traditional approach to licensing the PAL spectrum. For instance, if we adopt the economic definition of “use” proposed above, would a 50/50 split between initial payments and an option “strike” price provide appropriate incentives for PAL use (or non-use)? We also seek renewed comment on the other payment, application and default questions raised in the *FNPRM* in the event that we adopt one of the proposals discussed above.⁹⁰²

429. Third, how would the options approach fit not only with our auctions authority under 47 U.S.C. 309(j) but also decades of experience in holding auctions? Would an option scheme, such as that proposed here, be sufficiently distinguishable from the Commission’s prior use of installment payments since under this proposal the full rights in the license would presumably not be perfected until the time of a second payment?⁹⁰³ Would the use of a two-payment option, in practice, lead to complications similar to those experienced in the past with installment payments? Is the Commission’s existing legal authority sufficient to permit it to adopt auction and payment rules to implement this option? We note that our auction authority is limited to the award of an initial “license” (or permit), and that the Act defines a license not as the right to exclude others but rather as an “instrument of authorization . . . for the use or operation of apparatus for transmission . . .”⁹⁰⁴ In the case of the options approach, could economic performance serve as a legally viable substitute for traditional build out or service-based performance requirements? Are there any statutory or other legal considerations that the Commission should consider

⁸⁹⁷ See 47 C.F.R. § 1.2106.

⁸⁹⁸ See 47 C.F.R. § 1.2107.

⁸⁹⁹ See *id.*

⁹⁰⁰ See 47 C.F.R. §§ 1.2107; 1.2109.

⁹⁰¹ See 3.5 GHz *FNPRM*, 29 FCC Rcd at 4311-12, ¶¶ 127-30.

⁹⁰² See *id.*

⁹⁰³ When the Commission first adopted competitive bidding rules in 1994, it established an installment payment loan program under which qualified small businesses that won licenses in certain services were allowed to pay their winning bids in quarterly installments over the initial term of the license. Implementation of Section 309(j) of the Communications Act – Competitive Bidding, PP Docket No. 93-253, *Second Report and Order*, 9 FCC Rcd 2348, 2389-91 ¶¶ 231-40 (1994). The first Commission auction for which installment payments were available was Auction 2 (218-219 MHz Service), which concluded on July 29, 1994. The Commission discontinued the use of installment payments based on its findings that (1) installment payments are not necessary to ensure meaningful opportunities for small businesses to participate successfully in auctions; (2) the Commission must consider all of the objectives of Section 309(j), including the development and rapid deployment of new services for the benefit of the public; (3) filings for bankruptcy by entities unable to pay their winning bids may result in delays in the deployment of service; and (4) requiring the payment of bids in full within a short time after the close of auctions ensures greater financial accountability from applicants. Amendment of Part 1 of the Commission's Rules – Competitive Bidding Procedures, WT Docket No. 97-82, *Third Report and Order and Second Further Notice of Proposed Rulemaking*, 13 FCC Rcd 374, 397-400 ¶¶ 38-40 (1998). The Commission affirmed this decision in 2000. Amendment of Part 1 of the Commission's Rules – Competitive Bidding Procedures, WT Docket No. 97-82, *Order on Reconsideration of the Third Report and Order, Fifth Report and Order, and Fourth Further Notice of Proposed Rule Making*, 15 FCC Rcd 15,293, 15,322 ¶ 55 (2000). The last Commission auction for which installment payments were available for small businesses was Auction 11 (Broadband PCS F block), which ended on January 14, 1997.

⁹⁰⁴ 47 U.S.C. § 153(49).

in revising its existing payment, application and default rules to accommodate these proposals?

430. *Hybrid Definition.* We also seek comment on any hybrid proposals that combine aspects of the engineering and economic approaches. For example, Federated Wireless suggests that Priority Access licensees, in the context of their proposed sensing framework, should pay a “nominal usage fee for those periods that the spectrum [is] actively needed.”⁹⁰⁵ Federated maintains that such a usage fee would incentivize Priority Access licensees to only reserve spectrum that they intend to use.⁹⁰⁶ Could we think of such a usage fee as a form of “option” superimposed on an engineering definition of “use”? Do we have authority to impose such a fee and, if so, how would we set the price? How would we define the unit volume (*i.e.*, quantity) of “use” to which a price could be applied? Could such a framework make use of an auction, with price set through competitive bidding, rather than a fee? Could the auction payment be pro-rated across sub-divisions of the license area (*e.g.*, Census Block Groups) to account for use in only a portion of the geography? What would be the simplest and most practical approach to implementing a hybrid scheme?

B. Implementing Secondary Markets in Priority Access Licenses

431. In the *FNPRM* we sought comment on the extent to which our existing secondary market rules (both for license transfers and for leases) might be appropriately modified with respect to the secondary market for PALs in the 3.5 GHz Band.⁹⁰⁷ We emphasized that auctions would be our initial assignment methodology, but that the secondary market could provide a viable means of matching supply and demand in units more granular than our proposed PAL structure.⁹⁰⁸ We noted that the development of one or more spectrum exchanges, operating pursuant to our secondary market rules, could facilitate a vibrant and deep market for PAL rights.⁹⁰⁹

432. Relatively few commenters addressed the significant issues associated with the potential application of our secondary market rules to the transfer of PALs. Commenters who did address the issue were generally supportive of a framework in which PALs can be traded in the secondary market. These commenters note that the development of a robust secondary market in the 3.5 GHz Band would be beneficial for potential Priority Access Licensees.⁹¹⁰ AT&T, for example, believes that flexibility in the deployment of PALs will be important to both commercial operators and other Priority Access Licensees as PAL use may be short term, *e.g.*, coverage for a large event, or longer term, *e.g.*, backhaul or access applications.⁹¹¹ AT&T maintains that partitioning and a secondary market mechanism will enable Priority Access licensees to gain access to additional spectrum as future needs arise.⁹¹² Qualcomm and WISPA support affording PAL licensees the flexibility to disaggregate or partition their licenses.⁹¹³ In addition, WISPA and Spectrum Bridge argue that prior Commission approval of secondary market transactions should not be required given the absence of build-out rules for the band and a streamlined auction

⁹⁰⁵ Federated *FNPRM* Comments at 20.

⁹⁰⁶ *Id.*

⁹⁰⁷ See *3.5 GHz FNPRM*, 29 FCC Red at 4314, ¶ 135.

⁹⁰⁸ *Id.*

⁹⁰⁹ See *id.*, citing Ex Parte Letter from Andrew D. Lipman and Tim Bransford, Bingham McCutcheon LLP on behalf of Cantor Fitzgerald Telecom Services, LLC to Marlene H. Dortch, Secretary, Federal Communications Commission in GN Docket No. 12-354 (filed July 31, 2013) (Cantor *Ex Parte*).

⁹¹⁰ See Alcatel Lucent *Licensing PN* Comments at 6-7; TIA *NPRM* Comments at 5, *Licensing PN Comments* at 8, *FNPRM* Comments at 8; Cantor *Ex Parte* at 3.

⁹¹¹ AT&T *Licensing PN* Comments at 4.

⁹¹² *Id.*

⁹¹³ Qualcomm *Licensing PN* Comments at 3-4; WISPA *Licensing PN* Comments at 15.

process, among other reasons.⁹¹⁴ Instead, WISPA argues that written notification to the Commission and SAS would be sufficient to ensure that appropriate contact information is available in the event of harmful interference.⁹¹⁵ TIA also supports application of the Commission's secondary market rules and emphasizes the need for secondary leasing arrangements, which will "allow providers to adjust to changing market circumstances in order to enhance their service quality."⁹¹⁶ Federated Wireless, on the other hand, opposes application of the secondary market rules noting that "[t]he development of secondary markets to manage geographical subsets of PALs takes the control of spectrum management and enforcement out of the hands of the SAS and the FCC."⁹¹⁷

433. Some commenters support the development of one or more spectrum exchanges, operating pursuant to our secondary market rules, which could facilitate a vibrant and deep market for PAL rights.⁹¹⁸ Such an exchange could improve the ability of individual licensees to obtain micro-targeted (in geography, time, and bandwidth) access to priority spectrum rights narrowly tailored to their needs on a highly customizable, fluid basis. Cantor proposes a spectrum exchange managed by an independent third party and modeled on platforms which exist for the trading of other U.S. Government securities.⁹¹⁹ Cantor envisions that such a spectrum exchange would integrate the SAS functions in order to provide market participants with use right information and to resolve any interference issues that might arise.⁹²⁰ In addition, Cantor explains that a spectrum exchange should include: "(1) universal access to information; (2) dynamic transactional access by and among authorized market participants; (3) real-time reporting of 3.5 GHz spectrum resource use right utilization; and (4) market maintenance."⁹²¹ InterDigital suggests that the SAS could act as a spectrum exchange to manage secondary market transactions.⁹²² We note that any spectrum exchange would be subject to the requirements of Section 310(d) of the Communications Act and other relevant statutory provisions.⁹²³

434. We believe that it is in the public interest to develop a fuller record on the implications of applying our secondary market rules to the 3.5 GHz Band ecosystem. While we agree with commenters on the record thus far that application of our secondary market rules will increase liquidity of the spectrum as well as reduce costs and increase flexibility of use, we seek additional information on how we should implement the rules with respect to the 3.5 GHz Band. To the extent that commenters agree with this concept, we request specific and focused comment on any necessary changes to our Part 1 rules to facilitate the secondary market for PALs in the 3.5 GHz Band. For example, regarding partitioning and disaggregation, our initial view is to prohibit such further segmentation of PALs given their relatively small size (census tracts) and limited duration (three years) as well as the availability of significant GAA spectrum in all license areas. Some commenters, however, urge the Commission to allow partitioning and disaggregation of PALs.⁹²⁴ We seek comment on this proposal. Would partitioning and disaggregation of

⁹¹⁴ WISPA *Licensing PN* Comments at 15; Spectrum Bridge *Licensing PN* Comments at 5, *FNPRM* Comments at 8.

⁹¹⁵ WISPA *Licensing PN* Comments at 15.

⁹¹⁶ TIA *Licensing PN* Comments at 8; TIA *FNPRM* Comments at 8; TIA *FNPRM* Reply Comments at 5.

⁹¹⁷ Federated Wireless *Licensing PN* Reply Comments at 15.

⁹¹⁸ See Cantor *Ex Parte* at 3; InterDigital *FNPRM* Comments at 22.

⁹¹⁹ Cantor *FNPRM* Comments at i.

⁹²⁰ *Id.* at 4-6; Cantor *NPRM* Comments at 2-4.

⁹²¹ Cantor *FNPRM* Comments at 9. Market maintenance includes (1) publishing unclassified U.S. Government use data; (2) qualifying market participants dynamically; (3) coordinating use rights held and purchased by qualified market participants; and settling disputes related to spectrum use rights.

⁹²² InterDigital *FNPRM* Comments at 22.

⁹²³ 47 U.S.C. § 310(d).

⁹²⁴ Qualcomm *Licensing PN* Comments at 3-4; WISPA *Licensing PN* Comments at 15.

PALs benefit the Citizens Broadband Radio Service or would such flexibility prove administratively burdensome and unnecessary given the size and duration of these licenses? We also seek comment on the potential use of spectrum exchanges to facilitate the transfer of PALs in the secondary market. Would such exchanges be mandatory or could the existing Part 1 rules, in combination with the SAS framework adopted in the *R&O*, above, be sufficient to allow voluntary development of exchanges to trade PALs? We are particularly interested in modifications to our rules that could reduce transaction costs and allow increased automation of transfer and lease applications. What legal, technical, or logistical issues should we consider?

435. For secondary markets purposes, we also seek comment on the application of our spectrum aggregation limits for PAL licensees. Should we use the attribution standard applied in our existing rules to transactions involving mobile wireless licenses for commercial use?⁹²⁵ We also seek comment on how this standard can reflect the need for a streamlined process, potentially through a database administrator, for transactions involving PALs. In addition, we seek comment on the application of our spectrum aggregation limit in the context of the initial licensing of PALs, including how any unique characteristics of PAL auctions, such as the need for streamlined processing, should be taken into account in resolving this issue.

C. Optimizing Protections for FSS

1. In-band Protection of FSS in the 3650-3700 MHz Band

436. We raise five topics for consideration in a second *FNPRM* with respect to the methodology and parameters for protecting in-band FSS earth stations, in addition to the adoption of section 96.17 as described in the section III(G)(2) of the *Report and Order*.

437. *Calculation Methodology.* As noted above in section III(G)(2) of the *Report and Order*, we agree with Google that the Commission's example methodology in the 3650–3700 MHz proceeding is a useful starting point for coexistence analysis.⁹²⁶ We seek comment on the use of this methodology by the SAS to calculate exclusion distances for CBSDs with respect to individual FSS earth stations in the 3650-3700 MHz band. Is the methodology accurate? Does it require further specification?

438. *Propagation Modeling.* While we recognize the challenge of effective propagation modeling for band sharing,⁹²⁷ we believe that research in propagation path loss models in recent years has advanced considerably and offers an increasing array of practical and realistic tools and methods for predicting path loss and determining practical bounds on prediction errors. However, despite these advances, there are many different propagation models, with little integration of these models across diverse environments. Many existing models have been tailored for specific and diversely different environments. A research article by Phillips, Sicker, and Grunwald illustrates the scope of the challenge as well as the significant benefit of improved statistical analysis of path loss prediction. They described and implemented “30 propagation models of varying popularity that have been proposed over the last 70 years” and found “...the landscape of path loss models is precarious... we recommend the use of a few well-accepted and well-performing standard models in scenarios where *a priori* predictions are needed and argue for the use of well-validated, measurement-driven methods whenever possible.”⁹²⁸ We agree with this finding and believe that improved statistical analysis of propagation path loss can lead to significant improvements in shared spectrum utilization and interference prediction and mitigation. We

⁹²⁵ See 47 C.F.R. § 20.22.

⁹²⁶ See Google *FNPRM* Comments at 22.

⁹²⁷ See SIA *FNPRM* Comments at 10-11; SIA/RKF Engineering Report at 2-3; NPR *FNPRM* Comments at 8; and Federated Wireless *FNPRM* Comments at 22.

⁹²⁸ “Bounding the Practical Error of Path Loss Models,” C. Phillips, D. Sicker, D. Grunwald, *International Journal of Antennas and Propagation*, 2012.

propose that all SAS Administrators use an agreed upon set of propagation modeling methods, using models that can be tuned with measurements. We seek comment on what propagation model(s) are best suited for SAS-based protections of FSS. We solicit measurement results that validate model parameters for combined short range and long range propagation scenarios, involving indoor and outdoor propagation channels. What model(s) are the most accurate in accounting for urban clutter and other environmental factors such as rain attenuation, ducting, etc., and most suitable for modeling statistical variations to support analysis – including possible Monte-Carlo analysis – of many potential interfering sources? In order to generate the same exclusion distances between CBSDs and any individual FSS earth stations in 3650-3700 MHz, we expect each SAS to enforce the same minimum separation distance and we tentatively conclude that each SAS must use the same propagation model. We seek comment and objective analysis from anyone who believes otherwise.

439. *Interference Protection Criteria.* We agree with commenters that, in principle, an Equivalent Power Flux Density (EPFD) of aggregate interference power at the FSS earth station receiver could be an appropriate interference protection criterion (IPC) for establishing interference limits of FSS earth stations. However, our equitable and competitive concerns about using aggregate limits is noted above and discussed further below. Were we to adopt an aggregate level, we believe it should be based not only on the theoretical thermal noise floor (I/N), but should also account for the measurement of receiver performance degradation when presented with both interfering signals and wanted desired signals ($C / (I+N)$). We seek comment on the appropriate FSS earth station interference protection criteria, the appropriate probability of such threshold not being exceeded, and supporting field measurements to validate such proposals. Commenters should assume the use of appropriate, commercially available earth station receiver input filtering to limit the receiver bandwidth to the authorized spectrum.⁹²⁹

440. We propose that co-channel CBSD and End User Device signal levels up to this threshold be permissible, at the antenna output after FSS earth station antenna gain and discrimination per section 25.209(a)(3).⁹³⁰ We propose that the SAS will calculate the distance, bearing, and elevation differences between registered FSS earth stations and each CBSD that requests activation. The SAS will then authorize CBSD activation if it is at or beyond the permissible distance, and deny CBSD activation if it is less than the permissible distance from the earth station. How should existing link budget margins be treated in establishing value(s) for interference protection criteria, where such margins are built in to FSS earth station link budgets to account for rain attenuation, and other impairments? What is the statistical and temporal correlation of environmental effects that may not be independent nor occur simultaneously (e.g., stable atmosphere anomalous ducting, occurring naturally at different times than convective atmospheric heavy rain)? We also invite comment as to whether we can establish a default earth station protection area based on an assumed minimum earth station receiving system gain-to-temperature ratio (G/T) and minimum antenna elevation angle, and what the assumed values of the G/T and elevation angle should be. CBSD operation outside of such a default protection area would be assumed not to cause interference to earth stations receiving in the 3700-4200 MHz band. Such a default protection area would be adjusted by the SAS to accommodate the actual operating characteristics of earth stations that are registered in order to achieve additional protection.

441. *Avoiding Policy Concerns Related to Aggregate Interference Protection Criteria (IPC).* We seek comment on fair and non-discriminatory methods of adjudicating demands for increased spectrum use at a location that would result in the IPC for an FSS earth station receiver being exceeded. SIA has argued that protection zones may be insufficient if densely deployed CBSD and End User Devices outside of these areas cause aggregate interference thresholds to be exceeded.⁹³¹ They argue that unless the Commission is prepared to periodically revisit and enlarge protection zones to address such

⁹²⁹ See *supra* section III(G)(2).

⁹³⁰ 47 C.F.R. § 25.209(a)(3).

⁹³¹ SIA *FNPRM* Reply Comments at 5

events, it will need to either set deployment density constraints or build in a significant margin in calculating protection zones to account for aggregate interference. We seek comment on solutions that avoid discriminatory caps on CBSD service deployment, while protecting FSS earth stations from harmful interference. For example, are there probabilistic “bilateral” approximations (between an individual CBSD and an earth station) of an aggregate metric that address our concerns about the use of aggregate interference protections while also avoiding worst-case assumptions about interference from unlikely or infeasible quantities of nearby CBSDs? To the extent that commenters do support an aggregated EPFD limit, we encourage solutions to avoid a “land rush” when balancing service demands that exceed interference limits, if they occur. How could such IPC criteria be implemented by CBSDs and the SAS?

