AUTHENTICATED
U.S. GOVERNMENT
INFORMATION
GPO

FEDERAL REGISTER

Vol. 81 Tuesday,
No. 143 July 26, 2016

Part IV

Federal Communications Commission

47 CFR Parts 1, 2, and 96
Amendment of the Commission's Rules With Regard to Commercial Operations in the 3550–3650 MHz Band; Final Rule

FEDERAL COMMUNICATIONS COMMISSION

47 CFR Parts 1, 2, and 96

[WT Docket No. 12–354; FCC 16–55]

Amendment of the Commission's Rules With Regard to Commercial Operations in the 3550–3650 MHz Band

AGENCY: Federal Communications Commission.

ACTION: Final rule; petition for reconsideration.

SUMMARY: In this document, the Federal Communications Commission addresses eight petitions for reconsideration on certain rules adopted in the *Report and Order* (*Report and Order*) in this proceeding governing the Citizens Broadband Radio Service in the 3.5 GHz band. The Commission also finalizes the regulatory scheme established in the *Report and Order* to make this spectrum available for wireless broadband through dynamic sharing among three tiers of users.

DATES: Effective August 25, 2016 except for §§ 1.9046, 96.3, 96.17(b), 96.25(c)(1)(i), and 96.32(a) and (b) which contain information collection requirements subject to approval by the Office of Management and Budget. The Federal Communications Commission will publish a document in the **Federal Register** announcing the effective date for those sections.

FOR FURTHER INFORMATION CONTACT: Paul Powell, *Paul.Powell@fcc.gov*, of the Wireless Telecommunications Bureau, Mobility Division, (202) 418–1618. For additional information concerning the Paperwork Reduction Act information collection requirements contained in this document, contact Cathy Williams at (202) 418–2918 or send an email to *PRA@fcc.gov.*

SUPPLEMENTARY INFORMATION: This is a summary of the Commission's Order on Reconsideration and Second Report and Order in GN Docket No. 12–354, FCC 16–55 released on May 2, 2106. The complete text of the public notice is available for viewing via the Commission's ECFS Web site by entering the docket number, WT Docket No. 12–354. The complete text of the public notice is also available for public inspection and copying from 8:00 a.m. to 4:30 p.m. Eastern Time (ET) Monday through Thursday or from 8:00 a.m. to 11:30 a.m. ET on Fridays in the FCC Reference Information Center, 445 12th Street SW., Room CY–B402, Washington, DC 20554, telephone 202–488–5300, fax 202–488–5563.

The Commission will send a copy of this Order on Reconsideration and Second Report & Order in a report to be sent to Congress and the Government Accountability Office pursuant to the Congressional Review Act, see 5 U.S.C. 801(a)(1)(A).

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. (80 FR 36163, June 23, 2015)

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) 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 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 a 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* (78 FR 1188, January 8, 2013) 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. Specifically, the *NPRM* proposed to create a new Citizens Broadband Radio Service. 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.

11. In November 2013, in response to comments received on the record up to that point, the Commission released the *Licensing PN* (78 FR 73794, December 9, 2013), which described a Revised Framework that elaborated upon some of the licensing concepts and alternatives set forth in the *NPRM.* The Revised Framework retained the three-tier model proposed in the *NPRM* but expanded eligibility for access to the Priority Access tier with competitive bidding for assigning licenses within that tier. 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.

12. In April 2014, the Commission released the *3.5 GHz FNPRM* (79 FR 31247, June 2, 2014), 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. 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. 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.

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.*

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 (47 CFR 96.15, 96.17, 96.21). In addition, an ESC 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 (47 CFR 96.15, 96.67).

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 (47 CFR 96.25, 96.29).

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. 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. 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 (80 FR 69662, November 10, 2015) 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. 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. 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.

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 (80 FR 59705, October 2, 2015). 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 OOBE 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. 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.'' Instead he argues that the Commission should grant PALs in every market where there is demand, even if there is only one bidder.

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.

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.

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. 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. 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.

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 OOBE 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 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.

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.

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.

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 OOBE limits and states the 3.5 GHz FNPRM provided adequate notice that that the Commission would extend these limits for the 3650–3700 MHz band. CTIA claims the power limits for non-rural Category B CBSDs should be increased to provide operators with additional flexibility. 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.

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; (2) modify the elevation accuracy requirement to allow the SAS to play a role in determining CBSD location; and (3) allow PALs to be issued even when there is a single applicant in a given census tract. 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.

31. Google Opposition. Google argues that the Commission should reject SIA's request to strengthen OOBE limits and eliminate registration requirements for FSS earth station operators. 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. Google also supports many of the petitioners for technical amendments to the rules to maximize spectrum availability.

32. SIA Opposition. SIA asks the Commission to reject requests to relax OOBE limits and use an RMS detection methodology for measuring a device's compliance with the Commission's OOBE 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. Finally, SIA supports elimination of the professional installation option for reporting location accuracy.

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

34. T-Mobile Opposition. T-Mobile supports increasing the license term for PALs from three years to ten years with a renewal expectancy. 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 OOBE and EIRP limits for CBSDs and eliminate conducted power limits; and (3) increase the reconfiguration response time when an incumbent user is detected. Finally, T-Mobile asks the Commission to continue to evaluate whether geo-location capabilities can be built into devices in the future.

35. Verizon Opposition. Verizon states that the Commission should deny SIA's request for stricter OOBE limits and that SIA's concerns about FSS protections are premature. 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. However, WISPA supports requests to relax OOBE limits and to use an RMS detector to measure these levels. WISPA opposes the petitions that request increasing the three-year license term for PALs and opposes permitting a renewal expectancy. However, WISPA supports the requests to award PALs in census tracts even if there is only one application. Finally, WISPA supports retaining the FSS earth station registration requirements.

