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

In the Matter of	)	
Amendment of the Commission's Rules with Regard to Commercial Operations in the 3550-3650 MHz Band	)	GN Docket No. 12-354
	)	

NOTICE OF PROPOSED RULEMAKING AND ORDER

Adopted: December 12, 2012 **Released: December 12, 2012**

Comment Date: February 20, 2013

Reply Date: March 22, 2013

By the Commission: Chairman Genachowski and Commissioners McDowell, Clyburn, Rosenworcel, and Pai issuing separate statements.

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I. INTRODUCTION AND EXECUTIVE SUMMARY

1. With this *Notice of Proposed Rulemaking* (*Notice*), we propose to create a new Citizens Broadband Service in the 3550-3650 MHz band (3.5 GHz Band) currently utilized for military and satellite operations, which will promote two major advances that enable more efficient use of radio spectrum: *small cells* and *spectrum sharing*. The 3.5 GHz Band was identified by the National Telecommunications and Information Administration (NTIA) for shared federal and non-federal use in the 2010 Fast Track Report.[1] Our proposal builds on our experience with spectrum sharing in the television white spaces (TVWS), proposes ideas teed up in our recent *Notice of Inquiry* on Dynamic Spectrum Access technologies, and broadly reflects recommendations made in a recent report by the President's Council of Advisors on Science and Technology (PCAST).[2] We also seek comment on whether to include under these proposed new, flexible rules the neighboring 3650-3700 MHz band, which is already used for commercial broadband services.[3] Together, these proposals would make up to

[1] *See* NTIA, An Assessment of the Near-Term Viability of Accommodating Wireless Broadband Systems in the 1675-1710 MHz, 1755-1780 MHz, 3500-3650 MHz, 4200-4220 MHz, and 4380-4400 MHz Bands (rel. October 2010) (Fast Track Report), *available at* http://www.ntia.doc.gov/files/ntia/publications/fasttrackevaluation_11152010.pdf.

[2] *See* Unlicensed Operation in the TV Broadcast Bands; Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band, ET Docket No. 04-186, *Second Memorandum Opinion and Order*, 25 FCC Rcd 18661 (2010) (*White Spaces Second Memorandum Opinion and Order*); Promoting More Efficient Use of Spectrum Through Dynamic Spectrum Use Technologies, ET Docket 10-237, *Notice of Inquiry*, 25 FCC Rcd 16632 (2010) (*Dynamic Spectrum NOI*); PCAST, Report to the President: Realizing the Full Potential of Government-Held Spectrum to Spur Economic Growth (rel. July 20, 2012) (PCAST Report), *available at* http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast_spectrum_report_final_july_20_2012.pdf.

[3] *See* 47 C.F.R. Part 90 Subpart Z; Wireless Operations in the 3650-3700 MHz Band, ET Docket No. 04-151, *Report and Order and Memorandum Opinion and Order*, 20 FCC Rcd 6502 (2005) (*3650-3700 MHz Report and Order and Memorandum Opinion and Order*).

150 megahertz of contiguous spectrum available for innovative mobile and fixed wireless broadband services without displacing mission-critical incumbent systems.

2. Demand for wireless broadband capacity is growing much faster than the availability of new spectrum. While the Commission and the President have outlined a path for nearly doubling the amount of available spectrum for fixed and wireless broadband uses, some experts forecast a need for a thousand-fold increase in wireless capacity by 2020.[4] To meet this demand, future generations of wireless technology and services must continue to increase their yield of bits per hertz per second. Future wireless traffic demands also require new wireless network architectures and new approaches to spectrum management.

3. The PCAST Report identifies two technological advances as holding great promise for increasing our nation's wireless broadband capabilities. First, increased use of small cell network deployments can multiply wireless capacity within existing spectrum resources.[5] Second, increased spectrum sharing can make large swaths of otherwise "stovepiped" spectrum—nationwide bands set aside for important, but localized, government and non-government uses—newly available for broadband use.[6] The proposed Citizens Broadband Service would foster the widespread utilization of both of these technological advances and promote the efficient use of the 3.5 GHz Band.

4. Small cells are low-powered wireless base stations intended to cover targeted indoor or localized outdoor areas ranging in size from homes and offices to stadiums, shopping malls, hospitals, and metropolitan outdoor spaces. Typically, they provide wireless connectivity in areas that present capacity and coverage challenges to traditional wide-area macrocell networks. Small cells can be deployed relatively easily and inexpensively by consumers, enterprise users, and service providers. Networks that incorporate small cell technology can take advantage of greater "reuse" of scarce wireless frequencies, greatly increasing data capacity within the network footprint. For example, deploying ten small cells in a location in place of a single macro cell could result in a tenfold increase in capacity, using the same quantity of spectrum. Small cells can also be used to help fill in coverage gaps created by buildings, tower siting difficulties, and/or challenging terrain.

5. Spectrum sharing in this context refers to the use of automated techniques to facilitate the coexistence of disparate unaffiliated spectrum dependent systems that would conventionally require separate bands to avoid interference. Such coexistence may happen, for example, by authorizing targeted use of new commercial systems in specific geographical areas where interference into incumbent systems is not a problem. The need to minimize interference risks has caused, over time, much spectrum to be reserved for "high value" systems that protect national security, safety of life, etc. For example, the military may need spectrum for advanced radar systems or hospitals may deploy networks to enable real-time monitoring of patient vital signs. However, many of these uses are highly localized in nature. Therefore, more agile technologies and sharing mechanisms could potentially allow large quantities of special-purpose federal and non-federal spectrum to be used for more general purposes, such as commercial broadband services, on a shared basis.

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[4] *See, e.g.*, QUALCOMM, Rising to Meet the 1000X Mobile Data Challenge (October 29, 2012) (QUALCOMM 1000X Data Challenge Presentation), *available at* http://www.qualcomm.com/media/documents/rising-meet-1000x-mobile-data-challenge; Nokia Siemens Networks, 2020: Beyond 4G Radio Evolution for the Gigabit Experience 3, (Nokia Siemens 4G White Paper), *available at* http://www.nokiasiemensnetworks.com/sites/default/files/document/nokia_siemens_networks_beyond_4g_white_paper_online_20082011_0.pdf.

[5] PCAST Report at vi, 17-20.

[6] *Id.* at vi ("If the Nation instead expands its options for managing federal spectrum, we can transform the availability of a precious national resource —spectrum—from scarcity to abundance.").

~~6.~~ The 3.5 GHz Band appears to be an ideal band in which to propose small cell deployments and shared spectrum use. The NTIA Fast Track Report identified the 3.5 GHz Band for potential shared federal and non-federal broadband use.[7] Incumbent uses in the band include high powered Department of Defense (DoD) radars[8] as well as non-federal Fixed Satellite Service (FSS) earth stations for receive-only, space-to-earth operations and feeder links.[9] In the adjacent band below 3550 MHz there are high-powered ground and airborne military radars.[10] The Fast Track Report recommended, based on the commercial wireless broadband technology that was assessed,[11] that new commercial uses of the band occur outside of large "exclusion zones," which we estimate to cover approximately 60 percent of the U.S. population, to protect government operations.[12] For this reason, and because of limited signal propagation at 3.5 GHz, the commercial wireless industry has expressed a viewpoint that the 3.5 GHz Band would not be particularly well-suited for macrocell deployment,[13] with some suggesting that it might be more appropriate for fixed wireless or unlicensed use.[14] We agree with the PCAST Report that the perceived disadvantages of the 3.5 GHz Band might be turned into advantages from the standpoint of promoting spectrum sharing and small cell innovation. Such a paradigm could vastly increase the usability of the band for wireless broadband.[15]

7. We propose to structure the Citizens Broadband Service according to a multi-tiered shared access model that reflects the PCAST recommendation. We propose that the Citizens Broadband Service be managed by a spectrum access system (SAS) incorporating a dynamic database and, potentially, other interference mitigation techniques. The SAS would ensure that Citizens Broadband Service users operate only in areas where they would not cause harmful interference to incumbent users and could also help manage interference protection among different tiers of Citizens Broadband Service users. The three tiers of service would be: (1) Incumbent Access; (2) Priority Access; and (3) General Authorized Access (GAA). We seek comment on this approach. In addition, consistent with the Fast

[7] Fast Track Report at v, 1-6.

[8] There are many types of military radars operating in the 3.5 GHz Band (*e.g.*, shipborne, groundbased, etc.). For purposes of the *Notice*, the term "DoD radar" refers generally to all of the radar systems in the 3.5 GHz Band. The term "Navy radar" refers only to shipborne radars operating in the 3.5 GHz Band. Other specific radar systems (*e.g.* "DoD ground-based radar") are specifically referenced as necessary.

[9] *Id.* at 3-30 – 3-33.

[10] 47 C.F.R. § 2.106.

[11] The Fast Track Report's recommendations for the 3.5 GHz Band were based on an assessment of commercial deployment of Worldwide Interoperability for Wireless Microwave (WiMAX) equipment in the band.

[12] .*See* Fast Track Report at 1-6 – 1-7 and Appendix D. Commission staff developed an estimate of the US population residing within exclusion zones by first making an approximation of the average exclusion zone distance from the shoreline on the East coast, Gulf coast, and West coast from the Fast Track report. Then, using geospatial data, including census block population estimation data (from the year 2012), and a more fine-grained definition of the US shoreline, we determined the population in census blocks within the average distance of the closest shoreline. We then compared this number to the total US population of 316 million. The result of this analysis is an approximation of 60%.

[13] Comments of CTIA – The Wireless Association, Spectrum Task Force Requests Information on Frequency Bands Identified by NTIA as Potential Broadband Spectrum, ET Docket No. 10-123, at 9-10 (filed April 22, 2011) (CTIA Spectrum Task Force Comments).

[14] Comments of AT&T, Spectrum Task Force Requests Information on Frequency Bands Identified by NTIA as Potential Broadband Spectrum, ET Docket No. 10-123, at 7 (filed Apr. 22, 2011) (AT&T Spectrum Task Force Comments).

[15] PCAST Report at 16-21, 82-84.

Track Report, we propose to protect existing federal systems operating in the 3.5 GHz Band and seek comment on appropriate allocation models to accomplish the goals set forth in this *Notice.* Qualcomm, Inc. has proposed a similar multi-tiered framework, which it calls "Authorized Shared Access," and we also seek comment on this concept.[16]

8. We propose that the Incumbent Access tier would consist solely of authorized federal and grandfathered licensed FSS 3.5 GHz Band users. These Incumbent Access users would be protected from harmful interference from Citizens Broadband Service users through appropriate regulatory and technical means. Citizens Broadband Service users would not be permitted to operate within geographically designated Incumbent Use Zones, which would encompass the geographic area where low-powered small cells could cause harmful interference to incumbent operations. ~~We seek comment on whether the use of small cell technology incorporating lower power levels and other distinguishing technical characteristics compared to higher power cellular architecture systems could significantly reduce the exclusion zones proposed in NTIA's Fast Track Report~~. Outside of these zones, the SAS would manage Citizens Broadband Service access and would ensure that lower tiered users would not operate in a manner that would cause harmful interference to federal and FSS users in the 3.5 GHz Band.

9. The Priority Access tier would consist of a portion of the 3.5 GHz Band designated for small cell use by certain critical, quality-of-service dependent users at specific, targeted locations. We seek comment on who these eligible users should be and suggest that they could include hospitals, utilities, state and local governments, and/or other users with a distinct need for reliable, prioritized access to broadband spectrum at specific, localized facilities. We expect that the availability of the Priority Access tier could bring the benefits of mass-market commercial scale to specialized uses and provide a new alternative to dedicated spectrum, which is in short supply. In order to prevent an expectation of quality of service in areas where such an expectation might not be warranted, Priority Access operations would only be permitted in geographic zones with no likelihood of harmful interference from Incumbent Access users and no expectation of harmful interference from Citizens Broadband Service users to Incumbent Access users. Priority Access users would be required to register in the SAS and accorded protection from interference from lower tier users and other Priority Access users within their local facilities.

10. The General Authorized Access (GAA) tier would be assigned for use by the general public on an opportunistic, non-interfering basis within designated geographic areas. GAA users could include a wide range of residential, business, and others, including wireless telephone and Internet service providers. We propose to authorize GAA use in zones where small cell use would not interfere with incumbent operations. Unlike the Priority Access tier, we propose to allow GAA use in areas where some interference from incumbent operations might be expected. We also propose that GAA users be required to register in the SAS and comply with all applicable technical, regulatory, and enforcement rules to ensure that GAA users avoid causing harmful interference to Incumbent Access and Priority Access users and always accept harmful interference from such users. We also seek comment on whether federal entities could be authorized GAA users. We seek comment on what technologies could be used to enable effective GAA use of the 3.5 GHz Band.

11. Under our main proposal, users in the Priority Access and GAA tiers would be licensed by rule as Citizens Broadband Service users under Part 95 of the Commission's rules. A license-by-rule

[16] Comments of Qualcomm, Inc., Spectrum Task Force Requests Information on Frequency Bands Identified by NTIA as Potential Broadband Spectrum, ET Docket No 10-123, at ii-iv (filed Apr. 22, 2011) (Qualcomm Spectrum Task Force Comments). We note that the European Union is considering a similar sharing concept, which it calls "Licensed Shared Access" (LSA). *See* Radio Spectrum Policy Group, Report on Collective Use of Spectrum (CUS) and Other Spectrum Sharing Approaches (Nov. 2011), *available at* http://rspg.ec.europa.eu/_documents/documents/meeting/rspg26/rspg11_392_report_CUS_other_approaches_final.pdf.

approach would provide individuals, organizations, and service providers with "automatic" authorization to deploy small cell systems, in much the same way that our Part 15 unlicensed rules have allowed widespread deployment of Wi-Fi access points. In the present context, we believe licensing by rule provides two advantages compared to unlicensed authorization. First, as a licensed service, 3.5 GHz Band operations would enjoy greater interference protection status in the Table of Frequency Allocations consistent with the proposed multi-tiered approach. Second, licensing by rule might allow for a more unified authorization framework for multiple tiers of users that otherwise might fall into different parts of the Commission's rules. We seek comment on whether the proposed framework could be implemented through other regulatory approaches, including through the Part 15 unlicensed rules or through geographic area licensing. We also seek comment on the benefits that could accrue to federal users through use of the Citizens Broadband Service.

12. We also offer a supplemental proposal to integrate the 3650-3700 MHz band within the proposed Citizens Broadband Service, thereby encompassing an additional 50 megahertz of contiguous spectrum. The Commission currently licenses the 3650-3700 MHz band on a non-exclusive basis, with protections for incumbent FSS operations. The 3650-3700 MHz band is used extensively by wireless Internet service providers (WISPs), among others, to provide commercial broadband service. Expanding the Citizens Broadband Service to include this band could bring benefits of greater spectrum availability and equipment scale economies to current 3650-3700 MHz licensees. Under our proposal, the SAS would authorize existing licensees as GAA users in the larger, combined band, and would authorize higher power levels in less congested areas, provided there is no risk of harmful interference to Incumbent Access or Priority Access operations. This proposal contemplates conversion of the existing non-exclusive licensing framework to the license-by-rule framework proposed herein. We also note that the 3650-3700 MHz band is currently allocated on a primary basis to the federal radiolocation service in three locations. We seek comment on the potential impact of these proposed changes in the use of the 3650-3700 MHz band on these and other incumbent operations.

13. If implemented, the new Citizens Broadband Service could help address the ongoing capacity shortage and promote new innovations in broadband technology, deployment, and spectrum management while protecting incumbent authorized federal and grandfathered FSS users. In order to develop a comprehensive record on this proposal, we seek comment on a wide range of technical, licensing, and other related issues. To that end, we seek comment on: (1) appropriate licensing schemes; (2) specific flexible and resilient interference mitigation technologies and techniques that could be implemented by Citizens Broadband Service users; (3) appropriate deployment strategies for Citizens Broadband Service devices; and (4) the SAS dynamic database that is envisioned to manage access to and use of the 3.5 GHz Band. To ensure the development of a comprehensive record, we may release additional notices, analyses, or white papers for comment during the course of this proceeding. Moreover, because this proceeding raises significant novel technical issues with respect to sharing with federal users, we expect to work closely with NTIA and relevant federal agencies to perform necessary further analysis, and we encourage commenters to provide relevant technical input to inform this analysis, where appropriate.

II. BACKGROUND

A. Spectrum Policy Objectives

14. The Commission recognizes the shortage of available spectrum for commercial broadband uses in this country and the urgent need to make additional spectrum available while respecting the ongoing spectrum needs of incumbent users. Notably, Cisco projects a compound annual growth rate in North American mobile data traffic of 75% between 2011 and 2016,[17] resulting in a

[17] *See* Cisco Systems Inc., Cisco Visual Networking Index: Forecast and Methodology, 2011-2016 (May 30, 2012), *available at* http://www.cisco.com/en/US/solutions/collateral/ns341/ns525/ns537/ns705/ns827/white_paper_c11- (continued….)

roughly sixteen-fold increase in mobile broadband traffic by 2016.[18] Indeed, some industry experts are anticipating the need for 1,000 times the current levels of mobile broadband capacity in the near future.[19] It is essential that government and the private sector work together to find creative solutions to address this growing need. To that end, the Commission has worked with NTIA, the private sector, and other federal agencies to identify spectrum bands that could be designated for dedicated use by commercial entities or shared with existing users.

15. The National Broadband Plan put forth a set of comprehensive policy recommendations to unleash the benefits of wireless broadband access for all Americans. These recommendations included: (1) making 500 megahertz of spectrum available for broadband use by 2020, with 300 megahertz between 225 MHz and 3.7 GHz to be made available for mobile broadband use by 2015; (2) freeing up additional spectrum for unlicensed use; (3) encouraging the development of opportunistic technologies to enable dynamic shared access to spectrum; and (4) initiating proceedings to enhance research and development to advance the science of spectrum access.[20] The National Broadband Plan also recommended that the Commission and NTIA work together to identify federal and non-federal spectrum that can be made accessible for both mobile and fixed wireless broadband use, on an exclusive, shared, licensed, and/or unlicensed basis.[21]

16. On June 28, 2010, President Obama released a Presidential Memorandum entitled "Unleashing the Wireless Broadband Revolution" which set forth the Administration's wireless broadband policy goals.[22] The Presidential Memorandum explained that expanding access to wireless broadband would lead to the creation of new businesses, increase productivity, improve public safety, and foster innovation in areas such as mobile telemedicine, distance learning, and telework.[23] Moreover, it predicted that increased broadband access and the development of new mobile technologies would create a virtuous cycle of technological innovation that would continually improve access and services for all Americans.[24] Further, the Memorandum instructed all executive branch departments, agencies, and offices, and strongly encouraged independent agencies, to take aggressive steps, working with the FCC, to unleash access to wireless spectrum for commercial broadband uses, including the identification of spectrum bands that could be made available for shared federal and non-federal services within 10 years, while ensuring no loss of critical government capabilities.[25] To that end, the Memorandum encouraged the FCC to work with NTIA to make 500 megahertz of spectrum suitable for fixed and mobile broadband available for commercial wireless services on an exclusive licensed or shared basis and to work with the NTIA to complete a plan for making such spectrum available by October 1, 2010.[26]

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481360_ns827_Networking_Solutions_White_Paper.html.

[18] *Id.;* Prepared Remarks of FCC Chairman Julius Genachowski, Winning the Global Bandwidth Race: Opportunities and Challenges for Mobile Broadband (October 4, 2012), *available at* http://www.fcc.gov/document/chairman-genachowski-winning-global-bandwidth-race.

[19] *See, e.g.*, QUALCOMM 1000X Data Challenge Presentation; Nokia Siemens 4G White Paper.

[20] FCC, Connecting America: The National Broadband Plan at 75, 84-85, 94-96 (2010) (National Broadband Plan).

[21] *Id.* at 96.

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

[23] *See id.*

[24] *See id.*

[25] *See id.*

[26] *See id.*

B. NTIA Ten Year Plan and Fast Track Report

17. Pursuant to the Presidential Memorandum, in October 2010, NTIA released two reports: (1) the Ten-Year Plan and Timetable to Make 500 megahertz of Spectrum Available for Wireless Broadband (Ten-Year Plan);[27] and (2) the Fast Track Report.[28] In the Ten-Year Plan, NTIA, in collaboration with the FCC and other federal agencies, identified approximately 2200 megahertz of spectrum for potential evaluation for wireless broadband opportunities to meet the Administration's 500 megahertz benchmark.[29] The Ten-Year Plan and timetable (1) identifies an initial list of candidate spectrum bands for evaluation for commercial wireless broadband deployment; (2) outlines steps to identify additional bands for evaluation; (3) sets forth a methodical process to assess the feasibility of the identified bands; and (4) identifies the actions required to make such spectrum available by 2020.[30]

18. In the Fast Track Report, NTIA identified four specific bands for evaluation with respect to their suitability for commercial broadband, specifically WiMAX and LTE technology deployment (1675-1710 MHz, 1755-1780 MHz, 3500-3650 MHz, and 4200-4220 MHz and 4380-4400 MHz).[31] NTIA ultimately recommended that 115 megahertz of spectrum (1695-1710 MHz and 3550-3650 MHz) could be made available for commercial wireless broadband by 2015 based on the conditions outlined in the Fast Track Report.[32] NTIA's recommendation with regard to the 3.5 GHz Band included significant geographic restrictions to protect existing DoD radar and FSS operations and to protect new commercial systems from co-channel interference from high-powered military in-band shipborne and adjacent band DoD ground-based radar systems.[33] The radar systems that operate in the 3.5 GHz Band overcome the inherent limitations due to increased propagation losses by employing high transmitter power levels and high-gain antennas.[34] These characteristics of the radar systems were a contributing factor to the size of the exclusion zones in the Fast Track evaluation.

C. 3.5 GHz Band Overview

1. Band Characteristics

19. NTIA selected the 3.5 GHz Band as a "fast track" band because: (1) WiMAX equipment has already been developed and deployed in this band; (2) federal operations in the band are geographically limited; and (3) the band has already been allocated for fixed services in other parts of the world.[35] This band is above the 3 GHz threshold often identified as the cutoff for ideal spectrum for mobile cellular uses.[36] Accordingly, the 3.5 GHz Band has not been considered an ideal band for

[27] NTIA, Plan and Timetable to Make Available 500 MHz of Spectrum for Wireless Broadband (rel. October 2010) (Ten-Year Plan), *available at* http://www.ntia.doc.gov/files/ntia/publications/tenyearplan_11152010.pdf.

[28] *See* Fast Track Report.

[29] *See* Ten-Year Plan at 4, 7.

[30] *See id.* at 4; *See also* Presidential Memorandum.

[31] Fast Track Report at 2-1 to 2-7.

[32] *Id.* at 1-8.

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

[34] *Id.* at 3-30 – 3-33.

[35] Fast Track Report at 2-5 to 2-6.

[36] NTIA, Federal Operations in the 1755-1850 MHz Band: The Potential for Accommodating Third Generation Mobile Systems, *Interim Report*, at 7-8 (rel. November 15, 2000) ("Because of the physical processes governing the propagation of radio waves in the frequency range below 3 GHz, these frequencies can be efficiently transmitted and received by small, compact, relatively lightweight user terminals. This feature, coupled with the ability to support high data rates, makes them ideally suited for uses requiring mobility and portability of telecommunications (continued….)

exclusive licensed commercial mobile broadband uses.[37] All other things being equal under the free space line of sight condition, a signal propagating at 3.5 GHz would be expected to decay faster than a signal in lower frequency bands, yielding approximately 29 percent reduced range compared to Broadband Radio Service/Educational Broadband Service (2.5 GHz), 45 percent compared to Personal Communications Service (1.9 GHz), and 75 percent compared to the Cellular bands (850 MHz).[38] These range limitations would be even greater in attenuated environments, where higher frequency signals are less prone to penetrate building materials.

20. The 3.5 GHz Band, considered purely from a radio propagation standpoint, holds great potential for small cell applications. Small cell use could turn some of the perceived disadvantages of the band into advantages. Small cell deployments inherently require less range to meet users' needs than macrocell networks. Moreover, limited signal propagation can facilitate dense deployment of small cells with a reduced risk of harmful interference to geographically or spectrally adjacent users, greatly increasing frequency reuse and available network capacity. On the other hand, the signal propagation at 3.5 GHz is still viable for non-line-of-site use, allowing for flexible network topologies. In short, given the characteristics of the band, the 3.5 GHz Band appears to be a good candidate for small cell uses.