442. *End User Devices.* Recognizing that CBSDs have geo-location requirements and End User Devices do not, the location of End User Devices and the propagation channel between such devices and FSS earth stations to be protected are indeterminate. We expect CBSDs to be deployed such that terrain, buildings, and other forms of clutter can be accounted for and will provide a certain amount of propagation loss between the CBSD and a nearby FSS earth station to ensure incumbent service protection. However, End User Devices served by such CBSDs may be portable or mobile and be situated within line-of-sight or near-line-of-sight propagation, with much less propagation loss between the End User Device and FSS earth station than the propagation channel from the CBSD to FSS earth station. The indeterminate location of the End User Devices and the uncertain propagation channel between them and FSS earth stations make it challenging to ensure protection of nearby FSS earth stations. Moreover, assuming worst case line-of-sight propagation from End User Devices in determining allowable locations for CBSDs can lead to unnecessarily large protection distances. We seek comment on reasonable methods for ensuring that the mobility, location, and orientation of End User Devices are managed effectively to avoid excessive interference to in-band FSS earth stations, while avoiding a mandate for geo-location requirements on End User Devices.

2. Out-of-Band Protection of C-Band FSS Earth Stations

443. As discussed above, we recognize that our stringent out-of-band emissions limit of $70 + 10 \text{ Log (P)}$, i.e., -40 dBm / MHz , for CBSDs leaves potential room for more optimization. On the one hand, additional protection may benefit C-Band earth stations when CBSDs or End User Devices are located nearby. On the other, -40 dBm / MHz may prove overly stringent in situations where Citizens Broadband Radio Service operations are distant from FSS earth stations, resulting in reduced usability of frequencies near the 3700 MHz band edge. We believe the registration and protection mechanisms of the SAS, in place of an across-the-board out-of-band limit, could provide a great deal more flexibility and protection to benefit FSS operators and Citizens Broadband Radio Service users alike. Therefore, we seek further comment on whether and how the same IPC used to ensure protection from co-channel emitters could also be used with respect to out-of-band interference from Citizens Broadband Radio Service to C-Band FSS earth stations. To the extent that many different stakeholders may find such an approach appealing, we encourage industry discussions that could lead to a consensus recommendation.

444. We seek comment on whether the received power interference protection criteria for out-of-band FSS earth stations should be the same or different from co-channel protections. Can a default protection area be defined based on these criteria and specific assumptions about FSS earth station receiving system G/T and minimum antenna elevation angle? For example, a C-Band licensee with an earth station having a low elevation angle above heavily populated areas may desire protection beyond that afforded with the required out-of-band emission limit. The licensee may register the earth station, including the antenna gain pattern. This information could be used by an SAS to calculate the requisite protection distance near the main beam to enable closer CBSD operation in the back of the earth station where there is higher antenna discrimination and ensure that the IPC is not exceeded.

445. Moreover, we agree with Google that market incentives may be feasible to encourage

industry to deploy radios with improved (lower) adjacent emissions and thereby have greater access to spectrum.⁹³² However, we do not see how this can be accomplished within the current regime of equipment authorization subject to the Commission's Part 2 requirements. We seek comment on how this can practically be achieved without burdensome changes to equipment authorization requirements that do not currently require precise emission measurements below the regulatory thresholds (*i.e.*, the noise floor of measurement equipment configurations often mask the emission performance of a device below the pass/fail regulatory limit). One possibility would be to define a small number of classes of devices, that are distinguished by increasingly stringent OOB limits (*e.g.*, Class X complies with -40 dBm / MHz, Class Y with -45 or -50 dBm / MHz, Class Z with -60 dBm / MHz, etc.). The device class would be tied to the device's FCC ID, and this information communicated to the SAS, which could provide protection commensurate with the class of the device. We seek comment on whether such a scenario would work, and if so, what levels of OOB limits should be specified and how would those correspond to protection distance. At what point would lower OOB limits cease to offer additional benefit, due to other effects such as FCC earth station receiver blocking? We also seek comment on whether we would need to make changes in our equipment authorization procedures and changes to adopted SAS rules.

V. PROCEDURAL MATTERS

A. *Ex Parte* Presentations

446. This proceeding shall continue to be treated as a "permit-but-disclose" proceeding in accordance with the Commission's *ex parte* rules.⁹³³ Persons making *ex parte* presentations must file a copy of any written presentation or a memorandum summarizing any oral presentation within two business days after the presentation (unless a different deadline applicable to the Sunshine period applies). Persons making oral *ex parte* presentations are reminded that memoranda summarizing the presentation must (1) list all persons attending or otherwise participating in the meeting at which the *ex parte* presentation was made, and (2) summarize all data presented and arguments made during the presentation. If the presentation consisted in whole or in part of the presentation of data or arguments already reflected in the presenter's written comments, memoranda or other filings in the proceeding, the presenter may provide citations to such data or arguments in his or her prior comments, memoranda, or other filings (specifying the relevant page and/or paragraph numbers where such data or arguments can be found) in lieu of summarizing them in the memorandum. Documents shown or given to Commission staff during *ex parte* meetings are deemed to be written *ex parte* presentations and must be filed consistent with section 1.1206(b).⁹³⁴ In proceedings governed by section 1.49(f)⁹³⁵ or for which the Commission has made available a method of electronic filing, written *ex parte* presentations and memoranda summarizing oral *ex parte* presentations, and all attachments thereto, must be filed through the electronic comment filing system available for that proceeding, and must be filed in their native format (*e.g.*, .doc, .xml, .ppt, searchable .pdf). Participants in this proceeding should familiarize themselves with the Commission's *ex parte* rules.

447. We note that our *ex parte* rules provide for a conditional exception for all *ex parte* presentations made by NTIA or Department of Defense representatives.⁹³⁶ This proceeding raises significant technical issues implicating federal and non-federal spectrum allocations and users. Staff from NTIA, DoD, and the FCC have engaged in technical discussions in the development of this *Report and Order and Second Further Notice of Proposed Rulemaking*, and we anticipate these discussions will continue after this *Report and Order and Second Further Notice of Proposed Rulemaking* is

⁹³² See Google January 2015 *Ex Parte*.

⁹³³ 47 C.F.R. § 1.1200 *et seq.*

⁹³⁴ 47 C.F.R. § 1.1206(b).

⁹³⁵ 47 C.F.R. § 1.49(f).

⁹³⁶ See 47 C.F.R. § 1.1204

released. These discussions will benefit from an open exchange of information between agencies, and may involve sensitive information regarding the strategic federal use of the 3.5 GHz Band. Recognizing the value of federal agency collaboration on the technical issues raised in this *Report and Order and Second Further Notice of Proposed Rulemaking*, NTIA's shared jurisdiction over the 3.5 GHz Band, the importance of protecting federal users in the 3.5 GHz Band from interference, and the goal of enabling spectrum sharing to help address the ongoing spectrum capacity crunch, we find that this exemption serves the public interest.

B. Comment Filing Procedures

448. Pursuant to sections 1.415 and 1.419 of the Commission's rules, 47 CFR §§ 1.415, 1.419, interested parties may file comments and reply comments on or before the dates indicated on the first page of this document. Comments may be filed using the Commission's Electronic Comment Filing System (ECFS). See *Electronic Filing of Documents in Rulemaking Proceedings*, 63 FR 24121 (1998).

- Electronic Filers: Comments may be filed electronically using the Internet by accessing the ECFS: <http://fjallfoss.fcc.gov/ecfs2/>.
- Paper Filers: Parties who choose to file by paper must file an original and one copy of each filing. If more than one docket or rulemaking number appears in the caption of this proceeding, filers must submit two additional copies for each additional docket or rulemaking number.

Filings can be sent by hand or messenger delivery, by commercial overnight courier, or by first-class or overnight U.S. Postal Service mail. All filings must be addressed to the Commission's Secretary, Office of the Secretary, Federal Communications Commission.

- All hand-delivered or messenger-delivered paper filings for the Commission's Secretary must be delivered to FCC Headquarters at 445 12th St., SW, Room TW-A325, Washington, DC 20554. The filing hours are 8:00 a.m. to 7:00 p.m. All hand deliveries must be held together with rubber bands or fasteners. Any envelopes and boxes must be disposed of before entering the building.
- Commercial overnight mail (other than U.S. Postal Service Express Mail and Priority Mail) must be sent to 9300 East Hampton Drive, Capitol Heights, MD 20743.
- U.S. Postal Service first-class, Express, and Priority mail must be addressed to 445 12th Street, SW, Washington DC 20554.

People with Disabilities: To request materials in accessible formats for people with disabilities (braille, large print, electronic files, audio format), send an e-mail to fcc504@fcc.gov or call the Consumer & Governmental Affairs Bureau at 202-418-0530 (voice), 202-418-0432 (tty).

C. Regulatory Flexibility Analysis

449. As required by the Regulatory Flexibility Act of 1980,⁹³⁷ the Commission has prepared a Final Regulatory Flexibility Analysis (FRFA) and an Initial Regulatory Flexibility Analysis (IRFA) of the possible significant economic impact on small entities of the policies and rules adopted and proposed in this document, respectively. The FRFA is set forth in Appendix B. The IRFA is set forth in Appendix C. Written public comments are requested on the IRFA. These comments must be filed in accordance with the same filing deadlines as comments filed in response to this *Report and Order and Second Further Notice of Proposed Rulemaking* as set forth on the first page of this document, and have a separate and distinct heading designating them as responses to the IRFA. The Commission's Consumer and

⁹³⁷ See 5 U.S.C. §§ 603-04.

Governmental Affairs Bureau, Reference Information Center, will send a copy of this *Report and Order and Second Further Notice of Proposed Rulemaking*, including the FRFA and IRFA, to the Chief Counsel for Advocacy of the Small Business Administration (SBA).⁹³⁸ In addition, the *Report and Order and Second Further Notice of Proposed Rulemaking* and IRFA (or summaries thereof) will be published in the Federal Register.⁹³⁹

D. Paperwork Reduction Act

450. The *Report and Order* contains new information collection requirements subject to the Paperwork Reduction Act of 1995 (PRA), Public Law No. 104-13. It will be submitted to the Office of Management and Budget (OMB) for review under section 3507(d) of the PRA. OMB, the general public, and other Federal agencies are invited to comment on the new information collection requirements contained in this proceeding.

451. The *Second Further Notice of Proposed Rulemaking* contains proposed new information collection requirements. The Commission, as part of its continuing effort to reduce paperwork burdens, invites the general public and OMB to comment on the information collection requirements contained in this document, as required by PRA. In addition, pursuant to the Small Business Paperwork Relief Act of 2002,⁹⁴⁰ we seek specific comment on how we might “further reduce the information collection burden for small business concerns with fewer than 25 employees.”⁹⁴¹

E. Congressional Review Act

452. The Commission will send a copy of this *Report and Order and Second Further Notice of Proposed Rulemaking* in a report to be sent to Congress and the Government Accountability Office pursuant to the Congressional Review Act (CRA), *see* 5 U.S.C. § 801(a)(1)(A).

VI. ORDERING CLAUSES

453. Accordingly, IT IS ORDERED, pursuant to Sections 1, 2, 4(i), 4(j), 5(c), 302a, 303, 304, 307(e), and 316 of the Communications Act of 1934, as amended, 47 U.S.C. §§ 151, 152, 154(i), 154(j), 155(c), 302a, 303, 304, 307(e), and 316, that this *Report and Order and Second Further Notice of Proposed Rulemaking* in GN Docket No. 12-354 IS ADOPTED and shall become effective thirty (30) days after publication of the text or summary thereof in the Federal Register, except for those rules and requirements that require approval by the Office of Management and Budget (OMB) under the Paperwork Reduction Act, which shall become effective after the Commission publishes a notice in the Federal Register announcing such approval and the relevant effective date.

454. IT IS FURTHER ORDERED that the Commission’s Consumer and Governmental Affairs Bureau, Reference Information Center, SHALL SEND a copy of this *Report and Order and Second Further Notice of Proposed Rulemaking*, including the Final Regulatory Flexibility Analysis and Initial Regulatory Flexibility Analysis, to the Chief Counsel for Advocacy of the Small Business Administration.

455. IT IS FURTHER ORDERED, that the freeze on acceptance of applications with respect to new earth stations in the fixed-satellite service imposed in the 3.5 GHz NPRM is lifted, effective thirty (30) days after publication of the text or summary of this *Report and Order and Second Further Notice of*

⁹³⁸ *See id.* § 603(a).

⁹³⁹ *See id.*

⁹⁴⁰ Pub. L. No. 107-198.

⁹⁴¹ 44 U.S.C. § 3506(c)(4).

Proposed Rulemaking in the Federal Register.⁹⁴²

FEDERAL COMMUNICATIONS COMMISSION

Marlene H. Dortch
Secretary

⁹⁴² The rules adopted herein provide that such facilities will thereafter be secondary to non-federal stations in the fixed and land mobile services. *See supra* section III(A); Appendix A, § 2.106, note US107.

APPENDIX A**Final Rules**

The Federal Communications Commission (FCC or Commission) proposes to amend parts 0, 1, 2, 90, and 95 and add a new Part 96 to Part 47 of the Code of Federal Regulations (CFR) as set forth below:

Part 0 – Commission Organization

1. The authority citation for Part 0 continues to read as follows:

AUTHORITY: Sec. 5, 48 Stat. 1068, as amended; 47 U.S.C. 155, 225, unless otherwise noted.

2. Section 0.241 is amended to read as follows:

(j) The Chief of the Office of Engineering and Technology is delegated authority jointly with the Chief of the Wireless Telecommunications Bureau to administer the Spectrum Access System (SAS) and SAS Administrator functions set forth in Part 96 of this chapter. The Chief is delegated authority to develop specific methods that will be used to designate SAS Administrators; to designate SAS Administrators; to develop procedures that these SAS Administrators will use to ensure compliance with the requirements for SAS operation; to make determinations regarding the continued acceptability of individual SAS Administrators; and to perform other functions as needed for the administration of the SAS. The Chief is delegated the authority to perform these same functions with regard to the Environmental Sensing Capability.

3. Section 0.331 is amended to read as follows:

(f) The Chief of the Wireless Telecommunications Bureau is delegated authority jointly with the Chief of the Office of Engineering and Technology to administer the Spectrum Access System (SAS) and SAS Administrator functions set forth in Part 96 of this chapter. The Chief is delegated authority to develop specific methods that will be used to designate SAS Administrators; to designate SAS Administrators; to develop procedures that these SAS Administrators will use to ensure compliance with the requirements for SAS operation; to make determinations regarding the continued acceptability of individual SAS Administrators; and to perform other functions as needed for the administration of the SAS. The Chief is delegated the authority to perform these same functions with regard to the Environmental Sensing Capability.

Part 1 – Practice and Procedure

4. The authority citation for Part 1 continues to read as follows:

AUTHORITY: 15 U.S.C. 79 *et seq.*; 47 U.S.C. 151, 154(i), 154(j), 155, 157, 225, 227, 303(r), 309, 1403, 1404, and 1451.

5. Section 1.901 is amended to read as follows:

§1.901 Basis and purpose

These rules are issued pursuant to the Communications Act of 1934, as amended, 47 U.S.C. 151 *et seq.* The purpose of these rules is to establish the requirements and conditions under which entities may be licensed in the Wireless Radio Services as described in this part and in parts 13, 20, 22, 24, 26, 27, 74, 80, 87, 90, 95, 96, 97 and 101 of this chapter.

6. Section 1.902 is amended to read as follows:

§1.902 Scope

In case of any conflict between the rules set forth in this subpart and the rules set forth in Parts 13, 20, 22, 24, 26, 27, 74, 80, 87, 90, 95, 96, 97, and 101 of title 47, chapter I of the Code of Federal Regulations, the rules in part 1 shall govern.

7. Section 1.907 is amended to read as follows:

§ 1.907 Definitions

Private Wireless Services. Wireless Radio Services authorized by parts 80, 87, 90, 95, 96, 97, and 101 that are not Wireless Telecommunications Services, as defined in this part.

Wireless Radio Services. All radio services authorized in parts 13, 20, 22, 24, 26, 27, 74, 80, 87, 90, 95, 96, 97 and 101 of this chapter, whether commercial or private in nature.

Wireless Telecommunications Services. Wireless Radio Services, whether fixed or mobile, that meet the definition of “telecommunications service” as defined by 47 U.S.C. 153, as amended, and are therefore subject to regulation on a common carrier basis. Wireless Telecommunications Services include all radio services authorized by parts 20, 22, 24, 26, and 27 of this chapter. In addition, Wireless Telecommunications Services include Public Coast Stations authorized by part 80 of this chapter, Commercial Mobile Radio Services authorized by part 90 of this chapter, common carrier fixed microwave services, Local Television Transmission Service (LTTS), Local Multipoint Distribution Service (LMDS), and Digital Electronic Message Service (DEMS), authorized by part 101 of this chapter, and Citizens Broadband Radio Services authorized by part 96 of this chapter.

8. Section 1.1307 is amended to read as follows:

§ 1.1307 - Actions that may have a significant environmental effect, for which Environmental Assessments (EAs) must be prepared.

* * * *

(b) * * * *

(2)(i) Mobile and portable transmitting devices that operate in the Commercial Mobile Radio Services pursuant to part 20 of this chapter; the Cellular Radiotelephone Service pursuant to part 22 of this chapter; the Personal Communications Services (PCS) pursuant to part 24 of this chapter; the Satellite Communications Services pursuant to part 25 of this chapter; the Miscellaneous Wireless Communications Services pursuant to part 27 of this chapter; the Maritime Services (ship earth stations

only) pursuant to part 80 of this chapter; the Specialized Mobile Radio Service, the 4.9 GHz Band Service, or the 3650 MHz Wireless Broadband Service pursuant to part 90 of this chapter; the Wireless Medical Telemetry Service (WMTS), or the Medical Device Radiocommunication Service (MedRadio) pursuant to part 95 of this chapter; or the Citizens Broadband Radio Service pursuant to part 96 of this chapter are subject to routine environmental evaluation for RF exposure prior to equipment authorization or use, as specified in §§ 2.1091 and 2.1093 of this chapter.

* * * * *

Part 2 – Frequency Allocations and Radio Treaty Matters; General Rules and Regulations

9. The authority citation for Part 2 continues to read as follows:

AUTHORITY: 47 U.S.C. 154, 302a, 303, and 336, unless otherwise noted.