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. 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 (47 CFR 1.429). The eight petitions for reconsideration filed in this proceeding were assessed pursuant to the requirements set forth in section 1.429 (47 CFR 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. 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.* 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.

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. CTIA argues that the existing three-year license term does not provide operators sufficient time or assurance to realize a return on investment. 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. 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 Band as a signal that the *3.5 GHz R&O* is already affecting investment and innovation. Three parties, AT&T, PCIA, and T-Mobile, support CTIA's position.

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. 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.

42. CTIA filed a reply to WISPA's opposition reiterating its arguments. 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.

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. 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. 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.'' 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. Indeed, the arguments raised by CTIA and supporting parties are similar to those raised by commenters in response to the FNPRM. These arguments were already thoroughly considered by the Commission in the *3.5 GHz R&O.* As such, we continue to believe that three-year, non-renewable license terms strike the proper balance of interests for the 3.5 GHz Band.

44. We also continue to believe that the current rules will effectively incentivize network investment. 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. 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. 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 (47 U.S.C. 309(j)(1)–(2), (j)(6)(E)). 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. 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 available in a License Area, PAL applications are mutually exclusive because granting one application would create conflict with another application.

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.

48. CTIA, Jon Peha, and Motorola Solutions seek reconsideration of the Commission's method for determining mutual exclusivity for PALs. Federated Wireless, UTC, and WISPA support these petitions. 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. 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. 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. 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.

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. 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. 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.

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 defined in section 96.3 (47 CFR 96.3), we will allow for the assignment of one PAL in that License Area. 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), the best way to discharge our statutory mandate to ''encourage the larger and more effective use of radio in the public interest'' (47 U.S.C. 303(g)) is to provide access to such spectrum via shared GAA use.

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'' (47 U.S.C. 309(j)(3), 309(j)(4)). 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. 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 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. 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. 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. 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.'' 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,'' but rather one likely to encourage speculation, reduce spectrum availability, and discourage innovation in the band.

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. 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.'' 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 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. 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. 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.'' 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. We continue to believe the adopted rules are the best way to ''encourage the larger and more effective use of radio in the public interest'' 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) (47 CFR 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.'' The Commission adopted identical requirements for CBSDs operating in the 3650–3700 MHz band. 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.''

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. 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. 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. 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. Google and WISPA also support WinnForum's Petition.

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) (47 CFR 96.39). 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. Google contends that, to resolve this tension, the 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.

62. SIA argues that the 60-second response time in section 96.39 (47 CFR 96.39) for CBSDs to move or discontinue operations is too long and asks that the Commission reduce that timeframe. 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. 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. 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 (47 CFR 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 (47 CFR 96.39).

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. 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 (b)(4) of the rules (47 CFR 96.15(a)(4) and (b)(4)) and extend the SAS reconfiguration

timeframe to 300 seconds. 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. They do not provide a basis for why as much as 600-seconds is needed, even for a large network. We also amend sections 96.15(a)(4) and (b)(4) (47 CFR 96.15(a)(4) and (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. 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 Federal Government entity) issues instructions to discontinue use of CBSDs pursuant to section 706 of the Communications Act of 1934 (47 U.S.C. 157), as amended (War Powers of President) (47 U.S.C. 606). 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 (47 CFR 96.15(a)(4), 96.39(c)(2)) pointed out by Google. 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. As Google correctly notes, SIA's arguments on this point were considered by the Commission when the rule was adopted. 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) (47 CFR 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 (47 CFR 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.'' 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. 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 (47 CFR 96.41, 96.43, 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) (47 CFR 96.41(b), 96.43(a)). 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.*

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 (47 CFR 96.41(b), 96.45). 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 (47 CFR 96.41(b)). 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.

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

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. WinnForum contends that the proposed increases would bring the Commission's rules in line with the power levels of existing urban pico-cells. 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 cell could achieve, driving up network costs. 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.''

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. 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. 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. WinnForum argues that this approach would not preclude the use of omni-directional antennas while still maintaining adequate coverage areas for outdoor deployments.

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.* 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.

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. Federated Wireless disagrees with WISPA and contends that increased EIRP and flexibility is essential to promote innovation and enable more efficient spectrum use.

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 (47 CFR 96.15, 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.

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. 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. 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. 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 (47 CFR 96.15, 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. 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. 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. 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 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. 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 (47 CFR 96.39(c)). 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. 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. 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. 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 OOBE 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 OOBE 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 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. 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 (47 CFR 24.232(d) and 27.50(a)(1)(B) and (d)(5)).

84. Finally, SIA argues that unlimited antenna heights for Category B CBSDs will necessitate larger protection areas for FSS earth stations. SIA does not propose a specific remedy or alternate rule governing antenna heights. We note that Category B CBSDs are required to report antenna height as part of their CBSD registration under section 96.45(d) (47 CFR 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 (47 CFR 96.17(d), 96.45(d), 96.53, 96.55). 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. OOBE and Adjacent Channel Emissions Limits

1. OOBE 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 OOBE 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 OOBE limits. CTIA contends that the −40 dBm/MHz OOBE limit simply is too restrictive and is not necessary to protect operations in the adjacent band below 3530 MHz and above 3720 MHz. 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. Qualcomm supports CTIA's comments and asserts that the FCC should not implement tighter OOBE limits at the 3700 MHz band edge for certain classes of devices to protect C-band FSS earth stations. According to Qualcomm, stringent OOBE 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. Google, T-Mobile, and WISPA also support relaxation of the OOBE limits.