21. Additionally, the band's characteristics make it well-suited to spectrum sharing, particularly geographic sharing. The limited propagation – especially in combination with low-power operation – should allow disparate radio systems to operate in closer proximity than lower frequency bands. This feature of the band should enable greater sharing opportunities with incumbent systems (such as radars and satellite communications networks) with appropriate geographic separation and other mitigation techniques such as resilient and flexible technologies. It also raises the possibility of greater sharing between disparate commercial systems in the band. These physical characteristics are essential enablers of the three-tier licensing construct proposed in this *Notice*.

2. Domestic Use of the 3.5 GHz Band

22. The 3.5 GHz Band is allocated to the Radiolocation Service (RLS) and the Aeronautical Radionavigation Service (ARNS) (ground-based)[39] on a primary basis for federal use.[40] Footnote G59 states that all federal non-military RLS use of the 3500-3650 MHz band shall be on a secondary basis to military RLS operations.[41] Footnote G110 states that federal ground-based stations in the ARNS may be authorized in the 3500-3650 MHz band when accommodation in the 2700-2900 MHz band is not technically and/or economically feasible.[42]

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services."). *See also* CTIA Spectrum Task Force Comments at 13-14.

[37] *See* AT&T Spectrum Task Force Comments at 7 (suggesting that the 3.5 GHz band is likely to "be of limited utility for mobile broadband," but may be useful for fixed broadband or unlicensed use).

[38] The values for reduced range are calculated based on the simple free space path loss model. This model demonstrates the most prominent effect of the relationship between frequency and distance in open conditions, with distance decreasing as the square of the frequency. Starting with a site radius typical for 850 MHz systems, the distance that would provide the same path loss was calculated to produce the values shown. Other mechanisms that affect propagation such as clutter and antenna efficiency can also be frequency dependent. More detailed models that take these into account may show somewhat different results, but generally the relationship should be similar.

[39] In the case where there is a parenthetical addition to an allocation in the International Table of Allocations, that service allocation is restricted to the type of operation so indicated, *i.e.*, federal use of this primary ARNS allocation is restricted to ground-based stations. 47 C.F.R. § 2.104(h)(4).

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

[41] 47 C.F.R. § 2.106, note G59.

[42] *Id.* § 2.106, note G110.

23. The 3500-3600 MHz and 3600-3650 MHz bands are allocated to RLS on a secondary basis for non-federal use.[43] The 3600-3650 MHz band is also allocated to the FSS (space-to-Earth) on a primary basis for non-federal use and, per footnote US245, use of this FSS downlink allocation is limited to international inter-continental systems and is subject to case-by-case electromagnetic compatibility analysis.[44]

24. The Commission has licensed primary FSS earth stations to receive frequencies in the 3600-3650 MHz band in 37 cities. FSS earth station facilities in 32 cities are authorized to receive frequencies in the 3625-3650 MHz sub-band, and Vizada, Inc. operates two gateway earth stations (located northeast of Los Angeles and New York City) that provide feeder links for Inmarsat's L-band mobile-satellite service system.[45]

25. There are three non-federal licensees in the RLS operating in the 3.5 GHz Band. These licensees are authorized to operate radiolocation land stations (station class LR) and radiolocation mobile stations (station class MR) using frequencies in the 3300-3500 MHz and 3500-3650 MHz bands.[46]

3. Domestic Uses of Adjacent Spectrum Bands

26. *Federal Users*. The federal RLS allocation for DoD radar systems described above extends from 3500-3650 MHz.[47] Both fixed and mobile high-powered DoD radar systems on ground-based, shipboard, and airborne platforms operate in this band. These radar systems are used in conjunction with weapons control systems and for the detection and tracking of air and surface targets. The U.S. Navy uses the band for a major radar system on guided missile cruisers, and the U.S. Army uses the band for a major firefinder system to detect enemy projectiles.[48] The U.S. Air Force uses the band for airborne radar Station Keeping Equipment throughout the United States and Possessions to assist pilots in formation flying and to support drop-zone training. The upper adjacent 3650-3700 MHz band is allocated for primary use by the federal RLS at three designated sites.[49] The 3650-3700 MHz band is also allocated for use by ship stations located at least 44 nautical miles from shore in offshore

[43] *Id.* § 2.106.

[44] *Id.* § 2.106, note US245.

[45] *See* Appendix A for a complete list of these FSS earth stations. It should be noted that commercial satellites are also authorized to operate and transmit in this band.

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

[47] *See* 47 C.F.R. § 2.106.

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

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

ocean areas on a non-interference-basis.[50] The lower adjacent 3100-3500 MHz band is also allocated for primary use by military radar systems, including multifunction systems used on cruisers and destroyers.

27. *Non-Federal Users*. As described above, the 3500-3600 MHz band is used for non-federal RLS on a secondary basis.[51] In the 3300-3500 MHz band, survey operations, using transmitters with a peak power not to exceed five watts, may be authorized for federal and non-federal use on a secondary basis to other federal radiolocation operations.[52] This band is also used by the Amateur Radio Service.[53] The 3600-3700 MHz band is used by FSS operators for space to Earth operations.[54]

28. The 3650-3700 MHz band is also allocated for terrestrial non-Federal use.[55] In March 2005, the Commission adopted a *Report and Order* that amended Part 90 by adding new Subpart Z – Wireless Broadband Services in the 3650-3700 MHz Band.[56] Service in the 3650-3700 MHz band is authorized through non-exclusive nationwide licenses and requires the registration of individual fixed and base stations.[57] All stations operating in this band must employ a contention-based protocol.[58] Base and fixed stations are limited to 25 watts per 25 megahertz equivalent isotropically radiated power (EIRP) and the peak EIRP power density shall not exceed 1 watt in any 1 megahertz slice of spectrum; mobile and portable stations are limited to 1 watt per 25 megahertz EIRP and the peak EIRP density shall not exceed 40 mW in any 1 megahertz slice of spectrum.[59] Base and fixed stations may only be located within 150 kilometers of an FSS earth station if the licensee of the earth station agrees to such operation.[60] Requests for base or fixed station locations closer than 80 kilometers to three Federal Government radiolocation facilities are only approved upon successful coordination by the Commission

[50] *See id.* § 2.106, note US349.

[51] *See id.* § 2.106.

[52] *See id.* § 2.106, note US108.

[53] *See id.* § 2.106.

[54] *See id*.

[55] *See id*.

[56] 47 C.F.R. Part 90 Subpart Z. *See 3650-3700 MHz Report and Order and Memorandum Opinion and Order*; Amendment of the Commission's Rules with Regard to the 3650-3700 MHz Government Transfer Band, ET Docket No. 98-237, *Notice of Proposed Rule Making and Order*, 14 FCC Rcd 1295 (1999); Amendment of the Commission's Rules with Regard to the 3650-3700 MHz Government Transfer Band, ET Docket No. 98-237, *Memorandum Opinion and Order*, 15 FCC Rcd 9340 (2000); Amendment of the Commission's Rules with Regard to the 3650-3700 MHz Government Transfer Band, ET Docket No. 98-237, *First Report and Order and Second Notice of Proposed Rule Making*, 15 FCC Rcd 20488 (2000). *See also* Unlicensed Operation in the Band 3650-3700 MHz, ET Docket No. 04-151, *Notice of Proposed Rulemaking*, 19 FCC Rcd 7545 (2000); Wireless Operations in the 3650-3700 MHz Band, ET Docket No. 04-151, *Memorandum Opinion and Order*, 22 FCC Rcd 10421 (2007).

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

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

[59] *Id.* § 90.1321.

[60] *See id.* § 90.1331. Pre-existing FSS earth stations are accorded geographic protection from terrestrial operations in the 3650-3700 MHz band. The coordinates of these stations are available at *http://www.fcc.gov/ib/sd/3650/.*

with NTIA.[61] Mobile and portable stations may operate only if they can positively receive and decode an enabling signal transmitted by a base station; airborne operations are prohibited.[62]

4. International Allocation of the 3.5 GHz Band

29. At the 2007 World Radiocommunication Conference (WRC-07), the 3400-3600 MHz band was identified for International Mobile Telecommunications (IMT) in much of ITU Region 1 and in 8 areas within ITU Region 3.[63] In ITU Region 2,[64] the 3500-3700 MHz band is allocated to the Fixed, Fixed Satellite (space-to-Earth), and Mobile (except aeronautical mobile) Services on a primary basis, and to RLS on a secondary basis.[65]

D. Small Cells

30. Small cells are low-powered wireless base stations intended to cover small indoor or outdoor areas ranging in size from homes and offices to stadiums, shopping malls, and metropolitan outdoor spaces. Small cells are typically used to extend wireless coverage to areas where macro cell signals are weak or to provide additional data capacity in areas where existing macro cells are overloaded. Small cells are also characterized by their inclusion of novel sensing technologies such as environmental recognition and auto-configuration.[66]

31. The definition of what constitutes a "small cell" device is fluid and includes, from the lowest to highest maximum power levels, femtocells, picocells, microcells, and metrocells.[67] These devices can cover areas ranging from 10 meters to several kilometers.[68] Femtocells are typically low powered units deployed in residences and small businesses.[69] Picocells are typically used in larger

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

[62] 47 C.F.R. § 90.1333.

[63] See International Telecommunication Union (ITU) Final Acts of the World Radiocommunication Conference (Geneva 2007) (*WRC-07 Final Acts*), available for purchase at http://www.itu.int/publ/R-ACT-WRC.8-2007/en.

[64] ITU Region 2 includes member countries in North and South America. A list of ITU member countries and their associated ITU region designations can be found at: http://life.itu.int/radioclub/rr/itureg.htm.

[65] We also note that, while the radiocommunication services listed in the ITU Region 3 Table are the same as those listed in the ITU Region 2 Table, the listed frequency bands are different. Specifically, the 3500-3600 MHz and 3600-3700 MHz bands are shown in the Region 3 Table so two international footnotes could be added: 1) footnote 5.433A states that in eight areas within ITU Region 3 (including China, India, Japan, New Zealand, Pakistan, and South Korea), the 3500-3600 MHz band is identified for IMT use; and 2) footnote 5.435 states that, in Japan, in the band 3620-3700 MHz, the RLS is excluded. International footnote 5.433 also states: "In Regions 2 and 3, in the band 3400-3600 MHz the radiolocation service is allocated on a primary basis. However, all administrations operating radiolocation systems in this band are urged to cease operations by 1985. Thereafter, administrations shall take all practicable steps to protect the fixed satellite service and coordination requirements shall not be imposed on the fixed-satellite service."

[66] *See* Informa and Small Cell Forum, Small Cell Market Status – June 2012 at 7 (rel. June 2012) (Small Cell Report), *available at* http://www.smallcellforum.org/resources-white-papers (presenting the results of an industry survey of opinions on the key components of small cells).

[67] Small Cell Forum, Small Cells – What's the Big Deal: Femtocells are Expanding Beyond the Home at 2 (rel. February 2012) (Small Cell Report), *available at* http://www.smallcellforum.org/resources-white-papers.

[68] *Id.*

[69] For a discussion of femtocell deployment, see Implementation of Section 6002(b) of the Omnibus Budget Reconciliation Act of 1993, WT Docket 10-333 (Terminated), *Fifteenth Report*, 26 FCC Rcd 9664, at 9876-77, ¶ 376 (2011).

public indoor spaces.[70] Microcells and metrocells are generally used for wider area outdoor deployments.[71] Small cell technology can be utilized in the whole range of licensed and unlicensed mobile technologies, such as those standardized by the Third Generation Partnership Projects (3GPP and 3GPP2) and the Institute of Electrical and Electronics Engineers (IEEE).

32. Unlike macrocells, small cells can be deployed relatively easily and inexpensively for capacity and coverage purposes. By adding one or more small cells, consumers, enterprises, and service providers can benefit from improved coverage, better service quality, increased capacity, higher data throughput, and longer battery life.[72] Indeed, as consumer demand for wireless data has skyrocketed, network operators and others have increasingly recognized the benefits of small cell deployments and have significantly expanded the integration of these technologies into existing networks.[73] Small cells that are available today can support voice and data communications. Depending on the technology, small cells may be deployed by end users, network operators, or third-party service providers.

33. Some consider Wi-Fi to be the most prevalent example of small cell technology, while others place it in a different category by virtue of its reliance solely on unlicensed spectrum. Nonetheless, the widespread adoption of Wi-Fi illustrates many of the potential benefits of small cells.[74] Wi-Fi operates at high frequencies, using small, low powered base stations deployed in dense configurations with bandwidths that have grown from 20 MHz to the current draft standard of 160 megahertz wide.[75] Moreover, it is not uncommon to see as many as 25 different Wi-Fi networks operated from a single location.[76] At this time, an ever-increasing amount of smartphone traffic flows over Wi-Fi networks, complementing the mobile services offered by macrocell networks.[77]

E. Recent Developments

1. Recent Commission Action Promoting Spectrum Sharing

34. In recent years, the Commission has continued to work extensively to clear wireless spectrum for traditional, exclusive licensing uses.[78] However, it has become increasingly clear that such efforts alone will not suffice to meet the growing demand for commercial wireless spectrum. As such, the Commission has taken several concurrent actions to promote spectrum sharing and innovative licensing models designed to address the spectrum shortage. Notably, the Commission's TVWS rules

[70] Small Cell Report at 2.

[71] *Id.*

[72] *See* Small Cell Forum, What is a Small Cell?, *available at* http://www.smallcellforum.org/aboutsmallcells-small-cells-what-is-a-small-cell.

[73] Small Cell Report at 4 (showing rapid growth in projected carrier expenditures on small cell deployments over the next five years).

[74] PCAST Report at 18-19.

[75] *Id.*

[76] *Id.*

[77] *Id.*

[78] *See, e.g.*, Amendment of Part 27 of the Commission's Rules to Govern the Operation of Wireless Communications Services in the 2.3 GHz Band, WT Docket No. 07-293, IB Docket No. 95-91, FCC 12-130, *Order on Reconsideration* (rel. October 17, 2012); Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions, Docket No. 12-268, *Notice of Proposed Rulemaking*, 27 FCC Rcd 12357 (2012); Service Rules for Advanced Wireless Services in the 2000-2020 MHz and 2180-2200 MHz Bands, WT Docket No. 12-70, ET Docket No. 10-142, WT Docket No. 04-356, *Notice of Proposed Rulemaking and Notice of Inquiry*, 27 FCC Rcd 3561 (2012).

serve as a model for enabling dynamic spectrum sharing between licensed and unlicensed users.[79] In the TVWS proceeding, the Commission created a methodology for allowing unlicensed wireless use of vacant TV channels through a dynamic access database.[80] The result is a system that coordinates efficient shared access to spectrum between users with different access rights. The TVWS proceeding underpins PCAST's report and informs the proposals in this *Notice*.[81] The TVWS can be used to provide powerful public Internet connections, wireless broadband to schools, campus networks that can manage increasing demands for bandwidth, and smart grid support.[82] The Commission has authorized testing of fixed white spaces devices and TVWS databases for the provision of wireless broadband to rural schools in Nottoway, VA, and for the provision of wireless broadband to government entities and other users in the city of Wilmington, NC and the county of Hanover, NC.[83]

35. In addition, in 2010, the Commission began an inquiry into dynamic spectrum access technologies and techniques with a goal of promoting more efficient use of spectrum.[84] Specifically, the Commission sought comment on ways in which dynamic spectrum access radios and techniques could promote more intensive and efficient use of the radio spectrum and the potential that these technological innovations have for enabling more effective management of spectrum. The Commission explored technical developments, and ways to promote these innovative strategies for use on both a licensed and unlicensed basis.[85]

36. Other recent Commission actions have also illustrated the growing importance of sharing as a means of addressing the nation's spectrum shortage. For example, earlier this year, the Commission allocated the 2360-2400 MHz band for secondary use by Medical Body Area Networks (MBANs). However, the 2360-2390 MHz portion of this spectrum was already being used for other, higher priority operations, including critical flight testing carried out by federal and non-federal aeronautical mobile telemetry users.[86] To avoid interfering with these existing users, MBAN operations in the 2360-2390 MHz portion of the band must register with a frequency coordinator and are restricted to indoor uses at health care facilities.[87] More recently, the Commission's Office of Engineering and Technology (OET), after coordination with NTIA, approved T-Mobile's application for special temporary authority (STA) to begin testing shared operations in the 1755-1780 MHz band on an experimental basis.[88] This is the first authorization that the Commission, in coordination with NTIA, has granted for commercial experimental testing of federal and non-federal shared use in that band.[89] The data collected under this STA will be

[79] *See White Spaces Second Memorandum Opinion and Order*, 25 FCC Rcd at 18662, ¶ 1.

[80] *See id.* at 18700-01, ¶ 94.

[81] *See* PCAST Report at 24-27, 31, 82-83.

[82] *White Spaces Second Memorandum Opinion and Order*, 25 FCC Rcd at 18662, ¶ 1.

[83] Letter from Julius P. Knapp, Chief, Office of Engineering and Technology, to John Malyar, Telcordia Technologies, Inc., 27 FCC Rcd 4148 (OET Apr. 19, 2012); Office of Engineering and Technology Announces the Approval of Spectrum Bridge, Inc.'s TV Bands Database System for Operation, *Public Notice*, 26 FCC Rcd 16924 (OET 2011).

[84] See *Dynamic Spectrum NOI.*

[85] *Id*. 25 FCC Rcd at 16632-3, ¶ 2.

[86] *See* 47 C.F.R. § 2.106; *See also* Amendment of the Commission's Rules to Provide Spectrum for the Operation of Medical Body Area Networks, ET Docket No. 08-59, *First Report and Order and Further Notice of Proposed Rulemaking*, 27 FCC Rcd 6422, 6430-32, 6435, ¶¶ 14-17, 24 (2012) (*MBAN Order*).

[87] *MBAN Order*, 27 FCC Rcd at 6448-6456, ¶¶ 56-73.

[88] *See* T-Mobile Licensee LLC, STA Application for callsign WF9XQW, File No. 0373-EX-ST-2012.

[89] Statement of FCC Chairman Julius Genachowski on FCC Granting the First Authorization of Testing in the 1755- (continued….)

used to inform the ongoing efforts of the Commission, NTIA, and the wireless industry in bringing additional spectrum to market for mobile broadband services.

37. In addition, in 2005, NTIA and the FCC launched an automated web-based coordination capability in the 70/80/90 GHz bands that employs innovative IT solutions enabling non-federal users to get faster, easier access to spectrum shared with the federal agencies.[90] This capability has proven to be very successful in reducing the time and cost involved in spectrum coordination between federal and non-federal users. Software tools, databases, and procedures have evolved over time to increase the number of users in a band, the speed at which they can access it, and the cost.

38. Apart from these recent Commission actions, we note that one of the greatest examples of the success of shared access to spectrum is the increasing and widespread use of unlicensed devices. Part 15 of the Commission's rules authorize unlicensed use of the spectrum, which allows for a great diversity of uses within any given band. The technical rules for Part 15 devices are designed to ensure that there is a low probability that unlicensed devices will cause harmful interference to other users of the spectrum. The primary operating conditions under part 15 are that the operator must accept whatever interference is received and must not cause harmful interference.[91] Should harmful interference occur, the operator is required to immediately correct the interference problem, even if correction of the problem requires ceasing operation of the system.[92]

39. In 1985, the FCC expanded its Part 15 rules to encompass the operation of low power, unlicensed spread spectrum systems in the 900 – 928 MHz, 2400 – 2483.5 MHz, and 5725 – 5850 MHz bands.[93] The FCC rules were subsequently broadened to include radio frequency devices using digital modulation techniques. In 1997, the Commission amended Part 15 of the rules to make available 300 megahertz of spectrum at 5.15-5.25 GHz (U-NII-1), 5.25-5.35 GHz (U-NII-2), and 5.725-5.825 GHz (U-NII-4) for use by a new category of unlicensed equipment, called Unlicensed Nation Information Infrastructure (U-NII) devices[94] New Subpart E was created in Part 15 of CFR. In 2003, the Commission amended Part 15 of the rules to make an additional 255 megahertz of spectrum available in the 5.470-5.725 GHz for U-NII devices (U-NII-3).[95] Notably, these rule changes led to commercial adoption of standards such as Wi-Fi.[96] These unlicensed spectrum bands have become increasingly important for mobile broadband data capacity and coverage over the past several years.

(Continued from previous page)
1780 MHz Band, *News Release* (rel. August 14, 2012).

[90] *See* Wireless Telecommunications Bureau Announces Permanent Process for Registering Links in the 71-76 GHz, 81-86 GHz, and 92-95 GHz Bands, *Public Notice*, 20 FCC Rcd 2261 (WTB 2005).

[91] *See* 47 C.F.R. § 15.5.

[92] *See id.*

[93] *See* Authorization of Spread Spectrum an Other Wideband Emissions Not Presently Provided for in the FCC Rules and Regulations, GN Docket No. 81-413, *First Report and Order*, 101 FCC 2d 419 (1985).

[94] In the Matter of the Commission's Rules to Provide for Operation of Unlicensed NII Devices in the 5 GHz Frequency Range, ET Docket No. 96-102, *Report and Order*, 12 FCC Rcd 1576 (1997).

[95] Revision of Parts 2 and 15 of the Commission's Rules to Permit Unlicensed NII Devices in the 5 GHz Band, ET Docket No. 03-122, *Report and Order*, 18 FCC Rcd 24484 (2003).

[96] Wi-Fi is a short range technology that is often used in conjunction with a customer's DSL or cable modem service to connect end-user devices, such as PCs, laptops and smartphones, located within the customer's home or business, to the Internet. In these cases, Wi-Fi allows users to move Wi-Fi-enabled devices around within their homes or businesses without installing additional inside wiring, but the actual "connection" to the service provider is via the customer's DSL or cable modem service. Wi-Fi technology can also be "networked" to provide wider geographic coverage, and when configured this way, may be used by some service providers in offering broadband service. Wi-Fi is widely available in airports, city parks, restaurants, bookstores and other public places called "hotspots," (continued….)

2. PCAST Report

40. The PCAST Report concludes that, given the exploding demand for commercial wireless spectrum and the continuing spectrum needs of federal users, the traditional practice of clearing portions of federally held spectrum for exclusive commercial use is not a sustainable basis for future spectrum policy.[97] Instead, PCAST argues that the best way to increase the availability of spectrum for commercial broadband is to leverage new technologies to allow spectrum to be shared between federal and commercial users.[98] The PCAST Report also notes that current approaches to spectrum sharing can be augmented by a variety of means, including dynamic frequency management, utilization of spectrum databases, and improved interference mitigation technologies.[99] Indeed, PCAST contends that sharing should be the preferred model for spectrum use and that, by adopting its recommendations, the effective capacity of federal spectrum could be multiplied by a factor of 1,000.[100]

41. PCAST recommends that shared spectrum be organized into three tiers. To ensure interference protection, all users would be required to register in a database modeled on the TVWS database. The first tier would consist of incumbent federal users (Federal Primary Access).[101] These users would be entitled to full protection for their operations within their deployed areas, consistent with the terms of their assignments.[102] The second tier (Secondary Access) would consist of users that would receive short-term priority authorizations to operate within designated geographic areas.[103] Secondary users would receive protection from interference from third tier users but would be required to avoid interference with and accept interference from Federal Primary users.[104] Third tier users (GAA) would be entitled to use the spectrum on an opportunistic basis and would not be entitled to interference protection. PCAST states that devices in this tier should be capable of operating on multiple frequencies and should incorporate spectrum sensing and other cognitive radio features to prevent harmful interference to other users.[105]

42. In all, PCAST recommends that the Federal Government should identify 1,000 megahertz of federal spectrum for shared use under this system to create "the first shared use spectrum superhighways."[106] To manage these "superhighways" and ensure that its three tiered use model is effective, PCAST recommends that the Federal Government authorize and implement a Federal Shared Access system to serve as a clearinghouse for band-by-band registrations and conditions of use for each spectrum band that is authorized for sharing.[107] The Report also recommends that the Federal Government should, in collaboration with private industry, establish new sharing methodologies, taking

(Continued from previous page)
allowing those who are away from their homes or businesses to access the Internet.

[97] PCAST Report at vi.

[98] It should be noted that PCAST does not foreclose clearing and reallocating Federal spectrum as an option entirely, but it does not believe clearing and reallocating Federal spectrum is sustainable over time. *Id*.

[99] *Id.* at 20-27 and 30-37.

[100] *Id.* at vi and 21.

[101] *Id.* at 23-24.

[102] *Id*.

[103] *Id.*

[104] *Id*.

[105] *Id*.

[106] *Id.* at 50-52.

