



UNITED STATES DEPARTMENT OF COMMERCE
National Telecommunications and
Information Administration
Washington, D.C. 20230

Mr. Julius P. Knapp
Chief, Office of Engineering and Technology
Federal Communications Commission
445 12th Street, SW
Washington, DC 20554

MAR 24 2015

RE: Commercial Operations in the 3550-3650 MHz Band (GN Docket No. 12-354)

Dear Mr. Knapp:

The National Telecommunications and Information Administration (NTIA) appreciates that the Federal Communications Commission (FCC) will soon adopt final rules in the above-referenced proceeding to facilitate sharing between a new Citizens Broadband Radio Service (CBRS) and federal incumbents in the 3550-3650 MHz band (3.5 GHz Band).¹ This rulemaking addresses advanced sharing with commercial operations to improve wireless broadband connectivity. NTIA's 2010 *Fast Track Report* identified the 3.5 GHz Band as potentially suitable for commercial broadband use, subject to certain geographic limitations.² The 3.5 GHz Band is one of the candidate bands identified by NTIA in response to the President's initiative to make available 500 megahertz of spectrum for commercial wireless broadband.³

The 3.5 GHz Band is well suited to exploring the next generation of shared spectrum technologies, driving greater productivity and efficiency in spectrum use. In this letter, NTIA responds to the *3.5 GHz Band FNPRM* for the purposes of: (1) proposing specific changes to the regulatory framework of the spectrum sharing model to effectively protect federal operations and maximize available spectrum available for commercial broadband; (2) outlining a phased implementation and approval process for commercial access to the 3.5 GHz Band; (3) designating smaller zones for the protection of federal systems based on new technical analysis; (4) addressing protection of commercial operations in the 3.5 GHz Band from federal radar systems; and (5) correcting the rules regarding an active protected federal radar site in the 3650-3700 MHz band.

¹ See Amendment of the Commission's Rules with Regard to Commercial Operations in the 3550-3650 MHz Band, *Further Notice of Proposed Rulemaking* in GN Docket No. 12-354, 29 FCC Rcd 4273 (Apr. 23, 2014) (*3.5 GHz Band FNPRM*); see also *Notice of Proposed Rulemaking* in GN Docket No. 12-354, 27 FCC Rcd 15594 (Dec. 12, 2012) (*3.5 GHz Band NPRM*).

² 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, and 4200-4220 MHz, 4380-4400 MHz Bands* (Nov. 15, 2010) (*Fast Track Report*), available at http://www.ntia.doc.gov/reports/2010/FastTrackEvaluation_11152010.pdf; see also Letter from Karl B. Nebbia, Assoc. Admin., Office of Spectrum Mgt., NTIA, to Julius Knapp, Chief, Office of Eng. and Tech., FCC (Jan. 19, 2011).

³ See Memorandum for the Heads of Executive Departments and Agencies, *Unleashing the Wireless Broadband Revolution* (rel. Jun. 28, 2010), published at 75 Fed. Reg. 38387 (Jul. 1, 2010).

Regulatory Framework

The functional elements of the CBRs regulatory framework in the 3.5 GHz Band as proposed by the FCC include: the Spectrum Access System (SAS), Citizens Broadband Radio Service Device (CBSD), and user equipment (UE). As described below, we agree with this functional characterization of the CBRs, but recommend the addition of a fourth component, which we call the “Environmental Sensing Capability” (ESC). We believe that these four functional elements, acting in concert under the rules, can enable an advanced sharing regime that effectively protects federal operations while maximizing spectrum available for commercial use.

Spectrum Access System. The SAS is the network-based system for authorizing commercial use of the band, acting as the frequency coordinator for Priority Access (PA) and General Authorized Access (GAA) tier users. We recommend that the FCC require any SAS to have the following capabilities:

- Authorize CBSDs to operate at a given location given certain parameters such as the operating frequency and maximum transmit power level;
- Ensure that PA and GAA users do not operate in the exclusion zones established to protect federal radar systems;
- Synchronize with other SASs to ensure protection of federal systems;
- Operate without any connectivity to any military or other sensitive federal databases or systems;
- Ensure operational information (*e.g.*, on the movements or positions of federal systems) is not stored, retained, transmitted, or disclosed;
- Provide for manual override by area or time that has the capability to trigger changes in commercial use necessary to comply with general FCC enforcement actions or to respond to emergency instructions from the President of the United States, or another designated federal government entity, issued pursuant to Section 606 of the Communications Act, as amended.⁴

In general, we believe the SASs with these capabilities can play an important role to enable spectrum sharing between federal and non-federal users in the band.

Citizens Broadband Service Device. The term CBSD refers to network infrastructure nodes (*i.e.*, a base station or group of base stations). The CBSD transmits local data (*e.g.*, geo-location) to the SAS and receives authorization instructions from the SAS. A CBSD maintains power control over connected UEs at all times.

⁴ 47 U.S.C. § 606.