10. Section 2.106, the Table of Frequency Allocations, is amended as follows:

a. Revise page 41.

b. In the list of United States (US) Footnotes, add footnotes US105, US107, and US433.

§ 2.106 Table of Frequency Allocations.

The revisions and additions read as follows:

* * * * *

Federal Communications Commission

FCC 15-47

Table of Frequency Allocations			3500-5460 MHz (SHF)	
International Table			United States Table	
Region 1 Table	Region 2 Table	Region 3 Table	Federal Table	Non-Federal Table
(See previous page)	3500-3700 FIXED FIXED-SATELLITE (space-to-Earth) MOBILE except aeronautical mobile Radiolocation 5.433	3500-3600 FIXED FIXED-SATELLITE (space-to-Earth) MOBILE except aeronautical mobile 5.433A Radiolocation 5.433	3500-3550 RADIOLOCATION G59 AERONAUTICAL RADIONAVIGATION (ground-based) G110	3500-3550 Radiolocation
3600-4200 FIXED FIXED-SATELLITE (space-to-Earth) Mobile		3600-3700 FIXED FIXED-SATELLITE (space-to-Earth) MOBILE except aeronautical mobile Radiolocation 5.433	3550-3650 RADIOLOCATION G59 AERONAUTICAL RADIONAVIGATION (ground-based) G110	3550-3600 FIXED MOBILE except aeronautical mobile US105 US433
			US105 US107 US245 US433	3600-3650 FIXED FIXED-SATELLITE (space-to-Earth) US107 US245 MOBILE except aeronautical mobile US105 US433
		5.435	3650-3700	3650-3700 FIXED FIXED-SATELLITE (space-to-Earth) NG169 NG185 MOBILE except aeronautical mobile US109 US349
	3700-4200 FIXED FIXED-SATELLITE (space-to-Earth) MOBILE except aeronautical mobile		3700-4200	3700-4200 FIXED FIXED-SATELLITE (space-to-Earth) NG180
4200-4400 AERONAUTICAL RADIONAVIGATION 5.438			4200-4400 AERONAUTICAL RADIONAVIGATION	
5.439 5.440			5.440 US261	
4400-4500 FIXED MOBILE 5.440A			4400-4940 FIXED MOBILE	4400-4500
4500-4800 FIXED FIXED-SATELLITE (space-to-Earth) 5.441 MOBILE 5.440A				4500-4800 FIXED-SATELLITE (space-to-Earth) 5.441 US245
4800-4990 FIXED MOBILE 5.440A 5.442 Radio astronomy			US113 US245 US342	4800-4940 US113 US342
5.149 5.339 5.443			4940-4990	4940-4990 FIXED MOBILE except aeronautical mobile
			5.339 US342 US385 G122	5.339 US342 US385

4990-5000 FIXED MOBILE except aeronautical mobile RADIO ASTRONOMY Space research (passive) 5.149	4990-5000 RADIO ASTRONOMY US74 Space research (passive) US246
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UNITED STATES (US) FOOTNOTES

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US105 In the band 3550-3650 MHz, non-Federal stations in the radiolocation service that were licensed or applied for prior to [effective date of Report and Order] may continue to operate on a secondary basis until the end of the equipment's useful lifetime.

US107 In the band 3600-3650 MHz, the following provisions shall apply to earth stations in the fixed-satellite service (space-to-Earth):

(a) Earth stations authorized prior to, or granted as a result of an application filed prior to, [effective date of the Report and Order] and constructed within 12 months of initial authorization may continue to operate on a primary basis. Applications for modifications to such earth station facilities filed after [the effective date of the Report and Order] shall not be accepted, except for changes in polarization, antenna orientation, or ownership; and increases in antenna size for interference mitigation purposes.

(b) The assignment of frequencies to new earth stations after [the effective date of the Report and Order] shall be authorized on a secondary basis.

US109 The band 3650-3700 MHz is also allocated to the Federal radiolocation service on a primary basis at the following sites: St. Inigoes, MD (38 10' N, 76 23' W); Pascagoula, MS (30 22' N, 88 29' W); and Pensacola, FL (30 21' 28" N, 87 16' 26" W). The FCC shall coordinate all non-Federal operations authorized under 47 CFR Part 90 within 80 km of these sites with NTIA on a case-by-case basis. For stations in the Citizens Broadband Radio Service these sites shall be protected consistent with the procedures set forth in 47 CFR 96.15(b) and 96.67.

* * * * *

US433 In the band 3550-3650 MHz, the following provisions shall apply to Federal use of the aeronautical radionavigation (ground-based) and radiolocation services and to non-Federal use of the fixed and mobile except aeronautical mobile services:

(a) Non-Federal stations in the fixed and mobile except aeronautical mobile services are restricted to stations in the Citizens Broadband Radio Service and shall not cause harmful interference to, or claim protection from, Federal stations in the aeronautical radionavigation (ground-based) and radiolocation services at the locations listed at: ntia.doc.gov/category/3550-3650-mhz. New and modified federal stations shall be allowed at current or new locations, subject only to approval through the National Telecommunications and Information Administration frequency assignment process with new locations added to the list at: ntia.doc.gov/category/3550-3650-mhz. Coordination of the Federal stations with Citizens Broadband Radio Service licensees or users is not necessary. Federal operations, other than airborne radiolocation systems, shall be protected consistent with the procedures set forth in 47 CFR 96.15 and 96.67.

(b) Non-federal fixed and mobile stations shall not claim protection from federal airborne radar systems.

(b) Federal airborne radar systems shall not claim protection from non-Federal stations in the fixed and mobile except aeronautical mobile services operating in the band.

* * * * *

§ 2.1091 Radiofrequency radiation exposure evaluation: mobile devices

* * * * *

(c)(1) Mobile devices that operate in the Commercial Mobile Radio Services pursuant to part 20 of this chapter; the Cellular Radiotelephone Service pursuant to part 22 of this chapter; the Personal Communications Services pursuant to part 24 of this chapter; the Satellite Communications Services pursuant to part 25 of this chapter; the Miscellaneous Wireless Communications Services pursuant to part 27 of this chapter; the Maritime Services (ship earth station devices only) pursuant to part 80 of this chapter; the Specialized Mobile Radio Service, and the 3650 MHz Wireless Broadband Service pursuant to part 90 of this chapter; and the Citizens Broadband Radio Service pursuant to part 96 of this chapter are subject to routine environmental evaluation for RF exposure prior to equipment authorization or use if:

* * * * *

§ 2.1093 Radiofrequency radiation exposure evaluation: portable devices

* * * * *

(c)(1) Portable devices that operate in the Cellular Radiotelephone Service pursuant to part 22 of this chapter; the Personal Communications Service (PCS) pursuant to part 24 of this chapter; the Satellite Communications Services pursuant to part 25 of this chapter; the Miscellaneous Wireless Communications Services pursuant to part 27 of this chapter; the Maritime Services (ship earth station devices only) pursuant to part 80 of this chapter; the Specialized Mobile Radio Service, the 4.9 GHz Band Service, and the 3650 MHz Wireless Broadband Service pursuant to part 90 of this chapter; the Wireless Medical Telemetry Service (WMTS) and the Medical Device Radiocommunication Service (MedRadio), pursuant to subparts H and I of part 95 of this chapter, respectively, unlicensed personal communication service, unlicensed NII devices and millimeter wave devices authorized under §§ 15.253(f), 15.255(g), 15.257(g), 15.319(i), and 15.407(f) of this chapter; and the Citizens Broadband Radio Service pursuant to part 96 of this chapter are subject to routine environmental evaluation for RF exposure prior to equipment authorization or use.

* * * * *

Part 90 – Private Land Mobile Radio Services

1. The authority citation for Part 90 continues to read as follows:

AUTHORITY: Sections 4(i), 11, 303(g), 303(r), and 332(c)(7) of the Communications Act of 1934, as amended, 47 U.S.C. 154(i), 161, 303(g), 303(r), 332(c)(7), and Title VI of the Middle Class Tax Relief and Job Creation Act of 2012, Pub. L. 112-96, 126 Stat. 156.

2. Section 90.103 is amended by revising the “3500 to 3650” entry in the Megahertz portion of the Radiolocation Service Frequency Table in paragraph (b) to read as follows:

§ 90.103 Radiolocation Service.

* * * * *

RADIOLOCATION SERVICE FREQUENCY TABLE

Frequency or band	Class of station(s)	Limitation
Kilohertz		
* *	* *	*
Megahertz		
420 to 450 .....	.....do	21
2450 to 2500 .....	.....do	9, 22, 23
2900 to 3100 .....	.....do	10, 11
3100 to 3300 .....	.....do	12
3300 to 3500 .....	.....do	12, 13
3500 to 3550 .....	.....do	12
3550 to 3650.....	.....do	30
* *	* *	*

(30) This frequency band is shared with and is on a secondary basis to the Government Radiolocation Service, the Fixed Satellite Service (part 25), and the Citizens Broadband Radio Service (part 96). No new licenses for Non-Federal Radiolocation Services in this band will be issued after [R&O Effective Date].

3. Section 90.1307 is amended to read as follows:

90.1307 – Licensing

(b) The Commission shall issue no new licenses or license renewals under this section after April 17, 2015, except as specified below.

(c) If a license issued under this section expires between April 17, 2015 and April 17, 2020, the licensee may request a one-time renewal and the Commission may renew that license for a term ending no later than April 17, 2020.

(d) Licenses that were issued after January 8, 2013 will be afforded protection from harmful interference from Citizens Broadband Radio Service users pursuant to Section 90.1338 until April 17, 2020 regardless of their expiration date.

4. Section 90.1311 is amended to read as follows:

90.1311 – License Term

The license term is ten years, except as set forth in section 90.1307, beginning on the date of the initial authorization (non-exclusive nationwide license) grant. Registering fixed and base stations will not change the overall renewal period of the license.

5. Section 90.1331 is amended to read as follows:

§ 90.1331 Restrictions on the operation of base and fixed stations.

* * * * *

(b)(1) Except as specified in paragraph (b)(2) of this section, base and fixed stations may not be located within 80 km of the following Federal Government radiolocation facilities:

St. Inigoes, MD—38° 10' N., 76°, 23' W
Pensacola, FL—30° 21' 28" N., 87°, 16' 26" W
Pascagoula, MS---30 22' N, 88 29' W

NOTE: Licensees installing equipment in the 3650-3700 MHz band should determine if there are any nearby Federal Government radar systems that could affect their operations. Information regarding the location and operational characteristics of the radar systems operating adjacent to this band are provided in NTIA TR-99-361.

6. Section 90.1338 is added to read as follows:

90.1338 – Grandfathered Operation and Transition to Citizens Broadband Radio Service

(a) Fixed and base station registrations filed in ULS on or before April 17, 2015 that are constructed, in service, and fully compliant with the rules in part 90, subpart Z as of April 17, 2016 will be afforded protection from harmful interference caused by Citizens Broadband Radio Service users until the end of their license term (with one exception that fixed and base stations registered under licenses issued after January 8, 2013 will only be afforded protection until April 17, 2020), consistent with section 90.1307. Protection criteria for such registered base stations are described in section 96.21. Registrations originally filed after April 17, 2015 will only be afforded protection from harmful interference under this section within the licensee's Grandfathered Wireless Protection Zone, as defined in sections 96.3 and 96.21.

(b) Existing licensees as of April 17, 2015 may add new mobile or portable stations (as defined in 90.1333) and/or add new subscriber units that operate above the power limit defined in 90.1333, only if they can positively receive and decode an enabling signal from a base station. Such units will be afforded protection within the licensee's Grandfathered Wireless Protection Zone (as defined in sections 96.3 and 96.21) until April 17, 2020 or until the end of their license term, whichever is later (with one exception that mobile and portable stations associated with licenses issued after January 8, 2013 will only be afforded protection until April 17, 2020).

Part 95 – Personal Radio Services

7. The authority citation for Part 95 continues to read as follows:

AUTHORITY: Secs. 4, 303, 48 Stat. 1066, 1082, as amended; 47 U.S.C. 154, 303.

8. Section 95.401 is amended to read as follows:

§ 95.401 (CB Rule 1) What are Citizens Band Radio Services?

(h) Citizens Broadband Radio Service – The rules for this service, including technical rules, are contained in Part 96 of the Commission’s rules. Only Citizens Broadband Radio Service Devices authorized on a General Authorized Access basis, as those terms are defined in section 96.3, are considered part of the Citizens Band Radio Services.

9. Section 95.601 is amended to read as follows:

§95.601 Basis and purpose

This section provides the technical standards to which each transmitter (apparatus that converts electrical energy received from a source into RF (radio frequency) energy capable of being radiated) used or intended to be used in a station authorized in any of the Personal Radio Services listed below must comply. This section also provides requirements for obtaining certification for such transmitters. The Personal Radio Services to which these rules apply are the GMRS (General Mobile Radio Service)—subpart A, the Family Radio Service (FRS)—subpart B, the R/C (Radio Control Radio Service)—subpart C, the CB (Citizens Band Radio Service)—subpart D, the Low Power Radio Service (LPRS)—subpart G, the Wireless Medical Telemetry Service (WMTS)—subpart H, the Medical Device Radiocommunication Service (MedRadio)—subpart I, the Multi-Use Radio Service (MURS)—subpart J, and Dedicated Short-Range Communications Service On-Board Units (DSRCS-OBUs)—subpart L.

10. A new Part 96 is added to read as follows:

AUTHORITY: Sections 4(i), 303, and 307 of the Communications Act of 1934, as amended, 47 U.S.C. 154(i), 303, and 307.

Part 96 – Citizens Broadband Radio Service

Subpart A – GENERAL RULES

§ 96.1 – Scope

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§ 96.5 – Eligibility

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§ 96.15 – Protection of Federal Incumbents

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§ 96.23 – Authorization

§ 96.25 – Priority Access Licenses

§ 96.27 – Application Window

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§ 96.31 – Aggregation of Priority Access Licenses

Subpart D – GENERAL AUTHORIZED ACCESS

§ 96.33 – Authorization

§ 96.35 – General Authorized Access Use

Subpart E – TECHNICAL RULES

§ 96.39 – Citizens Broadband Radio Service Device (CBSD) General Requirements

§ 96.41 – General Radio Requirements

§ 96.43 - Additional Requirements for Category A CBSDs

§ 96.45 – Additional Requirements for Category B CBSDs

§ 96.47 – End User Device Additional Requirements

§ 96.49 – Equipment Authorization

§ 96.51 – RF Safety

Subpart F – SPECTRUM ACCESS SYSTEM

§ 96.53 – Spectrum Access System Purposes and Functionality

§ 96.55 – Information Gathering and Retention

§ 96.57 – Registration, Authentication, and Authorization of Citizens Broadband Radio Service Devices

§ 96.59 – Frequency Assignment

§ 96.61 – Security

§ 96.63 – Spectrum Access System Administrators

§ 96.65 – Spectrum Access System Administrator Fees

Subpart G – ENVIRONMENTAL SENSING CAPABILITY

§ 96.67 – Environmental Sensing Capability

Subpart A - GENERAL RULES**96.1 – Scope**

(a) This section sets forth the regulations governing use of devices in the Citizens Broadband Radio Service. Citizens Broadband Radio Service Devices (CBSDs) may be used in the frequency bands listed in section 96.11. The operation of all CBSDs shall be coordinated by one or more authorized Spectrum Access Systems (SASs).

(b) The Citizens Broadband Radio Service includes Priority Access and General Authorized Access tiers of service. Priority Access Licensees and General Authorized Access Users must not cause harmful interference to Incumbent Users and must accept interference from Incumbent Users. General Authorized Access Users must not cause harmful interference to Priority Access Licensees and must accept interference from Priority Access Licensees.

96.3 – Definitions

Census Tract. Statistical subdivisions of a county or equivalent entity that are updated prior to each decennial census as part of the Census Bureau's Participant Statistical Areas Program. Census tracts are defined by the United States Census Bureau and census tract maps can be found at <http://www.census.gov>. For purposes of this part, Census Tracts shall be defined as they were in the 2010 United States Census. The Commission may from time to time update this definition to reflect boundaries used in subsequent decennial Census definitions.

Citizens Broadband Radio Service Device (CBSD). Fixed Stations, or networks of such stations, that operate on a Priority Access or General Authorized Access basis in the Citizens Broadband Radio Service consistent with this rule part. For CBSDs which comprise multiple nodes or networks of nodes, CBSD requirements apply to each node even if network management and communication with the SAS is accomplished via a single network interface. End User Devices are not considered CBSDs.

Category A CBSD. A lower power CBSD that meets the general requirements applicable to all CBSDs and the specific requirements for Category A CBSDs set forth in sections 96.41 and 96.43.

Category B CBSD. A higher power CBSD that meets the general requirements applicable to all CBSDs and the specific requirements for Category B CBSDs set forth in sections 96.41 and 96.45.

Coastline. The mean low water line along the coast of the United States drawn according to the principles, as recognized by the United States, of the Convention on the Territorial Sea and the Contiguous Zone, 15 U.S.T. 1606, and the 1982 United Nations Convention on the Law of the Sea, 21 I.L.M. 1261.

End User Device. A device authorized and controlled by an authorized CBSD. These devices may not be used as intermediate service links or to provide service over the frequencies listed in section 96.11 to other End User Devices or CBSDs.

Environmental Sensing Capability (ESC). A system that detects and communicates the presence of a signal from an Incumbent User to an SAS to facilitate shared spectrum access consistent with sections 96.15 and 96.67.

Exclusion Zone. A geographic area wherein no CBSD shall operate. Exclusion Zones shall be enforced and maintained by the SAS. Exclusion Zones will be converted to Protection Zones following the approval and commercial deployment of an ESC and SAS consistent with this part.

Fixed Station. A CBSD or End User Device that transmits and/or receives radio communication signals at a fixed location. Fixed Stations may be moved from time to time but Fixed CBSDs must turn off and re-register with the SAS prior to transmitting from a new location.

Geo-Location Capability. The capability of a CBSD to register its geographic coordinates within the level of accuracy specified in section 96.39. The CBSD location is used by the SAS to determine frequency availability and maximum transmit power limits for CBSDs.

General Authorized Access (GAA) User. An authorized user of one or more CBSDs operating on a General Authorized Access basis, consistent with section 96.33, *et seq.*

Grandfathered Wireless Broadband Licensee. A licensee authorized to operate in the 3650-3700 MHz band consistent with section 90.1338.