[107] *Id.* at 24-27.

into consideration both transmitter and receiver characteristics, and develop a system of incentives to encourage federal agencies to share their spectrum.[108]

43. The PCAST Report acknowledges that these changes will take time. However, it recommends that the Commission, in conjunction with NTIA, work expeditiously to implement some of the PCAST's recommendations in the 3.5 GHz Band and other, as yet undetermined, bands.[109] Specifically, PCAST recommends that the Commission modify its rules to allow GAA devices to use these bands.[110] PCAST asserts that low-powered, high spatial re-use GAA devices (*i.e.* small cells) could be used in the 3.5 GHz Band through extension of the TVWS database to the band.[111] The PCAST Report notes that several third-party vendors are already developing databases for use in the TVWS bands and that these vendors could adapt their databases to be used in the 3.5 GHz Band relatively easily, but the report notes NTIA and the FCC should determine the most appropriate management technology.[112] Under PCAST's approach, GAA devices would be required to register in the database and be "frequency agile" to ensure that incumbent operations are not affected.[113] By using this interim model, PCAST asserts that the 3.5 GHz Band could be brought into use for GAA purposes relatively quickly in a manner that would protect existing federal users, provide a useful model for future sharing operations, and position the band to easily transition once the broader SAS is implemented.[114]

3. TAC Small Cell Recommendation

44. The TAC has also advocated for the increased use of small cell devices in spectrum constrained areas and supported dedicating a spectrum band to small cell uses.[115] Indeed, on October 28, 2011, the TAC hosted a Small Cell Technology Forum, at which industry leaders and government representatives discussed emerging small cell technologies and strategies to facilitate future deployment, with a focus on in-building solutions. These solutions included the designation of a dedicated spectrum band for indoor small cell purposes.[116]

4. Emerging Perspectives on the 3.5 GHz Band

45. In 2011, the Commission's Spectrum Task Force sought comment via Public Notice on whether and to what extent the spectrum bands in NTIA's Fast Track Report could be used for broadband.[117] Commenters generally supported Commission action to free additional spectrum for wireless broadband but expressed varying levels of interest in the 3.5 GHz Band for traditional wireless broadband uses.

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[108] *Id.* at 29-48 and 54-56.

[109] *Id.* at 82-83.

[110] *Id.* at 82.

[111] *Id.* at 82-83.

[112] *Id.* at 82.

[113] *Id*.

[114] *Id.* at 82-83.

[115] *See* Technical Advisory Council, Chairman's Report, at 3 (rel. April 22, 2011) (TAC Report), *available at* http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-306065A1.pdf.

[116] *See id.*; FCC Announces Agenda for Indoor Small Cell Forum, WT Docket No. 11-161, *Public Notice*, 26 FCC Rcd 15049 (2011).

[117] Spectrum Task Force Requests Information on Frequency Bands Identified by NTIA as Potential Broadband Spectrum, ET Docket No. 10-123, *Public Notice*, 26 FCC Rcd 3486 (2011).

46. Wireless service providers and organizations responding to the *Public Notice* were somewhat restrained as to the usefulness of the 3.5 GHz Band for traditional, macrocell mobile broadband.[118] Notably, AT&T stated that, due to the extensive exclusion zones proposed by NTIA, it would be questionable whether mobile broadband service providers could effectively provide service in the 3.5 GHz Band. However, AT&T did suggest that the 3.5 GHz Band could be "quite useful for fixed broadband or for unlicensed use."[119] CTIA has also noted that, while spectrum above 3 GHz is not suitable for "greenfield" mobile broadband deployment due to its less favorable propagation characteristics (as compared to spectrum below 3 GHz), the 3.5 GHz Band has significant potential to be used for the small cell components of a heterogeneous network.[120]

47. On the other hand, wireless internet service providers see significant value in the use of 3.5 GHz for fixed wireless broadband.[121] Indeed, the Wireless Internet Service Providers Association (WISPA) has urged the Commission to adopt licensing and operational rules consistent with the rules adopted for fixed broadband use in 3650-3700 MHz.[122] By doing so, they argue, the Commission would create a contiguous 150 megahertz band for fixed wireless broadband use.[123]

48. With regard to spectrum sharing between federal and commercial users generally, Qualcomm, Inc. has identified the potential applicability of its authorized shared access model.[124] Qualcomm describes this technology as a database-enabled approach to spectrum sharing between incumbent federal users and commercial wireless users on a licensed basis.[125]

49. Members of the satellite industry have expressed concern regarding use of the 3.5 GHz band for commercial broadband purposes and has urged the Commission to ensure that any new terrestrial services be compatible with satellite networks.[126] Specifically, the Satellite Industry Association has asked the Commission to either restrict new uses to those that are wholly compatible with existing satellite uses on a co-primary basis, or adopt protection zones for grandfathered stations.[127]

[118] *See* CTIA Spectrum Task Force Comments at 13-14; AT&T Spectrum Task Force Comments at 7; Comments of T-Mobile, Spectrum Task Force Requests Information on Frequency Bands Identified by NTIA as Potential Broadband Spectrum, ET Docket No. 10-123, at 4, 7 (filed Apr. 22, 2011).

[119] AT&T Spectrum Task Force Comments at 7.

[120] CTIA Spectrum Task Force Comments at 13-14.

[121] Comments of the Wireless Internet Service Providers Association, Spectrum Task Force Requests Information on Frequency Bands Identified by NTIA as Potential Broadband Spectrum, ET Docket No. 10-123, at 5 (filed Apr. 22, 2011) (WISPA Spectrum Task Force Comments).

[122] WISPA Spectrum Task Force Comments at 1.

[123] Motorola Solutions, Inc. also supports this proposal, arguing that the 3.5 GHz would be put to quick use by existing providers using existing infrastructure. Comments of Motorola Solutions, Inc., Spectrum Task Force Requests Information on Frequency Bands Identified by NTIA as Potential Broadband Spectrum, ET Docket No. 10-123, at 3-5 (filed Apr. 22, 2011).

[124] Qualcomm Spectrum Task Force Comments at ii-iv.

[125] *See* Qualcomm Spectrum Task Force Comments at 5-9.

[126] Comments of the Satellite Industry Association, Spectrum Task Force Requests Information on Frequency Bands Identified by NTIA as Potential Broadband Spectrum, ET Docket No. 10-123, at 3 (filed Apr. 22, 2011) (SIA Spectrum Task Force Comments).

[127] *Id.* at 7-12.

III. DISCUSSION

50. In this *Notice*, we propose to create a new Citizens Broadband Service in the 3.5 GHz Band which would be authorized under Part 95 of the Commission's rules.[128] If implemented, this innovative service would help to unleash broadband opportunities for consumers throughout the country, particularly in areas with overburdened spectrum resources. The new service would be modeled on the spectrum access framework proposed in the PCAST Report. It would utilize an SAS incorporating a dynamic database and, potentially, other mitigation techniques to maximize the utility of the 3.5 GHz Band for broadband use, provide dedicated access for authorized priority users at critical use facilities, and protect the vital services currently provided by incumbent federal and non-federal systems operating in the band.

51. Throughout the *Notice*, where we seek comment on the costs and benefits of a proposal, we ask that commenters take into account only those costs and benefits that directly result from the implementation of the particular rules that could be adopted, including any proposed requirement or potential alternative requirement. Further, to the extent possible, commenters should provide specific data and information, such as actual or estimated dollar figures for each specific cost or benefit addressed, including a description of how the data or information was calculated or obtained, and any supporting documentation or other evidentiary support.

52. To ensure the development of a comprehensive record, we may release additional notices, analyses, or white papers for comment during the course of this proceeding. Moreover, because this proceeding raises significant novel technical issues with respect to sharing with federal users, we expect to work closely with NTIA and relevant federal agencies to perform necessary further analysis, and we encourage commenters to provide relevant technical input to inform this analysis, where appropriate.

A. Licensing Framework

1. Proposed Multi-Tier Framework

53. We propose a three-tiered licensing and interference protection framework to manage access to and use of the 3.5 GHz Band, providing different levels of protection for different levels of access in the 3.5 GHz Band. The three proposed tiers are Incumbent Access, Priority Access, and General Authorized Access.[129] To govern the interaction between the three tiers, we propose to establish an SAS, incorporating a geo-location enabled dynamic database and, potentially other appropriate mitigation techniques.

54. Under the proposed framework, Incumbent Access users would include authorized federal and grandfathered FSS users in the 3.5 GHz Band.[130] Incumbent Access users would have protection from harmful interference from all other users in the 3.5 GHz Band, which would be achieved through appropriate interference mitigation techniques, including geographic restrictions on Citizens Broadband Service use in the SAS. In this way, our proposal would ensure that federal users and grandfathered FSS licensees would be able to continue to use the band without interference from new Citizens Broadband Service users.

55. In the Priority Access tier, the Commission would authorize certain users with critical quality-of-service needs operate with a measure of interference protection in portions of the 3.5 GHz

[128] *See* 47 C.F.R. §§ 95.1, *et seq.*

[129] We note that our proposal uses slightly different terminology than that used by PCAST to account for protection of a broader class of incumbents (*e.g.*, commercial FSS users in addition to federal users) and to avoid confusion with existing terms of art employed in spectrum management (*e.g.*, "Secondary Access").

[130] *See infra* Part III.A.3.a.

Band at specific locations. Priority Access users would be eligible to use authorized devices on an interference protected basis within their facilities as controlled by the SAS. The Priority Access tier would be available only in areas where Citizens Broadband Service devices would not cause interference to incumbent operations and would not be expected to receive interference from incumbents (Priority Access Zones).[131] In addition, Priority Access users would be required to provide interference protection to and accept interference from Incumbent Access users (even though no such interference would be anticipated in Priority Access Zones), but would not be required to provide such protection to GAA users.

56. In the GAA tier, licensees would be authorized to use the 3.5 GHz Band on an opportunistic basis within designated geographic areas. GAA users would be required to accept interference from Incumbent and Priority Access tier users and would be required to avoid causing harmful interference to any users in those tiers. GAA use would permit ready access to unused portions of the 3.5 GHz Band for a broad class of residential, commercial, enterprise, and government users. Uses could include fixed or mobile consumer level devices, similar to Wi-Fi or TVWS devices. Use of GAA devices would be permitted in Priority Access Zones as well as areas where such devices would not cause harmful interference to incumbent operations but where signals from incumbent operations could be expected to interfere with GAA uses on occasion (GAA Zones).[132] Additionally, as described below in Part III.A.4, a supplemental proposal would allow GAA use at higher power levels in non-congested areas where those power levels do not pose an interference risk to higher tier users.

57. In general, under this three-tiered licensing proposal we believe incumbent users would be able to operate on a fully protected basis, while the technical benefits of small cells could be leveraged to facilitate innovative and efficient uses in the 3.5 GHz Band. Figure 1, below, provides a conceptual illustration how the different tiers, and corresponding zones, might interrelate from a geographic perspective within the 3.5 GHz Band. We seek comment on these tentative conclusions. We also seek detailed comments on the proposed three-tiered licensing and interference protection model, including the proposed geographic restrictions on Citizens Broadband Service operations, and request comprehensive analyses of the costs and benefits of this approach.

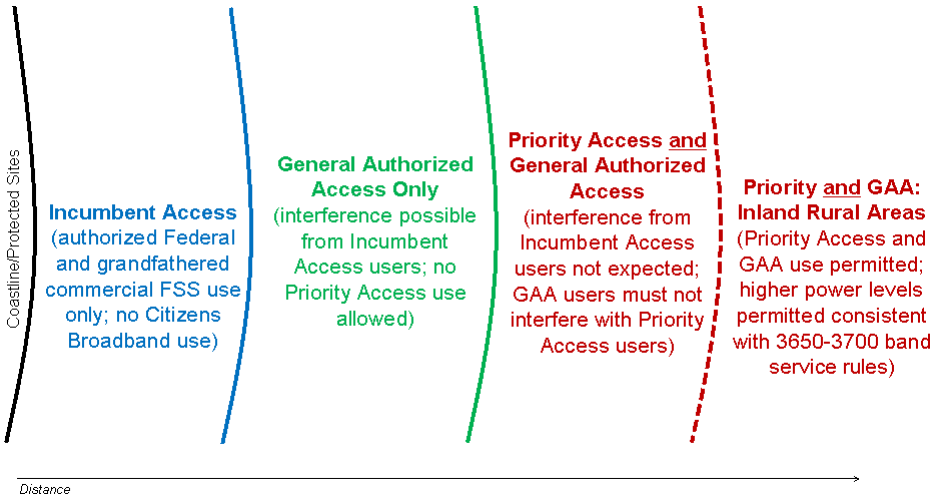

Figure 1

[131] *See infra* Part III.A.3.b.

[132] *See infra* fig. 1.

58. *Spectrum Access System.* We propose to enable an SAS to govern operation within and among tiers.[133] We propose that the SAS would incorporate a geo-location enabled dynamic database to manage access across a number of access planes, including geography, time, and frequency, and by other technological coordination techniques, modeled after the existing TVWS database requirements.[134] We believe that current database technology can be used to achieve dynamic frequency assignment while mitigating interference between devices in the same frequency band. We recognize, however, that the Spectrum Access System as applied to the 3.5 GHz Band would implicate some novel issues. The SAS would involve a new generation of this dynamic database technology. Its creation would require significant planning and testing. Therefore, as set forth in greater detail in Part III.C.1, below we seek detailed comment on the design of the SAS, including appropriate data security protection for sensitive federal information, and whether the existing TVWS database[135] model could be modified to accommodate the 3.5 GHz Band. As noted above, we expect to work closely with NTIA and relevant federal agencies to perform necessary further analysis, and we encourage commenters to support relevant technical input to inform this analysis, where appropriate.

59. *Federal Radar Interference into Citizens Broadband Service Systems.* ~~As noted above, the Fast Track Report proposed exclusion zones around DoD radars that were calculated to protect not only the DoD radar systems but also to prevent harmful interference from such systems into commercial devices.~~[136] Under our proposal, GAA use would be allowed in areas where small cell devices would not cause harmful interference to incumbent operations but where signals from incumbent operations could possibly interfere with GAA uses on occasion (GAA Zones).[137] In addition, we propose to allow "mission critical" operations in Priority Access Zones, where interference from radars into small cell use would not be expected.[138] As described below, we inquire about possible technological approaches to designing resilient small cells that can avoid interference from high-powered radars. Nonetheless, given the Fast Track Report's concerns about incumbent interference into commercial systems, should GAA operations be permitted in areas where they can possibly receive interference from radars? Or should such use be restricted to areas where no harmful interference from Incumbent Access users would be expected. Similarly, should "mission critical" operations be permitted in the 3.5 GHz Band? Or does the threat of such interference render the band unusable for such sensitive operations, suggesting they be prohibited even in places where there is no expectation of harmful interference from DoD radars? How

[133] The proposed SAS is described in greater detail in Part III.C.1 below.

[134] PCAST proposes that interactions among users of the three access tiers be governed by comprehensive access system comprised of geo-location databases, sensing technologies, signal beacons, and access rules administered by the Commission and NTIA. PCAST Report at 22-23.

[135] The Commission required the creation of a database or databases to manage opportunistic unlicensed access to unused TV bands. *See White Spaces Second Memorandum Opinion and Order*, 25 FCC Rcd at 18700-01, ¶ 94. The Commission conditionally designated nine database administrators and has authorized two to provide service to the public. *See* Unlicensed Operation in the TV Broadcast Bands; Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band, *Order*, 26 FCC Rcd 554 (OET 2011); Letter from Julius P. Knapp, Chief, Office of Engineering and Technology, to Rodney Dir, CEO, Spectrum Bridge, Inc., 26 FCC Rcd 16927 (OET Dec. 22, 2011) (notifying Spectrum Bridge that it may begin providing service to the public); Letter from Julius P. Knapp, Chief, Office of Engineering and Technology, to John Malyar, Chief Architect, Interconnection Solutions, Telcordia Technologies, Inc., 27 FCC Rcd 2931 (OET Mar. 26, 2012) (notifying Telcordia Technologies that it may begin providing service to the public).

[136] *See supra* Part II.B.

[137] *See supra* Part III.A.1. and fig. 1.

[138] *Id.*

do the answers to these questions affect the value of the band? We seek comment on these important questions that go to the heart of the proposed Citizens Broadband Service.

60. *Federal Use of Citizen's Band Service*. We are cognizant that, much as federal agencies today make extensive use of commercial wireless technologies including cellular networks and Wi-Fi, so, too, they might find great value in small cell use. Therefore, we seek comment on the applicability of the Citizens Broadband service, including GAA and Priority Access tiers, to federal users. Federal agencies are permitted to operate various systems consistent with the FCC rules in various frequency bands. These federal systems are required by Section 2.103 of the Commission's rules[139] and NTIA's Manual of Regulations and Procedures for Federal Radio Frequency Management (NTIA Manual) to operate in accordance with FCC rules and technical requirements.[140] Non-federal services used by federal agencies span the various methods of authorization used by the FCC including license-by-rule, individual and blanket licenses, and unlicensed operation. Examples of these services include mobile services authorized by the FCC for ship stations,[141] Family Radio Service,[142] Wireless Medical Telemetry Service,[143] unlicensed devices,[144] and FCC licensed commercial services.[145] In the case of the Wireless Medical Telemetry Service, there are shared allocations for federal and non-federal use, while in many instances there are no federal allocations. We propose that federal end users be able to make use of our proposed three-tier access system provided that agencies follow the technical and regulatory requirements developed through our rulemaking process. We seek comment on this proposal, including the appropriate regulatory means to effectuate it.

2. Proposed Licensing Model

61. We propose to establish the Citizen's Broadband Service by rule under Section 307(e) of the Communications Act.[146] We believe that a license-by-rule licensing framework would allow for rapid deployment of small cells by a wide range of users, including consumers, enterprises, and service providers, at low cost and with minimal barriers to entry. Much wireless broadband use occurs indoors or in other enclosed facilities. Typically, the owners or users of such facilities already have access to the siting permissions, backhaul facilities, electrical power, and other key non-spectrum inputs for the provision of service. Moreover, as explained above, our proposal for small cell operation at the relatively high frequency 3.5 GHz Band would generally tend to contain service within such facilities, allowing for a very high degree of spectrum reuse. Therefore, authorizing these end users—or their agents or assignees—to have direct access to the 3.5 GHz Band in the physical locations that they otherwise are able to access would seem to facilitate expeditious and low-cost provision of service. A license-by-rule framework is very compatible with and conducive toward these aims.

62. Section 307(e) states in part that, "[n]otwithstanding any license requirement established in this Act, if the Commission determines that such authorization serves the public interest, convenience, and necessity, the Commission may by rule authorize the operation of radio stations without individual

[139] 47 C.F.R. § 2.103.

[140] *See* NTIA, Manual of Regulations and Procedures for Federal Radio Frequency Management (May 2011 revision to 2008 edition), *available at* http://www.ntia.doc.gov/files/ntia/publications/manual_5_11.pdf.

[141] NTIA Manual at 7.5.2.

[142] *Id.* at 7.5.8.

[143] *Id.* at 7.5.9.

[144] *Id.* at 7.8.

[145] *Id.* at 7.23.

[146] 47 U.S.C. § 307(e).

licenses in the following radio services: (A) citizens band radio service; ….”[147] Section 307(e) states further that, “[f]or purposes of this subsection, the terms ‘citizens band radio service’ … shall have the meanings given them by the Commission by rule.”[148] We believe that a license-by-rule framework is an appropriate methodology for authorizing users in the 3.5 GHz Band consistent with the tiers of service proposed herein. This proposed framework would facilitate the rapid deployment of compliant small cell devices in critical use facilities, while minimizing administrative costs and burdens on the public, licensees, and the Commission. Moreover, this proposed framework would allow the Commission a great deal of flexibility to establish appropriate service and allocation rules. It would also promote administrative efficiency by maintaining the rules governing the Citizens Broadband Service in a single rule part. Thus, we tentatively conclude that authorizing the operation of compliant devices in the 3.5 GHz Band by rule under Section 307(e) of the Act would further the public interest, convenience, and necessity. However, we also seek comment on alternative licensing and spectrum access models.[149]

63. The Commission’s authority to license new services by rule under Section 307 is well established.[150] Indeed, the Commission has licensed an array of beneficial services by rule by defining the Citizens Band Radio Services to include the Family Radio Service, the Low Power Radio Service, the Medical Device Radiocommunication Service, the Wireless Medical Telemetry Service, and the Dedicated Short-Range Communications Service On-Board Units.[151] Accordingly, we propose to establish a new 3.5 GHz Citizen’s Broadband Service under Part 95 of the Commission’s Rules, and define it as a Citizens Band Radio Service pursuant to the Commission’s authority under Sections 307(e)(1) and (e)(3) of the Act.[152] We believe the creation of a wireless Citizens Broadband Service under the license by rule framework of Section 307 is consistent with Commission precedent creating new services with flexible assignments for any number of users.[153] We seek detailed comment on our proposed license-by-rule framework.

3. Proposed Licensing Tiers

64. Below we seek comment on specific elements of the Incumbent Access, Priority Access, and General Authorized Access tiers, including possible technical and operational rules. Where applicable, we seek comment on how the proposed access database, or some access management technology, could be implemented to govern access and mitigate interference among all users.

a. Tier 1: Incumbent Access

65. We believe that the ultimate success of shared use of the 3.5 GHz Band depends on providing wide ranging commercial access to the band for Citizens Broadband Service applications while ensuring that current users of the band continue to be protected from harmful interference.[154] We

[147] *Id.* § 307(e)(1).

[148] *Id.* § 307(e)(3).

[149] *See infra* Part III.A.4-5.

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

[151] *See* 47 C.F.R. §§ 95.401(a)-(g).

[152] *See* 47 U.S.C. § 307(e)(1), (e)(3).

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

[154] Nationwide access to the band should facilitate greater economies of scale in devices and services, as well as (continued….)

therefore propose to create an Incumbent Access tier composed of authorized federal and grandfathered FSS commercial users in the 3.5 GHz Band that would be afforded protection from harmful interference generated by commercial users in lower service tiers while maximizing the amount of useable spectrum for new services. Further, Incumbent Access users would not be required to mitigate any interference to the lower service tiers. Incumbent protection would be enforced by the SAS and would include strict geographic limitations on Citizens Broadband Service use. We seek comment on this proposal generally, including proposed implementation details of the SAS, and on the specific protections for federal and commercial incumbents set forth below.

66. *Federal Incumbent Protections*. As noted above, federal use in the 3.5 GHz Band – which includes high-powered radar systems – is essential to the national defense.[155] However, federal users do not use the entire band at all times and may, in fact, use the 3.5 GHz Band at short intervals, in geographically limited areas. However, it should be noted that the requirements for these systems are limited by neither time nor geography when the need arises to prepare for or execute national defense missions. Therefore, to the extent that we can identify the unused portion of the spectrum – in frequency, geography, and time – in a way that does not cause interference to federal users while limiting any performance reduction to new users, the band can be shared effectively between federal and commercial users.

67. In its Fast Track Report, NTIA recommends frequency and geographic separation to mitigate interference, assuming traditional macrocell network deployments.[156] It recommends exclusion zones around ground-based and airborne radar systems from around 1 kilometer to 60 kilometers, combined with a frequency offset of 40 megahertz or 50 megahertz.[157] With respect to shipborne radars, NTIA determined that extremely large geographic exclusion zones are necessary, reaching a maximum of 557 kilometers from one type of shipborne radar into a base station located in the Gulf Coast region.[158] Based upon NTIA's exclusion zone calculations for shipborne radar systems in 3.5 GHz Band, we estimate that approximately 60 percent of the United States population fall within an exclusion zone.[159] The separation parameters and the assumptions NTIA relied upon to calculate the parameters are discussed in greater detail in Part III.C.

68. NTIA's analysis only considered WiMAX technology for shared use of the 3.5 GHz Band. As detailed below, the small cell and access management technologies proposed in this *Notice* alter some of the assumptions in this analysis. We expect new analyses reflecting the changed assumptions set forth in this *Notice* to be an integral part of the record in this proceeding. As detailed below, we seek comment on these altered assumptions and their possible impact on interference to and from federal systems in the 3.5 GHz Band.

69. *Fixed Satellite Service Protections*. Thirty-seven FSS earth stations are licensed to operate in the 3600-3650 MHz portion of the 3.5 GHz Band.[160] Recognizing the important services that are provided by FSS operators in this band, we take action in the accompanying *Order* to grandfather

(Continued from previous page)
enable true mobility for users of the 3.5 GHz Band.

[155] *See supra* Part II.C.2.

[156] Fast Track Report at 5-3 – 5-6.

