

**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
)	
)	

ORDER ON RECONSIDERATION AND SECOND REPORT AND ORDER

Adopted: April 28, 2016

Released: May 2, 2016

By the Commission: Chairman Wheeler and Commissioners Clyburn and Rosenworcel issuing separate statements; Commissioner Pai approving in part, concurring in part and issuing a statement; and Commissioner O’Rielly approving in part, dissenting in part and issuing a statement.

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I. INTRODUCTION AND EXECUTIVE SUMMARY

1. In this *Report and Order and Order on Reconsideration (Second Order)* we finalize the rules governing the innovative Citizens Broadband Radio Service in the 3550-3700 MHz band (3.5 GHz Band). Facing ever-increasing demands of wireless innovation and constrained availability of clear sources of spectrum, the Citizens Broadband Radio Service is an opportunity to add much-needed capacity through innovative sharing. With this *Second Order*, we finalize the regulatory scheme we created in 2015, putting in place the last rules necessary for this service to become commercially available.¹

2. The Citizens Broadband Radio Service takes advantage of advances in technology and spectrum policy to dissolve age-old regulatory divisions between commercial and federal users, exclusive and non-exclusive authorizations, and private and carrier networks. The regulatory framework takes from recommendations from the President's Council of Advisors on Science and Technology (PCAST) and substantial engagement and input from stakeholders representing a cross section of the communications, technology, and public interest realms.

3. The comprehensive regulatory scheme adopted in the *3.5 GHz R&O* included specific licensing, technical, and service rules to enable dynamic sharing between three tiers of users in the 3.5 GHz Band. The Spectrum Access System (SAS)² is the advanced frequency coordinator (or coordinators) necessary to assign rights and maximize efficiency in the band. The SAS(s) will incorporate information from the Environmental Sensing Capability (ESC), which will be used to increase available spectrum in coastal areas while continuing to protect incumbent Department of Defense (DoD) radar systems.

4. In this *Second Order*, we reaffirm the regulatory approach adopted in the *3.5 GHz R&O*. In doing so, we deny several petitions for reconsideration that are inconsistent with our goals and grant others that advocated rule modifications that would facilitate more equitable and efficient use of the 3.5 GHz Band. In the *3.5 GHz R&O*, we developed a comprehensive approach intended to balance consideration of the complex issues and competing considerations involved in creating a sharing regime in this band, and each rule is a vital part of that approach. We reaffirm our commitment to add much needed capacity spectrum to the marketplace through innovative sharing rules and techniques, and believe the rules established in the *3.5 GHz R&O* are the best means to do so.

5. Nonetheless, we do agree with some petitioners who argue for an increase in the power level for non-rural Category B CBSDs and greater flexibility in how to measure and direct the power. This will provide additional flexibility for all CBSD deployments to potentially increase their utility, and create additional flexibility for non-rural deployments. While rejecting arguments both to increase and to decrease our out-of-band emission (OOBE) limits for CBSDs, we revise our measurement of such limits to conform to the well-established root mean square (RMS) measurement technique reflected in our rules for other services. We also adopt a limited exception to the PAL assignment rules that would allow a single PAL to be issued in License Areas located in Rural Areas in the absence of mutually exclusive applications. At SIA's request, we also revise our rules to make clear that SASs must be capable of receiving and responding to interference complaints from Fixed Satellite Service (FSS) earth station licensees.

6. While we created a robust and substantial regulatory framework in the *3.5 GHz R&O*, there were several technical issues that required further refinement and input on the record. To bolster the record on these issues, we released a *Second FNPRM* seeking comment on how to: (1) define "use" of

¹ See Amendment of the Commission's Rules with Regard to Commercial Operations in the 3550-3650 MHz Band, GN Docket No. 12-354, *Report and Order and Second Further Notice of Proposed Rulemaking*, 30 FCC Rcd 3959 (2015) (*3.5 GHz R&O* or *Second FNPRM*, as applicable).

² Unless otherwise defined herein, capitalized terms have the definitions given them in 47 C.F.R. § 96.3 or Appendix A if added or modified in this *Second Order*.

Priority Access License (PAL) areas to determine the availability of spectrum for General Authorized Access (GAA) use; (2) implement and promote a robust secondary market in the band; and (3) optimize protections for licensed in-band and out-of-band FSS earth stations.

7. These are important issues, and are fundamental to the fabric of the Citizens Broadband Radio Service. They explore how to maximize the efficient use of spectrum by allowing opportunistic GAA use of spectrum when and where it is not utilized by Priority Access Licensees. They look at how we can maximize the amount of spectrum available in the band by optimizing the protection of in-band and out-of-band FSS earth stations, while leveraging the SAS and other tools to maximize operations towards the 3700 MHz band edge. They examine how to create reliable and flexible secondary market rules that can be implemented across hundreds of thousands of licenses.

8. In resolving these final issues, we strive to establish simple rules that are implementable in the near term, while protecting DoD radar systems consistent with the process and procedures established in the *3.5 GHz R&O*. We establish a definition of use that allows Priority Access Licensees to certify the extent of their service area to an SAS, while also establishing a maximum point at which they will receive protection. This is both a flexible and objective way to allow Priority Access Licensees to design and deploy networks, and SAS Administrators to provide objective protection and effective GAA access. We authorize “light-touch leasing” to allow Priority Access Licensees to leverage the secondary market to provide access to any qualified lessee with minimal administrative requirements or transaction costs. Finally, we establish protection criteria for in-band FSS, and out-of-band FSS sites used for telemetry, command, and control (TT&C) that provides a high level of reliability, while also allowing the SASs to optimize based on the characteristics of the FSS earth station, the terrain, the CBSD deployment characteristics near the site, and other factors.

9. With these decisions, we complete the regulatory framework for the Citizens Broadband Radio Service, and set the stage for the commercial availability of a contiguous 150 megahertz of spectrum for wireless broadband use.

II. PROCEDURAL BACKGROUND

A. 3.5 GHz NPRM, Licensing Public Notice, and FNPRM

10. As part of its ongoing efforts to address the growing demand for fixed and mobile broadband capacity, the Federal Communications Commission (FCC or Commission) released a *Notice of Proposed Rulemaking* in December 2012 proposing to make an additional 100 megahertz (or up to 150 megahertz under a supplemental proposal) of spectrum available for shared wireless broadband use.³ Specifically, the *NPRM* proposed to create a new Citizens Broadband Radio Service.⁴ The technical rules focused on the use of low-powered small cells to drive increases in broadband capacity and spectrum reuse and an SAS that would coordinate multiple tiers of users.⁵

11. In November 2013, in response to comments received on the record 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*.⁶ The Revised Framework retained the three-tier model proposed in the *NPRM* but expanded eligibility for access to the Priority Access tier with

³ See 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, *Notice of Proposed Rulemaking*, 27 FCC Rcd 15594 (2012) (*3.5 GHz NPRM* or *NPRM*).

⁴ See *id.* 15615-16, ¶¶ 61-63.

⁵ See *id.* at 15612-14, ¶¶ 53-58.

⁶ See Commission Seeks Comment on Licensing Models and Technical Requirements in the 3550-3650 MHz Band, GN Docket No. 12-354, *Public Notice*, 28 FCC Rcd 15300, 15301, ¶ 2 (2013) (*Licensing PN*).

competitive bidding for assigning licenses within that tier.⁷ 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.⁸

12. 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 96.⁹ 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: (1) implement the three-tier authorization model proposed in the *NPRM*; (2) 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; (3) create an open eligibility authorization system for Priority Access and GAA operations; (4) establish granular, exclusive spectrum rights for the Priority Access tier, consistent with parameters discussed in the *Licensing PN*; (5) set a defined "floor" for GAA spectrum availability, to ensure that GAA access is available nationwide (subject to Incumbent Access tier use); (6) 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; (7) establish baseline technical rules for fixed or nomadic base stations operating in the 3.5 GHz Band; and (8) set guidelines for the operation and certification of SASs in the band.¹⁰ The *FNPRM* also sought comment on: (1) protection criteria for Incumbent Access users; (2) potential protection of FSS earth stations in the 3700-4200 MHz band (C-Band); (3) competitive bidding procedures for resolving mutually exclusive applications for Priority Access Licenses (PALs); and (4) the possible extension of the proposed rules to include the 3650-3700 MHz band.¹¹

B. Report and Order and Second Further Notice of Proposed Rulemaking

13. On April 17, 2015, the Commission released the *3.5 GHz R&O*, which established the Citizens Broadband Radio Service under a new part 96 of the Commission's rules. The *3.5 GHz R&O* established a three-tier framework for making the entirety of the 3.5 GHz Band available for shared commercial use utilizing an SAS to coordinate operations between and among users in different tiers. This three-tier sharing framework is largely consistent with the proposals put forth in the *FNPRM*.¹²

14. Incumbent Access users represent the highest tier in this framework and receive interference protection from all Citizens Broadband Radio Service users. Protected incumbents include federal shipborne and ground-based radar operations and FSS earth stations in the 3600-3700 MHz band and, for a finite period, grandfathered terrestrial wireless operations in the 3650-3700 MHz portion of the band. Non-federal incumbents must register the parameters of their operations with the Commission and/or an SAS to receive protection from Citizens Broadband Radio Service users.¹³ In addition, an ESC

⁷ *Id.* at 15305-10, ¶¶ 10-27.

⁸ *See id.* The Commission also convened two workshops to discuss technical issues related to this proceeding. 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); 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); 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>.

⁹ *See generally*, *3.5 GHz FNPRM*, 29 FCC Rcd 4273.

¹⁰ *Id.* at 4280, ¶ 17.

¹¹ *Id.*

¹² *See generally*, *3.5 GHz R&O*.

¹³ *See* 47 C.F.R. §§ 96.15, 96.17, 96.21.

may be used to detect transmissions from DoD radar systems and transmit that information to an SAS to ensure that federal Incumbent Users are protected from interference.¹⁴

15. The Citizens Broadband Radio Service itself consists of two tiers—Priority Access and GAA - both assigned in any given location and frequency by an SAS. Priority Access operations receive protection from GAA operations. A PAL is defined as a non-renewable authorization to use a 10 megahertz channel in a single census tract for three years. PALs will be assigned via competitive bidding in up to 70 megahertz of the 3550-3650 MHz portion of the band. One Priority Access Licensee may hold up to forty megahertz of PALs in any given census tract at any given time.¹⁵

16. GAA use will be licensed by rule throughout the 150 megahertz band. Both Priority Access and GAA use will be assigned and coordinated by an SAS, which will also perform additional coordination functions as set forth in the rules.¹⁶ GAA users will be permitted to operate on any frequencies not assigned to PALs. GAA users will receive no interference protection from other Citizens Broadband Radio Service users, including other GAA users, and must not interfere with higher tier operations.¹⁷

17. The *Second FNPRM*, which was released along with the *3.5 GHz R&O*, sought comment on how to define “use” by Priority Access Licensees and whether the Commission should rely on an engineering definition, an economic definition, or a hybrid of the two to determine whether frequencies are in use. The *Second FNPRM* also sought comment on the applicability of existing secondary market rules to PALs and the appropriate administration of secondary market transactions in the band. Finally, the *Second FNPRM* a sought comment on the methodology and parameters for protecting in-band and C-Band FSS earth stations.

18. After the adoption of the *3.5 GHz R&O*, and as directed therein, on October 23, 2015, the Wireless Telecommunications Bureau (WTB) released a Public Notice seeking comment on the appropriate methodology for determining the contours for protecting existing 3650-3700 MHz wireless broadband licensees from Citizens Broadband Radio Service users during a fixed transition period.¹⁸ Finally, as directed by the Commission in the *3.5 GHz R&O*, WTB and the Office of Engineering and Technology (OET) released a Public Notice seeking proposals for future SAS Administrator(s) and ESC operator(s) in the 3.5 GHz Band.¹⁹ The Public Notice summarized the requirements for both SAS Administrators and ESC operators, as established in the *3.5 GHz R&O*, and described the process for submitting proposals. It also briefly described the process that WTB/OET will use to evaluate prospective SAS Administrators and ESC operators.²⁰

¹⁴ See *id.* §§ 96.15, 96.67.

¹⁵ See *id.* §§ 96.25, 96.29.

¹⁶ See *id.* §§ 96.53, *et seq.*

¹⁷ See *id.* § 96.35.

¹⁸ See Wireless Telecommunications Bureau Seeks comment on an Appropriate Method for Determining the Protected Contours for Grandfathered 3650-3700 MHz Band Licensees, GN Docket No. 12-354, *Public Notice*, 30 FCC Rcd 11557, (WTB/OET 2015) (*3650-3700 MHz Protection Contours PN*).

¹⁹ See Wireless Telecommunications Bureau and Office of Engineering and Technology Establish Procedure and Deadline for Filing Spectrum Access System (SAS) Administrator(s) and Environmental Sensing Capability (ESC) Operator(s) Applications, GN Docket No. 12-354, GN Docket No. 15-319, *Public Notice*, 30 FCC Rcd 14170 (2015) (*SAS/ESC Proposal PN*).

²⁰ See *id.*

C. Petitions for Reconsideration

19. Petitions for Reconsideration on the *3.5 GHz R&O* were due July 23, 2015. The following eight parties filed petitions for reconsideration: CTIA, Jon Peha, Motorola Solutions, NAB, Nokia Solutions, SIA, Verizon, and WinnForum. The arguments raised in these petitions are described in greater detail in the relevant sections of the *Second Order*.

20. *CTIA – The Wireless Association Petition*. CTIA seeks revisions to the licensing process for PALs, arguing that the Commission should adopt a five-year license term with a renewal expectancy. CTIA asks the Commission to reconsider its decision not to award a PAL in census tracts unless there are mutually exclusive applications. CTIA also seeks change to the technical rules, including changes to the OOB limits and the measurement procedure for such limits. Finally, CTIA requests that the Commission increase the maximum effective isotropic radiated power (EIRP) and conducted power limits for Category A and Category B CBSDs.²¹

21. *Jon Peha Petition*. Jon Peha seeks reconsideration of the Commission’s decision that “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.”²² Instead he argues that the Commission should grant PALs in every market where there is demand, even if there is only one bidder.²³

22. *Motorola Solutions Petition*. Motorola Solutions supports WinnForum’s Petition and also seeks reconsideration of the Commission’s decision to only issue PALs where two or more parties file an application.²⁴

23. *NAB Petition*. NAB asks the Commission to eliminate professional installation as a method to report the geographic location of a CBSD to an SAS. NAB contends that location data should be reported automatically by a mandatory geo-location capability built into the device.²⁵

24. *Nokia Solutions Petition*. Nokia Solutions asks the Commission to increase the response time from when an ESC communicates it has detected a signal from a federal system in a given area that the SAS must either confirm suspension of the CBSD’s operation or relocation from 60 seconds to 600 seconds. Nokia Solutions also argues that the Commission should specify emission limits for End User Devices that are compliant with 3GPP specifications.²⁶ Nokia Solutions seeks changes to the power limits, asking that the total transmit power for CBSDs be stated simply as maximum EIRP and increased by 6 dB for Category A and 9 dB for Category B CBSDs.²⁷ Finally, Nokia Solutions asks that the Commission revise the vertical location accuracy requirements to align with US Government Position Accuracy standard for outdoor installation and remove such requirements for indoor installations.²⁸

25. *SIA Petition*. SIA seeks changes to a variety of technical rules and aspects of the FSS protection rules. Among other things, SIA states that the Commission should adopt a stringent OOB limit at 3680 MHz to protect C-Band operations immediately above the 3700 MHz band edge. SIA also argues that the Commission should: (1) decrease the maximum power limits for CBSDs; (2) reduce the 60-second timeframe for a CBSD to confirm deactivation or a change in frequency; (3) eliminate or

²¹ CTIA Petition at 7-8.

²² Jon Peha Petition at 2, citing *3.5 GHz R&O*, 30 FCC Rcd at 4002-03, ¶ 134.

²³ *See id.* at 2.

²⁴ *See* Motorola Solutions Petition at 1; 5-7.

²⁵ *See* NAB Petition at 5.

²⁶ *See* Nokia Solutions Petition at 10-12.

²⁷ *See id.* at 9-10.

²⁸ *See id.* at 13-14.

clarify the annual registration requirements for FSS earth stations; (4) establish procedures for reporting FSS interference to SASs and implementing immediate shutdown procedures in response to such reports; and (5) reconsider the freeze on new co-primary FSS earth stations in the band.²⁹

26. *Verizon Petition.* Verizon seeks reconsideration of the power limits, stating that the Commission should increase the EIRP to levels closer to real-world small cell deployments and to rely solely on EIRP rather than imposing limits on both EIRP and conducted power.³⁰

27. *WinnForum Petition.* The WinnForum asks the Commission to reconsider a number of the technical rules governing the 3.5 GHz Band. WinnForum argues that the Commission should: (1) increase the reconfiguration response time from when an ESC communicates it has detected a signal from a federal system in a given area that the SAS must either confirm suspension of the CBSD's operation or relocation from 60 seconds to 600 seconds; (2) increase Category A and Category B CBSD EIRP limits and provide additional flexibility between EIRP and conducted power limits; and (3) modify the geo-location rules to allow SASs to estimate CBSD elevation above ground level for purpose of determining vertical location accuracy.³¹

D. Oppositions and Replies to Petitions for Reconsideration

28. Oppositions to the petitions for reconsideration were due October 19, 2015, and replies to oppositions were due October 29, 2015. Eight parties filed responses. The arguments raised in these oppositions are described in greater detail in the relevant sections of the *Second Order*.

29. *CTIA Opposition.* CTIA opposes SIA's petition and supports the petitions filed by Jon Peha and Motorola Solutions. CTIA asks the Commission to reject SIA's request to impose stricter OBE limits and states the *3.5 GHz FNPRM* provided adequate notice that the Commission would extend these limits for the 3650-3700 MHz band.³² CTIA claims the power limits for non-rural Category B CBSDs should be increased to provide operators with additional flexibility.³³ Finally, CTIA supports Jon Peha's and Motorola Solutions' request that the Commission issue PALs in all census tracts, even if there is only one applicant.³⁴

30. *Federated Wireless Opposition.* Federated Wireless asks that the Commission take the following actions in response to the petitions for reconsideration: (1) increase maximum EIRP and conducted power limits for CBSDs;³⁵ (2) modify the elevation accuracy requirement to allow the SAS to play a role in determining CBSD location;³⁶ and (3) allow PALs to be issued even when there is a single applicant in a given census tract.³⁷ Federated Wireless also asks the Commission to reject the petitions that seek elimination of the option to allow a professional installer to report geo-location and petitions that request adoption of a maximum antenna height limitation for Category B CBSDs.³⁸

²⁹ See SIA Petition.

³⁰ See Verizon Petition.

³¹ See WinnForum Petition.

³² See CTIA Opposition at 2-4.

³³ See *id.* at 5-6.

³⁴ See *id.* at 6-7.

³⁵ See Federated Wireless Opposition at 6.

³⁶ See *id.* at 5.

³⁷ See *id.* at 8-9; 13

³⁸ See *id.*

31. *Google Opposition.* Google argues that the Commission should reject SIA's request to strengthen OOB limits and eliminate registration requirements for FSS earth station operators.³⁹ Google also argues that professional installation can protect incumbents and the Commission should retain this option to report geo-location accuracy and that the SAS should not be required to perform additional validation of location data.⁴⁰ Google also supports many of the petitioners for technical amendments to the rules to maximize spectrum availability.⁴¹

32. *SIA Opposition.* SIA asks the Commission to reject requests to relax OOB limits and use an RMS detection methodology for measuring a device's compliance with the Commission's OOB rules. SIA also opposes: (1) higher EIRP limits for CBSDs; (2) unlimited antenna height for Category B CBSDs; and (3) any increase in the CBSD or SAS reconfiguration time.⁴² Finally, SIA supports elimination of the professional installation option for reporting location accuracy.⁴³

33. *Qualcomm Opposition.* Qualcomm supports CTIA's request to allow the use of an RMS detector to measure OOB.⁴⁴ Qualcomm also supports CTIA's request to relax the requirement limiting OOB below 3530 MHz and above 3720 MHz to -40 dBm/MHz.⁴⁵

34. *T-Mobile Opposition.* T-Mobile supports increasing the license term for PALs from three years to ten years with a renewal expectancy.⁴⁶ T-Mobile also argues that the Commission should: (1) make the total number of PALs in a census tract for which applicants have applied available for renewal; (2) increase OOB and EIRP limits for CBSDs and eliminate conducted power limits; and (3) increase the reconfiguration response time when an incumbent user is detected.⁴⁷ Finally, T-Mobile asks the Commission to continue to evaluate whether geo-location capabilities can be built into devices in the future.⁴⁸

35. *Verizon Opposition.* Verizon states that the Commission should deny SIA's request for stricter OOB limits and that SIA's concerns about FSS protections are premature.⁴⁹ Verizon reiterates its position that allowing CBSDs to operate at higher power limits is crucial to the success of this band.

36. *WISPA Opposition.* WISPA argues that the Commission should retain the majority of its technical rules, including the maximum power limit, absence of height restrictions for Category B CBSDs, elevation reporting rule and the professional installation requirements.⁵⁰ However, WISPA supports requests to relax OOB limits and to use an RMS detector to measure these levels.⁵¹ WISPA opposes the petitions that request increasing the three-year license term for PALs and opposes permitting a renewal expectancy.⁵² However, WISPA supports the requests to award PALs in census tracts even if

³⁹ See Google Opposition at 7.

⁴⁰ See *id.* at 10-14.

⁴¹ See *id.* at 15-20.

⁴² See SIA Opposition at 2-6; 8.

⁴³ See *id.* at 10.

⁴⁴ See Qualcomm Opposition at 3-6.

⁴⁵ See *id.* at 6.

⁴⁶ See T-Mobile Opposition at 2-3.

⁴⁷ See *id.* at 2-8.

⁴⁸ See *id.* at 8-9.

⁴⁹ See Verizon Opposition at 1-2; 4.

⁵⁰ See WISPA Opposition at 2-6; 8.

⁵¹ See *id.* at 6.

there is only one application.⁵³ Finally, WISPA supports retaining the FSS earth station registration requirements.⁵⁴

E. Responses to *Second FNPRM*

37. The Commission received comment on the three outstanding issues in the *Second FNPRM* described above: (1) defining use by PALs; (2) creating secondary markets in the 3.5 GHz Band; and (3) FSS protection criteria.⁵⁵ These comments, and those received in subsequent rounds, are summarized and referenced in the *Second Order* below.

III. ORDER ON RECONSIDERATION

38. Section 1.429 of the Commission's rules establishes the standards for submission, review, and consideration of petitions for reconsideration.⁵⁶ The eight petitions for reconsideration filed in this proceeding were assessed pursuant to the requirements set forth in section 1.429. The arguments made by petitioners are addressed on an issue-by-issue basis below. Except as otherwise set forth below, these petitions do not raise any new issues not considered in the *3.5 GHz R&O*, or where they do, we do not find these arguments persuasive. Through this Order on Reconsideration we reaffirm our commitment to the rules and comprehensive regulatory framework established in the *3.5 GHz R&O*.

A. PAL License Terms and Renewability

39. *Background.* In the *3.5 GHz R&O*, the Commission adopted a three-year non-renewable license term for PALs.⁵⁷ This represents an increase from the one-year, non-renewable term that was originally proposed in the *FNPRM* and on which the Commission sought comment in the *Licensing PN*.⁵⁸ After review of the record, the Commission found that three-year, non-renewable license terms strike an appropriate balance between the public interest need for targeted, flexible licensing and the need to provide sufficient certainty for licensees to invest in the 3.5 GHz Band.⁵⁹

40. CTIA asks that the Commission extend PAL license terms to five years and grant an ongoing renewal expectancy, provided that the licensee has deployed services and registered with an SAS.⁶⁰ CTIA argues that the existing three-year license term does not provide operators sufficient time or assurance to realize a return on investment.⁶¹ CTIA contends that many challenges associated with network deployment, such as developing and certifying equipment, obtaining appropriate zoning and permitting, and deploying infrastructure, are amplified in the 3.5 GHz Band given the novelty and complexity of higher frequency small cell deployments.⁶² Further, CTIA cites IEEE's reluctance to develop a standard to support IEEE 802.11 Wireless Local Area Networks (WLAN) for the 3.5 GHz

(Continued from previous page) _____

⁵² See *id.* at 11.

⁵³ See *id.* at 13.

⁵⁴ See *id.* at 14.

⁵⁵ These commenters are listed in Appendix D.

⁵⁶ See 47 C.F.R. § 1.429.

⁵⁷ See *3.5 GHz R&O*, 30 FCC Rcd at 3994-97, ¶¶ 105-113; 47 C.F.R. § 96.25 (b)(3).

⁵⁸ See *3.5 GHz FNPRM*, 29 FCC Rcd at 4288, ¶ 49; See *Licensing PN*, 28 FCC Rcd at 15306, ¶ 13

⁵⁹ See *3.5 GHz R&O*, 30 FCC Rcd at 3995-96, ¶¶ 107.

⁶⁰ CTIA Petition at 3.

⁶¹ See *id.* AT&T supports this assertion, arguing that PAL holders need certainty that they will be able to access their licensed spectrum free from interference in order to invest in licenses and infrastructure. AT&T *Second FNPRM* Reply Comments at 7.

⁶² CTIA Petition at 3.

Band as a signal that the 3.5 GHz R&O is already affecting investment and innovation.⁶³ Three parties, AT&T, PCIA, and T-Mobile,⁶⁴ support CTIA's position.⁶⁵

41. WISPA filed an opposition to the CTIA Petition stating that the Commission should not revisit the carefully balanced compromise that resulted in the Commission's adoption of a three-year license term.⁶⁶ WISPA contends that the approach adopted in the 3.5 GHz R&O reflects a balance between the views of parties that prefer short-term licenses - including WISPA members - and those that prefer longer license terms. Further, WISPA doubts that large wireless carriers will choose not to deploy in this band. Rather, WISPA notes that, in recent years, the mobile wireless industry has embraced unlicensed deployment models and argues that the Citizens Broadband Radio Service will provide similar investment incentives for the industry.⁶⁷

42. CTIA filed a reply to WISPA's opposition reiterating its arguments.⁶⁸ CTIA argues that, while WISPA's members may not need the same level of certainty that mobile operators will require, the Commission should not ignore the novelty and complexity that mobile operators will face when deploying in the 3.5 GHz Band.⁶⁹

43. *Discussion.* We deny CTIA's request and reaffirm our decision to issue PALs with three-year non-renewable license terms. We agree with WISPA that the 3.5 GHz R&O already reflects a balance among parties that advocated for short license terms and those that prefer longer terms.⁷⁰ We originally proposed a one-year non-renewable license term for PALs but, based on the record, we instead adopted a longer, three-year license term and allowed applicants to apply for two consecutive terms, during the first applications window, for a total of six years.⁷¹ We continue to 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."⁷² We set forth several arguments in favor of these findings in the 3.5 GHz R&O and CTIA has not provided any new information that would cause us to alter our analysis.⁷³ Indeed, the arguments raised by CTIA and supporting parties are similar to those raised by commenters in response to the FNPRM.⁷⁴ These arguments were already thoroughly considered by the Commission in the 3.5 GHz R&O. As such, we

⁶³ *Id.* at 2 (citing IEEE 802.11 Working Group *Second FNPRM* Comments at 1). AT&T also notes the lack of IEEE WLAN standards for this band. *See* AT&T *Second FNPRM* Reply comments at 7.

⁶⁴ T-Mobile advocates for a ten-year license term with renewal expectancy for PALs, similar to licenses in other wireless services. *See* T-Mobile Reply at 1-3.

⁶⁵ *See* AT&T *Second FNPRM* Reply comments at 7. *See* T-Mobile Reply at 3; PCIA *Second FNPRM* Reply Comments at 7-8.

⁶⁶ *See* WISPA Opposition at 2.

⁶⁷ *Id.* at 12.

⁶⁸ *See* CTIA Reply at 7-8.

⁶⁹ *See* CTIA Reply at 8 *citing* WISPA Opposition at 11.

⁷⁰ *See* WISPA Opposition at 12.

⁷¹ *See* 3.5 GHz R&O, 30 FCC Rcd 3959 at 3994-3995, ¶ 105.

⁷² *Id.* at 3995-96, ¶ 107.

⁷³ *See id.* at 3994-95, ¶¶ 105-113.

⁷⁴ *See* Ericsson *Licensing PN* Comments at 7-8; Nokia Solutions *Licensing PN* Comments at 4-5; Nokia Solutions *FNPRM* Comments at 11-12; Qualcomm *Licensing PN* Comments at 7-8; Qualcomm *FNPRM* Comments at 6; Qualcomm *FNPRM* Reply Comments at 3, 7.

continue to believe that three-year, non-renewable license terms strike the proper balance of interests for the 3.5 GHz Band.⁷⁵

44. We also continue to believe that the current rules will effectively incentivize network investment.⁷⁶ As we found in the *3.5 GHz R&O*, the rules governing the 3.5 GHz Band work in concert to promote shared access to the band, foster innovation, and ensure that Citizens Broadband Radio Service users are able to efficiently target their use of the 3.5 GHz Band to their specific needs. Non-renewable, short-term licenses are an essential component of this overall framework. They allow operators to obtain PALs when and where Priority Access to the band is needed while permitting periodic, market-based reassignment of these rights in response to changes in local conditions and operator needs. The technical rules and band-wide operability requirement ensure that operators can easily utilize both Priority Access and GAA spectrum in their networks and seamlessly switch between tiers without purchasing additional equipment. In addition, our decision not to impose specific construction requirements for PALs further increases the flexibility and fungibility of these licenses and reduces the barriers to fluid movement between service tiers. These unique features of the Citizens Broadband Radio Service effectively negate the risk of stranded investment for operators and incentivize efficient network deployments.

45. CTIA asserts that deploying a network takes “several years,” and that six years is not a sufficient time period to build a network and obtain the financial return an operator would need to justify making such investments.⁷⁷ But CTIA offers no support for its assertion that “several years” must be more than six years to do so or that a PAL is necessary to facilitate network construction. Nor does it address our conclusion, as WISPA notes, that, even for larger carriers, the economics and upgrade cycles for small cell use may resemble those for Wi-Fi deployments rather than traditional macro cell deployments.⁷⁸ Furthermore, PAL Licenses Areas are significantly smaller, and therefore require less network deployment, than market areas for other wireless services. Given the differences in the nature and scope of service in this shared band, we continue to believe that three-year, non-renewable PAL terms along with the opportunity to acquire two consecutive three-year licenses during the initial PAL auction reasonably balance the stated interests of different users of this shared band. This approach will promote competition, spur innovation, and encourage rapid network deployment in the 3.5 GHz Band.

B. Assignment of PALs

46. *Background.* 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 in this band.⁷⁹ In the *3.5 GHz R&O*, we found that mutual exclusivity exists when multiple applicants elect to bid on more PALs than exist in a given census tract.⁸⁰ We also found that, consistent with previous spectrum auctions, mutual exclusivity will be determined based upon the Commission’s acceptance of competing applications. Because of the “generic” nature of PAL frequency assignments, when total PAL applications exceed the PAL bandwidth

⁷⁵ See *3.5 GHz R&O*, 30 FCC Rcd at 3994-96, ¶¶ 105, 107.

⁷⁶ CTIA also references IEEE’s comments as an indicator that our rules are diminishing interest in the band, noting that IEEE raised concerns about the ability of the WLAN community to use the 3.5 GHz band. However, IEEE’s concerns are related to spectrum constraints due to incumbent protection requirements, not PAL license terms or renewability. See IEEE 802.11 Working Group *Second FNPRM* Comments at 2-4.

⁷⁷ CTIA Petition at 3.

⁷⁸ WISPA Opposition at 12 (citing *3.5 GHz R&O*, 30 FCC Rcd at 3996, ¶ 110).

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

⁸⁰ *3.5 GHz R&O*, 30 FCC Rcd at 4002, ¶ 132.

available in a License Area, PAL applications are mutually exclusive because granting one application would create conflict with another application.⁸¹

47. 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. 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.⁸²

48. CTIA, Jon Peha, and Motorola Solutions seek reconsideration of the Commission's method for determining mutual exclusivity for PALs.⁸³ Federated Wireless, UTC, and WISPA support these petitions.⁸⁴ Petitioners assert that the Commission should make PALs available even if only one applicant applies for a PAL in any given census tract and that the number of available PALs should not depend on the number requested by applicants.⁸⁵ Petitioners claim that prospective licensees may have need for exclusive access to spectrum in the 3.5 GHz Band and those needs are not dependent on other parties.⁸⁶ In addition, Motorola Solutions, Federated Wireless, and UTC contend that the Commission's rule would have negative effects on critical infrastructure industries that may have an interest in exclusive spectrum access.⁸⁷ Federated Wireless, UTC, and WISPA argue that the Commission's approach to determining mutual exclusivity is likely to have a disproportionate negative effect on applicants in rural areas, where demand is likely to be sparser than in more densely populated urban and suburban areas.⁸⁸

49. John Peha argues that the Commission has the legal authority to auction PALs even when all applications in a given License Area are received from the same source.⁸⁹ WISPA and Motorola solutions suggest that the Commission should set a reasonable licensing or administrative fee if a single applicant applies for a PAL in a given census tract.⁹⁰ Federated Wireless and CTIA argue that PALs should be assigned on a non-auctioned basis when there is only one applicant in a given License Area.⁹¹

50. *Discussion.* After review of the record, we largely affirm our decision in the *3.5 GHz R&O* and deny the petitions for reconsideration of our determination not to assign PALs in the Citizens Broadband Radio Service in geographic areas for which there is only one applicant, with one limited exception. We modify our original decision to address the limited case of applicants in Rural Areas that may exhibit lower demand than other areas. Specifically, in the absence of mutually exclusive applications, if there is a single applicant for one or more PALs in a License Area within a Rural Area, as

⁸¹ *Id.* at 4002, ¶ 134.

⁸² *Id.* at 4002-03, ¶ 133.

⁸³ See CTIA Petition at 4; Jon Peha Petition at 1-3; Motorola Solutions Petition at 5-7.

⁸⁴ See Federated Wireless Reply at 4; UTC Reply at 1; WISPA Opposition at 13.

⁸⁵ See CTIA Petition at 4; Jon Peha Petition at 1-3; Motorola Solutions Petition at 5-7.

⁸⁶ See CTIA Petition at 4; John Peha Petition at 1-3; Motorola Solutions Petition at 5-7.

⁸⁷ See Federated Wireless Reply at 7; Motorola Solutions Petition at 6; UTC Reply at 1-2.

⁸⁸ See Federated Wireless Opposition at 7; UTC Reply at 2.

⁸⁹ See Jon Peha Petition at 2-3.

⁹⁰ See Motorola Solutions Petition at 7; WISPA Opposition at 14.

⁹¹ See Federated Wireless Petition at 6-7; CTIA Opposition at 6-7.

defined in section 96.3, we will allow for the assignment of one PAL in that License Area.⁹² We believe that this narrow exception is appropriate to create an opportunity for operators that provide broadband services to Rural Areas to secure assured exclusive access to spectrum, regardless of competitive demand. As described below, other than this very limited exception, we affirm our decision to issue PALs only through competitive bidding.

51. Given the unique features of this band, we concluded in the *3.5 GHz R&O* that our approach is consistent with the Commission's statutory authority and precedent, and best serves the public interest. Specifically, we found that if there is only a single applicant seeking PALs in a geographic area, and therefore no mutual exclusivity (and hence we have no auction authority),⁹³ the best way to discharge our statutory mandate to "encourage the larger and more effective use of radio in the public interest"⁹⁴ is to provide access to such spectrum via shared GAA use.⁹⁵

52. We continue to believe that the approach adopted in the *3.5 GHz R&O* fulfills our statutory mandate because it establishes an auction process that promotes "efficient and intensive use" of this spectrum, it allows for the "development and rapid deployment of new technologies, products, and services for the benefit of the public, including those residing in rural areas," and it "recover[s] for the public . . . a portion of the value of the public spectrum resource made available for commercial use."⁹⁶ This is a market-based approach that targets Priority Access rights where and when there is actual market demand. None of the petitioners presented new evidence to cause us to reconsider the conclusion that this approach drives greater productivity and efficiency in spectrum use and promotes innovation and the development of the next generation of shared spectrum technologies by providing ample opportunities for both GAA and PAL operations.

53. Petitioners indicate that there may be certain types of users or applications that will require PALs for their operations, regardless of whether there are competing users filing applications in a given census tract.⁹⁷ The fundamental benefit of a PAL is the right to exclusive use of 10 megahertz of spectrum in a given census tract. In the absence of competition for the spectrum, exclusivity is unnecessary. Further, since there is no difference in the technical rules governing GAA and Priority Access devices and users, the permissible use cases for each tier of service are the same. In the absence of multiple competing applications that exceed the supply of PALs in a geographic area, there should be ample GAA spectrum available for interested parties, thereby obviating the need for exclusive rights. To the extent that petitioners advocate for the assignment of PALs in geographic areas for which there is only one applicant because a particular PAL applicant might anticipate operations that it believes will require

⁹² See 47 C.F.R. § 96.3 (Rural Area) ("For purposes of this part, any Census Tract which is not located within, or overlapping: (1) A city, town, or incorporated area that has a population of greater than 20,000 inhabitants; or (2) An urbanized area contiguous and adjacent to a city or town that has a population of greater than 50,000 inhabitants.")

⁹³ Our rules permit the assignment of up to seven PALs in each census tract when we accept mutually exclusive applications. No party has demonstrated how prospective GAA users who are not applicants for PALs in a particular census tract, and thus who may be licensed by rule only for lower priority use, can be deemed to have filed a "mutually exclusive application" within the meaning of Section 309(j)(1). See 47 U.S.C. § 309(j)(1) (providing for competitive bidding where "mutually exclusive applications are accepted for any initial license"). Nothing in our incentive auction order, applying the specific mandate of Section 6403 of the Spectrum Act, among other things, to a one-time only broadcast television spectrum incentive auction with interdependent reverse and forward auction applications, is inconsistent with our interpretation of Section 309(j)(1) here. See 47 U.S.C. §§ 1452(c)(1), 1452(e); Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions, Report and Order, 29 FCC Rcd 6567 ¶¶ 467-71 (2014).

⁹⁴ 47 U.S.C. § 303(g).

⁹⁵ See *3.5 GHz R&O*, 30 FCC Rcd at 4003, ¶ 136.

⁹⁶ See 47 U.S.C. §§ 309(j)(3), 309(j)(4).

⁹⁷ See Jon Peha Petition at 2; Motorola Solutions Petition at 3.

the interference protection that is associated with those authorizations, we decline to revise the hybrid framework we adopted in the *3.5 GHz R&O*. In balancing competing public interest objectives, as we often must, that framework was designed to select the best approach to spectrum management based on local supply and demand.⁹⁸ Accordingly, where competitive rivalry for spectrum access is low, we determined to allow the GAA tier to provide a low-cost entry point to the band. Where rivalry for spectrum access is high, an auction will resolve mutually exclusive applications for PALs in specific geographic areas. We further adopted finite-term licensing to facilitate evolution of the band and an ever-changing mix of GAA and Priority Access bandwidth over time.⁹⁹ As we explained in the *3.5 GHz R&O*, 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.¹⁰⁰ By adopting rules that provide for 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.

54. We reject WISPA's assertion that our approach "substitutes the Commission's business judgment about shared spectrum use over an applicant's business decision that may favor exclusive spectrum use."¹⁰¹ Whether or not a business desires exclusivity is independent of whether there is a market-based need for exclusivity caused by rising demand for the spectrum. The Commission's approach does indeed promote shared spectrum use – a fundamental feature of the Citizens Broadband Radio Service since its inception – while providing for prioritized access in areas with heightened demand. In fact, the Commission's approach relies purely on market demand to both trigger an auction and allocate PALs according to that demand, consistent with long-standing Commission practices that efficiently assign spectrum licenses via auction. Any method that would allow PALs to be assigned absent competing applications would not, as WISPA suggests, ensure "a marketplace decision,"¹⁰² but rather one likely to encourage speculation, reduce spectrum availability, and discourage innovation in the band.¹⁰³

55. After review of the record, we do however conclude that it would serve the public interest to allow providers in Rural Areas to have limited PAL access, even in the absence of mutually exclusive applications in that area. Petitioners assert that, in the absence of mutually exclusive PAL applications accepted for a geographic area, the approach adopted in the *3.5 GHz R&O* will have a disproportionate negative effect on rural providers, utilities, and critical infrastructure facilities.¹⁰⁴ Petitioners claim that such users may have a need for the "high quality of service and interference protection that can only be afforded through acquisition of a PAL."¹⁰⁵ We note that many of these entities – including utilities and rural WISPs – currently utilize the 3650-3700 MHz band (and other bands including 2.4 GHz, 5 GHz, and 900 MHz) on a non-exclusive basis without the option of acquiring priority rights. These entities should

⁹⁸ *3.5 GHz R&O* at 3962, ¶ 5.

⁹⁹ *Id.*

¹⁰⁰ *See id.* at 3962, ¶ 6.

¹⁰¹ *See* WISPA Opposition at 13.

¹⁰² *Id.*

¹⁰³ CTIA argues that the Commission's policy "risks gradually phasing out PALs with each subsequent auction." CTIA Petition at 4. It hypothesizes that if each licensee applies to bid for the same number of licenses it currently holds, one less PAL will be made available in the next auction. This hypothesis ignores any participation in future auctions by *additional* prospective PAL bidders. It also fails to address the problems for efficient use of spectrum from a system of continuing to issue up to seven PALs in each census tract without any assurance of a market mechanism for valuing any of that spectrum.

¹⁰⁴ *See* Jon Peha Petition at 2; Federated Wireless Reply at 7; WISPA Opposition at 13.

¹⁰⁵ *See* Jon Peha Petition at 2; Motorola Solutions Petition at 5.

be able to provide similar services in the 3.5 GHz Band operating on a GAA basis with the added option of purchasing a PAL if and when demand from more than one party exists in a given geographic area. In addition, as described in this section and section III(A), there is no type of service that is permitted with a PAL that would not be technically allowed or viable under a GAA authorization – the only variable is the ability to exclude others from the use of the spectrum to ensure interference protection, a need which has not been fully supported in the scenario of a single PAL applicant in a geographic area.

56. However, given that demand for PALs may well be lower in less populated areas – particularly early in the Citizens Broadband Radio Service deployment cycle – some Rural Areas may not have multiple applicants for PALs. While we believe that rural service providers can and will provide a variety of robust broadband services in these areas on a GAA basis, we believe that the public interest would be served by ensuring that a PAL is available to a provider in these Rural Areas in the unlikely event that there is a single PAL applicant in a given area. Under this limited exception we will allow for one PAL in a License Area located in a Rural Area in which mutually exclusivity does not exist. If the Commission receives only one application that is acceptable for filing for a License Area located in a Rural Area, the Commission will issue a Public Notice cancelling the auction for this license and establishing a date for the filing of a long-form application, the acceptance of which would trigger the relevant procedures permitting petitions to deny.¹⁰⁶ We believe that granting this limited exception to our decision not to assign PALs in the Citizens Broadband Radio Service in License Areas for which there is only one applicant is an appropriate balance that will serve the public interest by allowing for the opportunity for a rural service provider to acquire exclusive spectrum use in a Rural Area where such access may facilitate its ability to provide innovative services to customers in more remote locations. However, recognizing the unique nature of this exception, the Commission reserves the right to review and reconsider this approach at a later date. We do not believe there is any reason to change any other aspect of the PAL licensing scheme for Rural Areas or any other use case.

57. We also note that the opportunity to purchase PALs 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.¹⁰⁷ Therefore, as the band develops, our approach provides mechanisms to make PALs available in response to changing market conditions.

58. While we could issue PALs on a non-auctioned basis - as suggested by Federated Wireless and CTIA - 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, except for the limited exception described above. As part of its proposal that we assign PALs in a license area with only one applicant, Motorola Solutions asserted that the “interested party would be expected to pay a reasonable licensing/administrative fee for such PAL use, and may be expected to pay a reasonable fee to a SAS database provider for interference protection.”¹⁰⁸ Neither Motorola Solutions nor WISPA put forward any theory as to how we would assess this fee under our statutory authority, or how it could replicate a mechanism reflecting the spectrum’s fair market value. We believe the record on this issue is insufficient to support Motorola’s proposal.¹⁰⁹ We continue to believe the adopted rules are the best way to

¹⁰⁶ Implementation of Section 309(j) of the Communications Act – Competitive Bidding, PP Docket No. 93-253, *Second Report and Order*, 9 FCC Rcd 2348 at 2376, ¶ 165 (1993).

¹⁰⁷ *3.5 GHz R&O*, 30 FCC Rcd at 4004, ¶ 139.

¹⁰⁸ Motorola Solutions Petition at 7. *See also* WISPA Opposition at 14.

¹⁰⁹ Motorola Solutions suggests that the Commission’s concerns could be addressed by limiting to two or four channels per census tract the number of PALs that could be obtained without an auction mechanism to establish market prices. Motorola Solutions Petition at 7. This approach would still pose the problem of promoting

(continued....)

“encourage the larger and more effective use of radio in the public interest”¹¹⁰ and nothing in the record supports reconsideration of this determination.

C. SAS and CBSD Response Time

59. *Background.* In the 3.5 GHz R&O, the Commission adopted section 96.15(a)(4), which requires that, for CBSDs operating in the 3550-3650 MHz band, “[w]ithin 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.”¹¹¹ The Commission adopted identical requirements for CBSDs operating in the 3650-3700 MHz band.¹¹² The Commission also requires that “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.”¹¹³

60. Motorola Solutions, Nokia Solutions, and WinnForum petition the Commission to increase the first of these two intervals (SAS reconfiguration response time in section 96.15) from 60 seconds to 600 seconds.¹¹⁴ WinnForum contends that this increase is necessary to ensure a smooth handover of CBSDs to new frequencies or bands. They emphasize the complexity of optimizing these transitions among a number of different SASs and network operators.¹¹⁵ WinnForum also argues that some critical infrastructure and emergency use cases may need a longer time to effect a seamless transition from the affected frequencies. However, they acknowledge that most CBSDs could probably be cleared after only 300 seconds.¹¹⁶ Nokia Solutions also suggests that the reconfiguration time be increased to 600 seconds and indicates that, even in a best case scenario, a complex network cannot be suspended or relocated within 60 seconds.¹¹⁷ Google and WISPA also support WinnForum’s Petition.¹¹⁸

61. Google notes that there is a tension between the SAS reconfiguration rule and the second of these two intervals (the reconfiguration requirement in section 96.39 that requires CBSDs to cease operations or move to a non-interfering frequency within 60 seconds of receiving instructions from the SAS).¹¹⁹ According to Google, in practice, the combination of these two rules would be to effectively require CBSDs to take action in less than 60 seconds.¹²⁰ Google contends that, to resolve this tension, the

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speculation, and it would not provide a clear solution for the likely scenario in which the Commission would be forced to differentiate in some way between those required to bid at auction for PALs and those who do not. We note that the Commission is now barred from using a system of random selection. 47 U.S.C. § 309(i)(5)(A).