Grandfathered Wireless Protection Zone. A geographic area and frequency range in which Grandfathered Wireless Broadband Licensees will receive protection from Citizens Broadband Radio Service transmissions and defined using methodology determined by the Wireless Telecommunications Bureau and Office of Engineering and Technology.

Incumbent User. A federal entity authorized to operate on a primary basis in accordance with the table of frequency allocations, fixed satellite service operator, or Grandfathered Wireless Broadband Licensee authorized to operate on a primary basis on frequencies designated in section 96.11.

License Area. The geographic component of a PAL. Each License Area consists of one Census Tract.

Mobile Station. A device intended to be used while in motion or during halts at unspecified points.

Portable Station. A device designed to be used within 20 centimeters of the body of the user.

Priority Access License (PAL). A license to operate on a Priority Access basis, consistent with section 96.23, *et seq.*

Priority Access Licensee. A holder of one or more PALs. Priority Access Licensees shall be entitled to protection from General Authorized Access Users and other Priority Access Licensees within the defined temporal, geographic, and frequency limits of their PAL, consistent with the rules set forth in this part.

Protection Zone. A geographic area wherein CBSDs may operate only with the permission of an approved SAS and ESC.

Rural Area. For purposes of this Part, any Census Tract which is not located within, or overlapping: (i) a city, town, or incorporated area that has a population of greater than 20,000 inhabitants; or (ii) an urbanized area contiguous and adjacent to a city or town that has a population of greater than 50,000 inhabitants.

Service Area. One or more contiguous License Areas held by the same Priority Access Licensee.

Spectrum Access System (SAS). A system that authorizes and manages use of spectrum for the Citizens Broadband Radio Service in accordance with subpart F.

SAS Administrator. An entity authorized by the Commission to operate an SAS in accordance with the rules and procedures set forth in section 96.63.

96.5 – Eligibility

Any entity, other than those precluded by section 310 of the Communications Act of 1934, as amended, 47 U.S.C. 310, and otherwise meets the technical, financial, character, and citizenship qualifications that the Commission may require in accordance with such Act is eligible to be a Priority Access Licensee or General Authorized Access User under this part; provided further, that no entity barred by 47 U.S.C. 1404 is eligible to be a Priority Access Licensee.

96.7 – Authorization Required

(a) CBSDs and End User Devices must be used and operated consistent with the rules in this part.

(b) Authorizations for PALs may be granted upon proper application, provided that the applicant is qualified in regard to citizenship, character, financial, technical and other criteria established by the Commission, and that the public interest, convenience and necessity will be served. See 47 U.S.C. 301, 308, 309, and 310. The holding of an authorization does not create any rights beyond the terms, conditions, and period specified in the authorization and shall be subject to the provisions of the Communications Act of 1934, as amended, and the Commission's rules and policies thereunder.

(c) Grandfathered Wireless Broadband Licensees are authorized to operate consistent with section 90.1338.

96.9 – Regulatory Status

Priority Access Licensees and General Authorized Access Users are permitted to provide services on a non-common carrier and/or on a common carrier basis. An authorized Citizens Broadband Radio Service user may render any kind of communications service consistent with the regulatory status in its authorization and with the Commission's rules applicable to that service.

96.11 – Frequencies

(a) The Citizens Broadband Radio Service is authorized in the 3550-3700 MHz frequency band.

(1) General Authorized Access Users may operate in the 3550-3700 MHz frequency band.

(2) Priority Access Users may operate in the 3550-3650 MHz frequency band.

(3) Grandfathered Wireless Broadband Licensees may continue to use the 3650-3700 MHz band in accordance with section 90.1338.

96.13 – Frequency Assignments

(a) Each PAL shall be authorized to use a 10 megahertz channel in the 3550-3650 MHz band.

(1) No more than seven PALs shall be assigned in any given License Area at any given time.

(2) Multiple channels held by the same Priority Access Licensee in a given License Area shall be assigned consistent with the requirements of section 96.25.

(3) Any frequencies designated for Priority Access that are not in use by a Priority Access Licensee may be utilized by General Authorized Access Users.

(b) The 3650-3700 MHz band shall be reserved for Grandfathered Wireless Broadband Licensees and GAA Users.

(c) An SAS shall assign authorized CBSDs to specific frequencies, which may be reassigned by that SAS, consistent with this part.

Subpart B - INCUMBENT PROTECTION

96.15 – Protection of Federal Incumbent Users

(a) This subsection applies only to CBSDs operating in the 3550-3650 MHz band.

(1) CBSDs and End User Devices must not cause harmful interference to and must accept interference from federal Incumbent Users authorized to operate in the 3550-3700 MHz band and below 3550 MHz.

(2) The SAS shall only authorize the use of CBSDs consistent with information on federal frequency use obtained from an approved ESC, except as provided in this section.

(3) For Category A CBSDs, Exclusion Zones shall be maintained along the Coastline, as shown at ntia.doc.gov/category/3550-3650-mhz. Exclusion Zones shall also be maintained around federal radiolocation sites as set forth at ntia.doc.gov/category/3550-3650-mhz. NTIA shall notify the Commission in writing if and when the list of protected federal radiolocation sites is updated. Exclusion Zones shall be maintained and enforced until one or more ESCs are approved and used by at least one SAS, in accordance with section 96.67. Thereafter, Exclusion Zones shall be converted to Protection Zones.

(i) Category A CBSDs may be authorized by an approved SAS in geographic areas outside of Exclusion Zones before an ESC is approved.

(ii) Once an ESC is approved and used by at least one SAS, Category A CBSDs may only be authorized consistent with information on federal frequency use provided to the SAS by an approved ESC.

(iii) Category B CBSDs may only be authorized consistent with information on the presence of a signal from a federal system provided to the SAS by an approved ESC.

(4) Within 60 seconds after the ESC communicates that it has detected a signal from a federal system in a given area, the SAS must either confirm suspension of the CBSD's operation or its relocation to another unoccupied frequency, if available.

(5) The Commission will, as necessary, add or modify Exclusion Zones or Protection Zones to protect current and future federal Incumbent Users.

(6) The Commission may temporarily extend or modify Exclusion Zones and Protection Zones to protect temporary operations by federal Incumbent Users. Federal Incumbent Users will coordinate with the Commission prior to the beginning of any non-emergency operation requiring additional protection. Such modifications will be communicated to the SAS along with the expiration date and time of any modification.

(b) This subsection applies to CBSDs operating in the 3650-3700 MHz band.

(1) CBSDs and End User Devices must not cause harmful interference to and must accept interference from federal Incumbent Users authorized to operate in the 3500-3700 MHz band.

(2) Exclusion Zones shall be maintained for an 80 km radius around the federal radiolocation sites listed in 47 CFR 90.1331 and 47 CFR 2.106, US 109. These Exclusion Zones shall be maintained and enforced until one or more ESCs are approved and used by at least one SAS, in accordance with section 96.67. Thereafter, Exclusion Zones shall be converted to Protection Zones.

(3) CBSDs may only be authorized within these Protection Zones consistent with information on the presence of a signal from a federal system provided to the SAS by an approved ESC, in accordance with section 96.67.

(4) Within 60 seconds after the ESC communicates that it has detected a signal from a federal system in a given area, the SAS must either confirm suspension of the CBSD's operation or its relocation to another unoccupied frequency.

96.17 - Protection of Existing FSS Earth Stations in the 3600-3650 MHz Band and 3700-4200 MHz Band

(a) CBSDs shall protect the FSS earth stations authorized to operate in the 3600-3650 MHz band listed at fcc.gov/cbrs-protected-fss-sites in accordance with the Commission's rules.

(b) CBSDs shall protect the FSS earth stations authorized to operate in the 3700-4200 MHz band listed at fcc.gov/cbrs-protected-fss-sites in accordance with the Commission's rules.

(c) These protection criteria will be enforced by the Spectrum Access System authorized consistent with section 96.53, *et seq.* below.

(d) FSS earth station licensees requesting protection under this Part must register with the Commission annually, no later than 30 days before the end of the preceding calendar year, or upon making changes to any of the operational parameters listed in this section. Registration information will be made available to all approved SASs.

(1) Annual registration for each earth station shall include, at a minimum:

- (i) the earth station's geographic location (Using NAD83 coordinates);
- (ii) antenna gain;
- (iii) azimuth and elevation antenna gain pattern;
- (iv) antenna azimuth relative to true north; and
- (v) antenna elevation angle.

(2) Such information must be made available to SAS Administrators and maintained consistent with section 96.55.

(e) CBSDs may operate within areas that may cause interference to FSS earth stations provided that the licensee of the FSS earth station and the authorized user of the CBSD mutually agree on such operation and the terms of any such agreement are provided to an SAS Administrator that agrees to enforce them. The terms of any such agreement shall be communicated promptly to all other SAS Administrators.

96.19 – Operation Near Canadian and Mexican Borders

Citizens Broadband Radio Service operation in the 3550-3700 MHz band is subject to current and future international agreements with Mexico and Canada. The terms of these agreements shall be implemented by the SAS.

96.21 – Protection of Existing Operators in the 3650-3700 MHz Band

(a) Grandfathered Wireless Broadband Licensees shall be granted Incumbent User status consistent with sections 90.1307 and 90.1338. Notwithstanding this status, Grandfathered Wireless Broadband Licensees shall not cause harmful interference to federal Incumbent Users and grandfathered FSS earth stations consistent with the rules governing Citizens Broadband Radio Service operators in this part.

(1) Incumbent User protections for a Grandfathered Wireless Broadband Licensee shall only apply within its Grandfathered Wireless Protection Zone.

(2) Incumbent User protections for a Grandfathered Wireless Broadband Licensee shall only apply to Grandfathered Wireless Protection Zones around base or fixed stations that are registered in ULS on or before April 17, 2015 and constructed, in service, and fully compliant with the rules in Part 90, subpart Z as of April 17, 2016. Grandfathered Wireless Protection Zones will be reduced in geographic area and/or applicable frequency range if portions of the protected network fail to meet the above criteria after April 17, 2016. Grandfathered Wireless Protection Zones will not be defined for subscriber units operated by Grandfathered Wireless Broadband Licensees, regardless of whether they have been registered in ULS.

(3) Grandfathered Wireless Protection Zones must be registered in the SAS for these protections to apply.

(b) Grandfathered Wireless Broadband Licensees may operate within their Grandfathered Wireless Protection Zones and operational frequencies consistent with the technical rules in Part 90, subpart Z, consistent with the transition period set forth in sections 90.1307 and 90.1338.

(c) Grandfathered Wireless Broadband Licensees and Citizens Broadband Radio Service users must protect authorized grandfathered FSS earth stations in the 3650-3700 MHz band, consistent with the existing protection criteria in part 90, subpart Z until the last Grandfathered Wireless Broadband Licensee's license expires within the protection area defined for a particular grandfathered FSS earth station. Thereafter, the protection criteria in section 96.17 applicable to similarly situated facilities shall apply.

Subpart C - PRIORITY ACCESS**96.23 – Authorization**

(a) Applications for PALs must:

(1) Demonstrate the applicant's qualifications to hold an authorization;

(2) State how a grant would serve the public interest, convenience, and necessity;

(3) Contain all information required by FCC rules and application forms;

(4) Propose operation of a facility or facilities in compliance with all rules governing the Citizens Broadband Radio Service; and

(5) Be amended as necessary to remain substantially accurate and complete in all significant respects, in accordance with the provisions of section 1.65 of this chapter.

(b) CBSDs used for Priority Access must register with an SAS and comply with its instructions consistent with section 96.39 and subpart F.

(c) Records pertaining to PALs, including applications and licenses, shall be maintained by the Commission in a publicly accessible system.

96.25 – Priority Access Licenses

(a) Priority Access Licensees must operate CBSDs consistent with the technical rules and interference protection requirements set forth in this part.

(b) PALs have the following parameters:

(1) *Geography*: Each PAL consists of a single License Area.

(i) *Contiguous Geographic Areas*: An SAS must assign geographically contiguous PALs held by the same Priority Access Licensee to the same channels in each geographic area, to the extent feasible. The SAS may temporarily reassign individual PALs held by the same Priority Access Licensee to different channels, so that geographical contiguity is temporarily not maintained, to the extent necessary to protect Incumbent Users or if necessary to perform its required functions under subpart F.

(2) *Channels*: Each PAL consists of a 10 megahertz channel within the frequency range set forth in section 96.11. Channels must be assigned by the SAS. Priority Access Licensees may request a particular channel or frequency range from the SAS but will not be guaranteed a particular assignment.

(i) *Contiguous Channels*: An SAS must assign multiple channels held by the same Priority Access Licensee to contiguous channels in the same License Area, to the extent feasible. The SAS may temporarily reassign individual PALs to non-contiguous channels to the extent necessary to protect Incumbent Users or if necessary to perform its required functions under subpart F.

(3) *License Term*: Each PAL has a three-year license term. Each PAL must automatically terminate at the end of its three-year term and may not be renewed. However, Priority Access Licensees may reapply for subsequent authorizations in the same License Area, subject to the limitations set forth in section 96.27. Priority Access Licensees may hold consecutive PALs up to the maximum number set forth in section 96.27.

(c) Unused PAL channels shall be made available for assignment by the SAS for General Authorized Access use.

96.27 – Application Window

(a) Applications for PALs will be accepted every three years, or at such other times with respect to PALs not previously licensed as determined by the Wireless Telecommunications Bureau in accordance with these rules. The application window and application process will be announced via Public Notice.

(b) The Wireless Telecommunications Bureau must make up to two consecutive three-year terms for any given PAL available during the first application window. During subsequent application windows, the Wireless Telecommunications Bureau shall make only one three-year license term available for any given PAL.

96.29 – Competitive Bidding Procedures

(a) Mutually exclusive initial applications for a Priority Access License are subject to competitive bidding. The general competitive bidding procedures set forth in part 1, subpart Q of this chapter will apply unless otherwise provided in this subpart.

(b) Applications for Priority Access Licenses are mutually exclusive when they seek in total more PALs in a particular geographic area than the number of PALs available in that geographic area.

(c) When there are two or more accepted applications for PALs in a given License Area for a specific auction, the Commission will make available for assignment one less PAL than the total number of PALs in that License Area for which all applicants have applied, up to a maximum of seven.

(d) When there is only one application for initial Priority Access Licenses in a License Area that is accepted for filing for a specific auction, no PAL will be assigned for that License Area, the auction with respect to that License Area will be canceled, and the spectrum will remain accessible solely for shared GAA use until the next filing window for competitive bidding of PALs.

96.31 – Aggregation of Priority Access Licenses

Priority Access Licensees may aggregate up to four PAL channels in any License Area at any given time.

Subpart D - GENERAL AUTHORIZED ACCESS

96.33 – Authorization

(a) Any party meeting the requirements set forth in section 96.5 is eligible to operate a CBSD on a General Authorized Access basis.

(b) CBSDs used for General Authorized Access must register with the SAS and comply with its instructions.

96.35 – General Authorized Access Use

(a) General Authorized Access Users shall be permitted to use frequencies assigned to PALs when such frequencies are not in use, as determined by the SAS.

(b) Frequencies that are available for General Authorized Access Use shall be made available on a shared basis.

(c) General Authorized Access Users shall have no expectation of interference protection from other General Authorized Access Users operating in accordance with this part.

(d) General Authorized Access Users must not cause harmful interference to and must accept interference from Priority Access Licensees and Incumbent Users in accordance with this part.

(e) General Authorized Access Users operating Category B CBSDs must make every effort to cooperate in the selection and use of available frequencies provided by an SAS to minimize the potential for interference and make the most effective use of the authorized facilities. Such users shall coordinate with an SAS before seeking station authorization, and make every effort to ensure that their CBSDs operate at a location, and with technical parameters, that will minimize the potential to cause and receive interference among CBSDs. Operators of CBSDs suffering from or causing harmful interference are expected to cooperate and resolve interference problems through technological solutions or by other mutually satisfactory arrangements.

Subpart E - TECHNICAL RULES

96.39 Citizens Broadband Radio Service Device (CBSD) General Requirements

This section applies to all CBSDs. Additional rules applicable only to Category A or Category B CBSDs are set forth in sections 96.43 and 96.45.

(a) *Geo-location and Reporting Capability:*

(1) All CBSDs must be able to determine their geographic coordinates (referenced to the North American Datum of 1983 (NAD83)) to an accuracy of ± 50 meters horizontal and ± 3 meters of elevation. Such geographic coordinates shall be reported to an SAS at the time of first activation from a power-off condition.

(2) For professionally installed CBSDs, geographic coordinates to the same accuracy specified in section 96.39(a)(1) may be determined and reported to the SAS as part of the installation and registration process. Geographic coordinates must be determined and reported each time the CBSD is moved to a new location.

(3) A non-professionally installed CBSD must check its location and report to the SAS any location changes exceeding 50 meters horizontal and ± 3 meters elevation from its last reported location within 60 seconds of such location change.

(b) *Operability:* All CBSDs must be capable of two-way operation on any authorized frequency assigned by an SAS. Equipment deployed by Grandfathered Wireless Broadband Licensees during their license term will be exempt from this requirement.

(c) *Registration with SAS:* A CBSD must register with and be authorized by an SAS prior to its initial service transmission. The CBSD must provide the SAS upon its registration with its geographic location, antenna height above ground level (in meters), CBSD class (Category A/Category B), requested authorization status (Priority Access or General Authorized Access), FCC identification number, call sign, user contact information, air interface technology, unique manufacturer's serial number, sensing capabilities (if supported), and additional information on its deployment profile required by sections 96.43 and 96.45. If any of this information changes, the CBSD shall update the SAS within 60 seconds of such change, except as otherwise set forth in this section. All information provided by the CBSD to the SAS must be true, complete, correct, and made in good faith.

(1) A CBSD must operate at or below the maximum power level authorized by an SAS, consistent with its FCC equipment authorization, and within geographic areas permitted by an SAS on the channels or frequencies authorized by an SAS.

(2) A CBSD must receive and comply with any incoming commands from its associated SAS about any changes to power limits and frequency assignments. A CBSD must cease transmission, move to another frequency range, or change its power level within 60 seconds as instructed by an SAS.

(d) *Signal Level Reporting:* A CBSD must report to an SAS regarding received signal strength in its occupied frequencies and adjacent frequencies, received packet error rates or other common standard metrics of interference for itself and associated End User Devices as directed by an SAS.

(e) If directed by the SAS, a CBSD that receives a range of available frequencies or channels from an SAS must promptly report to the SAS which of the available channels or frequencies it will utilize.