[157] *Id.* at 5-3 – 5-4. NTIA also highlights US348 in the Table of Allocations, which requires the Commission to coordinate all non-Federal operations in 3650-3700 within 80 kilometers of three land-based air traffic control radar training sites. *Id.* at 3-31; 47 C.F.R. § 2.106 US348.

[158] Fast Track Report at 5-6, tbl. 5-4.

[159] *See id.* at 5-7, fig. 5-3, and Appendix D; *See supra* note 12.

[160] See Appendix A for a full list of licensed FSS earth stations in 3600-3650 MHz portion of the 3.5 GHz Band.

existing FSS earth stations in this portion of the 3.5 GHz Band, and freeze applications for any new earth stations more than 10 statute miles from a grandfathered earth station.[161] We propose to include the grandfathered FSS earth stations in the Incumbent Access tier, and propose to adopt coordination and protection techniques to maximize the useable spectrum for all other 3.5 GHz Band users. We seek comment in Part III.C.2.b on methods to protect grandfathered FSS earth stations, including the incorporation of geographic restrictions in the SAS.

b. Tier 2: Priority Access

70. There are a variety of facilities with an urgent need for uninterrupted spectrum access to support "mission critical" uses.[162] While there is not enough spectrum available to efficiently allocate dedicated spectrum bands to all of these users, we believe that the 3.5 GHz Band can be used to provide localized, protected spectrum to many of these quality of service dependent users throughout much of the country. Therefore, we propose to establish a Priority Access tier of service in which qualified Priority Access users can expect protection from harmful interference from other operations from the same or lower tier of users within their facilities. Priority Access operations would be permitted only in geographic areas where Citizens Broadband operations would not interfere with incumbent operations and, because they would have a quality-of-service expectation, where no interference from incumbent operations would be reasonably anticipated (Priority Use Zones).[163] Priority Access users would be required to register in the SAS, employ appropriate mitigation techniques, and otherwise take all necessary steps to avoid causing harmful interference to incumbent operations.[164] We believe that this combination of geographic separation and database management could provide Priority Access users with adequate assurance of a consistent high quality service environment.

71. We seek comment on whether Priority Access operations should be allowed in the 3.5 GHz Band. Commenters should consider the following questions: Should a Priority Access tier be implemented and, if so, is this the appropriate scope? Should critical safety-of-life applications be permitted in this tier? Would Priority Access users be able to achieve a meaningful level of service given the restrictions we have proposed? Would Incumbent Access tier users be sufficiently protected from harmful interference? How would the SAS dynamically manage interaction between the Priority Access tier and other tiers? Should Priority Access devices be explicitly limited to indoor operations or would higher power levels and expanded, outdoor operations be appropriate? Commenters are encouraged to provide detailed comments and proposals, including alternatives to the proposals in this *Notice* and to fully address implementation details of the dynamic database as well as the technical licensing and regulatory ramifications of the proposal in this *Notice* with respect to Priority Access users.

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[161] *See infra* Part IV.

[162] *See, e.g.*, *MBAN Order*, 27 FCC Rcd at 6422 (allocating spectrum specifically for the use of medical body area networks); Implementing Public Safety Broadband Provisions of the Middle Class Tax Relief and Job Creation Act of 2012; Service Rules for the 698-746, 747-762 and 777-792 MHz Bands; Implementing a Nationwide, Broadband, Interoperable Public Safety Network in the 700 MHz Band, PS Docket No. 12-94, WT Docket No. 06-150, PS Docket No. 06-229, *Order*, 27 FCC Rcd 9652, ¶ 1 (2012) (Cmnr. McDowell concurring; Cmnr. Pai approving in part and concurring in part) (explaining that the Middle Class Tax Relief and Job Creation Act of 2012 established a long-term vision for using part of the 700 MHz band for a nationwide public safety broadband network); Petition for Rulemaking to Establish Rules Governing Critical Infrastructure Industry Fixed Service Operations in the 14.0-14.5 GHz Band, RM -11429, Petition for Rulemaking of the Utilities Telecom Council and Winchester Cator, LLC (filed May 6, 2008) (seeking a rulemaking to allocate spectrum specifically for critical infrastructure industries).

[163] *See supra* fig.1.

[164] Our proposed approach is similar to the "Secondary Access" tier proposed in the PCAST Report. However, our approach differs in that we propose a term-less license by rule approach as opposed to the short term, opportunistic licensing model proposed by PCAST. *See* PCAST Report at 23-24.

72. *General Description*. We propose that eligible users be authorized to operate on a Priority Access basis within a substantial portion of contiguous spectrum (*e.g.*, 50 megahertz) in the 3.5 GHz Band, subject to the technical rules that are ultimately adopted in this proceeding. Under our proposal, eligible users would be required to register their identity along with the location of their facilities in the SAS.[165] The database would authorize Priority Access use only by eligible users operating within eligible facilities within designated geographic areas. Reservation of frequencies for Priority Access use in a given location would occur only while Priority Access users are actually operating, ensuring that Priority Access spectrum would be available for GAA users when systems are not in use. Through use of the SAS and any other mitigation strategies that are ultimately adopted in this proceeding (including maximum transmitter power levels, limits on in-band and out-of-band emissions, flexible and resilient spectrum sharing technologies, and contention protocols), we anticipate that Priority Access users would be able to deliver a variety of consistent, high quality wireless broadband services to their users. Due to the propagation characteristics of the 3.5 GHz Band and the relatively low power levels we propose, we anticipate that Priority Access users would operate primarily indoors, though it may be possible to extend the construct to outdoor deployments.

73. *Eligibility*. In recent years, many kinds of "mission critical" users have sought dedicated spectrum to provide quality-assured operations.[166] However, dedicated spectrum is in short supply and it is unlikely that enough spectrum will be freed in the near future to meet the escalating needs of these critical users. Setting aside nationwide bands for specific uses—even when shared with other existing users—may preclude access by others that might occur at different locations without a risk of harmful interference. We believe that the high spatial reuse characteristics of low-power 3.5 GHz transmissions, combined with access management facilitated by the SAS, should allow the 3.5 GHz Band to be utilized on a shared, licensed basis by a variety of critical users to provide high quality services to localized facilities. Therefore, we propose to limit eligibility for inclusion in the Priority Access tier to these kinds of critical uses. We seek comment on the viability of this service tier and the ideal scope of the eligible class of users. Commenters should consider whether Priority Access use should be limited to critical use facilities and, if so, who should be considered a critical user. What issues could be raised by including federal entities as eligible Priority Access users? We also seek comment on methods for validating whether a user qualifies as a critical user. Alternatively, should the Priority Access tier be expanded to include all real property owners in eligible geographic areas, so that the Priority Access protections convey as an "air right" with use of the premises? How would eligible users be registered and verified in the dynamic database? What security measures could be implemented to prevent unauthorized users from obtaining Priority Access use of the 3.5 GHz Band?

74. *Band Plan*. We propose to allow Priority Access services across one-half of the 3.5 GHz Band (50 megahertz). We believe that this approach would provide adequate capacity for Priority Access users while ensuring that GAA users may access the remainder of the spectrum at any given location.[167] We seek comment on this approach, including whether dividing the 3.5 GHz Band in this manner would serve the public interest. We seek comment on the specific portion of the band that should be reserved for Priority Access uses. We also seek comment on whether the specific frequencies available for Priority Access use should be set by rule to be consistent on a nationwide basis or should be set dynamically in the SAS on a location-by-location basis. We also seek comment on other band plans. For instance, should the 3.5 GHz Band be divided into channels? If so, how large should the channels be

[165] The SAS is described in greater detail in Part III.C.1.

[166] *See, e.g.*, *supra* note 153.

[167] We note that nothing in this proposal would prevent Priority Access users from accessing the remainder of the band on a GAA basis, it would merely afford them protected access to one-half of the spectral capacity in that location, provided they are actively using the spectrum, as described above.

and should they be paired or unpaired? Should all channels be available for all Citizens Broadband Service users in all geographic areas? Or should some form of static or dynamic channel assignment be implemented as part of the SAS? We encourage commenters to explain in detail how any such alternative a band plan would be structured.[168]

c. Tier 3: General Authorized Access

75. We believe that for the 3.5 GHz Band to be used efficiently, we must authorize opportunistic uses beyond the Priority Access tier described above. Under our proposal, GAA devices could be used for a variety of residential, business, and enterprise purposes to offset capacity shortages and extend wireless coverage to currently unserved or underserved areas. We propose that such devices be permitted to operate only in GAA and Priority Access Zones, that they be required to register in the SAS, and that they be required to employ mitigation technologies to avoid interference with Priority Access and Incumbent Access tier users, including geo-location capabilities.[169] GAA users, regardless of the geographic zone in which they operate, would not have an expectation of protection from harmful interference. We seek comment on this proposed approach.

76. We propose that the GAA tier be licensed-by-rule as part of the new Citizens Broadband Service proposed above, subject to applicable technical rules.[170] We propose that GAA users be permitted to operate across the entire 3.5 GHz Band in GAA Zones and in at least 50 megahertz in Priority Access Zones (depending on whether Priority Access services are in active use or not at a given location).[171] We envision that many of the same devices could be used for the Priority Access and GAA tiers, with allowable power levels and interference protections managed by the SAS. We seek comment on this approach. Specifically, should GAA tier users be licensed-by-rule or should they be authorized under Part 15 of the Commission's rules? Should federal agencies be authorized as GAA users? Since GAA users would be permitted to operate in areas where some interference from Incumbent Access users could be expected, we ask below whether GAA devices should be required to incorporate flexible and resilient technologies to avoid or mitigate interference from such devices.[172]

4. Supplemental Proposal to Include the 3650-3700 MHz Band

77. In addition to the proposal set forth above for the 3.5 GHz Band, we seek comment on the potential inclusion of the 3650-3700 MHz band into the proposed regulatory regime.[173] The 3650-3700 MHz band is currently licensed on a "licensed light" basis whereby prospective operators may register for ten-year, non-exclusive, nationwide license to operate facilities in the band.[174] The Commission adopted this innovative licensing model to encourage multiple entrants and promote rapid deployment of wireless broadband services to rural and underserved areas of the country.[175] Currently there are 2,117 licensees with more than 25,000 registered sites[176] throughout the United States.[177] These

[168] We seek further comment on the technical aspects of band segmentation in Part III.C.3.b.

[169] *See infra* Part III.C.3.c.

[170] *See supra* Part III.A.3.b.

[171] *See infra* fig.1.

[172] This issue is addressed in greater detail in Part III.C below.

[173] *See supra* Part II.C.3. for a description of the current allocation and use of the 3650-3700 MHz Band.

[174] *3650-3700 MHz Report and Order and Memorandum Opinion and Order*, 20 FCC Rcd at 6511, ¶¶ 25-26.

[175] *Id.* at 20 FCC Rcd at 6503, ¶ 1.

[176] Registered sites reflect single sectors of a base station, meaning that multi-sector base stations are represented by more than one co-located registration, and also include fixed subscriber units that operate above the power limit for mobile devices.

licensees are providing a variety of important services to utility companies, public safety entities, businesses, and consumers.

78. This proceeding presents us with the opportunity to create a 150 megahertz contiguous block of spectrum that could be used by existing licensees in the 3650-3700 MHz band, as well as new licensees, to expand the services that they are already providing. Under our proposal, the Citizens Broadband Service licensing regime proposed in this *Notice* would replace the existing 3650-3700 MHz "licensed light" licensing regime for all existing and future operators. Current 3650-3700 MHz licensees would be reclassified from licensees under the existing licensed light regime to Citizens Broadband Service GAA users, subject to the service rules adopted in this proceeding. These licensees would be required to register in the SAS and avoid causing harmful interference to Priority and Incumbent Access users.

79. Under this supplemental proposal, we propose that current 3650-3700 MHz licensees be permitted to operate within Higher Power Operation Zones[178] at maximum power levels that mirror the current maximum power levels in the 3650-3700 MHz Band, subject to control by the SAS.[179] Higher Power Operation Zones would be subsets of Priority Access Zones[180] wherein the Citizens Broadband Service users would be permitted to operate at these power levels on a GAA basis. We seek comment on how these Higher Power Operations Zones should be defined, both geographically, and by population density.

80. Expanding the applicability of our proposed licensing model for the Citizens Broadband Service in this way could have significant benefits for current 3650-3700 MHz operators, new entrants, and the general public. Aside from the obvious benefits inherent in gaining access to an additional 100 megahertz of spectrum, existing operators would benefit from the new device ecosystem that is likely to develop within this space. By combining it with the 3.5 GHz Band, the utility of the band could increase, attracting new operators and encouraging the development of a larger equipment market. Economies of scale could drive down the price of equipment for current 3650-3700 MHz licensees and future Citizens Broadband licensees, making it more affordable for new and existing operators to expand their service offerings. On the other hand, including the 3650-3700 MHz Band in the Citizens Broadband Service could subject current licensees to transition costs and a potentially more complicated regulatory regime. We seek comment on the relative costs and benefits of the supplemental proposals, as compared to retaining the current framework for 3650-3700 MHz band licensees.

81. If this proposal is adopted, we anticipate providing existing 3650-3700 MHz licensees a reasonable period of time to transition from their existing system to the new licensing regime. The transition would likely entail equipment upgrades and technology conversion. We seek comment on the appropriate length for this transition period. We also seek comment on the potential costs that operators would incur as a result of this transition. Would these costs outweigh the potential public interest benefits of the proposal?

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[177] Results bases on searches conducted in ULS on October 3, 2012.

[178] Higher Power Operation Zones would be a subset of Priority Access Zones, which would correspond to the geographic area where WISPs could operate at higher power levels without causing interference to Incumbent Access users. *See supra* fig. 1.

[179] Base and mobile wireless broadband services in 3650-3700 MHz are limited to 25 watts per 25 MHz EIRP and peak EIRP power density may never exceed 1 watt in any one-megahertz slice of spectrum. 47 C.F.R. § 90.1321.

[180] In Higher Power Operation Zones, no harmful interference from Incumbent Access users would be expected and higher powered operations would be geographically distant enough from Incumbent Access users so as to minimize the possibility of harmful interference to Incumbent Access operations. *See supra* fig. 1.

82. We seek detailed comments on this proposal. In particular, commenters should address whether allocating a contiguous 150 megahertz block of spectrum for shared commercial broadband deployment in this manner is in the public interest. Commenters should also address the costs and benefits to the public and existing 3650-3700 MHz service providers associated with this proposal. How will the transition be managed for existing 3650-3700 MHz operators? What are the costs associated with such a transition? Is there any reason or benefit to treating existing stations using an unrestricted protocol in the 3675-3700 MHz band differently than those using a restricted protocol in the 3650-3700 MHz band? How will existing sharing agreements between current operators be treated? What criteria should determine whether the SAS may authorize higher power levels in a specific location? We also seek comment on the degree to which combining the bands in this manner will improve the device marketplace and drive economies of scale. What effect, if any, will these proposed changes have on existing incumbent operations in the 3650-3700 MHz Band?

5. Alternative Licensing and Spectrum Access Models

83. While we believe that the three-tiered license-by-rule approach described above would provide a comprehensive framework for authorizing and managing access to the 3.5 GHz Band, we acknowledge that other approaches could be taken to manage non-federal access to the band. To that end, we seek detailed comment on alternative licensing and spectrum access models for the 3.5 GHz Band, taking into account: (1) the need for compatible operation with Incumbent Access users, including the acceptance of interference from these users and (2) our proposed technical rules to enable small cell use in this band. Commenters should thoroughly compare and contrast their preferred alternative models to the proposals set forth herein.

84. *Two-Tier Variation.* We seek comment on whether a two-tiered model composed solely of Incumbent Access and Priority Access tiers, similar in concept to Qualcomm's Authorized Shared Access proposal, would be more appropriate for the 3.5 GHz Band.[181] Under this regulatory model, Incumbent Access users would continue to be protected from harmful interference and the remaining available spectrum would be licensed under criteria similar to those applicable to the proposed Priority Access tier. Similar database and technological coordination techniques described above would apply to this model as well and access would be permitted only within designated geographic areas. However, GAA use would not be permitted under this alternate proposal. We expect that this model would be compatible with the alternative licensing approaches described herein. We seek comment on this two-tier alternative, including the costs and benefits. What impact could this alternative have on spectrum efficiency in the 3.5 GHz Band relative to our three-tiered approach? Under this approach, should Priority Access users be allowed to operate in areas where interference could be expected from Incumbent Access users? Is there a specific licensing approach that is most compatible with this model? How would the use of a two-tiered framework affect the costs and benefits to wireless operators, enterprise users, consumers, or other potential users of the spectrum?

85. *Geographic Area Exclusive Licensing Alternative.* Rather than utilizing the license-by-rule approach described above, should the Commission entertain mutually exclusive applications for the Priority Access tier within defined geographic service areas? We note that Section 309(j) of the Communications Act provides that the Commission will resolve mutually exclusive applications accepted for spectrum licenses through competitive bidding, subject to specified exemptions.[182] Nevertheless, the Commission, consistent with Section 309(j), has the "freedom to consider all available spectrum management tools and the discretion to evaluate which licensing mechanism is most appropriate for the services being offered."[183] In licensing users of private radio spectrum, the

[181] *See* Qualcomm Spectrum Task Force Comments.

[182] *See* 47 U.S.C. § 309(j)(1).

[183] Implementation of Sections 309(j) and 337 of the Communications Act of 1934, as Amended, *Report and Order* (continued….)

Commission has traditionally limited the filing of mutually exclusive applications where "the frequencies are intensively shared, assigned on a first-come, first-served basis, and/or subject to frequency coordination."[184] Commenters that support exclusive geographic area licensing should assess the costs and benefits of this approach as opposed to a license-by-rule framework. Commenters should also consider whether the entire band should be licensed in this alternative way, or just a portion? Should the whole band be licensed on a nationwide basis, or should it be subdivided into discrete spectrum blocks and/or geographic license areas? Depending upon the characteristics of services offered by eligible Priority Access users, would Section 309(j)(2)(A) of the Communications Act prohibit competitive bidding, to the extent that the predominant use of the spectrum would be the provision of "public safety radio services, including" specified types of "private internal radio services"?[185] Commenters are also encouraged to consider the feasibility of a hybrid model in which geographic area licenses would be issued for public property or outdoor areas, while a license-by-rule approach would be employed in private property or indoor areas. Would such an approach combine benefits of both licensing models? If so, how would our proposed low-power technical rules and the propagation characteristics of the 3.5 GHz Band effectively reduce harmful interference between different kinds of users?

86. *Other Authorization Alternatives.* Alternatively, should we adopt a "licensed light" approach akin to the licensing methodology used in the 3650-3700 MHz band?[186] Or could our three-tiered framework be implemented on an unlicensed basis pursuant to Part 15 of the Commission's rules?[187] We believe that our proposed licensing framework offers certain advantages over these alternative frameworks, including a unified licensing model for both tiers of licensed service, reduced administrative burden, and the potential for improved economies of scale in the equipment marketplace. Commenters that support an alternative regulatory framework should explain in detail how an alternative approach would be structured, its legal basis, its relative costs and benefits, and the advantages it would have over our license-by-rule proposal.

B. Allocation

87. The proposed authorization approaches described in this *Notice* also raise novel questions regarding the legal status of different classes of users.

88. In the Fast Track Report, NTIA noted that, to implement its proposed licensing model a new non-federal allocation would need to be added to the Table of Frequency Allocations for Fixed and

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and Further Notice of Proposed Rulemaking, 15 FCC Rcd 22709, 22721, ¶ 25 (citing 47 U.S.C. § 309(j)(3)(D))(2000) (*Balanced Budget Act Report and Order*).

[184] Implementation of Sections 309(j) and 337 of the Communications Act of 1934 as Amended, *Notice of Proposed Rulemaking*, 14 FCC Rcd 5206, 5216 & n.61 ¶ 13 (1999). *See, e.g.,* Amendment of Part 90 of the Commission's Rules to Provide for Flexible Use of the 896-901 MHz and 935-940 MHz Band Allotted to the Business and Industrial Land Transportation Pool, et al, WT Docket No. 05-62, WT Docket No. 02-55, *Report and Order*, 23 FCC Rcd 15856 (2008) (retaining site-based licensing for B/ILT Pool and defining interference protection rights and obligations for critical infrastructure industry and other licensees).

[185] *See* 47 U.S.C. § 309(j)(2)(A); 47 C.F.R. § 1.2102(b)(1). The Commission has interpreted this statutory exclusion from auctions to extend to "utilities, railroads, transit systems, and others that provide essential services to the public at large that need reliable internal communications in order to prevent or respond to disasters or crises affecting their service to the public…[but] only to services in which these public safety uses comprise the dominant use of the spectrum." *Balanced Budget Act Report and Order*, 15 FCC Rcd at 22740, ¶ 64.

[186] *See 3650-3700 MHz Report and Order and Memorandum Opinion and Order*.

[187] *See, e.g.,* 47 C.F.R. §§ 15.707-717 (allowing the unlicensed use of the TVWS coordinated through a database).

Mobile Services.[188] NTIA also noted that this proposal, by licensing new users outside of designated exclusion zones, would limit DoD's future flexibility to implement new systems or expand its existing operations. We note that these statements regarding allocation status were made in the context of the Fast Track report's specific proposal, based on higher-powered WiMAX operations, which involved extensive exclusion zones developed for DoD radar systems that employ high transmitter power and high gain antennas.

89. The PCAST Report takes a different approach, recommending replacing the current service-specific model for spectrum management with a new database-oriented framework. Specifically, Recommendation 2.1 of the PCAST says:

> [R]ather than the current pre-allocation and assignment of spectrum, there should be a new "dynamic sharing" model that makes spectrum sharing by Federal users the norm, and also allows sharing with commercial users. Shared access to Federal spectrum should be governed according to a three-tier hierarchy: Federal primary systems would receive the highest priority and protection from harmful interference; secondary licensees must register deployments and use in a database and may receive some quality of service protections, possibly in exchange for fees; and General Authorized Access users would be allowed opportunistic access to unoccupied spectrum to the extent that no Federal Primary or Secondary Access users are actually using a given frequency band in a specific geographical area or time period. All Federal agencies should be required to cooperate in the implementation of these changes.[189]

We note that current law, international treaties, and longstanding policy rely extensively on the current "pre-allocation and assignment" concept that PCAST proposes to replace.[190] Nonetheless, we believe that our current regulatory framework is sufficiently flexible to accommodate the PCAST three-tier model.

90. Consistent with the licensing and technical rules proposed elsewhere in this *Notice*, and fully respecting the need to protect national security interests associated with incumbent users, we propose to retain the primary allocation for existing DoD radar systems. Pursuant to the Fast Track Report, we also believe that the 3.5 GHz Band should be allocated for non-federal Fixed and Mobile use. Therefore, we seek comment on how we should allocate the 3.5 GHz Band to Fixed and Mobile Services? What allocation scheme would best accomplish the goals set forth in this *Notice*? How should our allocation model account for federal small cell use of the band in addition to non-federal use? Commenters are encouraged to consider the implications of allocation changes for the relationship between different tiers of users in our proposed hierarchy generally and in specific locations, depending on specific interference scenarios.

91. We believe our proposed framework meets the requirements for the allocation of flexible use spectrum under Section 303(y) of the Act.[191] Section 303(y) allows the Commission to allocate spectrum for flexible uses if the allocation is consistent with international agreements and after a finding that (1) the allocation is in the public interest; (2) the allocation does not deter investment in communications services, systems, or development of technologies; and (3) such use would not result in

[188] *See* Fast Track Report at 1-6.

[189] PCAST Report at 15.

[190] Allocation (of a frequency band) is the entry in the Table of Frequency Allocations of a given frequency band for the purpose of its use by one or more terrestrial or space radiocommunication services or the radio astronomy service under specified conditions. This term shall also be applied to the frequency band concerned. 47 C.F.R. §§ 2.1(c), 2.106.

[191] *See* 47 U.S.C. § 303(y).

harmful interference among users.[192] A non-federal Fixed and Mobile allocation is consistent with international allocations for use of the 3.5 GHz Band.[193] Further, as explained throughout the *Notice*, we believe our proposed licensing framework for the 3.5 GHz Band will spur innovation and investment in new wireless technologies, with little to no impact on incumbent uses. Finally, the framework we propose is structured to prevent interference between users of the band through the SAS and technical and operational rules proposed herein. We seek comment on this analysis.