¹¹⁰ 3.5 GHz R&O, 30 FCC Rcd at 4003, ¶ 136 (citing 47 U.S.C. § 303(g)).

¹¹¹ 47 C.F.R. § 96.15(a)(4).

¹¹² *Id.* § 96.15(b)(4).

¹¹³ *Id.* § 96.39 (c)(2).

¹¹⁴ See Motorola Solutions Petition at 3; Nokia Solutions Petition at 4-6; WinnForum Petition at 3-5..

¹¹⁵ See WinnForum Petition at 3-5.

¹¹⁶ See *id.*

¹¹⁷ See Nokia Solutions Petition at 4-6.

¹¹⁸ See Google Opposition at 17-19; WISPA Opposition at 2-4.

¹¹⁹ See Google Opposition at 18-19; 47 C.F.R. § 96.39(c)(2).

¹²⁰ See Google Opposition at 18-19.

Commission should increase the interval for SASs to respond to ESC directions but retain the 60-second timeframe for CBSDs to respond to SAS commands.¹²¹

62. SIA argues that the 60-second response time in section 96.39 for CBSDs to move or discontinue operations is too long and asks that the Commission reduce that timeframe.¹²² SIA argues that even a one-minute delay could cause significant damage to incumbent satellite systems. SIA asserts that, since the CBSD response time is in addition to any additional time needed for the SAS to process information from the CBSD and communicate with the device, interference could continue for longer than 60 seconds in practice.¹²³ SIA asserts that the petitions for increases in SAS response time only reinforce their concerns about how quickly harmful interference into incumbent FSS earth stations can be addressed.¹²⁴ Google asserts that SIA misunderstands the different types of commands addressed by the Commission's rules and the arguments made by petitioners. Google contends that nothing in petitioners' requests to increase the SAS reconfiguration timeframe in section 96.15 casts doubt on the ability of CBSDs to respond to instructions from an SAS within the 60-second window established by section 96.39.¹²⁵

63. *Discussion.* After review of the record, we believe that the SAS reconfiguration time should be increased. Petitioners contend that 60 seconds is an insufficient window for SASs and licensees to effectively reconfigure their networks in response to reported interference. Indeed, Nokia Solutions argues that it may be impossible to effect such changes even under ideal circumstances.¹²⁶ These problems are likely to be more acute with networks consisting of a large number of CBSDs. While we take no position on the veracity of these claims, from the evidence presented, it appears that increasing the SAS reconfiguration timeframe will help to promote robust development and deployment of broadband networks in the 3.5 GHz Band.

64. However, given the importance of the incumbent services present in the band, we do not believe that the 600-second SAS reconfiguration timeframe suggested by commenters is appropriate. Federal Incumbent Users must be assured that their mission critical operations will be protected from harmful interference and that any interference reported will be addressed in a timely manner. Therefore, we amend section 96.15(a)(4) and 96.15(b)(4) of the rules and extend the SAS reconfiguration timeframe to 300 seconds.¹²⁷ Both Nokia Solutions and WinnForum indicated that, while not ideal, a 300-second reconfiguration window would be adequate for a majority of CBSDs to effectively cease transmitting or transition to a non-interfering frequency.¹²⁸ They do not provide a basis for why as much as 600-seconds is needed, even for a large network. We also amend 96.15(a)(4) and 96.15(b)(4) to clarify that the 300-second reconfiguration window applies to notifications regarding federal use from the ESC or any other source, including federal Incumbent Users themselves.¹²⁹ This modification is necessary to ensure that federal Incumbent Users are protected from harmful interference in all circumstances. However, the 300-second timeframe will not necessarily apply if the President of the United States (or another designated

¹²¹ See Google Reply at 2.

¹²² See SIA Petition at 12.

¹²³ See *id.* at 11-12.

¹²⁴ See *id.* at 24.

¹²⁵ See Google Reply at 2.

¹²⁶ See Nokia Solutions Petition at 6.

¹²⁷ See Appendix A, §§ 96.15 (a)(4) ;96.15(b)(4).

¹²⁸ See *Ex Parte* Letter from Brian Hendricks, Head of Technology Policy and Government Relations Nokia (d/b/a/ Nokia Solutions and Networks US LLC) to Marlene H. Dortch in GN Docket No. 12-354 (filed Aug. 20, 2015) Attachment at 6 (Nokia Solutions August 2015 *Ex Parte*) at 2; WinnForum Petition at 4.

¹²⁹ See Appendix A, §§ 96.15 (a)(4) and 96.15(b)(4).

Federal Government entity) issues instructions to discontinue use of CBSDs pursuant to Section 706 of the Communications Act of 1934, as amended (War Powers of President).¹³⁰ In such cases, SAS Administrators must instruct CBSDs to cease operations as soon as technically possible (but no more than 300-seconds). We also note that at this time there is no indication of how the increase in the SAS reconfiguration time will impact federal radar systems. If it is demonstrated there is an operational impact to the federal radar systems, the Commission will review the SAS reconfiguration timeframe and will take appropriate steps to address the operational impact to federal radar systems.

65. While some commenters claim that even this extended reconfiguration window may cause service interruptions in some cases, we believe that 300 seconds will ordinarily provide operators with sufficient time to smoothly discontinue transmissions or move to non-interfering frequencies. Moreover, given the critical importance of the federal operations in the band, we must ensure that CBSDs are shut down as quickly as possible after the presence of federal operations is reported by an ESC or actual interference is reported by a federal user. This change also resolves the tension between sections 96.15 and 96.39 pointed out by Google.¹³¹ Therefore, we find that a 300-second response timeframe strikes the appropriate balance between protecting incumbent operations and facilitating commercial deployments in the band. In addition, given the technical capabilities of SASs and CBSDs, we believe that it is both reasonable and technically feasible to require Citizens Broadband Radio Service users to comply with this modified response timeframe.

66. We refuse SIA's request to shorten the 60-second CBSD reconfiguration timeframe in section 96.39 of the rules.¹³² As Google correctly notes, SIA's arguments on this point were considered by the Commission when the rule was adopted.¹³³ SIA does not raise any substantive new arguments that would compel us to override our prior decision. To the extent that incumbent FSS earth station licensees may have specific, time-limited requests for protection during certain periods, we encourage FSS licensees to work with SAS Administrators to address these concerns. As detailed in section III(H)(2) and section 96.17(f), SAS Administrators must develop procedures to receive and respond to such requests. Accordingly, in light of this requirement, we continue to believe that the 60-second CBSD reconfiguration timeframe in section 96.39 is sufficient to ensure that federal and non-federal users are protected.

D. CBSD Power Limits

67. *Background.* In the *3.5 GHz R&O*, the Commission found 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."¹³⁴ To advance this goal, the Commission defined two categories of CBSDs - Category A and Category B - with parameters appropriate for different use cases. Category A and Category B CBSDs are differentiated primarily by their maximum permissible power and the rules governing their deployment. In addition, Category B CBSDs may only be authorized in the 3550-3650 MHz portion of the band after an ESC is approved and operational.¹³⁵ GAA users and Priority Access Licensees may operate CBSDs in both categories and must operate in accordance with instructions from an SAS which, for interference prevention purposes, may authorize an operational power level below the maximum allowable power level.¹³⁶

¹³⁰ 47 U.S.C. § 606 (War Powers of President).

¹³¹ See Google Opposition at 18-19; 47 C.F.R. §§ 96.15(a)(4), 96.39 (c)(2).

¹³² See SIA Petition at 12.

¹³³ See Google Opposition at 19-20.

¹³⁴ See *3.5 GHz R&O*, 30 FCC Rcd at 4024, ¶ 205.

¹³⁵ Category B CBSDs are permitted in the 3650-3700 MHz band prior to ESC deployment. See 47 C.F.R. § 96.45.

¹³⁶ See *3.5 GHz R&O*, 30 FCC Rcd at 4024, ¶ 205; 47 C.F.R. §§ 96.41, 96.43, and 96.45.

68. Category A CBSDs are limited to a maximum conducted transmit power of 24 dBm and a maximum EIRP of 30 dBm in 10 megahertz and may be deployed either indoors or outdoors (with antennas for outdoor deployments not exceeding 6 meters height above average terrain).¹³⁷ These parameters are consistent with the baseline small cell use case proposed in the *FNPRM* and the phased federal-commercial sharing plan proposed by NTIA and adopted in the *3.5 GHz R&O*.¹³⁸

69. Category B CBSDs, which may only be used outdoors, are permitted to operate at higher power than Category A, providing greater flexibility and ensuring ongoing compatibility with existing 3650-3700 MHz band operations.¹³⁹ In non-rural areas, the conducted power limit is the same as Category A (24 dBm/10 MHz), but the EIRP limit is 40 dBm/10 MHz. In rural areas, the conducted power limit is increased to 30 dBm/10 MHz and EIRP to 47 dBm/10 MHz.¹⁴⁰ The EIRP limit was set to encourage the use of higher gain antennas and directional transmission in urban areas to facilitate co-existence of PALs and GAAs in spatially tight spectrum sharing environment. 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.¹⁴¹

70. CTIA, Motorola Solutions, Nokia Solutions, Verizon, and WinnForum petitioned the Commission to increase CBSD power limits.¹⁴² AT&T and Federated Wireless supported these arguments.¹⁴³ Petitioners assert that the maximum power levels for Category A devices should be raised to 36 dBm EIRP.¹⁴⁴ Petitioners contend that the Category A power levels adopted by the Commission are insufficient to provide significant indoor coverage.¹⁴⁵ Nokia Solutions and WinnForum also contend that a 36 dBm maximum EIRP would be consistent with levels the Commission has approved for unlicensed devices.¹⁴⁶

71. Petitioners also argue that the maximum permissible EIRP for Category B CBSDs should be raised to 49 dBm for non-rural deployments and to 56 dBm for rural deployments.¹⁴⁷ WinnForum contends that the proposed increases would bring the Commission's rules in line with the power levels of existing urban pico-cells.¹⁴⁸ Verizon contends that the maximum EIRP that the Commission adopted for Category B CBSDs is well below the power levels of the small cells that are used in current licensed deployments. Verizon also argues that the existing rules would significantly limit the coverage that each

¹³⁷ 47 C.F.R. § 96.41(b) and 96.43(a).

¹³⁸ See *3.5 GHz FNPRM*, 29 FCC Rcd at 4278, 4281, 4308-4309, ¶¶ 13-14, 17, 114; *3.5 GHz R&O* at 3972, 3975, ¶¶ 34, 44; 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) at 4-5.

¹³⁹ See 47 C.F.R. §§ 96.41(b), 96.45.

¹⁴⁰ See *id.* § 96.41(b).

¹⁴¹ See *3.5 GHz R&O*, 30 FCC Rcd at 4025, ¶ 209.

¹⁴² See CTIA Petition at 7; Motorola Solutions Petition at 4; Nokia Solutions Petition at 6-7; Verizon Petition at 3-4; WinnForum Petition at 6-7.

¹⁴³ See AT&T Reply Comments at 7; Federated Wireless Opposition at 2-3.

¹⁴⁴ See CTIA Petition at 6-7; Federated Wireless Reply at 3-5; Nokia Solutions Petition at 9; Verizon Petition at 5; WinnForum Petition at 6-7.

¹⁴⁵ See WinnForum Petition at 6; Nokia Solutions Petition at 8;

¹⁴⁶ Nokia Solutions Petition at 8; WinnForum Petition at 6.

¹⁴⁷ See; CTIA Petition at 6-7; Federated Wireless Opposition at 3-5; Motorola Solutions Petition at 3; Nokia Solutions Petition at 7-9; Verizon Petition at 3-5; WinnForum Petition at 6-7.

¹⁴⁸ See CTIA Petition at 7-8; Nokia Solutions Petition at 7-9; WinnForum Petition at 6-7.

cell could achieve, driving up network costs.¹⁴⁹ Federated Wireless agrees and adds that “Even at the increased EIRP limit, CBSDs will still operate at power levels no greater than those employed in typical small cell deployments.”¹⁵⁰

72. Many petitioners also assert that the Commission should increase the flexibility for operators to deploy lower gain antennas by relaxing the limitations on conducted power for Category A and B CBSDs.¹⁵¹ For example, Nokia Solutions and Verizon argue that the limitations on conducted power should be removed entirely to provide additional flexibility network operators in the 3.5 GHz Band.¹⁵² WinnForum proposes that the allowed conducted power be scaled up 1 dB for each 1 dB lost in antenna gain, up to the maximum of 40 dBm conducted power for Category B CBSDs.¹⁵³ WinnForum argues that this approach would not preclude the use of omni-directional antennas while still maintaining adequate coverage areas for outdoor deployments.¹⁵⁴

73. SIA opposes any increase in maximum EIRP for Category A or Category B CBSDs and, in fact, argues that they should be reduced to levels stated in the *FNPRM*.¹⁵⁵ SIA contends that higher EIRP limits will increase the risks of interference with incumbent FSS earth stations and significantly increase the size of required separation distances around these stations. They also see risks associated with not limiting the antenna height for Category B CBSDs due to interference to incumbent in-band and out-of-band FSS receivers.¹⁵⁶

74. WISPA argues that the Commission should not change the maximum allowable EIRP for Category B CBSDs. In WISPA’s view, the Commission’s rules strike the proper balance between various interests and encourage operators of outdoor networks to deploy more efficient, high-gain, sectorized antennas.¹⁵⁷ Federated Wireless disagrees with WISPA and contends that increased EIRP and flexibility is essential to promote innovation and enable more efficient spectrum use.¹⁵⁸

75. *Discussion.* After review of the record, we agree with commenters that contend that additional flexibility for non-rural outdoor CBSDs would promote deployment in the band and, accordingly, we increase the maximum allowable EIRP for non-rural Category B CBSDs from 40 dBm/10 MHz to 47 dBm/10 MHz, making the power levels allowed for both non-rural and rural deployments the same. Category B CBSDs will continue to be authorized for use in the 3550-3650 MHz band only after an ESC is approved and commercially deployed consistent with Sections 96.15 and 96.67. We also eliminate the conducted power limits for all CBSDs. However, we also conclude that it would not be in the public interest to increase the maximum allowable EIRP for Category A CBSDs and rural Category B CBSDs beyond the levels established in the *3.5 GHz R&O*. Combined, these changes will provide increased flexibility to all network operators without increasing the potential for interference in the 3.5 GHz Band.

¹⁴⁹ See Verizon Petition at 3-4; Verizon Opposition at 3-4.

¹⁵⁰ See Federated Wireless Opposition at 4.

¹⁵¹ See e.g., Federated Wireless Opposition at 3-5; Motorola Solutions Petition at 3; Nokia Solutions Petition at 7-9; Verizon Petition at 3-5; WinnForum Petition at 6-7.

¹⁵² See Nokia Solutions Petition at 7; Verizon Petition at 4 and Solondz Declaration at 3-4. See also T-Mobile Opposition at 6-8.

¹⁵³ See WinnForum Petition at 7-9.

¹⁵⁴ See *id.* at 7-9.

¹⁵⁵ See SIA Petition at 6-7.

¹⁵⁶ See *id.*; SIA Opposition at 6-7.

¹⁵⁷ See WISPA Opposition at 4-5.

¹⁵⁸ See Federated Wireless Reply at 3-5.

76. As we stated in the *3.5 GHz R&O*, we are cognizant that the determination of power limits for all categories of CBSD must balance the consideration of several different public interest objectives.¹⁵⁹ On the one hand, higher limits may provide more technical and operational flexibility for users of the band to increase coverage with fewer CBSDs, 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. Our determinations herein strive to balance these considerations to create a flexible regime suitable for a wide variety of use cases.

77. With regard to Category B CBSDs, we agree with commenters that higher maximum EIRP may help promote more flexible use and reduce deployment costs in non-rural areas while not significantly increasing coexistence issues.¹⁶⁰ Specifically, we increase the maximum EIRP for Category B CBSDs in non-rural areas to 47 dBm/10 MHz to match the maximum EIRP permitted in rural areas. Petitioners generally argue that higher power is needed to facilitate network deployment and decrease costs. Although we remain concerned about more substantial power increases in more congested areas, we agree that allowing non-rural CBSDs to match the EIRP of rural CBSDs is consistent with the Commission's goals for the Citizens Broadband Radio Service and is a modest increase that will not adversely affect the interference environment in the 3.5 GHz Band.

78. However, we do not agree that the maximum EIRP for Category B CBSDs should be increased to 49 dBm/10 MHz in non-rural areas and 56 dBm/10 MHz in rural areas as requested by several petitioners.¹⁶¹ While we see the merit in increasing the maximum power available to network operators using Category B CBSDs in non-rural areas, we believe that an increase to 47 dBm/10MHz to match the level permitted for rural CBSDs will adequately address the concerns raised by Petitioners without negative effects on the interference environment in the band. This change represents a significant increase in power for non-rural applications with a corresponding potential for more coverage area for each CBSD. This change will also simplify the rules by removing the distinction between rural and non-rural power levels, allowing for uniform development and deployment of Category B CBSDs. We also note that Category B CBSDs will continue to be authorized for use in the 3550-3650 MHz band only after an ESC is approved and commercially deployed consistent with Sections 96.15 and 96.67.

79. We continue to believe that the power limit that we adopted for Category A CBSDs in the *3.5 GHz R&O* is appropriate for the baseline - primarily indoor or at street level - small cell use case in the band.¹⁶² Moreover, the Exclusion Zones protecting federal radar systems that were studied by NTIA and adopted in the *3.5 GHz R&O* are based on a maximum EIRP of 30 dBm/10 MHz.¹⁶³ Any change to the maximum EIRP for Category A CBSDs would require the Exclusion Zones to be reconsidered and expanded, preventing deployment in large portions of the country prior to the development and approval of an ESC.

80. While we acknowledge that some petitioners would prefer that we increase the Category A power levels to allow higher power levels indoors, we believe that the rules appropriately balance the need for operational flexibility with the need to promote efficient spatial and spectral reuse of the band.¹⁶⁴ Transmitting at higher power levels indoors and low outdoor elevations - especially in high traffic areas with multiple PALs and GAAs operating in the same or nearby locations - would likely present

¹⁵⁹ See *3.5 GHz R&O*, 30 FCC Rcd at 4026-27, ¶ 214.

¹⁶⁰ See CTIA Petition at 6-7; Motorola Solutions Petition at 3; Nokia Solutions Petition at 7-9; Verizon Petition at 3-5; WINN Forum Petition at 6-7; Federated Wireless Opposition at 3-5.

¹⁶¹ See CTIA Petition at 7; Nokia Petition at 9; Verizon Petition at 5.

¹⁶² See *id.* at 4024, ¶ 206; *3.5 GHz FNPRM*, 29 FCC Rcd at 4295, ¶ 70;

¹⁶³ See *3.5 GHz R&O*, 30 FCC Rcd at 4038-39, ¶ 259-60.

¹⁶⁴ See CTIA Petition at 7; Motorola Petition at 4; Nokia Solutions Petition at 6-7; T-Mobile Petition at 7; Verizon Petition at 3-4; WinnForum Petition at 6-7.

significant coexistence challenges. Higher power levels in dense indoor deployments would also increase the likelihood of interference from operators assigned to adjacent channels due to receiver blocking effects. Thus, given the interference risks associated with higher power levels, the delays in deployment of this new service that would result from revisiting the size of the Exclusion Zones prior to implementing an ESC capability, and the disruption to the balance between PAL and GAA use struck in the *3.5 GHz R&O*, we conclude that the maximum EIRP for Category A CBSDs should remain capped at 30 dBm/10 MHz.

81. We are also cognizant of the concerns raised by SIA regarding the need for greater protections for FSS earth stations in the presence of higher power CBSDs but note that the FSS interference protection criteria described in section IV(C)(1) addresses these concerns.¹⁶⁵ We emphasize that the increase in allowable EIRP for non-rural Category B CBSDs is an increase in the *maximum allowable* EIRP and should not be construed as a guaranteed power level for CBSD deployments, whether they are operated on a GAA or Priority Access basis. We note that CBSDs must still comply with the Commission's rules to prevent interference to Incumbent Users, including the requirements to operate only at power levels and in locations authorized by the SAS.¹⁶⁶ Indeed, given that the potential for co-channel and adjacent channel interference may increase at higher power levels, the SAS's responsibility to authorize lower maximum operational power limits, when and where needed to meet the interference protection requirements as defined in Commission's rules, will be even more important in light of the increased maximum power levels authorized herein.

82. Finally, we find that removing maximum conducted power limits for all CBSDs will provide operators with additional flexibility for network deployments and encourage investment in the band.¹⁶⁷ Several petitioners, including WinnForum, Verizon, and Federated Wireless, contend that the Commission's rules requiring Category B CBSDs to use sectorized, highly directional antennas in urban areas would lead to inefficient deployments.¹⁶⁸ Notably, Federated Wireless contends that, since most CBSDs will be deployed below the clutter in urban areas, sectorized antennas would be unable to provide the coverage needed for urban deployment.¹⁶⁹ In addition, since the Exclusion Zones and other protection contours in the band are based on EIRP, removing the conducted power limits should not increase the required protection areas around incumbent sites. Therefore, we agree with petitioners that, on balance, increased flexibility will serve the public interest and promote investment in the 3.5 GHz Band. We note that this has no impact on our OOB requirements, which continue to be expressed in terms of conducted power. That is, although the rule changes described in this section will allow higher total conducted power, they do not allow higher OOB power.

83. In making this change to remove maximum conducted power limits for all CBSDs we also recognize that we must limit the peak to average power ratio (PAPR) of signals in the band so that excessive peak power levels do not cause transient interference into other systems. Many commenters have expressed interest in deploying LTE equipment in the 3.5 GHz Band. We note that such signals use

¹⁶⁵ See SIA Petition at 6-7; SIA Opposition at 6-7.

¹⁶⁶ 47 C.F.R. § 96.39(c).

¹⁶⁷ We also change the title of 96.41(b) from "Conducted and Radiated Power Limits" to "Power Limits" to reflect the changes to the maximum power limits adopted herein.

¹⁶⁸ See Federated Wireless Opposition at 3-4 ("in many urban scenarios—the very environment where small cells could provide the greatest utility—the radio node will be situated below local clutter, and thus sectorized installations are not practical"); Verizon Petition at 4 ("exclusively using sectorized antennas for covering reasonable-sized areas in urban or suburban environments would be inefficient and inconsistent with typical deployments in such settings"); WinnForum Petition at 9 ("use of highly directional antennas in urban environments, especially those with narrow vertical (elevation plane) half power beamwidths is often not advantageous").

¹⁶⁹ See Federated Wireless Opposition at 3-4.

OFDM based modulation, which can have a large PAPR. NTIA recently published emission spectrum measurements for a 3.5 GHz LTE hot spot device shows that the peak to average ratio of such devices may range as high as 12-13 dB.¹⁷⁰ Thus, based on these measurements and consistent with the Commission's rules in other licensed mobile broadband services, we are limiting CBSD PAPR to no more than 13 dB.¹⁷¹

84. Finally, SIA argues that unlimited antenna heights for Category B CBSDs will necessitate larger protection areas for FSS earth stations.¹⁷² SIA does not propose a specific remedy or alternate rule governing antenna heights.¹⁷³ We note that Category B CBSDs are required to report antenna height as part of their CBSD registration under section 96.45(d) and SASs are required to take such antenna height (along with maximum power, location, antenna configuration, and other registered information) into consideration when calculating potential interference effects and protection distances.¹⁷⁴ Indeed, the protection criteria set forth in the rules may require an effective limit on Category B antenna elevation in some cases. We continue to believe that the SAS can utilize information reported by CBSDs to effectively coordinate operations in the 3.5 GHz Band and see no reason to impose restrictions on the height of Category B CBSD antennas at this time.

E. OOB and Adjacent Channel Emissions Limits

1. OOB and Adjacent Channel Emissions

85. *Background.* In the 3.5 GHz R&O, we adopted emissions and interference limits that will further the Commission's goals and promote effective coexistence of different users in the band. Specifically, we adopted the following conducted OOB limits for devices in the Citizens Broadband Radio Service:

- -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

86. CTIA, Nokia Solutions, and SIA petition the Commission to change its OOB limits. CTIA contends that the -40 dBm/MHz OOB limit simply is too restrictive and is not necessary to protect operations in the adjacent band below 3530 MHz and above 3720 MHz.¹⁷⁵ CTIA also asserts that, if the Commission determines that the -40 dBm/MHz limit is necessary to protect adjacent operations, the Commission should increase the transition gap to 40 megahertz to allow operators using 20 megahertz LTE channels to operate at higher power.¹⁷⁶ Qualcomm supports CTIA's comments and asserts that the

¹⁷⁰ See NTIA Technical Report TR 15-512, Emission Spectrum Measurements of a 3.5 GHz LTE Hotspot, available at <http://www.its.bldrdoc.gov/publications/2790.aspx>.

¹⁷¹ See 47 C.F.R. § 24.232(d) (PAPR for Broadband PCS station transmission may not exceed 13 dB). See 47 C.F.R. §§ AWS bands 27.50(a)(1)(B), 27.50(d)(5) (the PAPR of the transmit output power of AWS band stations may not exceed 13 db).

¹⁷² See SIA Opposition at 7, 9.

¹⁷³ See Federated Wireless Opposition at 13-14. SIA asks the Commission to reconsider the increase in maximum EIRP for Category B CBSDs and the decision not to impose height limits on such deployments and "revert to the original proposals in the Further Notice." However, the Commission did not propose height restrictions in the FNPRM. See SIA Petition at 9.

¹⁷⁴ See 47 C.F.R. §§ 96.17(d), 96.45(d), 96.53, 96.55.

¹⁷⁵ See CTIA Petition at 5-7.

¹⁷⁶ See *id.* at 6.

FCC should not implement tighter OOB limits at the 3700 MHz band edge for certain classes of devices to protect C-band FSS earth stations.¹⁷⁷ According to Qualcomm, stringent OOB limits will challenge equipment designs and likely force mobile devices to use significantly less power and/or operate well inside the 3.5 GHz Band edges to comply.¹⁷⁸ Google, T-Mobile, and WISPA also support relaxation of the OOB limits.¹⁷⁹

87. Nokia Solutions recommends that the Commission define OOB limits that comply with 3GPP specifications and would allow the use of Bands 42 and 43 in the United States. According to Nokia only the requirement of -25 dBm/MHz beyond 10 MHz from the assigned channel edge down to 3530 MHz and up to 3720 MHz complies with the 3GPP specification.¹⁸⁰

88. CTIA also argues that the Commission should adopt a limit of -13 dBm/MHz from 0-20 megahertz outside the assigned channel edge and a limit of -25 dBm/MHz for frequencies more than 20 megahertz outside each assigned channel edge.¹⁸¹ Qualcomm agrees and contends that the emissions limits that apply outside of the channel of operation were designed around supporting 10 MHz-wide LTE channels, and thus would force 20 MHz LTE and 40 MHz LTE operations to use substantially lower transmit power than the level 10 MHz LTE operations are permitted to use.¹⁸² According to Qualcomm, such reductions will create coverage challenges and limit the band's ability to support wider bandwidth LTE operations.¹⁸³ Similarly, T-Mobile argues that 20 megahertz LTE channels would have to be at least 20 megahertz from the channel-edge to meet the -25 dBm/MHz limit without significantly reducing power levels. The reduced power necessary to meet the -25 dBm/MHz limit would in turn reduce coverage of those 20 megahertz channels and would depress operators' desire to deploy those channels.¹⁸⁴

89. On the other hand, SIA argues that more restrictive OOB limits are needed to effectively protect C-Band FSS earth stations from CBSD transmissions.¹⁸⁵ SIA also asserts that the OOB limits adopted by the Commission were implemented without the required legal notice.¹⁸⁶ According to SIA, under the Commission's current OOB rules, separation distances between CBSDs and FSS earth stations could be more than 15 km.¹⁸⁷ GCI also argues that the Commission should implement more stringent OOB limits at the upper edge of the 3.5 GHz Band.¹⁸⁸ According to GCI, at a

¹⁷⁷ See Qualcomm Opposition at 2, 6-7.

¹⁷⁸ See *id.* at 2, 5.

¹⁷⁹ See T-Mobile Opposition at 9; WISPA Opposition at 7; See *Ex Parte* Letter from Austin C. Schlick, Director, Communications Law, Google, Inc. to Marlene H. Dortch, Secretary, Federal Communications Commission in GN Docket No. 12-354 (filed April 14, 2016) (Google April 14 *Ex Parte*); *Ex Parte* Letter from Austin C. Schlick, Director, Communications Law, Google, Inc. to Marlene H. Dortch, Secretary, Federal Communications Commission in GN Docket No. 12-354 (filed April 22, 2016) (Google April 22 *Ex Parte*)

¹⁸⁰ See Nokia Solutions Petition at 11 and 12.

¹⁸¹ See CTIA Reply at 3.

¹⁸² See Qualcomm Opposition at 6-7.

¹⁸³ See *id.* at 2, 4.

¹⁸⁴ See T-Mobile Petition at 6.

¹⁸⁵ See SIA Petition at 3-4.

¹⁸⁶ See SIA Opposition at 2.

¹⁸⁷ See *id.* at 2.

¹⁸⁸ See GCI *Second FNPRM* Reply Comments at 8; *Ex Parte* Letter from Michael Lazarus, Counsel, Telecommunications Law Professionals PLLC, to Marlene H. Dortch in GN Docket No. 12-354 (filed Sept. 21, 2015) (GCI September 2015 *Ex Parte*) at 2.

minimum, a -40 dBm/MHz limit should be implemented at the band edge to protect C-Band FSS earth station receivers.¹⁸⁹

90. Some parties support the Commission's current OOB limits. Notably, Verizon argues that the current OOB limits are sound and oppose further OOB restrictions.¹⁹⁰ Federated Wireless also contends that the Commission need not reconsider the OOB issue now.¹⁹¹

91. *Discussion.* After review of the diverse record on this issue, we deny the petitions for reconsideration that requested changes to the OOB limits that the Commission adopted in the *3.5 GHz R&O*.¹⁹² We continue to believe that the existing OOB rules properly balance the need to protect operations in adjacent bands – and in adjacent channels within the 3.5 GHz Band – with the need to create an environment that will promote robust deployment of broadband systems in the band.

92. We also believe that, while the OOB limits are more restrictive than those in other bands, they are wholly consistent with the capabilities of the equipment and services likely to be deployed in the 3.5 GHz Band. For emissions below 3530 MHz and above 3720 MHz, NTIA measurements show that the OOB of commercial products that operate within the 3.5 GHz Band can be lower than -40 dBm / MHz at offsets higher than 20 megahertz.¹⁹³ Thus, according to NTIA research, the approach adopted by the Commission appears to be practically realizable with existing state-of-the-art products at little or no added cost and will provide additional protection for incumbent systems while allowing for more extensive deployment of CBSDs in the 3.5 GHz Band.¹⁹⁴

93. We disagree with CTIA and Qualcomm's argument that the Commission's OOB limits should be changed since they would force operators using 20 megahertz channels to reduce power to comply with the rules.¹⁹⁵ As we noted in the *3.5 GHz R&O*, 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.¹⁹⁶ While Citizens Broadband Radio Service users are permitted to aggregate PAL channels or operate across wider bandwidths - consistent with section 96.31 - the technical rules required for effective coexistence between and among different users of the band do not change, regardless of the how much bandwidth is in use. We also note that power reduction may not be necessary if Citizens Broadband Radio Service users utilize robust filters or other alternative methods to address our OOB limits. While the flexibility to aggregate spectrum is a key element of the Commission's licensing regime, reducing OOB limits solely to accommodate wider bandwidths would not further the principles of shared access that are at the heart of this proceeding.

94. Moreover, petitioners do not provide convincing evidence or technical analysis to support their claims regarding power reduction nor do they address the potential effects such changes could have

¹⁸⁹ See GCI Opposition at 8.

¹⁹⁰ See Verizon Opposition at 4.

¹⁹¹ See Federated Wireless Opposition at 13.

¹⁹² See CTIA Petition at 5-7; Nokia Solutions Petition at 10-12; SIA Petition at 3-6.

¹⁹³ See *3.5 GHz R&O*, 30 FCC Rcd at 4019-20, ¶ 189, nn.430-31 *citing* NTIA Technical Report TR 15-512, Emission Spectrum Measurements of a 3.5 GHz LTE Hotspot *available at* <http://www.its.bldrdoc.gov/publications/2790.aspx>; NTIA Technical Report 14-506, Effects of Radar Interference on LTE (FDD) eNodeB and UE Receiver Performance in the 3.5 GHz Band, *available at* <http://www.its.bldrdoc.gov/publications/2759.aspx>.

¹⁹⁴ These protections are designed to accommodate not only C-Band FSS earth stations, operating at frequencies above the 3.5 GHz Band, but also DoD ground-based radar systems operating at frequencies below 3550 MHz.

¹⁹⁵ See CTIA Reply at 3. See also Qualcomm Opposition at 2; T-Mobile Opposition at 6.

¹⁹⁶ See *3.5 GHz R&O*, 30 FCC Rcd at 3989, ¶ 91.

on adjacent channel operations.¹⁹⁷ We also expect to see more spectrally efficient commercial products enter the marketplace in the near future that will meet or exceed our requirements. The current rules support the development of such new and innovative technologies while ensuring a proper balance between the current and future users of the band.

95. We also reject SIA's arguments that the strictest OOB limits adopted by the Commission (-40 dBm/MHz) should have been set beginning at 3680 MHz, which is 20 megahertz below the lower edge of the adjacent C-Band, rather than at 3720 MHz. SIA argues that failing to do so will lead to impermissible interference into C-Band FSS earth stations. As we stated in the *3.5 GHz R&O*, the -13 dBm/MHz OOB limit at the band edge is consistent with Commission precedent both in this band and in other licensed spectrum bands. In addition, the transition gap that requires OOB to drop to -25 dBm/MHz after a 10 megahertz offset and -40 dBm/MHz above 3720 megahertz is significantly more stringent than limits in other bands or the limits that the Commission previously adopted for the 3650-3700 MHz Wireless Broadband Radio Service.¹⁹⁸ The Commission adopted these more stringent limits in recognition of the need to provide additional protection for important operations in the C-Band. Indeed, as detailed above, several petitioners continue to object to these limits as too stringent for certain wireless broadband uses in the Citizens Broadband Radio Service.¹⁹⁹ After review of the record, we remain convinced that the OOB limits adopted in the *3.5 GHz R&O* strike the appropriate balance between the need to facilitate innovation and investment in the 3.5 GHz Band and the need to protect licensed C-Band FSS earth stations from interference.

96. However, while we maintain the existing OOB limits, we do acknowledge SIA's concerns regarding potential interference into C-Band receivers used for critical telemetry, tracking, and control (TT&C) operations at the band edge.²⁰⁰ Therefore, as detailed in section IV(C)(2), we adopt rules to provide additional protection for these facilities.²⁰¹ We also adopt new rules to facilitate coordination between Citizens Broadband Radio Service users and licensed C-Band FSS earth stations to address any interference issues that may arise.²⁰²

97. Finally, we reject SIA's assertion that the Commission did not provide proper notice prior to adopting the current OOB rules in the *3.5 GHz R&O*.²⁰³ As SIA itself notes, in the *FNPRM*, the Commission: (1) proposed an OOB limit of -13 dBm/MHz at the band edge and -40 dBm/MHz and 30 megahertz above and below the proposed band edges; (2) sought comment on both OOB limits and the size of the transition gap; and (3) sought comment on extending the Citizens Broadband Radio Service to 3700 MHz.²⁰⁴ Even prior to that time, the *Licensing PN* sought comment on "[w]hat provisions would need to be made for incumbent operators" if the band were so extended.²⁰⁵ And in the *3.5 GHz R&O*

¹⁹⁷ Google asserts that it has tested a currently available device that is unable to comply with the Commission's OOB rules while operating at full power and that relaxing the OOB limits will not materially increase the risk of harmful interference to adjacent channel users. However, Google does not provide specific test results or technical analysis to support these claims. See Google April 14 *Ex Parte*; Google April 22 *Ex Parte*.

¹⁹⁸ See CTIA Opposition at 3; CTIA Reply at 4. See *3.5GHz R&O*, 30 FCC Rcd at 4047, ¶ 293. See In the Matter of Wireless Operations in the 3650-3700 MHz Band Rules for Wireless Broadband, ET Docket No. 04-151, *Report and Order and Memorandum Opinion and Order*, 20 FCC Rcd 6502, 6530, ¶ 75 (2005) (*3650-3700 MHz Band R&O*).

¹⁹⁹ See CTIA Opposition at 2-5; Qualcomm Opposition at 6-7.

²⁰⁰ See SIA Petition at 4.

²⁰¹ See section IV(C)(2).

²⁰² See sections III(H)(2), IV(C)(2).

²⁰³ SIA Petition at 5.

²⁰⁴ See *3.5 GHz FNPRM*, 29 FCC Rcd at 4298-99; 4322-24, ¶¶ 81; 83-84; 163-169.

²⁰⁵ *Licensing PN*, 28 FCC Rcd at 15315-16, ¶ 51.

itself, the Commission determined to seek *further* comment on “steps we can take over and above those we’ve already taken to preempt and mitigate the potential for interference” to incumbent C-Band licensees, referring specifically to “our baseline emission performance rule.”²⁰⁶

98. As SIA correctly states, “a final rule need not be an exact replica of the rule proposed in the Notice, the final rule must be a ‘logical outgrowth’ of the rule proposed.”²⁰⁷ In this case, the Commission had sought comment on the need for interference protections relating to extension of the band edge from 3650 MHz to 3700 MHz. The OOB limits later proposed in the *FNPRM* were clearly intended to apply to the upper and lower bounds of the Citizens Broadband Radio Service and the Commission made it clear that those bounds could extend to 3700 MHz. Indeed, the Commission originally sought comment on extending the Citizens Broadband Radio Service to 3700 MHz in the original *NPRM* released in December of 2012.²⁰⁸ Thus, the extension of the 3.5 GHz Band - and with it the OOB rules applicable at and beyond the band edge - was wholly foreseeable and a clear logical outgrowth of the Commission’s proposals. In addition, the *3.5 GHz R&O* itself provided parties with yet a further opportunity to comment on the approaches that the Commission could utilize to protect C-Band FSS earth stations.²⁰⁹

2. Emission Power Measurements and Testing Methodology

99. *Background.* In the *3.5 GHz R&O*, we adopted a rule that requires that emission power measurements be performed with a peak detector in maximum hold.²¹⁰ CTIA objects to this testing methodology and asks the Commission to adopt a different measurement technique.²¹¹ Qualcomm, T-Mobile, WinnForum, and WISPA support CTIA’s request. CTIA contends that the use of an RMS detector to measure emissions would be wholly consistent with the Commission’s rules governing most other commercial licensed and unlicensed services.²¹² In addition, CTIA states that the peak to average ratio for emissions from LTE signals can easily exceed 10 dB and compelling Citizens Broadband Radio Service users to operate with that much less power would effectively cripple the band’s ability to support mobile broadband operations.²¹³ WISPA agrees and adds that, not only would measuring at peak power require mobile operations to operate at significantly less power, but this would similarly impinge upon the ability of fixed providers to operate at the maximum authorized power.²¹⁴

100. In addition, WinnForum argues that 10+ dB signal strengths over average captured by the current rule would exist for less than 0.01% of the time for any one signal.²¹⁵ WinnForum also contends that requiring devices to be tested using a peak detector at maximum hold effectively requires that devices be certified at the maximum possible signal strength at any given time and is a very poor representation of actual interference impact.²¹⁶ According to WinnForum, the Part 96 emission limits are already stringent,

²⁰⁶ *3.5 GHz R&O*, 30 FCC Rcd at 4047-48, ¶ 296.

²⁰⁷ See SIA Petition at 5-6 quoting National Black Media Coal. v. FCC, 791 F.2d 1016, 1022 (D.C. Cir. 1986).

²⁰⁸ See *3.5 GHz NPRM*, 27 FCC Rcd at 15620-22, ¶¶ 77-82.

²⁰⁹ See *Second FNPRM*, 30 FCC Rcd at 4089-90, ¶¶ 443-45.

²¹⁰ See *3.5 GHz R&O*, 30 FCC Rcd at 4116. See 47 C.F.R. § 96.41(e)(3)(iv).

²¹¹ See CTIA Petition at 6-7.

²¹² See *id.* at 6-7.

²¹³ See *id.* at 6-7.

²¹⁴ See WISPA Opposition at 7.

²¹⁵ See also *Ex Parte* Letter from the Wireless Innovation Forum to Marlene H. Dortch in Docket No. 12-354 (filed Dec. 7, 2015) (WinnForum December 2015 *Ex Parte*) at slide 11.

²¹⁶ *Id.* at 16. (“The combination of peak detector and max hold displays maximum signal encountered in each bucket over each sweep, combined with the maximum signal encountered for each bucket over all of the sweeps... For

(continued...)

and become simply unattainable when adding over 10dB penalty through the peak detector/max hold requirement. WinnForum also claims that the effects would likely be similar for other wideband systems (Wi-Fi, WiMAX, etc.).²¹⁷

101. SIA disagrees with WinnForum and argues that the Commission should retain the peak measurement test for OOB. ²¹⁸ SIA states that ignoring peak emission levels in favor of reliance on average measurements would undermine the prophylactic objectives of the OOB limits. ²¹⁹ SIA contends that, by CTIA's own admission, the change would allow power increases of 10 dB or more. According to SIA, because peak emissions can have significant interference effects, the Commission must continue to require use of a peak detector to determine OOB limit compliance. ²²⁰

102. Google supports WinnForum's filing and argues that SIA's claims should be rejected. ²²¹ Google asserts that all signals, including LTE, Wi-Fi, WiMAX, and even Gaussian thermal noise will have statistical variations in the instantaneous amplitude of the waveform and argues that, for this reason neither cellular, AWS, PCS, or 700 MHz emission are measured using peak hold. Google also asserts that, since the PAPR and signal statistics of LTE and Gaussian thermal noise are similar, the measurement of their interference potential should be treated in the same way. Accordingly, Google argues that if SIA insists on measuring CBSD emissions using peak values, the system noise of FSS receivers should be characterized in the same manner. ²²²

103. *Discussion.* After careful review of the record, we conclude that emission power measurements may be performed using either RMS-detection or peak-detection. We agree with petitioners that requiring the use of a peak detector operating at maximum hold to test emission limits does not serve the public interest. As WinnForum argues, requiring the use of peak measurements may effectively prevent the development and deployment of equipment in the band. ²²³ Moreover, the decision to allow the use of RMS measurements is consistent with existing Commission rules for several other licensed services in the past, including the AWS bands. ²²⁴ In other services, the Commission has adopted the emission power measurement by giving the option of detecting peak value or average value. ²²⁵ This decision will provide the measurement lab with a great deal of flexibility to select the appropriate detection type during the certification process.

104. RF power measurement is a function of the receiver bandwidth and detection method

(Continued from previous page) _____

example, a thermal noise source of 290 K would be reported as well over 3000 K in amplitude if measured using the peak detector/max hold combination, when in fact from a noise or interference impact perspective, the proper value is 290 K.”),

²¹⁷ See *id.* at slide 8-9.

²¹⁸ See SIA Opposition at 5-6

²¹⁹ *Id.*

²²⁰ *Id.*

²²¹ See *Ex Parte* Letter Austin C. Schlick, Director, Communications Law and Aparna Sridhar, Counsel, Google, Inc. to Marlene H. Dortch, Secretary, Federal Communications Commission in GN Docket No. 12-354 (Feb. 16, 2016) (Google February 2016 *Ex Parte*) at 9.

²²² *Id.* at 9 (“An rms system noise temperature of 142.8 K corresponds to a “peak noise temperature” of 2263 K after application of a 12 dB crest factor appropriate for Gaussian noise. However, many satellite providers have argued that a 78 K system noise temperature is appropriate for calculating noise-to-interference ratios. In other words, they believe a mean level is appropriate for characterizing their own operations.”).

²²³ See WinnForum December 2015 *Ex Parte* at slide 9.

²²⁴ See 47 C.F.R. §§ 27.50(b)(11), (c)(11), (d)(6), (h)(4)(i), 24.132(d)-(f).

²²⁵ See 47 C.F.R. §§ 27.53(a)(7), (h)(3)(iii).

whether the signal is detected using a peak or average technique. LTE signals are using OFDM based modulation in downlink which are known to have large PAPRs which may be beyond the 10 dB margin.²²⁶ Google also points out that the PAPRs and signal statistics of LTE and Gaussian thermal noise are generally similar, and thermal noise is typically evaluated using mean measurements.²²⁷ Recent NTIA lab measurements of emission spectrum for a commercial LTE hot spot device operating in the 3.5 GHz Band has shown PAPRs of up to about 12-13 dB.²²⁸ The PAPR for an LTE signal is a random value that fluctuates over a wide range and depends on modulation type and number of sub-carriers used.

105. We reject SIA's argument that retaining the peak detector at maximum hold measurement requirement is necessary to prevent harmful interference into C-Band FSS earth stations.²²⁹ SIA contends that this measurement approach is necessary because "peak emissions may have significant interference effects."²³⁰ However, the issue is not what is commonly referred to as "peak power" but rather extremely short duration transient signals that typically have little energy and, therefore, generally do not reflect interference potential. In effect, requiring devices to be tested using a peak detector at max hold requires devices to be certified at their "worst case" configuration which would present an unrealistic view of the actual interference potential of any given device. This approach is inconsistent with our oft stated rejection of worst case approaches to measurements and interference protection analysis.²³¹ Moreover, as Google notes, SIA's assertion that CBSD emission levels should be measured using a peak detector, while their own system noise levels are exempt from such a requirement, is logically inconsistent and mathematically unsound.²³²

106. In addition, WinnForum argues that, since incumbent protections in the 3.5 GHz Band will be calculated using aggregate interference from multiple CBSDs, certifying CBSDs using a peak detector at max hold will compound the effects of these worst case certifications, yielding an unrealistic picture of the RF environment. On the other hand, calculating aggregate interference effects based on average measurements will present a more realistic picture of the actual RF environment for the purpose of determining protection of incumbent systems, including FSS earth stations.²³³ We agree with CTIA, Google, and WinnForum that maintaining the peak detector at maximum hold requirement would be unnecessary, particularly in light of the cap on peak-to-average emissions we adopt below. Maintaining this approach would also be inconsistent with the Commission's goals for the Citizens Broadband Radio Service and would not promote spectral efficiency and co-existence among various users in the 3.5 GHz Band and adjacent bands.

107. It is also typically easier to measure emissions using the peak detected signal as part of standard measurements. Accordingly, under our revised rules, if the device passes the peak detection requirements, no further RMS-detection is needed to meet the OOB conditions; otherwise, the RMS-detection method can be applied. However, in order to circumvent any effect of peak power spikes, as indicated in the CBSD power requirement section, we will also require that the PAPR of the transmitter output power not exceed 13 dB consistent with the Commission's previous rules in other licensed mobile

²²⁶ See WinnForum December 2015 *Ex Parte*.

²²⁷ See Google February 2016 *Ex Parte* at 9.