(f) *Security:* CBSDs shall incorporate security measures sufficient to ensure that they are capable of communicating only with SASs operated by approved SAS Administrators, and that communications between CBSDs and SASs, between individual CBSDs, and between CBSDs and End User Devices are secure to prevent corruption or unauthorized interception of data.

(1) For purposes of obtaining operational limits and frequency availabilities and their updates, CBSDs shall only contact SASs operated by SAS Administrators approved by the Commission in accordance with subpart F.

(2) All communications between CBSDs and SASs must be transmitted using secure methods that protect the systems from corruption or unauthorized modification of the data.

(3) Communications between a CBSD and its associated End User Devices for purposes of obtaining operational power, location, and frequency assignments shall employ secure methods that protect the system from corruption or unauthorized modification of the data.

(g) *Device Security*: All CBSDs and End User Devices must contain security features sufficient to protect against modification of software and firmware by unauthorized parties. Applications for certification of CBSDs and End User Devices must include an operational description of the technologies and measures that are incorporated in the device to comply with the security requirements of this section. In addition, applications for certification of CBSDs and End User Devices must identify at least one of the SAS databases operated by an approved SAS Administrator that the device will access for channel/frequency availability and affirm that the device will conform to the communications security methods used by such databases.

(h) Airborne operations by CBSDs and End User Devices are prohibited.

96.41 – General Radio Requirements

The requirements in this section apply to CBSDs and their associated End User Devices, unless otherwise specified.

(a) *Digital Modulation*: Systems operating in the Citizens Broadband Radio Service must use digital modulation techniques.

(b) *Conducted and Emitted Power Limits*: Unless otherwise specified in this subsection, the maximum conducted output power, maximum transmit antenna gain, maximum EIRP, and maximum Power Spectral Density (PSD) of any CBSD and End User Device must comply with the limits shown in the table below:

Device	Geographic Area	Maximum Conducted Output Power (dBm/10 megahertz)**	Maximum EIRP (dBm/10 megahertz)	Maximum Conducted PSD (dBm/MHz)
End User Device	All	n/a	23	n/a
Category A CBSD	All	24	30	14
Category B CBSD*	Non-Rural	24	40	14
Category B CBSD*	Rural	30	47	20

* Category B CBSDs will only be authorized for use after an ESC is approved and commercially deployed consistent with sections 96.15 and 96.67.

(c) *Power Management*: CBSDs and End User Devices shall limit their operating power to the minimum necessary for successful operations.

(1) CBSDs must support transmit power control capability and the capability to limit their maximum EIRP and the maximum EIRP of associated End User Devices in response to instructions from an SAS.

(2) End User Devices shall include transmit power control capability and the capability to limit their maximum EIRP in response to instructions from their associated CBSDs.

(d) *Received Signal Strength Limits:*

(1) For both Priority Access and GAA users, CBSD transmissions must be managed such that the aggregate received signal strength, measured at any location on the Service Area boundary of any co-channel PAL, shall not exceed an average (rms) power level of -80 dBm in any direction when integrated over a 10 megahertz reference bandwidth, with the measurement antenna placed at a height of 1.5 meters above ground level, unless the affected PAL licensees agree to an alternative limit and communicate that to the SAS.

(2) These limits shall not apply for co-channel operations at the boundary between geographically adjacent PALs held by the same Priority Access Licensee.

(e) *3.5 GHz Emissions and Interference Limits:*

(1) *General protection levels.* Except as otherwise specified below, for channel and frequency assignments made by the SAS to CBSDs, the power of any emission outside the fundamental emission (whether in or outside of the authorized band) shall not exceed -13 dBm/MHz within 0-10 megahertz above the upper SAS-assigned channel edge and within 0-10 megahertz below the lower SAS-assigned channel edge. At all frequencies greater than 10 megahertz above the upper SAS assigned channel edge and less than 10 MHz below the lower SAS assigned channel edge, the power of any emission shall not exceed -25 dBm/MHz. The upper and lower SAS assigned channel edges are the upper and lower limits of any channel assigned to a CBSD by an SAS, or in the case of multiple contiguous channels, the upper and lower limits of the combined contiguous channels.

(2) *Additional protection levels.* Notwithstanding paragraph (d)(1) of this section, the power of any emissions below 3530 MHz or above 3720 MHz shall not exceed -40dBm/MHz.

(3) *Measurement procedure:*

(i) Compliance with this provision is based on the use of measurement instrumentation employing a resolution bandwidth of 1 megahertz or greater. However, in the 1 megahertz bands immediately outside and adjacent to the licensee's authorized frequency channel, a resolution bandwidth of no less than one percent of the fundamental emission bandwidth may be employed. A narrower resolution bandwidth is permitted in all cases to improve measurement accuracy provided the measured power is integrated over the full reference bandwidth (*i.e.*, 1 MHz or 1 percent of emission bandwidth, as specified). The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power.

(ii) When measuring unwanted emissions to demonstrate compliance with the limits, the CBSD and End User Device nominal carrier frequency/channel shall be adjusted as close to the licensee's authorized frequency block edges, both upper and lower, as the design permits.

(iii) Emission power measurements shall be performed with the CBSD and End User Devices operating at their maximum EIRP levels.

(iv) Emission power measurements shall be performed with a peak detector in maximum hold.

(4) When an emission outside of the authorized bandwidth causes harmful interference, the Commission may, at its discretion, require greater attenuation than specified in this section.

(f) *Reception Limits*: Priority Access Licensees must accept adjacent channel and in-band blocking interference (emissions from other authorized Priority Access or GAA CBSDs transmitting between 3550 and 3700 MHz) up to a power spectral density level not to exceed -40 dBm in any direction with greater than 99% probability when integrated over a 10 megahertz reference bandwidth, with the measurement antenna placed at a height of 1.5 meters above ground level, unless the affected Priority Access Licensees agree to an alternative limit and communicates that to the SAS.

Note to paragraph (f): Citizens Broadband Radio Service users should be aware that there are Federal Government radar systems in the band and adjacent bands that could adversely affect their operations.

96.43 – Additional Requirements for Category A CBSDs

(a) Category A CBSDs shall not be deployed or operated outdoors with antennas exceeding 6 meters height above average terrain. CBSDs deployed or operated outdoors with antennas exceeding 6 meters height above average terrain will be classified as, and subject to, the operational requirements of Category B CBSDs.

(b) When registering with an SAS, Category A CBSDs must transmit all information required under section 96.39. This transmission shall also indicate whether the device will be operated indoors or outdoors.

(c) Any CBSD operated at higher power than specified for Category A CBSDs in section 96.41 will be classified as, and subject to, the operational requirements of a Category B CBSD.

96.45 - Additional Requirements for Category B CBSDs

(a) Category B CBSDs must be professionally installed.

(b) In the 3550-3650 MHz band, Category B CBSDs must be authorized consistent with information received from an ESC, as described in section 96.15.

(c) Category B CBSDs are limited to outdoor operations.

(d) When registering with an SAS, Category B CBSDs must transmit all information required under section 96.39 plus the following additional information: antenna gain, beamwidth, azimuth, downtilt angle, and antenna height above ground level.

96.47 - End User Device Additional Requirements

(a) End User Devices may operate only if they can positively receive and decode an authorization signal transmitted by a CBSD, including the frequencies and power limits for their operation.

(1) An End User Device must discontinue operations, change frequencies, or change its operational power level within 10 seconds of receiving instructions from its associated CBSD.

(b) Any device operated at higher power than specified for End User Devices in section 96.41 will be classified as, and subject to, the operational requirements of a CBSD.

96.49 – Equipment Authorization

(a) Each transmitter used for operation under this part and each transmitter marketed as set forth in section 2.803 of this chapter must be of a type which has been certificated for use under this part.

(b) Any manufacturer of radio transmitting equipment to be used in these services must request equipment authorization following the procedures set forth in subpart J of part 2 of this chapter.

96.51 – RF Safety

Licenseses and manufacturers are subject to the radio frequency radiation exposure requirements specified in sections 1.1307(b), 1.1310, 2.1091, and 2.1093 of this chapter, as appropriate. Applications for equipment authorization of Mobile or Portable devices operating under this section must contain a statement confirming compliance with these requirements for both fundamental emissions and unwanted emissions and technical information showing the basis for this statement must be submitted to the Commission upon request.

Subpart F – SPECTRUM ACCESS SYSTEM

96.53 – Spectrum Access System Purposes and Functionality

The purposes of the SAS include:

- (a) To enact and enforce all policies and procedures developed by the SAS Administrator pursuant to section 96.63.
- (b) To determine and provide to CBSDs the permissible channels or frequencies at their location.
- (c) To determine and provide to CBSDs the maximum permissible transmission power level at their location.
- (d) To register and authenticate the identification information and location of CBSDs.
- (e) To retain information on, and enforce, Exclusion Zones and Protection Zones in accordance with sections 96.15 and 96.17.
- (f) To communicate with the ESC to obtain information about federal Incumbent User transmissions and instruct CBSDs to move to another frequency range or cease transmissions.
- (g) To ensure that CBSDs operate in geographic areas and within the maximum power levels required to protect federal Incumbent Users from harmful interference, consistent with the requirements of sections 96.15 and 96.21.
- (h) To ensure that CBSDs protect non-federal Incumbent Users from harmful interference, consistent with the requirements of section 96.17 and 96.21.
- (i) To protect Priority Access Licensees from interference caused by other PALs and from General Authorized Access Users consistent with section 96.25.
- (j) To facilitate coordination between GAA users operating Category B CBSDs, consistent with section 96.35.
- (k) To resolve conflicting uses of the band while maintaining, as much as possible, a stable radio frequency environment.

(l) To ensure secure and reliable transmission of information between the SAS and CBSDs.

(m) To protect Grandfathered Wireless Broadband Licensees consistent with section 90.1307, 90.1338, and 96.21.

(n) To implement the terms of current and future international agreements as they relate to the Citizens Broadband Radio Service.

96.55 - Information Gathering and Retention

(a) The SAS shall maintain current information on registered CBSDs, the geographic locations and configuration of protected FSS locations as set forth in section 96.17, and the federal Incumbent User Exclusion Zones and Protection Zones.

(1) For registered CBSDs, such information shall include all information required by section 96.39 and 96.45.

(2) SAS Administrators must make all information necessary to effectively coordinate operations between and among CBSDs available to other SAS Administrators.

(3) SAS Administrators must make CBSD registration information available to the general public, but they must obfuscate the identities of the licensees providing the information for any public disclosures.

(4) For non-federal Incumbent Users, the SAS shall maintain a record of the location of protected earth stations as well as the all registration information required by section 96.17.

(b) The SAS shall maintain records not pertaining to federal Incumbent User transmissions for at least 60 months.

(c) The SAS shall only retain records of information or instructions received regarding federal Incumbent User transmissions from the ESC in accordance with information retention policies established as part of the ESC approval process.

(d) The SAS shall be technically capable of directly interfacing with any necessary FCC database containing information required for the proper operation of an SAS.

(e) The SAS shall process and retain acknowledgements by all entities registering CBSDs that they understand the risk of possible interference from federal Incumbent User radar operations in the band.

96.57 – Registration, Authentication, and Authorization of Citizens Broadband Radio Service Devices

(a) An SAS must register, authenticate, and authorize operations of CBSDs consistent with this rule part.

(b) CBSDs composed of a network of base and fixed stations may employ a subsystem for aggregating and communicating all required information exchanges between the SAS and CBSDs.

(c) An SAS must also verify that the FCC identifier (FCC ID) of any CBSD seeking access to its services is valid prior to authorizing it to begin providing service. A list of devices with valid FCC IDs and the FCC IDs of those devices is to be obtained from the Commission's Equipment Authorization System.

(d) An SAS must not authorize operation of CBSDs within Protection Zones except as set forth in section 96.15.

96.59 - Frequency Assignment

(a) An SAS must determine the available and appropriate channels/frequencies for CBSDs at any given location using the information supplied by CBSDs, including location, the authorization status and operating parameters of other CBSDs in the surrounding area, information communicated by the ESC, other SASs, and such other information necessary to ensure effective operations of CBSDs consistent with this part. All such determinations and assignments shall be made in a non-discriminatory manner, consistent with this part.

(1) Upon request from the Commission or a CBSD, an SAS must confirm whether frequencies are available in a given geographic area.

(2) Upon request from the Commission, an SAS must confirm that CBSDs in a given geographic area and frequency band have been shut down or moved to another available frequency range in response to information received from the ESC.

(3) If an SAS provides a range of available frequencies or channels to a CBSD, it may require that CBSD to confirm which channel or range of frequencies it will utilize.

(b) Consistent with the requirements of 96.25, an SAS shall assign geographically contiguous PALs held by the same Priority Access Licensee to the same channels in each geographic area, where feasible. The SAS shall also assign multiple channels held by the same Priority Access Licensee to contiguous frequencies within the same License Area, where feasible.

(c) An SAS may temporarily assign PALs to different channels (within the frequency range authorized for Priority Access use) to protect Incumbent Access Users or if necessary to perform its required functions.

96.61 – Security

(a) An SAS must employ protocols and procedures to ensure that all communications and interactions between the SAS and CBSDs are accurate and secure and that unauthorized parties cannot access or alter the SAS or the information it sends to a CBSD.

(b) Communications between CBSDs and an SAS, between an ESC and an SAS, between individual CBSDs, and between different SASs, must be secure to prevent corruption or unauthorized interception of data. An SAS must be protected from unauthorized data input or alteration of stored data.

(c) An SAS must verify that the FCC identification number supplied by a CBSD is for a certified device and must not provide service to an uncertified device.

96.63 – Spectrum Access System Administrators

The Commission will designate one or more SAS Administrators to provide nationwide service. The Commission may, at its discretion, permit the functions of an SAS, such as a data repository, registration, and query services, to be divided among multiple entities; however, it shall designate one or more specific entities to be an SAS Administrator responsible for coordinating the overall functioning of an SAS and providing services to operators in the Citizens Broadband Radio Service. Each SAS Administrator designated by the Commission must:

(a) Maintain a regularly updated database that contains the information described in section 96.55.

(b) Establish a process for acquiring and storing in the database necessary and appropriate information from the Commission's databases, including PAL assignments, and synchronizing the database with the current Commission databases at least once a day to include newly licensed facilities or any changes to licensed facilities.

(c) Establish and follow protocols and procedures to ensure compliance with the rules set forth in this part, including the SAS functions set forth in section 96.53, *et seq.*

(d) Establish and follow protocols and procedures sufficient to ensure that all communications and interactions between the SAS, ESC, and CBSDs are accurate and secure and that unauthorized parties cannot access or alter the SAS or the information transmitted from the SAS to CBSDs.

(e) Provide service for a five-year term. This term may be renewed at the Commission's discretion.

(f) Respond in a timely manner to verify, correct or remove, as appropriate, data in the event that the Commission or a party brings a claim of inaccuracies in the SAS to its attention. This requirement applies only to information that the Commission requires to be stored in the SAS.

(g) Securely transfer the information in the SAS, along with the IP addresses and URLs used to access the system, and a list of registered CBSDs, to another approved entity in the event it does not continue as the SAS Administrator at the end of its term. It may charge a reasonable price for such conveyance.

(h) Cooperate to develop a standardized process for coordinating operations with other SASs, avoiding any conflicting assignments, maximizing shared use of available frequencies, ensuring continuity of service to all registered CBSDs, and providing the data collected pursuant to section 96.55.

(i) Coordinate with other SAS Administrators including, to the extent possible, sharing information, facilitating non-interfering use by CBSDs connected to other SASs, maximizing available General Authorized Access frequencies by assigning PALs to similar channels in the same geographic regions, and other functions necessary to ensure that available spectrum is used efficiently consistent with this part.

(j) Provide a means to make non-federal non-proprietary information available to the public in a reasonably accessible fashion in conformity with these rules.

(k) Ensure that the SAS shall be available at all times to immediately respond to requests from authorized Commission personnel for any and all information stored or retained by the SAS.

(l) Establish and follow protocols to respond to instructions from the President of the United States, or another designated Federal government entity, issued pursuant to 47 U.S.C. 606.

(m) Establish and follow protocols to comply with enforcement instructions from the Commission.

(n) Ensure that the SAS:

(1) operates without any connectivity to any military or other sensitive federal database or system, except as otherwise required by this part; and

(2) does not store, retain, transmit, or disclose operational information on the movement or position of any federal system or any information that reveals other operational information of any federal system that is not required by this part to effectively operate the SAS.

96.65 – Spectrum Access System Administrator Fees

(a) An SAS Administrator may charge Citizens Broadband Radio Service users a reasonable fee for provision of the services set forth in section 96.53, *et seq.*

(b) The Commission, upon request, will review the fees and can require changes to those fees if they are found to be unreasonable.

Subpart G – ENVIRONMENTAL SENSING CAPABILITY

96.67 – Environmental Sensing Capability

(a) The primary purpose of the ESC is to facilitate coexistence of Citizens Broadband Radio Service users with federal Incumbent Users through signal sensing. An ESC will be operated by a non-governmental entity and, except as set forth below, will not rely on governmental agencies to affirmatively communicate information about the operations of incumbent radio systems.

(b) An ESC may only operate after receiving approval by the Commission. Such approval shall be conditioned on meeting the requirements of this part and any other requirements imposed by the Commission. The Commission may revoke, modify, or condition ESC approval at its discretion.

(c) An ESC must meet the following requirements:

(1) Be managed and maintained by a non-governmental entity;

(2) Accurately detect the presence of a signal from a federal system in the 3550-3700 MHz band and adjacent frequencies using approved methodologies that ensure that any CBSDs operating pursuant to ESC will not cause harmful interference to federal Incumbent Users;

(3) Communicate information about the presence of a signal from a federal Incumbent User system to one or more approved SASs;

(4) Maintain security of detected and communicated signal information;

(5) Comply with all Commission rules and guidelines governing the construction, operation, and approval of ESCs;

(6) Ensure that the ESC shall be available at all times to immediately respond to requests from authorized Commission personnel for any information collected or communicated by the ESC; and

(7) Ensure that the ESC operates without any connectivity to any military or other sensitive federal database or system and does not store, retain, transmit, or disclose operational information on the movement or position of any federal system or any information that reveals other operational information of any federal system that is not required by this part to effectively operate the ESC.

(d) ESC equipment may be deployed in the vicinity of the Exclusion Zones and Protection Zones to accurately detect federal Incumbent User transmissions.