87. Nokia Solutions recommends that the Commission define OOBE 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.

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. 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. According to Qualcomm, such reductions will create coverage challenges and limit the band's ability to support wider bandwidth LTE operations. 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.

89. On the other hand, SIA argues that more restrictive OOBE limits are needed to effectively protect C-Band FSS earth stations from CBSD transmissions. SIA also asserts that the OOBE limits adopted by the Commission were implemented without the required legal notice. According to SIA, under the Commission's current OOBE rules, separation distances between CBSDs and FSS earth stations could be more

than 15 km. GCI also argues that the Commission should implement more stringent OOBE limits at the upper edge of the 3.5 GHz Band. According to GCI, at a minimum, a −40 dBm/MHz limit should be implemented at the band edge to protect C-Band FSS earth station receivers.

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

91. Discussion. After review of the diverse record on this issue, we deny the petitions for reconsideration that requested changes to the OOBE limits that the Commission adopted in the *3.5 GHz R&O.* We continue to believe that the existing OOBE 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 OOBE 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 OOBE of commercial products that operate within the 3.5 GHz Band can be lower than −40 dBm/MHz at offsets higher than 20 megahertz. 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.

93. We disagree with CTIA and Qualcomm's argument that the Commission's OOBE limits should be changed since they would force operators using 20 megahertz channels to reduce power to comply with the rules. 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. While Citizens Broadband Radio Service users are permitted to aggregate PAL channels or operate across wider bandwidths—consistent with section 96.31 (47 CFR 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 OOBE limits. While the flexibility to aggregate spectrum is a key element of the Commission's licensing regime, reducing OOBE 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 on adjacent channel operations. 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 OOBE 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 OOBE 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 OOBE 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. 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. After review of the record, we remain convinced that the OOBE 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 OOBE 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. Therefore, as detailed in section IV(C)(2), we adopt rules to provide additional protection for these facilities. 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.

97. Finally, we reject SIA's assertion that the Commission did not provide proper notice prior to adopting the current OOBE rules in the *3.5 GHz R&O.* As SIA itself notes, in the FNPRM, the Commission: (1) Proposed an OOBE 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 OOBE limits and the size of the transition gap; and (3) sought comment on extending the Citizens Broadband Radio Service to 3700 MHz. 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. And in the *3.5 GHz R&O* 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.''

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.'' 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 OOBE 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. Thus, the extension of the 3.5 GHz Band—and with it the OOBE 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.

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. CTIA objects to this testing methodology and asks the Commission to adopt a different measurement technique. 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. 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. 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.

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. 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. According to WinnForum, the part 96 emission limits are already stringent, 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.).

101. SIA disagrees with WinnForum and argues that the Commission should retain the peak measurement test for OOBE. SIA states that ignoring peak emission levels in favor of reliance on average measurements would undermine the prophylactic objectives of the OOBE limits. 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 OOBE limit compliance.

102. Google supports WinnForum's filing and argues that SIA's claims should be rejected. 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.

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. 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 47 CFR 27.50(b)(11), (c)(11), (d)(6), (h)(4)(i), 24.132(d)–(f). In other services, the Commission has adopted the emission power measurement by giving the option of detecting peak value or average value 47 CFR 27.53(a)(7), (h)(3)(iii). 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 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. 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. 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. 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. SIA contends that this measurement approach is necessary because ''peak emissions may have significant interference effects.'' 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. 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.

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. 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 OOBE 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 broadband services 47 CFR 24.32(d), 27.50(a)(1)(B) and (d)(5). NTIA lab measurements on LTE hot spot devices also support our finding that a 13 dB margin is reasonable for industry to achieve.

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. 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.

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) and ±3 meters (vertical) (47 CFR 96.39(a)). 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. Google and Federated Wireless also support alternative approaches to ascertaining the location of CBSDs. 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. 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. Google argues this would incentivize manufacturers to improve location accuracy.

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. 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. 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.

112. Nokia Solutions also recommends that the Commission establish separate vertical location accuracy requirements for outdoor and indoor installations. 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. 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.

113. SIA and NAB both stress the importance of reliable location accuracy necessary to protect incumbent operations. 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. 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. 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.

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

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. 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. 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. 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 (47 CFR 96.39(a), 96.45(a)). 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.

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 capability. NAB contends that the Commission's rule is analogous to a similar professional installation requirement adopted in the White Spaces proceeding. 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. 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. NAB also claims that the professional installation is inherently flawed and cannot be rehabilitated by a certification process. 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. In addition, on February 26, 2016, the Commission adopted a Notice of Proposed Rulemaking and Order (81 FR 15210, March 22, 2016) that proposed to require automated geo-location capabilities in White Spaces devices, consistent with an agreement between NAB and several White Spaces device manufacturers.

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. 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. 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. Federated Wireless also notes that professional installation has been used successfully in a number of other licensed services—including two-way satellite broadband.

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. 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 available technology. 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. As discussed in detail above, several petitioners highlighted the difficulties associated with attaining an accurate vertical reading within +/− 3 meters. 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. 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 or 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. 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.

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. Indeed, NAB claims that professional installation has proven to be inherently unreliable and that it cannot be rehabilitated through any kind of certification regime. 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 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.'' In the White Spaces service, the Commission determined not to ''define the qualifications of a professional installer in the rules.'' 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. 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. We reiterate that industry-led professional accreditation processes have been used by the Commission and have, in fact, proven successful in other similar situations. 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. 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. 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.

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 (47 CFR 96.53(d), 96.57(a), 96.63(f)). 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 (47 CFR 95.55). 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. 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. 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. 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 CBSD. In the alternative, the Commission could define a maximum deployment radius. 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.''

131. Google and WISPA expressly oppose mandating End User Devices to include geo-location technology. 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. 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.