²²⁸ See NTIA Technical Report TR 15-512, Emission Spectrum Measurements of a 3.5 GHz LTE Hotspot.

²²⁹ See SIA Opposition at 5-6.

²³⁰ *Id.* at 6.

²³¹ See section IV(C)(1)

²³² Google February 2016 *Ex Parte* at 10.

²³³ See WinnForum December 2015 *Ex Parte*.

broadband services.²³⁴ NTIA lab measurements on LTE hot spot devices also support our finding that a 13 dB margin is reasonable for industry to achieve.²³⁵

108. We believe the combination of changing the requirement to include the use of RMS detection for emission measurement, along with setting the PAPR limitation, will diminish the potential for interference between and among Citizens Broadband Radio Service users and Incumbent Users while promoting efficient use of the band. We disagree with SIA's assertions and note that RMS measurement is commonly used by the Commission and, in fact, is commonly used in other bands.²³⁶ Indeed, allowing such flexible measurement techniques here will help promote the next generation of shared spectrum technologies, and will drive greater productivity and efficiency in spectrum usage.²³⁷

F. Device Geo-Location

1. Location Accuracy and Alternative Measurement Approaches

109. *Background.* In the *3.5 GHz R&O* we required 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)²³⁸ and ± 3 meters (vertical).²³⁹ We found that, for the SAS to accurately predict and evaluate interference and channel availability, it must receive and store accurate location information for all CBSDs.

110. Motorola Solutions, Nokia Solutions, and WinnForum filed petitions for reconsideration requesting that Commission relax the existing accuracy requirements and suggest, alternatively, that the Commission allow the SAS to play a role in estimating CBSD location.²⁴⁰ Google and Federated Wireless also support alternative approaches to ascertaining the location of CBSDs.²⁴¹ Specifically, Federated Wireless explains that there are a variety of methods the SAS could use to verify location, such as coordinating with downstream infrastructure or reference to its power levels and other measurements.²⁴² Google suggests that even if devices cannot meet the specific requirements established by the *3.5 GHz R&O*, the Commission should permit an SAS to calculate spectrum availability based on the geolocation reported by the device, making appropriate adjustments for differences in specificity.²⁴³ Google argues this would incentivize manufacturers to improve location accuracy.²⁴⁴

²³⁴ See 47 C.F.R. § 24.232(d) (peak-to-average ratio for Broadband PCS station transmission may not exceed 13 dB). See *id.* §§ 27.50(a)(1)(B), 27.50(d)(5) (the PAPR of the transmit output power of AWS band stations may not exceed 13 db).

²³⁵ See NTIA Technical Report TR 15-512, Emission Spectrum Measurements of a 3.5 GHz LTE Hotspot; *3.5 GHz R&O*, 30 FCC Rcd at 4015-16, 4019-20, ¶¶ 182, 189.

²³⁶ See 47 C.F.R. § 24.232(d) (peak-to-average ratio for Broadband PCS station transmission may not exceed 13 dB). See *id.* §§ 27.50(a)(1)(B), 27.50(d)(5) (the PAPR of the transmit output power of AWS band stations may not exceed 13 db).

²³⁷ Section 96.41(e)(3)(iv) of the rules has been modified and section 96.41(e)(3)(iii) has been deleted consistent with this approach. See Appendix A.

²³⁸ The horizontal geo-location requirement is consistent with a similar requirement in the White Spaces rules. See 47 C.F.R. § 15.711(b).

²³⁹ See *3.5 GHz R&O*, 30 FCC Rcd at 4027-28, ¶¶ 215, 219; 47 C.F.R. § 96.39(a).

²⁴⁰ See Motorola Solutions Petition at 3; Nokia Solutions Petition at 14; WinnForum Petition at 10.

²⁴¹ See Google Reply at 13-14; Federated Wireless Reply at 9-10.

²⁴² See Federated Wireless Reply at 9-10

²⁴³ Google Reply Petition at 13-14. Under this approach, if a device cannot establish its horizontal location within 50 meters, the SAS would calculate spectrum availability based on the radius of uncertainty.

²⁴⁴ *Id.* at 14.

111. WinnForum proposes that the SAS should estimate CBSD elevation and ground level using detailed terrain databases based on the device's reported operating location.²⁴⁵ Further, WinnForum states that while the ability to meet the horizontal accuracy requirement is readily achievable, the elevation accuracy requirement significantly exceeds the capability of standard GPS equipment, which will be utilized by both CBSDs and professional installers.²⁴⁶ WinnForum suggests that, in lieu of the vertical location accuracy requirements, for Category A CBSD's, professional installation reports should include the highest floor from which the device will operate and, for Category B CBSDs, the reports should include the antenna height above ground level.²⁴⁷

112. Nokia Solutions also recommends that the Commission establish separate vertical location accuracy requirements for outdoor and indoor installations.²⁴⁸ Nokia Solutions states that, since the primary method used by many equipment vendors for outdoor location is GPS-based, the vertical location accuracy requirement should be aligned to the US Government Position Accuracy standard for worst site conditions as stated in the Global Positioning System Standard Positioning Service Performance Standard.²⁴⁹ Nokia Solutions argues that, since GPS does not work well or at all indoors, the Commission should eliminate the elevation reporting requirement for indoor installations, allowing the SAS to estimate the CBSD elevation, and require only the GPS location of the building for the horizontal location.²⁵⁰

113. SIA and NAB both stress the importance of reliable location accuracy necessary to protect incumbent operations.²⁵¹ SIA recognizes that complying with the current requirements may be challenging, particularly with respect to indoor devices where GPS data may not be readily available and both SIA and NAB would support looser requirements so long as "worst case" assumptions are built into the calculations to account for the reduced accuracy.²⁵² However, in regard to vertical location, simply relaxing the accuracy requirements and allowing the SAS to "estimate" or "compute" a device's elevation is not an acceptable solution, given the importance of a device's vertical position in calculating the potential for harmful interference.²⁵³ Therefore, NAB and SIA argue, the Commission must implement a larger separation distance to account for this uncertainty, if a device cannot meet the requirements or the SAS cannot independently verify a device's elevation.²⁵⁴

114. WISPA opposes the petitions that propose to relax or eliminate the existing vertical location accuracy requirements and argues that there is no current mechanism for CBSDs or an SAS to determine the antenna height above ground within the required accuracy.²⁵⁵ WISPA states the elevation of the CBSD becomes irrelevant for CBSDs installed using external antenna systems and that only the elevation of the actual antenna is relevant for interference mitigation purposes. According to WISPA, the

²⁴⁵ See WinnForum Petition at 10

²⁴⁶ See *id.* at 9.

²⁴⁷ See *id.* at 10.

²⁴⁸ Nokia Solutions Petition at 12.

²⁴⁹ *Id.* at 13.

²⁵⁰ *Id.* at 13-14.

²⁵¹ See NAB Petition at 3; SIA Petition at 16.

²⁵² SIA Opposition at 11.

²⁵³ *Id.*

²⁵⁴ *Id.*; NAB Petition at 8.

²⁵⁵ WISPA Opposition at 6.

only way for the SAS to ascertain the CBSD antenna system elevation is by using location information provided by a professional installer.²⁵⁶

115. *Discussion.* We maintain the location accuracy requirements established in the *3.5 GHz R&O* and decline the Nokia Solutions and WinnForum Petitions insofar as they request that we modify these rules. We recognize that there are technological challenges to achieving indoor location accuracy. However, as we stated in the *3.5 GHz R&O*, CBSD location is essential for coordinating interactions between and among users in the band and for protecting Incumbent Access users from harmful interference.²⁵⁷ Without accurate location data, SASs cannot fulfill their core functions in effectively instructing CBSDs to discontinue their operations or change frequencies to protect Incumbent Users.

116. Further, we believe that the location accuracy requirements in the rules are achievable. First, CBSDs are fixed devices, simplifying the reporting of accurate geo-location information, either automatically or with the input of a professional installer. Second, automated reporting of geo-location to our location accuracy requirements may already be achievable in some conditions (*e.g.*, outdoors with clear line of sight to GPS). In addition, at least one party has stated on the record that it has developed technology that can meet the indoor location accuracy rules set forth in the existing rules.²⁵⁸ Finally, as discussed in section III(F)(2), professional installation will play an important role in ensuring the SAS can accurately locate devices while automatic location technologies that meet our requirements are tested and developed.

117. Some commenters also suggest that location accuracy requirements could be met alternatively via SAS calculations. We anticipate that SASs will play a key role in verifying the geographic locations of CBSDs and, as technology continues to develop, we encourage SAS Administrators to offer functions to supplement and reinforce CBSD geo-location functions. However, the CBSD is the best source of its own location information, and such features will not discharge the CBSD from complying with our rules.

118. Finally, regarding Nokia Solutions' suggestion that we allow operators to meet vertical location accuracy requirements at a certain confidence level, we decline to make changes to the existing rules.²⁵⁹ For the aforementioned reasons, the current rules ensure that the SAS can properly locate CBSDs in order to perform its core functions, and we believe them to be achievable over time.

2. Automated Geo-Location and Professional Installation for CBSDs

119. *Background.* In the *3.5 GHz R&O*, we concluded that Category A CBSDs may utilize either a technical geo-location capability or be professionally installed while Category B CBSDs must be professionally installed.²⁶⁰ We noted that, since CBSDs will be fixed installations, the professional installation option should allow for network deployment in the near term while automatic geo-location technologies for this band are tested and developed that meet our accuracy requirements. We also strongly encouraged 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.²⁶¹

120. NAB and SIA argue that the Commission should eliminate the option for professional installers to report the locations of CBSDs and, instead, require all CBSDs to include a geo-location

²⁵⁶ *Id.*

²⁵⁷ See *3.5 GHz R&O*, 30 FCC Rcd at 4028, ¶ 221.

²⁵⁸ See *iPosi Second FNRPM Comments* at 2.

²⁵⁹ See *Nokia Solutions Petition* at 13.

²⁶⁰ 47 C.F.R. §§ 96.39(a), 96.45(a).

²⁶¹ See *3.5 GHz R&O*, 30 FCC Rcd at 4028-29, ¶¶ 219-222.

capability.²⁶² NAB contends that the Commission's rule is analogous to a similar professional installation requirement adopted in the White Spaces proceeding.²⁶³ NAB argues that, in that proceeding, it identified several errors in device registrations made by professional installers and that such errors prove that the professional installation option is not acceptable in either the White Spaces or the Citizens Broadband Radio Service.²⁶⁴ NAB contends that professional installation is not necessary for indoor deployments, citing both technological advances and a compromise approach that it submitted in the White Spaces proceeding.²⁶⁵ NAB also claims that the professional installation is inherently flawed and cannot be rehabilitated by a certification process.²⁶⁶ SIA agrees with NAB and contends that, regardless of the safeguards adopted, it will be impossible to remove the risk of human error from installations.²⁶⁷ In addition, on February 26, 2016, the Commission adopted a *Notice of Proposed Rulemaking and Order* that proposed to require automated geo-location capabilities in White Spaces devices, consistent with an agreement between NAB and several White Spaces device manufacturers.²⁶⁸

121. Federated Wireless, Google, T-Mobile, and WISPA disagree with NAB and SIA and argue that the Commission should permit professional installation of CBSDs in the Citizens Broadband Radio Service.²⁶⁹ Google contends that: (1) discussions of individual records in the White Spaces proceeding are not relevant to this proceeding and that, in any case, the White Spaces entries may have been good faith test cases; (2) the record demonstrates that professional installers can protect Incumbent Access users; and (3) the industry is working collaboratively to develop an effective framework for certifying professional installers in the band.²⁷⁰ Federated Wireless agrees and argues that, given the requirements of the band, SAS Administrators and Citizens Broadband Radio Service users will be incentivized to ensure that all geo-location information provided to the SAS is accurate.²⁷¹ Federated Wireless also notes that professional installation has been used successfully in a number of other licensed services – including two-way satellite broadband.²⁷²

122. *Discussion.* We deny NAB and SIA's petitions for reconsideration of the professional installation rule. We also decline to mandate automated geo-location capabilities for CBSDs. As described in the *3.5 GHz R&O*, accurate CBSD location information is essential for coordinating interactions between and among users in the band and for protecting federal and non-federal Incumbent Users from harmful interference.²⁷³ However, we also noted that, while we expect location accuracy technology to continue to develop, in many circumstances, automated reporting of geo-location information that complies with our accuracy requirements will be challenging in this band given currently

²⁶² See NAB Petition at 5; SIA Reply at 5-6.

²⁶³ NAB Petition at 6.

²⁶⁴ See NAB Petition at 3-6.

²⁶⁵ See *id.* at 7.

²⁶⁶ See NAB Reply at 5-7.

²⁶⁷ See SIA Petition at 14-15.

²⁶⁸ See Amendment of Part 15 of the Commission's Rules for Unlicensed White Space Devices, ET Docket No. 16-56, RM-11745, *Notice of Proposed Rulemaking and Order*, 31 FCC Rcd 1657 (2016) (*White Spaces NPRM*).

²⁶⁹ See Federated Wireless Opposition at 11-12; Google Opposition at 10-15; T-Mobile Reply at 9-10; and WISPA Opposition at 8-11.

²⁷⁰ See Google Opposition at 10-15.

²⁷¹ See Federated Wireless Opposition at 11-12.

²⁷² See *id.*

²⁷³ *3.5 GHz R&O*, 30 FCC Rcd at 4028, ¶ 220.

available technology.²⁷⁴ Professional installation is intended to fill that gap and facilitate deployment of CBSDs with accurately reported geo-location information while the next generation of automatic geo-location technology is developed.

123. Based on the record, we are not convinced that the capabilities of today's equipment and technology are sufficiently developed to ensure that CBSDs will be able to perform automated geo-location functions in order to reliably meet the location accuracy requirements for the Citizens Broadband Radio Service. As a result, limiting CBSDs to automated geo-location as the only way to meet these requirements would deter near-term deployment on any reasonable scale in the 3.5 GHz Band.²⁷⁵ As discussed in detail above, several petitioners highlighted the difficulties associated with attaining an accurate vertical reading within +/- 3 meters.²⁷⁶ Federated Wireless also argues that, while current technology may be sufficient to provide the SAS with a CBSD's location at the requisite degree of accuracy in some outdoor situations, such readings may not be currently possible for a variety of indoor deployments in this band.²⁷⁷ Since we expect much of the deployment in the 3.5 GHz Band to be indoors, the inability of a CBSD to provide its location indoors would be fatal to many potential use cases for the Citizens Broadband Radio Service. While we are encouraged by iPosi's claim that its technology can provide indoor accuracy readings that meet or exceed requirements, it has not yet been used commercially in the 3.5 GHz Band, so it is yet to be determined if this technology is appropriate – or economically viable – for all use cases at this time.²⁷⁸ Thus, while the accuracy of geo-location technology is improving, integrated geo-location technology may not be a viable option for all potential network deployments in the 3.5 GHz Band at this time.²⁷⁹

124. We also find unconvincing NAB and SIA's reliance on NAB's claims regarding inaccurately entered location information in the White Spaces databases. NAB and SIA assert that, since professional installers allegedly entered inaccurate locations of devices in White Spaces databases, the entire notion of a professional installation regime is inherently flawed.²⁸⁰ Indeed, NAB claims that professional installation has proven to be inherently unreliable and that it cannot be rehabilitated through any kind of certification regime.²⁸¹ NAB and SIA reach these conclusions despite the fact that no SASs have been approved or CBSDs deployed in the Citizens Broadband Radio Service and, as such, there is no evidence of actual harm or impropriety in the band to support their claims. Moreover, these parties have provided no convincing evidence that a professional installation option in this band presents any significant potential for such harm. The alleged failures of a dissimilar, uncertified professional

²⁷⁴ See *id.* at 4028, ¶¶ 219-222.

²⁷⁵ As we stated in section III(F)(1) above, the current geo-location accuracy requirements are necessary to effectively protect Incumbent Users and, as such, we reject any proposal that relies on allowing CBSDs to report their locations at a lower degree of accuracy.

²⁷⁶ See section III(F)(1).

²⁷⁷ See Federated Wireless Reply at 7.

²⁷⁸ See Iposi *Second FNPRM* Comments at 2.

²⁷⁹ Various commenters propose alternative location accuracy benchmarks such as terrain data, or worst case assumptions about the positioning of a CBSD based on its location (*i.e.*, the top of a building). These alternate methodologies, however, would be less accurate, particularly with respect to vertical location. They would also be less efficient, which is a critical problem in the sharing regime contemplating for the 3.5 GHz Band. For example, assuming a CBSD is operating on the tenth floor of a building, rather than at its actual location on the second floor, would unnecessarily limit its operations as well as those of other Citizens Broadband Radio Service users.

²⁸⁰ See NAB Petition at 4; SIA Petition at 13-14. National Association of Broadcasters Emergency Motion for Suspension of Operations and Petition for Rulemaking, RM-11745 (March 19, 2015) at 9.

²⁸¹ See NAB Petition at 5-6.

installation regime in another service do not warrant eliminating the professional installation option for the Citizens Broadband Radio Service.

125. The Commission noted that the recent changes proposed in the *White Spaces NPRM*, which included a proposal to eliminate the professional installer option for fixed White Space devices, were “based upon the circumstances specific to fixed white space devices and white spaces databases.”²⁸² In the White Spaces service, the Commission determined not to “define the qualifications of a professional installer in the rules.”²⁸³ Here, in contrast, as explained in the *3.5 GHz R&O* and detailed below, the Commission will require professional installers to be trained and certified using an established industry-led process.

126. NAB and SIA unfairly dismiss the importance of a robust industry certification process for professional installers.²⁸⁴ By relying on such a certification process here, as the Commission has in a variety of other contexts, the rules provide an important protection against the prospect that “any purchaser of a device” could serve as a professional installer.²⁸⁵ We reiterate that industry-led professional accreditation processes have been used by the Commission and have, in fact, proven successful in other similar situations.²⁸⁶ In the *3.5 GHz R&O*, we recognized the importance of accurate geo-location information and we strongly encouraged prospective SAS Administrators and Citizens Broadband Radio Service users to develop programs for accrediting professional installers and associated technical best practices.²⁸⁷ WinnForum announced that, consistent with the Commission’s wishes, its members are developing a set of professional installation standards to be implemented by SAS Administrators.²⁸⁸ Any certification regime developed by WinnForum – or any other entity or organization – must ensure that registered CBSDs comply with the Commission’s geo-location rules. WTB and OET will review the SAS’s ability to implement and verify the information submitted by professional installers as part of the SAS approval process.²⁸⁹

²⁸² See *White Spaces NPRM*, 31 FCC Rcd at 1662, n.32.

²⁸³ Unlicensed Operation in the TV Broadcast Bands, ET Docket No. 04-186, *Second Memorandum Opinion and Order*, 25 FCC Rcd 18661,18723, ¶ 150 (2010).

²⁸⁴ See NAB Reply at 5-7; SIA Petition at 15.

²⁸⁵ SIA Petition at 14.

²⁸⁶ Section 4(f)(4)(D) of the Communications Act of 1934, as amended, 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 individuals who are not officers or employees of the Federal Government.” 47 U.S.C. § 154(f)(4)(D). 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. See *3.5 GHz R&O*, 30 FCC Rcd at 4028-29, ¶ 222 citing Requirement for Licensed Operators in Various Radio Services, GN Docket No. 83-222, *Report and Order*, 96 FCC 2d 1123 at 1141-45, ¶¶ 36-43 (1984).

²⁸⁷ See *3.5 GHz R&O*, 30 FCC Rcd at 4028-29, ¶ 222.

²⁸⁸ *Ex Parte* Letter from Lee Pucker, CEO, Software Defined Radio Forum Inc. d/b/a The Wireless Innovation Forum, to Marlene H. Dortch in GN Docket No. 12-354 (filed Sept. 17, 2015) (WinnForum Sept. 2015 *Ex Parte*) at Slides 4, 11. SIA is an active member of WinnForum and, as such, will presumably have input into the development of these standards.

²⁸⁹ See *SAS/ESC Proposal PN*.

127. Most importantly, the White Spaces service itself is not directly analogous to the Citizens Broadband Radio Service. While both White Spaces devices and CBSDs rely on the White Space databases and SASs, respectively, to protect incumbent services, White Space devices are unlicensed and have no expectation of interference protection. On the other hand, the Citizens Broadband Radio Service is a licensed service in which SASs must be able to effectively coordinate CBSD interactions (both PAL and GAA) to prevent interference between and among the three tiers of users and ensure a stable spectral environment for commercial operations in the 3.5 GHz Band. In other words, in the Citizens Broadband Radio Service the accuracy of the information is important both to protect incumbent services and to protect and enable every other user. This licensed nature of the service coupled with industry certification requirements for professional installers provides a higher degree of accountability for Citizens Broadband Radio Service users and SAS Administrators, ensuring that CBSD locations are accurately reported and verified. In addition, all Citizens Broadband Radio Service users have the rights and obligations incumbent on all Commission licensees, which include serious consequences for violation of Commission rules, including potential revocation and license qualification issues. The Commission has extensive mechanisms available to it to ensure that licensees comply with its rules.

128. In addition, as the Commission has stated on several occasions, approved SASs will have capabilities and responsibilities that exceed those of White Spaces database administrators. Drawing on the lessons learned from the White Spaces proceeding, the Commission will expect SAS Administrators to take appropriate steps to authenticate and verify information that is submitted by professional installers and to immediately correct any inaccurate information in their databases.²⁹⁰ 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.²⁹¹ Federated Wireless also notes that there are a variety of “quality control methods” that an SAS Administrator may employ - including IP validation, Wi-Fi assistance, and downstream infrastructure coordination - to help verify a CBSD’s location.²⁹² We expect SAS Administrators to develop and implement technological safeguards appropriate to ensure the integrity and accuracy of location data submitted by CBSDs, and we will carefully review proposals from prospective SAS Administrators to determine whether they have demonstrated the capability to do so.

129. While we believe that professional installation is necessary and appropriate for the Citizens Broadband Radio Service at this time, future technological developments may obviate the need to rely on professional installation to ensure the accuracy of CBSDs’ location information in some circumstances. Accordingly, we direct WTB and OET to seek input on developments in geo-location technology for CBSDs and the status of the professional installation regime in the Citizens Broadband Radio Service no later than April 28, 2020.

3. End User Device Requirements

130. *Background.* In its petition, SIA seeks reconsideration of the Commission decision not to mandate that End User Devices include geo-location capabilities.²⁹³ SIA argues that such a mandate is necessary so that an SAS is aware of the location of End User Devices and without such a requirement, the SAS calculations to protect FSS earth stations must be based on worst-case assumptions about location.²⁹⁴ SIA states these assumptions would include the maximum operational distance between the End User Device and CBSD and the maximum number of End User Devices that could be served by the

²⁹⁰ See 47 C.F.R. §§ 96.53(d), 96.57(a), 96.63(f).

²⁹¹ See *id.* § 96.55.

²⁹² See Federated Wireless Opposition at 10-11.

²⁹³ See SIA Petition at ii, 15; *Second FNRPM*, 30 FCC Rcd 3959 at 4089, ¶ 442.

²⁹⁴ SIA *Second FNPRM Comments* at 7; SIA Petition at 15; SIA Opposition at 10.

CBSD.²⁹⁵ In the alternative, the Commission could define a maximum deployment radius.²⁹⁶ However, SIA argues, “the use of such worst-case assumptions would result in fewer End User Devices being authorized – and therefore less efficient utilization of the spectrum – than if the SAS had actual location data for each device.”²⁹⁷

131. Google and WISPA expressly oppose mandating End User Devices to include geo-location technology.²⁹⁸ Google argues that a geo-location requirement would unnecessarily limit the types of devices available to consumers, as Wi-Fi dongles and other miniature broadband devices are so small that adding geo-location technology would fundamentally alter the form of the device.²⁹⁹ Both WISPA and Google claim that such a requirement is not needed to protect users from interference, as the SAS can take into account the “cloud” of End User Devices associated with a particular CBSD when calculating interference protection and the Commission requires End User Devices to positively receive and decode authorization signals from CBSDs.³⁰⁰

132. Rajant states that while it is not opposed to requiring geo-location in End User Devices, it would add additional costs to operation in the band.³⁰¹ Further, Rajant states that it plans to deploy in places such as enclosed stadiums and underground mass transit tunnels where it would be difficult to obtain GPS location data and while GPS simulators are available, they would be burdensome and hinder flexibility.³⁰² Therefore, Rajant argues that the Commission should not require geo-location for consumer devices and limit such a requirement to devices intended for industrial, public safety, or commercial use in confined, managed sites.³⁰³

133. *Discussion.* We deny SIA’s request to mandate geo-location technology in all End User Devices and find that such a requirement is not necessary to ensure compliance with our location accuracy rules or to effectively mitigate interference into incumbent systems. We recognize that FSS earth station licensees are concerned about interference from End User Devices and, indeed we sought comment on how to address these issues in the *Second FNPRM*.³⁰⁴ However, we agree with Google and WISPA that it is not necessary to mandate that End User Devices include automatic geo-location capabilities to effectively protect Incumbent Users from interference. In addition, such a requirement would unnecessarily limit the types of consumer devices that may be deployed and utilized in the 3.5 GHz Band.³⁰⁵

134. Indeed, the rationale we articulated in section III(F)(2) for not requiring automatic geo-location reporting by CBSDs is even more compelling in the case of End User Devices. End User Devices operate at a much lower power than even Category A CBSDs, lowering their potential interference effects and reducing their range of operation. End User Devices are also inherently limited in their area of operation by the coverage of a given CBSD or network of CBSDs. Moreover, since End

²⁹⁵ SIA *Second FNPRM Comments* at 7-8.

²⁹⁶ *Id.* at 8.

²⁹⁷ *Id.*

²⁹⁸ See Google *Second FNPRM Reply Comments* at 18; WISPA *Opposition* at 11.

²⁹⁹ See Google *Second FNPRM Reply Comments* at 18.

³⁰⁰ See *id.* at 19; WISPA *Opposition* at 11; 47 C.F.R. § 96.47.

³⁰¹ See Rajant *Second FNPRM Comments* at 8.

³⁰² *Id.*

³⁰³ *Id.*

³⁰⁴ See *Second FNPRM*, 30 FCC Rcd at 4089, ¶ 442.

³⁰⁵ See Google *Second FNPRM Reply Comments* at 19; WISPA *Opposition* at 11.

User Devices will likely include mobile devices - as opposed to fixed CBSDs - reporting their location to the level of accuracy required by our rules would likely exceed the limits of current technology in many locations.

135. Further, the SAS is responsible for managing CBSDs, not End User Devices. Requiring End User Devices to report their locations to the SAS and requiring the SAS to track and manage these devices would greatly exceed the limits of the SAS's responsibilities. As such, it is not appropriate to include End User Devices in our location accuracy rules. However, as noted by WISPA, the rules do require End User Devices to "positively receive and decode an authorization signal transmitted by a CBSD, including the frequencies and power limits for their operation,"³⁰⁶ and any device to be certified by the Commission must meet these requirements. Both Google and WISPA also state that WinnForum is reviewing how to treat End User Devices in interference calculations, which will further supplement the SAS's ability to account for End User Device locations.³⁰⁷ WTB and OET will review any such approaches submitted during the SAS approval process.

G. PAL Protection Criteria

136. *Background.* To ensure that Priority Access operations are protected from harmful interference, we adopted an aggregate received signal level at PAL license boundaries to be at or below an average power level³⁰⁸ 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.³⁰⁹ We also permitted Priority Access Licensees to agree to an alternative limit other than -80 dBm/10 MHz at their Service Area boundaries and communicate it to an SAS. In addition, we noted that these signal level requirements would not apply to adjacent census tracts held by the same Priority Access Licensee.³¹⁰

137. WinnForum asks that the Commission modify its PAL protection criteria to more effectively reflect real world interference concerns and protect Priority Access Licensees. WinnForum contends that the PAL protection rule creates several problems that the Commission did not consider in developing the *3.5 GHz R&O*.³¹¹ According to WinnForum, these problems include: (1) the requirement would place a significant burden on the SAS by requiring it to calculate point-to-line interference along a lengthy border; (2) border protections may not effectively protect interior portions of a Priority Access Licensee's Service Area; (3) high elevation census tracts will have a disproportionate effect on CBSD deployments; and (4) the requirement will unnecessarily block co-channel devices.³¹² WinnForum suggests that the SAS implement an alternate protection scheme whereby the SAS would protect an operator-defined contour around Priority Access CBSDs to a protection level of -80 dBm/10 MHz anywhere within the contour.³¹³ WinnForum claims that this revised approach addresses all of the concerns raised in its Petition. Federated Wireless, Google, and Motorola Solutions support WinnForum's Petition.³¹⁴ WISPA also agrees that the -80 dBm criterion is inadequate for the reasons described by WinnForum.³¹⁵

³⁰⁶ See 47 C.F.R. § 96.47(a).

³⁰⁷ See Google *Second FNPRM* Reply Comments at 19; WISPA Opposition at 11.

³⁰⁸ As measured using the RMS method.

³⁰⁹ See *3.5 GHz R&O*, 30 FCC Rcd at 4021-22, ¶ 195; 47 C.F.R. § 96.41(f).

³¹⁰ See *3.5 GHz R&O*, 30 FCC Rcd at 4021-22, ¶ 195.

³¹¹ See WinnForum Petition at 11-16.

³¹² See *id.*

³¹³ See *id.* at 17.

³¹⁴ See Federated Wireless *Second FNPRM* Comments at 8; Google Reply at 15; Motorola Solutions Petition at 4-5.

³¹⁵ WISPA Opposition at 8.

138. *Discussion.* We agree with WinnForum’s Petition in part and, accordingly, we revise the rule. Under the revised rule, allowable interference will be calculated for the area within the PAL Protection Area³¹⁶ described in detail in section IV(A) below rather than along the borders of a Priority Access Licensee’s Service Area.³¹⁷ To protect CBSDs authorized to provide service on a Priority Access basis, the SAS must not authorize other CBSDs – whether Priority Access or GAA – on the same channel in geographic areas and at maximum power levels that will cause aggregate interference in excess of -80 dBm/10 MHz channel within a PAL Protection Area. Consistent with our approach elsewhere in this *Order*, the aggregate co-channel interference level will be defined by a common models utilizing common inputs and assumptions. These models, inputs, and assumptions – including the propagation model and any clutter or terrain assumptions – will be determined during the SAS approval process. This approach is also consistent with the methods that will be used to model and measure the aggregate interference to protect incumbent FSS earth stations and incumbent federal radar systems.³¹⁸

139. Several commenters, including Federated Wireless, Google, Motorola Solutions, and WinnForum support a protection methodology based on modeled aggregate interference protections within the area served by a Priority Access Licensee rather than along the border of a given Service Area or census tract.³¹⁹ Notably, Google and WinnForum contend that a protection methodology that utilizes point-to-area interference models to calculate aggregate interference into a Priority Access Licensee’s service area will be relatively simple and inexpensive for SASs to implement.³²⁰ Motorola Solutions, WinnForum, and Google also highlight several negative unintended consequences of the Commission’s rule requiring CBSDs to meet an aggregate interference threshold along the border of a Service Area.

140. We find the evidence presented by Petitioners compelling and modify section 96.41(d) to address the concerns raised in their filings. We note that there were no objections to the protection level of -80 dBm/10 MHz and, indeed, several petitioners supported this interference protection level. Therefore, under the revised rule, the SAS must assign CBSDs such that the modeled aggregate power of co-channel CBSDs is no greater than -80 dBm/10 MHz within the PAL Protection Area. Consistent with our approach to geographic guard bands, described in section IV(A), we conclude that the SAS may not consider adjacent channel interference when calculating these protections and assigning CBSDs. We believe that the stringent out-of-channel emission limits set forth in section 96.41 are sufficient to make adjacent channel interference unlikely, particularly for synchronized systems and Category A CBSDs.

H. FSS Protection

141. In its petition, SIA asked the Commission to reconsider or clarify several of its rules regarding the protection of in-band and out-of-band FSS earth stations. These issues included: (1) the status of new FSS earth stations in the band; (2) interference notification procedures; (3) protections for international FSS earth stations; (4) FSS registration requirements; and (5) clarification of protections afforded to in-band and out-of-band earth stations.³²¹ Specific protection methods for in-band and out-of-

³¹⁶ See Appendix A, § 96.3 (PAL Protection Area) (“The area within the Priority Access Licensee’s default protection contour, as calculated by the SAS in accordance with section 96.25 (or smaller, self-reported protection contour). This area will be protected from interference in accordance with sections 96.25 and 96.41(d).”)

³¹⁷ See 47 C.F.R. § 96.3 (Service Area) (“One or more contiguous License Areas held by the same Priority Access Licensee.”) and (License Area) (“The geographic component of a PAL. Each License Area consists of one Census Tract.”).

³¹⁸ See section IV(C)(1).

³¹⁹ See *Federated Wireless Second FNPRM Reply Comments at 2-3*; *Google Second FNPRM Comments at 2-11*; *Motorola Solutions Petition at 3*; *WinnForum Petition at 11*.

³²⁰ See *Google Second FNPRM Comments at 11*.

³²¹ See generally, *SIA Petition*.

band FSS earth stations were raised by the Commission in the *Second FNPRM* and, as such, are addressed in section IV(C) below. SIA's other requests are addressed in this section.

1. Status of New In-band FSS Earth Stations

142. *Background.* In the *3.5 GHz R&O*, the Commission adopted a change to the Table of Allocations limiting co-primary FSS earth stations in the 3600-3650 MHz band to those authorized prior to, or granted as a result of an application filed prior to the effective date of the *3.5 GHz R&O*, and constructed within 12 months of the initial authorization.³²² This rule is consistent with proposals made in the *NPRM* and *FNPRM* as well as the licensing freeze imposed concurrently with the *NPRM* and sunsetted in the *3.5 GHz R&O*.³²³

143. SIA contends that new in-band FSS earth stations should be authorized on a co-primary basis like grandfathered earth stations.³²⁴ They assert that existing limits on FSS operations in the 3600-3650 MHz band and the relatively limited number of recent applications demonstrate that allowing new stations to operate on a co-primary basis will not have a negative effect on the spectrum ecosystem. SIA also argues that restoring the co-primary authorization will further the public interest by allowing FSS licensees to meet the evolving needs of new customers.³²⁵ SIA requests that, at a minimum, the Commission make it clear that existing licensees can replace their equipment while maintaining their current co-primary authorization.³²⁶

144. *Discussion.* We reject SIA's petition for reconsideration of the status of new 3600-3650 MHz earth stations. SIA's arguments echo the arguments made by the organization in response to the *NPRM*, *Licensing PN*, and *FNPRM*.³²⁷ The Commission took these arguments into consideration when it adopted the changes to the Table of Allocations and found that the changes were necessary to ensure the ongoing stability of the band and facilitate widespread access to the Citizens Broadband Radio Service.³²⁸ SIA has not presented any new evidence that would compel us to change our conclusions.

145. However, we agree with SIA's assertion that existing FSS earth station licensees should be permitted to replace antennas and other equipment associated with their licensed earth stations.³²⁹ Such changes may be necessary to ensure continuity of service for existing licensees. Therefore, we find that it is in the public interest to amend our rules to explicitly permit equipment replacement that is otherwise compliant with the Commission's rules.³³⁰ Licensees must update their registrations submitted pursuant to section 96.17 if such replacements change any of the parameters included in the registration to continue receiving accurate interference protection under section 96.17.³³¹

³²² See *3.5 GHz R&O*, 30 FCC Rcd at 3973-74, ¶¶ 37-39; 47 C.F.R. § 2.106, note US 107.

³²³ See *id.*; *3.5 GHz NPRM*, 27 FCC Rcd at 15642, ¶ 154; *3.5 GHz FNPRM*, 29 FCC Rcd at 4307, ¶ 114.

³²⁴ See SIA Petition at 22-23.

³²⁵ See *id.*

³²⁶ See *id.* at 23-24.

³²⁷ See *id.* at 22-23. See SIA *NPRM* Comments at 21; SIA *Licensing PN* Comments at 3-5; SIA *Licensing PN* Reply Comments at 2-5; SIA *FNPRM* Comments at 19.

³²⁸ See *3.5 GHz R&O*, 30 FCC Rcd at 3973, ¶ 37.

³²⁹ See SIA Petition at 23-24.

³³⁰ See Appendix A, § 2.106, note US 107.

³³¹ See 47 C.F.R. § 96.17(d).

2. Notification of Interference

146. *Background.* SIA contends that, while the SAS may be able to resolve interference disputes under the rules, the Commission does not establish specific procedures to address interference complaints from FSS licensees. SIA argues that the Commission “must determine to whom interference complaints should be addressed, and should put in place procedures that require immediate suspension of CBSD operations pending investigation. In addition, the Commission should set strict time deadlines for ultimate resolution of an interference complaint.”³³²

147. *Discussion.* We agree with SIA that SASs should be capable of receiving and responding to interference complaints from FSS earth station licensees and we amend our rules to require SASs to accommodate such complaints. One of the core functions of the SAS is to ensure that all registered users operate according to the Commission’s rules, including the rules protecting non-federal Incumbent Users.³³³ This includes enforcing the protection criteria set forth in sections 96.17 and 96.21 and, under the modified rule, processing and responding to reports of harmful interference or special coordination requests from non-federal FSS licensees.³³⁴ As with all coordination and interference mitigation efforts in the 3.5 GHz Band, we encourage the parties to work collaboratively to resolve any interference issues that may arise. Although we expect the parties and the SAS to resolve most interference issues among themselves, the Commission retains ultimate authority over the licensees in the band (and the SAS Administrators), as well as the responsibility for enforcing the rules to resolve interference issues in the band.

148. However, we do not believe that it is in the public interest to establish fixed timeframes for investigation and resolution of such issues or to require immediate suspension of CBSDs pending investigation. Rather, each SAS will have to demonstrate the ability to promptly respond to reports of interference during the SAS approval process. We also recognize that different interference cases may be more complex than others and SAS response times may differ depending on the unique circumstances of any given case. In addition, requiring immediate shutdown of CBSDs after any complaint from an FSS licensee would establish an unfair presumption that the complaint is true prior to any investigation.³³⁵ We encourage SAS Administrators and incumbent FSS earth station licensees to work together to establish effective protocols for receiving and responding to complaints of interference.

3. Protection for International FSS Earth Stations

149. *Background.* In the *3.5 GHz R&O*, we adopted a rule that explains that operations in the 3.5 GHz Band are subject to current and future agreements with the governments of Canada and Mexico and requires SAS Administrators to implement the terms of any such agreements.³³⁶ As we stated in the *3.5 GHz R&O*, this approach is consistent with our usual practice for new services.³³⁷

150. SIA argues that the Commission should impose more strict restrictions on deployments near the Canadian and Mexican borders absent agreements between the countries. Specifically, SIA

³³² SIA Petition at 11.

³³³ See 47 C.F.R. §§ 96.17, 96.21, 96.53(h).

³³⁴ See *id.*; Appendix A, § 96.17(f).

³³⁵ Nor has SIA demonstrated the need for an automatic shutoff rule when CBSDs lose contact with the SAS or suffer an operational failure, particularly in light of our existing requirements for SAS and CBSD communications. See SIA Petition at 12. As stated in the *3.5 GHz R&O*, we continue to encourage multi-stakeholder groups to incorporate *acceptable contact intervals* between CBSDs and SASs into their developing protocols to ensure that CBSDs only transmit pursuant to instructions from an authorized SAS and in accordance with our rules. See *3.5 GHz R&O*, 30 FCC Rcd at 4032, ¶ 234.

³³⁶ See 47 C.F.R. §§ 96.19, 96.53(n).

³³⁷ See *3.5 GHz R&O*, 30 FCC Rcd at 4048, ¶ 299.

suggests that the Commission impose similar restrictions to those included in section 90.1337 for 3650-3700 MHz licensees authorized under Part 90 of the Commission's rules.³³⁸

151. *Discussion.* We reject SIA's petition for reconsideration of the Commission's rules governing Citizens Broadband Radio Service operations near international borders.³³⁹ SIA raised similar objections when the Commission proposed this approach in the *FNPRM* and the Commission considered those arguments in reaching its decision.³⁴⁰ As noted above, this approach is consistent with our usual practice for new services. SAS Administrators will be required to comply with existing agreements and also 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 once such agreements are completed.³⁴¹ We continue to believe that this approach will ensure that CBSD deployments near international borders comply with all applicable international agreements as those agreements are finalized with respect to this band.

4. FSS Registration

152. *Background.* In the *3.5 GHz R&O*, the Commission adopted measures designed to protect incumbent in-band and adjacent C-Band FSS earth stations from interference.³⁴² We sought further comment on additional protection measures for both in-band and out-of-band sites, addressed in detail below.³⁴³ In order to adequately implement these measures, the Commission required FSS earth station licensees in the 3600-3650 MHz band and the neighboring C-Band seeking protection under the rules to submit an annual registration that includes certain technical information that will be made available to SAS Administrators.³⁴⁴

153. SIA requests that the Commission eliminate the requirement that FSS earth station operators must register their stations annually, and if the Commission retains the registration rules, that we revise and clarify these rules.³⁴⁵ SIA suggests that the SAS obtain the registration information from the publicly available International Bureau Filing System (IBFS) and argues that an annual registration is an unwarranted administrative burden.³⁴⁶ However, if the Commission does not eliminate the registration requirement, SIA argues for the following changes to the rules: (1) clarify that earth station operators can register a range of antenna azimuth and elevation angles; (2) explicitly state that new licensees will be protected; and (3) clarify the deadline for registration.³⁴⁷ SIA also requests that the Commission revise its

³³⁸ See SIA Petition at 24-25; 47 C.F.R. § 90.1337.

³³⁹ See SIA Petition at 25.

³⁴⁰ See SIA *FNPRM* Reply Comments at 16-17.

³⁴¹ See *3.5 GHz R&O*, 30 FCC Rcd at 4048, ¶ 299. Existing international agreements are available at: <https://www.fcc.gov/general/international-agreements>.

³⁴² See *3.5 GHz R&O*, 30 FCC Rcd at 4045-48, ¶¶ 287-91, 295-96.

³⁴³ See *Second FNPRM* at 4087-90, ¶¶ 436-445; section IV(C).

³⁴⁴ See *3.5 GHz R&O*, 30 FCC Rcd at 4046, ¶ 290. The annual registration must 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. See 47 C.F.R. §§ 96.17(d)-(e).

³⁴⁵ See SIA Petition at 16, 21.

³⁴⁶ See *id.* at 17.

³⁴⁷ Currently, the rules require registration "no later than 30 days before the end of the preceding calendar year." See 47 C.F.R. § 96.17(d). SIA argues that, if the Commission intends to require registration each year by no later than December 1, it should revise the rule to make that explicit. See SIA Petition at 21-22.

rule to clarify that the interference protection rights extend to unlicensed receive-only C-Band earth stations and replace the annual registration requirement with a one-time registration requirement.³⁴⁸

154. WISPA opposes SIA's request to eliminate or change the registration requirements, arguing that reporting information on a regular basis and after critical technical changes is necessary to ensure that the SAS can protect FSS earth stations from harmful interference.³⁴⁹ However, WISPA agrees with SIA that the Commission should harmonize registration requirements for C-Band earth stations so that the SAS can gather all of the information from one source and that the Commission should clarify that the protected area around an earth station refers to the existing 150 km circular zone as specified in section 90.1331(a).³⁵⁰

155. Google states that the registration requirements are reasonable and asks that the Commission reject SIA's request to eliminate this requirement.³⁵¹ Google notes that the Citizens Broadband Radio Service rules are designed to protect actual users and that the annual registration requirement achieves this objective.³⁵² Google contends that SIA concedes that the basic technical information required by the registration is necessary to calculate interference protection, and argues that the earth station operators themselves are in the best position to provide such information.³⁵³ Google also requests that the Commission clarify that the registration requirement applies to grandfathered earth stations in the 3650-3700 MHz band.³⁵⁴

156. *Discussion.* We deny SIA's request to eliminate the annual FSS earth station registration requirement. However, we do make minor modifications to the existing rules governing earth station registrations. Specifically, we adopt changes to effectively implement the FSS earth station protection rules described in section IV(C) and further clarify that the registration rules apply to FSS earth stations in the 3650-3700 band after the transition period for Grandfathered Wireless Broadband Licensees. Management of sharing in a dynamic environment between three tiers of users requires as much accurate information as possible about the operation in each tier. In addition, as detailed in section IV(C), to provide additional protection for licensed C-Band FSS earth stations with TT&C responsibilities, we will allow these licensees to register for additional protection around these sites.³⁵⁵ Operators of these sites must provide the same registration information as in-band FSS earth station licensees seeking protection³⁵⁶ and, additionally, must affirm that each site is being used for TT&C.

157. We decline SIA's requested changes and reaffirm our findings in the *3.5 GHz R&O*. As stated in the *3.5 GHz R&O*, we adopted registration rules in order to ensure that the Commission and SAS Administrators have the accurate, up to date information necessary to protect incumbent licensed FSS earth stations.³⁵⁷ In order for the SAS to adequately protect FSS incumbents, it must be able to access

³⁴⁸ See SIA Petition at 20.

³⁴⁹ WISPA Reply at 14-15.

³⁵⁰ See WISPA Reply to Opposition at 14. Section 90.1331(a) states that base and fixed stations may not be located within 150 km of any grandfathered satellite earth station operating in the 3650–3700 MHz band unless coordinated with the earth station licensee. See 47 C.F.R. § 90.1331(a).

³⁵¹ See Google Reply at 7.

³⁵² See *id.*

³⁵³ See *id.*

³⁵⁴ See *id.* at 8-9.

³⁵⁵ See Appendix A, § 96.17.

³⁵⁶ See 47 C.F.R. § 96.17(d).

³⁵⁷ See *3.5 GHz R&O*, 30 FCC Rcd at 4046, ¶ 290; 47 C.F.R. § 96.17(d).

detailed information on the technical and operational characteristics of each FSS earth station seeking protection. If these characteristics change, the operator must update the relevant registration.