APPENDIX B

Final Regulatory Flexibility Analysis

1. As required by the Regulatory Flexibility Act of 1980, as amended (RFA), the Commission has prepared this Final Regulatory Flexibility Analysis (FRFA) of the possible significant economic impact on small entities by the policies and rules adopted in this *Report and Order (R&O)*. The Commission will send a copy of this *R&O*, including this FRFA, to the Chief Counsel for Advocacy of the Small Business Administration (SBA). In addition, the *R&O* and FRFA (or summaries thereof) will be published in the Federal Register.

2. As required by the RFA,¹ the Commission incorporated an Initial Regulatory Flexibility Analysis (IRFA) in the *Notice of Proposed Rulemaking and Order (NPRM)* and *Further Notice of Proposed Rulemaking (FNPRM)*. The Commission sought written public comment on the proposals in the *NPRM* and *FNPRM*, including comment on the IRFA. No comments were filed addressing the IRFA. This present FRFA conforms to the RFA.²

A. Need for, and Objectives of, the Rules

3. In the *R&O*, the Commission adopted rules for commercial use of 150 megahertz in the 3550-3700 MHz band (3.5 GHz Band). The 3.5 GHz Band is currently used for Department of Defense Radar services and commercial fixed Satellite Service (FSS) earth stations (space-to-earth). The creation of a new Citizens Broadband Radio Service in this band will add much-needed capacity to meet the ever-increasing demands of wireless innovation. As such, it represents a major contribution toward the Commission's goal of making 500 megahertz newly available for broadband use and will help to unleash broadband opportunities for consumers throughout the country, particularly in areas with overburdened spectrum resources.

4. The *R&O* also adopts a new approach to spectrum management, which makes use of advances in computing technology to facilitate more intensive spectrum sharing: between commercial and federal users and among multiple tiers of commercial users. This three-tiered sharing framework is enabled by a Spectrum Access System (SAS). The SAS incorporates a dynamic spectrum database and interference mitigation techniques to manage all three tiers of authorized users (Incumbent Access, Priority Access, and General Authorized Access (GAA)). The SAS thus serves as an advanced, highly automated frequency coordinator across the band – protecting higher tier users from those beneath and optimizing frequency use to allow maximum capacity and coexistence in the band.

5. Incumbent users represent the highest tier in the new 3.5 GHz framework and receive interference protection from Citizens Broadband Radio Service users. Protected incumbents include the federal operations described above, as well as FSS and, for a finite period, grandfathered terrestrial wireless operations in the 3650-3700 MHz portion of the band. The Citizens Broadband Radio Service itself consists of two tiers—Priority Access and GAA—both authorized in any given location and frequency by an SAS. As the name suggests, Priority Access operations receive protection from GAA operations. Priority Access Licenses, defined as an authorization to use a 10 megahertz channel in a single census tract for three years, will be assigned in up to 70 megahertz of the 3550-3650 MHz portion of the band. GAA will be allowed, by rule, throughout the 150 megahertz band. GAA users will receive no interference protection from other Citizens Broadband Radio Service users. In general, under this three-tiered licensing framework incumbent users would be able to operate on a fully protected basis,

¹ See 5 U.S.C. § 603. The RFA, see 5 U.S.C. § 601 – 612, has been amended by the Small Business Regulatory Enforcement Fairness Act of 1996 (“SBREFA”), Pub. L. No. 104-121, Title II, 110 Stat. 857 (1996).

² See 5 U.S.C. § 604.

while the technical benefits of small cells are leveraged to facilitate innovative and efficient uses in the 3.5 GHz Band.

6. As a result of the Commission's actions in the *R&O*, small business will have access to spectrum that is currently unavailable to them. The potential uses for this spectrum are vast. For example, wireless carriers can deploy small cells on a GAA basis where they need additional capacity. Real estate owners can deploy neutral host systems in high-traffic venues, allowing for cost-effective network sharing among multiple wireless providers and their customers. Manufacturers, utilities, and other large economic sectors, can construct private wireless broadband networks to automate industrial processes that require some measure of interference protection and yet are not appropriately outsourced to a commercial cellular network. All of these applications can potentially share common wireless technologies, providing economies of scale and facilitating intensive use of the spectrum. The Commission's actions in the *R&O* thus constitute a significant benefit for small businesses.

7. In the *R&O*, the Commission also adopted its supplemental proposal to integrate the 3650-3700 MHz band within the Citizens Broadband Radio Service, thereby encompassing an additional 50 megahertz of contiguous spectrum. The Commission currently licenses the 3650-3700 MHz band on a non-exclusive basis, with protections for incumbent FSS operations. Smart grid, rural broadband, small cell backhaul, and other point-to-multipoint networks will enjoy three times more bandwidth than was available under our previous 3650-3700 MHz band rules. The adoption of the supplemental proposal will promote spectrum efficiency and availability, as well as economies of scale for equipment across the full 150 MHz band.

B. Legal Basis

8. The actions are authorized under Sections 1, 2, 4(i), 4(j), 5(c), 302a, 303, 304, 307(e), and 316 of the Communications Act of 1934, as amended, 47 U.S.C. §§ 151, 152, 154(i), 154(j), 155(c), 302a, 303, 304, 307(e), and 316

C. Description and estimate of the number of small entities to which the rules will apply

9. The RFA directs agencies to provide a description of, and, where feasible, an estimate of the number of small entities that may be affected by the proposed rules and policies, if adopted.³ The RFA generally defines the term "small entity" as having the same meaning as the terms "small business," "small organization," and "small governmental jurisdiction."⁴ In addition, the term "small business" has the same meaning as the term "small business concern" under the Small Business Act.⁵ A "small business concern" is one which: (1) is independently owned and operated; (2) is not dominant in its field of operation; and (3) satisfies any additional criteria established by the SBA.⁶

10. *Small Businesses, Small Organizations, and Small Governmental Jurisdictions.* Our action may, over time, affect small entities that are not easily categorized at present. We therefore describe here, at the outset, three comprehensive, statutory small entity size standards that encompass entities that could be directly affected by the proposals under consideration.⁷ As of 2010, there were 27.9 million small

³ 5 U.S.C. § 603(b)(3).

⁴ *Id.* § 601(6).

⁵ *Id.* § 601(3) (incorporating by reference the definition of "small-business concern" in the Small Business Act, 15 U.S.C. § 632). Pursuant to 5 U.S.C. § 601(3), the statutory definition of a small business applies "unless an agency, after consultation with the Office of Advocacy of the Small Business Administration and after opportunity for public comment, establishes one or more definitions of such term which are appropriate to the activities of the agency and publishes such definition(s) in the Federal Register." *Id.*

⁶ 15 U.S.C. § 632.

⁷ *See* 5 U.S.C. § 601(3)–(6).

businesses in the United States, according to the SBA.⁸ Additionally, a “small organization” is generally “any not-for-profit enterprise which is independently owned and operated and is not dominant in its field.”⁹ Nationwide, as of 2007, there were approximately 1,621,315 small organizations.¹⁰ Finally, the term “small governmental jurisdiction” is defined generally as “governments of cities, counties, towns, townships, villages, school districts, or special districts, with a population of less than fifty thousand.”¹¹ Census Bureau data for 2007 indicate that there were 89,527 governmental jurisdictions in the United States.¹² We estimate that, of this total, as many as 88,761 entities may qualify as “small governmental jurisdictions.”¹³ Thus, we estimate that most governmental jurisdictions are small.

11. *Wireless Telecommunications Carriers (except satellite)*. This industry comprises establishments engaged in operating and maintaining switching and transmission facilities to provide communications via the airwaves. Establishments in this industry have spectrum licenses and provide services using that spectrum, such as cellular phone services, paging services, wireless Internet access, and wireless video services.¹⁴ The appropriate size standard under SBA rules is for the category Wireless Telecommunications Carriers. The size standard for that category is that a business is small if it has 1,500 or fewer employees.¹⁵ Census Bureau data for 2007, show that there were 1,383 firms in this category that operated for the entire year. Of this total, 1,368 had employment of 999 or fewer, and 15 firms had employment of 1,000 employees or more.¹⁶ Thus, under this category and the associated small business size standard, the Commission estimates that the majority of wireless telecommunications carriers (except satellite) are small entities that may be affected by our actions.

12. *Satellite Telecommunications and All Other Telecommunications*. Satellite telecommunications service providers include satellite and earth station operators. Since 2007, the SBA has recognized two census categories for satellite telecommunications firms: “Satellite Telecommunications” and “Other Telecommunications.” Under the “Satellite Telecommunications” category, a business is considered small if it had \$32.5 million or less in annual receipts.¹⁷ Under the

⁸ See Small Business Administration, Office of Advocacy, “Frequently Asked Questions,” available at http://www.sba.gov/sites/default/files/FAQ_Sept_2012.pdf (last visited Feb. 11, 2015).

⁹ 5 U.S.C. § 601(4).

¹⁰ INDEPENDENT SECTOR, THE NEW NONPROFIT ALMANAC & DESK REFERENCE (2010).

¹¹ 5 U.S.C. § 601(5).

¹² U.S. CENSUS BUREAU, STATISTICAL ABSTRACT OF THE UNITED STATES: 2011, Table 427 (2007).

¹³ The 2007 U.S. Census data for small governmental organizations are not presented based on the size of the population in each such organization. There were 89,476 local governmental organizations in 2007. If we assume that county, municipal, township, and school district organizations are more likely than larger governmental organizations to have populations of 50,000 or less, the total of these organizations is 52,095. As a basis of estimating how many of these 89,476 local government organizations were small, in 2011, there were a total of 715 cities and towns (incorporated places and minor civil divisions) with populations over 50,000. CITY AND TOWNS TOTALS: VINTAGE 2011 – U.S. Census Bureau, available at <http://www.census.gov/popest/data/cities/totals/2011/index.html>. If we subtract the 715 cities and towns that meet or exceed the 50,000 population threshold, we conclude that approximately 88,761 are small. U.S. CENSUS BUREAU, STATISTICAL ABSTRACT OF THE UNITED STATES 2011, Tables 427, 426 (Data cited therein are from 2007).

¹⁴ <http://www.census.gov/cgi-bin/sssd/naics/naicsrch?code=517210&search=2007%20NAICS%20Search>.

¹⁵ 13 C.F.R. § 121.201, NAICS code 517210.

¹⁶ See http://factfinder2.census.gov/bkmk/table/1.0/en/ECN/2007_US/51SSSZ5//naics~517210

¹⁷ See 13 C.F.R. § 121.201, NAICS code 517410.

“Other Telecommunications” category, a business is considered small if it had \$32.5 million or less in annual receipts.¹⁸

13. The first category of Satellite Telecommunications “comprises establishments primarily engaged in providing point-to-point telecommunications services to other establishments in the telecommunications and broadcasting industries by forwarding and receiving communications signals via a system of satellites or reselling satellite telecommunications.”¹⁹ For this category, Census Bureau data for 2007 show that there were a total of 512 satellite communications firms that operated for the entire year.²⁰ Of this total, 482 firms had annual receipts of under \$25 million.²¹

14. The second category of Other Telecommunications is comprised of entities “primarily engaged in providing specialized telecommunications services, such as satellite tracking, communications telemetry, and radar station operation. This industry also includes establishments primarily engaged in providing satellite terminal stations and associated facilities connected with one or more terrestrial systems and capable of transmitting telecommunications to, and receiving telecommunications from, satellite systems. Establishments providing Internet services or voice over Internet protocol (VoIP) services via client-supplied telecommunications connections are also included in this industry.”²² For this category, Census Bureau data for 2007 show that there were a total of 2,383 firms that operated for the entire year.²³ Of this total, 2,346 firms had annual receipts of under \$25 million.²⁴ We anticipate that some of these “Other Telecommunications firms,” which are small entities, are earth station applicants/licenseses that might be affected by our rule changes.

15. While, our rule changes may have an impact on earth and space station applicants and licensees, space station applicants and licensees rarely qualify under the definition of a small entity. Generally, space stations cost hundreds of millions of dollars to construct, launch and operate. Consequently, we do not anticipate that any space station operators are small entities that would be affected by our actions.

16. *Radio and Television Broadcasting and Wireless Communications Equipment Manufacturing.* The Census Bureau defines this category as follows: “This industry comprises establishments primarily engaged in manufacturing radio and television broadcast and wireless communications equipment. Examples of products made by these establishments are: transmitting and receiving antennas, cable television equipment, GPS equipment, pagers, cellular phones, mobile communications equipment, and radio and television studio and broadcasting equipment.”²⁵ The SBA has developed a small business size standard for firms in this category, which is: all such firms having 750 or fewer employees.²⁶ According to Census Bureau data for 2010, there were a total of 810 establishments

¹⁸ See 13 C.F.R. § 121.201, NAICS code 517919.

¹⁹ U.S. Census Bureau, 2007 NAICS Definitions, “517410 Satellite Telecommunications.”

²⁰ See http://factfinder.census.gov/servlet/IBQTable?_bm=y&-geo_id=&-_skip=900&-ds_name=EC0751SSSZ4&-_lang=en.

²¹ *Id.*

²² U.S. Census Bureau, 2007 NAICS Definitions, “517919 Other Telecommunications”, <http://www.census.gov/naics/2007/def/ND517919.HTM>.

²³ See 13 C.F.R. § 121.201, NAICS code 517919.

²⁴ U.S. Census Bureau, 2007 Economic Census, Subject Series: Information, Table 5, “Establishment and Firm Size: Employment Size of Firms for the United States: 2007 NAICS Code 517919” (issued Nov. 2010).

²⁵ U.S. Census Bureau, 2007 NAICS Definitions, “334220 Radio and Television Broadcasting and Wireless Communications Equipment Manufacturing”; <http://www.census.gov/naics/2007/def/ND334220.HTM#N334220..>

²⁶ 13 C.F.R. § 121.201, NAICS code 334220.

in this category that operated for the entire year.²⁷ Of this total, 787 had employment of under 500, and an additional 23 had employment of 500 to 999.²⁸ Thus, under this size standard, the majority of firms can be considered small.

17. *3650-3700 MHz Band Licensees.* In March 2005, the Commission released an order providing for the nationwide, non-exclusive licensing of terrestrial operations, utilizing contention-based technologies, in the 3650 MHz band (*i.e.*, 3650–3700 MHz). As of April 2010, more than 1270 licenses have been granted and more than 7433 sites have been registered. The Commission has not developed a definition of small entities applicable to 3650–3700 MHz band nationwide, non-exclusive licensees. However, we estimate that the majority of these licensees are Internet Access Service Providers (ISPs) and that most of those licensees are small businesses.

D. Description of Projected Reporting, Recordkeeping, and Other Compliance Requirements for Small Entities

18. Under the new rules, Citizens Broadband Radio Services Devices (CBSDs) must comply with technical and operational requirements aimed at preventing interference to Incumbent Access and Priority Access users, including: complying with technical parameters (*e.g.*, power and unwanted emissions limits) and specific deployment conditions; reporting location information to an SAS as part of initial registration by a professional installer; having the ability to operate across all frequencies from 3550-3700 MHz; having the ability to measure and report on their local interference levels; and incorporating security features to protect against modification of software and firmware by unauthorized parties, and to protect communication data that are exchanged between CBSDs and End User Devices. Under the new rules, End User Devices must operate under the power and control of an SAS-authorized CBSD and contain security features to protect against modification of software and firmware by unauthorized parties. The new rules require Citizens Broadband Radio Service users to meet certain qualification requirements, designate whether they will provide service on a common carrier or non-common carrier basis, and register their devices with an SAS.

19. In the *R&O*, the Commission adopted a number of measures to protect Incumbent operators. To protect incumbent federal users, the Commission established Exclusion Zones and Protection Zones to ensure compatibility between Federal Incumbent Users and Citizens Broadband Radio Service users. In addition, Fixed Satellite Service Earth Stations in the 3600-3650 MHz Band and the 3700-4200 MHz Band will be afforded protection from harmful interference from CBSDs under the new rules if they register with the Commission annually. Likewise, Grandfathered Wireless Broadband Providers in the 3650-3700 MHz Band must register their frequency usage with an SAS in order to receive protection from harmful interference during their grandfathered period.

20. In addition, the Commission adopted its supplemental proposal to incorporate the 3650-3700 MHz band into the Citizens Broadband Radio Service. Accordingly, small businesses operating in this band must transition from the current non-exclusive nationwide licensing approach to the Citizens Broadband Radio Service licensing framework. Recognizing that this transition would likely entail additional costs and administrative burdens, the Commission adopted enhanced protections for Grandfathered Wireless Broadband Providers in the 3650-3700 MHz Band. First, the Commission determined not to allow Priority Access use in the 3650-3700 MHz band segment; this means that this

²⁷ U.S. Census Bureau, American FactFinder, 2010 Economic Census, Industry Series, Industry Statistics by Employment Size, NAICS code 334220 (released June 26, 2012); <http://factfinder.census.gov>. The number of “establishments” is a less helpful indicator of small business prevalence in this context than would be the number of “firms” or “companies,” because the latter take into account the concept of common ownership or control. Any single physical location for an entity is an establishment, even though that location may be owned by a different establishment. Thus, the numbers given may reflect inflated numbers of businesses in this category, including the numbers of small businesses.

²⁸ *Id.* Eighteen establishments had employment of 1,000 or more.

portion of the band will continue to be licensed on a non-exclusive basis, and thus will continue to be available on a non-exclusive basis to former Part 90 incumbents. Second, the Commission adopted technical rules for Category B CBSDs, which will accommodate existing 3650-3700 MHz network deployments and, in fact, will increase technical flexibility in rural areas. Third, the Commission exempted equipment already deployed under preexisting Part 90, subpart Z rules from the band-wide operability requirement. This exemption will allow 3650-3700 MHz users to continue operating under the new 3.5 GHz Band rules, without need to retrofit or abandon their existing equipment. Fourth, defining a CBSD in a flexible way to encompass a *network* of base stations should allow legacy network equipment to interact with the SAS at relatively low cost, through the addition of a proxy controller device. The Commission believes that it has made necessary and appropriate rule accommodations to allow prior existing 3650-3700 MHz licensees to continue operations in the band under a framework that provides access to greater spectrum that may better meet their needs in the long run. To the extent that the Commission may have overlooked any technical obstacles to achieving this goal, Part 90 incumbents may avail themselves of the Commission's waiver process on a case-by-case basis.

21. While our proposals require small businesses to register with an SAS and comply with the rules established for the Citizens Broadband Radio Service, they will receive the ability to access spectrum that is currently unavailable to them. On balance, this would constitute a significant benefit for small business.