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. 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. 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.

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.* 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.

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 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,'' (47 CFR 96.47(a)) 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. 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 level of −80 dBm when integrated over a 10 MHz reference bandwidth with the measurement antenna placed at a height of 1.5 meters above ground level (47 CFR 96.41(f)). 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.

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.* 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. 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. 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. WISPA also agrees that the −80 dBm criterion is inadequate for the reasons described by WinnForum.

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 Area (47 CFR 96.3) described in detail in section IV(A) below rather than along the borders of a Priority Access Licensee's Service Area (47 CFR 96.3). 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.

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. 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. 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) (47 CFR 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 (47 CFR 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. Specific protection methods for in-band and out-of-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 (47 CFR 2.106, note US107). 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.*

143. SIA contends that new in-band FSS earth stations should be authorized on a co-primary basis like grandfathered earth stations. 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. 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.

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.* 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. 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. 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 (47 CFR 2.106, note US107). 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 (47 CFR 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."

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 (47 CFR 96.17, 96.21, 96.53(h)). This includes enforcing the protection criteria set forth in sections 96.17 and 96.21 (47 CFR 96.17, 96.21) and, under the modified rule, processing and responding to reports of harmful interference or special coordination requests from non-federal FSS licensees (47 CFR 96.17(f)). 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. 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. As we stated in the *3.5 GHz R&O,* this is approach is consistent with our usual practice for new services.

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 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 (47 CFR 90.1337).

151. Discussion. We reject SIA's petition for reconsideration of the Commission's rules governing Citizens Broadband Radio Service operations near international borders. SIA raised similar objections when the Commission proposed this approach in the FNPRM and the Commission considered those arguments in reaching its decision. 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. 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. We sought further comment on additional protection measures for both in-band and out-of-band sites, addressed in detail below. 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 (47 CFR 96.17(d) and (e)).

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. 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. 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 (47 CFR 96.17(d)). SIA also requests that the Commission revise its 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.

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. 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 to refers to the existing 150 km circular zone as specified in section 90.1331(a) (47 CFR 90.1331(a)).

155. Google states that the registration requirements are reasonable and asks that the Commission reject SIA's request to eliminate this requirement. Google notes that the Citizens Broadband Radio Service rules are designed to protect actual users and that the annual registration requirement achieves this objective. 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. Google also requests that the Commission clarify that the registration requirement applies to grandfathered earth stations in the 3650–3700 MHz band.

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 (47 CFR 96.17). Operators of these sites must provide the same registration information as in-band FSS earth station licensees seeking protection (47 CFR 96.17(d)) 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 (47 CFR 96.17(d)). In order for the SAS to adequately protect FSS incumbents, it must be able to access 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 (47 CFR 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) (47 CFR 90.1331(a)) 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'' (47 CFR 96.21(c)). Thereafter, such earth stations would be protected under section 96.17 (47 CFR 96.17) using the same criteria applicable to ''similarly situated earth stations in the 3600–3650 MHz band'' (47 CFR 96.21(c)). 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 (47 CFR 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 (section 96.17(a)(1)).

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. 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. This aligns with the over-arching 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.

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. Second, as SIA itself notes, earth station operators already provide much of this information to IBFS. 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 (47 CFR 96.23(b), 96.33(b), 96.39(c)).

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 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.'' 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. 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 (47 CFR 96.25(c)). On multiple occasions prior to the *3.5 GHz R&O,* we sought comment on this ''use-it-or-share-it'' concept. 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. 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.

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. We asked proponents of an 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. 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.

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.'' 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. 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. 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. 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. 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. Federated Wireless and Microsoft argue that an economic definition of use will allow Priority Access Licensees to hoard spectrum and exclude legitimate GAA users. Sony contends that the economic approach would be inefficient and difficult to implement and would increase

uncertainty for GAA users. 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.

168. AT&T, CTIA, and Qualcomm argue for a definition of ''use'' that is not, strictly speaking, an economic or engineering approach. 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. 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. 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.

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. 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. According to Verizon, the Commission should accord Priority Access Licensees a rebuttable presumption that their coverage area showings are appropriate. WinnForum agrees with the proposal to allow operators to self-define their protected coverage areas.

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. According to Google, PAL protection areas should be supported by engineering analysis of actual operations and that documentation of such analysis should be submitted by the Priority Access Licensee at the time that the protection is requested.

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.

172. Federated Wireless contends that utilizing an engineering definition is consistent with the goals set forth by the Commission and is technologically feasible. 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. 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. 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.

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. WISPA and OTI/PK argue that the Commission should require SAS administrators to calculate service contours using the reported technical parameters and geo-location of registered CBSDs. 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. 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.'' 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.

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 (47 CFR 96.25). 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. 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. 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. 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. As Federated Wireless and WISPA correctly note, these approaches are not actually engineering definitions of use and are directly contrary to the purpose of the Commission's rules. 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. 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'' (47 U.S.C. 309(j)(4)(B)).

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, 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. 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.

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. 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. 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 (47 CFR 96.25). 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 (47 CFR 96.32). 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. 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 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. 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 (47 CFR 96.41, 96.43, 96.45). 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) (47 CFR 96.41(d)). 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. 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. 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.

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 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. 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). 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—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 (47 CFR 96.39(c)(2)).

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 (47 CFR 96.39(c)(2)). Registration information must include the requested authorization status (GAA or Priority Access) for each CBSD (47 CFR 96.39(c)(2)). We also require all CBSDs to inform the SAS of any changes in operational parameters or registration information, including requested authorization status (47 CFR 96.39(c)(2)). 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 (47 CFR 96.25(c)(1)(ii)). 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.'' 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. 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.'' 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 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. 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 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. 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.'' 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. 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.