158. Several parties indicated that the rules were unclear regarding how they apply to existing FSS earth stations in the 3650-3700 MHz band. Section 96.21 of the Commission's rules states that the existing protection criteria or in-band FSS earth stations in the 3650-3700 MHz band in Part 90 of the Commission's rules (*i.e.*, 150 km coordination zones around each earth station)³⁵⁸ would remain in place "until the last Grandfathered Wireless Broadband Licensee's license expires within the protection area defined for a particular grandfathered FSS earth station."³⁵⁹ Thereafter, such earth stations would be protected under section 96.17 using the same criteria applicable to "similarly situated" earth stations in the 3600-3650 MHz band.³⁶⁰ We hereby modify the rules to clearly state that, after the expiration of the Part 90 protection criteria, as set forth in section 96.21, grandfathered FSS earth station licensees operating in the 3650-3700 MHz band will be permitted to register for protection under the same terms applicable to FSS earth station licensees in the 3600-3650 MHz band.³⁶¹

159. We agree with Google and WISPA that the SAS must have access to accurate and up-to-date technical information in order to adequately protect licensed FSS earth stations.³⁶² Operators must update the registration if this information changes so that the SAS is able to consistently verify this information to provide ongoing protection to individual sites. As we stated in the *3.5 GHz R&O*, and noted by Google, the annual registration requirement allows us to balance the protection of incumbent FSS earth stations and greater Citizens Broadband Radio Service spectrum utilization instead of relying on a one-size-fits-all approach using worst-case interference assumptions.³⁶³ This aligns with the overarching goal of protecting actual use in the 3.5 GHz Band to maximize capacity and coexistence of all users for the most efficient use of the band.³⁶⁴

160. We disagree with SIA's assertion that the registration requirement is overly burdensome and imposes unnecessary obligations on satellite providers. First, we agree with Google that operators are in the best position to supply accurate information to the Commission.³⁶⁵ Second, as SIA itself notes, earth station operators already provide much of this information to IBFS.³⁶⁶ As such, providing that information along with additional necessary information on the operational characteristics of FSS earth stations not included in IBFS, should not present a significant burden to FSS licensees but is critical for SAS Administrators to effectively perform their duties. We also note that registration requirements are not unique to earth station operators. Registration of operational features is a key means of managing interference in a shared use regime. Indeed, all Citizens Broadband Radio Service user must register the operational characteristics of their CBSDs prior to commencing operation and upon making changes to any operational parameters of their base stations.³⁶⁷

161. We also confirm that FSS earth station registration – and the protections it confers – do not extend to unlicensed in-band or out-of-band FSS earth stations. SIA presents no argument that would

³⁵⁸ See 47 C.F.R. § 90.1331(a).

³⁵⁹ *Id.* § 96.21(c).

³⁶⁰ *Id.*

³⁶¹ See Appendix A, § 96.17(a)(1).

³⁶² See Google Reply at 7; WISPA Opposition at 14-15.

³⁶³ *3.5 GHz R&O*, 30 FCC Rcd at 4045-4046, ¶ 290. See Google Reply at 8.

³⁶⁴ See *3.5 GHz R&O*, 30 FCC Rcd at 3962, 3983, ¶¶ 5, 73.

³⁶⁵ See Google Reply at 7.

³⁶⁶ See SIA Petition at 17-18.

³⁶⁷ See 47 C.F.R. §§ 96.23(b), 96.33(b), 96.39(c).

compel the Commission to take the extraordinary step of protecting unlicensed sites from interference from licensed services.

162. Finally, in regard to SIA's request that we clarify the registration deadline, we note that the Commission directed WTB to release a public notice describing the registration process. In a June 2015 public notice, WTB announced that it would release this public notice in "early 2016."³⁶⁸ We direct WTB to include the annual filing deadline in this public notice.

IV. SECOND REPORT AND ORDER

163. With this *Second R&O*, we address the three issue areas raised in the *Second FNPRM*. The *Second FNPRM* sought comment on how to: (1) define "use" by Priority Access Licensees; (2) effectively facilitate secondary market transactions in the band; and (3) effectively protect in-band FSS earth stations and C-Band FSS earth stations.

A. Defining "Use" of PAL Frequencies

1. Background

164. In the *3.5 GHz R&O*, we determined that allowing opportunistic access to channels not being used by Priority Access Licensees would serve the public interest by maximizing the flexibility and utility of the 3.5 GHz Band for the widest range of potential users.³⁶⁹ When PALs 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.³⁷⁰ On multiple occasions prior to the *3.5 GHz R&O*, we sought comment on this "use-it-or-share-it" concept.³⁷¹ While there was broad support in the record for some form of opportunistic GAA use, the record diverged greatly as to the proper methodology for defining and implementing a "use-it-or-share-it" framework.³⁷² Therefore, in the *Second FNPRM*, we sought focused comment on particular options for defining "use" by Priority Access Licensees. Specifically, we sought comment on whether we should adopt an engineering definition, an economic definition, or a hybrid definition and how any such approach should be implemented.³⁷³

165. Several commenters advocated approaches that would rely on an engineering-based definition of "use" to allow GAA access when frequencies are not being used by Priority Access Licensees while protecting the areas actually utilized by such licensees.³⁷⁴ We asked proponents of an

³⁶⁸ See Wireless Telecommunications Bureau Announces Comment Dates for 3.5 GHz Second FNPRM and Upcoming Releases in GN Docket No. 12-354, GN Docket No. 12-354, *Public Notice*, 30 FCC Rcd 6482, 6483 (2015).

³⁶⁹ See *3.5 GHz R&O*, 30 FCC Rcd at 3983-3982, ¶¶ 72-74.

³⁷⁰ See 47 C.F.R. § 96.25(c).

³⁷¹ See *3.5 GHz NPRM*, 27 FCC Rcd at 15612, ¶ 56; *Licensing PN*, 28 FCC Rcd at 15310, ¶ 28; *3.5 GHz FNPRM*, 29 FCC Rcd at 4283, ¶ 29.

³⁷² AT&T *FNPRM* Comments at 12; CTIA *FNPRM* Comments at 9-10; Federated Wireless *FNPRM* Comments at 19-20; Federated *Licensing PN* Comments at 36-38; Interdigital *FNPRM* Comments at 6-7, 21-22; Microsoft *FNPRM* Comments at 5; Microsoft *FNPRM* Reply Comments at 4; Dynamic Spectrum Alliance *FNPRM* Comments at 2; PISC *FNPRM* Reply Comments at 19-23; Shared Spectrum Company *FNPRM* Comments at 10; Verizon *FNPRM* Comments at 10-11; White Space Alliance *FNPRM* Comments at 3; Wi-Fi Alliance *3.5 GHz FNPRM* Comments at 6; WISPA *FNPRM* Comments at 27; WISPA *Licensing PN* Comments at 16.

³⁷³ See *3.5 GHz R&O*, 30 FCC Rcd at 4082-85, ¶ 419.

³⁷⁴ See Dynamic Spectrum Alliance *Second FNPRM* Comments at 1; Federated Wireless *Second FNPRM* Comments at 6-7; Federated Wireless *Second FNPRM* Reply Comments at 2-5; Google *Second FNPRM* Comments at 2; Google *Second FNPRM* Reply Comments at 1-4; InterDigital *Second FNPRM* Comments at 3; Microsoft *Second FNPRM* Comments at 2; OTI/PI *Second FNPRM* Comments at 4; Sony Electronics *Second FNPRM*

(continued...)

engineering definition of “use” to submit a detailed description of their methodology along with technical criteria and metrics that could be readily implemented by multiple SASs.³⁷⁵ We also asked them to address potential issues with the engineering approach, including: (1) whether utilizing a vacant PAL channel as a guard band should constitute “use;” (2) how to prevent gaming the “use-or-share” rules; and (3) whether an equitable approach to calculating aggregate interference can be implemented across multiple SASs.³⁷⁶

166. An alternative approach is to define “use” from an economic perspective for the purposes of determining GAA access to unused spectrum. William Lehr, an economist at the Massachusetts Institute of Technology, argued that the Commission should “view the PAL as an option to exclude GAA usage. PAL licensees would acquire the right to exclude GAA access.”³⁷⁷ Under this approach, actual operation as a Priority Access Licensee would not be the trigger for excluding GAA use. Rather, the price paid by a Priority Access Licensee at auction would be divided into two parts. The first payment would be made after the licensee acquires its PAL at auction. After that, the licensee would have the right, but not the obligation, to exercise its option to exclude GAA access from the PAL by making a second payment.³⁷⁸ We sought comment on this approach and asked commenters to address potential issues with the economic approach, including: (1) whether the framework would encourage hoarding of PALs; (2) how payments should be apportioned between the initial payment and the option “strike” price; and (3) how the economic approach would fit in with the Commission’s auction authority and its prior experience conducting auctions.³⁷⁹ We also sought comment on whether a hybrid approach incorporating elements of the engineering and economic models would be preferable.

167. Most commenters argue that the Commission should not adopt an economic definition of use and should, instead, implement some form of engineering-based approach.³⁸⁰ Commenters, including the Dynamic Spectrum Alliance, Federated Wireless, Google, the Information Technology Industry Council, Microsoft, Sony and WISPA specifically argue against the adoption of the economic approach.³⁸¹ Google argues that, because an economic definition places no obligation on the Priority Access Licensee to actually deploy equipment or provide service in an area where it exercises its option to exclude GAA users, it would encourage licensees to bid on spectrum that they have no intention of using and increase the risk of warehousing.³⁸² Federated Wireless and Microsoft argue that an economic definition of use will allow Priority Access Licensees to hoard spectrum and exclude legitimate GAA

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Comments at 1; Wi-Fi Alliance *Second FNPRM* Comments at 3; WISPA *Second FNPRM* Comments at 2-7; WISPA *Second FNPRM* Reply Comments at 2-6.

³⁷⁵ See *Second FNPRM*, 30 FCC Rcd at 4082, ¶ 421.

³⁷⁶ See *id.* at 4081-83, ¶¶ 420-24.

³⁷⁷ William Lehr *FNPRM* Reply Comments at 1.

³⁷⁸ The licensee may exercise the option immediately or any time before the license expires. See *id.* at 5.

³⁷⁹ See *Second FNPRM*, 30 FCC Rcd at 4083-85, ¶¶ 425-29.

³⁸⁰ See Dynamic Spectrum Alliance *Second FNPRM* Comments at 1; Federated Wireless *Second FNPRM* Comments at 6-7; See Federated Wireless *Second FNPRM* Reply Comments at 2-5; Google *Second FNPRM* Comments at 2; Google *Second FNPRM* Reply Comments at 1-4; InterDigital *Second FNPRM* Comments at 3; Microsoft Corporation at 2; OTI/PI *Second FNPRM* Comments at 4; Sony Electronics *Second FNPRM* Comments at 1; Wi-Fi Alliance *Second FNPRM* Comments at 3; WISPA *Second FNPRM* Comments at 2-7; WISPA *Second FNPRM* Reply Comments at 2-6.

³⁸¹ See Dynamic Spectrum Alliance *Second FNPRM* Comments at 3; Federated Wireless *Second FNPRM* Reply Comments at 3-4; Goggle *Second FNPRM* Comments at 19-20; Microsoft *Second FNPRM* Comments at 4-5; Sony *Second FNPRM* Comments at 1-2; WISPA *Second FNPRM* Comments at 6-7.

³⁸² See Google *Second FNPRM* Comments at 19-20.

users.³⁸³ Sony contends that the economic approach would be inefficient and difficult to implement and would increase uncertainty for GAA users.³⁸⁴ On the other hand, Key Bridge expresses enthusiasm for the economic approach and argues that the Commission should pursue a hybrid model that incorporates some of the ideas put forth by William Lehr.³⁸⁵

168. AT&T, CTIA, and Qualcomm argue for a definition of “use” that is not, strictly speaking, an economic or engineering approach.³⁸⁶ According to AT&T and Qualcomm, GAA use should only be allowed on channels assigned to a Priority Access Licensee until that Priority Access Licensee begins providing service or informs an SAS that it will be using the channel(s) in its Service Area.³⁸⁷ AT&T contends that a “bright line rule”, whereby GAA users are foreclosed from accessing spectrum once a Priority Access Licensee begins to offer service in a census tract is necessary to provide certainty to potential licensees and encourage investment in the band.³⁸⁸ CTIA agrees, arguing that both economic and engineering models would create uncertainty in the PAL marketplace, burden investment, and delay efficient use of the 3.5 GHz Band.³⁸⁹

169. Verizon and WinnForum argue that the best way to ensure quality of service and promote investment is for Priority Access Licensees to directly input their coverage contours into an SAS.³⁹⁰ According to Verizon, it is impossible for third parties to divine – and to design interference protections that respect – each Priority Access Licensee’s specific uses and network configuration. Verizon also asserts that Commission oversight could prevent operators from seeking protection for overlarge areas and that legitimate operator-defined “use” should include guard bands and reserve channels.³⁹¹ According to Verizon, the Commission should accord Priority Access Licensees a rebuttable presumption that their coverage area showings are appropriate.³⁹² WinnForum agrees with the proposal to allow operators to self-define their protected coverage areas.³⁹³

170. Google argues that the Commission should adopt an engineering-based definition of use based on actual deployment conditions that would be implemented and enforced by the SAS. Google contends that Priority Access Licensees should be permitted to register their own protected coverage areas within their Service Areas and that Priority Access Licensees should be permitted to agree to alternative protection limits and communicate such agreements to the SAS.³⁹⁴ According to Google, PAL protection areas should be supported by engineering analysis of actual operations and that documentation of such

³⁸³ See Federated Wireless *Second FNPRM* Reply Comments at 3; Microsoft *Second FNPRM* Comments at 4; WISPA *Second FNPRM* Comments at 6.

³⁸⁴ See Sony *Second FNPRM* Comments at 1-2.

³⁸⁵ See Key Bridge *Second FNPRM* Comments 10-12.

³⁸⁶ See AT&T *Second FNPRM* Comments at 2; Qualcomm *Second FNPRM* Comments at 3.

³⁸⁷ See AT&T *Second FNPRM* Comments at 2; CTIA *Second FNPRM* Comments at 3; Qualcomm *Second FNPRM* Comments at 3.

³⁸⁸ See AT&T *Second FNPRM* Comments at 3.

³⁸⁹ See CTIA *Second FNPRM* Comments at 6-9.

³⁹⁰ See Verizon *Second FNPRM* Comments at 1-3; WinnForum Petition at 17.

³⁹¹ See Verizon *Second FNPRM* Comments at 2-3.

³⁹² See *id.* at 3.

³⁹³ See WinnForum Petition at 17.

³⁹⁴ See Google *Second FNPRM* Comments at 3; Google *Second FNPRM* Reply Comments at 2-4.

analysis should be submitted by the Priority Access Licensee at the time that the protection is requested.³⁹⁵

171. Google elaborated on its arguments and provided examples of a proposed methodology in a February 2016 *ex parte* letter. In that letter, Google argues that, to confirm that the protection requested by Priority Access Licenses is based on reasonable technical considerations, the Commission should require all Priority Access Licensee coverage area claims to be measured against maximum service areas calculated by an SAS. Google also asserts that, to ensure that reasonable assumptions are used, SASs should be required to demonstrate that the methodology used in calculating claimed coverage areas is consistent with the methodology used to calculate protection areas for Incumbent Access users and other Priority Access Licensees in the band.³⁹⁶

172. Federated Wireless contends that utilizing an engineering definition is consistent with the goals set forth by the Commission and is technologically feasible.³⁹⁷ Under Federated Wireless's proposal, SASs, using data provided by Priority Access Licensees, would define a protection boundary, or protected service contour, around active CBSDs authorized to operate on a Priority Access basis.³⁹⁸ The SAS, in turn, would prohibit GAA user access to channels used by Priority Access Licensees where the corresponding interference threshold to the CBSDs in the protected boundary is exceeded.³⁹⁹ While Federated Wireless agrees with Google and Verizon that Priority Access Licensees are in the best position to determine where their operations are, they do not state a preference between the methodologies proposed by those two entities.⁴⁰⁰

173. Others, including Interdigital OTI/PK, the Wi-Fi Alliance, and WISPA argue for an engineering definition that incorporates both geographic and temporal elements to ensure that GAA use is only foreclosed when CBSDs are in active use.⁴⁰¹ WISPA and OTI/PK argue that the Commission should require SAS administrators to calculate service contours using the reported technical parameters and geolocation of registered CBSDs.⁴⁰² WISPA contends that the Commission should consider a PAL channel to be in use whenever it has received 300 or more end-user data packets within a five-minute interval.⁴⁰³ Wi-Fi Alliance argues that the definition of "use" should be based on actual transmission or reception of radio signals and, specifically, that "[u]nless there is a current report that radiofrequency (RF) energy is being actively transmitted or received on PAL channels, those channels should be available for GAA use."⁴⁰⁴ OTI/PK agrees that the that the Commission should incorporate a temporal element of use that would prevent licenses from permanently foreclosing GAA access in a given geographic area for temporary or transient Priority Access uses such as pre-deployment network testing and notes that it believes that WISPA's methodology is technologically feasible.⁴⁰⁵

³⁹⁵ See Google *Second FNPRM* Comments at 12; Google *Second FNPRM* Reply Comments at 2-4.

³⁹⁶ See Google February 2016 *Ex Parte* at 1-5.

³⁹⁷ See Federated Wireless *Second FNPRM* Comments at 2.

³⁹⁸ See *id.* at 4.

³⁹⁹ See Federated Wireless *Second FNPRM* Comments at 4-5.

⁴⁰⁰ See Federated Wireless *Second FNPRM* Reply Comments at 4.

⁴⁰¹ See InterDigital *Second FNPRM* Comments at 3; OTI/PK *Second FNPRM* Comments at 6-7; Wi-Fi Alliance *Second FNPRM* Comments at 3.

⁴⁰² See OTI/PK *Second FNPRM* Comments at 4-5; WISPA *Second FNPRM* Comments at 2-3.

⁴⁰³ See WISPA *Second FNPRM* Comments at 2-3.

⁴⁰⁴ Wi-Fi Alliance Comments at 3.

⁴⁰⁵ See OTI/PK *Second FNPRM* Comments at 5-7; OTI/PK *Second FNPRM* Reply Comments at 5-10.

2. Discussion

174. We find that a consistent, SAS-based engineering approach to determining when channels assigned to Priority Access Licensees are “in use” will maximize the flexibility and utility of the Citizens Broadband Radio Service and promote widespread deployment of broadband services in the 3.5 GHz Band. Specifically, we adopt a two pronged approach to determining “use” by Priority Access Licensees. First, Priority Access Licensees may report their PAL Protection Areas on the basis of their actual network deployments. Second, to establish an objective *maximum* PAL Protection Area, the SASs will use a consistent model to define a default -96 dBm/10 MHz protection contour.⁴⁰⁶ We find that the two pronged approach provides licensees with the flexibility to self-report their protection areas while also providing an objective maximum. Further, we find that utilizing SASs to determine default protection contours around registered CBSDs that are authorized to operate on a Priority Access basis will provide an effective baseline protection criteria for Priority Access Licensees while allowing GAA users reasonable opportunities for additional access to the band. Default protection contours must be based on common inputs and engineering assumptions to ensure consistent results across SASs.

175. In addition, we encourage Priority Access Licensees, working with SAS Administrators, to restrict their PAL Protection Areas to less than the -96 dBm/10 MHz default protection contour to reflect the actual needs and capabilities of their particular networks (within the boundaries defined by the default protection contours) to increase spectrum availability and further promote flexible use of the band and to self-report these contours to an SAS. We expect that, through ongoing technological innovation and industry collaboration, the default protection contours will be further refined in the future. As described in section III(G), SASs will also protect the PAL Protection Areas from aggregate interference from Priority Access and GAA CBSDs using common assumptions and modeling that we will review during the SAS approval process. The PAL Protection Areas will be enforced by the SAS for registered CBSDs authorized to operate pursuant to a PAL.

a. Importance of Opportunistic Spectrum Access

176. In the *3.5 GHz R&O*, we found that permitting opportunistic access to unused Priority Access channels would maximize the flexibility and utility of the 3.5 GHz Band.⁴⁰⁷ We also found that, by allowing GAA users to access bandwidth that is not actually in use by Priority Access Licensees, we would ensure that the band will be in consistent and productive use.⁴⁰⁸ We hereby reaffirm these findings and confirm that promoting flexible access to the 3.5 GHz Band for a diverse group of users is in the public interest.

177. Consistent with these findings, we conclude that the proposals made by AT&T, CTIA, and Qualcomm regarding the definition of “use” are inconsistent with the Commission’s goals for the band. AT&T, CTIA, and Qualcomm argue that the Commission should define a geographic area as “in use” whenever a Priority Access Licensee notifies an SAS of its intent to operate in a given area.⁴⁰⁹ They argue that this approach is needed to provide potential Priority Access Licensees with the regulatory certainty needed to invest in PALs and provide service in the band.⁴¹⁰ As Federated Wireless and WISPA correctly note, these approaches are not actually engineering definitions of use and are directly contrary to

⁴⁰⁶ See Appendix A, § 96.25.

⁴⁰⁷ See *3.5 GHz Second FNPRM*, 30 FCC Rcd at 4081, ¶ 419.

⁴⁰⁸ See *id.* at 4081, ¶ 419.

⁴⁰⁹ See AT&T *Second FNPRM* Comments at 2; CTIA *Second FNPRM* Comments at 3; Qualcomm *Second FNPRM* Comments at 3.

⁴¹⁰ These arguments are also consistent with revisions to the Commission’s licensing proposal requested by CTIA in its petition for reconsideration - which AT&T supported - and arguments made by the parties during earlier phases of the proceeding. AT&T *Second FNPRM* Reply Comments at 7; See CTIA Petition at 2-3.

the purpose of the Commission's rules.⁴¹¹ As we stated in the *3.5 GHz R&O* and reiterated in sections I and III(A) above, the Citizens Broadband Radio Service rules are designed to facilitate shared – rather than exclusive – access to the 3.5 GHz Band. Adopting rules that would allow a Priority Access Licensee to foreclose access to its entire Service Area (or even a single census tract) with nothing but a notification of its intent to provide service – or transmission of an initial signal – would over-protect Priority Access Licensees, facilitate spectrum warehousing, and encourage inefficient use of spectrum resources.⁴¹² We believe that the “use it or share it” approach of our rules for this unique band also thus more reasonably accommodates the goals of Section 309(j) of the Act, including “to prevent stockpiling or warehousing of spectrum.”⁴¹³

178. Moreover, contrary to the assertions made by AT&T, Qualcomm, and CTIA, we believe that adopting a true shared access model based on sound engineering principles will encourage investment in the band. A diverse group of commenters, including Google, WinnForum,⁴¹⁴ Federated Wireless, WISPA, Microsoft, OTI/PK, and Verizon have submitted filings indicating support for some variation of a true “use or share” model based on engineering principles.

179. We also agree with the diverse group of commenters that contend that an economic approach to defining “use” would not promote the most efficient use of the 3.5 GHz Band.⁴¹⁵ We believe that shared access to the 3.5 GHz Band should be grounded in sound engineering principles to ensure that spectrum resources are equitably assigned between and among various users. However, we note that economic approaches may warrant further study and we encourage interested parties to continue to examine how such economic models may be applied towards spectrum sharing in the future.

b. Contour-based Engineering Model

180. Many commenters support some form of engineering-based methodology for determining whether channels assigned to Priority Access Licensees are actually “in use” in a given geographic area. We agree and find that a methodology based on sound, commonly applied, engineering principles will best ensure appropriate protection for Priority Access Licensees and equitable access to spectrum for GAA users while discouraging warehousing of spectrum resources. Several commenters also argue that Priority Access Licensees should have the flexibility to build and design their networks and to report the contours they need protected to the SAS. The approach we adopt incorporates both concepts by allowing Priority Access Licensees to report their network contours on the basis of their actual network deployments while also defining an objective default protection contour around CBSDs operating on a Priority Access basis.

⁴¹¹ See Federated Wireless *Second FNPRM* Reply comments at 4-5; WISPA *Second FNPRM* Reply Comments at 7.

⁴¹² See WISPA *Second FNPRM* Reply Comments at 5-6 (“Blanket declarations of intent or planned use would encourage spectrum warehousing across an entire license area and would allow PAL holders to claim ‘use’ before any CBSDs have been deployed and are delivering service to actual end users in the field.”); Federated Wireless *Second FNPRM* Comments at 4 -5 (“These proposals should be rejected because they are directly contrary to the Commission’s goal of maximizing efficient use of spectrum in the Citizens Band by both PAL and GAA users.”).

⁴¹³ 47 U.S.C. 309(j)(4)(B).

⁴¹⁴ AT&T and Qualcomm are members of WinnForum’s steering committee.

⁴¹⁵ See Dynamic Spectrum Alliance *Second FNPRM* Comments at 2 (“By allowing and perhaps even encouraging PAL holders to limit access to spectrum even if they have no plans to put such spectrum into productive use, an economic approach encourages warehousing.”); Google *Second FNPRM* Comments at 20 (“Because an economic definition places no obligation on the PAL holder actually to use PAL spectrum, it increases the likelihood of spectrum hoarding or warehousing.”); See Microsoft *Second FNPRM* Comments at 4 (“This definition would allow Priority Access licensees to exclude GAA devices from opportunistically accessing the channel regardless of whether the licensee ever actually used the spectrum... such behavior would result in a highly inefficient use of spectrum.”).

181. *Self-Reporting by Priority Access Licensees.* While we agree with Federated Wireless, Verizon, and WinnForum that Priority Access Licensees are uniquely positioned to determine their own network needs and communicate those needs to the SAS, we also believe that it is in the public interest to encourage stability and predictability in determining protections for CBSDs operating on a Priority Access basis and to maximize spectral efficiency by ensuring that all unused spectrum is available for GAA.⁴¹⁶ Therefore, we will allow Priority Access Licensees to report their protection contours on the basis of the network deployment, so long as they are within the boundaries established by the objective default protection contour. A predictable and consistent approach to defining the maximum reach of PAL Protection Areas is important for network planning purposes and to ensure that all SASs protect Priority Access Licensees consistently and allow GAA users equitable access to unused channels. Priority Access Licensees are encouraged to work with SAS Administrators to tailor their self-reported PAL Protection Areas to their particular needs within the boundaries defined by the default protection contours. This approach will provide flexibility to Priority Access Licensees while also creating an objective means of determining a maximum protection contour and minimizing the risk that Priority Access Licensees might claim protections beyond the extent of their actual network deployments.

182. Under a system relying on pure self-reporting, we are concerned that Priority Access Licensees would be effectively encouraged to deploy their networks inefficiently and seek protection for extremely low signal levels or in areas without facilities that are in actual use. We agree with Public Knowledge, OTI/PK, and WISPA that allowing Priority Access Licensees to self-define their network parameters without reference to a common set of engineering assumptions is likely to encourage warehousing and disincentivize efficient spectrum use.⁴¹⁷ Under such a system, Priority Access Licensees would have no reason to deploy facilities or define their network parameters in a manner that would encourage sharing with GAA users.

183. On the other hand, it is our hope that the approach we adopt herein will encourage Priority Access Licensees to use their unique knowledge of their own networks – in collaboration with SAS Administrators - to craft more tailored protection contours within the bounds of the default protection contours defined in section 96.25 that will encourage more spectral reuse by both Priority Access Licensees and GAA users.⁴¹⁸ For example, we believe that a variety of economic factors will incentivize Priority Access Licensees to self-report their protection contours so as to limit them to areas of actual use (*i.e.*, to contours smaller than default contours). Specifically, it would be in the interest of the licensee not to overstate its PAL Protection Area to the extent that it plans to take advantage of the newly established secondary markets rules for this band. Claiming a smaller protection area would make more area available to lease on the secondary market, as described in section IV(B). Our rules do not permit a PAL licensee to lease its spectrum in areas where it asserts actual use of the spectrum, *i.e.*, within its PAL Protection Area.⁴¹⁹ Thus, by reducing the size of its PAL Protection Area, the licensee could signal to potential lessees that a significant portion of its Service Area is available for lease, on a short or long term basis, which could provide a greater financial benefit to this licensee than would be possible with a larger PAL Protection Area.⁴²⁰ In addition, a Priority Access Licensee that accepts a protection contour that is larger than needed to protect its operations could limit the ability of GAA users to access what is essentially an unused portion of the Service Area and, in turn, contribute to a collective action problem in which Priority Access Licensees and GAA users have little incentive to cooperate with each other. To the extent that a Priority Access Licensee also intends to make use of spectrum on a GAA basis, either within

⁴¹⁶ See Federated Wireless *Second FNPRM* Reply Comments at 4; Verizon *Second FNPRM* Comments at 2-3; WinnForum *Second FNPRM* Reply Comments at 3.

⁴¹⁷ See OTI/PK *Second FNPRM* Reply Comments at 9; WISPA *Second FNPRM* Reply Comments at 4.

⁴¹⁸ See Appendix A, § 96.25.

⁴¹⁹ See *id.*, § 96.32.

⁴²⁰ See section IV(B).

its Service Area or elsewhere, it is in the interest of that Priority Access Licensee not to seek to establish larger protection areas than needed, because establishing such protection where it is not needed may well encourage other Priority Access Licensees to do likewise. Nevertheless, we plan to monitor the operation of our rules in this novel sharing environment, to ensure that spectrum is utilized efficiently.

184. We also note that Priority Access Licensees may alter their reported PAL Protection Areas freely throughout their license term. As set forth herein, PAL Protection Areas are reported or calculated based on the registered characteristics of a Priority Access Licensee's active CBSDs and, as such, they may change depending on the licensee's network deployments or business decisions.

185. *Default Protection Contour Boundaries.* The default protection contour will be defined and modeled by the SAS as a -96 dBm/10 MHz contour around each CBSD operating on a Priority Access basis. If the contours modeled around each individual CBSD overlap, the SAS will combine them into a single contour boundary.⁴²¹ The precise shape of the contour will be modeled by the SAS using the characteristics of CBSDs provided pursuant to sections 96.41, 96.43, and 96.45 of the Commission's rules and commonly applied technical assumptions as determined during the SAS Approval Process.⁴²² The default protection contour is the outer limit of the maximum area that any Priority Access Licensee may claim as its PAL Protection Area. Any area within the PAL Protection Area will be protected from interference from other CBSDs, consistent with section 96.41(d).⁴²³ To ensure consistent protection, the default protection contours and, by extension, the maximum PAL Protection Areas, must be consistent across all SASs.

186. While the Commission's rules are technologically neutral, we believe that, given the likely uses of the 3.5 GHz Band, it is appropriate to use a reasonable reference sensitivity for LTE technologies as the basis for the modeled default protection contours.⁴²⁴ For example, 3GPP has defined two LTE bands that overlap the 3.5 GHz band, Band 42 from 3400 MHz to 3600 MHz, and Band 43 from 3600 MHz to 3800 MHz. For both of these bands, the reference sensitivity in a 10 MHz bandwidth is -96 dBm indicating that below this value the signal becomes too weak relative to the noise floor for adequate reception.⁴²⁵ Thus, we find that defining the default protection contour by reference to a signal strength of -96 dBm/10 MHz is appropriate for existing and expected use cases, technologies, and network deployments in the band.⁴²⁶

187. We believe that this level of protection is appropriate for the types of dense, relatively low power deployments that we expect in the band. Equipment in such deployments typically operate at levels above those defined in the standard and we expect that to hold true here too. Thus, using a default protection contour referenced to -96 dBm/10 MHz offers a degree of protection sufficient to protect the most common likely use cases in the band without over-protecting Priority Access licensees to an unreasonably low signal level and thereby precluding GAA use of the spectrum. Moreover, we believe that a contour referenced to -96 dBm/10 MHz is technologically neutral and will provide appropriate

⁴²¹ If contour edges do not overlap, a Priority Access Licensee may have multiple PAL Protection Areas in a single Service Area.

⁴²² 47 C.F.R. §§ 96.42, 96.43, 96.45.

⁴²³ This area will be referred to collectively as the PAL Protection Area.

⁴²⁴ Commenters have shown interest in using LTE technology in the 3.5 GHz Band and, indeed, companies have already developed LTE base stations in the 3650-3700 MHz portion of the band. *See Ex Parte* Letter from Stephen E. Coran on behalf of Telrad Networks to Marlene H Dortch, Secretary, FCC, in GN Docket No. 12-354 (December 3, 2015).

⁴²⁵ *See* 3GPP TR 37.801 V10.0.0 (2011-10), "Technical Specification Group Radio Access Networks; UMTS-LTE 3500 MHz Work Item Technical Report (Release 10)."

⁴²⁶ *See* iPosi *Second FNPRM* Comments at 7 (recommending that the Commission define a PAL's CBSD's "use" geography at its 097 dBm contour).

protection for a variety of current and future technologies. Given the unique licensing model used for PALs (e.g., short term licenses, no renewal expectancy, census tract license areas, no specific build out requirements) and the technical interchangeability of GAA and Priority Access authorizations, we believe that this approach to determining Priority Access use will effectively discourage warehousing and ensure that Priority Access Licensees receive protection only in areas that are in active use.

188. *Calculation of Default Protection Contours.* While we do not mandate a specific propagation model to determine the default protection contour, we do believe that it is in the public interest to ensure that all SASs operate from a common set of assumptions and methodologies for determining the default protection contours. Operating from a common set of assumptions and a common propagation model will provide a predictable interference landscape for potential licensees, encouraging rapid deployment of network elements and promoting investment in the band. Moreover, we believe that, at this time, these assumptions should be as simple and easily implementable as possible to promote rapid deployment in the band. These assumptions and methodologies will be reviewed - and common models and assumptions will be approved - by WTB and OET as part of the SAS approval process.⁴²⁷ We expect that the assumptions and the implementation within SASs will evolve over time to build off of the collective learned experience and expertise of SAS Administrators and Priority Access Licensees. WTB and OET will review revised approaches and assumptions as they are developed.

189. WTB and OET will consider the consistency and ease of implementation of proposed methodologies when reviewing proposals from prospective SAS Administrators. As such, we encourage prospective SAS Administrators to consider proposing a simple, easily implementable model (e.g., Cost-231, NTIA model, extended HATA). The end-result of any model should be a simple contour that is more realistic than models that rely on worst case assumptions (such as free space path loss) or worst case parameters (such as assuming all CBSDs are at the maximum allowed height and power). The model may be updated or modified in the future - after review by WTB and OET - as new data is collected from actual deployments in the band.

190. This approach to propagation, terrain, and clutter modeling is consistent with the approach adopted in section IV(C)(1)(d) for protection of FSS earth stations and general propagation determinations. At this time, we believe that allowing SAS Administrators to adopt proprietary approaches to propagation, clutter, and terrain modeling for purposes of determining default protection contours would be overly complex and would lead to inconsistent – and possible contradictory – results. A simple, easily implementable model applied across all approved SASs is in the public interest as it is more likely to promote robust, rapid investment in the band.

191. It is important to note that the assumptions and modeling methodologies that are approved as part of the SAS approval process are only the first step of an iterative process. We expect to further refine these models based on the real-world experiences of SAS Administrators and Citizens Broadband Radio Service users. We encourage Priority Access Licensees, GAA users, SAS Administrators, and other interested stakeholders to work collaboratively to improve the initial default protection contours and leverage their technological capabilities to develop revised sharing models over time. Such improvements may be implemented at a later date.

c. Temporal Criteria

192. We will require the SAS to enforce the PAL Protection Areas, consistent with section 96.25 and 96.41(d).⁴²⁸ We believe that the public interest will be best served by ensuring that all such CBSDs are protected so long as they continue to operate under a PAL but that the SAS should not be responsible for ensuring that CBSDs are actually transmitting at any specific time. Thus, we require that, if a CBSD ceases to operate on a Priority Access basis – or discontinues service for more than seven days

⁴²⁷ See *SAS and ESC Operator Application PN; 3.5 GHz R&O*, 30 FCC Rcd at 4067, ¶ 369.

⁴²⁸ See Appendix A, §§ 96.25, 96.41(d).

– it must inform the SAS of this change in status and the SAS must alter the PAL Protection Area accordingly. If a CBSD discontinues service and is later reactivated on a Priority Access basis, the SAS must expeditiously re-establish the PAL Protection Area around that CBSD.⁴²⁹

193. Pursuant to section 96.39(c) of the Commission’s rules, a CBSD must register with and be authorized by an SAS prior to its initial service transmission and must update the SAS if any registration information changes.⁴³⁰ Registration information must include the requested authorization status (GAA or Priority Access) for each CBSD.⁴³¹ We also require all CBSDs to inform the SAS of any changes in operational parameters or registration information, including requested authorization status.⁴³² In addition, to ensure that only operational Priority Access authorized CBSDs are protected, we adopt a new rule that requires each CBSD to inform the SAS if it will cease providing service on a permanent basis and requires the SAS to discontinue the PAL Protection Area for any CBSD that does not contact the SAS for more than seven days.⁴³³ As OTI/PK correctly argues, without some requirement limiting protections for registered Priority Access CBSDs to periods of actual use, Priority Access Licensees may be incentivized to deploy CBSDs as “license savers” to foreclose GAA use in areas without active service. We agree with OTI/PK that CBSDs “regularly contact the SAS and provide (or could provide) basic information on whether they are actively transmitting.”⁴³⁴ Thus, the notification requirement is wholly consistent with our stated goal of protecting the actual service contours of Priority Access Licensees and making unused spectrum available for GAA use.

194. While we agree with OTI/PK, Wi-Fi Alliance, and WISPA that it is important to ensure that CBSDs are only protected from interference when they are in actual use, we do not believe that implementing a technical methodology to measure active use is necessary or appropriate. The proposals put forth by Wi-Fi Alliance and WISPA – and supported by OTI/PK – would require the SAS to affirmatively track data packets or active RF transmissions on individual CBSDs and allow GAA access whenever the benchmarks for active transmission are not met.⁴³⁵ If implemented, such a requirement would place a significant new burden on SAS Administrators, increasing the technological complexity of the SAS, and complicating enforcement and oversight for the Commission. Even if the level of oversight envisioned by WISPA and Wi-Fi Alliance is technologically viable, we believe that providing SAS Administrators with a higher level of granular oversight over individual CBSDs would hinder investment in PALs and disincentivize widespread deployment in the band. Moreover, WISPA and Wi-Fi Alliance’s proposals would not actually prevent warehousing or the deployment of “license-saver” CBSDs since any CBSD could simply be directed to transmit null data packets at intervals sufficient to satisfy the proposed requirements.

195. We also disagree with those commenters that argue that Priority Access Licensees should be permitted to reserve portions of the band (by time, frequency, or geography) as “guard bands.”⁴³⁶ While we acknowledge that such guard bands could offer additional protection for Priority Access Licensees, we do not believe they are necessary in light of the technological and regulatory features

⁴²⁹ Any CBSD that the SAS assigns to a different channel or maximum transmit power after re-establishing the PAL Protection Area will have 60-seconds to receive and comply with the instructions of the SAS. *See* 47 C.F.R. § 96.39(c)(2).

⁴³⁰ 47 C.F.R. § 96.39 (c).

⁴³¹ *Id.*

⁴³² *Id.*

⁴³³ *See* Appendix A, § 96.25(c)(1)(ii).

⁴³⁴ OTI/PK *Second FNPRM* Reply Comments at 2.

⁴³⁵ *See* Wi-Fi Alliance *Second FNPRM* Comments at 3; WISPA *Second FNPRM* Comments at 2-3.

⁴³⁶ *See* Federated Wireless *Second FNPRM* Comments at 10-11; Verizon *Second FNPRM* Comments at 2.

implemented in this band. Moreover, allowing guard bands would run counter to the Commission's goals for equitable shared use of the 3.5 GHz Band. As we stated above, the three-tier authorization framework is designed to facilitate true, shared access to the band between and among a wide variety of users.⁴³⁷ Foreclosing access to an unused portion of the band as a protective measure does not advance these goals and, indeed, would be likely to encourage warehousing and inefficient spectrum utilization by Priority Access Licensees.

196. Our approach to temporal sharing appropriately balances the need to provide a degree of certainty for prospective Priority Access Licensees and the need to ensure that portions of the 3.5 GHz Band are made available for GAA users whenever frequencies are not actually utilized by higher tier users. In addition, consistent with our usual policies, the rules place the responsibility for accurately reporting use – and the associated penalties for non-compliance – on Priority Access Licensees. We believe that this approach will encourage investment in both the Priority Access and GAA tiers, facilitate efficient and widespread spectrum use, and promote innovation in the 3.5 GHz Band.

d. Congestion Metric and Advanced Planning

197. In the *3.5 GHz R&O*, we noted that, as technology develops, advanced techniques such as contention-based protocols, “congestion metrics,” and other advanced techniques could be used by the SAS to coordinate power levels in high-density areas among GAA users. We noted that we intend to continue an informal dialog with stakeholders on these topics and suggested that such approaches might be appropriate areas of work for a multi-stakeholder group.⁴³⁸ Federated Wireless contends that such a “congestion metric” could “be used to define the conditions to which the SAS will manage GAA uses to ensure a consistent level of service can be achieved as congestion occurs.”⁴³⁹ Federated Wireless suggests that such techniques could be used to ensure that a definition of use based on aggregate interference criteria does not cause unfair treatment to GAA users and that specific techniques should be developed by a multi-stakeholder group.⁴⁴⁰ Federated also suggests that technologies that employ contention-based protocols or other mechanisms to enable coexistence could help to facilitate equitable use of the band by GAA users.⁴⁴¹

198. The Commission has consistently emphasized the importance of ensuring that GAA users have consistent, equitable access to the 3.5 GHz Band. We are pleased that industry stakeholders continue to work towards the development of innovative approaches to the issue of GAA co-existence. We encourage these efforts – by both independent actors and multi-stakeholder groups – and encourage interested parties to continue to inform us of new developments. We also direct WTB and OET to review any approaches to GAA coexistence submitted as part of the SAS approval process.

B. Secondary Markets

1. Background

199. In the *FNPRM* we sought comment on appropriate secondary market rules for the 3.5 GHz Band.⁴⁴² Many commenters addressed secondary markets issues and generally supported a framework that would allow secondary market transactions involving PALs.⁴⁴³

⁴³⁷ See section III(A).

⁴³⁸ See *3.5 GHz R&O*, 30 FCC Rcd 3959 at 4026-27, ¶ 214.

⁴³⁹ See Federated Wireless *Second FNPRM* Comments at 12.

⁴⁴⁰ *Id.*

⁴⁴¹ See *id.* at 11-13.

⁴⁴² See *3.5 GHz FNPRM*, 29 FCC Rcd at 4314, ¶ 135.

⁴⁴³ See e.g., AT&T *Second FNPRM* Comments at 3-6; CTIA *Second FNPRM* Comments at 9; Information Technology Industry Council *Second FNPRM* Comments at 3-4; Federated Wireless *Second FNPRM* Comments at

200. In the *Second FNPRM*, we sought comment on specific aspects of the secondary markets rules and requested detailed proposals for implementing any required rule changes. In particular, we requested comment on any necessary changes to our Part 1 rules to facilitate the development of a secondary market for PALs in the 3.5 GHz Band. Notably, we asked whether partitioning and disaggregation of PALs should be permitted and sought comment on the costs and benefits of allowing such transactions.⁴⁴⁴ We also sought comment on the potential use of spectrum exchanges to facilitate the transfer of PALs in the secondary market and whether such exchanges should be mandatory or could be allowed to develop voluntarily under current rules.⁴⁴⁵ Finally, we sought comment on the legal, technical, and logistical issues that should be considered, particularly in regard to modifications to our rules that could reduce transaction costs and allow increased automation of transfer and lease applications.⁴⁴⁶

201. We also sought comment on the application of our spectrum aggregation limits for Priority Access Licensees, both in the context of secondary markets and in the context of initial licensing of PALs, and we inquired as to how the unique characteristics of PAL auctions should be taken into account.⁴⁴⁷ Further, we asked whether we should apply the attribution standard used in our existing rules to transactions involving mobile wireless licenses for commercial use, and we inquired how this standard could reflect the need for a streamlined process, potentially through a database administrator, for transactions involving PALs.⁴⁴⁸

202. Several commenters responded to these questions with a variety of suggested approaches to secondary markets rules for the Citizens Broadband Radio Service. There is near uniform support in the record for allowing access to the 3.5 GHz Band through secondary markets.⁴⁴⁹ Commenters including AT&T, CTIA, Federated Wireless, Google, Information Technology Industry Council, PCIA, Rajant, Verizon, WinnForum, and WISPA agree that permitting access to PAL spectrum through secondary markets will increase flexibility and encourage efficient use of spectrum in the 3.5 GHz Band.⁴⁵⁰ AT&T further argues that flexible secondary markets will promote investment and innovation in this band.⁴⁵¹ Most commenters urge the Commission to apply its secondary markets rules to the 3.5 GHz Band,⁴⁵² and some go further, recommending that the Commission apply a more streamlined and flexible system to allow secondary use of PAL spectrum, instead of its traditional secondary market rules.⁴⁵³ Verizon, for example, advocates forbearance from prior approval of PAL leases (and also license transfers) under

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14; Federated Wireless *Second FNPRM* Reply Comments at 8-10; Google *Second FNPRM* Reply Comments at 20; PCIA *Second FNPRM* Reply Comments at 7; Rajant *Second FNPRM* Comments at 3; WinnForum *Second FNPRM* Reply Comments at 10.

⁴⁴⁴ See *Second FNPRM*, 30 FCC Rcd at 4087, ¶ 434.

⁴⁴⁵ See *id.*

⁴⁴⁶ See *id.*

⁴⁴⁷ See *id.* at 4087, ¶ 435.

⁴⁴⁸ See *id.*; See also 47 C.F.R. § 20.22.

⁴⁴⁹ See *supra* n.441.

⁴⁵⁰ See, e.g., AT&T *Second FNPRM* Comments at 3-6; CTIA *Second FNPRM* Comments at 9; Information Technology Industry Council *Second FNPRM* Comments at 3-4; Federated Wireless *Second FNPRM* Comments at 14; Federated Wireless *Second FNPRM* Reply Comments at 8-10; Google *Second FNPRM* Reply Comments at 20; PCIA *Second FNPRM* Reply Comments at 7; Rajant *Second FNPRM* Comments at 3; Verizon *Second FNPRM* Comments at 3; WinnForum *Second FNPRM* Reply Comments at 10; WISPA *Second FNPRM* Comments at 7.

⁴⁵¹ AT&T *Second FNPRM* Reply Comments at 2.

⁴⁵² See CTIA *Second FNPRM* Comments at 9. See also AT&T *Second FNPRM* Comments at 4.

⁴⁵³ See Federated Wireless *Second FNPRM* Comments at ii; Key Bridge *Second FNPRM* Comments at 8.

Section 310(d) of the Communications Act.⁴⁵⁴ Similarly, Federated Wireless argues that permitting access to PAL spectrum on the secondary market “does not warrant formal Commission approval any more than does opportunistic GAA use of PAL spectrum.”⁴⁵⁵ Rajant points out that there is inherent liquidity due to the nature of the PALs, in particular due to their short license terms and small geographic areas,⁴⁵⁶ and that establishing a streamlined process to allow access to secondary markets will bolster this liquidity.

203. Only Microsoft and the Wi-Fi Alliance state that a secondary market is unnecessary and potentially contrary to the public interest.⁴⁵⁷ They both state that the SAS will enable GAA access to PAL spectrum that is not in use, obviating the need for secondary markets in this band.⁴⁵⁸ Microsoft further argues that allowing a secondary market will encourage companies to speculate on PALs, profiting by obtaining more PALs than they need in order to make this spectrum available in the secondary market.⁴⁵⁹ Both Key Bridge and Cantor Telecom address this concern, stating that given the short license terms, small geographic coverage areas and ample availability of GAA spectrum, it would be nearly impossible for licensees to speculatively warehouse spectrum.⁴⁶⁰

2. Light-touch Leasing for Priority Access Licensees

a. Background

204. Key Bridge and Federated Wireless both state that the existing spectrum leasing procedure is designed for traditional wireless service in traditionally licensed bands, which does not apply to the 3.5 GHz Band, particularly since any number of GAA users can access and share unused PAL spectrum.⁴⁶¹ Federated Wireless and Rajant both state that certain entities need the assured use of protected PAL spectrum for only a short period of time, such as for a special event, to provide service to targeted areas, such as transit rail lines and venues.⁴⁶² Spectrum Bridge argues that the time and expense associated with the Commission’s traditional approach to transaction review in other licensed bands would make it difficult or impossible for a secondary market to develop in the 3.5 GHz Band.⁴⁶³

205. A number of commenters endorse a spectrum leasing procedure similar to the one suggested by Federated Wireless whereby the Commission would first formally certify lessees to use PAL spectrum and then upon entering a leasing arrangement with a PAL, the licensee would notify the SAS, rather than obtaining prior approval by the Commission for each PAL secondary market transaction.⁴⁶⁴ Federated Wireless suggests a standardized electronic certification process could be

⁴⁵⁴ Verizon *Second FNPRM* Comments at 3. See 47 U.S.C. § 310(d).