User Equipment. UEs are the end user devices (*i.e.*, mobile handsets) that communicate with the CBSD. The UEs operate at low power and are authorized and power controlled by a CBSD.⁵

Environmental Sensing Capability. NTIA recommends that an ESC should be included as an optional functional element of the regulatory framework. NTIA's review of the public record indicates that many commenters proposed employing sensing technologies to augment the SAS, better enabling cooperative, opportunistic access to the spectrum.⁶ NTIA agrees with these commenters and believes that sensing will help provide maximum flexibility to commercial PA and GAA tier users as well as allow for the continued protection and evolution of federal use in the 3.5 GHz Band. Based on ESC inputs, the SAS would instruct commercial users to vacate a channel when proximity to federal use (in frequency, location, or time) presents a risk of harmful interference. The inputs from the ESC can be used by the SAS to direct the PA and GAA tier users to another channel or, if necessary, to cease transmissions to avoid potential harmful interference to federal radar systems.

An ESC would consist of a system of sensors that inform a SAS about the presence of incumbent federal operations that need to be protected. NTIA recommends that rules governing an ESC reflect the following objectives:

- *Commercially-owned and operated.* The ESC should be commercially owned and operated by SAS administrators or a third-party servicing one or more SAS administrators. The Federal Government should not be expected to operate an ESC.
- *Technological flexibility.* Sensing of incumbent radar signals could be accomplished through a dedicated sensing infrastructure, device-based sensing, or a combination of the two.
- *Non-retention and disclosure of military operations.* The ESC shall not store or disclose platform movement or position information with respect to sensitive data related to military operations, nor should it be implemented in a manner that could provide insights into operations of federal systems or otherwise affect the Department of Defense's (DoD) operational security posture.

⁵ The typical equivalent isotropically radiated power (EIRP) level for UE is less than 23 dBm in the channel bandwidth. The FCC proposed a 10 megahertz channel measurement bandwidth. See *3.5 GHz Band FNPRM* at 4296 ¶ 74.

⁶ See, e.g., Wireless Innovation Forum *3.5 GHz Band NPRM* Comments at 3 (Feb. 20, 2013); Spectrum Bridge Inc. *3.5 GHz Band NPRM* Comments at 19 (Feb. 20, 2013); Shared Spectrum Company *3.5 GHz Band NPRM* Comments at 8-10 (Feb. 20, 2013); White Space Alliance *3.5 GHz Band NPRM* Comments at 2 (Feb. 17, 2013); InterDigital Inc. *3.5 GHz Band NPRM* Comments at 9, 16, and 17 (Feb. 20, 2013); Wireless Internet Service Provider Association *3.5 GHz Band NPRM* Reply Comments at 16 (Apr. 5, 2013); Dynamic Spectrum Alliance *Ex Parte* filing at 6-7 (Mar. 17, 2014); BLINQ Networks *Ex Parte* filing at 7, 11, 12, and 18; Ericsson *3.5 GHz Band FNPRM* Comments at 25 (Jul. 14, 2014); Telcordia Technologies Inc. *3.5 GHz Band FNPRM* Comments at 7 (Jul. 14, 2014); Federated Wireless *3.5 GHz Band FNPRM* Comments at 24-28 (Jul. 14, 2014); Verizon and Verizon Wireless *3.5 GHz Band FNPRM* Comments at 15 (Jul. 14, 2014); Federated Wireless *3.5 GHz Band FNPRM* Reply Comments at 2, 6, and 7 (Aug. 15, 2014); BLINQ Networks *3.5 GHz Band FNPRM* Reply Comments at 8 and 9 (Aug. 15, 2014); Google Inc. *3.5 GHz Band FNPRM* Reply Comments at 5 and 6 (Aug. 15, 2014); and Public Interest Spectrum Coalition *3.5 GHz Band FNPRM* Reply Comments at 32 and 33 (Aug. 15, 2014).

- *Geographic relevance.* The ESC will not be necessary everywhere, but only in the vicinity of the exclusion zones established to protect the federal radar systems (*i.e.*, along the coasts for shipborne radars and near facilities used for ground-based radar operations).

Implementation and approval of an ESC is key to authorizing dynamic spectrum access within geographic protection zones, which otherwise will be treated as static exclusion zones.

Phased Implementation and Approval Process

NTIA recommends that the FCC use a phased approach to effectuate the SAS and ESC rules and approval process. In the first phase, one or more approved SASs (without ESC) will enforce coastal and ground-based static exclusion zones to protect federal radar systems from commercial small cell operations. Provisions should be included in the SAS to address evolving federal operations, emphasizing adaptability by commercial users. This should include adapting to future use of the band by new radar systems introduced into the band by federal agencies. In the second phase, one or more approved ESCs will allow conversion of the exclusion zones to dynamic protection zones and also allow for higher-power commercial operations in the 3.5 GHz Band. The FCC will oversee and administer the SAS and ESC approval processes in consultation with NTIA and DoD.

Phase 1. In the first phase, any SAS that demonstrably meets all of the functional requirements specified in the FCC rules, including those recommended above, can be approved. The SAS may authorize operation of CBSDs with an EIRP level of less than 30 dBm as measured in a 10 megahertz bandwidth outside of the exclusion zones established to protect the federal radar systems. The SAS will also manage spectrum access among the PA and GAA tier users outside the exclusion zones.