E. Steps taken to Minimize Significant Economic Impact on Small Entities, and Significant Alternatives Considered

22. The RFA requires an agency to describe any significant alternatives that it has considered in reaching its approach, which may include the following four alternatives (among others): (1) the establishment of differing compliance or reporting requirements or timetables that take into account the resources available to small entities; (2) the clarification, consolidation, or simplification of compliance or reporting requirements under the rule for small entities; (3) the use of performance, rather than design, standards; and (4) an exemption from coverage of the rule, or any part thereof, for small entities.²⁹

23. The reporting, recordkeeping, and other compliance requirements resulting from the *R&O* will apply to all entities in the same manner. The Commission believes that applying the same rules equally to all entities in this context promotes fairness. The Commission does not believe that the costs and/or administrative burdens associated with the rules will unduly burden small entities. The rules the Commission adopts should benefit small entities by giving them more information, more flexibility, and more options for gaining access to valuable wireless spectrum. Specifically, the hybrid framework adopted in the *R&O* leverages advances in computing technology and economics to select, automatically, the best approach based on local conditions. Where competitive rivalry for spectrum access is low, the General Authorized Access tier provides a low-cost mode of access, similar to unlicensed uses. Where rivalry is high, an auction resolves mutually exclusive applications in specific geographic areas for Priority Access Licenses. Finite-term licensing facilitates evolution of the band and an ever-changing mix of General Authorized Access and Priority Access bandwidth over time.

F. Federal Rules that May Duplicate, Overlap, or Conflict with the Final Rules

24. None.

G. Report to Congress

25. The Commission will send a copy of the *Report and Order and Second Further Notice of Proposed Rulemaking*, including the FRFA, in a report to Congress pursuant to the Congressional Review Act.³⁰ In addition, the Commission will send a copy the *Report and Order and Second Further Notice of*

²⁹ 5 U.S.C. § 604(a)(6).

³⁰ See 5 U.S.C. § 801(a)(1)(A). The Congressional Review Act is contained in Title II, § 251, of the CWAAA, see Pub. L. No. 104-121, Title II, § 251, 110 Stat. 868.

Proposed Rulemaking, including the FRFA, to the Chief Counsel for Advocacy of the Small Business Administration. A copy of this *Report and Order and Second Further Notice of Proposed Rulemaking* and FRFA (or summaries thereof) will be published in the Federal Register.³¹

³¹ See 5 U.S.C. § 604(b).

APPENDIX C

Initial Regulatory Flexibility Analysis

26. As required by the Regulatory Flexibility Act of 1980 (RFA),¹ the Commission prepared an Initial Regulatory Flexibility Analysis (IRFA) relating to the *NPRM* and *FNPRM*.² No parties filed comments responding to either the IRFA in the *NPRM* or the IRFA in the *FNPRM*. In addition, we incorporated a Final Regulatory Flexibility Analysis (FRFA) in the *Report and Order*. We seek comment on how the proposed rules set forth herein the *Second Further Notice of Proposed Rulemaking (Second FNPRM)* could affect the IRFA. These comments must be filed in accordance with the same filing deadlines as comments filed in response to the *Second FNPRM* as set forth on the first page of this document and have a separate and distinct heading designating them as responses to the IRFA.

27. Our previous IRFA in the *NPRM* set forth the need for and objectives of our proposed rules;³ the legal basis for the proposed action;⁴ a description and estimate of the number of small entities to which the proposed rules would apply;⁵ a description of projected reporting, recordkeeping, and other compliance requirements for small entities;⁶ steps taken to minimize the significant economic impact on small entities and significant alternatives considered;⁷ and a statement that there are no federal rules that may duplicate, overlap, or conflict with the proposed rules.⁸ Those descriptions remain unchanged by our *FNPRM*, except that we proposed unrestricted eligibility for Priority Access use of the 3.5 GHz Band. The IRFA in our *FNPRM* did, however, provide greater detail on some of the specific reporting, recordkeeping, and other compliance requirements on which we sought comment.⁹

28. These descriptions also remain unchanged by our *Second FNPRM*. The *Second FNPRM* seeks comment on how define to “use” of PAL frequencies in regard to the implementation of the “use-it-or-share it” rule. Specifically, we seek comment on three specific options to define “use”: an engineering definition relying on a technical criteria; an economic definition which would allow PAL licensees to acquire rights to exclude GAA access; and a hybrid approach. We also seek comment on the extent to which our existing secondary market rules might be modified for PALs in the 3.5 GHz Band. And finally, we seek comment on a variety of options for optimizing protections for FSS in the 3.5 GHz Band, both in-band protection for FSS in 3650-3700MHz and out-of-band protection for C-Band FSS.

¹ See 5 U.S.C. § 603. The RFA, see 5 U.S.C. § 601 *et seq.*, has been amended by the Small Business Regulatory Enforcement Fairness Act of 1996 (SBREFA), Pub. L. No. 104-121, Title II, 110 Stat. 857 (1996). The SBREFA was enacted as Title II of the Contract with America Advancement Act of 1996 (CWAAA).

² *3.5 GHz NPRM*, 27 FCC Rcd at 15649-15652, App. B ¶¶ 1-19; *3.5 GHz FNPRM*, 29 FCC Rcd 4273, ¶¶ 176-178.

³ *3.5 GHz NPRM*, 27 FCC Rcd at 15649, App. B ¶¶ 2-5; *3.5 GHz FNPRM*, 29 FCC Rcd 4273, ¶¶ 176-178.

⁴ *3.5 GHz NPRM*, 27 FCC Rcd at 15650, App. B ¶ 6.

⁵ *Id.* at 15650-51, App. B ¶¶ 7-12.

⁶ *Id.* at 15651, App. B ¶¶ 13-15.

⁷ *Id.* at 15652, App. B ¶¶ 16-18.

⁸ *Id.* at 15652, App. B ¶ 19.

⁹ *3.5 GHz FNPRM*, 29 FCC Rcd 4273, ¶ 178.

APPENDIX D**List of Commenters****NPRM Comments:**

4G Americas
Alcatel-Lucent
Allied Communications LLC
American Petroleum Institute (API)
Astrium Services Government, Inc.
AT&T Services, Inc. (AT&T)
Baron Services, Inc.
BLiNQ Networks, Inc. (BLiNQ)
Cambium Networks, Ltd.
Cantor Telecom Services L.P. (Cantor)
Competitive Carriers Association
Comsearch
Consumer Electronics Association (CEA)
Content Companies (Fox Entertainment Group, Inc., Time Warner Inc., Viacom Inc., and The Walt Disney Company)
CTIA-The Wireless Association (CTIA)
Daniel Devasirvatham. Wi-Plan Wireless consulting
Edison Electric Institute
EIBASS
Ericsson
Global TD-LTE Initiative
Google, Inc. (Google)
Great River Energy
Harris Corporation
IEEE 802 LMSC
IEEE Dynamic Spectrum Access Network Standard Committee
Information Technology Industry Council
InterDigital, Inc. (InterDigital)
Justin Tallon, CTVR- The Telecommunications Research Centre, Trinity College Dublin
KanOkla Communications, Inc.
Microsoft Corporation (Microsoft)
Mobile Future
Motorola Solutions, Inc. (Motorola Solutions)
National Association of Broadcasters
National Cable & Telecommunications Association (NCTA)
National Public Radio, Inc. (National Public Radio)
Neptuno Media, Inc. d/b/a Neptuno Networks (Neptuno Networks)
Nickolaus E. Leggett
Nokia Siemens Networks US LLC (NSN)
PCIA-The Wireless Infrastructure Association and The DAS Forum (PCIA and DAS)
Pierre de Vries, Silicon Flatirons Center for Law, Technology, and Entrepreneurship

Public Interest Spectrum Coalition (PISC)
Qualcomm Inc. (Qualcomm)
Rajant Corporation
Redline Communications Inc.
Salt river Project Agricultural Improvement and Power District
Satellite Industry Association (SIA)
Shared Spectrum Company
SITA
Spectrum Bridge, Inc.
Tarana Wireless, Inc.
Telecommunications Industry Association (TIA)
T-Mobile USA, Inc. (T-Mobile)
UK Broadband Limited (UK Broadband)
Utilities Telecom Council (UTC)
Utilities Telecom Council, Edison Electric Institute and National Rural Electric Cooperative (Utility Groups))
Vanu, Inc.
Whitespace Alliance
Wi-Fi Alliance
WiMAX Forum
Wireless Innovation Forum
Wireless Internet Service Providers Association (WISPA)
Xchange Telecom Corp.

NPRM Reply Comments:

4G Americas
American Petroleum Institute
AT&T Services Inc. (AT&T)
Baron Services, Inc.
BLiNQ Networks, Inc. (BLiNQ)
Content Interests (CBS Corporation, the National Association of Broadcaster, Fox Entertainment Group, Inc., Time Warner Inc., Viacom Inc., and The Walt Disney Company)
Exelon Corporation (Exelon)
Google Inc. (Google)
Harris Corporation
National Public Radio, Inc. (National Public Radio)
Neptuno Media, Inc. d/b/a Neptuno Networks (Neptuno Networks)
Nokia Siemens Networks (NSN)
PCIA - The Wireless Infrastructure Association and The DAS Forum (PCIA and DAS)
Pierre de Vries, Silicon Flatirons Center for Law, Technology, and Entrepreneurship
Public Interest Spectrum Coalition (PISC)
Qualcomm Incorporated (Qualcomm)
Rajant Corporation
Satellite Industry Association (SIA)
Shared Spectrum Company

Spectrum Bridge, Inc.
Telecommunications Industry Association (TIA)
T-Mobile USA, Inc. (T-Mobile)
Utilities Telecom Council (UTC)
Verizon and Verizon Wireless
Wireless Internet Service Providers Association (WISPA)
Xchange Telecom Corp.

Licensing PN Comments:

Alcatel-Lucent (Alcatel-Lucent)
AT&T Services, Inc. (AT&T)
BLiNQ Networks, Inc. (BLiNQ)
Cantor Telecom Services, L.P (Cantor)
CommScope
Consumer Electronics Association (CEA)
Ericsson
Federated Wireless, LLC
Google Inc. (Google)
KanOkla Communications, Inc.
IEEE Dynamic Spectrum Access Standards Committee
Microsoft Corporation (Microsoft)
Motorola Mobility LLC (Motorola Mobility)
Motorola Solutions, Inc. (Motorola Solutions)
National Public Radio, Inc. (National Public Radio)
Neptuno Media, Inc. d/b/a Neptuno Networks (Neptuno Networks)
Nokia Solutions and Networks US LLC (Nokia Solutions)
Open Technology Institute and Public Knowledge (OTI/PK)
PCIA-The Wireless Infrastructure Association & The HetNet Forum
Qualcomm Incorporated (Qualcomm)
Satellite Industry Association (SIA)
Shared Spectrum Company
Spectrum Bridge Inc
Telecommunications Industry Association (TIA)
Teri Mayhew Macon Public Library
T-Mobile USA, Inc. (T-Mobile)
Utilities Telecom Council (UTC)
Verizon and Verizon Wireless
WhiteSpace Alliance
Wireless Innovation Forum
Wireless Internet Service Providers Association (WISPA)

Licensing PN Reply Comments:

American Petroleum Institute (API)
AT&T Services, Inc. (AT&T)

BLiNQ Networks, Inc. (BLiNQ)
Blooston 3.65 GHz Coalition
CenterPoint Energy Houston Electric, LLC
Enterprise Wireless Alliance
Exelon Corporation (Exelon)
Federated Wireless, LLC (Federated Wireless)
Fixed Wireless Communications Coalition
Keep Enterprise Mobility Inc.
Microsoft Corporation (Microsoft)
Neptuno Media, Inc. d/b/a Neptuno Networks (Neptuno Networks)
Nokia Solutions and Networks US LLC (Nokia Solutions)
Oncor Electric Delivery Company (Oncor Electric Utility)
Open Technology Institute and Public Knowledge (OTI/PK)
PCIA - The Wireless Infrastructure Association & The HetNet Forum (PCIA and HetNet)
Pierre de Vries, Silicon Flatirons Center for Law, Technology, and Entrepreneurship
Qualcomm Incorporated (Qualcomm)
Satellite Industry Association (SIA)
Shared Spectrum Company
Telecommunications Industry Association (TIA)
The Wireless Internet Service Providers Association (WISPA)
Utilities Telecom Council (UTC)
Wi-Fi Alliance
William Lehr, Massachusetts Institute of Technology
WiMAX Forum
Xcel Energy Services Inc. (Xcel Energy)

FNRPM Comments:

4G Americas
Airspan Networks
Alcatel-Lucent
Ameren Services
American Petroleum Institute (API)
AT&T Services, Inc. (AT&T)
Baron Services, Inc.
BLiNQ Networks, Inc. (BLiNQ)
Blooston 3.65 GHz Coalition
Cantor Telecom Services L.P. (Cantor)
Cloud Alliance, LLC (Cloud Alliance)
Cohere Technologies
CTIA-The Wireless Association (CTIA)
Dynamic Spectrum Alliance, WhiteSpace Alliance, and Public Interest Spectrum Coalition
EchoStar Satellite Operating Company and Hughes Network Systems LLC
ENTELEC
Ericsson
Exelon Corporation (Exelon)
Federated Wireless, Inc. (Federated Wireless)

Google Inc. (Google)
Great River Energy
HKT Limited
Iberdrola USA
iconectiv
InterDigital, Inc. (Interdigital)
iPosi, Inc.
Marcus J. Lockard (Lockard & White)
Microsoft Corporation (Microsoft)
Mobile Future
Motorola Mobility LLC (Motorola Mobility)
Motorola Solutions, Inc. (Motorola Solutions)
National Cable & Telecommunications Association (NCTA)
National Public Radio, Inc. (National Public Radio)
Neptuno Media, Inc. d/b/a Neptuno Networks (Neptuno Networks)
NMS Enterprises LLC
Nokia Solutions and Networks US LLC (Nokia Solutions)
Oncor Electric Delivery Company LLC (Oncor Electric Utility)
Pierre de Vries, Silicon Flatirons Center for Law, Technology, and Entrepreneurship
Qualcomm Incorporated (Qualcomm)
Sacred Wind Communications Inc.
Salt River Project Agricultural Improvement and Power District
Satellite Industry Association (SIA)
Shared Spectrum Company
Shure Incorporated (Shure)
Siemens Industry Inc. (Siemens Industry)
Sony Electronics Inc. (Sony Electronics)
Southern Company Services, Inc.
Spectrum Bridge, Inc.
Sprint Corporation (Sprint)
Telecommunications Industry Association (TIA)
Telrad Networks
T-Mobile USA, Inc. (T-Mobile)
UK Broadband Limited (UK Broadband)
Utilities Telecom Council (UTC)
Verizon
Western WiMAX LLC
Whitespace Alliance
Wi-Fi Alliance
WiMax Forum
Wireless Innovation Forum
Wireless Internet Service Providers Association (WISPA)
xG Technology, Inc.

FNPRM Reply Comments:

American Petroleum Institute
AT&T Services, Inc. (AT&T)
BLiNQ Networks, Inc. (BLiNQ)
Blooston 3.65 GHz Coalition
CenterPoint Energy Houston Electric, LLC
Content Interests (CBS Corporation, the National Association of Broadcaster, Fox Entertainment Group, Inc., Time Warner Inc., Viacom Inc., and The Walt Disney Company)
Enterprise Wireless Alliance
Exelon Corporation (Exelon)
Federated Wireless, LLC (Federated Wireless)
Fixed Wireless Communications Coalition
Keep Enterprise Mobility Inc.
Microsoft Corporation (Microsoft)
Neptuno Media, Inc. d/b/a Neptuno Networks (Neptuno Networks)
Nokia Solutions and Networks US LLC (Nokia Solutions)
Oncor Electric Delivery Company (Oncor Electric Utility)
PCIA - The Wireless Infrastructure Association & The HetNet Forum (PCIA and HetNet)
Pierre de Vries, Silicon Flatirons Center for Law, Technology, and Entrepreneurship
Public Interest Spectrum Coalition (PISC)
Qualcomm Incorporated (Qualcomm)
Satellite Industry Association (SIA)
Shared Spectrum Company
Telecommunications Industry Association (TIA)
Utilities Telecom Council (UTC)
Verizon
Wi-Fi Alliance
William Lehr (Massachusetts Institute of Technology)
WiMAX Forum
Wireless Internet Service Providers Association (WISPA)
Xcel Energy Services Inc. (Xcel Energy)

**STATEMENT OF
CHAIRMAN TOM WHEELER**

Re: *Amendment of the Commission's Rule with Regard to Commercial Operations in the 3550-3650 MHz Band, Report and Order and Second Further Notice of Proposed Rulemaking*, GN Docket No. 12-354.

Today, we take a significant step forward in spectrum policy by creating a new Citizens Broadband Radio Service. This new service leverages innovative new sharing rules and technologies to create a 150 megahertz band of contiguous spectrum to help meet the Nation's wireless broadband needs. Of this amount, 100 megahertz was previously unavailable for commercial use. Both the President's Advisory Council on Science and Technology (PCAST) and the FCC's Technological Advisory Council, which I was honored to lead at the time, recommended that the Commission target the 3.5 GHz as an "innovation band." Building on what the Commission did under the leadership of Chairman Genachowski and Chairwoman Clyburn, we adopt final rules to do so today.

When looking back over the long history of spectrum policy the bedrock policy question hasn't changed: how do we best manage a scarce public resource?

Over time, the Commission has made fundamental advances in how it manages spectrum. We improved spectrum reuse by relying on frequency coordinators to maximize efficiencies. We implemented spectrum auctions, using a market mechanism to resolve who should have exclusive rights to use frequencies at a given location. We provided spectrum for unlicensed use – the sandbox where great innovations were born and now thrive. Today, we create a new three-tiered access scheme in the Citizens Broadband Radio Service that accommodates many users and use cases, and manages scarcity in several new ways.

First, we are leveraging advances in computing technology to rely on an innovative Spectrum Access System to automatically coordinate access to the band. It's the traditional frequency coordination role, but modernized using advanced technologies to maximize efficiency.

Second, we are using auctions to grant exclusionary interference protections only when the spectrum is actually scarce. Under our rules, anyone with a certified device can use the spectrum, sharing it with others. In areas where the spectrum is scarce, users can participate in an auction to seek a license to gain priority access to the band.