⁴⁵⁵ Federated Wireless *Second FNPRM* Comments at 14.

⁴⁵⁶ Rajant *Second FNPRM* Comments at 3.

⁴⁵⁷ See Microsoft *Second FNPRM* Comments at 2, 5-6; Wi-Fi Alliance *Second FNPRM* Comments at 4-5.

⁴⁵⁸ *Id.*

⁴⁵⁹ Microsoft *Second FNPRM* Comments at 6.

⁴⁶⁰ See Cantor Telecom *Second FNPRM* Reply Comments at 3; Key Bridge *Second FNPRM* Comments at 9.

⁴⁶¹ See Federated Wireless *Second FNPRM* Comments at ii; Key Bridge *Second FNPRM* Comments at 8.

⁴⁶² See Federated Wireless *Second FNPRM* Comments at 15; Rajant *Second FNPRM* Comments at 3-4

⁴⁶³ Spectrum Bridge *Second FNPRM* Reply Comments at 1 (“transaction costs and fees for secondary market transaction can exceed \$10,000, regardless of the asset size! Furthermore, the time it takes to execute a spectrum transaction is measured in months.”).

⁴⁶⁴ See Cantor Telecom *Second FNPRM* Comments at 12; Federated Wireless *Second FNPRM* Comments at 16-17; Information Technology Industry Council *Second FNPRM* Comments at 3; Jon M. Peha *Second FNPRM* Comments at 4; Key Bridge *Second FNPRM* Comments at 7-8. We note that prior approval from the Commission is not

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established so that PAL licensees can provide users with electronic consent, perhaps with a secure verification key or certificate, and the user can then submit the electronic consent and verification key to the SAS.⁴⁶⁵ Cantor Telecom states that a precertification process permitting rapid trades in the secondary market will result in significant efficiency, which is especially beneficial given the tremendous number of potential PALs available over more than 74,000 census tracts.⁴⁶⁶

206. Both Google and Federated Wireless state that the SAS can easily manage secondary use of PAL spectrum without extra complexity, as SASs will be designed and scaled to manage many thousands of PAL and GAA assignments and deployments.⁴⁶⁷ Key Bridge suggests that the SAS can help ensure transactions do not raise public interest risks.⁴⁶⁸

207. Rajant and WISPA support a notice-only process.⁴⁶⁹ Rajant describes how certain entities need the assured use of PAL spectrum and argues that a notice-only process will most effectively allow such service to emerge in a secondary market.⁴⁷⁰ WISPA states that by requiring notification to the SAS and not the Commission, the agency would have very few administrative burdens.⁴⁷¹

208. Key Bridge and Cantor Telecom suggest that the Commission assign all unsold PALs to the secondary market for resale.⁴⁷² Key Bridge argues that reverting unsold PALs to GAA use creates artificial scarcity and starves the secondary market. Instead, Key Bridge states, the Commission could foster economic innovation through a single auction that will enable commercial operators of all size and type to innovate at their own pace.⁴⁷³ Cantor Telecom supports a similar approach but suggests that the PAL remain available for GAA use until acquired on the secondary market.⁴⁷⁴

b. Discussion

209. We believe there are significant benefits to a robust secondary market for PAL spectrum. While our existing Part 1 rules already provide for substantial flexibility in this regard, we amend those rules to include a streamlined spectrum manager leasing process, based on the current spectrum manager leasing rules, tailored for the PAL leasing context. We expect there will be a demand for Priority Access rights for a wide variety of use cases. We believe that a robust, flexible, and lightly regulated secondary market through these band-specific spectrum manager leasing rules will incentivize efficient spectrum use, promote innovation, and encourage the rapid deployment of broadband networks in the 3.5 GHz Band. We will also permit *de facto* transfer leasing under the existing Part 1 rules.

210. The focus of our secondary markets policy for the 3.5 GHz Band will be to permit Priority Access Licensees to enter into a spectrum manager lease under the “light-touch leasing” regime we establish herein for any portion of their licensed geographic area for any bandwidth or period of time

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required to secure and exercise spectrum usage rights under a spectrum manager lease in our current rules. *See* 47 C.F.R. § 1.9020(a).

⁴⁶⁵ *See* Federated Wireless *Second FNPRM* Comments at 17.

⁴⁶⁶ Cantor Telecom *Second FNPRM* Comments at 13-14.

⁴⁶⁷ *See* Federated Wireless *Second FNPRM* Comments at 17; Google *Second FNPRM* Comments at 18.

⁴⁶⁸ *See* Key Bridge *Second FNPRM* Comments at 8-10.

⁴⁶⁹ *See* Rajant *Second FNPRM* Comments at 3; WISPA *Second FNPRM* Comments at 8.

⁴⁷⁰ Rajant *Second FNPRM* Comments at 3-4.

⁴⁷¹ WISPA *Second FNPRM* Comments at 8.

⁴⁷² *See* Cantor Telecom *Second FNPRM* Comments at 11-12; Key Bridge *Second FNPRM* Comments at 6.

⁴⁷³ *See* Key Bridge *Second FNPRM* Comments at 6.

⁴⁷⁴ *See* Cantor Telecom *Second FNPRM* Comments at 12.

within the scope of the PAL but outside of its PAL Protection Area.⁴⁷⁵ We also believe that the principles underlying the streamlining of our rules for assignments and transfers of control, as well as for *de facto* transfer leasing, for licenses of other Wireless Radio Services (WRS),⁴⁷⁶ including our Section 310(d) forbearance determinations that enabled us to introduce significant streamlining into the approval process for such transactions involving WRS common carrier licensees,⁴⁷⁷ apply with even greater force here, given the relatively short license terms and small License Areas of PALs.⁴⁷⁸ We believe that further changes in our rules governing these types of transactions are not warranted at this time. Moreover, as noted below, in order to achieve a balance between promoting a significant amount of flexibility for PALs and enabling the Commission to adequately enforce its rules related to ownership and control, we decline to permit PAL licensees to engage in assignments, transfers of control, or *de facto* transfer leasing agreements that result in partitioning or disaggregation of their licenses in this band.⁴⁷⁹

211. The light-touch leasing framework for PAL spectrum manager leases builds off the Commission's existing spectrum manager leasing rules and will provide Priority Access Licensees the ability to lease certain spectrum usage rights pursuant to a highly streamlined process, while also preserving the Commission's ability to fulfill its oversight and enforcement responsibilities. With respect to the Commission's ability to fulfill these responsibilities, we conclude that the immediate processing procedures under the existing spectrum manager leasing rules (set forth in section 1.9020(e)(2)) would present certain challenges due to the high numbers – often for very short-term durations – of spectrum manager leases that we expect to see in this service.⁴⁸⁰ Given the diverse range of deployments and services that the Citizens Broadband Radio Service is expected to support - coupled with the large number of PALs that we expect to issue and their relatively small License Areas - we see the potential for many thousands of leases in the 3.5 GHz Band. We expect that a significant percentage of these leases will cover a short period of time or even a single event. Under the existing immediate processing procedures, such transient lease terms would render any reasonable degree of Commission oversight exceedingly difficult to maintain during the lifetime of the lease. Therefore, to facilitate development of a robust secondary market, we believe that it is critical to employ a highly streamlined regulatory approach for handling the spectrum manager leasing process. In particular, given that PALs are limited to three-year, non-renewable license terms, it is clear that any sort of prolonged leasing process would be especially inefficient.⁴⁸¹

212. To address both the need for a streamlined process and the Commission's obligation to maintain its ability to fulfill its oversight and enforcement responsibilities, we are modifying the existing spectrum manager lease rules - which are designed for traditionally licensed, exclusive use bands -⁴⁸² to

⁴⁷⁵ See section IV(A).

⁴⁷⁶ See 47 C.F.R. § 1.948.

⁴⁷⁷ See Promoting Efficient Use of Spectrum Through Elimination of Barriers to the Development of Secondary Markets, WT Docket No. 00-230, *Report and Order and Further Notice of Proposed Rulemaking*, 18 FCC Rcd 20604 at 20660-20678, 20682-20685, ¶¶ 126-181, 195-203 (2003) (*Secondary Markets Report and Order*); Promoting Efficient Use of Spectrum Through Elimination of Barriers to the Development of Secondary Markets, WT Docket No. 00-230, *Second Report and Order*, 19 FCC Rcd 17503, 17509-17526, ¶¶ 11-45, 100-108 (2004) (*Secondary Markets Second Report and Order*).

⁴⁷⁸ The Commission concluded that certain transactions do not raise potential public interest concerns that necessitate prior public notice or individualized review and, therefore, can be approved in a more streamlined manner. See *Secondary Markets Second Report and Order*, 19 FCC Rcd at 17512, 17523-24, 17554-57, ¶¶ 14, 39, 101-08.

⁴⁷⁹ For similar reasons, we also decline to permit lessees to sublease.

⁴⁸⁰ See 47 C.F.R. § 1.9020(e).

⁴⁸¹ See Spectrum Bridge *Second FNPRM Reply Comments* at 1.

⁴⁸² *Secondary Markets Report and Order*, 18 FCC Rcd at 20643, ¶¶ 84-85.

create a process tailored to this band. Specifically, we are establishing a procedure, based on the immediate processing procedures in the Part 1 spectrum manager leasing rules, to permit parties contemplating spectrum manager lease agreements with Priority Access Licensees to submit the required, non-lease specific certifications to the Commission at any time prior to reaching a spectrum manager lease agreement with a Priority Access Licensee. Potential lessees must update their certification if any of the required information changes, including ownership information, and the Commission may request verification of any information contained in the certifications at any time. The Commission will process these certifications expeditiously in order to provide the SASs with confirmation that the future lessee meets the corresponding eligibility criteria for a spectrum manager lease. With this confirmation in hand, the SAS will be positioned to expeditiously complete a notification process for any spectrum manager lease involving that lessee and a Priority Access Licensee, once the licensee notifies the SAS of the leasing agreement. The SAS can then rapidly: (1) confirm that the lessee meets the non-lease-specific basic qualifications criteria (as evidenced by the Commission's prior verification of this fact) and that the parties meet the lease-specific eligibility requirements;⁴⁸³ and (2) notify the Commission that the parties to the spectrum leasing agreement have satisfied the requirements for invoking the immediate processing procedures. Once the SAS provides that confirmation to the licensee and lessee, the lessee may immediately begin exercising leased spectrum usage rights under the lease agreement.⁴⁸⁴

213. In sum, the lessee's ability to provide the required non-lease specific certifications to the Commission in advance for its future spectrum manager leases in this service, enables the lessee to take advantage of a similar form of expedited processing and use procedures offered under the section 1.9020(e)(2) spectrum manager leasing rules for other Wireless Radio Services, while ensuring that the lessee makes the necessary certifications with the Commission regarding its qualifications to enable the Commission to fulfill its oversight and enforcement obligations.⁴⁸⁵

214. The following bullets highlight the essential elements of this light-touch process for Priority Access spectrum manager leases, and the discussion that follows provides additional details:

- The lessee must certify with the Commission that it meets the basic qualifications for holding a license authorization.
- The licensee must notify the SAS of the leasing arrangement.
- The SAS must be able to confirm that: (1) the lessee has provided the required certification to the Commission; (2) the lease will not violate the 40 megahertz Priority Access spectrum aggregation limit for the given geographic area; and (3) the lease area is within the lessor's Service Area but outside of its PAL Protection Area.
- On a daily basis, the SAS will provide the Commission with an electronic report of the leasing notifications received from Priority Access Licensees.
- The Commission will release a weekly Public Notice listing the leasing arrangements.

⁴⁸³ Under the two lease-specific eligibility requirements, the lease must not trigger a violation of the 40 megahertz Priority Access spectrum aggregation limit for the given geographic area, and the leased area must fall within the lessor's Service Area but outside of its PAL Protection Area.

⁴⁸⁴ The SAS will be required to provide the Commission, on a daily basis, with an electronic report of the leasing notifications received from Priority Access Licensees. *See* Appendix A, § 96.66(a)(2).

⁴⁸⁵ Although for PAL licensees and lessees we are substituting this new light touch advance notification scheme for the *immediate* processing procedure under section 1.9020(e)(2) of our existing rules, such licensees and lessees may also enter into spectrum manager leases using the *general* 21-day notification procedure in section 1.9020(e)(1) of our current rules. *See* 47 C.F.R. § 1.9020(e)(1).

215. *Applicability of Existing Spectrum Leasing Rules to Priority Access Licensees.* Priority Access Licensees may enter into spectrum manager leases⁴⁸⁶ in accordance with Section 1.9020 of the Commission's rules, as amended in this order, and pursuant to the rules adopted herein.⁴⁸⁷ As required by Section 1.9020,⁴⁸⁸ Priority Access Licensees must retain *de facto*⁴⁸⁹ and *de jure*⁴⁹⁰ control of the license. Under the *de facto* control standard, both Priority Access Licensees and their lessees must comply with all applicable Commission service and technical rules, and the Priority Access Licensee is "directly and primarily responsible for ensuring the spectrum lessee's compliance."⁴⁹¹ The Priority Access Licensee remains responsible for all interactions with the Commission and must be the sole point of contact for such interactions.

216. Consistent with these requirements for retaining *de facto* control, the licensee will notify the SAS of any spectrum manager leasing arrangement and continue to be directly and primarily responsible for maintaining its own eligibility to hold a Commission license and for ensuring the lessee's compliance with Commission rules, including operation in conformance with applicable technical and use rules as well as the lessee's own eligibility. The SAS will function and communicate with CBSDs in the same manner it would in the absence of a lease. Thus, consistent with the rules governing CBSD authorization and coordination, the SAS will communicate directly with all CBSDs, regardless of whether they are operated by a licensee or lessee, thereby facilitating a lessee's compliance with technical and service rules and safeguarding other users. For example, if the SAS determines that a lessee's CBSD is causing interference, the SAS will relocate the CBSD to an unencumbered channel or deauthorize its operation without the need for licensee involvement.⁴⁹²

217. As stated above, we will permit parties that contemplate becoming lessees in the 3.5 GHz Band to certify with the Commission in advance of entering into a leasing arrangement that they meet the basic qualifications for holding a license authorization (other than those qualifications that can only be determined on a license-specific basis), similar to the suggestions of Cantor Telecom and Federated Wireless.⁴⁹³ Basic qualifications that can be certified through this advance processing include, for example, the applicable foreign ownership eligibility criteria, character and other qualification

⁴⁸⁶ See 47 C.F.R. § 1.9020.

⁴⁸⁷ See Appendix A (47 C.F.R. § 1.9046).

⁴⁸⁸ See 47 C.F.R. § 1.9020(a).

⁴⁸⁹ The Commission adopted a more flexible *de facto* control standard for spectrum leasing in 2003. Under the *de facto* control standard, the licensee must maintain an active, ongoing oversight role to ensure that the spectrum lessee complies with the Communications Act and all applicable Commission policies and rules. See *Secondary Markets Report and Order*, 18 FCC Rcd at 20629-20639, ¶¶ 12, 51-70. The *de facto* control standard is also defined in section 1.9010 of the Commission's rules. See 47 C.F.R. § 1.9010.

⁴⁹⁰ *De jure* control means legal control, or control as a matter of law. Typically, ownership of more than 50 percent of the voting stock of a corporate licensee evidences *de jure* control. See generally *In re Application of Fox Television Stations, Inc.*, *Memorandum Opinion and Order*, File No. BRCT-940201KZ, 10 FCC Rcd 8452, 8513-14 ¶¶ 151-153 (1995). See also, *Secondary Markets Second Report and Order*, 19 FCC Rcd at 17608, ¶ 7, n.11 (2004).

⁴⁹¹ See 47 C.F.R. § 1.9020(b)(1).

⁴⁹² While required to assist the Commission in its enforcement responsibilities, SAS Administrators will not conduct dispute resolutions and the Commission retains the authority to enforce its rules and resolve disputes among lessees and licensees. See *3.5 GHz R&O*, 30 FCC Rcd at 4062, ¶ 351; 47 C.F.R. § 96.63(m).

⁴⁹³ Cantor Telecom *FNPRM* Comments at 12; Federal Wireless *Second FNPRM* Comments at 16-17. "Federated Wireless urges the Commission to establish a PAL user certification process under which an entity could apply to the Commission to be certified once as eligible to formally use (as opposed to opportunistically use) PAL spectrum. Thereafter, the certified user would be free to use PAL spectrum nationwide as long as (1) the certified user obtains the PAL licensee's consent; and (2) the certified user provides notice of its use of the PAL spectrum to the SAS Administrator." Federated Wireless *Second FNPRM* Reply Comments at 9.

requirements criteria applicable to the licensee, and eligibility under the Anti-Drug Abuse Act of 1988.⁴⁹⁴ Would-be lessees that already hold PALs will automatically be deemed to meet this requirement, as they have already demonstrated that they are qualified to be a Commission licensee. WTB will establish a process for entities that do not hold PALs to provide such certification to the Commission electronically and issue a Public Notice detailing this process. The Commission will maintain a publicly available list of all entities that have made the requisite advance certifications,⁴⁹⁵ and those listed parties may enter into leasing arrangements with Priority Access licensees and commence leased operations when the SAS provides the required confirmation. The foregoing approach balances the Commission's oversight obligations while still permitting an efficient leasing process that places lessees in a position to offer service upon confirmation from the SAS. This is particularly important given that multiple parties have expressed an interest in using secondary market transactions to acquire Priority Access spectrum rights for specific, time-limited events.⁴⁹⁶

218. *SAS Notification Procedure.* Separate from the lessee's certification with the Commission, *Priority Access Licensees* will be required to submit the following information about each spectrum lease to any SAS that accepts leasing notifications: (1) necessary information on the identity of the spectrum lessee (including necessary contact information) and its eligibility to lease spectrum as demonstrated by appearing on the certification list; (2) the specific spectrum leased (in terms of amount of bandwidth and geographic area involved),⁴⁹⁷ including the call sign affected by the lease; and (3) the length of the lease. The licensee must also certify that its ownership information is current and update its ownership information, if necessary. After the licensee has provided this information and the SAS has provided confirmation that the notification has been received and the lease meets the qualifications set forth in section 96.66, the lessee may commence operations.⁴⁹⁸ This is consistent with our current practice of allowing immediate processing for certain spectrum manager leasing arrangements,⁴⁹⁹ while ensuring that the Commission has adequate time in advance of what may be very short-term event leasing to confirm that potential lessees are qualified under our rules. Leasing parties may extend the leasing arrangement beyond the initial term, by providing advance notification to the SAS, and they may terminate the arrangement early by providing notification to the SAS no later than ten days after the early termination.

219. The SAS Administrators must provide an electronic report of these notifications to the Commission on a daily basis. The Wireless Telecommunications Bureau will then issue a weekly informational Public Notice listing the leasing arrangements. As with all spectrum manager leases, the leasing notifications are subject to post-notification review by interested parties or the Bureau within 30 days, and by the Commission within 40 days.⁵⁰⁰ As under our existing spectrum manager leasing rules, the Commission retains the right to investigate and terminate any such leasing arrangement if it

⁴⁹⁴ See Appendix A, § 1.9020.

⁴⁹⁵ This list will be available to the public on the Commission's website.

⁴⁹⁶ See e.g., Federated Wireless *Second FNPRM Comments* at 15 ("owners of CAFs or other buildings, and entities that only need access to PAL spectrum for short periods of time (e.g., for a special event) do not need access to PAL spectrum for an entire census tract or an entire term"); Rajant *Second FNPRM Comments* at 3-4 ("To better serve targeted areas, as opportunities arise such as extension of transit rail lines, new venues added, etc., licensees should be able to acquire or sub-lease additional 10 MHz blocks, or additional geographic areas, on fairly short order."). Applicants must make similar certifications to qualify for immediate approval procedures under existing spectrum manager leasing rules. See 47 C.F.R. §§ 1.9020(e).

⁴⁹⁷ Unlike traditional leases, licensees cannot specify the specific frequency, as it will be assigned dynamically by an SAS.

⁴⁹⁸ See Appendix A, § 96.66.

⁴⁹⁹ See *Secondary Markets Second Report and Order*, 19 FCC Rcd at 1727-17528, ¶ 49. See 47 C.F.R. § 1.9020(e).

⁵⁰⁰ See *Secondary Markets Second Report and Order* 19 FCC Rcd at 1727-17528, ¶ 49.

determines, post-notification, that the arrangement constitutes an unauthorized transfer of *de facto* control, is otherwise in violation of the Commission's rules, or raises foreign ownership, competitive, or other public interest concerns.⁵⁰¹

220. *SAS Responsibilities Regarding 3.5 GHz Band Spectrum Manager Leasing Arrangements.* An SAS Administrator may choose whether it will accept leasing notifications and support leasing arrangements. However, regardless of whether an SAS accepts leasing notifications, it is responsible for meeting the core functions established in the *3.5 GHz R&O* and in the Commission's rules, including obtaining and storing sufficient information to recognize and protect lessees CBSDs authorized by other SASs.⁵⁰² SASs that do choose to accept and support leasing arrangements must, at a minimum: (1) accept and store the information required in a licensee's notification; (2) verify whether the lessee has made the required certification with the Commission; (3) verify that the lease will not result in the lessee holding more than the 40 megahertz of Priority Access spectrum in a given License Area, and that lessee operation will not extend beyond the licensee's Service Area or within its PAL Protection Area; (4) inform the licensee as to whether the notification has been received and verified; and (5) provide the Commission with electronic reports of the leasing notifications it received on a daily basis.⁵⁰³ Upon receipt of confirmation from the SAS, the lessee may commence operation consistent with the rules governing Priority Access Licensees set forth in section 96.25.⁵⁰⁴

221. *Assigning Unsold PALs for Resale.* In response to Key Bridge and Cantor Telecom's suggestion that the Commission automatically assign all unsold PALs from the auction for resale on the secondary market, we believe this runs contrary to the three-tier system which already permits access to this spectrum through GAA use. Key Bridge and Cantor argue that resale of PALs will foster innovation, but operators of all types can still innovate through GAA use. Further, if there is market demand, we will hold another auction before three-year license expiration, creating another opportunity to access PAL spectrum.

222. *Filings.* The licensee retains the responsibility to engage in all interactions with the SAS and Commission, including the submission of requisite filings that are directly related to the use of spectrum by the licensee or lessee.

223. *Regulatory Status.* Priority Access lessees are free to select their regulatory status, regardless of the licensee's status. In the *3.5 GHz R&O* we allowed both Priority Access Licensees and GAA users to choose whether to provide service on a common carrier or non-common carrier basis and for the same reasons, we allow lessees to do the same.⁵⁰⁵ As noted in the *3.5 GHz R&O*, this will encourage the ability of Citizens Broadband Radio Service users' ability to use the same equipment interchangeably and avoid hindering a potential lessee's ability to use spectrum based on a Priority Access Licensee's regulatory status.

3. Partitioning and Disaggregation

a. Background

224. The Commission has permitted partitioning and disaggregation on a service-by-service basis, in order to allow licensees to transfer the right to use a portion of the spectrum (disaggregation) or a

⁵⁰¹ See 47 C.F.R. § 1.9020(g).

⁵⁰² See *3.5 GHz R&O*, 30 FCC Rcd at 4054-4055, ¶ 320. See 47 C.F.R. § 96.53.

⁵⁰³ See Appendix A, §§ 1.9046(c), 96.66.

⁵⁰⁴ See *id.* § 96.25. Due to the absence of specific build-out requirements and inapplicability of the spectrum screen, the presumption is that leasing agreements are in the public interest if the parties follow the proper procedure, but the Commission has the authority to review and overturn any transaction that is found to be contrary to the public interest.

⁵⁰⁵ See *3.5 GHz R&O*, 30 FCC Rcd at 4014, ¶ 172. See 47 C.F.R. § 1.9020(d)(6).

portion of the geographic license area for that spectrum (partitioning) to parties that value it more highly. In so doing, the Commission is able to promote such goals as more efficient use of and greater access to spectrum, fewer barriers to entry, greater competition, and increased services to consumers.⁵⁰⁶ The Commission has allowed partitioning and disaggregation for many services, including Multipoint Distribution Service (MDS),⁵⁰⁷ General Wireless Communications Services (GWCS),⁵⁰⁸ 800 MHz and 900 MHz Specialized Mobile Radio (SMR),⁵⁰⁹ 39 GHz fixed point-to-point microwave,⁵¹⁰ the Wireless Communications Service (WCS),⁵¹¹ PCS,⁵¹² the 700 MHz Band,⁵¹³ and the AWS-3 Band.⁵¹⁴

225. As these examples make clear, the Commission has permitted partitioning and disaggregation in services with license areas that range in size from CMAs and BTAs (with 734 units and 496 units, respectively) to the much-larger EAs and REAGs (with 176 units and 12 units, respectively). In so doing, the Commission has provided greater flexibility for licensees to meet market demand.⁵¹⁵ For example, when the Commission proposed partitioning and disaggregation for PCS, it stated such a policy would speed service to rural areas and allow market entry by entities that only have the ability to serve a limited population.⁵¹⁶ When the Commission later established rules to allow AWS-3 Band and 700 MHz Band licensees to partition and disaggregate their spectrum, it reiterated that this would allow market entry by new entrants and provide flexibility.⁵¹⁷ In each of these services, the Commission also adopted

⁵⁰⁶ See *In the Matter of Geographic Partitioning and Spectrum Disaggregation by Commercial Mobile Radio Service Licensees, Implementation of Section 257 of the Communications Act – Elimination of Market Entry Barriers*, GN Docket No. 96-113, *Report and Order and Further Notice of Proposed Rulemaking*, 11 FCC Rcd 21831, ¶ 2 (1996) (*Partitioning and Disaggregation Report and Order*).

⁵⁰⁷ See Amendment of Parts 21 and 74 of the Commission's Rules With Regard to Filing Procedures in the Multipoint Distribution Service and in the Instructional Television Fixed Service, *Report and Order*, 10 FCC Rcd 9589, 9614-15, (1995) (allowing partitioning of MDS licenses).

⁵⁰⁸ See Allocation of Spectrum Below 5 GHz Transferred from Federal Government Use, ET Docket No. 94-32, *Second Report and Order*, 11 FCC Rcd 624 (1995) (permitting rural telcos to partition GWCS licenses).

⁵⁰⁹ See Amendment of Part 90 of the Commission's Rules to Facilitate Future Development of SMR Systems in the 800 MHz Frequency Band, GN Docket No. 93-252, *Second Report and Order*, 12 FCC Rcd 19079, 19127-53 (1997) (adopting flexible partitioning and disaggregation rules for all 800 MHz and 900 MHz SMR licensees).

⁵¹⁰ Amendment of the Commission's Rules Regarding the 37.0 – 38.6 GHz and 38.6 – 40.0 GHz Bands, ET Docket No. 95-183, *Report and Order and Second Notice of Proposed Rulemaking*, 12 FCC Rcd 18600, 18634-36 (1997) (adopting partitioning and disaggregation rules for licenses in the 39 GHz Band).

⁵¹¹ Amendment of the Commission's Rules to Establish Part 27, the Wireless Communications service (WCS), GN Docket No. 96-228, *Report and Order*, 12 FCC Rcd 10785 at 10834-10839, ¶¶ 92-103 (adopting partitioning and disaggregation rules for WCS licensees).

⁵¹² See *Partitioning and Disaggregation Report and Order*, 11 FCC Rcd at 21843, 21858-21859, ¶¶ 1, 14, 46.

⁵¹³ See *In the Matter of 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 at 15356-15359, ¶¶ 182-188 (2007) (*Second 700 MHz Report and Order*).

⁵¹⁴ See *In the Matter of 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 at 4671-4672, ¶¶ 167-169 (2014) (*AWS-III Report and Order*).

⁵¹⁵ See *Partitioning and Disaggregation Report and Order*, 11 FCC Rcd 21831, ¶ 1; *Second 700 MHz Report and Order*, 22 FCC Rcd at 15355-15359, ¶¶ 178-188.

⁵¹⁶ See *In the Matter of Geographic Partitioning and Spectrum Disaggregation by Commercial Mobile Radio Service Licensees*, GN Docket No. 96-113, *Notice of Proposed Rulemaking*, 11 FCC Rcd 10187, 10197, ¶ 14 (1996).

⁵¹⁷ See *700 MHz Report and Order* at 15356-15357, ¶ 83. See also *In the Matter of 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, 4671-4672, ¶¶ 168-169.

specific construction requirements to ensure the spectrum was put to use. However, the Commission has also limited or prohibited partitioning and disaggregation in bands that permit different services to share the spectrum in order to prevent interference and promote shared use.⁵¹⁸

226. In the *Second FNPRM*, the Commission sought comment on whether to allow partitioning and disaggregation of PALs in the 3.5 GHz Band and stated that its initial view was “to prohibit such further segmentation of PALs given their relatively small size (census tracts) and short license terms (three years) as well as the availability of significant GAA spectrum.”⁵¹⁹ Many commenters, including AT&T, Cantor Telecom, CTIA, Information Technology Industry Council, Qualcomm, WinnForum, and WISPA, support partitioning and disaggregation in the 3.5 GHz Band and argue it will increase liquidity in the secondary market.⁵²⁰ In response to concerns regarding license size, WISPA states that while census tracts in non-rural areas may be small, that is not always the case for rural areas.⁵²¹ Further, AT&T notes that there are numerous scenarios where smaller areas benefit from partitioning and disaggregation, such as when a licensee wants to make its spectrum available in a specific portion of its license area (e.g., a hospital or university) while maintaining use for the rest of this area, and it observes that such arrangements are easy to administer.⁵²² Cantor Telecom and WISPA both state there are business cases that cannot be achieved only through GAA use, as it does not provide the same level of protection, but WISPA recognizes that leasing can be used to achieve the same results.⁵²³ The Information Technology Industry Council suggests that concerns regarding administrative burdens can be alleviated by permitting secondary markets without requiring prior Commission approval.⁵²⁴

227. Other commenters, however, do not agree that partitioning and disaggregation are needed for successful spectrum utilization in this band, or argue that it should be handled through significantly different administrative procedures. Key Bridge argues that secondary market transactions involving transfers (as opposed to leases) should be promoted by the Commission.⁵²⁵ In particular, Key Bridge contends that traditional rules for transactions do not apply well to the 3.5 GHz Band and it therefore recommends that the Commission minimize transaction costs by allowing for immediate processing of certain transactions, including transactions that would normally fall under rules specified in section 1.913.⁵²⁶ Although CTIA states that to the extent that Priority Access Licensees find value in partitioning

⁵¹⁸ The MVDDS service rules permit licensees to partition along county borders but prohibit spectrum disaggregation. See 47 C.F.R. §§ 101.1405, 101.1415. See also Amendment of Parts 2 and 25 of the Commission’s Rules to Permit Operation of NGSO FSS Systems Co-Frequency with GSO and Terrestrial Systems in the Ku-Band Frequency Range, ET Docket No. 98-206, *Memorandum Opinion and Order and Second Report and Order*, 17 FCC Rcd 9614, 9685-9687, ¶¶ 180-184 (2002).

⁵¹⁹ See *3.5 GHz FNPRM*, 30 FCC Rcd at 4086-4087, ¶ 434.

⁵²⁰ See AT&T *Second FNPRM* Comments at 4; Cantor Telecom *Second FNPRM* Comments at 8-9; CTIA Comments at 9, ITI *Second FNPRM* Comments at 3; WinnForum *Second FNPRM* Reply Comments at 10; WISPA *Second FNPRM* Comments at 7-8.

⁵²¹ WISPA *Second FNPRM* Comments at 7.

⁵²² See AT&T *Second FNPRM* Comments at 4-5.

⁵²³ See Cantor Telecom *Second FNPRM* Comments at 9; WISPA *Second FNPRM* Comments at 8.

⁵²⁴ Information Technology Industry Council *Second FNPRM* Comments at 3.

⁵²⁵ Key Bridge *Second FNPRM* Comments at 7-8.

⁵²⁶ *Id.* at 8. “These existing spectrum leasing and transfer apparatus and reporting requirements are designed for traditional wireless services in traditionally licensed bands, none of which apply in the 3.5 GHz Band where GAA and PAL users are free to innovate and may deploy whichever type of wireless service their needs may require, within a fairly limited set of technical operating constraints. Accordingly, the Commission should determine that 47 C.F.R. § 1.913 does not apply to PAL users in the 3.5 GHz Band and should not require extensive transaction reporting such as through FCC Form 603.”

and disaggregation, it should be permitted, CTIA notes the already splintered nature of census tract licensing raises questions about the utility of partitioning and disaggregation.⁵²⁷ In its initial comments, Federated Wireless states that partitioning and disaggregation of PALs would prove both administratively burdensome and unnecessary due to the relatively small size of PALs and their limited three-year license terms.⁵²⁸ In its reply comments, Federated Wireless clarifies that this opposition was based on the fact that “pursuant to Commission rules [partitioning and disaggregation] processes would entail applying for, and obtaining, Commission approval to formally segment PALs into smaller service areas or blocks of spectrum smaller than 10 MHz.”⁵²⁹ Federated Wireless further clarifies that it objects to the administrative burden and not the ability to move spectrum to parties that value it more highly, as summarized in its reply comments: “[I]f commenters merely are advocating for secondary uses of PAL spectrum for less than a full census tract (partitioning) or less than the full 10 MHz of PAL spectrum (disaggregation), by using a certification or notice procedure rather than submission of formal Commission applications for partitioning or disaggregation, then Federal Wireless agrees.”⁵³⁰

b. Discussion

228. The light-touch leasing process adopted herein can achieve the objectives sought by the majority of commenters to make the spectrum use rights held by Priority Access Licensees available in secondary markets without need for the Commission oversight required of partitioning and disaggregation. Under the light-touch leasing rules, Priority Access Licensees are free to lease any portion of their spectrum or license outside of their PAL Protection Area. This has the same effect – lessees can provide targeted access to geographic areas or quantities of spectrum – without additional administrative burden. Coupled with the availability of 80 MHz or more of GAA spectrum in each License Area, these rules will provide the necessary flexibility to service specific or targeted markets. In response to WISPA’s concern that census tracts are larger in rural areas, making targeted service more difficult without holding multiple PALs, we expect GAA spectrum to be particularly abundant in those rural areas, making such services achievable through GAA use.

229. In addition, we note that the reasons for permitting partitioning and disaggregation in more traditionally licensed bands are not prevalent or are absent in the 3.5 GHz Band, which has much different characteristics. The Commission’s primary reason for allowing partitioning and disaggregation in other bands was to promote key policy goals such as access to spectrum and flexibility of use, which in turn can result in greater service to consumers. In contrast to more traditional licensing governing other bands, the existing 3.5 GHz Band rules inherently provide this flexibility. As such, the Commission allowed partitioning and disaggregation to increase competition and expedite the provision of service in the near term.⁵³¹ For example, the rules governing 700 MHz band licenses, which service rules do allow partitioning and disaggregation,⁵³² include a ten-year license term and larger license areas. However, in the 3.5 GHz Band, relatively short license terms and small license areas should facilitate faster deployment of service and allow providers to target smaller populations, meeting the same goals. Further, lower power limits, the ability to dynamically share spectrum, and the absence of construction obligations offer licensees the ability to experiment with different business models and serve niche markets, another basis for allowing partitioning and disaggregation in other services. This flexibility is further bolstered by the rules adopted herein to permit secondary market transactions.

⁵²⁷ See CTIA *Second FNPRM* Comments at 9.

⁵²⁸ See Federated Wireless *Second FNRPM* Comments at 22.

⁵²⁹ Federated Wireless *Second FNPRM* Reply Comments at 10.

⁵³⁰ *Id.* at 10-11.

⁵³¹ See *Partitioning and Disaggregation Report and Order*, 11 FCC Rcd at 21831, ¶ 1.

⁵³² See 47 C.F.R. § 27.15.

230. Finally, the Commission cannot easily address administrative burdens associated with partitioning and disaggregation through a pre-approval process, as Information Technology Industry Council suggests. Unlike leases, parties seeking approval for partitioning and disaggregation must file an application for partial assignment or transfer of control of a license, even if the transaction does not require prior Commission approval.⁵³³ While certain assignments and transfers of control do not require prior Commission approval, the assignor must file an application for Commission approval regardless.⁵³⁴

4. Spectrum Exchanges

a. Background

231. The majority of commenters advocate that Commission should permit spectrum exchanges for PALs. Cantor Telecom states that a spectrum exchange would permit qualified participants to gain immediate access to PAL usage rights along with additional benefits, including enhanced price discovery, transparency, and paperwork and cost efficiencies, thereby improving access to available bandwidth and significantly increasing the liquidity of the spectrum.⁵³⁵ AT&T, Verizon, and WISPA, also support voluntary spectrum exchanges.⁵³⁶ Alternatively, Federated Wireless states that spectrum exchanges would add complexity and are unnecessary because they serve functions already authorized to be performed by the SAS.⁵³⁷ Further, Federated Wireless claims that only a fully functional SAS will have sufficient knowledge to confirm whether a secondary transaction meets the conditions necessary to operate.⁵³⁸ However, Cantor Telecom responds that an SAS's main purpose is to function as a geolocation database, while a spectrum exchange focuses on facilitating secondary market access to PALs.⁵³⁹

232. Other commenters address whether the SAS should act as a spectrum exchange. Verizon asks that the Commission not only permit, but encourage SAS Administrators to establish spectrum exchanges.⁵⁴⁰ AT&T, Google, and WISPA state that the Commission should neither prohibit nor require an SAS to operate as a spectrum exchange.⁵⁴¹ AT&T also states that if an SAS does act as a spectrum exchange, these functions should be separable from the core functions of the SAS.⁵⁴²

b. Discussion

233. The rules that govern the 3.5 GHz Band do not explicitly address spectrum exchanges, and we take no action to establish or prohibit spectrum exchanges, nor do we take action to favor any particular type of private market exchange mechanism. In keeping with the operational flexibility we have created for the 3.5 GHz Band, we agree with WISPA that market mechanisms should drive the creation of spectrum exchanges, instead of Commission rules.⁵⁴³ This approach is consistent with the

⁵³³ See *id.* § 1.948.

⁵³⁴ See *id.* § 1.948(c).

⁵³⁵ See Cantor Telecom *Second FNPRM* Comments at 10.

⁵³⁶ See AT&T *Second FNPRM* Comments at 5; Verizon *Second FNPRM* Comments at 4, WISPA *Second FNPRM* Comments at 9.

⁵³⁷ See Federated Wireless *Second FNPRM* Comments at ii, 20.

⁵³⁸ See Federated Wireless *Second FNPRM* Reply Comments at 11-12.

⁵³⁹ See Cantor Telecom *Second FNPRM* Comments at 4.

⁵⁴⁰ See Verizon *Second FNPRM* Comments at 4.

⁵⁴¹ See AT&T *Second FNPRM* Comments at 5; Google *Second FNPRM* Reply Comments at 21; WISPA *Second FNPRM* Comments at 8.

⁵⁴² See AT&T *Second FNPRM* Comments at 5.

⁵⁴³ See WISPA *Second FNPRM* Comments at 9.

Commission's general approach of relying on market processes where possible in regard to secondary markets.⁵⁴⁴ If a market demand develops for spectrum exchanges in the 3.5 GHz Band, it is in the public interest to allow such exchanges to respond to this demand consistent with the requirements of the Communications Act and our rules.

234. In regard to whether an SAS should be permitted to also act as a spectrum exchange, again we will let market forces determine the role of the SAS, and as such, stand-alone exchanges or SAS-managed exchanges are permitted. As suggested by Google, there may be SAS Administrators who decide that it is economical to operate a spectrum exchange as a function of the SAS.⁵⁴⁵ We also acknowledge Federated Wireless' concern that spectrum exchanges will add unnecessary complexity to band management. However, the Citizens Broadband Radio Service rules already require an SAS to track Priority Access, GAA and Incumbent Access operations and, as such, we do not believe tracking PAL ownership or coordinating with an independent spectrum exchange would be overly-burdensome. Moreover, our rules do not require individual SAS Administrators to act as spectrum exchanges or to work with any third-party spectrum exchanges that may develop. Rather, they provide the flexibility for SAS Administrators to provide these services at their option to meet market demand. Similar to offering leasing, the option to operate a spectrum exchange is voluntary and so long as SAS Administrators can fulfill their core duties and comply with Commission rules, an SAS may also operate a spectrum exchange.

5. Spectrum Aggregation and Attribution in the 3.5 GHz Band

a. Background

235. In the *3.5 GHz R&O*, the Commission adopted a spectrum aggregation limit that would allow licensees to hold no more than four PALs in one census tract at any given time (or no more than 40 megahertz out of the 70 megahertz allocated to PALs).⁵⁴⁶ The Commission concluded that this limit of 40 megahertz would facilitate competition, innovation, and efficient use of the 3.5 GHz Band, ensuring that it would be allocated in a manner that serves the public interest, convenience, and necessity.⁵⁴⁷ However, for a variety of reasons, the Commission decided it would not include the 3.5 GHz Band in the spectrum screen.⁵⁴⁸ The *Second FNPRM* sought comment on the application of our spectrum aggregation limits in the context of the initial licensing of PALs, whether to use the Commission's existing attribution standard for these purposes, and how any unique characteristics of PAL auctions, such as the need for streamlined processing, should be taken into account.⁵⁴⁹

236. The majority of commenters do not directly address spectrum aggregation limits but those that do urge the Commission to refrain from adopting spectrum aggregation rules. AT&T believes that the Commission should not stifle secondary markets by adopting spectrum aggregation rules for this band, as the 3.5 GHz Band is nascent and no competitive issues have arisen that suggest a need for regulation.⁵⁵⁰ For the same reasons, AT&T opposes applying the attribution standard in existing rules to PALs,⁵⁵¹ and no other commenters address the application of our attribution standard. Federated Wireless also urges the Commission not to count PALs toward spectrum aggregation limits, stating this would not

⁵⁴⁴ See *Secondary Markets Second Report and Order*, 19 FCC Rcd at 17559, ¶ 115.

⁵⁴⁵ See Google *Second FNPRM* Reply Comments at 21.

⁵⁴⁶ See *3.5 GHz R&O*, 30 FCC Rcd at 3998, ¶ 117.

⁵⁴⁷ See *id.*

⁵⁴⁸ See *id.* at 3998, ¶ 117 n. 276.

⁵⁴⁹ See *Second FNPRM*, 30 FCC Rcd at 4087, ¶ 435.

⁵⁵⁰ See AT&T *Second FNPRM* Comments at 4-6.

⁵⁵¹ See *id.* at 6.

be equitable since by its nature, PALs will likely not be in use full time by the licensee.⁵⁵² The Information Technology Industry Council requests that the Commission consider allowing a Priority Access Licensee to hold more than four PALs (*i.e.*, 40 megahertz) of spectrum in one census tract, even for a limited duration or geography.⁵⁵³

b. Discussion

237. As noted above, we do not include 3.5 GHz Band in the Commission's spectrum screen, as PALs are not suitable and available for the provision of mobile telephony and broadband services in the same manner as other bands that are currently included in the Commission's spectrum screen applied to secondary market transactions.⁵⁵⁴ This finding was based on the unique characteristics of the band, including multiple tiers of many users and short license terms.⁵⁵⁵ We do not revisit this finding here and there is no support on the record for doing so.

238. In the *3.5 GHz R&O*, the Commission also addressed a spectrum aggregation limit within the Priority Access tier and concluded that one licensee may not hold more than 40 megahertz of the maximum of the 70 megahertz of Priority Access spectrum in each License Area.⁵⁵⁶ As the Commission decided in the order, this spectrum aggregation limit will promote diversity by ensuring the availability of PALs to at least two users in those geographic areas where there is the greatest likelihood of demand, and will incentivize innovation and competition that will likely lead to more choices for the consumer, while still allowing for applications that require larger blocks of spectrum.⁵⁵⁷ The Information Technology Industry Council presents no additional arguments and we also decline to revisit the 40 megahertz spectrum aggregation limit.

239. In light of the spectrum aggregation limit in our rules, these secondary markets rules must make clear to whom the limit should apply. Given the lack of record on attribution issues in the Citizens Broadband Radio Service context, we apply the attribution threshold as set forth in section 20.22 of the Commission's rules and referred to in the *Second FNPRM*.⁵⁵⁸ These controlling and non-controlling interests delineated in section 20.22 shall be attributable to applicants for licenses and parties to leasing arrangements in the 3.5 GHz Band.⁵⁵⁹

C. FSS Protection

1. In-band Protection of FSS in the 3600 – 3700 MHz Band

a. Background

240. The Commission has licensed FSS earth stations to receive on frequencies in the 3600-3650 MHz and 3650-3700 MHz bands. FSS use of the 3600-3650 MHz band is limited to non-federal international intercontinental systems.⁵⁶⁰ In the *3.5 GHz R&O*, we adopted rules that require CBSDs to

⁵⁵² See Federated Wireless *Second FNPRM* Comments at 23.

⁵⁵³ See Information Technology Industry Council *Second FNPRM* Comments at 4.

⁵⁵⁴ See *3.5 GHz R&O*, 30 FCC Rcd at 3998, n.276.

⁵⁵⁵ See *id.*

⁵⁵⁶ See *id.* at 3998, ¶ 117.

⁵⁵⁷ See *id.* at 3999, ¶¶ 119, 121.

⁵⁵⁸ See 47 C.F.R. § 20.22; *Second FNPRM* 30 FCC Rcd at 4087, ¶ 435.

⁵⁵⁹ This is consistent with our current practice of attributing long-term *de facto* transfer and spectrum manager leasing arrangements to both the lessor and lessee.