92. We also propose to restrict primary FSS earth station use to the FSS earth stations licensed or applied for as of the effective date of the Report and Order in this proceeding. We note that footnote NG169 contains similar grandfathering provisions for the 3650-3700 MHz band.[194] Accordingly, we propose to amend footnote NG169 to add the grandfathering provisions for the 3600-3650 MHz sub-band, to make conforming changes to the existing text of NG169. We propose to retain the primary FSS allocation but limit it to use on a primary basis in accordance with the technical parameters, including power limits, of the grandfathered earth stations. We propose to treat any new or modified station that changes the technical parameters of a grandfathered earth station as a secondary operation for purposes of interference protection.[195] We seek comment on this proposal.

93. We also note that allocations exist for a number of other incumbent operations. These include: (1) a federal allocation for ARNS;[196] (2) federal mobile ground-based radars;[197] and (3) non-federal secondary radiolocation services.[198] We will work with NTIA concerning the continued need for these federal allocations and seek comment on what allocation approach we should pursue for the non-federal secondary radiolocation services. Should we maintain the existing allocations? Again, we encourage commenters to focus on specific interference scenarios as they relate to our proposed licensing framework and important national security missions supported by the systems operating in the band.

94. Finally, regarding international coordination, Canada and Mexico utilize the 3.5 GHz Band for FSS operations. We seek comment on the potential for interference to and from existing and future international operations in the 3.5 GHz Band. We also seek comment on methods to reduce or eliminate the potential for interference along international borders.

C. Technical Proposals

1. Spectrum Access System

95. We propose to create a SAS to govern interactions between and among devices in the 3.5 GHz Band that is modeled on the TVWS database concept.[199] Current database technology can be used

[192] *Id.*

[193] *See* 47 C.F.R. §2.106.

[194] 47 C.F.R. § 2.106, note G169 (limiting FSS earth stations in 3650-3700 MHz operating on a primary basis to those that are grandfathered).

[195] While Section 316 of the Communications Act establishes an adjudicatory process for modifying individual licenses to "promote the public interest, convenience, and necessity," 47 U.S.C. § 316, the Commission may also adopt rules of general applicability that have the effect of modifying the terms of station licenses. *See, e.g., Committee for Effective Cellular Rules v. FCC*, 53 F.3d 1309, 1319 (D.C. Cir. 1995); *WBEN, Inc. v. United States*, 396 F.2d 601, 618 (2d Cir. 1968).

[196] *See* 47 C.F.R. § 2.106, note G110.

[197] *See* Fast Track Report at table 3-33; 3-4, 5-5 fig. 5-2.

[198] *See* 47 C.F.R. § 2.106.

[199] *See* 47 C.F.R. § 15, Subpart H – Television; Unlicensed Operation in the TV Broadcast Bands; Additional (continued….)

to achieve dynamic frequency assignment while mitigating interference between devices in the same frequency band. We recognize, however, that the SAS we propose would be a new iteration of database technology used to manage spectrum resources, and that its creation would require significant planning and testing. We nonetheless believe that as database and spectrum management technologies continue to develop the ability to manage spectrum resources dynamically and in real time will continue to improve. We believe that this approach holds promise in the 3.5 GHz Band and therefore propose that such database technology be used to prevent interference between small cell users and the incumbents and to manage access between tiers of authorized commercial users in the band, while protecting the integrity of critical federal information. We seek comment on the use of a dynamic spectrum access database, the SAS, to manage access and mitigate interference between all users in the 3.5 GHz Band. We also seek comment on what type of information must be included in the database and what technologies and techniques could be incorporated to protect classified and sensitive but unclassified federal data that is not publically releasable. We seek comment on the viability of the SAS described herein, including the anticipated real costs to create and manage the system relative to the benefits of freeing 100 MHz of spectrum for mobile broadband.

96. We propose that Citizens Broadband Service devices would be required to utilize integrated geo-location technology and be able to access a database that identifies incumbent users entitled to interference protection, including DoD radar and FSS earth stations. This geo-location capability would protect incumbent users and might also help Citizens Broadband Service users avoid interference from incumbents. No Citizens Broadband Service device would be permitted to operate at any power level without registering in the database and providing accurate location information. The database would assign available spectrum to Citizens Broadband Service devices in a manner that ensures that such devices would not interfere with existing radar or satellite earth station operations. Moreover, the database could manage access among tiers of users and prevent harmful interference among users operating within the same tier.

97. We seek comment generally on the SAS design and specifications necessary to ensure that access is accurately managed and interference is successfully mitigated. Building upon the Commission's experience in the TVWS context, we seek comment on the key elements of a SAS, including the architecture and number of databases or systems, the creation and management of the SAS, the parameters necessary for an effective SAS, and security measures to ensure the SAS and transmissions to and from the SAS are secure. Alternatively, consistent with PCAST's recommendation, we seek comment on whether the existing TVWS databases could be modified to include parameters necessary for facilitating coordination between and among 3.5 GHz Band users.

98. *Administration.* We seek comment on whether the Commission, a commercial entity, or another federal entity should create and manage the SAS.[200] PCAST envisions some level of federal involvement due to the need to access non-classified data and filtered classified data to facilitate

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Spectrum for Unlicensed Devices Below 900 MHz in the 3 GHz Band, *Second Report and Order and Memorandum Opinion and Order*, 23 FCC Rcd 16807, at 16877-16885, ¶¶ 201- 224 (2008) (*White Spaces Second Report and Order*). The TVWS rules provide the opportunity for both fixed and personal/portable devices to operate in the TV white spaces on an unlicensed basis. *White Spaces Second Report and Order*, 23 FCC Rcd at 16820-21, ¶¶ 32-34. The primary method of preventing interference to TV and other services is a geo-location capability of the white spaces devices combined with database access to identify vacant TV channels at specific locations. *White Spaces Second Report and Order*, 23 FCC Rcd at 16878-79, ¶¶ 204-07. The databases are established and administered by parties selected by the Commission. *See* Spectrum Bridge TVWS Database Letter; Telcordia TVWS Database Letter.

[200] We note that the Commission chose to authorize private whitespaces database administrators for TVWS services. A list of authorized TVWS database administrators is available at: http://www.fcc.gov/encyclopedia/white-space-database-administrators-guide.

spectrum sharing between federal and non-federal users.[201] What are the costs and benefits of a commercial entity as compared to a federal entity managing the SAS? Could a public-private partnership involving multiple stakeholders effectively create and manage the SAS? Could management of the system be effectively divided between different organizations, including, potentially, both federal and commercial entities?

99. We also seek comment on whether, if we opt to allow commercial entities to create and manage the database or databases, we should authorize multiple database administrators.[202] We note that, in the TVWS context, we determined that third parties "will be in the best position to develop and manage a database in a fair and equitable manner and to address the day-to-day operational demands."[203] Are there efficiencies to be gained by having multiple databases and administrators? What would be the cost for implementation, and how long would it take to design and deploy such a system? What process should be used to select qualified database managers? Should the database manager or managers be authorized to collect fees for their services, and if so, how should those fees be set and levied?

100. Finally, we seek comment on enforcement mechanisms. What would occur if a device operated outside of the parameters authorized by the SAS? Can safeguards be built in to Citizens Broadband devices and the SAS to power down any device that, due to human intervention or technical malfunction, operates in a manner inconsistent with the device's authorization? Can the devices be made effectively "tamper resistant"?

101. *SAS Data and Access*. Under our proposal, users within each tier would utilize the SAS differently to manage access and mitigate interference. In the Incumbent Access tier, the SAS would serve to enforce incumbent protections and protections from incumbents to Citizens Broadband Service users, including enforcement of the Incumbent Use Zones. Priority Access tier users would be in fixed locations, and would rely on the SAS to enforce their right to use a portion of the 3.5 GHz Band at a specific location on a protected basis. GAA users would rely on the database to identify available spectrum on a real time or near real time basis.

102. We therefore propose to incorporate into the SAS the relevant parameters, including the geographic zones of operation discussed herein,[204] necessary to protect DoD operations in the 3.5 GHz Band and grandfathered FSS sites.[205] We propose to require Priority Access tier users to register the coordinates of their locations into the database. Registration could occur manually or through an automated process facilitated by any equipment utilizing the band. We also propose to require GAA users to query the SAS at set intervals prior to and during operation. For instance, GAA devices could query the SAS anytime a device is activated, when a device is moved, or at some set time interval. We seek comment on these proposals.

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[201] *See* PCAST Report at 75.

[202] We recognize that the SAS, when implemented, may be a complex system of multiple databases managed by different entities that feed data into a central access controller. *See* Qualcomm Spectrum Task Force Comments at 7.

[203] *White Spaces Second Report and Order*, 23 FCC Rcd at 16878 ¶ 204.

[204] *See supra* fig. 1.

[205] With respect to DoD radar operations, while there is a possibility that a shipborne radar will be operating anywhere along the U.S. coast, it is unlikely that radars will be operating at all locations along the coast. In this situation, we believe that a database alone may not be the most efficient way to enable the sharing of spectrum. As described in Part III.C.3.c. *infra*, we believe there may be benefit in employing spectrum sensing techniques such as Dynamic Frequency Selection (DFS).

103. We also seek comment on issues regarding the content of and access to the database. For example, what information about stations should be included in the SAS, such as geographic coordinates, type and class of station, power level, antenna height and other antenna characteristics? How would a device access a database, and how often would a database need to be updated? How should the database account for fixed versus mobile uses? How will this approach protect other authorized services, such as mobile or airborne radar, the location of which may not be included in the SAS?

104. *Geo-location.* We propose that all Citizens Broadband Service devices be required to include geo-location technology to enable the SAS to accurately pinpoint their locations and manage access to the 3.5 GHz Band on a dynamic, real time or near real-time basis. We seek comment on this proposal, including how geo-location capabilities could be integrated into 3.5 GHz Band devices.[206] We seek comment on the availability and viability of geo-location methods to facilitate spatial sharing through the SAS. We also seek comment as to whether we should have different requirements for fixed or portable operations of Citizens Broadband devices. What are the most appropriate geo-location technologies for this purpose? Are there other options besides GPS, to the extent that much small cell use will happen indoors, where GPS signals may not be available? Are there new technologies that are cost-effective coming to market that would be available on a timely basis?

105. *Security and Transparency*. We seek comment on the security measures necessary to ensure that the information transmitted by devices accessing the database and the database itself meet the information security requirements of the different users. The accuracy of information in the SAS is critical to managing access and interference protections among users of the 3.5 GHz Band. In the TVWS proceeding, the Commission required that devices only be capable of accessing certified databases and that communications between devices and databases be transmitted using secure methods.[207] We recognize that the SAS would necessarily have to include information regarding spectrum use by government users. We seek comment on what type and level of information is necessary and any protections required to ensure that access coordination information is transmitted and stored consistent with the information security requirements of different users.

106. For instance, PCAST envisions an access system that would pull classified and non-classified data from the Federal Spectrum Management System (FSMS).[208] PCAST proposes that the FSMS should be developed to "create cross-domain access controls that permit a certified database manager to interface with the FSMS and to access non-classified data directly, but only summary or filtered access to classified information."[209] What techniques could be utilized to ensure that classified data is protected but usable by the SAS, consistent with national security requirements? What techniques could be used to protect other sensitive but unclassified federal information? Can a mechanism to identify representative technical and deployment information on the federal systems, instead of actual technical characteristics, be used (*e.g.*, energy detection)? Because this proceeding raises significant novel technical issues with respect to sharing with federal users, we expect to work closely with NTIA and relevant federal agencies to perform necessary further analysis, and we encourage commenters to provide relevant technical input to inform this analysis, where appropriate.

[206] The TVWS rules require that fixed devices are either professionally installed or are equipped with geo-location capability to within 50 meters of accuracy. 47 C.F.R. § 15.713. Certain devices access the TVWS database over the Internet and provide it with their location. *Id.* § 15.713(e). The database registers unlicensed fixed devices and records appropriate information, including the devices' location and user contact information. *Id.* § 15.713(f).

[207] *White Spaces Second Memorandum Opinion and Order*, 25 FCC Rcd at 18702-03 ¶¶ 98-100.

[208] PCAST Report at 75.

[209] *Id.*

107. We also seek comment on whether the information contained in the database should be available for public inspection. We understand that some of the information regarding incumbent government users will require protection from public inspection for national security reasons, but seek comment on whether the remainder of the data should be publicly available. As in the case of the TVWS database, it is possible that opening the data sets to public inspection will help verify data and detect errors.[210]

108. *Other Issues*. We seek comment generally on any other issues commenters believe we should consider for the creation, operation, and maintenance of the SAS. We note that the SAS proposed herein may be specific to the 3.5 GHz Band but could, ultimately, serve as a model for future sharing. We seek comment on ways to ensure the database can evolve with technology and can be adapted to accommodate additional frequency bands and access protocols over time.[211] We seek comment on the potential utility of the proposed model for other federal spectrum bands with significant federal use, and any modifications to the proposed SAS that would be necessary to incorporate additional frequencies and access protocols over time. In addition, we seek comment on whether we should rely on industry standards to facilitate sharing between Citizens Broadband Service devices operating in the same service tier.

2. Protection of Incumbent Access Users

109. In this section, we examine possible technical rules for use in the 3.5 GHz Band in order to enable the most efficient use of this band by flexible broadband technologies while ensuring that incumbent services remain protected. We examine existing and proposed geographic protections for authorized federal and grandfathered FSS users in the 3.5 GHz Band, and seek comment on methodologies for maximizing the amount of usable spectrum for new services. We believe that a combination of technical and service characteristics for small cell deployments in the 3.5 GHz Band has the potential to reduce geographic exclusion zones while still providing necessary protections for incumbents.

110. NTIA's Fast Track Report recommended that to the extent the 3.5 GHz Band is used on a shared basis, large geographic exclusion zones be imposed along the East, West, and Gulf Coasts to protect incumbent DoD shipborne radar operations.[212] Exclusion zones were also developed to protect ground-based radar systems.[213] The exclusion zones would prevent non-federal uses from interfering with DoD radar operations, but would also prevent interference from the high-powered DoD radar operations into federal uses. Similarly, when the Commission authorized the shared use of 3650-3700 MHz it adopted 150 kilometer exclusion zone around grandfathered FSS earth stations.[214] ~~The Commission allowed licensees in 3650-3700 MHz to negotiate with individual FSS earth station licensees for smaller exclusion zones~~.[215]

111. We propose to incorporate a geographic exclusion parameter to protect Incumbent Access users, to the extent necessary (Incumbent Use Zones).[216] Using the exclusion zones in the Fast

[210] *White Spaces Second Memorandum Opinion and Order*, 25 FCC Rcd at 18710, ¶ 119.

[211] The PCAST Report envisions a broader spectrum access system that would facilitate sharing between the Federal government and commercial entities across a broad swath of federally held spectrum. PCAST Report at 24-25.

[212] *See* Fast Track Report at 5-3 – 5-6.

[213] *Id.* at 3-32– 33 and E-1– E-4.

[214] *3650-3700 MHz Report and Order and Memorandum Opinion and Order*, 20 FCC Rcd at 6526, ¶ 64.

[215] *Id.* at 6526, ¶ 66.

[216] *See supra* fig. 1.

Track Report and the service rules for 3650-3700 MHz as a starting point, we believe that modifying some of the parameters on which these exclusion zones were based, in light of the small cell deployment scenarios and proposed technical rules, can reduce the size of the exclusion zones. We seek comment below on methods for ensuring that incumbent users are reasonably protected while maximizing the amount of usable spectrum.

a. RF Protection of Radar Services and Small Cells in 3.5 GHz

112. In this section, we discuss the analysis and conclusions in NTIA's Fast Track Report recommendation. Next, we examine certain assumptions that may be appropriate to revisit based on the use of small cell technology.

(i) Exclusion Zone Calculations in the Fast Track Report

113. As stated previously, NTIA's Fast Track Report identifies critical DoD radars that operate from sea, land, and airborne positions[217] within or near the 3.5 GHz Band and examines the potential for interference between these radars and commercial WiMAX broadband technology.[218] The Fast Track Report calculates "exclusion zone" separation distances, between ship borne,[219] airborne,[220] and ground-based[221] radar systems, and a prospective outdoor wide-area terrestrial mobile broadband WiMAX system.[222]

114. Exclusion zone distances are based on interference thresholds (I_T)[223] at which receiver performance starts to degrade,[224] for both radar receivers[225] and wireless broadband receivers,[226] and are based on a terrain dependent propagation model[227] and calculations[228] to determine the distance required for transmitted power to attenuate to the respective (I_T). The largest separation distances in the Fast Track Report result when a high-power radar pulse is co-channel with the wireless broadband system, and mainbeam coupling exists between the radar and wireless antennas.[229] Based on FCC staff analysis, the worst case exclusion distances in the Fast Track Report average 450 kilometers over coastal land areas, covering a U.S. population of approximately 190 million, or approximately 60 percent of the U.S.

[217] Fast Track Report, Section 3.

[218] *Id.* at Section 4.

[219] *Id.* at 5-6, Table 5-4, and Appendix D.

[220] *Id*. at 5-6, Table 5-3.

[221] *Id.* at 5-4, Table 5-2, and Appendix E.

[222] *Id*. at Appendix B.

[223] *Id*. at 4-6, Equation 4-1.

[224] Fast Track Report at 4-7, *citing* ITU Radiocommunication Sector, Procedures for Determining the Potential for Interference between Radars Operating in the Radiodetermination Service and Systems in Other Services, Recommendation ITU-R M.1461-1 (2000-2003) at Annex 1 (ITU-R Recommendation M.1461-1).

[225] *Id.* at 4-6 to 4-8.

[226] *Id*. at 4-9 to 4-11.

[227] *Id.* at 4-13 to 4-16.

[228] *Id.* at Section 4.

[229] *Id.* at 4-36 to 4-72.

population.[230] The sizes of the exclusion zones cover protection of wireless broadband systems that would operate in these populated areas due to the interference potential from high-power radar systems.

115. The Fast Track Report calculated exclusion zones based on a specific modeling approach with a number of assumptions, including especially the use of high-power, high-tower WiMAX base stations. However, our proposal for the 3.5 GHz Band is based on the use of low-power small cell devices. This use case may require much smaller exclusion zones. We believe it may be possible to reduce any exclusion zones through technical and operational parameters for small cells in combination with an effective SAS and other interference mitigation techniques. Particular attention and analysis is needed to address the harmful interference potential from high-power radar systems to the wireless broadband system. We seek comment on particular technologies and methodologies to protect commercial small cell wireless broadband systems from in-band interference from high-power radar systems.

116. The Fast Track Report states that the interference-to-noise (I/N) protection criterion (*i.e.*, the I/N that results in the maximum rise in the noise floor of the receiver to maintain acceptable performance) for interference from wireless broadband to radars operating in this band is -6 dB.[231] NTIA has also documented the analysis of communication type interference effects on various types of radars, which shows I/N thresholds varying between -2 dB and -10 dB.[232] The methodology used to calculate the aggregate interference from wireless broadband base and mobile stations to radars was based on an all-outdoor macro-cell deployment model.[233] The analysis in the Fast Track Report used to compute the exclusion zone distances for the shipborne and ground-based radar systems also makes certain assumptions for the in-band and out-of-band emission levels of the base and mobile stations. The exclusion zone distances calculated using this model range between 45 km to 310 km for different shipborne radars,[234] between 1 km to 32 km for different ground based radars (which operate outside of the 3550 – 3650 MHz band),[235] and no exclusion zone for airborne radars (which operate outside of the 3550 – 3650 MHz band).[236] Regarding interference from radars to commercial wireless broadband systems, the Fast Track Report calculates exclusion zone distances based on I/N thresholds between -6 dB and +10 dB.[237] Moreover, the Fast Track Report makes reference to previous tests and measurements that show the throughput performance of wireless broadband receivers at different levels of interference

[230] *See supra*, note 12.

[231] *See Id.* at 4-8, Table 4-5; ITU Radiocommunication Sector, Characteristics of and Protection Criteria for Radars Operating in the Radiodetermination Service in the Frequency Band 3100-3700 MHz, Recommendation ITU-R M.1.465-1 (March 2007), *available at* http://www.itu.int/dms_pubrec/itu-r/rec/m/R-REC-M.1465-1-200703-I!!PDF-E.pdf; NTIA, Interference Protection Criteria Phase 1 – Compilation from Existing Sources, Report 05-432 (October 2005), *available at* http://www.ntia.doc.gov/files/ntia/publications/ipc_phase_1_report.pdf.

[232] NTIA, Effects of RF Interference on Radar Receivers, TR-06-444 (released October 2006) at 136, Table 32, *available at* http://www.its.bldrdoc.gov/publications/2481.aspx.

[233] Fast Track Report at 4-4, 4-26, and Table 4-2. The analysis for the 3550-3650 MHz band considered both base station and mobile transmitters and receivers operating in TDD mode. The deployment had 675 base stations and 283,500 mobile stations. The base and mobile transmitters had a duty cycle of 62.5 and 37.5 percent, respectively. The total of base stations transmitting at any given instant was 422 and the total number of mobile stations was 106,313.

[234] *Id.* at 5-6, Table 5-4.

[235] *Id.* at 5-4, Table 5-2.

[236] *Id.* at 5-5 to 5-6, and Table 5-3.

[237] *Id.* at 4-9 to 4-11.

power, using interference thresholds based on the ratio of peak interference power to the desired "carrier" signal (*i.e.*, Carrier-to-Interference (C/I)), instead of I/N.[238] Further, the Fast Track Report notes that commercial "digital receivers are relatively robust in the presence of low duty cycle[239] pulsed interference."[240] We examine the case of C/I later in this section. It should be noted that our proposal addresses NTIA's concerns about interference into commercial systems by prohibiting Priority Access operations in areas where interference from DoD radars would be expected.[241] Moreover, GAA users should not have any expectation of interference protection and would be required to accept interference from Incumbent Access users, including DoD radar systems.[242] As such, our proposed spectrum management model assumes that the calculation of Incumbent Use Zones should be designed to prevent commercial interference into radar, not interference from DoD radar into commercial systems.[243] We seek comment on this assumption.

117. The net effect of the Fast Track Report modeling is that the largest exclusion zone distances are in protecting wireless broadband systems operating in the most populated areas of the country from interference from high-power Navy radars,[244] with the largest over-land protection zone distance from the shoreline averaging approximately 450 km, as illustrated in figure 2 below.[245] As noted above, we estimate that the worst case distance would cover approximately 1 million square miles (approximately 1/3 of the Continental U.S. landmass). Under this approach, approximately 190 million people or nearly 60 percent of the U.S. population would not have access to small cell technology in the 3.5 GHz band.[246]

[238] *See Id.* at notes 75 and 77, *citing* ERA Technology Ltd., Interference from Radars into Adjacent Band UMTS and WiMAX Systems (Sept 2007) at pages 46-47 (ERA Interference Report); NTIA, Measurements of Co-Channel Interference in a 4 GHz Digital Earth Station Receiver, Report 02-393 (May 2002) at page 16 (NTIA Report 02-393).

[239] Duty cycle is defined as the ratio of the sum of all pulse durations during a specified period of continuous operation to the total specified period of operation. *See* FED-STD 1037C. Available at: http://www.its.bldrdoc.gov/fs-1037/fs-1037c.htm.Federal.

[240] *Id.* at F-2.

[241] *See supra* Parts III.A.1. and A.3.b.

[242] *See supra* Parts III A.1. and A.3.c.

[243] *See supra* Part III.A.1.

[244] Fast Track Report at 5-6 to 5-7, Table 5-4 and Figure 5-3.

[245] *Id.* at 5-7, Figure 5-3.

[246] *See supra*, note 12.