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. Many commenters addressed secondary markets issues and generally supported a framework that would allow secondary market transactions involving PALs.

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. 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. 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.

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. 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 (47 CFR 20.22).

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. 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. AT&T further argues that flexible secondary markets will promote investment and innovation in this band. Most commenters urge the Commission to apply its secondary markets rules to the 3.5 GHz Band, 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. Verizon, for example, advocates forbearance from prior approval of PAL leases (and also license transfers) under section 310(d) of the Communications Act (47 U.S.C. 310(d)). 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.'' 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, 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. 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. 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. 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.

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. 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. 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.

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. Federated Wireless suggests a standardized electronic certification process could be 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. 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.

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. Key Bridge suggests that the SAS can help ensure transactions do not raise public interest risks.

207. Rajant and WISPA support a notice-only process. 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. WISPA states that by requiring notification to the SAS and not the Commission, the agency would have very few administrative burdens.

208. Key Bridge and Cantor Telecom suggest that the Commission assign all unsold PALs to the secondary market for resale. 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. Cantor Telecom supports a similar approach but suggests that the PAL remain available for GAA use until acquired on the secondary market.

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 within the scope of the PAL but outside of its PAL Protection Area. 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), including our section 310(d) (47 U.S.C. 310(d)) forbearance determinations that enabled us to introduce significant streamlining into the approval process for such transactions involving WRS common carrier licensees, apply with even greater force here, given the relatively short license terms and small License Areas of PALs. 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.

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)) (47 CFR 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. 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.

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—to 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; 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.

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) (47 CFR 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.

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.

215. Applicability of Existing Spectrum Leasing Rules to Priority Access Licensees. Priority Access Licensees may enter into spectrum manager leases in accordance with section 1.9020 (47 CFR 1.9020(e)(2)) of the Commission's rules, as amended in this order, and pursuant to the rules adopted herein. As required by section 1.9020 (47 CFR 1.9020(e)(2)), Priority Access Licensees must retain de facto and de jure 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.'' 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.

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. Basic qualifications that can be certified through this advance processing include, for example, the applicable foreign ownership eligibility criteria, character and other qualification requirements criteria applicable to the licensee, and eligibility under the Anti-Drug Abuse Act of 1988. 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, 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.

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), 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 (47 CFR 96.66), the lessee may commence operations. This is consistent with our current practice of allowing immediate processing for certain spectrum manager leasing arrangements, 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. As under our existing spectrum manager leasing rules, the Commission retains the right to investigate and terminate any such leasing arrangement if it 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.

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. 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. 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 (47 CFR 96.25).

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. 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 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. The Commission has allowed partitioning and disaggregation for many services, including Multipoint Distribution Service (MDS), General Wireless Communications Services (GWCS), 800 MHz and 900 MHz Specialized Mobile Radio (SMR), 39 GHz fixed point-to-point microwave, the Wireless Communications Service (WCS), PCS, the 700 MHz Band, and the AWS–3 Band.

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. 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. 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. In each of these services, the Commission also adopted 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.

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.'' 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. 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. 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. 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. The Information Technology Industry Council suggests that concerns regarding administrative burdens can be alleviated by permitting secondary markets without requiring prior Commission approval.

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. 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 (47 CFR 1.913). Although CTIA states that to the extent that Priority Access Licensees find value in partitioning 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. 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 licenses terms. 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.'' 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.''

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 he 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. For example, the rules governing 700 MHz band licenses, which service rules do allow partitioning and disaggregation (47 CFR 27.15), 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.

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 (47 CFR 1.948). While certain assignments and transfers of control do not require prior Commission approval, the assignor must file an application for Commission approval regardless (47 CFR 1.948(c)).

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. AT&T, Verizon, and WISPA, also support voluntary spectrum exchanges. 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. 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. 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.

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. AT&T, Google, and WISPA state that the Commission should neither prohibit not require an SAS to operate as a spectrum exchange. 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.

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. This approach is consistent with the Commission's general approach of relying on market processes where possible in regard to secondary markets. 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. 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). 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. However, for a variety of reasons, the Commission decided it would not include the 3.5 GHz Band in the spectrum screen. 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.

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. For the same reasons, AT&T opposes applying the attribution standard in existing rules to PALs, 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 be equitable since by its nature, PALs will likely not be in use full time by the licensee. 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.

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. This finding was based on the unique characteristics of the band, including multiple tiers of many users and short license terms. 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 many not hold more than 40 megahertz of the maximum of the 70 megahertz of Priority Access spectrum in each License Area. 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. 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* (47 CFR 20.22). These controlling and non-controlling interests delineated in section 20.22 (47 CFR 20.22) shall be attributable to applicants for licenses and parties to leasing arrangements in the 3.5 GHz Band.

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 (47 CFR 2.106). In the *3.5 GHz R&O,* we adopted rules that require CBSDs to protect existing in-band FSS earth stations from interference (47 CFR 96.17). 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) (47 CFR 96.17). 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. Therefore, in the *Second FNPRM,* we sought comment on specific approaches to calculating and implementing FSS protections.

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.

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. 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.

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. 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. 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. 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. 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. 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.

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. 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. 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.

246. In its reply comments, Google proposes a seven step methodology for calculating interference protection for FSS earth stations. 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.

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. 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.

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. 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) (47 CFR 25.209(a)), system noise temperature of 142.8 K, polarization (linear or circular), and receive bandwidth (40 kHz–36 MHz).

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. 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 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.

250. SIA supports the adoption of protection criteria that use worst-case assumptions rather than real-world deployment conditions. 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. 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.

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. 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.