⁵⁶⁰ See 47 C.F.R. § 2.106, US245, NG 169, NG 185.

protect existing in-band FSS earth stations from interference.⁵⁶¹ As described in section III(H), we also require FSS earth stations seeking protection under the rules to register with the Commission annually, or upon making changes to any of the parameters listed in §96.17(d).⁵⁶² The information included in these registrations will be used by the SASs to protect licensed FSS earth stations. We found that, while there were technical implementation details to be worked out, an SAS-based system should be an effective means of protecting licensed FSS earth stations and promoting broadband deployment in the band. We also noted that specific technical details and requirements may be developed as part of the SAS approval process and may be informed by the work of an industry-led multi-stakeholder group.⁵⁶³ Therefore, in the *Second FNPRM*, we sought comment on specific approaches to calculating and implementing FSS protections.⁵⁶⁴

241. In the *Second FNPRM*, we sought comment on: (1) interference protection criteria appropriate for establishing FSS interference limits; (2) the methodology for calculating exclusion distances for CBSDs, and in particular, the applicability of the Commission's example methodology in the 3650-3700 MHz proceeding; (3) whether or not to establish default protection areas around FSS earth stations; (4) the RF propagation model(s) best suited for SAS protections of FSS; (5) policy and methods for adjudicating demands for increased spectrum use at a location that would result in the protection criteria for an FSS earth station receiver being exceeded; and (6) methods for ensuring that End User Devices do not interfere with FSS earth stations while avoiding a mandate for geo-location requirements on end user devices.⁵⁶⁵

242. Numerous commenters responded to the *Second FNPRM*, presenting a range of proposed approaches to the issues presented. Those comments are addressed in detail on a subject-by-subject basis below, including calculation of FSS protection areas; interference protection criteria; RF propagation models; and other issues. As with our efforts to address other sharing issues in the 3.5 GHz Band, the rules we have developed are designed to enable use of the band for new wireless services, while maintaining protection for the in-band FSS operations. We adopt specific in-band FSS protections below based on the characteristics of the FSS sites and modeled to a conservative level, and provide unprecedented protections for certain C-Band FSS sites.

b. Calculation of FSS Protection Areas

(i) Background

243. In the *Second FNPRM*, we sought comment as to whether we should establish default earth station protection areas based on assumed FSS earth station receiver characteristics, such that CBSD operation outside of this area would be assumed not to cause interference to earth stations, and whether the geographic area could be adjusted by an SAS to accommodate actual FSS operating characteristics.⁵⁶⁶ We also noted that the Commission's example methodology set forth in Appendix D in the *3650-3700 MHz Band R&O* could be a useful starting point for co-existence analysis, and we sought comment on the use of this methodology by an SAS to calculate exclusion distances for CBSDs with respect to individual FSS earth stations in the 3.5 GHz Band.⁵⁶⁷

⁵⁶¹ See 47 C.F.R. § 96.17.

⁵⁶² See *id.* § 96.17(d)

⁵⁶³ See *3.5 GHz R&O*, 30 FCC Rcd at 4045-47, ¶¶ 287-291.

⁵⁶⁴ See *Second FNPRM*, 30 FCC Rcd at 4087-89, ¶¶ 436-442.

⁵⁶⁵ See *id.*

⁵⁶⁶ See *id.* at 4087-88, ¶¶ 437-440.

⁵⁶⁷ See *3650-3700 MHz Band R&O*, Appendix D.

244. Many commenters support protection of incumbent FSS earth stations from aggregate interference but assert that default protection areas are inefficient and utilizing worst case assumptions may lead to overprotection of FSS earth stations. Specifically, Dynamic Spectrum Alliance, Federated Wireless, Google, Information Technology Industry Council, Microsoft, Wi-Fi Alliance, and WinnForum argue against the imposition of default protection areas based on worst case assumptions.⁵⁶⁸ WinnForum claims that default areas are inherently inefficient, and almost inevitably, provide either too little protection to the incumbent, or overly restrict other operations. In addition, default protection zones may not account for aggregation effects and would have to be quite large to account for worst case aggregate interference.⁵⁶⁹ The Information Technology Industry Council also argues that for FSS, the Commission should not adopt default or generalized protection zones for all FSS earth stations.⁵⁷⁰ The Wi-Fi Alliance argues that the Commission should not over-protect FSS earth stations and SASs should be permitted to calculate protection areas based on terrain characteristics and FSS earth station operational parameters.⁵⁷¹ Microsoft claims that it is possible to protect FSS earth stations without imposing large protection zones and that the size and shape of each protected area should be limited to that which is technically necessary to protect licensed satellite operations.⁵⁷² Rajant argues for a fact-based approach to sharing spectrum with incumbent FSS and, from their deployments in the 3650-3700 MHz band, contends that much smaller coordination zones than 150 km are possible.⁵⁷³

245. Google also argues that the Commission should tailor FSS protections to actual conditions, rather than establishing a default protection zone for all FSS earth stations.⁵⁷⁴ According to Google, these protection zones should account for real world factors such as propagation, terrain, earth station pointing angles, and transmitter characteristics. They argue that utilizing worst case or near worst case assumptions for these elements would result in over protection of FSS earth stations, inefficient spectrum use, and diminished investment in the band.⁵⁷⁵ Google claims that an SAS can dynamically calculate an appropriate default protection area for each site, based upon local terrain, pointing directions for the FSS antenna, and other site-specific considerations. Such protection areas could be based upon the antenna gain and receiving system noise temperature of the particular antenna for which the protection area is being calculated. However, a default protection area would only demarcate a region beyond which all CBSDs will be considered non-interfering. Within the protection area, CBSDs would be permitted to operate, provided that an SAS determines that aggregate interference does not exceed the interference thresholds.⁵⁷⁶

⁵⁶⁸ See Dynamic Spectrum Alliance *Second FNPRM* Comments at 3; Google *Second FNPRM* Comments at 24; *Ex Parte* Letter from Kurt Schaubach, Chief Technology Officer, Federated Wireless to Marlene H. Dortch in Docket No. 12-354 (filed Oct. 26, 2015) (Federated Wireless October 2015 *Ex Parte*) at 1- 5; Information Technology Industry Council *Second FNPRM* Comments at 5; Microsoft *Second FNPRM* Comments at 7; OTI and Public Knowledge *Second FNPRM Comments* at 3; Rajant *Second FNPRM* Comments at 7; Wi-Fi Alliance *Second FNPRM* Comments at 5–6; WinnForum *Second FNPRM* Reply Comments at 8-9; WISPA *Second FNPRM* Comments at 9-10.

⁵⁶⁹ WinnForum *Second FNPRM* Reply Comments at 8-9.

⁵⁷⁰ Information Technology Industry Council *Second FNPRM* Comments at 5.

⁵⁷¹ Wi-Fi Alliance *Second FNPRM* Comments at 5.

⁵⁷² Microsoft *Second FNPRM* Comments at 7.

⁵⁷³ Rajant *Second FNPRM* Comments at 5-6.

⁵⁷⁴ Google *Second FNPRM* Comments at 24

⁵⁷⁵ *Id.*

⁵⁷⁶ Google *Second FNPRM* Reply Comments at 11-12.

246. In its reply comments, Google proposes a seven step methodology for calculating interference protection for FSS earth stations.⁵⁷⁷ Google's approach, which accounts for individual FSS site characteristics and interference from individual, as well as aggregate, CBSD operations, includes calculations of FSS antenna gain in the direction of a CBSD requesting authorization to operate, CBSD power spectral density in the direction of the FSS antenna, path loss between the CBSD and FSS earth station antenna, the received interference power at the FSS antenna from the CBSD seeking authorization and the aggregate interference power from all CBSDs within a default protection area, and a comparison of the aggregate calculated power to an interference threshold. Under Google's proposal, SASs would only allow CBSDs to operate if the aggregate power of all CBSDs in the area falls below the permissible interference threshold.⁵⁷⁸

247. Regarding the applicability of the example methodology in Appendix D of the *3650-3700 MHz Band R&O*, Google asserts that the Commission should not adopt the separation distance methodology in Appendix D because it contains latent assumptions that are not discernible from the information provided.⁵⁷⁹ Examples include assumptions regarding propagation models and interference objectives that are built into the equations. Electrodynamics states that their testing proves that the Appendix D methodology is insufficient because there is not an adequate basis for microclimate analysis to justify the methodology.⁵⁸⁰

248. WinnForum also recommends that the Commission adopt calculation methods to protect FSS earth stations that are based on actual deployment characteristics and public, scientifically reviewed propagation models.⁵⁸¹ WinnForum believes that the geometric approach in Appendix D is an appropriate method for the SAS to use in calculating protections for FSS earth stations. Specifically, WinnForum contends that the operating parameters laid out in Table 1 of Appendix D - including antenna gain parameters, system noise temperature, and bandwidth - are appropriate parameters for the SAS to use in protection calculations. These operating parameters also include the antenna reference pattern in section 25.209(a), system noise temperature of 142.8 K, polarization (linear or circular), and receive bandwidth (40 kHz – 36 MHz).⁵⁸²

249. SIA argues that while some aspects of the Appendix D methodology such as the geometric analysis are useful elements for conducting co-existence analyses and calculating exclusion distances for CBSDs with respect to individual FSS earth stations, the Appendix D methodology is not sufficient to adequately protect FSS operations from interference from CBSDs.⁵⁸³ SIA claims that Appendix D has two major flaws. First, it does not provide a means to calculate separation distances required when there are multiple small cell interfering transmitters and therefore cannot be used to consider aggregate interference. Second, the separation distance formula does not consider critically important variable parameters such as the power of the in-band interfering signal, the elevation profile from the earth station to the small cell location of the interfering in-band signal, the terrain profile for the specific location, the time variability of propagation path loss, and the earth station receiver noise temperature. Further, SIA states that, since Appendix D does not discuss the origin of the formula or the

⁵⁷⁷ See *id.* at 7-8.

⁵⁷⁸ See *id.* at 7-13.

⁵⁷⁹ See *id.* at 7, n.15.

⁵⁸⁰ Electrodynamics *Second FNPRM Reply Comments* at 2.

⁵⁸¹ WinnForum *Second FNPRM Reply Comments* at 3-4.

⁵⁸² *Id.*

⁵⁸³ SIA *Second FNPRM Comments* at 2-3.

constants it uses, SIA lacks the information necessary to suggest appropriate modifications and additional data for adapting the formula for application to the 3.5 GHz Band.⁵⁸⁴

250. SIA supports the adoption of protection criteria that use worst-case assumptions rather than real-world deployment conditions.⁵⁸⁵ SIA claims that an approach based on a real-world interference protection system is misguided because it would be difficult to achieve, unduly burden FSS operators, and raise significant confidentiality concerns.⁵⁸⁶ SIA argues that a real-world interference protection system would be challenging to implement because it would require design, development, installation, testing, and maintenance of carrier monitoring hardware, software, and communications links among the FSS earth stations and the SAS. According to SIA, such a system would impose unreasonable burdens on FSS operators who would have to report changes every time they occur. Moreover, the system would need to include highly commercially sensitive information such as frequencies, bandwidths, and carrier-to-noise ratios.⁵⁸⁷

251. Federated Wireless contends that SIA's approach is far too conservative and, by stacking worst case assumptions atop one another, presents an unrealistic view of the interference environment in the 3.5 GHz Band.⁵⁸⁸ Federated Wireless supports an approach based in real-world deployment characteristics and measured data. Federated Wireless notes that the Spectrum and Receiver Performance Working Group of the Commission's Technological Advisory Council (TAC) has endorsed a similar approach. Federated Wireless also proposes that active sensing of the radio environment in the vicinity of FSS earth station receivers, is technically feasible and could enhance the protection provided to incumbents. According to Federated Wireless, such an approach could be based on propagation models and providing real-time measurement of aggregate interference to the SAS as part of a closed loop system that ensures I/N levels do not exceed protection criteria, even during anomalous propagation conditions. It encourages field trials with the satellite community to demonstrate the effectiveness of SAS protections.⁵⁸⁹

(ii) Discussion

252. As we stated in the *3.5 GHz R&O*, we believe that protections for FSS earth stations in the 3.5 GHz Band should be flexible and customized to the specific parameters of each earth station and the interference environment in the vicinity of each earth station.⁵⁹⁰ We agree with commenters that argue that the information submitted by registered CBDs and FSS earth stations should be used to customize the protections afforded to FSS earth stations on temporal, spectral, and geographic bases and should not be based on worst case assumptions. In addition, as discussed below, while we do not mandate a specific methodology for determining such protection areas, certain assumptions used in Appendix D of the *3650-3700 MHz Band R&O* are appropriate for determining FSS protections in the 3.5 GHz Band as well.

253. We disagree with SIA's proposal to adopt static default protection zones based on worst case assumptions. As Google and Federated Wireless argue, such static protection zones are not reflective of the actual interference protection needs of individual FSS earth stations and will not promote efficient use of the band.⁵⁹¹ The approach advocated by Google and Federated Wireless is consistent with

⁵⁸⁴ *Id.*

⁵⁸⁵ SIA *Second FNPRM* Reply Comments at 6.

⁵⁸⁶ *Id.*

⁵⁸⁷ *Id.* at 6-7.

⁵⁸⁸ Federated Wireless October 2015 *Ex Parte* at 1-5.

⁵⁸⁹ *Id.* at 5.

⁵⁹⁰ *3.5 GHz R&O*, 30 FCC Rcd at 4045-47, ¶¶ 287-291.

⁵⁹¹ Google *Second FNPRM* Comments at 24; Federated Wireless October 2015 *Ex Parte* at 1-5.

the TAC's recommendation to the Commission, that "... worst case analyses, when applicable, [should be used] only to determine the consequences of harmful interference, and tested statistical techniques to assess risk [should be used] to perform a thorough assessment of the impact of mixing different services in the same or nearby bands."⁵⁹²

254. We agree that the adoption of static protection zones based on worst case assumptions would overprotect FSS earth stations at the expense of new Citizens Broadband Radio Service users and would effectively prohibit new deployment in some geographic areas without any demonstration that such deployments would actually cause interference to individual FSS earth stations. Such an approach would be inconsistent with the Commission's goals as it would be likely to impede innovation and erect barriers to efficient use of the band.

255. We also disagree with SIA's assertion that an interference protection methodology based on real-world deployment factors would be difficult to achieve, unduly burden FSS operators, and raise confidentiality concerns.⁵⁹³ We address - and reject - SIA's arguments with regard to the potential burdens of registering and updating earth station criteria in section III(H) above. Moreover, we do not believe that the information that FSS earth stations are required to register with the Commission is likely to be commercially sensitive or confidential.⁵⁹⁴ Indeed, SIA itself notes that much of the information that FSS earth station licensees must register under section 96.17 is already registered with the Commission in IBFS.⁵⁹⁵ We agree with those commenters, including Federated Wireless, Google, and WinnForum that state that, by using the information from FSS earth station registrations and CBSD registrations in the surrounding area, SASs will be able to enforce customized protection areas tailored to the specifications of each FSS earth station in the 3.5 GHz Band. We believe that such an approach will effectively protect FSS earth stations, maximize spectral efficiency, and promote deployment in the band.

256. We also believe that it is appropriate to establish an area around FSS earth stations over which SASs will calculate potential interference power levels from all CBSDs in that area to reduce the burden on SASs and narrow the field for interference calculations. CBSDs outside of this area are deemed to be too far away to cause interference. Reasonably defined areas will limit the number of CBSDs that SASs would have to account for in calculating protection areas without increasing the risk of interference to FSS earth stations. As such, we find that SASs should account for in-band, co-frequency interference from all CBSDs within 150 km of an FSS earth station when calculating protection distances.⁵⁹⁶ This distance is consistent with the 150 km FSS protection distance established in the *3650-3700 MHz Band R&O*. We also adopt 40 km as the distance for adjacent emission and blocking interference calculations based on the analysis presented in this proceeding by Alion.⁵⁹⁷ We emphasize that these *are not* default protection areas but merely the areas within which SASs must account for aggregate interference from CBSDs when calculating protections for individual FSS earth stations.

⁵⁹² TAC White Paper, *Basic Principles for Assessing Compatibility of New Spectrum Allocations*, December 11, 2015, Release 1.1 at 32; <https://transfon.fcc.gov/bureaus/oet/tac/tacdocs/meeting121015/Principles-White-Paper-Release-1.1.pdf>.

⁵⁹³ See SIA *Second FNPRM* Reply Comments at 6-8.

⁵⁹⁴ Filers may, however, request confidential treatment under section 0.459 of the Commission's rules, consistent with the Commission's rules and policies. 47 C.F.R. § 0.459. See, e.g., Examination of Current Policy Concerning the Treatment of Confidential Information Submitted to the Commission, GN Docket No. 96-55, *Report and Order*, 13 FCC Rcd 24816 (1998).

⁵⁹⁵ See section III(H).

⁵⁹⁶ See Appendix A, § 96.17.

⁵⁹⁷ Content Interests *Second FNPRM* Reply Comments, Attachment A, Alion Report, Figure 11 at 17 and Figure 15 at 19.

257. Regarding the methodology used to calculate protection areas for FSS earth stations the *3.5 GHz R&O* concluded that an analytic framework similar to the one detailed in the *3650-3700 MHz Band R&O* would be applicable to the 3.5 GHz Band.⁵⁹⁸ We sought comment on the applicability and use of this methodology in the *Second FNPRM*.⁵⁹⁹ While some commenters agree with aspects of the Appendix D methodology, most encouraged us not to adopt the approach in its entirety for the 3.5 GHz Band.⁶⁰⁰ After review of the record, we agree that the Appendix D methodology includes some relevant components but it is not wholly suitable for an SAS-based protection system. For instance, in the *Second FNPRM*, we proposed that FSS earth station protection criteria be based on the FSS earth station off-axis antenna gain performance standard that was in section 25.209(a) of our rules at that time.⁶⁰¹ Those rules specified an envelope of maximum FSS antenna gain as a function of the angle (in degrees) from the main lobe.⁶⁰² The SAS can use this standard for the calculation of aggregate interference from CBSDs located at different angles and distances from the FSS antenna main beam. We agree with WinnForum that the Commission's rules that allow earth stations to register pointing information along with its operating parameters would enable such geometric calculations.⁶⁰³ Specifically, we adopt the use of sections 25.209(a)(1) and 25.209(a)(4) FSS antenna gain envelopes in the methodology for calculating exclusion distances. We also agree with Google's suggestion that we adopt the FSS system noise floor value in Appendix D (142.8 K).⁶⁰⁴ This value was originally derived from SIA's filings in the 3650-3700 MHz proceeding.⁶⁰⁵ Since its adoption, we are unaware of any complaints related to the use of this system noise floor value in the 3650-3700 MHz Wireless Broadband Service.

258. We are encouraged by the efforts of commenters to address the development and implementation of protection methodologies for FSS earth stations in the 3.5 GHz Band.⁶⁰⁶ We believe that these approaches - or elements thereof - may be used to establish consistent, flexible, and effective

⁵⁹⁸ See *3.5 GHz R&O*, 30 FCC Rcd at 4046, ¶ 288.

⁵⁹⁹ See *Second FNPRM*, 30 FCC Rcd at 4087, ¶ 437.

⁶⁰⁰ Google *Second FNPRM* Comments at 2–23 (“The Commission’s 2005 order addressing coordination between FSS stations and fixed wireless stations contains useful elements for determining FSS protection in the context of this proceeding... a) complex spherical trigonometry equations that allow the calculation of the discrimination angle between an earth station and a potential source of interference... b) Table 1 of Appendix D provides a useful summary of typical FSS earth station parameters, including receive bandwidth and system noise temperature... c) ITU-R S.1432-1 design objective for FSS earth stations [should be the basis of] FSS protection... without adopting Appendix D’s overall approach”); SIA *Second FNPRM* Reply Comments at 3 – 4 (“Appendix D includes some useful elements (e.g., geometric analysis) for conducting co-existence analyses and calculating exclusion distances for CBSDs with respect to individual FSS earth stations, but the Appendix D methodology is not sufficient to adequately protect FSS services from CBSD operations”); WinnForum *Second FNPRM* Reply Comments at 4 (“...[T]he operating parameters laid out in Table 1 of Appendix D, such as antenna gain parameters, system noise temperature, and bandwidth are appropriate parameters for the SAS to use in protection calculations. In place of the [propagation] model used in the Commission’s Appendix D, Forum members recommend that the Commission adopt a policy requiring a SAS to use a publicly available, scientifically reviewed propagation model... and, FSS operators [should] be allowed, but not required, to update their pointing information directly with a SAS.”).

⁶⁰¹ See *Second FNPRM*, 30 FCC Rcd at 4088, ¶ 440. Subsequent to our adoption of the *3.5 GHz Second FNPRM*, we adopted revisions to section 25.209(a). Comprehensive Review of Licensing and Operating Rules for Satellite Services, IB Docket No. 12-267, FCC 15-167, *Second Report and Order*, (2015), at Appendix B.

⁶⁰² See 47 C.F.R. §§ 25.209(a)(1) (In the plane tangent to the GSO arc), 25.209(a)(4) (In the plane perpendicular to the GSO arc).

⁶⁰³ WinnForum *Second FNPRM* Reply Comments at 4.

⁶⁰⁴ See *3650-3700 MHz Band R&O*, Appendix D Table 1 at 55.

⁶⁰⁵ SIA Comments, ET Docket No. 04-151, Table 1-1 at 3.

⁶⁰⁶ See e.g., Google *Second FNPRM* Reply Comments at 7 – 13; Federated Wireless October 2015 *Ex Parte* at 1 - 5.

protections for FSS earth stations in the 3.5 GHz Band. However, in the interest of promoting technological and operational flexibility, we do not believe that the specific calculation approach in all aspects should be codified beyond the rules adopted in this section. We direct WTB and OET to address whether and how to do so during the SAS approval process, consistent with the approach adopted in this order.

259. We encourage industry to further develop improvements to protection criteria standards and incumbent reliability requirements that are more transparent and reproducible, based on measurements and operational experience, using realistic deployment scenarios that are representative of real risk. We also encourage industry to continue to develop novel technological approaches to interference protection, including sensing techniques, which may be used to improve protection criteria in the future.

c. Interference Protection Criteria

(i) Background

260. In the *Second FNPRM*, we agreed with commenters that responded to the *FNPRM* that FSS earth stations could be effectively protected by establishing a maximum aggregate power limit at each FSS earth station. We stated that an aggregate threshold level should be based on a theoretical thermal noise floor (Interference-to-Noise ratio; I/N) and account for earth station receiver performance degradation as a result of both desired and undesired signals (Carrier-to-Interference-plus-Noise ratio; C/(I+N)). We proposed that signals from CBSDs at the output of the FSS antenna system be permitted up to this aggregate threshold.⁶⁰⁷ We also proposed that each SAS calculate the permissible separation distance for a CBSD requesting activation, using an appropriate calculation methodology and propagation model, and taking into account the registered parameters of the CBSD and FSS earth station. We sought comment on appropriate interference protection criteria and requested technical analyses and field studies to support any such submissions. We instructed commenters to assume the use of appropriate, commercially available earth station receiver input filters in compiling their analyses.⁶⁰⁸

261. SIA, Google, and the WinnForum propose to protect in-band FSS earth stations from aggregate interference using a protection criterion equal to an I/N of -12 dB.⁶⁰⁹ This value is derived from ITU-R S.1432-1.⁶¹⁰ Google proposes that interference into FSS earth stations should not exceed 6% of the system noise temperature, corresponding to I/N of -12 dB.⁶¹¹ WinnForum agrees and contends that in-band FSS earth stations should be required to accept no more than 6% of the noise floor (I/N = -12 dB) in aggregate interference.⁶¹² SIA also argues that interference protection criteria should be based on limiting the increase of an earth station receiver's noise floor to 6%, equal to I/N of -12 dB.⁶¹³

262. Federated Wireless claims that I/N of -12 dB is overly conservative and that the real characteristics of FSS systems and potential interferers should be used for interference analysis.

⁶⁰⁷ Signals at the output of an FSS antenna are determined after accounting for antenna system gain / filtering, based on the antenna reference pattern in section 25.209(a). See 47 C.F.R. § 25.209(a).

⁶⁰⁸ See *3.5 GHz Second FNPRM*, 30 FCC Rcd at 4088, ¶¶ 439-440.

⁶⁰⁹ See Google *Second FNPRM* Reply Comments at 12; SIA *Second FNPRM* Comments at 5; SIA *Second FNPRM* Reply Comments at 7; WinnForum *Second FNPRM* Reply Comments at 6-8.

⁶¹⁰ ITU-R S.1432-1, Apportionment of the allowable error performance degradations to fixed-satellite service (FSS) hypothetical reference digital paths arising from time invariant interference for systems operating below 30 GHz, January 2006.

⁶¹¹ Google *Second FNPRM* Comments at 23; Google *Second FNPRM* Reply Comments at 12.

⁶¹² WinnForum *Second FNPRM* Reply Comments at 6.

⁶¹³ SIA *Second FNPRM* Comments at 5; SIA *Second FNPRM* Reply Comments at 7.

Federated Wireless goes on to say that at a minimum, the proper application of ITU-R S.1432 would result in the use of I/N of -12 dB criterion for long term effects, which suggests support for I/N of -12 dB as an initial long term median value for protection, subject to future change and improvement as more evidence of the real characteristics of FSS systems and potential interferers becomes known.⁶¹⁴ In a separate filing, Federated Wireless asked the Commission to take note of the approach to managing interference from End User Devices that was suggested in the final report of the Commerce Spectrum Management Advisory Committee (CSMAC) Working Group 1(CSMAC Report).⁶¹⁵ Federated Wireless argues that the CSMAC Report supports the use of a protection criterion equal to I/N of -10 dB as proposed in various ITU documents.⁶¹⁶ iPosi also disagrees with SIA regarding the level of protection that should be afforded, and proposes an aggregate source I/N of -6 dB, stating that while FSS link margins are small, the allowable aggregate interference must be measurable.⁶¹⁷

263. Radio Soft & LS Telecom contend that interference criteria should be based on $C/(I+N)$ because, as described in the *FNPRM*, noise floor itself is too pessimistic, considering that signals even a few dB above noise will allow dramatically improved access to CBSDs without any reliability degradation to an incumbent FSS.⁶¹⁸ While proposing an I/N value of -12 dB, Google asserts that this value represents only 0.25 dB in noise floor degradation, and represents an even smaller portion of the carrier-to-interference plus noise ($C/(I+N)$) ratio.⁶¹⁹ SIA argues that interference protection criteria should not be based on $C/(I+N)$, explaining that the desired signal level at the FSS should not be a part of the calculation. SIA states that this would require the FSS to report signal level changes every time they occur, which would be unduly burdensome and has not been proposed in this proceeding.⁶²⁰

(ii) Discussion

264. Many commenters argue that protection of FSS earth station receivers from aggregate interference should be based on a received interference power limit at the FSS receiver.⁶²¹ We agree that allowing the SAS to calculate protections based on an aggregate interference limit would be the most flexible and efficient means of protecting FSS earth stations and facilitating widespread deployment in the Citizens Broadband Radio Service. Accordingly, we require the SASs to utilize the received interference power to determine appropriate and consistent protections tailored to the actual deployment and operational parameters of FSS earth stations in the 3.5 GHz Band consistent with the approach described above.

265. Commenters representing both satellite interests and new-entrants contend that protection for FSS earth stations should be based on an I/N of -12 dB, as set forth in ITU-R S.1432-1 at the FSS earth station's receiver.⁶²² As noted above, there are also some commenters that believe this criterion is

⁶¹⁴ Federated Wireless October 2015 *Ex Parte* at 4-5.

⁶¹⁵ See *Ex Parte* Letter from Kurt Schaubach, Chief Technology Officer, Federated Wireless Inc. to Marlene H. Dortch, Secretary, Federal Communications Commission in GN Docket No. 12-354 (February 18, 2016) (Federated Wireless February 2016 *Ex Parte*).

⁶¹⁶ *Id.* at 2 citing ITU-R SF.1486, ITU-R SF.558, ITU-R SF.1006.

⁶¹⁷ iPosi *Second FNPRM* Reply Comments at 4.

⁶¹⁸ Radio Soft & LS Telecom *Second FNPRM* Comments at 2 (filing in response to the *3650-3700 MHz Protection Contours PN*).

⁶¹⁹ Google *Second FNPRM* Reply Comments at 12.

⁶²⁰ SIA *Second FNPRM* Reply Comments at 8

⁶²¹ Google *Second FNPRM* Comments at 24; Federated Wireless October 2015 *Ex Parte* at 1; WinnForum *Second FNPRM* Reply Comments at 6; SIA *Second FNPRM* Comments at 6; SIA *Second FNPRM* Reply Comments at 8.

⁶²² Google *Second FNPRM* Comments at 23; Google *Second FNPRM* Reply Comments at 12; SIA *Second FNPRM* Comments at 5; SIA *Second FNPRM* Reply Comments at 7; WinnForum *Second FNPRM* Reply Comments at 6.

overly conservative.⁶²³ Consistent with the majority of commenters on this issue, we find that using I/N of -12 dB as a long term median threshold will provide sufficient protection for in-band FSS earth stations. While we are basing our approach to FSS protection on this value, we note that some commenters believe that it may be more conservative than is necessary to protect FSS earth stations. We agree that this threshold may be conservative but we do not believe that commenters provide sufficient evidence for us to adopt a less conservative I/N value for protection of FSS earth stations at this time. Nonetheless, we will monitor industry efforts to study the real world protection needs of FSS earth stations in the band as well as the effects of Citizens Broadband Radio Service equipment on such earth stations. We may revisit the interference threshold in the future if justified by future technical studies and real world observations.

266. Consistent with these findings, we adopt a long term interference threshold for protecting FSS from in-band co-channel interference from CBSD fundamental emissions. We adopt a long term median aggregate protection limit based on I/N of -12 dB at the output of the FSS antenna system, with the FSS system noise, N, based on $T = 142.8$ K as noted above. Thus, the long term median threshold is the thermal system noise floor of the FSS receiver raised by the acceptable added interference (-12 dB) relative to that system noise level, which equates to: $I = -129$ dBm / MHz (this is calculated using the equation in dBm / MHz; $I = N + I/N = (k+T+B) + I/N = -198.6$ dBm/Hz/K + 21.5 dB-K + 60 dB-Hz/MHz + (-12 dB); where 21.5 dB-K is equivalent to 142.8 K; $21.5 = 10\log_{10}(142.8)$).

267. We also reject SIA's proposal to apply the interference protection methodology described in ITU-R S.1432-1 in the 3.5 GHz Band.⁶²⁴ We note that SIA has argued in favor of utilizing ITU-R S.1432-1 in other proceedings and we have consistently refused to adopt all of its methods and assumptions.⁶²⁵ Notably, in the *3650-3700 MHz Band R&O*, we found that the specifications in ITU-R S.1432-1 are design criteria for FSS earth stations, not interference protection criteria and, accordingly, rejected its specifications as suitable interference criteria in that proceeding.⁶²⁶ While ITU-R S.1432-1 utilizes the long-term I/N of -12 that commenters support and we adopt, it also includes assumptions and approaches that are inapplicable to terrestrial mobile services. Indeed, ITU-R S.1432-1 specifically addresses degradations to FSS signals from time invariant interference and notes that there are currently no recommendations dealing with interference from co-primary allocated mobile systems into FSS systems, while the 3.5 GHz Band will likely be used for terrestrial mobile service. As a result, the assumptions and methods used in ITU-R S.1432-1 are not necessarily applicable to this band. The assumptions are based on an arbitrary allotment of time invariant interference and do not clearly define the time allowance corresponding to other sources of interference. Moreover, the assumptions are unsupported by either performance measurements or operational experience. Therefore, consistent with established Commission precedent, we find that the ITU approach is inappropriate for use with terrestrial mobile service and decline to adopt the methodology described in ITU-R S.1432-1 for this band.

268. We believe that the long-term median interference limit adopted herein will effectively protect in-band FSS earth stations from interference. However, we encourage prospective SAS Administrators to consider the possibility of short-term interference while developing their protection

⁶²³ iPosi *Second FNPRM* Comments at 10; iPosi *Second FNPRM* Reply Comments at 4-5; Federated Wireless October 2015 *Ex Parte* at 4; Federated Wireless February 2016 *Ex Parte* at 2.

⁶²⁴ See SIA *Second FNPRM* Comments at 5-6.

⁶²⁵ See *3650-3700 MHz Band R&O*, 20 FCC Rcd at 6525; Revision of Part 15 of the Commission's Rules Regarding Ultra-Wideband Transmission Systems, ET Docket 98-153, *Report and Order*, 25 FCC Rcd 11390, 11392-94, ¶¶ 7-9 (1998).

⁶²⁶ See *3650-3700 MHz Band R&O*, 20 FCC Rcd at 6525, ¶ 63

models for submission during the SAS approval process and to work with FSS earth station licensees to resolve any reports of actual interference, consistent with section 96.17(f).⁶²⁷

269. *Reference FSS RF Filter.* In the *NPRM*, we sought comment on methods of mitigating out-of-band interference from CBSDs.⁶²⁸ In the *FNPRM*, we specifically sought comment on the use of filters to reduce or eliminate interference from out-of-band sources.⁶²⁹ In the *Second FNPRM*, we instructed commenters to assume the use of appropriate, commercially available earth station receiver input filters when performing interference analyses.⁶³⁰ A diverse array of commenters addressed the efficacy of filters throughout this proceeding and utilized filtering assumptions in analyzing interference effects on FSS earth stations.⁶³¹ After review of the record and consistent with the Commission's instructions in the *Second FNPRM*, we require that the SAS must utilize assumptions consistent with the capabilities of commercially available filters in determining interference protections for FSS earth stations.

270. The Content Interests sponsored analyses by Alion have referenced a commonly available RF filter from Microwave Filter Co (Model 13961W) in their coexistence studies.⁶³² The Content Interests sponsored analysis by Comsearch uses an FSS RF filter mask for a commercially available C-Band interference elimination filter that has similar characteristics.⁶³³ While these references are for commercial filters applied to the C-Band, we believe that these RF filter masks represent state-of-the-art filter performance that would also be commonly found for protecting FSS earth stations in the 3600 – 3700 MHz band. As evidence of this, we find two examples of C-Band RF filters from Microwave Filter Co. with passband lower edges at 3600 MHz and 3625 MHz, and a filter from Eagle Comtronics Inc. with a passband lower edge at 3600 MHz, all with similar rejection characteristics and low insertion loss.⁶³⁴

271. We expect that FSS licensees will take reasonable steps to protect their licensed band of operation with applicable RF interference rejection filters, and we therefore adopt a reference FSS RF filter mask with similar characteristics as those referenced here. Specifically, we adopt a reference RF filter to be considered for in-band FSS protection with 0.5 dB insertion loss in the passband, 0.6 dB/MHz attenuation to 30.5 dB at 50 MHz offset below the lower edge of the FSS earth station's authorized passband and 0.25 dB/MHz attenuation to 55.5 dB at greater than or equal to 150 MHz offset below the lower edge of the FSS earth station's authorized passband.⁶³⁵ Based on the filings in the record regarding

⁶²⁷ See Appendix A, § 96.17(f).

⁶²⁸ See 3.5 GHz *NPRM*, 27 FCC Rcd at 15635-36, ¶¶ 124-127.

⁶²⁹ 3.5 GHz *FNPRM*, 29 FCC Rcd at 4322, ¶ 161. The Commission sought comment on the use of filters to mitigate interference into C-Band FSS earth stations. However, such filters may also be used to address in-band interference from adjacent channel transmitters. The Commission recognized this in the *FNPRM*. See *Second FNPRM*, 30 FCC Rcd at 4088, ¶¶ 439-440.

⁶³⁰ See *Second FNPRM*, 30 FCC Rcd at 4088, ¶¶ 439-440.

⁶³¹ See e.g., Content Interests, *Second FNPRM* Reply Comments, Attachment A at 7; *Ex Parte* Letter from the Content Interests to Marlene H. Dortch, Secretary, Federal Communications Commission in GN Docket No. 12-354 (May 8, 2013), Figure 2 at 9 (Content Interests May 2013 *Ex Parte*); Google *FNPRM* Reply Comments at 24-25; Sony *FNPRM* Comments, Appendix.

⁶³² Content Interests *Second FNPRM* Reply Comments, Attachment A at 7.

⁶³³ Content Interests May 2013 *Ex Parte* at 9.

⁶³⁴ Microwave Filter Co., <http://www.microwavefilter.com/pdffiles/13961W-I.pdf> and <http://www.microwavefilter.com/pdffiles/11383.pdf>; aEagle Comtronics Inc., [http://www.eaglecomtronics.com/pdfs/Web Site - C-Band Interference Filters.pdf](http://www.eaglecomtronics.com/pdfs/Web%20Site%20-%20C-Band%20Interference%20Filters.pdf).

⁶³⁵ See Appendix A, § 96.17.

filter performance, we believe that these specifications represent common capabilities of filters that are commercially available in the band and should not be construed as an endorsement of any particular technology, filter type, or product.

272. *Blocking.* As detailed above, throughout this proceeding, we have sought comment on the effects of aggregate interference on FSS earth station receivers.⁶³⁶ While much of the record has been focused on the effects of co-channel interference and OOB on FSS earth stations in the 3.5 GHz Band, some commenters have argued that receiver blocking effects due to strong signal effects from adjacent channel CBSD transmissions may also cause significant interference to FSS earth stations by overloading or blocking the RF front end of these receivers.⁶³⁷ Indeed, the Commission specifically sought comment on the point at which even significantly reduced OOB limits would cease to provide additional protection benefits due to these blocking effects.⁶³⁸ Specifically, commenters have filed analyses with calculations of the maximum RF input power that can be fed to an FSS earth station's low noise block downconverter (LNB) from neighboring non-FSS transmitters operating outside of the FSS earth station's authorized passband, while still maintaining reasonable linear performance.⁶³⁹ They contend that RF input power from fundamental emissions outside of the FSS earth station's authorized passband that exceed this FSS input power limit can cause serious distortion and interference, called LNA/LNB overdrive, LNB saturation, or blocking. After review of this information, we find that it is appropriate to limit fundamental CBSD emissions outside of the FSS earth station's authorized passband so that the aggregate RF power at the output of a reference FSS RF filter and antenna system would not exceed a median adjacent blocking interference threshold.

273. SIA has filed a study of sharing considerations between small cells and geostationary satellite networks in the 3.4-4.2 GHz band.⁶⁴⁰ SIA references ITU-R M.2109 that analyzes the possibility of FSS LNA/LNB overdrive into non-linear operation at input power of -60 dBm.⁶⁴¹ SIA states, "There is a large variance between devices of this power level, with input power levels typically ranging anywhere from -44 dBm to -60 dBm. However, a median value of -55 dBm can be used as a representative number."⁶⁴² Furthermore, SIA states "The maximum input power that can be fed into the LNA/LNB and still maintain linear operation is unique to each device but is approximately 10 dB below the input power level associated with the 1 dB gain compression point (see Section 8.1.1 and Annex E of ITU-R M.2109). Accordingly, the maximum power that can be fed into the LNA/LNB and have the device remain in the linear mode of operation is approximately -65 dBm"⁶⁴³ The large variance in input power limits and the median value of -55 dBm cited by SIA above are all represented without reference to specific manufacturer products or specifications. We have analyzed a specific product that we believe has typical performance characteristics. That filter, on which we base the blocking limit, has an input power limit of -54 dBm,⁶⁴⁴ which differs from the median value cited by SIA by only 1 dB. Because we are basing the

⁶³⁶ See section IV(C)(1)(c)(i).

⁶³⁷ See *Ex Parte* Letter from Satellite Industry Association to Marlene H. Dortch, Secretary, Federal Communications Commission in GN Docket No. 12-354 (August 20, 2013) at 7 (SIA August 2013 *Ex Parte*); Content Interests May 2013 *Ex Parte*, Comsearch Report at 6-10.

⁶³⁸ See *Second FNPRM*, 30 FCC Rcd at 4090, ¶¶ 445.

⁶³⁹ See SIA August 2013 *Ex Parte*; Content Interests May 2013 *Ex Parte*, Comsearch Technical Paper at 6-10.

⁶⁴⁰ See SIA August 2013 *Ex Parte*.

⁶⁴¹ *Id.* at section 4 at 7.

⁶⁴² *Id.*

⁶⁴³ *Id.*

⁶⁴⁴ Norsat International Inc., http://www.norsat.com/wp-content/uploads/8000r_lnb1.pdf, Output P1dB (8 dBm) minus Conversion Gain (-62 dB) = Input P1dB (-54 dBm), last visited Mar. 7, 2016.

requirement on a typical filter and there is variance among filters that are commercially available, we believe that a more conservative 6 dB back-off from this input power limit, rather than the 3 dB recommended by SIA is appropriate. We therefore adopt -60 dBm RMS as the median blocking limit from aggregate adjacent CBSDs, at the output of a reference RF filter and antenna. We believe this results in a reasonable threshold that would effectively protect many devices but not necessarily the worst case weakest device with the lowest input power limit. Finally, we note that these specifications represent common capabilities of filters that are commercially available in the band and should not be construed as an endorsement of any particular technology, filter type, or product.

d. RF Propagation Models

(i) Background

274. In the *Second FNPRM*, we sought comment on what propagation model(s) are best suited for SAS-based protections of FSS. We also requested measurement results to validate model parameters for short range and long range propagation scenarios involving urban clutter, environmental factors, and indoor-to-outdoor propagation.⁶⁴⁵ We tentatively concluded that each SAS must use the same propagation model.⁶⁴⁶

275. Commenters including AT&T and SIA recommend the use of a single propagation model or a uniform set of models to promote fairness and consistency.⁶⁴⁷ AT&T advocates the use of uniform models across SAs, vetted and validated by an expert international body. AT&T asserts that such models would produce the same results, simplify SAS administration by reducing the frequency in which SAs need to communicate with each other, and would prevent conflicting spectrum assignments between users served by different SAs.⁶⁴⁸ SIA urges the Commission to mandate the use of ITU propagation model ITU-R P.452-15. SIA argues that this model is well suited for point-to-point interference predictions and able to account for actual terrain variations between transmitter and receiver. SIA asserts that, to adequately protect FSS incumbents, the prescribed level of interference cannot be exceeded, and that any propagation model must measure how high the interference is, rather than how often some level is exceeded. SIA also argues that it is crucial that the propagation model be vetted by ITU Study Group 3 or an appropriate scientific body such as NTIA's Boulder ITS.⁶⁴⁹

276. Other commenters argue that the Commission should allow SAS Administrators to adopt varying propagation models to promote investment, innovation, and more intensive spectrum use in the 3.5 GHz Band.⁶⁵⁰ Google argues that variation in interference determination capabilities does not cause disparate protection requirements or operational inconsistencies because the inability to determine non-interference is not the same as a determination of interference. According to Google, both results adequately protect incumbents, and they are not inconsistent - one simply employs methods that determine non-interference in a particular location with a higher degree of certainty. Moreover, Google argues that results of these interference determinations will be shared with other SAS Administrators, so all providers can make use of the most precise determination, without any additional operational complexity.⁶⁵¹ Google also argues that while ITU-R P.452-15 can serve as a suitable baseline or safe-harbor propagation model, the Commission's certification process provides a means for vetting modified

⁶⁴⁵ *Second FNPRM*, 30 FCC Rcd at 4087-88, ¶ 438.

⁶⁴⁶ *Id.*

⁶⁴⁷ AT&T *Second FNPRM* Comments at 7-8; SIA *Second FNPRM* Comments at 4.

⁶⁴⁸ AT&T *Second FNPRM* Comments at 7-8.

⁶⁴⁹ SIA *Second FNPRM* Reply Comments at 5-6.

⁶⁵⁰ See Dynamic Spectrum Alliance *Second FNPRM* Comments at 4; Google *Second FNPRM* Comments at 25-28; Google *Second FNPRM* Reply Comments at 13-18; OTI/PK *Second FNPRM* Comments at 11;.

⁶⁵¹ Google *Second FNPRM* Reply Comments at 13-17.

approaches followed by public testing. Dynamic Spectrum Alliance and OTI/PK also argue that the Commission should establish a baseline propagation model and allow SAS providers to differentiate themselves by offering more sophisticated modeling techniques.⁶⁵²

277. WinnForum members recommend that while such models are in development, the Commission should require SASs to use an existing public and reviewed interference prediction propagation model, such as ITU P.452-15, or the ITM model developed by NTIA. There is agreement among WinnForum members to use an interference prediction propagation model, however, there is no agreement as to whether different SAS implementations should be permitted to make use of different propagation models.⁶⁵³ As another alternative, iPosi proposes a conservative deterministic approach to FSS protection by using measured building loss coupled with free space path loss, arguing that clutter models are statistical and require a leap of faith as to their accuracy for the specific scenario.⁶⁵⁴

(ii) Discussion

278. After review of the record, we continue to believe that it is in the public interest for each SAS to utilize the same propagation model for FSS earth station protection. However, we also decline to impose a specific propagation model at this time and encourage industry to work collaboratively to develop a simple, easily implementable model (*e.g.*, the ITM/Extended Hata model used to determine the coastal Exclusion Zones). This model may account for terrain and clutter, must be implementable by any SAS, and must not rely on proprietary information unavailable to all SAS Administrators. We direct WTB and OET, in coordination with NTIA and DoD, to review any such models submitted as part of the SAS approval process and to select an appropriate model prior to final approval of any SASs.⁶⁵⁵

279. We disagree with commenters that contend that each SAS Administrator should be permitted to use its own propagation model to determine protection for FSS earth stations.⁶⁵⁶ Such an approach could result in inconsistent and, in some cases, incompatible protection determination between different SASs. While Google asserts that allowing for differentiated propagation models would not lead to inconsistent results between SAS Administrators, it has not presented sufficient evidence that would lead us to support such a counter intuitive conclusion.⁶⁵⁷ Moreover, even if Google's assertions are plausible, we believe that, especially at the outset, simplicity and consistency will serve the public interest more than additional flexibility for SAS Administrators. To effectively promote investment and ensure that FSS earth stations are protected, it is important for all users in the band – incumbents and Citizens Broadband Radio Service users alike – to have confidence that protection criteria will be applied uniformly by all SASs. This approach is consistent with our policies regarding federal incumbent protection and determinations of Priority Access use as set forth in section IV(A)(2). Consistency among SASs will promote predictable and stable spectrum assignments, assure uniform protection of FSS earth stations, and encourage robust deployment in the band. We therefore find that it is in the public interest for SASs to make use of the same propagation model for determining FSS protections.

280. While we decline to impose a particular propagation model at this time, we disagree with SIA's assertions that the Commission should use a propagation model that protects against worst case interference scenarios.⁶⁵⁸ Utilizing a free space model or another model that does not account for real

⁶⁵² Dynamic Spectrum Alliance *Second FNPRM* Comments at 4; OTI/PK *Second FNPRM* Comments at 11.

⁶⁵³ WinnForum *Second FNPRM* Reply Comments at 5-6.

⁶⁵⁴ iPosi *Second FNPRM* Comments at 12; iPosi *Second FNPRM* Reply Comments at 5.

⁶⁵⁵ See *SAS/ESC Proposal PN*.

⁶⁵⁶ Google *Second FNPRM* Comments at 25-28; Google *Second FNPRM* Reply Comments at 13-18; OTI/PK *Second FNPRM* Comments at 11.

⁶⁵⁷ Google *Second FNPRM* Comments at 25-28; Google *Second FNPRM* Reply Comments at 13-18.

⁶⁵⁸ SIA *Second FNPRM* Reply Comments at 6.

world propagation effects and conditions would unnecessarily overprotect FSS earth stations and impede deployment in the band. The Commission's goal is to ensure that Incumbent Users are protected consistent with real world applications and conditions and the propagation model used to protect Incumbent Users must reflect and further those goals.