Third, in cooperation with our federal partners, we are creating a new way to share spectrum with federal users. By leveraging the Spectrum Access System and technologies to monitor and sense when a federal user is present, we can move toward true dynamic sharing of the band between federal and non-federal users.

This is another demonstration of the results of effective collaboration with our federal partners. When this spectrum was originally identified for potential federal-commercial sharing, significant exclusion zones around the coasts were anticipated. As we promised last spring, we have revisited this analysis. Commission staff spent almost a year providing analytical support to NTIA, the Department of Defense – particularly the Navy – and others to facilitate their proposal to reduce the exclusion zones.

This was a significant engineering undertaking, with positive results: the zones shrunk by 77 percent. And, perhaps more importantly, by leveraging advances in spectrum sensing technology, we have a path toward making those zones disappear completely and at relatively low cost.

In years to come, I think we will look back on the effort as a watershed in furthering a cooperative environment between the FCC and our federal counterparts, and pushing forward the state of the art in spectrum sharing.

I want to thank the NTIA, Department of Defense, and our staff for coming together to solve a difficult spectrum sharing problem, for now and for the future.

In the end, our new approach will provide significant economic benefits. It will improve wireless network capacity in areas with high demand like dense urban areas or stadiums. It will provide “mainstream” spectrum for high-value industrial sectors, such as energy, manufacturing, and healthcare, that otherwise had to rely on expensive, specialized equipment in very fragmented bands. And it will create a band of at least 80 megahertz open and available to all those that wish to experiment, innovate, and create new devices, services, and applications that we can’t even imagine yet.

This item is built on a foundation of previous Commission actions, including the work on white spaces in the TV spectrum and our Notice of Inquiry in 2010 asking what the Commission might do to support dynamic spectrum access. Without those efforts, we would not be where we are today.

Finally, a note about LTE-Unlicensed and LAA. While this issue is not at the core of this proceeding, it has been getting a lot of attention lately. We maintain our historical policy of technological neutrality in today’s item, but will continue to closely monitor standards bodies’ deliberations with respect to the use of LTE-U in the 3.5 GHz band, and in the 5 GHz band, in addition to potential pre-standards deployments. Various parties have already met with Commission staff to discuss the technical aspects of these technologies. In order to ensure that the public has a window into these discussions, I have directed the staff to draft a Public Notice within 30 days, opening a docket in which interested parties can file their perspectives.

Thank you to the Wireless Bureau, the Office of Engineering and Technology, and the International Bureau for your work on this item, which marks an important breakthrough in spectrum policy.

**STATEMENT OF
COMMISSIONER MIGNON L. CLYBURN**

Re: *Amendment of the Commission's Rule with Regard to Commercial Operations in the 3550-3650 MHz Band, Report and Order and Second Further Notice of Proposed Rulemaking*, GN Docket No. 12-354.

Today is a significant moment in spectrum policy because we adopt a number of important paradigm shifts in our approach to find more spectrum for commercial wireless services and promote more efficient use of this valuable resource. In the past, our primary strategy for finding more spectrum for commercial wireless services was through NTIA identifying bands that could be repurposed from federal use. This is an often costly, clunky, approach that, in many cases, took decades to accomplish. This model is not a sustainable one because spectrum is finite, and as consumer demand for wireless services grows exponentially, finding more bands to repurpose only becomes more difficult. Wireless consumers and forward looking entrepreneurs deserve a new approach to spectrum management that is as tech savvy and innovative as they are.

Spectrum sharing is one such new approach. Driven by technological advances such as databases and environmental sensing, as well as just good old fashioned willingness to cooperate, spectrum sharing has become more acceptable to both the wireless industry and federal agencies. We are seeing databases that allow TV White Space devices alongside broadcasters and medical body area networks sharing spectrum with aeronautical telemetry services. But the primary reason we can turn the page and adopt a spectrum policy that leads with sharing is because of the tremendous cooperation between staff leaders here, at the Department of Defense, and at NTIA. Their work has led to substantially shrinking the protection zones for federal operations. Those zones, in the 3.5 GHz band, were reduced by a whopping 77 percent and Larry Strickling of NTIA, Fred Moorefield of DOD, and Julie Knapp and John Leibovitz, of the FCC, deserve praise for their leadership in this effort.

Another notable paradigm shift is the move away from highly fragmented long term exclusive use licenses to shorter term Priority Access Licenses with a rule to use it or share it with General Authorized Access users. These new regulatory approaches will create enough certainty to fuel investment in equipment for the 3.5 GHz band and the new PAL license will have lower administrative costs and allow for micro-targeted network deployments. Service providers will have flexibility in designing networks to address unique challenges posed by rural and other areas, and by using a Spectrum Access System database to dynamically assign frequencies in the band for both PAL licenses and GAA users, there will be more efficient use of spectrum in heavily populated areas.

In prior items, I have expressed optimism that our proposed technical rules could lead to interoperability by all commercial entities who choose to use this band. But a development, late in the proceeding, concerns me. Parties have expressed interest in deploying a version of LTE-U/Licensed Assisted Access (LAA) technology and some commenters hoping to deploy Wi-Fi technology, claim a version of LAA is being developed, in the 5GHz band that lacks 3GPP standards. They also assert that protocols necessary to coexist with Wi-Fi devices do not exist. Requests to formally coordinate with the relevant industry standard setting bodies, they charge, have gone unanswered.

I remember all too well the significant problem with the lack of interoperability in the 700 MHz band that developed in the industry standard setting process after Auction No. 73. Considerable time and effort was necessary to repair that technical impediment resulting in spectrum remaining unused and investment being stranded. To guarantee that there is no "deja vu all over again," I would have preferred that we ask questions about the LTE-U/LAA standards development process in the Further Notice.

Cooperation is allowing us to vote for the landmark spectrum management policies we adopt, today, and we anticipate the spurring of even greater technical innovation and new business models. I caution, however, that we will not fully realize the benefits that the 3.5 GHz band holds unless there is a standard setting process that includes the cooperation of all relevant parties.

I thank Paul Powell for his presentation and the myriad members of the staff for their hard work on this item and their contributions throughout this proceeding.

**STATEMENT OF
COMMISSIONER JESSICA ROSENWORCEL**

Re: *Amendment of the Commission's Rule with Regard to Commercial Operations in the 3550-3650 MHz Band, Report and Order and Second Further Notice of Proposed Rulemaking*, GN Docket No. 12-354.

Today, we make history. We chart a new course for spectrum policy. That's because in the 3.5 GHz band we adopt a creative three-tiered model for spectrum sharing and management. This is a paradigm shift that paves the way for new services, new technologies, and more mobile broadband.

To be sure, our decision is chock-full of the small, complex technical details that only a spectrum geek could love. But this is big. With our work in the 3.5 GHz band, we leave behind the tired notion that we face a choice between licensed and unlicensed airwaves. That's because we create new spectrum licenses custom-built for small cell deployments and at the same time open up more spectrum for unlicensed services—the jet-fuel of wireless innovation. Even better, we do all of this while protecting those already in the band, including military applications that help keep us safe.

But today's success was not preordained. After all, when the National Telecommunications and Information Administration first identified the 3.5 GHz band as underused and suitable for sharing, the response was a collective shrug. Interest was not high because there were challenges presented by government users already in the band. To put it even more bluntly, when it came to making commercial use of 3.5 GHz, the consensus was this was a junk band. But instead of discarding this band as junk, we got creative and a result this spectrum is now fertile ground for innovative wireless uses.

If this story sounds familiar, that's because it is. Thirty years ago, we also had underused frequencies—at the time, they were in the 900 MHz, 2.4 GHz, and 5.8 GHz bands. These were airwaves that had been designated for industrial, scientific, and medical uses. But so little was happening in these airwaves, they were known in Washington as garbage bands. They were scraps of spectrum where a lot of experts concluded that the demand for wireless services would just be limited.

But the Commission refused to dismiss these bands as junk. Instead, it got creative. Rather than following the traditional route of providing licenses to allow single operators to control in these bands for specific purposes—it made them available to the public. As a result, three decades ago the first significant swaths of unlicensed spectrum were made available in these so-called garbage bands. Now a lot happened in the interim, including the development of a standard—802.11. But fast forward and you can see how this is the spectrum where Wi-Fi was born. Since then, Wi-Fi has become our on-ramp to the Internet. It has become a platform for wireless innovation. And unlicensed spectrum is now responsible for billions of dollars of economic activity every year.

They say history repeats itself. If that happens here, it would be a good thing. That's because in the 3.5 GHz band we are building on the success of past unlicensed spectrum policy and pushing it into the future. This is exciting. But of course, it is not without its challenges. We will need to closely monitor the development of new unlicensed air interfaces. To this end, I appreciate that the Chairman has committed to discussing these issues in an upcoming Public Notice. I support this approach—and hope that as we move forward we can be guided by three simple principles.

First, let's recognize that unlicensed spectrum and Wi-Fi is one of the great wireless success stories of the last thirty years. It's a story we want to continue.

Second, unlicensed spectrum should be open to anyone who plays by the rules. This was the principle that informed our earliest thinking about unlicensed spectrum—and it should continue to inform us today.

Third, existing users of unlicensed spectrum should be open to new innovation and at the same time, new entrants should respect existing users.

But back to the here and now. Thank you to the Wireless Telecommunications Bureau and Office of Engineering and Technology for your creative work in the 3.5 GHz band. If the future of unlicensed spectrum in this band is anything like the past—we can all look forward to new services, new technologies, and more mobile broadband.

**STATEMENT OF COMMISSIONER AJIT PAI
APPROVING IN PART AND CONCURRING IN PART**

Re: *Amendment of the Commission's Rule with Regard to Commercial Operations in the 3550-3650 MHz Band, Report and Order and Second Further Notice of Proposed Rulemaking*, GN Docket No. 12-354.

Finding a way to put the 3.5 GHz band to its highest and best use has long been a challenge. Federal incumbents occupy much of the band. They make little use of the spectrum across large parts of the country, but their operations nonetheless have precluded others from using it. That's not efficient, to say the least. So for years, we've been exploring ways to allow this spectrum to be deployed for the benefit of consumers.

After considering several outside-the-box ideas, we are moving forward with an experiment to see if we can make this spectrum more productive. Will it work? Have we struck a balance that will allow a variety of innovative uses to flourish? We will see. This *Order* leaves many important details and complex questions to be resolved, including whether technologies will develop that can manage the complicated and dynamic interference scenarios that will result from our approach. It therefore remains to be seen whether we can turn today's spectrum theory into a working reality. Moreover, exclusion zones still cover about 40% of the U.S. population, and we leave the door open for the introduction of new federal uses across the country, neither of which is ideal. Because I am concerned that some of these decisions might hinder the types of investments and deployments necessary for this experiment to succeed, I will be voting to approve in part and concur in part.

Notwithstanding my concerns, I am pleased with the substantial progress that's been made in this proceeding. I would like to thank my colleagues for their willingness to accommodate some of my suggestions. *First*, by removing the 20 MHz set-aside that favored certain interests, we give everyone equal opportunity to access this spectrum *and* reduce unnecessary complexity. *Second*, the *Order* now ensures that existing wireless Internet service providers can continue to deploy broadband to rural consumers rather than freezing them out during the transition to a new 3.5 GHz regime. *Third*, the *Order* provides somewhat greater incentives to invest in the band than were contained in the original draft. For example, instead of making licenses unavailable in many markets, the *Order* now provides that they will be available in every market where applicants express a demand. *Finally*, although the exclusion zones remain, the *Order* now has a mechanism in place that hopefully will help in converting them to protection zones—which means that 3.5 GHz devices could then be used within those zones. These are pro-consumer, pro-competitive steps that I'm glad we're taking.

It bears mentioning that it could be years before consumers see the benefits of this rulemaking. In the meantime, we must redouble our efforts to free up additional spectrum for immediate consumer use—and the obvious place to look is the 5 GHz band. Since 2012, I've been calling for the FCC to make up to 195 MHz of 5 GHz spectrum available for unlicensed use.¹ And I appreciate the work of my colleagues, Commissioner Rosenworcel and Commissioner O'Rielly, to highlight the importance of that band. The 5 GHz band is tailor-made for the next generation of unlicensed uses. Its propagation characteristics

¹ See, e.g., Remarks of Commissioner Ajit Pai at CTIA's MobileCon, <http://go.usa.gov/4tkA> (Oct. 10, 2012); see also Statement of Ajit Pai, Commissioner, Federal Communications Commission, Hearing before the Subcommittee on Communications and Technology of the U.S. House of Representatives Committee on Energy and Commerce, <http://go.usa.gov/4t8Q> (Dec. 12, 2012); see also Remarks of FCC Commissioner Ajit Pai, "Looking Back and Looking Ahead: The FCC and the Path to the Digital Economy," <http://go.usa.gov/WRj4> (July 25, 2013); Commissioner Ajit Pai Applauds U.S. House of Representatives Committee on Energy and Commerce for Highlighting Promise of 5 GHz Band for Unlicensed Use and Calls for Prompt FCC Action to Facilitate Greater Use of 5 GHz Band, <http://go.usa.gov/3WySC> (Nov. 13, 2013); Remarks of FCC Commissioner Ajit Pai at WISPAPALOOZA, <http://go.usa.gov/3WySF> (Oct. 15, 2014).

minimize interference in the band and the wide, contiguous blocks of spectrum allow for extremely fast connections, with throughput reaching 1 gigabit per second. The technical standard to accomplish this, 802.11ac, already exists, and devices relying on it are already being built. With the potential of 5 GHz spectrum within our reach, the time has come for the FCC to act. I look forward to continuing to work with my colleagues to reach a consensus.

Finally, I would like to thank the staff of the International Bureau, the Office of Engineering and Technology, the Office of General Counsel, and the Wireless Telecommunications Bureau, including Kamran Etemad, Navid Golshahi, Joyce Jones, Ira Keltz, Julie Knapp, John Leibovitz, Gary Michaels, Bob Pavlak, Paul Powell, Bill Richardson, Christiaan Segura, Kelly Quinn, and Margy Wiener, for their persistence and hard work in this proceeding.

**STATEMENT OF COMMISSIONER MICHAEL O'RIELLY
APPROVING IN PART AND CONCURRING IN PART**

Re: *Amendment of the Commission's Rule with Regard to Commercial Operations in the 3550-3650 MHz Band, Report and Order and Second Further Notice of Proposed Rulemaking*, GN Docket No. 12-354.

I am excited about the possibilities that may arise from our action today. In sum, it will make available 150 megahertz of spectrum for new uses, whether for small cell systems, wireless backhaul, or a technology that has yet to be imagined, let alone invented. Let's just see what services our entrepreneurs and innovators can amaze us with using the two commercial prongs of the three-tier spectrum access structure.

Although I support placing this spectrum into the marketplace and approve of this item in part, I do have some reservations about several of the rules we adopt today, so I concur in part. What some have nicknamed the "innovation band," 3.5 GHz is a real-world experiment with many components – or variables. If services are able to prosper in this band, it will be hard to know which components were helpful and which were not. Sometimes, too much experimentation can harm and ultimately delay successful deployment of new services. I hope that we have struck the right balance here, but only time will tell.

First, I am pleased that my calls to reduce the exclusion zones' size were heard. Last April, when we released our Further Notice, a full 60 percent of the U.S. population was located in areas where 3.5 GHz services would be unavailable. The exclusion zones adopted today are 77 percent smaller than those originally proposed. Nonetheless, the covered area captures several of this country's largest cities, where the shortage of spectrum is most acute. Thus, we must exercise diligence in ensuring that the zones continue to shrink. As I previously suggested, these remaining exclusion zones must be converted into coordination zones, and the Environmental Sensing Capability (ESC) system is poised to do just that.

Second, I am concerned that some rules may hinder development of the Priority Access Licenses, known as PALs. I question whether auctioning PALs for three year terms with no renewal expectancy will create a meaningful incentive to entice auction participants. Similarly, while I thank the Chairman for agreeing to changes that facilitate PALs in areas where there is more than one auction bidder, I had hoped our rules would include a mechanism whereby any entity could receive a PAL even if mutually exclusive applications, which are necessary to trigger an auction, are not filed in a particular census tract. The Commission ought to encourage a diverse array of business models. Many entrepreneurs, even those living in rural communities, have told me of their strong preference for PALs, which they explain would ensure better reliability and quality of service. Our rules must not foreclose these prospective licensees from obtaining PALs just because they are the only one in a given census tract wanting priority access. We need to fix this in the near term.

Third, on a macro level, today's ruling relies on certain premises that I generally do not support. Spectrum aggregation limits are not necessary in the 3.5 GHz Band, nor is the Section 307(e) license-by-rule framework for General Authorized Access (GAA). Despite the cute play on names, this is not the CB Radio service. Instead, the GAA tier should be administered under the Part 15 rules, which have been instrumental to the ubiquitous nature of unlicensed use. Further, I oppose any attempt to ensnare 3.5 GHz offerings that resemble Broadband Internet Access Service under Title II or subject them to the requirements of the net neutrality order.

For those of you who have not read the item, which is just about everyone since we haven't made it available as I would hope, we are electing to defer action on several issues in this proceeding for the time being. Some final decisions will be made in response to the further notice accompanying this order, some will be put into the hands of a multi-stakeholder group, and others will be made in the context of future auction comment and procedures public notices. That means there is much more work to be done in this area.

Let me raise a couple of other points. Some people talk about the structure set up in this item as a new paradigm for future spectrum policy. It is premature to declare this a new paradigm, and I am not convinced that it is. Instead, it will likely be one way among our existing structures that can be used in the more difficult situations where government users absolutely cannot move. As I have said before, spectrum clearing and exclusive licensing will remain in high-demand, as reconfirmed by the AWS-3 auction and likely by our upcoming incentive auction.

Separately, the Commission needs to do more to facilitate the siting of small cell systems. Although we do not know the array of services that may develop, there is one commonality: they will not come to fruition without infrastructure. To ensure that the new services flowing from this 3.5 GHz spectrum reaches the hands of American consumers as quickly as possible, we must remove the burdensome roadblocks preventing installation of small cells, whether due to hyper-regulatory state, environmental or historical review. Small cell infrastructure deserves the Commission's immediate attention.

I thank the Chairman for incorporating a number of my suggested edits, including agreeing with me that the auction comment and procedures public notices should be voted on by the full Commission and ensuring that user information will not be stored in the Spectrum Access System (SAS) and thus potentially available for questionable purposes.

Finally, I do not underestimate the efforts of the Commission staff, which have gotten us to where we are today. I thank you all for your hard work.