(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. We agree with commenters that argue that the information submitted by registered CBSDs 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. The approach advocated by Google and Federated Wireless is consistent with 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.''

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. 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 (47 CFR 0.459). Indeed, SIA itself notes that much of the information that FSS earth station licensees must register under section 96.17 (47 CFR 96.17) is already registered with the Commission in IBFS. 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. 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. 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.

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. We sought comment on the applicability and use of this methodology in the *Second FNPRM.* 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. 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 (47 CFR 25.209(a)). Those rules specified an envelope of maximum FSS antenna gain as a function of the angle (in degrees) from the main lobe (47 CFR 25.209(a)(1) and (4)). 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. Specifically, we adopt the use of section 25.209(a)(1) and (4) (47 CFR 25.209(a)(1) and (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). This value was originally derived from SIA's filings in the 3650–3700 MHz proceeding. 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. We believe that these approaches—or elements thereof—may be used to establish consistent, flexible, and effective 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 47 CFR 25.209(a). 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.

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. This value is derived from ITU–R S.1432–1. Google proposes that interference into FSS earth stations should not exceed 6% of the system noise temperature, corresponding to I/N of −12 dB. 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. 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.

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. 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. 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). 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. 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.

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. 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. 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.

(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. 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. As noted above, there are also some commenters that believe this criterion is overly conservative. 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. 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. 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. 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 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) (47 CFR 96.17(f)).

269. Reference FSS RF Filter. In the NPRM, we sought comment on methods of mitigating out-of-band interference from CBSDs. In the FNPRM, we specifically sought comment on the use of filters to reduce or eliminate interference from out-of-band sources. In the *Second FNPRM,* we instructed commenters to assume the use of appropriate, commercially available earth station receiver input filters when performing interference analyses. 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. 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. 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. 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.

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. Based on the filings in the record regarding 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 (47 CFR 96.17). While much of the record has been focused on the effects of co-channel interference and OOBE 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. Indeed, the Commission specifically sought comment on the point at which even significantly reduced OOBE limits would cease to provide additional protection benefits due to these blocking effects. 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. 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. 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. 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.'' 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'' 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, which differs from the median value cited by SIA by only 1 dB. Because we are basing the 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. We tentatively concluded that each SAS must use the same propagation model.

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. AT&T advocates the use of uniform models across SASs, 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 SASs need to communicate with each other, and would prevent conflicting spectrum assignments between users served by different SASs. 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.

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. 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. 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 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.

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. 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.

(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.

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. 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. 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. Utilizing a free space model or another model that does not account for real 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. 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. 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.

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.

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. Google argues that a variety of approaches 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. 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. Google states that regardless of how the Commission chooses to protect aggregate effects, it is important for the Commission to do so.

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. 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. 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.'' 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.

(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 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.

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. In the *Second FNPRM,* we sought further comment on whether any measures in addition to the OOBE 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.

290. SIA argues that C-Band earth stations should be protected from OOBE 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. GCI supports this position and argues that this strict protection criteria is necessary to protect critical services provided by C-Band users. 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. 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. In addition, SIA notes that C-Band satellites are required to locate their TT&C operations close to the 3700 MHz band-edge.

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. 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.'' 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.'' According to Google, such grossly conservative interference thresholds would needlessly constrain deployment of CBSDs in the 3.5 GHz Band by restricting harmless emissions.

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

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. 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. 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. Federated Wireless also disagrees with the assumptions and engineering inputs applied in the Alion analysis. 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 CBSD operating frequencies; and (7) overly conservative interference thresholds. 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'').

294. Google also takes issue with the assumptions and methodologies put forth by the Content Interests and Alion. 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. 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. 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.

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.

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 (47 CFR 96.17).

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 commenters about the potential for harmful interference into C-Band FSS earth stations with the stringent OOBE 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 (47 CFR 90.1301 through 90.1338). 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 (47 CFR 25.202(g)). As a result, according to SIA, C-Band satellites frequently rely on a telemetry carrier near 3700 MHz. 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) (47 CFR 25.202(g)). 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. 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.'' 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 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. Similarly, we reject SIA's modelling

approach which is based on an even more stringent I/N of −23 dB. 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.'' 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 (47 CFR 96.17(f)). 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 (47 CFR 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 (47 CFR 96.17(f)). 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. We expect that, in an 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. We sought comment on how such protection could be practically implemented without burdensome equipment authorization requirements, necessitating changes to our part 2 rules (47 CFR 2.1, *et seq.*), and whether it could be achieved by defining a small number of classes of devices that are distinguished by increasingly stringent OOBE limits.

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. 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.

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 (47 CFR 96.41(e)). 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.

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. 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.

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.'' Further, SIA states that regardless of whether manufacturers choose to market devices that perform better than is required by OOBE limits, the devices would still need to be certified to provide consumers with adequate assurances about a given device's performance. Qualcomm expressly asks the Commission to reject Google's proposal, arguing that since the OOBE 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 OOBE 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*.'' 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 OOBE limits, it should first ''verify that satellite receiver blocking is 'not' the actual limiting factor, in which case more stringent OOBE limits would not help and would be an unnecessary

regulatory burden.'' Google counters Qualcomm's arguments claiming that Qualcomm appears to misunderstand Google's proposal, because no CBSD would be required to meet more stringent OOBE requirements than set forth in part 96. Instead, manufacturers would have the option to build devices that outperform baseline requirements.

b. Discussion

308. We decline to make changes to our existing equipment certification process or the rules governing OOBE 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 OOBE.

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 OOBE capabilities and we may revisit this issue in the future.