281. Finally, we recognize certain limitations of the models that have been suggested in the record, such as ITU-R P.452 and Longley-Rice ITM. We agree, for example, with the statement in ITU-R M.2109 that, in using the propagation model in ITU-R P.452, a smooth earth model that is representative of coastal areas and flat inland plain regions, is not representative of areas that have different physical characteristics and the use of such a model may result in the overestimation of the interference into a receiving FSS earth station.⁶⁵⁹ This is an example of the fact that one propagation model may not be suitable for all RF environments, and that multiple models (either in combination or applied individually in the circumstances for which they are best suited) may be appropriate in covering diverse environments with multiple characteristics (*e.g.*, urban clutter, over sea and land, long distance rural paths, etc.). We also note that the Extended-Hata model was creatively used in conjunction with ITM by NTIA for analyzing interference protection zones to protect incumbent DoD Navy radar systems in this band.⁶⁶⁰ We believe that the limitations of any single model in covering diverse RF environments (including indoor and outdoor environments) and the need for accurate modeling to help determine protections, require more industry model development prior to selecting a default propagation modeling method for use in the 3.5 GHz Band. We encourage the industry to continue to pursue creative approaches to propagation modeling that accurately account for real world effects across a variety of terrains and deployment scenarios.

e. Other Issues

(i) Background

282. *Policy and Methods for Adjudicating Demands for Increased Spectrum Use.* In the *Second FNPRM*, we sought comment on fair and non-discriminatory methods of adjudicating requests for increased spectrum use at a location that would exceed the protection threshold for an FSS earth station receiver. We also sought comment on solutions that avoid caps on CBSD service deployment, while protecting FSS earth stations from harmful interference.⁶⁶¹

283. WinnForum continues to study the issue of aggregate interference margin allotment and did not propose a specific methodology for addressing requests that could exceed the aggregate interference threshold for a particular FSS earth station. WinnForum members agree that aggregate interference protection for FSS earth stations is independent of the mechanism of application of those limits.⁶⁶²

284. SIA argues that protection of incumbent FSS is not possible with unconstrained interference growth and, as such, some maximum aggregate interference limit must be enforced. According to SIA, enforcement of such aggregate interference caps may result in a cap on CBSD deployment in a given geographic area or frequency range.⁶⁶³ Google argues that a variety of approaches

⁶⁵⁹ ITU-R M.2109, *Sharing studies between IMT-Advance systems and geostationary satellite networks in the fixed-satellite service in the 3400 – 4200 and 4500 – 4800 MHz frequency bands*, 6.2.3, at 8.

⁶⁶⁰ This model was used to develop the Exclusion Zones suggested by NTIA and adopted in the *3.5 GHz R&O*. 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). See also NTIA Technical Report, *Exclusion Zone Analyses and Methodology*, TR-15-517 (June 2015), available at <http://www.its.bldrdoc.gov/publications/2805.aspx>.

⁶⁶¹ See *Second FNPRM* 30 FCC Rcd at 4088-89, ¶ 441.

⁶⁶² WinnForum *Second FNPRM* Reply Comments at 6, 11.

⁶⁶³ See SIA *Second FNPRM* Comments at 7.

to managing aggregate interference from multiple CBSDs may be suitable, and it is neither necessary nor beneficial to impose one particular method in the Commission's rules.⁶⁶⁴ According to Google, it may be appropriate to impose some level of power adjustment in cases of extreme congestion, but the methodology for doing so need not be universal and can be better addressed by the Commission through the SAS approval process.⁶⁶⁵ Google states that regardless of how the Commission chooses to protect aggregate effects, it is important for the Commission to do so.⁶⁶⁶

285. *Methods for Ensuring That End User Devices Do Not Interfere with FSS.* In the *Second FNPRM*, we sought 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.⁶⁶⁷ As discussed in detail in section III(E), commenters were sharply divided on the issue of mandatory geo-location for End User Devices.

286. Federated Wireless also submitted a comment asking the Commission to take note of the approach to managing interference from End User Devices that was suggested in the CSMAC Report.⁶⁶⁸ According to Federated Wireless, “[i]n the CSMAC Report, the EIRP of each UE used to compute the aggregate interference level is randomly selected in accordance with the Cumulative Distribution Function (CDF) curves, generated through Monte-Carlo simulations based on realistic UE operating conditions.”⁶⁶⁹ Federated Wireless asserts that this is a useful corollary to the methods that the SAS will use to calculate potential interference from End User Devices in the 3.5 GHz Band.⁶⁷⁰

(ii) Discussion

287. *Policy and Methods for Adjudicating Requests for Increased Spectrum Use.* We decline to adopt a specific policy for adjudicating demands for increased spectrum use. We agree with Google that there are multiple methods and tools at the disposal of SAS Administrators (e.g., power control, GAA frequency reassignment, etc.) to ensure that the FSS protection criteria established in our rules are not exceeded. We believe that SAS Administrators should be permitted flexibility in addressing these issues within the framework established by the Commission's rules. We direct WTB and OET to carefully review any such approaches submitted as part of the SAS approval process.

288. *Methods for Ensuring That End User Devices Do Not Interfere with FSS.* As discussed in detail in section III(F), we will not adopt a mandate for geo-location of End User Devices. We believe that CBSDs – which operate at significantly higher power levels than End User Devices - will be the primary sources of potential interference in the band and, therefore, they are the devices that should be monitored for interference protection purposes. However, we recognize that some commenters have raised concerns about potential interference from End User Devices. In light of the low power permitted for these devices, we do not believe that it is necessary at this time to adopt rules to directly address potential interference from End User Devices. However, we encourage the industry to develop standards for analyzing and modeling interference from End User Devices. Similarly, we encourage SAS administrators to take such models into account when developing interference protection strategies. We direct WTB and OET to review such approaches during and after the SAS approval process and take appropriate steps to address any such interference if it arises.

⁶⁶⁴ See Google *Second FNPRM* Comments at 25.

⁶⁶⁵ Google *Second FNPRM* Reply Comments at 17-18.

⁶⁶⁶ Google *Second FNPRM* Comments at 25.

⁶⁶⁷ See *3.5 GHz Second FNPRM* at 4089, ¶ 442.

⁶⁶⁸ See Federated Wireless February 2016 *Ex Parte* at 2, citing CSMAC Report, Appendix 8.

⁶⁶⁹ *Id.* at 2.

⁶⁷⁰ *Id.*

2. C-Band FSS Protection

a. Background

289. As described in detail in section III(E) above, in the *3.5 GHz R&O*, we adopted stringent out-of-band emission limits for protection of adjacent C-band FSS earth stations.⁶⁷¹ In the *Second FNPRM*, we sought further comment on whether any measures in addition to the OOB limits are needed to protect C-Band FSS earth stations from out-of-band interference from Citizens Broadband Radio Service users and, if so, what those measures should be. We also sought comment as to whether the protection criteria for out-of-band FSS earth stations should be the same or different than for in-band FSS earth stations.⁶⁷²

290. SIA argues that C-Band earth stations should be protected from OOB from CBSDs and End User Devices based on limiting any increase in the noise floor to no more than 1%, equivalent to I/N of -20 dB, consistent with ITU-R S.1432-1.⁶⁷³ GCI supports this position and argues that this strict protection criteria is necessary to protect critical services provided by C-Band users.⁶⁷⁴ As described in section III(C) above, SIA also argued in its petition for reconsideration that significant separation distances would be needed to protect FSS earth stations.⁶⁷⁵ As part of its petition, SIA submitted a technical analysis by RKF Engineering using an out-of-band interference criterion of I/N = -23 dB.⁶⁷⁶ In addition, SIA notes that C-Band satellites are required to locate their TT&C operations close to the 3700 MHz band-edge.⁶⁷⁷

291. Google argues that the Commission should reject SIA's suggestion that C-Band FSS earth stations be protected at a level equivalent to an I/N of -20 dB.⁶⁷⁸ Google argues that this approach would limit noise floor degradation to a virtually unmeasurable 0.04 dB and limit interference temperature to an amount equivalent to about "half of the cosmic microwave background left over from the Big Bang."⁶⁷⁹ Put another way, Google claims that, using SIA's criterion, "satellite earth stations will experience harmful interference if exposed to the amount of radiated emissions received by an omnidirectional antenna placed approximately 10 cm from a cup of coffee."⁶⁸⁰ According to Google, such grossly conservative interference thresholds would needlessly constrain deployment of CBSDs in the 3.5 GHz Band by restricting harmless emissions.⁶⁸¹

292. The Content Interests also filed in support of expansive protections for C-Band FSS earth stations, in addition to the OOB limits adopted in the *3.5 GHz R&O*.⁶⁸² They contend that, since C-Band operations play a critical role in delivering television content to hundreds of millions of people, any

⁶⁷¹ See *3.5 GHz R&O* at 4017-20, ¶¶ 184-190.

⁶⁷² See *3.5 GHz Second FNPRM* at 4089-90, ¶¶ 443-445.

⁶⁷³ SIA *Second FNPRM* Comments at 9.

⁶⁷⁴ See GCI *Second FNPRM* Reply Comments at 6.

⁶⁷⁵ SIA Petition at 2-9, and 13-16.

⁶⁷⁶ SIA Petition, Technical Annex at 1. I/N = -23 dB is lower than I/N = -20 dB criterion in its comments as SIA argues that additional interference of 50% should be attributed to other services not primary in the C-band. Thus, it lowers I/N used for its modeling by 3 dB (a factor of 2) to -23 dB.

⁶⁷⁷ See SIA Petition at 3-4.

⁶⁷⁸ Google *Second FNPRM* Reply Comments at 12.

⁶⁷⁹ *Id.*

⁶⁸⁰ *Id.* at 12-13.

⁶⁸¹ *Id.*

⁶⁸² See Content Interests *Second FNPRM* Reply Comments at 1-3.

parameters the Commission adopts for operations in the 3.5 GHz Band must be carefully analyzed to ensure C-Band operations do not experience interference.⁶⁸³ The Content Interests also submitted a study by Alion to update two previous studies submitted in this proceeding on the effects of Citizens Broadband Radio Service operations on C-Band FSS earth stations, to account for the technical rules adopted in the *3.5 GHz R&O*, including the OOB limits adopted in that order.⁶⁸⁴ The new Alion study asserts that: protecting a C-Band earth station from a single CBSD would require a protection distance of up to 9.63 km for Category A devices and up to 16.4 km for Category B devices (rural or non-rural).⁶⁸⁵ Alion contends that, in one scenario which looked at potential anomalous propagation effects, the required protection distance could be more than 125 km for Category B rural and non-rural devices.⁶⁸⁶ Thus, Alion concludes that future Citizens Broadband Radio Service operations must be coordinated with C-Band FSS earth stations to prevent harmful interference to C-Band operations. Alion also claims that the protection distances for multiple CBSDs could be significantly larger than for single-entry cases and that the addition of a few dozen CBSDs could double or triple the required protection distance.⁶⁸⁷ Alion asserts that SAS(s) must be sophisticated enough to know how many CBSDs are deployed in an area and appropriately extend the protection zone such that aggregated emissions do not violate the interference threshold.⁶⁸⁸

293. Federated Wireless agrees with the Content Interests on the importance of protecting incumbent C-Band operations from any harmful interference that may be generated by CBSDs.⁶⁸⁹ It states that both knowledge of specific propagation conditions and providing accurate CBSD and incumbent earth station radio configuration information to the SAS is vital for spectrum sharing and incumbent protection. However, Federated Wireless notes that the aggregate interference calculations will not be overly complex, because they need only to be focused on a discrete site.⁶⁹⁰ As such, Federated Wireless argues that the calculations needed to determine FSS earth station protections are simpler than the mechanisms that will be implemented to protect PALs which require protection around an entire contour.⁶⁹¹ Federated Wireless also disagrees with the assumptions and engineering inputs applied in the Alion analysis.⁶⁹² Federated Wireless contends that these assumptions and inputs are overly conservative and, while theoretically possible, in no way reflect expected operating conditions for either C-Band FSS earth stations or Citizens Broadband Radio Service users. Federated Wireless argues that the Alion analysis compounds worst-case assumptions that do not accurately reflect the likely interference environment in the 3.5 GHz Band, leading to wholly unrealistic interference computations. According to Federated Wireless, these worst-case assumptions include: (1) unclear application of the propagation model; (2) misleading application of I/N thresholds; (3) unrealistic FSS elevation angle assumptions; (4) excessive CBSD installation height; (5) flawed application of device emission masks; (6) worst-case

⁶⁸³ *Id.* at 1.

⁶⁸⁴ *Id.*, Attachment A, Alion Report.

⁶⁸⁵ *Id.* at 2, Attachment A, Alion Report at 1.

⁶⁸⁶ *Id.*

⁶⁸⁷ *Id.*, Attachment A, Alion Report at 2.

⁶⁸⁸ *See id.*, Attachment A, Alion Report.

⁶⁸⁹ Federated Wireless October 2015 *Ex Parte* at 1–5 quoting The Spectrum and Receiver Performance Working Group of the Federal Communications Commission’s Technological Advisory Council, A Quick Introduction to Risk-Informed Interference Assessment (Apr. 1, 2015) at 5, <https://transition.fcc.gov/bureaus/oet/tac/tacdocs/meeting4115/Intro-to-RIA-v100.pdf>.

⁶⁹⁰ *Id.*

⁶⁹¹ *Id.*

⁶⁹² *Id.* at 1-2.

CBSD operating frequencies; and (7) overly conservative interference thresholds.⁶⁹³ Federated also cites a warning recently expressed by the Commission's Technological Advisory Council of the pitfalls of employing worst-case assumption in interference analysis (*i.e.*, "Selecting single values, often extreme 'worst case' values, is not representative of actual risk").⁶⁹⁴

294. Google also takes issue with the assumptions and methodologies put forth by the Content Interests and Alion.⁶⁹⁵ Google contends that the Content Interests and Alion's analysis depends on two mistaken presumptions: (1) that C-Band FSS earth stations are entitled to geographic protection in addition to the stringent OOBE limits established in the *3.5 GHz Order*; and (2) that worst-case assumptions should be used to establish such protections.⁶⁹⁶ Google also questions the validity of the Alion report's conclusions based on the fact that C-Band FSS earth stations are frequently deployed in close proximity to active 3650-3700 MHz band transmitters.⁶⁹⁷ Google argues that C-Band FSS earth stations are not necessarily entitled to geographic protection of their sites in addition to the OOBE limits adopted by the Commission and, if such protections are adopted, they should be based on known characteristics of FSS earth stations and CBSDs, not worst-case assumptions.⁶⁹⁸

295. There is no agreement among the members of the WinnForum on an appropriate protection level for C-Band FSS earth stations. However, consistent with its approach to the protection of in-band FSS earth stations, WinnForum opposes the imposition of default protection areas and supports a coordination approach based on terrain, clutter, and other real-world considerations.⁶⁹⁹

b. Discussion

296. As discussed in detail in section III(E), we continue to believe that our stringent OOBE limits will act as the primary means of protecting C-Band FSS earth station operations. Moreover, for reasons discussed below, we are not persuaded by the commenters who assert that measures in addition to those OOBE limits are needed to provide adequate protection from interference to C-Band FSS earth station operations, in most cases. However, we recognize that, in some situations, additional measures may be appropriate for earth stations performing critical TT&C functions. These protections will be determined consistent with the processes and protection levels used to determine protection areas for FSS earth stations in the 3600-3700 MHz band. In addition, as described in section III(H)(2), we adopt measures to facilitate communication and coordination among Citizens Broadband Radio Service users, C-Band FSS licensees, and SAS Administrators to effectively prevent and address any interference issues that may arise. Finally, we emphasize that any C-Band FSS earth station licensees seeking protection must submit an annual registration consistent with section 96.17 of the Commission's rules or upon making changes to any of the operational parameters listed in that section.⁷⁰⁰

297. We disagree with assertions made by SIA, GCI, and the Content Interests that all C-band FSS earth stations must be protected by geographic protection zones to prevent interference to the services provided by the operators of these earth stations. We address the concerns raised by these

⁶⁹³ *Id.* at 3-4.

⁶⁹⁴ *Id.* at 2.

⁶⁹⁵ See *Ex Parte* Letter Austin C. Schlick, Director, Communications Law and Aparna Sridhar, Counsel, Google, Inc. to Marlene H. Dortch, Secretary, Federal Communications Commission in GN Docket No. 12-354 (February 2016) (Google February 2016 FSS *Ex Parte*).

⁶⁹⁶ *Id.* at 1-2.

⁶⁹⁷ *Id.* at 10-13.

⁶⁹⁸ *Id.* at 3.

⁶⁹⁹ WinnForum *Second FNPRM* Reply Comments at 8-9.

⁷⁰⁰ See Appendix A, § 96.17.

commenters about the potential for harmful interference into C-Band FSS earth stations with the stringent OOB limits adopted in the 3.5 GHz R&O and affirmed in section III(E) above and with new rules protecting TT&C earth stations and facilitating coordination between Citizens Broadband Radio Service users and C-Band FSS licensees. We also note that creating mandatory geographic protection zones to protect FSS earth station licensees from co-primary commercial operations in an adjacent band would be unprecedented. Indeed, the Commission declined to extend such protections to licensees in the C-Band when it adopted rules governing the 3650-3700 MHz Band Wireless Broadband Service.⁷⁰¹ Accordingly, consistent with Commission precedent, we will not require SAS Administrators to establish geographic protection areas for C-Band FSS earth station licensees.

298. While we do not believe that geographic protections should be mandatory for all C-Band FSS earth stations, we do agree that it would be appropriate to extend additional protections to FSS earth stations used for TT&C using the same methods used to protect FSS earth stations in the 3.5 GHz Band. As SIA correctly notes, the Commission requires FSS operators to perform TT&C operations in band edge spectrum.⁷⁰² As a result, according to SIA, C-Band satellites frequently rely on a telemetry carrier near 3700 MHz.⁷⁰³ We recognize the critical importance of these TT&C functions to ensuring the safe operation and control of C-Band satellite systems and, accordingly, we will require SAS Administrators to implement and enforce additional protection criteria for these earth stations. Consistent with our approach to protecting in-band FSS earth stations, SAS Administrators will be required to model protection areas based on a median I/N of -12 dB at earth stations with TT&C earth stations operating in accordance with section 25.202(g).⁷⁰⁴ We find that utilizing the same protection criteria for in-band FSS earth stations and C-Band TT&C earth stations is in the public interest and consistent with the Commission's goals for this band. In addition, because these TT&C functions are performed from relatively few C-Band earth stations, the additional protection we are providing should not present a significant impediment to deployment in the 3.5 GHz Band or a significant additional burden for SAS Administrators. C-Band earth stations used for TT&C functions will be protected using the same processes and technological assumptions used to protect earth stations in the 3600-3700 MHz band, as described in section IV(C)(1). In light of our conclusions below on the potential for interference, we believe this approach strikes the appropriate balance between the concerns of C-Band licensees and the need to create an environment conducive to robust deployment in the 3.5 GHz Band.

299. Though we find that C-Band earth stations used for TT&C should be afforded protection based on a maximum I/N at their receivers, we do not agree with the methodology or results of the Alion report. As Federated Wireless argues, the Alion report submitted by the Content Interests relies on a series of worst case assumptions and overly conservative protection thresholds in reaching its conclusions about the requisite protection distances for C-Band FSS earth stations.⁷⁰⁵ We also take note of the TAC's recent assertion, cited by Federated Wireless, that "selecting single values, often extreme 'worst case' values, is not representative of actual risk."⁷⁰⁶ We agree and believe that Alion's worst case assumptions combine to predict unrealistic and overly restrictive protection areas which would stifle investment and disincentivize new deployments. Protecting C-Band earth stations in the manner suggested by Alion would be inconsistent with our approach to in-band FSS protection and would lead to inefficient spectrum

⁷⁰¹ See generally, 47 C.F.R. §§ 90.1301, *et seq.*

⁷⁰² See SIA Petition at 4; 47 C.F.R. § 25.202(g).

⁷⁰³ See SIA Petition at 4.

⁷⁰⁴ See 47 C.F.R. § 25.202(g).

⁷⁰⁵ Federated Wireless October 2015 *Ex Parte* at 1-4.

⁷⁰⁶ See *id.* at 1-5 quoting The Spectrum and Receiver Performance Working Group of the Federal Communications Commission's Technological Advisory Council, A Quick Introduction to Risk-Informed Interference Assessment at 5 (published Apr. 1, 2015), available at <https://transition.fcc.gov/bureaus/oet/tac/tacdocs/meeting4115/Intro-to-RIA-v100.pdf> (last accessed Oct. 15, 2015).

use. As such – just as with protection of in-band FSS earth stations – we are basing protection of C-Band FSS earth stations used for TT&C on real world deployment scenarios and operational conditions.

300. As evidenced by our adoption of an interference limit equal to an I/N of -12 dB, we also find that SIA and GCI's request to protect adjacent band FSS based on an I/N of -20 dB would lead to overprotection of C-Band FSS earth stations and is not reflective of the actual, real world protection requirements of C-Band earth stations.⁷⁰⁷ Similarly, we reject SIA's modelling approach which is based on an even more stringent I/N of -23 dB.⁷⁰⁸ We agree with Google that this level of protection is unnecessary and would likely overprotect C-Band FSS earth stations to a significant degree. Indeed, Google contends that limiting emissions at the earth station receiver to an I/N of -20 dB would limit noise floor degradation to a virtually unmeasurable 0.04 dB and limit interference temperature to an amount equivalent to about "half of the cosmic microwave background left over from the Big Bang."⁷⁰⁹ From the record, it is unclear why adjacent band receivers should be protected to such a stringent degree. Indeed, we can see no compelling public interest reason to provide a greater degree of protection to services in an adjacent band than we provide to co-primary services in the same band. Accordingly, we find that the I/N limits advocated by SIA, GCI, and the Content Interests are excessive and would lead to over-protection of FSS earth stations in the C-Band. Such excessive protection would be inconsistent with the Commission's desire to promote sharing and encourage the robust development of innovative services in the 3.5 GHz Band. Rather, we find that earth stations eligible for additional protections under the rules (*i.e.*, those with TT&C operations just above 3700 MHz) should be protected using the same I/N limit and methodology used to protect FSS earth stations in the 3.5 GHz Band.

301. While we do not believe that the public interest would be served by requiring geographic protection of all C-Band FSS earth stations, elsewhere in this order we adopt additional measures that will help to address and mitigate the interference concerns raised by commenters. Specifically, as described in section III(H), we adopt a rule requiring SAS Administrators to accept and respond promptly to reports of interference or requests for additional protection from C-Band licensees.⁷¹⁰ We encourage SAS Administrators to take appropriate steps to address any requests or complaints that they receive, and direct WTB and OET to review complaint receipt and resolution procedures during the SAS approval process. We emphasize that the Commission retains ultimate authority over and responsibility for addressing interference issues and conflicts between licensees. If interference issues are not addressed in a satisfactory matter, the Commission may impose additional requirements to ensure timely mitigation and resolution.

302. Finally, we note that, consistent with the approach used to protect in band FSS earth stations described in section IV(C)(1), the Commission's rules assume the use of commercially available filters to mitigate interference from OOBE. C-Band FSS earth stations seeking protection under section 96.17 of the Commission's rules should employ appropriate filters to mitigate interference issues. Any protections developed and implemented by SASs – whether mandatory protections of earth stations used for TT&C or protections developed by an SAS in response to a coordination request under section 96.17(f) - will assume that such filters are in use.⁷¹¹ While we acknowledge that filters may not address all interference issues, there is significant evidence in the record that filters are readily available at a reasonable price and can help alleviate interference concerns in many cases.⁷¹² We expect that, in an

⁷⁰⁷ SIA *Second FNPRM* Comments at 9; GCI *Second FNPRM Reply Comments* at 7.

⁷⁰⁸ SIA Petition, Technical Annex at 1.

⁷⁰⁹ Google *Second FNPRM Reply Comments* at 12.

⁷¹⁰ See Appendix A, § 96.17(f).

⁷¹¹ 47 C.F.R. § 96.17(f).

⁷¹² See *Ex Parte* Letter from Aparna Sridhar, Counsel, Google, Inc. to Marlene H. Dortch, Secretary, Federal Communications Commission in GN Docket No. 12-354 (Sept. 3, 2013).

environment with multiple co-primary services in adjacent bands, the responsibility for interference mitigation and avoidance will be shared among the parties.

3. Device Authorization

a. Background

303. In the *Second FNPRM* we sought comment on Google's suggestion that market incentives may be feasible to encourage industry to deploy radios with improved (lower) adjacent emissions.⁷¹³ We sought comment on how such protection could be practically implemented without burdensome equipment authorization requirements, necessitating changes to our Part 2 rules,⁷¹⁴ and whether it could be achieved by defining a small number of classes of devices that are distinguished by increasingly stringent OOBE limits.⁷¹⁵

304. In response, Google reiterated its argument that by allowing devices with better emissions performance to operate in closer proximity to FSS operations the Commission would foster investment in devices with improved OOBE characteristics.⁷¹⁶ Google stresses that CBSDs would not be required to meet OOBE requirements that are more stringent than the ones set forth in Part 96 but manufacturers should be given the option to build devices that outperform the baseline requirements. In turn, these devices could access spectrum in geographic areas not accessible to devices with standard OOBE performance.⁷¹⁷

305. Google claims that adopting such an approach to OOBE will require only minor adjustments to the Commission's equipment certification framework and proposes specific changes to this process. According to Google, certification reports should: (1) specify actual levels of OOBE; and (2) state the minimum level, in dB, by which the device is lower than the regulatory limits.⁷¹⁸ The test lab should also categorize the device within a class based on how much it reduces OOBE beyond what is required and the device's class should be included as a field in the FCC's certification database.⁷¹⁹

306. Federated Wireless states that it notionally supports Google's proposal but urges the Commission to carefully review the proposed modifications to our equipment authorization rules before making changes that could hinder commercial development in the 3.5 GHz Band.⁷²⁰ However, Federated Wireless also contends that it is possible that Google's proposal for a process to categorize better performing devices could be achieved by modifying the Part 96 rules to state that when equipment makers demonstrate conformance of CBSDs and end user devices pursuant to other rule parts, they should provide the supporting data to demonstrate conformance rather than just a pass/fail result.⁷²¹

307. SIA and Qualcomm both address this issue, as well. SIA cautions that that "relying on market incentives could undermine device quality, since competitive pricing can eliminate the price premium needed to achieve and maintain high quality in device production."⁷²² Further, SIA states that

⁷¹³ See *Second FNPRM*, 30 FCC Rcd at 4089, ¶ 445.

⁷¹⁴ See 47 C.F.R. §§ 2.1, *et seq.*

⁷¹⁵ See *Second FNPRM*, 30 FCC Rcd at 4089, ¶ 445.

⁷¹⁶ See Google *Second FNPRM* Comments at 28-31; Google *Second FNPRM* Reply Comments at 19-20.

⁷¹⁷ See Google *Second FNPRM* Comments at 28-31; Google *Second FNPRM* Reply Comments at 19-20.

⁷¹⁸ The current equipment authorization rules require manufacturers to meet the OOBE limits established by the rule rather than demonstrate actual emission levels at all frequencies measured in the test labs. See 47 C.F.R. § 96.41(e).

⁷¹⁹ See Google *Second FNPRM* Comments at 29-30.

⁷²⁰ Federated Wireless *Second FNPRM* Reply Comments at 13.

⁷²¹ *Id.*

⁷²² See SIA *Second FNPRM* Comments at 10.

regardless of whether manufacturers choose to market devices that perform better than is required by OOB limits, the devices would still need to be certified to provide consumers with adequate assurances about a given device's performance.⁷²³ Qualcomm expressly asks the Commission to reject Google's proposal, arguing that since the OOB limit "just 20 MHz outside the band edges will force 3.5 GHz equipment, at least mobile devices, to implement power back-off, the FCC should not implement even tighter OOB limits at the upper edge of the band for certain classes of devices to protect C-band FSS earth stations as described in the Second FNPRM."⁷²⁴ Qualcomm argues that developing multiple classes of devices would challenge equipment designs and likely force mobile devices to use significantly less power and/or operate well within the 3.5 GHz band edge to comply. Moreover, Qualcomm argues that should the Commission consider implementing classes of devices with tighter OOB limits, it should first "verify that satellite receiver blocking is 'not' the actual limiting factor, in which case more stringent OOB limits would not help and would be an unnecessary regulatory burden."⁷²⁵ Google counters Qualcomm's arguments claiming that Qualcomm appears to misunderstand Google's proposal, because no CBSD would be required to meet more stringent OOB requirements than set forth in Part 96. Instead, manufacturers would have the option to build devices that outperform baseline requirements.⁷²⁶

b. Discussion

308. We decline to make changes to our existing equipment certification process or the rules governing OOB power levels for CBSDs and End User Devices. We must balance our over-arching goal of encouraging innovation with the fact that the Citizens Broadband Radio Service and the devices that will operate in the band are in the nascent stages of development. As such, the rules that govern them must not be overly complicated and must adequately protect incumbents. At this stage, we believe that Google's proposal would add unnecessary complication to our device authorization process, particularly in the early stages of testing equipment that will operate in the Citizens Broadband Radio Service. Further, there is no specific data that shows this approach would not create a risk to incumbent operations and, as noted by Qualcomm, it may not be effective at all if satellite receiver blocking is more limiting than OOB.⁷²⁷

309. We disagree with Google that its proposal would only require minor changes to our equipment authorization process or that such changes would be easily implementable. As noted by Federated Wireless, the suggested modifications could require the Commission to conduct an additional rulemaking. Such a rulemaking - and any new certification procedures adopted therein - could delay commercial deployment in the Citizens Broadband Radio Service. Therefore, on balance, we find that it is in the public interest to proceed using the current device certification rules to ensure that service is made available quickly and without unintended consequences. However, we remain open to the possibility of variable device certifications for different OOB capabilities and we may revisit this issue in the future.

⁷²³ *Id.*

⁷²⁴ Qualcomm Opposition at 4.

⁷²⁵ Qualcomm *Second FNPRM* Comments at 5.

⁷²⁶ Google *Second FNPRM* Reply Comments at 19-20.

⁷²⁷ The spectral distance between the transponder on which an FSS receiver is tuned and the assigned CBSD channel will impact whether OOB or blocking is the limiting factor for providing protection. For the case where an FSS receiver is tuned far from the band edge and a Class B CBSD is near the band edge and both are in close proximity, blocking is likely to be more constraining. In this case, the CBSD may generate OOB below the FSS earth station interference limit, but the high adjacent received power of the CBSD fundamental emission may cause FSS receiver overload (LNB saturation) unless there is sufficient physical separation distance between the CBSD and FSS earth station. For FSS receivers tuned to a transponder near the band edge, OOB is likely to be more constraining.

V. PROCEDURAL MATTERS**A. Regulatory Flexibility Analysis**

310. Pursuant to the Regulatory Flexibility Act of 1980, as amended,⁷²⁸ the Commission's Final Regulatory Flexibility Analysis in this Report and Order is attached as Appendix C.

B. Paperwork Reduction Act

311. This *Order on Reconsideration and Second 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. In addition, pursuant to the Small Business Paperwork Relief Act of 2002,⁷²⁹ we seek specific comment on how we might "further reduce the information collection burden for small business concerns with fewer than 25 employees."⁷³⁰

C. Congressional Review Act

312. The Commission will send a copy of this *Order on Reconsideration and Second Report and Order* 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

313. Accordingly, IT IS ORDERED, pursuant to Sections 1, 2, 4(i), 4(j), 5(c), 302, 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), 302, 303, 304, 307(e), and 316, that this *Order on Reconsideration and Second Report and Order* in GN Docket No. 12-354 IS ADOPTED and the rules in Appendix A 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.

314. IT IS FURTHER ORDERED, pursuant to Section 405 of the Communications Act of 1934, as amended, 47 U.S.C. § 405, and Section 1.429 of the Commission's rules, 47 C.F.R. § 1.429, that the petitions for reconsideration of the Report and Order and Second Further Notice of Proposed Rulemaking are DENIED, except to the extent set forth in this *Order on Reconsideration and Second Report and Order*.

315. IT IS FURTHER ORDERED that the Commission's Consumer and Governmental Affairs Bureau, Reference Information Center, SHALL SEND a copy of this *Order on Reconsideration and Second Report and Order*, including the Final Regulatory Flexibility Analysis, to the Chief Counsel for Advocacy of the Small Business Administration.

FEDERAL COMMUNICATIONS COMMISSION

Marlene H. Dortch
Secretary

⁷²⁸ 5 U.S.C. § 601 *et. seq.*

⁷²⁹ Pub. L. No. 107-198.

⁷³⁰ 44 U.S.C. § 3506(c)(4).

APPENDIX A**Final Rules**

The Federal Communications Commission (FCC or Commission) proposes to amend parts 1, 2, 95, and Part 96 to Part 47 of the Code of Federal Regulations (CFR) as set forth below:

Part 1 – Practice and Procedure

1. 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.

* * * * *

2. Section 1.9005 is amended to read as follows:

§ 1.9005 Included services.

(p) The Citizens Broadband Radio Service in the 3550-3650 MHz band (Part 96 of this chapter)

3. Section 1.9020 is amended to read as follows:

§1.9020 Spectrum manager leasing arrangements.

(e) Notifications regarding spectrum manager leasing arrangements. A licensee that seeks to enter into a spectrum manager leasing arrangement must notify the Commission of the arrangement in advance of the spectrum lessee's commencement of operations under the lease. Unless the license covering the spectrum to be leased is held pursuant to the Commission's designated entity rules and continues to be subject to unjust enrichment requirements and/or transfer restrictions (see §§ 1.2110 and 1.2111, and §§ 24.709, 24.714, and 24.839 of this chapter) or restrictions in §§ 1.9046 and 96.32, the spectrum manager lease notification will be processed pursuant to either the general notification procedures or the immediate processing procedures, as set forth herein. The licensee must submit the notification to the Commission by electronic filing using the Universal Licensing System (ULS) and FCC Form 608, except that a licensee falling within the provisions of § 1.913(d) of this chapter may file the notification either electronically or manually. If the license covering the spectrum to be leased is held pursuant to the Commission's designated entity rules, the spectrum manager lease will require Commission acceptance of the spectrum manager lease notification prior to the commencement of operations under the lease.

4. Section 1.9046 is added to read as follows:

§ 1.9046 Special Provisions Related to Spectrum Manager Leasing in the Citizens Broadband Radio Service

(a) *Scope.* Subject to section 96.32, a Priority Access Licensee, as defined in section 96.3, is permitted to engage in spectrum manager leasing for any portion of its spectrum or geographic area, outside of the PAL Protection Area, for any bandwidth or duration period of time within the terms of the license with any entity that has provided a certification to the Commission in accordance with this section or pursuant to the general notification procedures of section 1.9020(e).

(b) *Certification.* The lessee seeking to engage in spectrum manager leasing pursuant to this section must certify with the Commission that it meets the same eligibility and qualification requirements applicable to the licensee before entering into a spectrum manager leasing arrangement with a Priority Access Licensee, as defined in section 96.3 and maintain the accuracy of such certifications.

(1) Priority Access Licensees, as defined in section 96.3, are deemed to meet the certification requirements.

(2) Entities may also certify by using the Universal Licensing System and FCC Form 608.

(c) *Notifications regarding spectrum manager leasing arrangements.* Prior to lessee operation, the licensee seeking to engage in spectrum manager leasing pursuant to section 1.9020(e) must submit notification of the leasing arrangement to the Spectrum Access System Administrator, as defined in section 96.3, by electronic filing. The notification shall include the following information:

(1) lessee contact information including name, address, telephone number, fax number, e-mail address;

(2) lessee FCC Registration Number (FRN);

(3) name of Real Party in Interest and related FCC Registration Number (FRN);

(4) the specific spectrum leased (in terms of amount of bandwidth and geographic area involved) including the call sign(s) affected by the lease; and

(5) the duration of the lease.

(d) *Expiration, extension, or termination of a spectrum leasing arrangement.*

(1) Absent Commission termination or except as provided in paragraph (d)(2) or (d)(3) of this section, a spectrum leasing arrangement entered into pursuant to this section will expire on the termination date set forth in the spectrum leasing notification.

(2) A spectrum leasing arrangement may be extended beyond the initial term set forth in the spectrum leasing notification for an additional period not to exceed the term of the Priority Access License, as defined in section 96.3, provided that the licensee notifies the Spectrum Access System Administrator, as defined in section 96.3, of the extension in advance of operation under the extended term and does so pursuant to the notification procedures in this section.

(3) If a spectrum leasing arrangement is terminated earlier than the termination date set forth in the notification, either by the licensee or by the parties' mutual agreement, the licensee must file a notification with the Spectrum Access System Administrator, no later than ten (10) days after the early termination, indicating the date of the termination. If the parties fail to put the spectrum leasing arrangement into effect, they must so notify the Spectrum Access System Administrator as promptly as practicable.

(e) The Commission will place information concerning the commencement, an extension or an early termination of a spectrum leasing arrangement on public notice.

Part 2 – Frequency Allocations and Radio Treaty Matters; General Rules and Regulations

5. The authority citation for Part 2 continues to read as follows:

AUTHORITY: 47 U.S.C. 154, 302a, 303, and 336, unless otherwise noted.

6. Section 2.106, the Table of Frequency Allocations, is amended as follows:

§ 2.106 Table of Frequency Allocations.

UNITED STATES (US) FOOTNOTES

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 July 23, 2015, 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 July 23, 2015 shall not be accepted, except for repair or replacement of equipment; 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 July 23, 2015 shall be authorized on a secondary basis.

Part 96 – Citizens Broadband Radio Service

7. The authority citation for Part 96 continues 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.

8. The table of contents is updated to read as follows:

Subpart C – PRIORITY ACCESS

§ 96.32 - Priority Access Assignments of Authorization, Transfers of Control, and Leasing Arrangements

Subpart F – SPECTRUM ACCESS SYSTEM

§ 96.66 – Spectrum Access System Responsibilities Related to Priority Access Spectrum Manager Leases

9. Section 96.3 is amended to read as follows:

96.3 – Definitions

PAL Protection Area: The area within the Priority Access Licensee’s default protection contour, as calculated by the SAS in accordance with section 96.25 (or smaller, self-reported protection contour). This area will be protected from interference in accordance with sections 96.25 and 96.41(d).

10. Section 96.15 is amended to read as follows:

Subpart B - INCUMBENT PROTECTION

96.15 – Protection of Federal Incumbent Users

(a)

(4) Within 300 seconds after the ESC communicates that it has detected a signal from a federal system in a given area, or the SAS is otherwise notified of current federal incumbent use of the band, the SAS must either confirm suspension of the CBSD's operation or its relocation to another unoccupied frequency, if available. If the President of the United States (or another designated Federal Government entity) issues instructions to discontinue use of CBSDs pursuant to 47 U.S.C. § 606, SAS Administrators must instruct CBSDs to cease operations as soon as technically possible.

(b)

(4) Within 300 seconds after the ESC communicates that it has detected a signal from a federal system in a given area, or the SAS is otherwise notified of current federal incumbent use of the band, the SAS must either confirm suspension of the CBSD's operation or its relocation to another unoccupied frequency. If the President of the United States (or another designated Federal Government entity) issues instructions to discontinue use of CBSDs pursuant to 47 U.S.C. § 606, SAS Administrators must instruct CBSDs to cease operations as soon as technically possible.

11. Section 96.17 shall be amended to read as follows:

96.17 - Protection of Existing FSS Earth Stations in the 3600-3700 MHz Band and 3700-4200 MHz Band

(a) FSS earth stations licensed to operate in the 3600-3700 MHz band listed at fcc.gov/cbrs-protected-fss-sites shall be protected from CBSD operation consistent with this section. The protections in this section shall only apply to registered FSS earth stations that are authorized to operate on a co-primary basis consistent with section 2.106.

(1) FSS earth stations in the 3650-3700 MHz band will be afforded protection consistent with this section only after the conditions set forth in section 96.21(c) are satisfied.

(2) *Co-channel*: The aggregate passband RF power spectral density at the output of a reference RF filter and antenna at the location of an FSS earth station operating in the 3600 – 3700 MHz band, produced by emissions from all co-channel CBSDs (within 150 km) operating in the Citizens Band Radio Service shall not exceed a median RMS value of -129 dBm / MHz. The reference antenna system requires SAS to calculate antenna gain using § 25.209(a)(1) and 25.209(a)(4), and a reference RF filter between the feed-horn and LNA/LNB, with 0.5 dB insertion loss in the passband.

(3) *Blocking*: The aggregate RF power at the output of a reference RF filter and antenna at the location of an FSS earth station operating in the 3600 – 3700 MHz band, produced by emissions from all CBSDs (within 40 km), shall not exceed a median RMS value of -60 dBm. The reference antenna system requires an SAS to calculate antenna gain using § 25.209(a)(1) and 25.209(a)(4), and a reference RF filter between the feed-horn and LNA/LNB, with a filter mask of 0.6 dB/MHz attenuation to 30.5 dB at 50 MHz offset below the lower edge of the FSS earth station's authorized passband, and 0.25 dB/MHz attenuation to 55.5 dB at an offset greater than or equal to 150 MHz below the lower edge of the FSS earth station's authorized passband.

(b) Registered FSS earth stations in the 3700-4200 MHz band listed at fcc.gov/cbrs-protected-fss-sites shall be protected from CBSD operation in accordance with this section. Only licensed FSS earth stations used for satellite telemetry, tracking, and control (TT&C) operations will be protected under this section. Other licensed 3700-4200 MHz earth stations may be protected consistent with section 96.17(f).

(1) *Out-of-Band Emissions into FSS*: The aggregate passband RF power spectral density at the output of a reference RF filter and antenna at the location of a TT&C FSS earth station operating in the 3700 – 4200 MHz band, produced by emissions from all CBSDs (within 40 km) operating in the Citizens

Band Radio Service shall not exceed a median RMS value of -129 dBm / MHz. The reference antenna system requires SAS to calculate antenna gain using § 25.209(a)(1) and 25.209(a)(4), and a reference RF filter between the feed-horn and LNA/LNB, with 0.5 dB insertion loss in the passband.

(2) *Blocking*: The aggregate RF power at the output of a reference RF filter and antenna at the location of a TT&C FSS earth station operating in the 3700 – 4200 MHz band, produced by emissions from all CBSDs (within 40 km), shall not exceed a median RMS value of -60 dBm. The reference antenna system requires SAS to calculate antenna gain using § 25.209(a)(1) and 25.209(a)(4), and a reference RF filter between the feed-horn and LNA/LNB, with a filter mask of 0.6 dB/MHz attenuation to 30.5 dB at 50 MHz offset below the lower edge of the FSS earth station’s authorized passband, and 0.25 dB/MHz attenuation to 55.5 dB at an offset greater than or equal to 150 MHz below the lower edge of the FSS earth station’s authorized passband.

(d)*****

(vi) whether the earth station is used for satellite telemetry, tracking, and control (for earth stations in the 3700-4200 MHz band).

(2) *****

(e) CBSDs may operate within areas that may cause interference to FSS earth stations, in excess of the levels described in section 96.17 (a) and (b), 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.

(f) FSS earth station licensees in the 3600-3700 and 3700-4200 MHz bands may request additional protection from SAS Administrators to prevent harmful interference into their systems. SAS Administrators must establish a process to receive and address such requests, consistent with section 96.53(o) and 96.63 and shall make good faith efforts to address interference concerns, consistent with their other responsibilities under this Part. In addressing such requests, SASs shall assume that 3700-4200 MHz earth stations are utilizing filters with the characteristics described in sections 96.17(a)(3) or (b)(2) as appropriate for the 3600-3700 or 3700-4200 MHz band.

12. Section 96.21 is amended to read as follows:

96.21 – Protection of Existing Operators in the 3650-3700 MHz Band

(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 FSS earth stations in the 3600-3700 MHz band shall apply.

Subpart C - PRIORITY ACCESS

13. Section 96.25 is amended to read as follows:

96.25 – Priority Access Licenses

(c) *PAL Protection Areas.* PAL channels shall be made available for assignment by the SAS for General Authorized Access use only in areas outside of PAL Protection Areas consistent with this section and section 96.41(d).

(1) A CBSD will be considered to be in use for purposes of calculating a PAL Protection Area once it is registered and authorized for use on a Priority Access basis by an SAS consistent with sections 96.39(c), 96.53, and 96.57.

(i) Priority Access Licensees must inform the SAS if a previously activated CBSD is no longer in use.

(ii) Any CBSD that does not make contact with the SAS for seven days shall not be considered in use and will be excluded from the calculation of the PAL Protection Area until such time as contact with the SAS is re-established.

(2) The default protection contour will be determined by the SAS as a -96 dBm/10 MHz contour around each CBSD. The default protection contour will be calculated based on information included in the CBSD registration and shall be determined and enforced consistently across all SASs.

(i) The default protection contour is the outer limit of the PAL Protection Area for any CBSD but a Priority Access Licensee may choose to self-report protection contours smaller than the default protection contour to the SAS.

(ii) If the PAL Protection Areas for multiple CBSDs operated by the same Priority Access Licensees overlap, the SAS shall combine the PAL Protection Areas for such CBSDs into a single protection area.

(3) The PAL Protection Area may not extend beyond the boundaries of the Priority Access Licensee's Service Area.

14. Section 96.29 is amended to read as follows:

96.29 – Competitive Bidding Procedures

(d) Except in Rural Areas, 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. In Rural Areas, when there is only one application for initial Priority Access Licenses in a License Area, that applicant will be granted a PAL if otherwise qualified under the Commission's rules.

15. Section 96.31 is amended to read as follows:

96.31 – Aggregation of Priority Access Licenses

(a) Priority Access Licensees may aggregate up to four PAL channels in any License Area at any given time.

(b) Attribution of interests. The criteria in § 20.22(b) of this chapter will apply in order to attribute partial ownership and other interests for the purpose of applying the aggregation limit in subsection (a).

16. A new Section 96.32 is added to read as follows:

96.32 - Priority Access Assignments of Authorization, Transfers of Control, and Leasing Arrangements

(a) Priority Access Licensees may transfer or assign their licenses and enter into *de facto* leasing arrangements in accordance with part 1 of this chapter.

(b) Priority Access Licensees may not partition or disaggregate their licenses or partially assign or transfer their licenses nor may they enter into *de facto* leasing arrangements for a portion of their licenses.

(c) Priority Access Licensees may enter into spectrum manager leasing arrangements with approved entities as prescribed in Section 1.9046 of this chapter. Priority Access Licensees may only enter into leasing arrangements for areas that are within their Service Area and outside of their PAL Protection Areas.

Subpart D - GENERAL AUTHORIZED ACCESS

17. Section 96.35 is updated to read as follows:

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, consistent with section 96.25(c).

Subpart E - TECHNICAL RULES

18. Section 96.41 is amended to read as follows:

96.41 – General Radio Requirements

(b) *Power Limits:* Unless otherwise specified in this subsection, the 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	Maximum EIRP (dBm/10 megahertz)	Maximum PSD (dBm/MHz)
End User Device	23	n/a
Category A CBSD	30	20
Category B CBSD*	47	37

* 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.