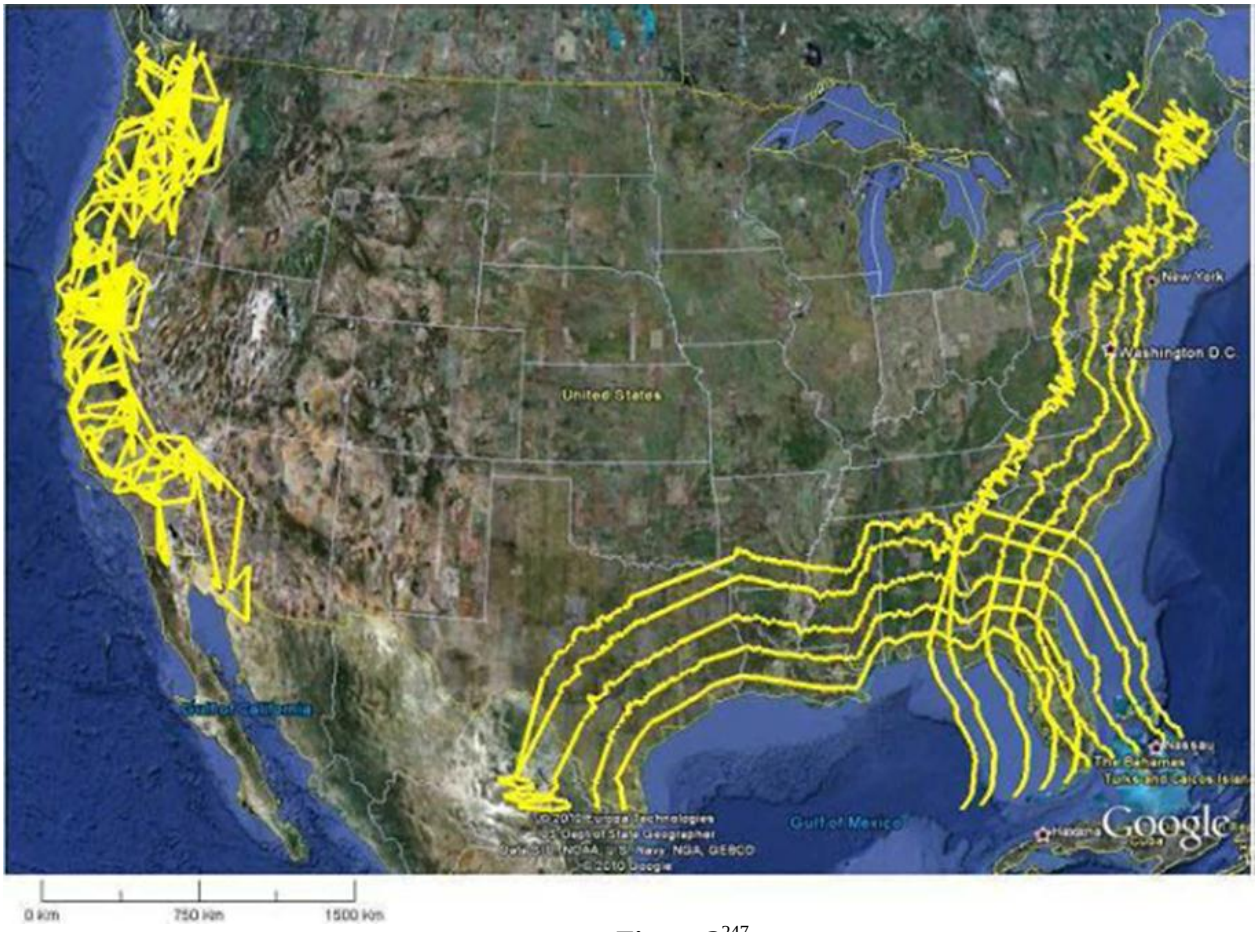

Figure 2[247]

ii. Key Interference Assumptions with Small Cells

118. In order to analyze the interference potential between small cells and radars, it is important to understand the RF factors that drive interference limits between systems. We also believe that given a small cell deployment model, some of the assumptions made in the Fast Track Report's analysis will not apply and would need to be revisited (*e.g.*, small cell antenna gain, height and location (being proposed for mostly indoor use), susceptibility to low duty cycle pulsed interference, propagation modeling, and transmit power). We expect that further analysis of these assumptions may result in less propagation loss required to meet required interference thresholds, and thereby smaller exclusion zone distances. However, reducing the exclusion zone distances may not completely address the potential interference from high-power radar systems to the wireless broadband systems, even if small cell technology is employed. The wireless broadband systems operating in the 3.5 GHz Band may need to employ interference mitigation techniques and technology that enable them to avoid or tolerate the in-band interference from the high-power radar systems. We seek comment below on proposed changes to the assumptions and technologies considered in the Fast Track Report to the modeling of exclusion

[247] Figure 2 is a map depicting a composite view of the exclusion zone distances for different shipborne radar systems as set forth in the Fast Track Report. It is based on the electromagnetic compatibility analysis documented in the Fast Track Report for Radar to wireless broadband system interaction. *See* Fast Track Report at Figure 5-3. This map does not include the ground-based radar exclusion zones set forth in the Fast Track Report. *See* Fast Track Report at Figure 5-2, plot of exclusion zones, ground-based radar systems.

zones in the 3.5 GHz band. Moreover, because this proceeding raises significant novel technical issues with respect to sharing with federal users, we expect to work closely with NTIA and relevant federal agencies to perform necessary further analysis, and we encourage commenters to provide relevant technical input to inform this analysis, where appropriate.

119. *Small Cell Characteristics.* Small cells have deployment characteristics that will reduce the RF interference coupling between commercial radio and radars, compared with the characteristics of macro cell networks. Small cells with lower antenna heights, lower transmit power, and the potential of lower gain indoor antennas along with building propagation loss, can result in reduced RF interference coupling with radar systems. We examine modeling characteristics and assumptions below from the perspective of the factors that (1) affect interference to (*i.e.*, common to) both radars and small cell stations, and (2) affect radar interference to small cells stations.

120. *Factors Common to Both Radars and Small Cells.* Factors that are common to the RF interference effects in both the direction to and from small cell stations, include antenna gain, the location of antennas (*e.g.*, height), and the RF propagation distance and environment between other systems and small cell stations. For example, a lower gain small cell antenna will reduce the effective radiated transmitted power as well as reduce the interference power from another system into small cells. Lower gain small cell antennas, that are mostly indoor, in highly attenuated (cluttered) environments, and at lower heights above average terrain, will reduce the degree of RF coupling in both directions and thereby reduce the propagation loss required to meet required interference threshold limits. We seek comment on what RF technical characteristics, deployment scenarios, and propagation models (including small cell and user station antenna gains) are the most appropriate for analyzing small cell networks with both indoor and outdoor cell sites and mobile users. We ask parties to submit propagation analysis and path loss models of small cell deployment (both indoor and outdoor) for use in determining interference impact and potential mitigation. What consideration, if any, should be given to the actual ambient RF environment noise floor (*e.g.*, in urban areas where the ambient noise floor may be higher than the thermal noise floor), versus the theoretical noise floor based on "thermal limits," when calculating protection limits? We seek comment on whether theoretical noise floor limits are overly conservative and what would be a realistic limit with respect to small cell technology. Commenting parties should provide measurements or a technical analysis to support any recommendations.

121. *Factors Affecting Radar Interference to Small Cells.* Small cell networks with closely spaced cell sites may be interference limited, versus noise limited. Interference protection thresholds based on the power of the interfering signal relative to the desired carrier signal (C/I) instead of the noise floor (I/N),[248] may significantly reduce the required separation distances defining the exclusion zones, while maintaining acceptable performance. We seek comment on the relevance and applicability of C/I thresholds for interference into wireless broadband systems especially for small cell network deployments. We seek comment on how this would impact the size of required exclusion zones.

122. While the Fast Track Report analyzes interference to commercial systems using I/N,[249] references made in the report to measurements and testing based on C/I[250] suggest that much higher power levels of radar interference may be tolerated by modern commercial radio receivers.[251] Use of a C/I criterion could lead to substantially smaller/reduced coordination or exclusion zone distances. We seek comment and request engineering studies where high power pulsed interference signals are injected into selected wireless broadband receivers (*e.g.*, LTE, WiMAX, 802.11) under controlled conditions to

[248] *Id;* ITU-R Recommendation M.1461-1 at Section 2.2.1.

[249] Fast Track Report at 4-9.

[250] *Id*. at F-2, notes 75 and 77.

[251] ERA Interference Report at 46-47; NTIA Report 02-393 at 16.

verify and analyze the interference effects to fixed or mobile stations, at varying radar signal power levels and duty cycles (various combinations of pulse width and pulse repetition frequency), and other types of modulation (*e.g.*, frequency sweeping). How effective are existing channel coding and error correction techniques in correcting for interference from pulsed radar signals, especially high duty cycle radars as those analyzed in the Fast Track Report?

123. Fixed and mobile broadband wireless access (BWA) services in the 3.3 – 3.7 GHz bands have been authorized around the world and, in many instances, "licensees have adopted and deployed BWA systems based on IEEE Std 802.16, often employing profiles for this band that have been developed by the WiMAX Forum."[252] In some cases, these bands continue to support incumbent radiolocation (radar) uses. The best practices developed by the WiMAX Forum identify several techniques that could improve sharing between WiMAX networks and radar systems.[253] These include reducing antenna coupling, beam forming, sector blanking, frequency tunability, MIMO implementation, site shielding, elevation antenna beam down-tilt, dynamic spectrum allocation, and higher layer interference mitigation. We seek comment on these and other mitigation techniques and how they can address the interference potential among and between the FSS, radars and broadband technologies in the 3.5 GHz Band. Parties proposing the use of these or other mitigation techniques should provide a technical analysis demonstrating how such techniques could be used for the 3.5 GHz Band.

b. RF Protection of Incumbent FSS Sites

124. Consistent with our proposal to create an Incumbent Access tier within the 3.5 GHz Band, we seek comment on ways to protect incumbent FSS earth stations from interference. While we take action in the *Order* portion of this document to freeze applications for new FSS earth stations in the 3600-3650 MHz Band, we intend to ensure that operation of grandfathered earth stations is not disrupted by new users in the 3.5 GHz Band. With the 150 kilometer exclusion zone imposed on operations in 3650-3700 MHz as a starting point, we seek comment on ways to reduce the exclusion zone given the nature of small cells and the technical rules proposed in this *Notice*. Is the 150 km exclusion zone distance appropriate for mobile stations?[254]

125. If we adopt geographic Incumbent Use Zones around existing FSS earth stations, we anticipate the coordinates of these zones will be incorporated into the SAS and enforced against all other users in the 3.5 GHz Band. The exclusion zone in 3650-3700 MHz was created based on the assumption that Commercial Mobile Radio Services licensees would operate high-powered WiMAX devices. What is the appropriate exclusion zone distance for future 3.5 GHz Band users given our proposal to allow only low-power small cell use in the band? What other mitigation techniques, such as spectrum sensing, could be employed to reduce or eliminate the size of these Incumbent Use Zones?

126. We also seek comment on ways to arrive at other reasonable technical protections and appropriate system architectures for the 3.5 GHz Band. Regarding the incumbent FSS earth stations, what are the potential interference scenarios we must consider? How could they be mitigated?

127. *Receiver Performance.* The PCAST report, in addition to recommending shared use of the 3.5 GHz Band, also recommended that the government take account of receiver performance as it

[252] WiMAX Forum White Paper, Radar / WiMAX Network Interference Mitigation Best Practices, WMF-M14-002-v01 (December 14, 2010), *available at* http://www.wimaxforum.org/sites/wimaxforum.org/files/document_library/WMF-M14-002-v01_WiMAX_Radar_Mitigation_Whitepaper.pdf.

[253] *Id*., at 6. Note that we recognize that WiMAX has many similar technical characteristics to other commercial wireless broadband technologies, such as Long Term Evolution (LTE).

[254] The 3650-3700 MHz band rules require that mobile and portable stations may operate only if they can positively receive and decode an enabling signal transmitted by a base station.

affects the availability of spectrum for new uses.[255] Moreover, the TAC has convened a group to make recommendations on ways to incorporate receiver performance into spectrum policy. We therefore seek comment on how performance of FSS receivers in the C-band and extended C-band may affect the potential for harmful interference and also create opportunities for mitigation of any such interference. We seek comment on the frequency response characteristics of the receivers used, including the characteristics of the low noise amplifiers (LNAs) and low noise block downconverters (LNBs)? What are the noise figures or noise temperatures of these receivers? What are the minimum carrier to noise ratios to achieve the intended data rates and throughputs? What are the input signal gain compression, overload and intermodulation interference characteristics of these receivers? If there are C-band or extended C-band earth stations with LNAs or LNBs that cover a broader frequency range than is required for reception of the desired signals, and such receiver characteristics might raise the possibility of interference from increased 3.5 GHz terrestrial activity, what is the technical feasibility of upgrading the receivers to prevent such interference? Examples might include replacing those LNAs or LNBs with units with only the necessary input frequency range or adding a filter between the antenna feedhorn and the LNA or LNB to narrow the frequency range to that required to receive the desired signals. What impact does adding such a filter have on receiver performance? How much time would be required to do so for all such earth stations? We seek comment on the potential costs associated with the implementation these new filters as well as potential compensation mechanisms should the costs be very large.

3. Technical Specifications for Priority Access and GAA Devices

128. In this section we seek comment on technical parameters that will be used to develop service rules that should govern transmissions in the 3.5 GHz Band by Priority Access and GAA users. Our overall approach is intended to: (1) maximize spectral efficiency; (2) promote a common equipment ecosystem for Priority Access and GAA tier equipment, taking advantage of economies of scale; (3) ensure that Priority Access and GAA users do not cause harmful interference to Incumbent Access users; and (4) assess methods by which Citizens Broadband Service users may be able to effectively avoid or mitigate harmful interference from Incumbent Access users. We seek comment on this overall approach, including technical specifications for Priority Access and GAA equipment, and whether the specific proposals contained herein tend to further these general goals.

a. Small Cell Technical Characteristics

129. As described above, we believe allowing small cell use in the 3.5 GHz Band would promote increased capacity through efficient reuse of spectrum, would best leverage the technical characteristics of the band, and would maximize usability of the band by facilitating geographic sharing with incumbents. We believe that Priority Access and GAA uses should generally have similar technical characteristics, in order to foster a larger equipment market that includes both kinds of uses. To this end, we propose the following technical characteristics for the band. We encourage detailed comment on these proposals, backed, where applicable, by specific technical analysis.

130. *Power Levels.* Limiting the power levels transmitted by Citizens Broadband Service users in a manner to protect against harmful interference enables spectrum sharing. This approach is used in permitting unlicensed devices to operate on nearly any frequency under Part 15 of our rules.[256] Low power devices also share frequencies on a licensed basis in ways that do not cause harmful interference to incumbent services.[257] We seek comment as to whether the 3.5 GHz Band could be shared using low power devices, and what power levels are appropriate to minimize the potential for

[255] *See* PCAST Report at 33-38.

[256] *See* 47 C.F.R. § 15.209.

[257] *See e.g.* 47 C.F.R. §95.1201, *et seq.* (Medical Device Radiocommunication Service).

interference with the incumbent users? Is there a low enough level that Incumbent Use Zones would not be required? How do power limits change if they are indoor or outdoor in terms of protecting radars and FSS stations? If the power is low, what would the impact be on service to consumers?

131. In order to ensure that the interference does not occur to in-band operation we must consider establishing appropriate power limits for base and mobile station operation. We believe that the maximum transmit power of the small cell must be at a level to protect the operation of high-powered radar and FSS and at the same time sufficient to provide adequate service to small cell broadband users. Accordingly, to limit the harmful interference to other in-band operations in the 3.5 GHz Band, we tentatively conclude that fixed station transmit power should be limited to 200 mW (23 dBm).[258] We seek comment on this tentative conclusion. We also propose and seek comment on a 7 dBi antenna gain for any installation requiring an external antenna. With the negligible cable and insertion loss, this makes the maximum EIRP 1W (30 dBm). We seek comment on this proposal. We also seek comment on whether we should establish a maximum EIRP for power and not set a requirement for antenna gain? Parties suggesting other limits are requested to provide a technical analysis. How should the elevation and azimuth gain patterns for the antenna be modeled?

132. We also seek comment on the appropriate power limit for base stations in order to prevent interference to radar and FSS operations. Since small cells may provide coverage and/or offload/capacity in both indoor and outdoor environments, we seek comment on the appropriate transmit power for both indoor and outdoor small cells. Should we set a different transmit power (or EIRP) for indoor operations and outdoor operations?

133. We seek comment on whether, in a small cell context, mobile stations should have different technical limits than base stations and if so, what these limits should be. With regard to the mobile station transmit power, we seek comment on what power level is appropriate to control interference levels and balance the link budget, especially considering the base station limits described above. Should consideration be given to establishing a very low initial maximum mobile transmit power (*e.g.*, 0 dBm), prior to authenticating the location of the transmitter station (*i.e.*, that it is not operating in an area in close proximity to in-band FSS earth stations or DoD radars) and authorizing a higher mobile transmit power limit? A low initial maximum mobile transmit power would minimize the potential interference power to incumbent stations, yet be high enough to establish (attach) communications with a serving small cell base station. We seek comment on the effectiveness of this approach to minimize potential harmful interference from new Citizens Broadband systems to Incumbent Access users.

134. Aside from the transmit power level, height-above-average-terrain of base station antenna may be a controlling factor to manage interference into other in-band operations. We seek comment on this view and whether we should include a maximum outdoor base station antenna height above the average terrain and what limitations are appropriate and feasible.

135. With deployment of low power small cells should we define a minimum emission bandwidth and/or a maximum emission bandwidth? Particularly in the Incumbent Use Zones, we seek comment on whether defining a maximum emission bandwidth would protect small cells from receiving unwanted emissions from high-powered radar. We also seek comment on whether we should define power spectral density to limit maximum power per a frequency unit?

136. *Out–of-Band and Spurious Emission Limit.* Transmissions originating in the 3.5 GHz Band may cause harmful interference to other services operating in the adjacent bands.[259] Even though

[258] FCC Public Forum, Indoor Deployments of Small Cell Sites, October 28, 2011. Some parties indicated a range of power output.

[259] Transmitter emissions are authorized to a defined frequency band with a specific bandwidth. Emissions that do not meet technical requirements are unwanted emissions that consist of spurious emissions and out of band (continued….)

small cells are aimed to transmit at low EIRP, once they operate at the close proximity of the frequency band edge, out-of-band emission (OOBE) may cause interference into the neighboring channels or neighboring bands that are providing other services. Accordingly, we seek comment on whether we need to adopt requirements to protect adjacent band operations.

137. There are three main adjacent operations that should be considered in evaluation of OOBE. Radar operates at 3500-3650 MHz, FSS earth stations that receive satellite signals at 3600-4200 MHz, and wireless broadband services that operate in the 3650-3700 MHz band.[260] We seek comment on OOBE with respect to each of these neighboring operations.

138. For example, in the 3650-3700 MHz band, we currently require compliance with 43+10log P dB out-of-band emission limit at the edge of their authorized licensed block.[261] We are not aware of any known out-of-band emission issue in 3650-3700 MHz with neighboring bands. We note that the current deployment in 3650-3700 MHz band is subject to geographic protection requirements for federal and FSS facilities and there is also a coordination requirement, which may be why there is no interference issue. Understanding the current operating environment in the 3.5 GHz Band, we seek comment on measures for limiting OOBE from Citizens Broadband Service systems into the adjacent bands. We seek comment on the appropriate OOBE limit for small cells in the 3.5 GHz Band. What are the interference protection threshold limits of relevant service(s) in adjacent bands?

139. *Equipment Authorization.* The FCC requires equipment authorization in order to ensure that the equipment is capable of meeting our interference rules. We propose that each small cell transmitter utilized for operation in 3.5 GHz Band, must be of a type that has been authorized by the Commission under the procedures set forth in Part 2 of the Commission's rules. We seek comment on this proposal. We also seek comment on what transmitter parameters should be tested as part of an equipment authorization procedure for 3.5 GHz Band equipment.

140. *Flexible and Resilient Technologies*. We seek comment on whether Citizens Broadband Service devices should be required to incorporate flexible and resilient technologies to avoid or mitigate interference from Incumbent Access users? What type of technology could be incorporated to accomplish these goals? We further propose that as a condition of FCC authorization, 3.5 GHz Band equipment employ measures to protect against permanent damage that could result from reception of high-powered radar signals operating in the band. To avoid receiver saturations and protect receivers from possible burn out, we seek comment generally on what level the RF filter and front-end of the receiver should be designed to operate in an environment to tolerate the risk of burnout due to Incumbent Access operations.[262] What maximum peak RF input power (*e.g.*, peak radar pulse power) and C/I thresholds are appropriate for protecting terrestrial small cell base stations and user devices from radar signals. What are the input power limits of existing commercial RF filters for user devices and base stations? What receiver design and engineering guidelines are appropriate for protecting small cell receivers and user devices? What are the frequency response characteristics and range of the LNA power levels for gain compression and saturation points of small cell user receivers? What are the costs

(Continued from previous page)
emissions that can become a source of interference into the other receivers operating in the adjacent channels or the adjacent bands. The main adjacent band/channel operations for 3.5 GHz are DoD radars that operate at 3.5 GHz, FSS earth stations receivers that operate at 3600-4200 MHz and commercial mobile radio service licensees that operate in the 3650-3700 MHz band.

[260] *See supra* Part II.C.3.

[261] *See* 47 C.F.R. § 90.1323(a).

[262] *See* Fast Track Report at G-1. NTIA noted "the burnout and saturation levels for base and mobile receivers are not available. In this analysis, threshold values of 0 dBm for burnout and -30 dBm for saturation are used for the large signal analysis of base and mobile receivers."

and benefits of employing these guidelines to mitigate the effects of radar interference on commercial radios?

141. We also note that the TAC is continuing its work on receivers and is contemplating an approach based on interference limits that would establish expectations as to the signal levels each service should expect to tolerate in order to have a valid claim of harmful interference. While this approach is expected to be further elaborated in the TAC, we invite comment as to whether there are receiver issues that need to be taken into account as we repurpose this spectrum, including for new services that may offered and the signal levels such as those in adjacent spectrum that should be taken into account in designing equipment.

142. *RF Exposure.* Generally, in order to protect consumers from RF exposure, we require that radio frequency devices meet our RF exposure limits. We propose that licensees in the 3.5 GHz Band be subject to the exposure requirements in Sections 1.1307(b), 2.1091 and 2.1093 of the Commission's rules.[263] We seek comment on this proposal.

143. *Environmental Compliance.* Under the National Environmental Policy Act of 1969, federal agencies are required to identify and take into account the environmental effects of their major federal actions, including actions that they entirely or partly finance, assist, conduct, regulate, or approve.[264] Similarly, the National Historic Preservation Act of 1966 (NHPA) requires federal agencies to take into account the effects of their proposed federal undertakings, including those undertakings that they permit, license, or approve, on historic properties.[265] In order to fulfill the Commission's obligations under these and other federal environmental statutes, our rules require parties constructing facilities to be used to provide licensed services to determine prior to construction whether the facilities may have certain significant environmental impacts and if so, or if otherwise directed by the licensing Bureau, to prepare an environmental assessment for Commission review.[266] Antennas mounted on an existing building or antenna tower are generally excluded from review for environmental effects other than RF exposure or, in some instances, effects on historic properties.[267] We propose to apply these environmental review requirements to licensees in the 3.5 GHz Band, and we seek comment on this proposal. We further seek comment on whether any tailoring or streamlining of our environmental requirements is appropriate in light of the physical characteristics of small cell facilities, consistent with the Commission's fulfillment of its obligations under federal environmental laws.

b. Band Segmentation

144. Spectrum segmentation is a tool that has been used successfully in the past as an interference mitigation technique. As noted above, we propose that, in Priority Access Zones, half of the 3.5 GHz Band should be available for Priority Access use with the remaining spectrum reserved for

[263] *See* 47 C.F.R. §§ 1.1307(b), 2.1091, and 2.1093.

[264] 42 U.S.C. § 4332; *see also* 40 C.F.R. § 1508.18 (defining "major Federal action").

[265] 16 U.S.C. §§ 470(f) and 470(w)(7).

[266] *See* 47 C.F.R. §§ 1.1307, 1.1308, 1.1312; *see also* National Environmental Policy Act Compliance for Proposed Tower Registrations, WT Docket No. 08-61, *Order on Remand*, 26 FCC Rcd 16700, 16730-33 at ¶¶ 77-84 (requiring on an interim basis EAs for all new registered antenna structures over 450 feet in height). The rules further specify in detail the process to be used to determine whether proposed facilities may affect historic properties under the NHPA. *See* Nationwide Programmatic Agreement for the Collocation of Wireless Antennas, 47 C.F.R. Part 1, App. B; Nationwide Programmatic Agreement Regarding the Section 106 National Historic Preservation Act Review Process, 47 C.F.R. Part 1, App. C.

[267] 47 C.F.R. § 1.1306, note 1; *see also* 47 C.F.R. Part 1, App. B (excluding most collocations from review for effects on historic properties).

GAA use.[268] We seek comment on the specific frequency ranges that would be most appropriate for this proposal.