V. Procedural Matters

A. Regulatory Flexibility Analysis

310. Pursuant to the Regulatory Flexibility Act of 1980, as amended, the Commission included a Final Regulatory Flexibility Analysis in the Report and Order (see *https://ecfsapi.fcc.gov/file/60001755029.pdf*).

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 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, we seek specific comment on how we might ''further reduce the information collection burden for small business concerns with fewer than 25 employees.''

Final Regulatory Flexibility Analysis

312. As required by the Regulatory Flexibility Act of 1980 (5 U.S.C. 603–604), 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**.

313. As required by the RFA, 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.

C. Need for, and Objectives of, the Rules

314. 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.

315. 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.

316. 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.

317. 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.

318. 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.

319. 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.

D. Legal Basis

320. 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.

E. Description and Estimate of the Number of Small Entities To Which the Rules Will Apply

321. 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. The RFA generally defines the term ''small entity'' as having the same meaning as the terms ''small business,'' ''small organization,'' and ''small governmental jurisdiction.'' In addition, the term ''small business'' has the same meaning as the term ''small business concern'' under the Small Business Act. 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.

322. 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. As of 2010, there were 28.2 million small businesses in the United States, according to the SBA. Additionally, a ''small organization'' is generally ''any not-for-profit enterprise which is independently owned and operated and is not dominant in its field.'' Nationwide, as of 2007, there were approximately 1,621,315 small organizations. 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.'' Census Bureau data for 2007 indicate that there were 89,527 governmental jurisdictions in the United States. We estimate that, of this total, as many as 88,761 entities may qualify as ''small governmental jurisdictions.'' Thus, we estimate that most governmental jurisdictions are small.

323. 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. The appropriate size standard under SBA rules is for the category Wireless Telecommunications Carriers. The size standard for that category is that a business is small if it has 1,500 or fewer employees. 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. 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.

324. 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. Under the ''Other Telecommunications'' category, a business is considered small if it had $32.5 million or less in annual receipts.

325. 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.'' 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. Of this total, 482 firms had annual receipts of under $25 million.

326. 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.'' For this category, Census Bureau data for 2007 show that there were a total of 2,383 firms that operated for the entire year. Of this total, 2,346 firms had annual receipts of under $25 million. 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.

327. 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.

328. 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.'' The SBA has developed a small business size standard for firms in this category, which is: All such firms having 750 or fewer employees. According to Census Bureau data for 2010, there were a total of 810 establishments in this category that operated for the entire year. Of this total, 787 had employment of under 500, and an additional 23 had employment of 500 to 999. Thus, under this size standard, the majority of firms can be considered small.

F. Description of Projected Reporting, Recordkeeping, and Other Compliance Requirements for Small Entities

329. 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.

330. 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.

331. *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 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.

332. 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.

G. Steps Taken To Minimize Significant Economic Impact on Small Entities, and Significant Alternatives Considered

333. 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.

334. 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.

335. *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 immediate access to spectrum to implement their business plans with reduced regulatory delay and transaction costs.

H. Federal Rules That May Duplicate, Overlap, or Conflict With the Final Rules

336. None.

I. Report to Congress

337. 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. 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 (5 U.S.C. 603(a)). A copy of this *Second Report and Order and Order on Reconsideration* and FRFA (or summaries thereof) will be published in the **Federal Register** (5 U.SC. 603(a)).

J. Congressional Review Act

338. 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

339. 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 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 document in the **Federal Register** announcing such approval and the relevant effective date.

340. *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 CFR 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.

341. *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.

List of Subjects

47 CFR Part 1

Administrative practice and procedure, Communications common carriers, Telecommunications.

47 CFR Part 2

Communications equipment, Telecommunications.

47 CFR Part 96

Telecommunications, Radio.

Federal Communications Commission.

Marlene H. Dortch,

Secretary.

Final Rules

For the reasons discussed in the preamble, the Federal Communications Commission amends 47 CFR parts 1, 2, and 96 as follows:

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, 160, 201, 225, 227, 303, 309, 332, 1403, 1404, 1451, 1452, and 1455.

■ 2. Section 1.9005 is amended by adding paragraph (p) 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 by revising paragraph (e) 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 of this chapter, 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) 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 § 96.32 of this chapter, a Priority Access Licensee, as defined in § 96.3 of this chapter, 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 § 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 manger leasing arrangement with a Priority Access Licensee, as defined in § 96.3 of this chapter and maintain the accuracy of such certifications.

(1) Priority Access Licensees, as defined in § 96.3 of this chapter, 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 § 1.9020(e) must submit notification of the leasing arrangement to the Spectrum Access System Administrator, as defined in § 96.3 of this chapter, by electronic filing. The notification shall include the following information:

(1) Lessee contact information including name, address, telephone number, fax number, email 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 (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 § 96.3 of this chapter, provided that the licensee notifies the Spectrum Access System Administrator, as defined in § 96.3 of this chapter, 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 is amended in the footnote for US107 by revising paragraph (a) to read as follows:

§ 2.106 Table of frequency allocations.

* * * * *

United States (US) Footnotes

* * * * *

US107 * * *

(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.

* * * * *

PART 96—CITIZENS BROADBAND RADIO SERVICE

■ 7. The authority citation for part 96 continues to read as follows:

Authority: 47 U.S.C. 154(i), 303, and 307.

■ 8. Section 96.3 is amended by adding the definition for ''PAL Protection Area'' in alphabetical order 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 § 96.25 (or smaller, self-reported protection contour). This area will be protected from interference in accordance with §§ 96.25 and 96.41(d).

* * * * *

■ 9. Section 96.15 is amended by revising paragraphs (a)(4) and (b)(4) to read as follows:

§ 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.