(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 for all locations within the PAL Protection Area 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.

(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 conducted 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 conducted 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 conducted power of any emissions below 3530 MHz or above 3720 MHz shall not exceed -40dBm/MHz.

(3) *Measurement procedure:*

(iii) [Delete]

(iv) Compliance with emission limits shall be demonstrated using either average (RMS)-detected or peak-detected power measurement techniques.

(g) *Power Measurement:* The peak-to-average power ratio (PAPR) of any CBSD transmitter output power must not exceed 13 dB. PAPR measurements should be made using either an instrument with complementary cumulative distribution function (CCDF) capabilities or another Commission approved procedure. The measurement must be performed using a signal corresponding to the highest PAPR expected during periods of continuous transmission.

Subpart F – SPECTRUM ACCESS SYSTEM

19. Section 96.53 is amended to read as follows:

96.53 – Spectrum Access System Purposes and Functionality

(i) To protect Priority Access Licensees from interference caused by other PALs and from General Authorized Access Users, including the calculation and enforcement of PAL Protection Areas, consistent with section 96.25.

(o) To receive reports of interference and requests for additional protection from Incumbent Access users and promptly address interference issues.

20. Section 96.57 is amended to read as follows:

96.57 – Registration, Authentication, and Authorization of Citizens Broadband Radio Service Devices

(e) An SAS must calculate and enforce PAL Protection Areas consistent with section 96.25 and such calculation and enforcement shall be consistent across all SASs.

21. Section 96.66 is added to read as follows:

96.66 – Spectrum Access System Responsibilities Related to Priority Access Spectrum Manager Leases

(a) An SAS Administrator that chooses to accept and support leasing notifications shall:

(1) Verify that the lessee is on the certification list, as established in section 1.9046 of this chapter.

(2) Establish a process for acquiring and storing the lease notification information and synchronizing this information, including information about the expiration, extension, or termination of leasing arrangements, with the Commission databases at least once a day;

(3) Verify that the lease will not result in the lessee holding more than the 40 megahertz of Priority Access spectrum in a given License Area;

(4) Verify that the area to be leased is within the Priority Access Licensee's Service Area and outside of the Priority Access Licensee's PAL Protection Area; and

(5) Provide confirmation to licensee and lessee whether the notification has been received and verified.

(b) During the period of the lease and within the geographic area of a lease, SASs shall treat any CBSD operated by the lessee the same as a similarly situated CBSDs operated by the lessor for frequency assignment and interference mitigation purposes.

APPENDIX B

Examples of PAL Protection Areas

I. INTRODUCTION

1. This Appendix provides examples of how the rules governing the use of PALs may be applied in certain hypothetical scenarios.¹ This Appendix is intended to illustrate the relationship between Census Tracts, License Areas, Service Areas, and PAL Protection Areas for the purpose of determining the use and protection of CBSDs authorized to operate on Priority Access basis. These simplified examples should be used for illustrative and informational purposes only. Unless otherwise noted, capitalized terms are defined as they are in section 96.3 of the Commission’s rules or Appendix A.²

II. DEFINITION OF PAL PROTECTED AREA

2. For this example, we assume a set of 4 simple rectangular census tracts, shown in Figure 1

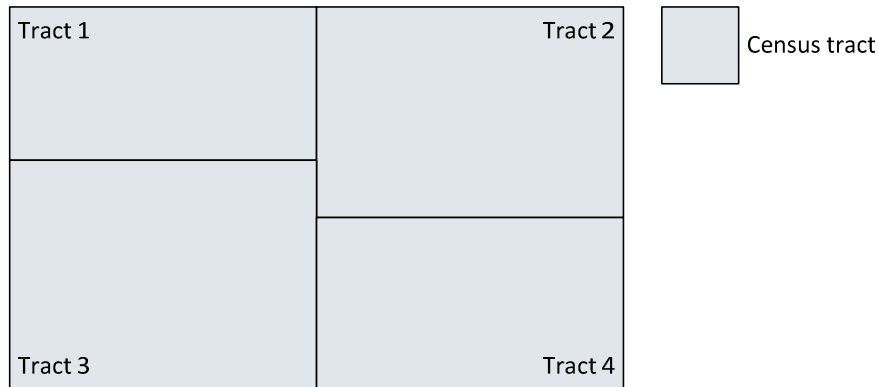


Figure 1. Four Hypothetical Census Tracts

3. Next, we consider a Priority Access Licensee (A), who has priority access licenses in Census Tracts 2 and 3. Therefore, the Service Area of licensee A is as shown in Figure 2.

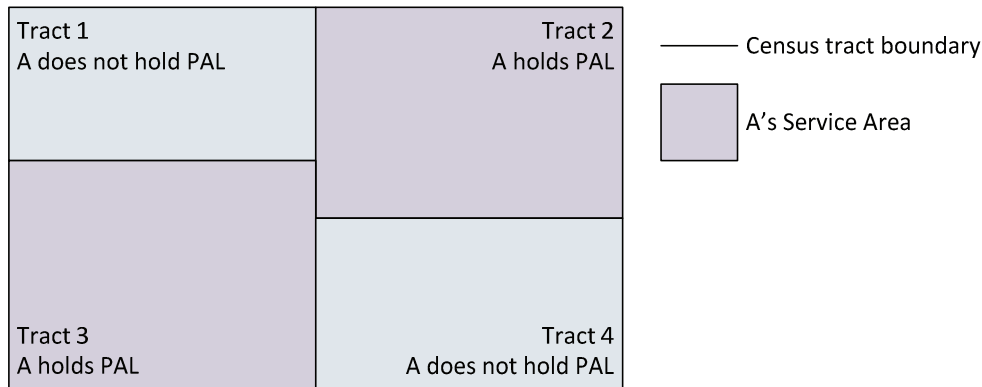


Figure 2. Service Area.

¹ See section IV(A); Appendix A, § 96.25.

² See 47 C.F.R. § 96.3; Appendix A § 96.3.

4. Next, we assume that A deploys a single CBSD and wishes to utilize it to provide service on a Priority Access basis. A will then register its CBSD and its intent to operate on a Priority Access basis with an SAS. Pursuant to section 96.25(c) of the Commission’s rules, the PAL Protection Area will be determined by either: (1) A’s self-reported protection contour smaller than the default protection contour; or (2) the default protection contour around its CBSD, which is based on a signal strength of -96 dBm in 10 MHz. As shown in Figure 3, the PAL Protection Area must be within the Priority Access Licensee’s Service Area. The Priority Access Licensee will be treated as a GAA user outside of the PAL Protection Area.

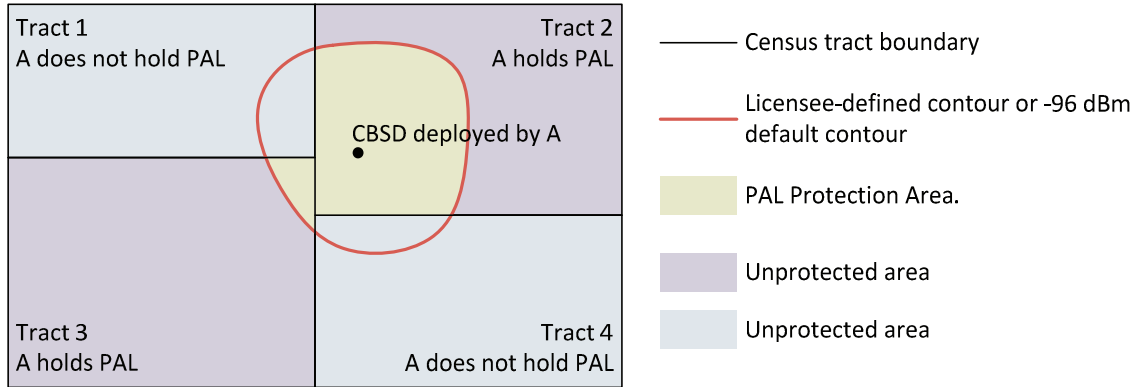


Figure 3. PAL Protection Area, based on Service Area and contour

III. INTERFERENCE PROTECTION OF PAL PROTECTION AREAS

5. As discussed in detail in section III(G), to protect CBSDs authorized to provide service on a Priority Access basis, the SAS must not authorize other CBSDs – whether Priority Access or GAA – on the same channel in geographic areas and at maximum power levels that will cause aggregate interference in excess of -80 dBm/10 MHz at or within a PAL Protection Area.³

6. The following figures provide examples of how the -80 dBm/10 MHz aggregate interference limit would be enforced in certain situations. For these examples we look at two hypothetical census tracts, where licensee A holds a license in Census Tract 1. Figure 4 shows that if there is no licensee in the adjacent census tract, there is no limit on transmissions from the CBSD deployed by A due to PAL Protection Areas.⁴

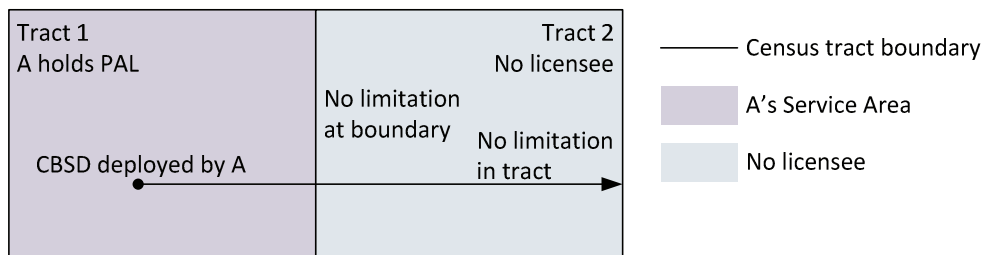


Figure 4. No co-channel PAL in adjacent tract

³ See section III(G).

⁴ However, transmissions from A’s CBSD would be treated as GAA at any point beyond A’s Service Area and will be assigned and coordinated by the SAs accordingly.

7. Figure 5 shows that when there is a deployed licensee, B, in portions of the adjacent tract, the limit applies only in those areas, not at B's Service Area boundaries.

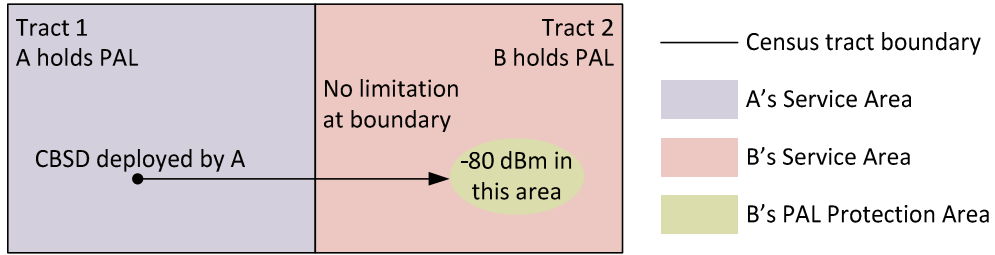


Figure 5. Co-channel PAL in adjacent tract, distant area in use

8. Figure 6 shows a case where the protected area of licensee B reaches the boundary between the Service Areas of A and B.

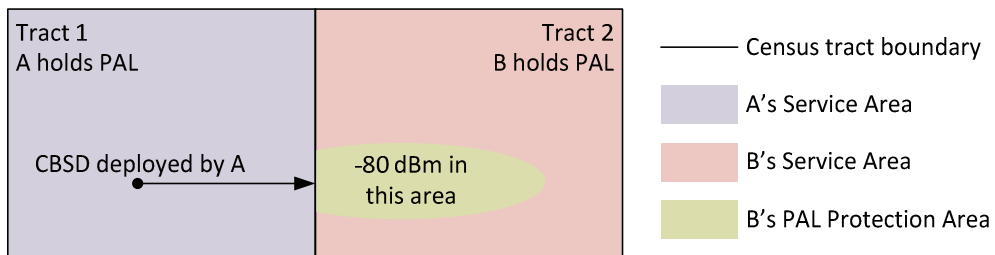


Figure 6. Co-channel PAL in adjacent tract, near area in use

APPENDIX C

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 *Second Report and Order and Order on Reconsideration (Second Order and Order on Reconsideration)*, as applicable. The Commission will send a copy of this *Second Order* including this FRFA, to the Chief Counsel for Advocacy of the Small Business Administration (SBA). In addition, the *Second Order and Order on Reconsideration* 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)*, *Further Notice of Proposed Rulemaking (FNPRM)* and *Second Further Notice of Proposed Rulemaking (Second FNPRM)* and a Final Regulatory Flexibility Analysis (FRFA) in the *R&O*. 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 this *Second Order and Order on Reconsideration* we finalize the rules governing the innovative Citizens Broadband Radio Service in the 3550-3700 MHz band (3.5 GHz Band). In the *R&O*, the Commission adopted rules for commercial use of the 3.5 GHz Band, including technical and use rules and interference protection measures, which was used for Department of Defense Radar services and commercial fixed Satellite Service (FSS) earth stations (space-to-earth) prior creation the Citizens Broadband Radio Service.³

4. Facing ever-increasing demands of wireless innovation and constrained availability of clear sources of spectrum, the Citizens Broadband Radio Service is an opportunity to add much-needed capacity through innovative sharing. The *R&O* represented 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. Through this *Second Order*, we finalize the regulatory scheme we created in 2015, putting in place the last rules necessary for this service to become commercially available. These rules address the definition of "use" by Priority Access Licensees, access to the 3.5 GHz Band via secondary markets, and FSS protection criteria.

5. The Citizens Broadband Radio Service takes advantage of advances in technology and spectrum policy to dissolve age-old regulatory divisions between commercial and federal users, exclusive and non-exclusive authorizations, and private and carrier networks. The regulatory framework takes from recommendations from the President's Council of Advisors on Science and Technology (PCAST) and substantial engagement and input from stakeholders representing a cross section of the communications, technology, and public interest realms.

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.

³ See Amendment of the Commission's Rules with Regard to Commercial Operations in the 3550-3650 MHz Band, GN Docket No. 12-354, *Report and Order and Second Further Notice of Proposed Rulemaking*, 30 FCC Rcd 3959 (2015) (3.5 GHz *R&O* or *Second FNPRM*, as applicable).

6. The comprehensive regulatory scheme adopted in the *R&O* included specific licensing, technical, and service rules to enable dynamic sharing between three tiers of users in the 3.5 GHz Band. The Spectrum Access System (SAS) is the advanced frequency coordinator (or coordinators) necessary to assign rights and maximize efficiency in the band. The SAS(s) will incorporate information from the Environmental Sensing Capability (ESC), which will be used to increase available spectrum in coastal areas while continuing to protect incumbent Department of Defense radar systems.

7. In this *Second Order* and *Order on Reconsideration*, we reaffirm this regulatory scheme, and deny several petitions for reconsideration of various aspects of the *R&O*. We also grant certain requests for reconsideration, including the following: we increase the power limit for non-rural Category B CBSDs to that applicable in rural areas, provide greater flexibility on how to measure and direct the power, revise our rules to make clear that SASs must be capable of receiving and responding to interference complaints from FSS earth station licensees, and allow a single PAL to be issued in License Areas located in Rural Areas without an auction. Finally, we define what PAL uses serve to preclude GAA uses, slightly modify our streamlined spectrum leasing and assignment procedures for application in the 3.5 GHz band, decline to permit partitioning and disaggregation in the band, and provide for interference protections for FSS earth stations in this band and the adjacent C-band. We developed a comprehensive approach intended to balance consideration of complex issues and competing considerations involved in creating a sharing regime in this band, and each rule is a necessary component. We reaffirm our commitment to add much needed capacity spectrum to the marketplace through innovative sharing rules and techniques, and believe the rules established in the *R&O*, as amended by the *Second Order* and *Order on Reconsideration* are the best means to do so.

8. As a result of the Commission's actions in the *R&O* and *Second Order* and *Order on Reconsideration*, 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. Further, small businesses can access this spectrum on the secondary market. The Commission's actions in the *Second Order* and *Order on Reconsideration* thus constitute a significant benefit for small businesses.

B. Legal Basis

9. 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

10. 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.⁴ The RFA generally defines the term "small entity" as having the same meaning as the terms "small business," "small organization," and "small governmental jurisdiction."⁵ In addition, the term "small business" has

⁴ 5 U.S.C. § 603(b)(3).

⁵ *Id.* § 601(6).

the same meaning as the term “small business concern” under the Small Business Act.⁶ 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.⁷

11. *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.⁸ As of 2010, there were 28.2 million small businesses in the United States, according to the SBA.⁹ Additionally, a “small organization” is generally “any not-for-profit enterprise which is independently owned and operated and is not dominant in its field.”¹⁰ Nationwide, as of 2007, there were approximately 1,621,315 small organizations.¹¹ 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.”¹² Census Bureau data for 2007 indicate that there were 89,527 governmental jurisdictions in the United States.¹³ We estimate that, of this total, as many as 88,761 entities may qualify as “small governmental jurisdictions.”¹⁴ Thus, we estimate that most governmental jurisdictions are small.

12. *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.¹⁵ The appropriate size standard under SBA rules is for the category Wireless

⁶ *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.*

⁷ 15 U.S.C. § 632.

⁸ See 5 U.S.C. § 601(3)–(6).

⁹ See Small Business Administration, Office of Advocacy, “Frequently Asked Questions,” http://www.sba.gov/sites/default/files/FAQ_Sept_2012.pdf.

¹⁰ 5 U.S.C. § 601(4).

¹¹ INDEPENDENT SECTOR, THE NEW NONPROFIT ALMANAC & DESK REFERENCE (2010).

¹² 5 U.S.C. § 601(5).

¹³ U.S. CENSUS BUREAU, STATISTICAL ABSTRACT OF THE UNITED STATES: 2011, Table 427 (2007).

¹⁴ 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, <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).

¹⁵ See <http://www.census.gov/cgi-bin/sssd/naics/naicsrch?code=517210&search=2007%20NAICS%20Search>.

Telecommunications Carriers. The size standard for that category is that a business is small if it has 1,500 or fewer employees.¹⁶ 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.¹⁷ 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.

13. *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.¹⁸ Under the “Other Telecommunications” category, a business is considered small if it had \$32.5 million or less in annual receipts.¹⁹

14. 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.”²⁰ 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.²¹ Of this total, 482 firms had annual receipts of under \$25 million.²²

15. 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.”²³ For this category, Census Bureau data for 2007 show that there were a total of 2,383 firms that operated for the entire year.²⁴ Of this total, 2,346 firms had annual receipts of under \$25 million.²⁵ We anticipate that some of these “Other Telecommunications firms,” which are small entities, are earth station applicants/licensees that might be affected by our rule changes.

¹⁶ 13 C.F.R. § 121.201, NAICS code 517210.

¹⁷ See http://factfinder2.census.gov/bkmk/table/1.0/en/ECN/2007_US/51SSSZ5//naics~517210.

¹⁸ See 13 C.F.R. § 121.201, NAICS code 517410.

¹⁹ See *id.* § 121.201, NAICS code 517919.

²⁰ U.S. Census Bureau, 2007 NAICS Definitions, “517410 Satellite Telecommunications.”

²¹ See http://factfinder.census.gov/servlet/IBQTable?_bm=y&-geo_id=&-_skip=900&-ds_name=EC0751SSSZ4&-_lang=en.

²² *Id.*

²³ U.S. Census Bureau, 2007 NAICS Definitions, “517919 Other Telecommunications”, <http://www.census.gov/naics/2007/def/ND517919.HTM>.

²⁴ See 13 C.F.R. § 121.201, NAICS code 517919.

²⁵ 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).

16. While our rule changes may have an impact on both 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.

17. *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.”²⁶ The SBA has developed a small business size standard for firms in this category, which is: all such firms having 750 or fewer employees.²⁷ According to Census Bureau data for 2010, there were a total of 810 establishments in this category that operated for the entire year.²⁸ Of this total, 787 had employment of under 500, and an additional 23 had employment of 500 to 999.²⁹ Thus, under this size standard, the majority of firms can be considered small.

D. Description of Projected Reporting, Recordkeeping, and Other Compliance Requirements for Small Entities

18. The projected reporting, recordkeeping, and other compliance requirements resulting from the *Second Order* and *Order on Reconsideration* will apply to all entities in the same manner, consistent with the approach we adopted in the *R&O*. It is possible that small entities will need to hire attorneys and engineers on a contract basis to comply with the rules. We believe that while our proposals require small entities to 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 will constitute a significant benefit for small business.

19. *Order on Reconsideration.* Under the amended rules, FSS earth station licensees may request additional protection from SAS Administrators to prevent harmful interference and in order to provide additional protection for out-of-band earth stations with telemetry, tracking, and control (TT&C) responsibilities, we extend the annual registration requirement to these sites.

20. *Second Order.* Under the new rules, Priority Access Licensees may transfer, assign, or lease their spectrum on the secondary market. In order to benefit from the streamlined approach to spectrum manager leasing applicable to the 3.5 GHz Band, lessees may seek certification from the Commission that they are qualified to act as a Commission licensee and licensees must notify the SAS of the leasing arrangement before the lessee commences service. This process is similar to the certification

²⁶ 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>.

²⁷ 13 C.F.R. § 121.201, NAICS code 334220.

²⁸ 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.

²⁹ *Id.* Eighteen establishments had employment of 1,000 or more.

and notification requirements to invoke immediate processing under existing spectrum manager leasing rules. Further, we extend the current process for transfers, assignments, and *de facto* leases to the 3.5 GHz Band. The reporting requirements are no different from the reporting requirements already required for all other services to which our secondary market policies apply.

21. Under the new rules, as part of the requirements for defining PAL Protection Areas, Priority Access Licensees must notify the SAS if a previously activated CBSD is no longer in use and may choose to self-report protection contours smaller than the default protection contour to the SAS.

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.³⁰

23. *Order on Reconsideration.* The reporting, recordkeeping, and other compliance requirements resulting from this order 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. All Citizens Broadband Radio Service Devices (CBSDs) must comply with the amended technical and operational requirements aimed at preventing interference to Incumbent Access and Priority Access users, including revised power limits non-rural Category B CBSDs and elimination of conducted power limits for all CBSDs and the revised method for defining a Priority Access Licensee's protection area. We believe changes will provide operational flexibility to Priority Access Licensees and GAA users, which, regardless of size, must operate CBSDs that meet these technical requirements.

24. *Second Order.* The reporting, recordkeeping, and other compliance requirements resulting from the *Second Order* 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 definition of use adopted in the *Second Order* leverages advances in computing technology and economics to determine protection contours by adopting a SAS-based engineering approach, while allowing Priority Access Licensees to report their Protection Areas based on actual network deployment. Establishing a baseline protection criteria will allow General Authorized Access users reasonable opportunities for additional access to the band. We considered adopting an economic or hybrid economic/engineering definition of use but determined an engineering approach would promote the most efficient use of the band by all entities. Further, we permit access to the 3.5 GHz Band through secondary markets and adopt a light-touch version of our leasing rules that will allow Priority Access Licensees to lease any portion of their spectrum or geographic area, outside of its PAL Protection Area, for any bandwidth or duration period of time within the terms of the license. We believe that this streamlined approach to leasing will benefit all entities, including small entities, by allowing them to gain

³⁰ 5 U.S.C. § 604(a)(6).

immediate access to spectrum to implement their business plans with reduced regulatory delay and transaction costs.

F. Federal Rules that May Duplicate, Overlap, or Conflict with the Final Rules

25. None.

G. Report to Congress

26. The Commission will send a copy of the *Second Report and Order* and *Order on Reconsideration*, including the FRFA, in a report to Congress pursuant to the Congressional Review Act.³¹ In addition, the Commission will send a copy the *Second Report and Order* and *Order on Reconsideration*, including the FRFA, to the Chief Counsel for Advocacy of the Small Business Administration. A copy of this *Second Report and Order* and *Order on Reconsideration* and FRFA (or summaries thereof) will be published in the Federal Register.³²

³¹ 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.

³² See 5 U.S.C. § 604(b).

APPENDIX D**List of Petitions for Reconsideration and Commenters**Petitions for Reconsideration

CTIA
Jon Peha
Motorola Solutions
National Association of Broadcasters (NAB)
Nokia Solutions
Satellite Industry Association (SIA)
Verizon
Wireless Innovation Forum (WinnForum)

Oppositions to Petitions for Reconsideration

CTIA
Federated Wireless, Inc. (Federated Wireless)
Google, Inc. (Google)
Qualcomm Incorporated (Qualcomm)
Satellite Industry Association (SIA)
T-Mobile USA, Inc. (T-Mobile)
Verizon
The Wireless Internet Service Providers Association (WISPA)

Replies to Oppositions to Petitions for Reconsideration

CTIA
Federated Wireless, Inc. (Federated Wireless)
Google, Inc. (Google)
iPosi, Inc. (iPosi)
National Association of Broadcasters (NAB)
Satellite Industry Association (SIA)
Utilities Telecom Council (UTC)

Comments

AT&T
Cantor Telecom Services, L.P. (Cantor Telecom)
CTIA
Dynamic Spectrum Alliance
Federated Wireless, Inc. (Federated Wireless)
Google, Inc. (Google)
Information Technology Industry Council
IEEE 802.11
InterDigital, Inc. (InterDigital)
iPosi, Inc.
Jon Peha
KanOkla Communications, Inc.
Key Bridge LLC (Key Bridge)

Microsoft Corporation (Microsoft)
Open Technology Institute and Public Knowledge (OTI/PK)
Peter Moncure
Qualcomm Incorporated (Qualcomm)
Rajant Corporation (Rajant)
Satellite Industry Association (SIA)
Sony Electronics Inc. (Sony)
WhiteSpace Alliance
The Wireless Internet Service Providers Association (WISPA)
Wi-Fi Alliance
Verizon

Reply Comments

AT&T
Cantor Telecom Services, L.P. (Cantor Telecom)
Content Interests
Federated Wireless, Inc.
General Communication, Inc. (GCI)
Google, Inc.
iPosi, Inc.
Open Technology Institute and Public Knowledge (OTI/PK)
PCIA - The Wireless Infrastructure Association (PCIA)
Satellite Industry Association (SIA)
Spectrum Bridge, Inc (Spectrum Bridge)
U.S. Electrodynamics, Inc. (Electrodynamics)
The Wireless Innovation Forum (WinnForum)
The Wireless Internet Service Providers Association (WISPA)

**STATEMENT OF
CHAIRMAN TOM WHEELER**

Re: *Amendment of the Commission's Rules with Regard to Commercial Operations in the 3550-3650 MHz Band, Order on Reconsideration and Second Report and Order*, GN Docket No. 12-354

A year ago, the Commission created a new Citizens Broadband Radio Service in the 3.5 GHz band – a significant step forward in spectrum policy. 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, including 100 megahertz previously unavailable for commercial use.

The 3.5 GHz band is an "Innovation Band," that provides an opportunity to smartly explore new ideas and new approaches to difficult policy and technical problems. It is a band in which, without these innovative solutions, the spectrum would not become widely available to the majority of the population.

The government is frequently criticized for thinking too narrowly and doing things one way because that is the way they have always been done. The Citizens Broadband Radio Service is not one of those cases. Here, the Commission has taken bold steps to pursue a new approach.

When this band was originally identified for potential sharing in 2010, there was very little interest from the private sector. Many assumed that accommodating incumbent Federal operations would prove too cumbersome and restrictive for conventional commercial deployments and that, therefore, the band would not be viable for non-Federal use.

Instead of giving up, we went back to the drawing board and developed a new approach based on small cells and dynamic spectrum access. The 2015 *First Order* establishing the framework for development of this spectrum created a new three-tiered access scheme in the Citizens Broadband Radio Service -- Incumbents, Priority Access, and General Authorized Access (GAA) -- which accommodates many users and use cases, and manages scarcity in several new ways. We rely on an innovative Spectrum Access System to automatically coordinate access to the band. This innovative, hybrid model weaves together elements of our licensed and unlicensed models, providing many of the benefits of both models in a single band.

Once we pursued the hybrid model, we witnessed extensive interest in the band from a variety of potential users and developers, both from the licensed and the unlicensed communities, and development of wireless technologies for this band is already under way. Numerous major providers and equipment manufacturers have already announced their plans to aggressively develop and market equipment for the band and deploy quickly.

Some have argued that we should stick with the exclusive licensed model alone, that the shorter license terms in this band will not support investment, and that the lack of renewal expectancies creates too much uncertainty. These concerns are misplaced and reflect 20th Century thinking that ignores the way networks are being developed and deployed today. Today's networks already combine both licensed and unlicensed technologies. We need to provide as much spectrum as possible using similarly flexible models. That is exactly what we are doing here and the strong commercial interest in 3.5 GHz reflects that we have struck a good balance.

Furthermore, the bold new action we are taking in the 3.5 GHz band is more than simply an "experiment." It is the product of careful compromise that has resulted in an innovative and creative solution that provides access to spectrum that would not otherwise exist, that provides room for new

service providers and competition, and that lets the market determine the highest valued use of the spectrum.

To be sure, I do not think the 3.5 GHz model is appropriate everywhere, and I will continue to support both the exclusive licensed and unlicensed approaches, independently, where such approaches make the most sense. But, in bands where the problem of spectrum access calls for a creative solution, we should not shy from breaking new ground.

In this *Second Order*, we reaffirm our commitment to this Innovation Band, while at the same time making several tweaks to the rules to provide additional flexibility to providers. We also resolve the few remaining issues from the proceeding's *Second Further Notice of Proposed Rulemaking*, in order to provide all stakeholders with a clear path forward in the band.

First, we establish rules for defining when a Priority Access License (PAL) is in use that both ensures flexibility for the licensee and consistent and equitable availability for other users, an approach that we term "use or share." In the April 2015 *First Order*, the Commission established rules that would allow GAA users to operate in "unused" Priority Access channels and sought comment on how such use should be defined. Today's *Second Order* adopts an engineering-based approach to determining which areas are "in use" that will allow PAL licensees to report their operational boundaries with an objective maximum protection area based on an engineering metric. This approach will ensure that actual Priority Access operations are protected, provide an objective measurement where necessary, and ensure consistent and equitable spectrum availability for GAA users.

Second, we seek to facilitate secondary market transactions in a manner that will leverage the unique technical characteristics and regulatory framework of the band to encourage investment, promote efficient spectrum use, and reduce administrative burdens. We therefore, adopt a "light touch leasing" approach that will minimize the administrative burdens of facilitating leasing potentially across over 500,000 licenses. This leasing approach will facilitate a robust, fluid, and flexible secondary market for PALs in a way that will leverage the unique technical characteristics and regulatory framework of the band to encourage investment, promote efficient spectrum use, and reduce administrative burdens.

Third, we adopt carefully balanced protections for fixed satellite earth stations with the need to maximize availability of the 3.5 GHz Band for commercial broadband use by utilizing the unique capabilities of the Spectrum Access System (SAS) to calculate protections for in-band earth stations – and a small subset of earth stations in the 3700-4200 MHz band – targeted to the unique characteristics of each site.

Finally, we have incorporated a bipartisan, compromise to accommodate the needs of rural providers in areas for which there is no competition for exclusive licensing. In rural license areas, if only one applicant is seeking a PAL and, therefore, the competitive bidding process in that license area is not triggered, the Commission will issue a single PAL to that applicant. While the Commission expects that mutual exclusivity will likely be triggered in all license areas, we believe that this narrow exception is appropriate to create an opportunity for operators that provide broadband services to Rural Areas to secure assured exclusive access to spectrum, regardless of competitive demand.

This item carefully balances the comments submitted by different stakeholders and potential future users of the band, and seeks to further the public interest, promote innovation, and stimulate future investment in the band. With its passage, we put the final regulatory puzzle pieces in place to complete the rules for the Citizens Broadband Radio Service. Next, the Wireless Bureau and Office of Engineering and Technology will turn to the process of reviewing, testing, and approving SAS Administrators and Environmental Sensing Capability operators. As we strive to maximize the spectrum opportunities, these tools become critical components of our spectrum toolbox.

Thank you to the Wireless Bureau, the Office of Engineering and Technology, and the International Bureau for their work on this item and their work over the years crafting innovative solutions to utilize this spectrum more efficiently and effectively.

**STATEMENT OF
COMMISSIONER MIGNON L. CLYBURN**

Re: *Amendment of the Commission's Rules with Regard to Commercial Operations in the 3550-3650 MHz Band, Order on Reconsideration and Second Report and Order*, GN Docket No. 12-354

In the 1989 film *Back to the Future Part II*, there were many predictions of what life in the second decade of the 21st century would look like. There were hoverboards and drones, mobile payment technology and flying cars. So while they clearly did not get everything right, the writers correctly foretold the importance of spectrum as well as our reliance on wireless technologies.

Spectrum is critical to continued growth and innovation in nearly every segment of our society. It is an essential tool for connecting communities. From that entrepreneur in Manning, SC, who is now able to market and sell her goods globally from a town with a population of less than 4,100, to that college-bound high school student who can take advanced online courses not offered in his neighborhood inner-city high school, it is clear that access to adequate spectrum has the power to exponentially maximize our collective potential. With global data traffic expected to increase nearly eightfold between 2015 and 2020, it is imperative that we find creative and flexible ways to maximize this valuable and finite resource, so that we may continue to unleash the possibilities of tomorrow.

Our action today will better enable us to do just that. The new Citizens Broadband Radio Service is a unique spectrum sharing regime that will, in a word, revolutionize the way we do things. It establishes a three-tier framework for making the entirety of the 3.5 GHz band available for shared commercial use, while putting in place protections for the band's incumbents. With Spectrum Access Systems taking on the complicated and vital role of frequency coordination, the three tiers: Incumbent Access users, Priority Access Licensees and General Authorized Access users, will soon be able to cohabitate in the band and maximize spectrum efficiency.

To be sure, there are parts of this novel regime that some parties wish were different. I understand that and hear you loud and clear. But what we must all realize is that in order to deliver on the promise of unlocking much needed additional spectrum, we need to embrace unconventional approaches that challenge, and sometimes up-end, the way we have done things in the past. We should not be so quick to predict failure simply because the tools are new and the terrain is changing. The possibilities are limitless; our talents are extraordinary; and the time is now to be bold and visionary.

I want to thank the staff of the Wireless Bureau, the Office of Engineering and Technology, and the International Bureau, for their dedicated and tireless contributions throughout this proceeding. I know I am not alone when I say that I eagerly await the cutting-edge innovations that will inure to our collective benefit because of your hard work.

**STATEMENT OF
COMMISSIONER JESSICA ROSENWORCEL**

Re: *Amendment of the Commission's Rules with Regard to Commercial Operations in the 3550-3650 MHz Band, Order on Reconsideration and Second Report and Order*, GN Docket No. 12-354

Welcome to the future of spectrum policy. It's happening right here and right now—with the 3.5 GHz band.

To understand why, roll back to the spectrum policy that has come before. There was a time, not that long ago, when wireless bands for mobile use were strictly licensed or unlicensed. One or the other. Pick one. No in-between. But as the demands on our airwaves have grown, we see new strain on this old binary model.

Enter the 3.5 GHz band. More than five years ago, the National Telecommunications and Information Administration identified the 3.5 GHz band as suitable for shared use between government and commercial interests, provided existing incumbents—including Department of Defense radars and fixed satellite services—were offered protection. The response to this proposal was a collective shrug. Enthusiasm for this band and its possibilities was hard to find.

But what a difference a few years make. That's because the Commission decided to take this band and experiment. We put in place a multi-tiered approach to spectrum access that is creative, efficient, and forward looking. Its system of tiered access simultaneously protects existing users, creates new licensed possibilities, and opens up the remaining spectrum to unlicensed services. This is a whole new way of making effective use of our airwaves. It is a blueprint for the future of spectrum policy.

Plus, with this multi-tiered approach, we finally ditch the tired notion that we face a choice between licensed and unlicensed airwaves. This is a good thing. That's because the next generation of wireless devices and coming Internet of Things will not rely on a single spectrum band to function. Instead, services will overcome spectral and physical challenges by moving from frequency to frequency—sometimes on spectrum that is licensed and sometimes on spectrum that is unlicensed. That is why our experiment in this band is so important.

Today we refine our multi-tiered framework. In particular, we increase opportunities for licenses in rural areas. We also increase power levels in this band for licensed and unlicensed devices in non-rural areas. In addition, we add flexibility to the measurement of emission limits. Taken together, these adjustments mean new services in this band will have a little more room to operate.

These changes may seem small, but the impact of this band and this approach is bound to be big. So thank you to the Wireless Telecommunications Bureau and Office of Engineering and Technology for their continuing efforts to develop, refine, and put in place the future of spectrum policy—in the 3.5 GHz band.

**STATEMENT OF
COMMISSIONER AJIT PAI
APPROVING IN PART AND CONCURRING IN PART**

Re: *Amendment of the Commission's Rules with Regard to Commercial Operations in the 3550-3650 MHz Band, Order on Reconsideration and Second Report and Order, GN Docket No. 12-354*

The 3.5 GHz proceeding is an experiment. Federal users occupy much of the band, and even though they make little use of the spectrum across large parts of the country, their operations have prevented others from utilizing it. So for years, the FCC has been working to find creative ways to let consumers use this spectrum.

The FCC would like to test a theory—to see if we can implement a sharing regime that will allow a mix of innovative offerings to flourish. Have we struck the right balance? Will we see a variety of providers and technologies competing in the band? I can't say for sure. It remains to be seen whether we can turn today's spectrum theory into a working reality.

For my part, I have not agreed with every decision that has been made in this proceeding. It is no secret that I have pushed for the FCC to shrink the exclusion zones and move much more quickly to open them up to consumer use. I have also said that the FCC should be creating greater incentives for providers to invest in this band. Indeed, the IEEE 802.11 Working Group has expressed little interest in developing a technical standard for this band because of these issues.¹

But notwithstanding my concerns, I appreciate that we have made some progress over the course of this proceeding. For instance, we earlier eliminated the 20 MHz spectrum set-aside for favored groups. We extended the initial license terms. We found a way to ensure that 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. And we adopted a mechanism that will allow more licenses to be issued.

Today's decision marks yet more incremental progress. One benefit I'd like to focus on involves rural Americans. Under our prior 3.5 GHz order, consumers in rural areas would not have been able to obtain any service that required quality of service assurance, including broadband, if only one provider was willing to serve them. Why? Because our rules limited Priority Access Licenses (the only ones that include interference protection) to areas where multiple providers sought them. Having grown up in rural Kansas, and having visited many rural communities in my time on the Commission, I can tell you that it is often difficult enough to get interest from one provider, let alone two.

So I made a proposal to my colleagues, and we were able to get a deal done. We will now be making a Priority Access License available in rural areas even when there is only one provider that seeks to obtain it. This should offer a greater incentive for wireless Internet service providers and others to bring a mix of technologies to rural America. I thank my colleagues for agreeing to this idea and will be voting to approve in part and concur in part.

¹ Comments of IEEE 802.11, GN Docket No. 12-354 (July 13, 2015), <http://go.usa.gov/3h8Eh>.

**STATEMENT OF
COMMISSIONER MICHAEL O'RIELLY
APPROVING IN PART, DISSENTING IN PART**

Re: *Amendment of the Commission's Rules with Regard to Commercial Operations in the 3550-3650 MHz Band, Order on Reconsideration and Second Report and Order*, GN Docket No. 12-354

The 3.5 GHz experiment has been touted as a potential new approach for spectrum allocation, enabling expanded use of certain bands where incumbents – often federal government agencies – are already using the frequencies. While I praised the concept of opening up this underused spectrum for additional uses, I expressed serious concerns about several sections – most important being the licensing structure of the Priority Access Licenses (PALs).¹ At the time, I noted that this structure was problematic and needed to be fixed.

The 3.5 GHz framework is based on a three-tiered hierarchy for spectrum access.² For this grand experiment to work, however, all three prongs need to be fully functional. Sadly, the Commission refuses to fix the PALs assignment mechanism, which is fundamentally flawed and undoes years of successful spectrum auction policy.

Specifically, PALs should be available in any census tract – even if there is only one entity interested in priority access. Not only does the record on reconsideration support this,³ but throughout this proceeding, many smaller wireless providers and entrepreneurs, including those in rural America, have told me that they seek priority and interference protection for their particular business plans. Further, many have stated that the certainty provided by a PAL is necessary to secure the funding needed to develop and deploy offerings in this band. I have also spoken to many GAA proponents who are supportive of providing PALs in any market in which they are sought, so long as the process does not preclude GAA use, which it does not.

The arguments put forth against resolving this issue are not compelling. A lack of multiple auction participants does not mean that the available GAA spectrum is sufficient to meet everyone's needs and, therefore, PALs are not necessary. Different business models have different spectrum needs. Some entities may be fine with GAA spectrum while others need quality and availability assurance. Issuing PALs to one entity will also not lead to inefficiencies or spectrum warehousing, as any spectrum that is not “in use” by a Priority Access licensee can be accessed by GAA so it doesn't necessarily lay fallow. Another argument is that multiple auction applicants in a market are likely, because established wireless providers tend to look for nationwide footprints. However, this is an “experiment” not a standard

¹ *Amendment of the Commission's Rule with Regard to Commercial Operations in the 3550-3650 MHz Band*, GN Docket No. 12-354, Report and Order and Second Further Notice of Proposed Rulemaking, 30 FCC Rcd 3959, 4144 (2015).

² Incumbent users would be fully protected and guaranteed access, the Priority Access licensees would be next in priority, followed by the General Authorized Access (GAA) users who obtain access when there are no operating incumbents or PALs.

³ See, e.g., Petition for Reconsideration of CTIA, GN Docket No. 12-354 (July 24, 2015) (“CTIA Petition for Reconsideration”); Posting of Joan Marsh, Reaching a Sound 3.5 GHz Framework (Apr. 11, 2016 11:44am), attached to Letter from Stacey Black, Assistant Vice President, Federal Regulatory, AT&T Services, Inc., to Marlene H. Dortch, Secretary, Federal Communications Commission, GN Docket No. 12-354 (Apr. 12, 2016) (Joan Marsh Blog Post); Opposition of The Wireless Internet Service Provider Association, GN Docket No. 12-354 (Oct. 20, 2015) (WISPA Opposition); Petition for Reconsideration of Motorola, GN Docket No. 12-354 (July 24, 2016).

auction for exclusive use licenses, and I am not convinced the licensing rules will entice providers to express interest in multiple PALs in more than 74,000 census tracts. Finally, the argument has been made that priority access should not be permitted for free. But as I and others have stated,⁴ we can use our well-established auction processes to resolve this issue.

Unfortunately, some at the Commission have decided that the statute prevents this.⁵ However, there is a good argument to be made that a PAL is, by its very nature, mutually exclusive to GAA use, because these license types cannot coexist on the same frequencies.

And this point is consistent with our decision in the Incentive Auction order that only one application for a license is sufficient to meet our mutual exclusivity rules.⁶ In coming to this decision, one of the justifications was that broadcast and wireless use are mutually exclusive.⁷ While some may argue that the Incentive Auction is unique because it was mandated by law, Congress did not change our rules in regard to how we conduct our forward auctions. The Spectrum Act says that spectrum should be allocated for wireless use “through a system of competitive bidding under [309(j)]”⁸ and that auction revenues should be used, in part, to compensate broadcasters that surrender their licenses in the reverse auction, but this language in no way demands a special interpretation of our mutual exclusivity rule.

Moreover, even if there is mutual exclusivity for a first auction, there is no guarantee that it will exist in future auctions. Therefore, an entity that invests in and constructs a network based on priority access may not even be able to participate in a future auction to maintain its status. This could result in stranded investment. Some argue that the investment is still worthwhile because they would continue to have access to GAA spectrum, but, as I indicated before, some industry participants have clearly stated that GAA is not sufficient. Instead, they want functioning licenses that this sharing model was supposed to offer.

An equally disturbing problem with the current structure – and subject to numerous petitions in this item – is the lack of renewability and short license terms for PALs.⁹ It has been made clear by numerous wireless providers that the short license terms and lack of renewal, along with the auction structure, will inform their business decisions as to whether they should apply for PALs or whether it is even worth investing in and developing this band. The fact that Commission staff would not even entertain discussions on changing the lack of renewability and licensing term is so telling about how this Commission is run and the unwillingness to listen to worthwhile ideas.

⁴ See, e.g., Petition for Reconsideration of John M. Peha, GN Docket No. 12-354 (July 24, 2015); Ex Parte Letter from Scott K. Bergmann, Vice President, Regulatory Affairs, CTIA, to Marlene H. Dortch, Secretary, Federal Communications Commission, GN Docket No. 12-354 (Apr. 27, 2016); see also WISPA Opposition.

⁵ Section 309(j)(1) of the Communications Act states that “if . . . mutually exclusive applications are accepted for any initial license . . . , the Commission shall grant the license or permit to a qualified applicant through a system of competitive bidding.” 47 U.S.C. § 309(j)(6)(E). The statute continues that nothing should be “construed to relieve the Commission of the obligation . . . to avoid mutual exclusivity in application and licensing procedures.” *Id.* § 309(j)(6)(E).

⁶ *Expanding the Economic and Innovation Opportunities of Spectrum through Incentive Auctions*, GN Docket No. 12-268, Report and Order, 29 FCC Rcd 6567, 6760 ¶ 470 (2014).

⁷ *Id.* at 6761 ¶ 471.

⁸ Middle Class Tax Relief and Job Creation Act of 2012, Pub. L. No. 112-96 § 6401(b)(1)(B), 126 Stat. 222 (2012).

⁹ See, e.g., CTIA Petition for Reconsideration; Response of T-Mobile, GN Docket No. 12-354 (Oct. 20, 2016); Joan Marsh Blog.

Fundamentally, such a decision undoes decades of successful spectrum policy by the Commission. For example, the Commission has touted internationally the need for longer license terms and renewability as prerequisites for a successful spectrum action and widespread wireless deployment. In fact, this exact subject was raised by a number representatives of foreign nations during my visit to the ITU Plenipotentiary in 2014. At the time, certain countries were leaning towards short license terms and a reauction of licenses because they wanted another round of cash down the road. But such a policy misses an important concept relevant today: there will be a lack of interest in spectrum licenses upfront if there is no predictability and certainty regarding investments made by those seeking the licenses.

And I want to make it clear, to the extent that people suggest that this unproven and flawed experiment should be replicated in other spectrum bands, such as millimeter wave frequencies, that is a proposition that I will not support.

I also am unable to support some of the delegations in this item. For example, decisions about how to define PAL interference protections and contours and how congestion will be handled will be made by the Office of Engineering and Technology and Wireless Telecommunications Bureau when the applications are filed by SAS administrators. While I have confidence in the abilities of staff to do such analysis, such decisions that are crucial to the workings of the band should be voted on by the Commission.

In conclusion, I am unable to support these portions of the order. Although a compromise offer was put on the table by the Chairman to allow for one free PAL when there was no mutual exclusivity, it did not fix the problem and just wasn't enough to excuse all of the other flaws in the licensing process. Basically, by rejecting commonsense and generally supported changes to this "experiment," we have created a tier of licenses where there may be little to no incentive to participate. As it stands now, the band plan for 3.5 GHz is like a three-legged stool that could topple over because one key component is missing. Therefore, I must dissent on the two portions already discussed.