145. We also seek comment on whether various aspects of our service rules should apply differently to different band segments in light of different levels of incumbent use throughout the band. DoD radars operate at 3500-3650 MHz and FSS earth station receivers operate at 3600-4200 MHz.[269] No FSS earth stations operate in the first 50 megahertz between 3550-3600 MHz. Should we divide the 100 megahertz of available spectrum into an upper band and lower band, and apply different service rules to each segment? Based on these parameters, is it possible to partition all or part of the 3.5 GHz Band in a manner that would improve interference management between different tiers of small cell use and incumbent services? If so, how would we design such an approach? Is band segmentation an efficient means of dividing the available spectrum? Should we consider alternative band segmentation approaches? Is there an appropriate connection between a particular band segmentation approach and the proposed multi-tiered licensing framework? We ask parties supporting different band segmentation approaches to provide a detailed analysis of their approach as well as a comparison against the proposal set forth herein.

c. Access Coordination and Interference Mitigation Techniques

146. In addition to the SAS, other access coordination and mitigation techniques may be useful in managing access to the 3.5 GHz Band and preventing harmful interference between users. We seek comment on how to incorporate these techniques into the overarching spectrum access system for the 3.5 GHz Band and how these techniques can be used to enable spectrum access for each proposed tier of users. We also seek comment on how these techniques will be used in each of the proposed geographic zones described above.[270]

147. Spectrum use occurs across a class of four individual parameters: (1) frequency; (2) location; (3) time; and (4) power level. Each of the four parameters can provide for mitigation of potential interference between incumbent services and new entrant services (as well as among new entrant services), by reducing the RF coupling between unwanted transmissions and victim receivers. Some mitigation techniques may provide benefits and promote compatibility across more than one of the parameters of spectrum use. Moreover, we recognize that a second class of interference mitigation techniques are embedded in modern receivers and transmitters, based on advanced channel coding and error correction algorithms, to mitigate the effects of received noise, interference, and other signal distortions (*e.g.*, intermodulation products) and may also assist to reduce the potential for interference. We seek comment on each approach and on how the approaches can be utilized together to further reduce the potential for interference. Generally, we seek comment on the extent to which our rules should require certain mitigation techniques or whether our rules should be left flexible to accommodate multiple technologies and standards. If the rules are flexible, how can such an approach be implemented in a way that is effective in protecting against interference with disparate technologies.

148. *Spectrum Sensing.* To ensure the protection of radar system and to avoid co-channel interference between small cells and radar receivers, we seek comment on utilizing spectrum sensing technology as a mitigation technique in 3.5 GHz Band capable small cells. Spectrum sensing devices employ a mechanism that detects the presence of radar signals and dynamically guides a transmitter to switch to another channel whenever a particular condition is met. Using this approach, prior to initiating a transmission, a device's spectrum sensing mechanism would monitor the available radar or small cell channel in a predefined band. If a signal is detected, the channel associated with that signal would either

[268] *See supra* Part III.A.3.b.

[269] *See* 47 C.F.R. § 2.106.

[270] *See supra* fig. 1.

be vacated and/or flagged as unavailable for use by the small cell device. Spectrum sensing features (also known as "dynamic frequency selection") are currently employed in 5250-5350 MHz and 5470-5725 MHz unlicensed bands.[271] We believe that similar spectrum sensing technologies could be integrated into transmitters and receivers in the 3.5 GHz Band to prevent harmful interference between the various tiers of users in a wide variety of use cases. How should the use of such technologies affect our analysis of Incumbent Use Zones? What are the advantages and disadvantages of utilizing spectrum sensing technology in a small cell environment? What are the costs associated with incorporating spectrum sensing technology into devices in the 3.5 GHz Band? Is this technology commercially available? If not, how long would it take for this equipment to become widely available on the market?

149. We also seek comment on any potential technical challenges associated with incorporating spectrum sensing technology into devices in the 3.5 GHz Band. If we were to utilize spectrum sensing capabilities for interference mitigation, what parameters should we utilize to avoid assigning the occupied channel to a small cell unit? In the case of FSS, could a beacon or other signaling technology be deployed to protect the receiver? We also seek comment on whether the radar detection techniques in use in the 5 GHz band can be applied in the 3.5 GHz Band and how complex the detection mechanism would be for new wireless technologies like LTE. Specifically, we ask commenters to provide the results of any relevant engineering tests or analyses that have been conducted in which radar signals are injected into specific broadband receivers in a controlled environment.

150. *Indoor/outdoor use.* Limiting Citizens Broadband Service use of the 3.5 GHz Band, at least in part, to indoor locations may reduce the amount of harmful interference received by incumbent users.[272] Buildings can significantly attenuate radio signals. The radio waves in the 3.5 GHz Band decay over shorter distances than the same signals in the lower frequencies where PCS and cellular services operate. The impact of propagation loss is even higher in dense urban environments where signals attenuate over shorter distances because of various phenomena like building blockage, shadowing, reflection, diffraction and scattering. All of these elements cause radio signal distortions and give rise to signal fades as well as additional signal propagation losses. Limiting use to indoor locations could also reduce the possibility of non-federal 3.5 GHz Band transmitters being installed on outdoor towers with very large line-of-sight footprints. On the other hand, limiting the 3.5 GHz band to indoor use could exclude a wide range of potential outdoor uses. We therefore seek comment on whether the benefits of limiting non-federal use of the 3.5 GHz Band to indoor spaces outweigh the costs. Could such a limitation minimize the interference from Citizens Broadband Service systems to Incumbent Access users or help limit the size of Incumbent Use Zones? What applications would be precluded by limiting Citizens Broadband Service devices to indoor use only? What consideration should be given to the tradeoffs between these factors? We also seek comment on approaches that can be used to model the effects of building attenuation. We ask that parties provide technical information supporting recommendations for modeling building attenuation.

151. We note that one difficulty with relying on indoor use as an interference mitigation strategy is that, once a piece of equipment is sold, it is difficult to exercise control over how that device will be used. We seek comment on ways to ensure that equipment that is authorized for indoor use is not modified in ways that make it deployable in outdoor locations. Are there technologies that can ensure an

[271] *See* 47 C.F.R. § 15.407(h)(2).

[272] In the Unlicensed National Information Infrastructure (U-NII) service the Commission restricted devices in the 5.15-5.25 GHz sub-band to indoor use only with an appropriate power limit. Amendment of the Commission's Rules to Provide for Operation of Unlicensed NII Devices in the 5 GHz Frequency Range, *Report and Order*, 12 FCC Rcd 1576, 1595-96, ¶ 44 (1997) (*U-NII Report and Order*); 47 C.F.R. § 15.407(e). The Commission believed that the indoor restriction would help ensure that devices do not cause harmful interference to co-channel Mobile Satellite Service feeder links "due to the attenuation of U-NII device signals as they pass through the walls and ceilings of buildings." *U-NII Report and Order*, 12 FCC Rcd at 1595-96, ¶ 44.

indoor system only operates when the attenuation provided by the building walls is sufficient to preclude harmful interference to incumbent systems? If so, what are the costs of such technologies?

152. *Other Mitigation Techniques.* There are a variety of other mitigation techniques that could be used to prevent interference both between Citizens Broadband Service users and incumbents, between Priority Access and GAA users, and between individual users within the same tier. We seek comment on alternative mitigation techniques that could be utilized to manage access and mitigate harmful interference in the 3.5 GHz Band. Specifically, we seek comment on: (1) the potential impact of duty cycle and average power on limiting interference between Incumbent Access users and Citizens Broadband Service users; (2) the use of time sharing technologies; (3) the use of automatic power control technology for base and fixed stations and mobile devices in the 3.5 GHz Band; and (4) the use of embedded mitigation techniques such as channel coding with forward error correction, adaptive modulation and coding schemes, and multiple input multiple output technology; (5) the use of beaconing technology; and (6) the possibility of requiring 3.5 GHz Band devices to have the capability of switching to other spectrum bands that they are authorized to use in the event of harmful interference from Incumbent Use tier operators in the band. Commenters should address the costs and benefits of their proposed alternative or supplemental mitigation approaches and provide technical analyses to support their arguments.

153. We believe it will be advantageous to adopt mitigation techniques to protect against the potential for interference for authorized users and new entrants in the 3.5 GHz Band. Some of the mitigation techniques described above may be employed cooperatively with other mitigation techniques resulting in greater compatibility then could be achieved by either technique individually. We seek comments on the network architecture and signaling capabilities as well as the synergies that could be realized by combining two or more of these mitigation techniques. We request comments as to any other techniques and the potential application of standard-based technologies for policy management that could be utilized to mitigate any potential interference between Citizens Broadband Service systems and Incumbent Access users in the 3.5 GHz Band. Commenters should address the costs and benefits of their proposed mitigation techniques in detail and, where applicable, compare and contrast their proposals to those set forth in this *Notice.* Commenters should also provide relevant technical information supporting their proposal.

IV. ORDER

154. *Freeze on New Earth Stations.* To preserve the stability of the spectral environment in the 3.5 GHz Band and ensure that opportunities continue to exist for wireless broadband services as proposed in the foregoing *Notice*, we direct the International Bureau to stop accepting applications in the 3600-3650 MHz band for new earth stations in the fixed-satellite service that are more than 10 statute miles from a licensed earth station's coordinates for the duration of this proceeding. This application freeze is narrowly tailored to ensure a stable spectral ecosystem for the proposed Citizens Broadband Service, while providing reasonable opportunities to obtain suitable real estate for the placement of new FSS earth station facilities near the 37 grandfathered stations identified in Appendix A. In light of the limited number of such grandfathered stations, such a freeze is expected to meet the immediate needs of earth station operators without significantly reducing the availability of spectrum for wireless broadband services by prohibiting expansion of new FSS earth stations in the 3600-3650 MHz band segment.

155. The decision to impose this freeze is procedural in nature, and therefore the freeze is not subject to the notice and comment requirements of the Administrative Procedure Act.[273] Moreover, for

[273] *See* 5 U.S.C. § 553(b)(A); *see also, e.g., Neighborhood TV Co. v. FCC*, 742 F.2d 629, 637-38 (D.C. Cir. 1984) (holding that the Commission's filing freeze is a procedural rule not subject to the notice and comment requirements of the Administrative Procedure Act); *Buckeye Cablevision, Inc. v. United States*, 438 F.2d 948, 952-53 (6th Cir. 1971); Kessler v. FCC, 326 F.2d 673 (D.C. Cir. 1963).

the reasons set forth above, in these circumstances there is good cause to find that notice and comment are impractical, unnecessary, and contrary to the public interest because it would undercut the purposes of the freeze.[274] For the same reasons, and in order to avoid undercutting the purposes of the freeze, we find that there is good cause for making the freeze effective as of the release date of this *Notice*.[275]

V. CONCLUSION

156. By this *Notice* we propose to create a new Citizens Broadband Service in the 3.5 GHz Band to unleash the benefits of wireless broadband access for a substantial number of consumers. If implemented, we believe that the proposals in this *Notice* will maximize the utility of the 3.5 GHz Band for the greatest number of consumers, businesses, and critical users while protecting important federal and non-federal incumbents from harmful interference. Moreover, we believe the three-tiered licensing model proposed herein will allow new services to flourish, will promote investment and innovation in new wireless technologies, and will ensure that incumbent operations – including mission critical DoD operations – are protected from harmful interference. We also believe that this innovative approach could ultimately serve as a model for shared access to spectrum in several other bands currently being used by federal operators, improving efficiency across the spectrum ecosystem and helping to address the growing demand for spectrum for broadband uses.

157. We realize that this is a complex proceeding, presenting a variety of novel issues. We look forward to working with DoD and NTIA as well as private industry, public interest groups, and academia to develop a comprehensive record on the proposals set forth herein. To that end, we may release additional notices, analyses, white papers, or other documents as necessary to supplement the record during this proceeding.

VI. PROCEDURAL MATTERS

A. Ex Parte Rules

158. The proceeding this *Notice of Proposed Rulemaking* initiates shall be treated as a "permit-but-disclose" proceeding in accordance with the Commission's *ex parte* rules.[276] Persons making *ex parte* presentations must file a copy of any written presentation or a memorandum summarizing any oral presentation within two business days after the presentation (unless a different deadline applicable to the Sunshine period applies). Persons making oral *ex parte* presentations are reminded that memoranda summarizing the presentation must (1) list all persons attending or otherwise participating in the meeting at which the *ex parte* presentation was made, and (2) summarize all data presented and arguments made during the presentation. If the presentation consisted in whole or in part of the presentation of data or arguments already reflected in the presenter's written comments, memoranda or other filings in the proceeding, the presenter may provide citations to such data or arguments in his or her prior comments, memoranda, or other filings (specifying the relevant page and/or paragraph numbers where such data or arguments can be found) in lieu of summarizing them in the memorandum. Documents shown or given to Commission staff during *ex parte* meetings are deemed to be written *ex parte* presentations and must be filed consistent with section 1.1206(b).[277] In proceedings governed by section 1.49(f)[278] or for which the Commission has made available a method of electronic filing, written *ex parte* presentations and memoranda summarizing oral *ex parte* presentations, and all

[274] *See* 5 U.S.C. § 553 (b)(B).

[275] *See* 5 U.S.C. § 553 (d)(3); *See also id.* § 553(d) (30 day notice provision applicable only to a "substantive" rule).

[276] 47 C.F.R. § 1.1200 *et seq.*

[277] 47 C.F.R. § 1.1206(b).

[278] 47 C.F.R. § 1.49(f).

attachments thereto, must be filed through the electronic comment filing system available for that proceeding, and must be filed in their native format (*e.g.*, .doc, .xml, .ppt, searchable .pdf). Participants in this proceeding should familiarize themselves with the Commission's *ex parte* rules.

159. We exempt from the disclosure requirement under our *ex parte* rules all *ex parte* presentations made by NTIA or Department of Defense representatives.[279] This *Notice* raises significant technical issues implicating federal and non-federal spectrum allocations and users. Staff from NTIA, DoD, and the FCC have engaged in technical discussions in the development of this *Notice*, and we anticipate these discussions will continue after this *Notice* is released. We believe that these discussions will benefit from an open exchange of information between agencies, and may involve sensitive information regarding the strategic federal use of the 3.5 GHz Band. Recognizing the value of federal agency collaboration on the technical issues raised in this *Notice*, NTIA's shared jurisdiction over the 3.5 GHz Band, the importance of protecting federal users in the 3.5 GHz Band from interference, and the goal of enabling spectrum sharing to help address the ongoing spectrum capacity crunch, we find that this exemption serves the public interest.

B. Filing Requirements

160. Pursuant to Sections 1.415 and 1.419 of the Commission's rules,[280] interested parties may file comments and reply comments on or before the dates indicated on the first page of this document. Comments may be filed using: (1) the Commission's Electronic Comment Filing System (ECFS), (2) the Federal Government's eRulemaking Portal, or (3) by filing paper copies.[281]

- Electronic Filers: Comments may be filed electronically using the Internet by accessing the ECFS: http://www.fcc.gov/cgb/ecfs/ or the Federal eRulemaking Portal: http://www.regulations.gov.
- Paper Filers: Parties who choose to file by paper must file an original and one copy of each filing. If more than one docket or rulemaking number appears in the caption of this proceeding, filers must submit two additional copies for each additional docket or rulemaking number.

  Filings can be sent by hand or messenger delivery, by commercial overnight courier, or by first-class or overnight U.S. Postal Service mail. All filings must be addressed to the Commission's Secretary, Office of the Secretary, Federal Communications Commission.

  - All hand-delivered or messenger-delivered paper filings for the Commission's Secretary must be delivered to FCC Headquarters at 445 12th St., SW, Room TW-A325, Washington, DC 20554. All hand deliveries must be held together with rubber bands or fasteners. Any envelopes must be disposed of before entering the building. The filing hours are 8:00 a.m. to 7:00 p.m.
  - Commercial overnight mail (other than U.S. Postal Service Express Mail and Priority Mail) must be sent to 9300 East Hampton Drive, Capitol Heights, MD 20743.
  - U.S. Postal Service first-class, Express, and Priority mail must be addressed to 445 12th Street, SW, Washington DC 20554.

[279] *See* 47 C.F.R. §1.1204

[280] *See id*. §§ 1.415, 1.419.

[281] *See* Electronic Filing of Documents in Rulemaking Proceedings, GC Docket No. 97-113, *Report and Order*, 13 FCC Rcd 11322 (1998).

161. Comments, reply comments, and *ex parte* submissions will be available for public inspection during regular business hours in the FCC Reference Center, Federal Communications Commission, 445 12th Street, S.W., CY-A257, Washington, D.C., 20554. These documents will also be available via ECFS. Documents will be available electronically in ASCII, Microsoft Word, and/or Adobe Acrobat.

162. To request information in accessible formats (Braille, large print, electronic files, audio format), send an e-mail to fcc504@fcc.gov or call the FCC's Consumer and Governmental Affairs Bureau at (202) 418-0530 (voice), (202) 418-0432 (TTY). This document can also be downloaded in Word and Portable Document Format (PDF) at: http://www.fcc.gov.

163. For additional information on this proceeding, please contact Paul Powell of the Wireless Telecommunications Bureau at (202) 418-1613 or Paul.Powell@fcc.gov .

C. Initial Regulatory Flexibility Analysis

164. As required by the Regulatory Flexibility Act of 1980 (RFA),[282] the Commission has prepared an Initial Regulatory Flexibility Analysis (IRFA) relating to the foregoing *Notice*. The IRFA is attached to this document as Appendix B. Written public comments are requested on the IRFA. These comments must be filed in accordance with the same filing deadlines as comments filed in response to this Notice of Proposed Rulemaking as set forth on the first page of this document and have a separate and distinct heading designating them as responses to the IRFA.

D. Initial Paperwork Reduction Act Analysis

165. This *Notice* contains proposed new and modified information collection requirements. The Commission, as part of its continuing effort to reduce paperwork burdens, invites the general public and the Office of Management and Budget (OMB) to comment on the information collection requirements contained in this *Notice*, as required by the Paperwork Reduction Act of 1995, Public Law 104-13. In addition, pursuant to the Small Business Paperwork Relief Act of 2002, Public Law 107-198,[283] we seek specific comment on how we might "further reduce the information collection burden for small business concerns with fewer than 25 employees." The foregoing *Order* does not contain new or modified information collection requirements subject to the PRA or, therefore, any new or modified information collection burden for small business concerns with fewer than 25 employees, pursuant to the SBPRA.

E. Congressional Review Act

166. The Commission will not send a copy of the foregoing *Order* pursuant to the Congressional Review Act, see 5 U.S.C. § 801(a)(1)(A), because the application freeze implemented in such *Order* is a rule of agency organization, procedure, or practice that does not substantially affect the rights or obligations of non-agency parties. *See id.* § 804(3)(C).

[282] *See* 5 U.S.C. § 603. The RFA, *see* 5 U.S.C. § 601 *et. seq.*, has been amended by the Small Business Regulatory Enforcement Fairness Act of 1996 (SBREFA), Pub. L. No. 104-121, Title II, 110 Stat. 857 (1996). The SBREFA was enacted as Title II of the Contract With America Advancement Act of 1996 (CWAAA).

[283] *See* 44 U.S.C. § 3506(c)(4).

VII. ORDERING CLAUSES

167. Accordingly, IT IS ORDERED, pursuant to Sections 1, 2, 4(i), 4(j), 7, 301, 302(a), 303, 307(e), and 316 of the Communications Act of 1934, as amended, 47 U.S.C. §§ 151, 152, 154(i), 154(j), 157, 301, 302(a), 303, 307(e), and 316, that this *Notice of Proposed Rulemaking and Order* in GN Docket No. 12-148 IS ADOPTED.

168. IT IS FURTHER ORDERED that license applications for new earth stations in the fixed-satellite service, which would receive on frequencies in the 3600-3650 MHz band on a primary basis, filed on or after December 12, 2012, shall not be accepted unless frequencies in this same band are currently licensed to an earth station within 10 miles of the requested coordinates.

FEDERAL COMMUNICATIONS COMMISSION

Marlene H. Dortch
Secretary

APPENDIX A

FSS Earth Stations Receiving in the 3600-3650 MHz Band

Earth Station No.	State	City	Call Sign	Coordinates
1	CA	Livermore	KA232	37° 45' 40.0" N, 121° 47' 53.0" W
2	CA	Malibu	E980066	34° 04' 52.6" N, 118° 53' 52.9" W
			KA273	34° 04' 50.3" N, 118° 53' 46.4" W
			KA91	34° 04' 49.7" N, 118° 53' 43.9" W
			KB32	34° 04' 51.0" N, 118° 53' 44.0" W
3	CA	Mountain Home	KA86	37° 45' 01.7" N, 121° 35' 38.8" W
4	CA	Napa	E950307	38° 14' 43.7" N, 122° 16' 50.9" W
5	CA	Nuevo	E010206	33° 47' 46.1" N, 117° 05' 15.1" W
			E020169	33° 47' 46.5" N, 117° 05' 15.0" W
			E020314	33° 47' 46.0" N, 117° 05' 14.0" W
			E020315	33° 47' 45.0" N, 117° 05' 15.0" W
6	CA	Salt Creek	KA371	38° 56' 20.2" N, 122° 08' 48.0" W
			KA372	38° 56' 21.0" N, 122° 08' 49.2" W
			KA373	38° 56' 22.3" N, 122° 08' 49.6" W
7	CA	San Ramon	E6241	37° 45' 39.7" N, 121° 47' 56.8" W
8	CA	Santa Paula	KA31	34° 24' 05.0" N, 119° 04' 26.0" W
			KB34	34° 24' 05.0" N, 119° 04' 29.4" W
			KA249	34° 24' 05.0" N, 119° 04' 29.4" W
			E980136	34° 24' 06.0" N, 119° 04' 21.8" W
9	CA	Somis	KA318	34° 19' 31.0" N, 118° 59' 41.0" W
10	CA	Sylmar	KA274	34° 19' 04.0" N, 118° 29' 00.0" W
			E6148	34° 18' 55.0" N, 118° 29' 12.0" W
11	CT	Southbury	KA312	41° 27' 06.3" N, 073° 17' 21.4" W
			KA313	41° 27' 06.3" N, 073° 17' 16.4" W
			WA28	41° 27' 05.0" N, 073° 17' 21.0" W
			WB36	41° 27' 05.3" N, 073° 17' 19.4" W
			WB36	41° 27' 05.1" N, 073° 17' 19.0" W
12	FL	Medley	E960068	25° 51' 19.0" N, 080° 19' 52.0" W
13		Miami	KA407	25° 48' 35.0" N, 080° 21' 10.0" W
			KA412	25° 48' 35.0" N, 080° 21' 11.0" W
14	GUM	Pulantat	KA28	13° 25' 00.0" N, 144° 44' 57.0" E
15	GUM	Yonagu	KA326	13° 25' 05.2" N, 144° 45' 05.7" E
16	HI	Haleiwa	E080059	21° 40' 10.4" N, 158° 01' 59.4" W
			KA25	21° 40' 14.6" N, 158° 02' 03.1" W
17	HI	Kapolei	E010016	21° 20' 08.0" N, 158° 05' 25.0" W
			E980250	21° 20' 12.6" N, 158° 05' 21.1" W
			E100091	21° 20' 10.2" N, 158° 05' 18.0" W
			E030087	21° 20' 09.0" N, 158° 05' 25.0" W
18	HI	Paumalu	KA265	21° 40' 27.0" N, 158° 02' 16.0" W
			KA266	21° 40' 15.5" N, 158° 02' 06.1" W
			KA267	21° 40' 14.1" N, 158° 02' 06.1" W
			KA270	21° 40' 24.0" N, 158° 02' 16.0" W
19	MD	Clarksburg	KA260	39° 13' 05.0" N, 077° 16' 12.0" W
			KA275	39° 13' 07.0" N, 077° 16' 12.0" W

Earth Station No.	State	City	Call Sign	Coordinates
			KA259	39° 13' 05.6" N, 077° 16' 12.4" W
			KA263	39° 13' 04.4" N, 077° 16' 13.9" W
			KA264	39° 13' 05.2" N, 077° 16' 13.9" W
20	MD	Hagerstown	KA262	39° 35' 57.0" N, 077° 45' 23.0" W
			E030071	39° 35' 57.9" N, 077° 45' 17.3" W
			E030082	39° 35' 57.9" N, 077° 45' 21.4" W
			E030100	39° 35' 59.6" N, 077° 45' 21.4" W
			E030101	39° 35' 59.6" N, 077° 45' 17.4" W
			E030103	39° 35' 59.1" N, 077° 45' 18.4" W
			E000296	39° 35' 54.0" N, 077° 45' 35.0" W
			KA261	39° 35' 57.0" N, 077° 45' 22.0" W
			E100118	39° 35' 55.0" N, 077° 45' 22.0" W
21	ME	Andover	E000700	44° 38' 01.2" N, 070° 41' 51.3" W
			KA386	44° 37' 58.2" N, 070° 41' 55.3" W
			KA349	44° 37' 58.2" N, 070° 41' 54.0" W
22	NJ	Franklin	E6777	41° 07' 04.0" N, 074° 34' 33.0" W
23	NY	Hauppauge	E950436	40° 49' 15.4" N, 073° 15' 48.4" W
24	PA	Catawissa	E980493	40° 53' 39.3" N, 076° 26' 19.8" W
25	PA	Roaring Creek	KA444	40° 53' 35.9" N, 076° 26' 22.6" W
			WA33	40° 53' 37.5" N, 076° 26' 21.8" W
26	PR	Humacao	E872647	18° 09' 05.0" N, 065° 47' 20.0" W
27	PR	San Juan	E050314	18° 24' 23.9" N, 066° 01' 46.6" W
28	TN	Nashville	E960050	36° 14' 05.7" N, 086° 45' 21.4" W
			E960073	36° 14' 05.7" N, 086° 45' 19.4" W
			E970010	36° 14' 06.2" N, 086° 45' 20.4" W
29	VA	Alexandria	KA81	38° 47' 36.0" N, 077° 09' 59.0" W
			E970267	38° 47' 38.0" N, 077° 09' 46.0" W
30	VA	Bristow	E000696	38° 47' 02.4" N, 077° 34' 21.9" W
			E000152	38° 47' 01.6" N, 077° 34' 24.3" W
			E000726	various
31	VA	Sterling	E030336	38° 59' 07.0" N, 077° 26' 45.0" W
32	VA	Quicksburg	E000589	38° 43' 45.4" N, 078° 39' 25.1" W
			E990175	38° 43' 45.4" N, 078° 39' 24.2" W
33	WA	Brewster	KA294	48° 08' 50.5" N, 119° 41' 33.2" W
			E960222	48° 08' 51.0" N, 119° 41' 29.0" W
			E120128	48° 08' 50.0" N, 119° 41' 28.0" W
34	WA	Yacolt	KA221	45° 51' 46.4" N, 122° 23' 44.3" W
			KA323	45° 51' 45.5" N, 122° 23' 43.8" W
35	WV	Albright	KA413	39° 34' 07.0" N, 079° 34' 45.0" W
36	WV	Etam	KA378	39° 16' 50.0" N, 079° 44' 13.0" W
			WA21	39° 16' 48.0" N, 079° 44' 14.0" W
37	WV	Rowlesburg	KA351	39° 16' 52.1" N, 079° 44' 10.7" W

APPENDIX B

Initial Regulatory Flexibility Analysis

1. As required by the Regulatory Flexibility Act of 1980, as amended (RFA),[1] the Commission has prepared this Initial Regulatory Flexibility Analysis (IRFA) of the possible significant economic impact on a substantial number of small entities by the policies and rules proposed in this *Notice*. Written comments are requested on this IRFA. Comments must be identified as responses to the IRFA and must be filed by the deadlines for comments on the *Notice*. The Commission will send a copy of the *Notice*, including this IRFA, to the Chief Counsel for Advocacy of the Small Business Administration (SBA).[2] In addition, the *Notice* and IRFA (or summaries thereof) will be published in the Federal Register.[3]

A. Need for, and Objectives of, the Proposed Rules

2. By this *Notice*, we propose to create a new Citizens Broadband Service in the 3.5 GHz Band to promote widespread shared small cell use of the band while protecting existing operators. The 3.5 GHz Band is currently used for DoD Radar services and commercial FSS earth stations (space to earth). If implemented, the Citizens Broadband Service would help to unleash broadband opportunities for consumers throughout the country, particularly in areas with overburdened spectrum resources.