■ 10. Section 96.17 is amended by revising the section heading and paragraphs (a), (b), and (e) and by adding paragraphs (d)(1)(vi) and (f) to read as follows:

§ 96.17 Protection of existing fixed satellite service (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 *www.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 § 2.106 of this chapter.

(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 § 96.21(c) are satisfied.

(2) *Co-channel.* The aggregate passband radiofrequency (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 root mean square (RMS) value of −129 dBm/MHz. The reference antenna system requires SAS to calculate antenna gain using § 25.209(a)(1) and (4) of this chapter, and a reference RF filter between the feed-horn and low noise amplifier (LNA)/low noise block

downconverter (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 (4) of this chapter, 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 *www.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 § 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 (4) of this chapter, 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 (4) of this chapter, 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 to150 MHz below the lower edge of the FSS earth station's authorized passband.

* * * * *

(d) * * *

(1) * * *

(vi) Whether the earth station is used for satellite telemetry, tracking, and control (for earth stations in the 3700–4200 MHz band).

* * * * *

(e) CBSDs may operate within areas that may cause interference to FSS earth stations, in excess of the levels described in § 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 §§ 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 § 96.17(a)(3) or (b)(2) as appropriate for the 3600–3700 or 3700–4200 MHz band.

■ 11. Section 96.21 is amended by revising paragraph (c) 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 47 CFR 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 § 96.17 applicable to FSS earth stations in the 3600–3700 MHz band shall apply.

■ 12. Section 96.25 is amended by revising paragraph (c) 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 § 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 §§ 96.39, 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.

■ 13. Section 96.29 is amended by revising paragraph (d) 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.

■ 14. Section 96.31 is revised 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) 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 paragraph (a) of this section.

■ 15. Add § 96.32 to subpart C 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 § 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.

■ 16. Section 96.35 is amended by revising paragraph (a) 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 § 96.25(c).

* * * * *

■ 17. Section 96.41 is revised to read as follows:

§ 96.41 General radio requirements.

The requirements in this section apply to CBSDs and their associated End User Devices, unless otherwise specified.

(a) *Digital modulation.* Systems operating in the Citizens Broadband Radio Service must use digital modulation techniques.

(b) *Power limits.* Unless otherwise specified in this section, the maximum effective isotropic radiated power (EIRP) and maximum Power Spectral Density (PSD) of any CBSD and End User Device must comply with the limits shown in the table in this paragraph (b):

Device	Maximum EIRP (dBm/10 megahertz)	Maximum PSD (dBm/MHz)
End User Device	23	n/a
Category A CBSD	30	20
Category B CBSD [1]	47	37

[1] Category B CBSDs will only be authorized for use after an ESC is approved and commercially deployed consistent with §§ 96.15 and 96.67.

(c) *Power management.* CBSDs and End User Devices shall limit their operating power to the minimum necessary for successful operations.

(1) CBSDs must support transmit power control capability and the capability to limit their maximum EIRP and the maximum EIRP of associated End User Devices in response to instructions from an SAS.

(2) End User Devices shall include transmit power control capability and the capability to limit their maximum EIRP in response to instructions from their associated CBSDs.

(d) *Received Signal Strength Limits.* (1) For both Priority Access and GAA users, CBSD transmissions must be managed such that the aggregate received signal strength 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.

(2) These limits shall not apply for co-channel operations at the boundary between geographically adjacent PALs held by the same Priority Access Licensee.

(e) *3.5 GHz Emissions and Interference Limits*—(1) *General protection levels.* Except as otherwise specified in paragraph (e)(2) of this section, 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.* (i) Compliance with this provision is based on the use of measurement instrumentation employing a resolution bandwidth of 1 megahertz or greater. However, in the 1 megahertz bands immediately outside and adjacent to the licensee's authorized frequency channel, a resolution bandwidth of no less than one percent of the fundamental emission bandwidth may be employed. A narrower resolution bandwidth is permitted in all cases to improve measurement accuracy provided the measured power is integrated over the full reference bandwidth (*i.e.,* 1 MHz or 1 percent of emission bandwidth, as specified). The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power.

(ii) When measuring unwanted emissions to demonstrate compliance with the limits, the CBSD and End User Device nominal carrier frequency/channel shall be adjusted as close to the licensee's authorized frequency block edges, both upper and lower, as the design permits.

(iii) Compliance with emission limits shall be demonstrated using either average (RMS)-detected or peak-detected power measurement techniques.

(4) When an emission outside of the authorized bandwidth causes harmful interference, the Commission may, at its discretion, require greater attenuation than specified in this section.

(f) *Reception limits.* Priority Access Licensees must accept adjacent channel and in-band blocking interference (emissions from other authorized Priority Access or GAA CBSDs transmitting between 3550 and 3700 MHz) up to a power spectral density level not to exceed −40 dBm in any direction with greater than 99% probability when integrated over a 10 megahertz reference bandwidth, with the measurement antenna placed at a height of 1.5 meters above ground level, unless the affected Priority Access

Licensees agree to an alternative limit and communicates that to the SAS.

Note to paragraph (f): Citizens Broadband Radio Service users should be aware that there are Federal Government radar systems in the band and adjacent bands that could adversely affect their operations.

(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.

■ 18. Section 96.53 is amended by revising paragraph (i) and by adding paragraph (o) 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 § 96.25.

* * * * *

(o) To receive reports of interference and requests for additional protection from Incumbent Access users and promptly address interference issues.

■ 19. Section 96.57 is amended by adding paragraph (e) 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 § 96.25 and such calculation and enforcement shall be consistent across all SASs.

■ 20. Add § 96.66 to subpart F 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 § 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.

[FR Doc. 2016–14505 Filed 7–25–16; 8:45 am]

BILLING CODE 6712–01–P