3. We propose to structure the Citizens Broadband Service according to a multi-tiered shared access model that mirrors the recommendations in the PCAST Report. The three tiers of service would be: (1) Incumbent Access; (2) Priority Access; and (3) GAA. The Incumbent Access tier would consist solely of authorized Federal and grandfathered licensed FSS 3.5 GHz Band users. The Priority Access tier would consist of a portion of the 3.5 GHz Band designated for small cell use by certain critical, quality-of-service dependent users at specific, targeted locations. The GAA tier would be assigned for use by the general public on an opportunistic, non-interfering basis within designated geographic areas.

4. Under our proposal, the Citizens Broadband Service would be managed by an SAS incorporating a dynamic spectrum database and, potentially, other interference mitigation techniques. The SAS would ensure that Citizens Broadband Service users operate only in areas where they would not cause interference to incumbent users (Incumbent Access, Priority Access, and GAA Zones) and could also help manage interference protection among different tiers of Citizens Broadband Service users. In general, under this three-tiered licensing proposal we believe incumbent users would be able to operate on a fully protected basis, while the technical benefits of small cells could be leveraged to facilitate innovative and efficient uses in the 3.5 GHz Band.

5. We also offer a supplemental proposal to integrate the 3650-3700 MHz band within the proposed Citizens Broadband Service, thereby encompassing an additional 50 megahertz of contiguous spectrum. The Commission currently licenses the 3650-3700 MHz band on a non-exclusive basis, with protections for incumbent FSS operations. Under this supplemental proposal, The SAS would authorize existing licensees as GAA users in the larger, combined band, and would authorize higher power levels in less congested areas, provided there is no risk of interference to Incumbent Access or Priority Access operations. This proposal contemplates conversion of the existing non-exclusive licensing framework to the proposed Citizens Broadband Service license-by-rule regime.

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[1] *See* 5 U.S.C. § 603. The RFA, *see* 5 U.S.C. §§ 601–612, has been amended by the Small Business Regulatory Enforcement Fairness Act of 1996 (SBREFA), Pub. L. No. 104-121, Title II, 110 Stat. 857 (1996).

[2] *See* 5 U.S.C. § 603(a).

[3] *See id*.

B. Legal Basis

6. The proposed action is authorized under Sections 1, 2, 4(i), 4(j), 7, 301, 302(a), 303, 307(e), and 316 of the Communications Act of 1934, as amended, 47 U.S.C. §§ 151, 152, 154(i), 154(j), 157, 301, 302(a), 303, 307(e), and 316.

C. Description and Estimate of the Number of Small Entities to Which the Proposed Rules Will Apply

7. 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, if adopted.[4] The RFA generally defines the term "small entity" as having the same meaning as the terms "small business," "small organization," and "small governmental jurisdiction."[5] In addition, the term "small business" has the same meaning as the term "small-business concern" under the Small Business Act.[6] A small-business concern" is one which: (1) is independently owned and operated; (2) is not dominant in its field of operation; and (3) satisfies any additional criteria established by the SBA.[7]

8. In the following paragraphs, the Commission further describes and estimates the number and type of small entities that may be affected by the proposals set forth in the *Notice*. However, since the 3.5 GHz Band is not currently used by small businesses for terrestrial broadband, the proposed new service is unlikely to impose significant new burdens on small businesses. However, if our proposals were adopted, small businesses that choose to use the Citizens Broadband Service on a Priority Access or GAA basis would most likely be required to comply with new registration and compliance requirements, including registration in the SAS. In addition, any device manufacturers that choose to manufacture devices for use in the 3.5 GHz Band will have to ensure that such devices comply with any rules adopted in this proceeding. Finally, if our supplemental proposal to incorporate the 3650-3700 MHz band into the proposed Citizens Broadband Service is adopted, these new rules will apply to any small businesses currently licensed to operate in the 3650-3700 MHz band.

9. *Small Businesses, Small Organizations, and Small Governmental Jurisdictions.* The proposals set forth in the *Notice*, 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 2009, small businesses represented 99.9% of the 27.5 million 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.

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[4] *See* 5 U.S.C. § 603(b)(3).

[5] *See* 5 U.S.C. § 601(6).

[6] *See* 5 U.S.C. § 601(3) (incorporating by reference the definition of "small-business concern" in the Small Business Act, 15 U.S.C. § 632). Pursuant to 5 U.S.C. § 601(3), the statutory definition of a small business applies "unless an agency, after consultation with the Office of Advocacy of the Small Business Administration and after opportunity for public comment, establishes one or more definitions of such term which are appropriate to the activities of the agency and publishes such definition(s) in the Federal Register."

[7] *See* 15 U.S.C. § 632.

10. *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 (except satellite). The size standard for that category is that a business is small if it has 1,500 or fewer employees. For this category, census data for 2007 show that there were 1,383 firms that operated for the entire year. Of this total, 1,368 firms had 999 or fewer employees and 15 had 1000 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 proposed action.

11. *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 2002, there were a total of 1,041 establishments in this category that operated for the entire year. Of this total, 1,010 had employment of under 500, and an additional 13 had employment of 500 to 999. Thus, under this size standard, the majority of firms can be considered small.

12. *3650-3700 MHz Band Licensees.* In March 2005, the Commission released an order providing for the nationwide, non-exclusive licensing of terrestrial operations, utilizing contention-based technologies, in the 3650 MHz band (i.e., 3650–3700 MHz). As of April 2010, more than 1270 licenses have been granted and more than 7433 sites have been registered. The Commission has not developed a definition of small entities applicable to 3650–3700 MHz band nationwide, non-exclusive licensees. However, we estimate that the majority of these licensees are Internet Access Service Providers (ISPs) and that most of those licensees are small businesses.

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

13. Under the Commission's proposal, all Citizens Broadband Service devices must comply with technical and operational requirements aimed at preventing interference to Incumbent Access and Priority Access users, including: complying with technical parameters (*e.g.*, power and unwanted emission limits) as well as RF exposure requirements for the type of device; and incorporation of geo-location capabilities. Citizens Broadband Service users would be required to register such devices in the SAS.

14. In addition, if our supplemental proposal to incorporate the 3650-3700 MHz band into the proposed Citizens Broadband Service is adopted, small businesses operating in this band will be required to transition from the current non-exclusive nationwide licensing approach to the Citizens Broadband Service license-by-rule approach. This will likely entail additional costs and administrative burdens. In the *Notice*, we seek comment on the extent of any such potential burdens.

15. While our proposals would require small businesses to register in the SAS and comply with the rules established for the Citizens Broadband Service, they would receive the ability to access spectrum that is currently unavailable to them. On balance, this would constitute a significant benefit for small business.

E. Steps Taken to Minimize the Significant Economic Impact on Small Entities, and Significant Alternatives Considered

16. The RFA requires an agency to describe any significant, specifically small business, alternatives that it has considered in reaching its proposed 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 and reporting requirements under the rule for such 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."[8]

17. In the *NPRM*, the Commission proposes that all Citizens Broadband Service users register in the SAS which will manage interference between different tiers of users. The *NPRM* specifically invites comments on a range of potential technical, legal, and policy aspects of its proposal, including equipment authorization requirements and the specific mechanics of the SAS. At this time, the Commission has not excluded any alternative proposal concerning the operation of the Citizens Broadband Service from its consideration, but it would do so in this proceeding if the record indicates that a particular proposal would have a significant and unjustifiable adverse economic impact on small entities. The Commission also solicits alternative licensing proposals, especially those that would not incur significant and unjustifiable adverse impacts on small entities.

18. With regard to the supplemental proposal to include the 3650-3700 MHz band, we seek comment on the costs and benefits of extending the Citizens Broadband Service to this band. We also specifically seek comment on the projected cost to existing 3650-3700 MHz licensees and the amount of time it would take such licensees to transition to the new proposed licensing regime.

F. Federal Rules that May Duplicate, Overlap, or Conflict with the Proposed Rules

19. None.

[8] 5 U.S.C. § 603(c)(1) – (c)(4).

STATEMENT OF
CHAIRMAN JULIUS GENACHOWSKI

Re: ***Amendment of the Commission's Rules with Regard to Commercial Operations in the 3550-3650 MHz Band, GN Docket No. 12-354***

It is now beyond debate that our country is facing a spectrum crunch. As recently as 2007, a mere 4 percent of the U.S. mobile consumers owned a smartphone. By the end of 2008, the number had grown to approximately 15 percent. Today, a majority of Americans have smartphones, which generate many times more data traffic than the old standard mobile phones. In 2009, the iPad hadn't been introduced. Today, more than one-third of Americans have tablets or e-readers, adding materially to demand on spectrum. These devices are being adopted faster than any communications or computing device in history and, as a result U.S. mobile data traffic grew almost 300 percent last year, and mobile traffic is projected to grow an additional 16-fold by 2016.

We saw this coming, and in 2009 sounded the alarm on the spectrum crunch.

In our National Broadband Plan, we set aggressive targets for freeing up spectrum for broadband, licensed and unlicensed, and introduced new ideas for doing so. Since then, incentive auctions have moved from proposal to law, with the Commission moving strongly and swiftly to implementation. We have moved forward on a next generation of unlicensed spectrum use, building on the concept that gave us Wi-Fi. And we are on track to meet our target of freeing up 300 MHz of spectrum by 2015.

Today's action is a major step toward unleashing an additional 100 megahertz of spectrum for broadband use.

It is also progress on major innovations in spectrum policy and technology. This is important because, to achieve our ambitious spectrum goals, we must continue look beyond traditional approaches and supplement them with new ways to unleash the airwaves for broadband. Spectrum is a scarce asset with transformative power – power to drive private investment, innovation, and economic growth; strengthen our global competitiveness; and provide broad opportunity to all Americans.

Specifically, today's proposal promotes two major policy and technology innovations that will advance our global competitiveness, and demonstrate our leadership in mobile: spectrum sharing and small cells. These innovations will help seize the opportunity of wireless broadband, economic opportunities as well as advances healthcare, education, energy and other uses yet to be discovered that touch people's lives every day. Both of these policies will help consumers capitalize on the massive opportunities presented by the expansion of wireless broadband.

Small cells are key elements of next-generation mobile networks, providing additional coverage in underserved areas and additional capacity where macro networks are overburdened, and improving the user experience for consumers and businesses. In the future, millions more small cells will be deployed, adding capacity and sucking up data demand. Earlier this year, global deployment of small cells surpassed macrocells.

Providing a dedicated band for small cell use will encourage further innovation and investment in this technology and facilitate the development of new business models, advancing our economy and benefitting consumers.

To maximize use of this band, today's proposal sets forth a comprehensive spectrum sharing model that reflects the Administration's commitment to exploring innovative ways to make use of scarce

spectrum resources, which also includes the recent launching of incentive auctions. These accomplishments would not have been possible without bi-partisan efforts.

The proposal envisions a three-tiered spectrum access model that broadly reflects the innovative thinking and recommendations made in a report this past summer by the President's Council on Science and Technology (PCAST), which includes distinguished members from academia, the technology industry, and the public interest community. The three tiers of service are Incumbent Access, Priority Access, and General Authorized Access.

The proposal will enable widespread deployment of small cell technologies across the 3.5 GHz Band, while ensuring that incumbent federal operations are protected from harmful interference. The General Authorized Access tier will permit innovative uses of small cell technology by the general public. The quality-assured Priority Access tier will be available on a hyper-local basis to important facilities such as hospitals, utilities, government facilities, and public safety entities for applications such as private broadband networks. Access to the 3.5 GHz Band would be managed and controlled by a dynamic spectrum access system, building on database technology used in the Television White Spaces.

Today's proposal reflects close cooperation and extensive coordination with NTIA and the Department of Defense, in particular. I thank all our federal partners for their engagement. We will continue to work closely with these and other affected federal agencies throughout the process.

I also look forward to continuing our productive dialogue with the members of PCAST, public interest groups, the technology community, wireless carriers, researchers, and others as we seek to ensure that the 3.5 GHz Band is put to its highest and best use.

America has regained global leadership in mobile. We have more 4G LTE subscribers than the rest of the world combined, and we are setting the pace on innovation in mobile software and devices. This leadership means that, like it or not, we face a particularly acute challenge in addressing exploding mobile demand.

This proposal today is one of many steps we are taking to meet that challenge.

Thank you to each of my colleagues on the Commission for continuing to work together to free up spectrum for broadband use and innovative approaches to spectrum management. Thank you also to the Wireless Telecommunications Bureau, Office of Engineering and Technology, and International Bureau for your thoughtful, creative and profoundly important work in this area and on this item. Thank you in particular to John Leibovitz in the Wireless Bureau for his leadership on this issue.

STATEMENT OF
COMMISSIONER ROBERT M. MCDOWELL

Re: ***Amendment of the Commission's Rules with Regard to Commercial Operations in the 3550-3650 MHz Band, GN Docket No. 12-354***

I am pleased that we are taking steps today to explore the possibility of introducing commercial operations in a heavily encumbered but potentially useful spectrum band. The 3550-3650 MHz band is currently used for military and satellite operations and its scope covers about 60 percent of the U.S. population. Nonetheless, we seek to learn whether newer, more agile technologies and spectrum sharing protocols could potentially free up the unencumbered portions of this band for non-governmental uses, including commercial mobile broadband services.

Specifically, we propose a three-tiered "Citizens Broadband Service," managed by a spectrum access system that would include a dynamic database and potentially other interference mitigation techniques. Although I do not necessarily agree with all of the findings of the recent report issued by the President's Council of Advisors on Science and Technology, I nonetheless support the undertaking we launch today. Just as with our efforts to introduce unlicensed low-powered commercial services in the TV white spaces, a project that I have ardently supported since arrival at the Commission, I am hopeful that this experiment in the 3.5 GHz range will promote additional investment and innovation that could be useful to consumers in other bands. Our decision to ensure development of a comprehensive record through additional notices, analyses or white papers, prior to releasing final draft rules is consistent with this educational approach.

I thank the staff of the Wireless Telecommunications Bureau and the Office of Engineering and Technology for your thoughtful work.

STATEMENT OF
COMMISSIONER MIGNON L. CLYBURN

Re: ***Amendment of the Commission's Rules with Regard to Commercial Operations in the 3550-3650 MHz Band, GN Docket No. 12-354***

There is no question that the Nation's seemingly endless demand for commercial fixed and mobile wireless services, makes it critically important for policymakers to design quicker ways to repurpose, and promote more efficient use of spectrum. I commend Chairman Genachowski for fast tracking rule making proceedings which should accomplish these twin policy goals.

The Incentive Auction NPRM we adopted, this past September, advances both of these priorities through a comprehensive process design that would allow broadcast TV licensees to voluntarily relinquish spectrum for wireless services reallocation. It also proposes a band plan and rules that would enable wireless carriers to continue using unlicensed Wi-Fi offload services to efficiently manage smartphone traffic on their networks.

This 3.5 GHz item is another great example of the Commission moving quickly to employ creative approaches toward finding more spectrum for commercial wireless services and promoting more efficient spectral uses. The NPRM initiates a proceeding, to implement the recommendations the President's Council on Science and Technology made, this past summer to share underutilized Federal spectrum to the maximum extent possible. PCAST recognized that these recommendations would represent a major evolution of existing spectrum management practices and that the transformation would be difficult and take a long to implement.

This item is a terrific start to adopting the first element of the PCAST recommendations -- commercial services sharing 100 megahertz of spectrum, in the 3550 and 3650 MHz bands that is currently allocated for Federal agency use. In the structure for licensing and using the 3.5 GHz band, the NPRM incorporates two new technological advances that can substantially increase our Nation's efficient use of spectrum: First, greater use of small cell network deployments, much like the small cell architecture, that large wireless carriers use now to offload their smartphone traffic on to unlicensed Wi-Fi networks. Second, it proposes a Spectrum Access System that would employ the concepts used, to establish the successful TV White Space databases.

The NPRM is structured to develop a comprehensive record on a wide range of issues, such as appropriate licensing schemes; flexible interference mitigation techniques; appropriate deployment strategies for 3.5 GHz band; and proposals for the Spectrum Access System database that would manage access to and use of the 3.5 GHz Band.

The NPRM also improves on the PCAST recommendation, by proposing ways to use 150 megahertz of spectrum, by including the 3650 to 3700 megahertz bands. These bands are used extensively by wireless Internet service providers, or WISPs, to provide commercial broadband service in rural and other underserved areas. This proposal would bring greater spectrum availability and equipment scale economies to WISPs and other current 3650-3700 MHz licensees.

Thanks are due to Paul Powell for his presentation and, I wish to commend Ruth Milkman and her creative staff, for presenting such an outstanding NPRM.

STATEMENT OF
COMMISSIONER JESSICA ROSENWORCEL

Re: ***Amendment of the Commission's Rules with Regard to Commercial Operations in the 3550-3650 MHz Band, GN Docket No. 12-354***

Today we are taking a peek into the future of wireless topology, technology, and policy. It's an exciting thing, and how we got here makes it all the more interesting.

Back in 2010, the National Telecommunications and Information Administration (NTIA) first identified the 3.5 GHz band as one of the spectrum bands most suitable for shared use between government and commercial interests. At the time, NTIA's proposal did not receive rave reviews. The need to protect existing users in the band, including Department of Defense radars and commercial fixed satellite services, meant significant geographic limitations. As a result, the ability to make use of this spectrum was limited in some of the most populous areas of the country. Moreover, because the band is above 3 GHz, it held little appeal for mobile broadband. After all, signals at high frequency like this can fade too quickly.

As a result, for some time, the outlook for commercial opportunity in the 3.5 GHz band was not good. But now, based on recommendations from the President's Council of Advisors on Science and Technology, rather than discarding this band as junk, we are staring at new opportunities for small cells. This is a big deal.

So with this proceeding, we are exploring the future of wireless network topology. Small cells can expand connectivity and facilitate more efficient use of existing frequencies. They can cover areas that cannot be reached using macro cell services and at the same time do not present the same interference risk. In fact, the very physical characteristic that was once considered a weakness of this band—its short propagation distance—can be turned into its strength. How cool is that?

We are also exploring the future of wireless system technology. To protect existing users, access to the 3.5 GHz band will require new database systems that facilitate dynamic spectrum access. These essential databases will protect the critical services that are already using this band.

Finally, we are looking at the future of wireless policy. The demand for our airwaves is going up and the supply of unencumbered spectrum is going down. We need creative spectrum policy responses. This approach is just that. It multiplies possibilities in the 3.5 GHz band while protecting existing users. This is interesting, creative, merits our attention—and has my full support.

Thank you to the Office of Engineering and Technology, the Wireless Telecommunications Bureau, and the International Bureau for their work on this important rulemaking.

STATEMENT OF
COMMISSIONER AJIT PAI

Re: ***Amendment of the Commission's Rules with Regard to Commercial Operations in the 3550-3650 MHz Band, GN Docket No. 12-354***

This afternoon, we launch a proceeding to explore the prospect of spectrum sharing and small cell use in the 3.5 GHz band. In order to free up more spectrum for mobile broadband, we must be willing to think creatively and to study out-of-the-box ideas. And we should approach spectrum policy from a practical perspective, not a theoretical or an ideological one. Our lodestar should be simple: what works?

It is in this spirit that I will examine the record that will be compiled in this proceeding. Can our proposals be implemented in the real world? If so, can they be executed in a timely manner? I am eager to hear from carriers, equipment manufacturers, federal government agencies, and other stakeholders on these important questions. If at that point we decide to ratify the proof of concept, we still will need the benefit of their wisdom on whatever specific technical rules we propose.

One issue I will be interested in examining is whether we can keep exclusion zones small. Approximately 60 percent of the U.S. population would not be able to use the 3.5 GHz band under the exclusion zones proposed in the National Telecommunications and Information Administration's Fast Track Report. This is especially troubling because the substantial majority of spectrum-limited markets fall within these zones. For example, if we cannot shrink these zones substantially, the 3.5 GHz band would not benefit Americans who live in New York City, Boston, Philadelphia, Washington, D.C., Miami, Tampa, Orlando, Atlanta, New Orleans, Houston, Dallas, San Diego, Los Angeles, San Francisco, Portland, Seattle, and Denver. (Fortunately, most Kansans from Overland Park to Goodland would do just fine.)

I hope that small cells will enable us to have much smaller exclusion zones and that commenters will provide us with valuable feedback on this issue. I also hope that the Commission will soon take action to exempt small cells from our environmental processing requirements. Small cells hold much promise for improving network coverage and capacity at lower power, and we shouldn't impede their deployment in the 3.5 GHz band (or any other bands) with unnecessary red tape.

My vote today should not be interpreted as an endorsement of all the recommendations contained in the recent report by the President's Council of Advisors on Science and Technology. I do not support abandoning the tried-and-true method of spectrum clearing and instead relying exclusively on spectrum sharing to make available additional spectrum for commercial use. In particular, I believe that we still must focus on clearing federal spectrum on lower frequencies for commercial use, starting with the 1755–1780 MHz band. By thinking creatively about all options, such as establishing financial incentives for federal users to relocate, we can make this and other bands usable for mobile broadband.

Finally, I would like to thank the staffs of the Wireless Telecommunications Bureau, International Bureau, and Office of Engineering Technology for their hard work on this item. I also look forward to receiving their counsel on the many difficult issues we will confront as we assess whether and how to implement the framework set forth in this NPRM.