Phase 2. In the second phase, any ESC that demonstrably meets all of the ESC regulatory requirements can be approved. With approved SAS and ESC operations, the exclusion zones for the coastal areas and the ground-based radars can effectively be converted to protection zones. The ESC deployment may be near the protection zones (*i.e.*, not nationwide) to meet the radar protection requirements. NTIA and DoD will work with the FCC to establish the parameters for authorizing the ESC, such as the detection threshold, time to detect, and time to vacate a channel. As a baseline, we expect that these parameters will be calibrated to permit wireless operation up to 30 dBm per 10 MHz EIRP inside the protection zones. In the *3.5 GHz Band FNPRM*, the FCC also proposed higher EIRP levels for CBSDs (*e.g.*, 47 dBm per 10 MHz EIRP in rural areas).⁷ We believe the rules may authorize CBSDs at higher EIRP levels than 30 dBm provided that the relevant system parameters required to protect DoD operations at these higher levels are determined through the ESC approval process. NTIA will work with the FCC and DoD in the determination of these parameters when ESC applications are received.

⁷ *3.5 GHz Band FNPRM* at 4296 ¶ 74.

NTIA believes that the different approval phases can occur with respect to each individual SAS and ESC provider and its associated users. Once a provider is approved to operate a SAS, the first phase begins for that provider and its users. After a provider is approved for both a SAS and an ESC, the second phase would begin for that provider and its users. Application for and approval of the SAS and ESC may be performed simultaneously for a given provider, combining the first and second phases into a single consolidated phase. Authorization of both the SAS and the ESC is conditioned on compliance with all regulations and subject to continual FCC oversight in consultation with NTIA and DoD.

Smaller Zones to Protect Federal Operations

In its *Fast Track Report*, NTIA concluded that geographic separation and frequency offsets could be used to minimize interference between a deployment of commercial high-power macro-cell networks and federal shipborne, ground-based, and airborne radar systems that operate or are planned to operate in and adjacent to the 3.5 GHz Band.⁸ Based on the analysis in the *Fast Track Report*, NTIA recommended large exclusion zones along the Continental United States coastlines (east, west, and gulf) and exclusion zones around selected ground-based radar sites. The *3.5 GHz Band FNPRM* indicated that the FCC would work with NTIA to reassess the exclusion zone distances using lower-powered small cell technology.⁹ NTIA engineers, with technical assistance from the FCC staff and DoD experts, performed further analysis to re-evaluate the exclusion zone distances needed to protect federal shipborne and ground-based radar systems.¹⁰

Shipborne Radar Protections. Using technical and deployment parameters for commercial small cell systems, as well as improvements in the propagation modeling in urban areas, the use of a terrain dependent propagation model, area specific clutter losses, and building attenuation loss for indoor devices, NTIA developed a model to compute revised exclusion zone distances for shipborne radar systems. Instead of uniformly distributing CBSD access points across a geographic area, NTIA used Geographic Information System (GIS) data from the U.S. Census Population database and the National Land Cover Database to more accurately predict deployment of the CBSD transmitters in areas representing urban, suburban, and rural regions.¹¹ The model uses Monte Carlo analysis techniques to statistically vary the technical, deployment, and environmental parameters used to compute the exclusion zone distances. The revised exclusion zone distances are based on a percentage of the total iterations of the Monte Carlo analysis as opposed to using a maximum or worst-case distance to establish the exclusion zone. This updated analysis results in a reduction of 77 percent of the total geographic area impacted by the coastal exclusion zones (averaged across three shipborne radar systems) compared to the

⁸ *Fast Track Report* at 1-6.

⁹ *3.5 GHz Band FNPRM* at 4276 ¶ 5.

¹⁰ This analysis has not yet considered states, territories, and U.S. possessions outside the Continental United States.

¹¹ The population data is based on the 2010 U.S. Census data available at <http://www.census.gov/geo/maps-data/data/gazetteer2010.html>. The National Land Cover Database data is available at <http://www.mrlc.gov/>.

Fast Track Report's findings. The results of the shipborne radar analysis are given in Enclosure 1.

In addition to the coastal exclusion/protection zones established for shipborne radar operations, there is a need to protect short duration non-emergency use of the shipborne radars during scheduled visits to ports located on inland waterways. NTIA believes that given the advanced notice associated with these types of events, the shipborne radars can be protected by temporarily extending the revised coastal exclusion/protection zones to include the port areas. Steps would have to be taken to protect the sensitive information on ship movements and to give reasonable notice to CBSD operators. NTIA will work with DoD and the FCC to develop the necessary procedures to adequately protect these types of temporary shipborne radar operations.¹²

There is also a need to protect a limited number of facilities used by DoD and its contractors for the development and testing of shipborne radar systems in the 3.5 GHz Band.¹³ Zones will be established around these test sites using NTIA's revised coastal exclusion/protection zone engineering methodology. There may be site-specific characteristics that can be employed to minimize the impact of the zones on CBSD operations; however, additional time is required to tailor the analysis for each test site. NTIA will work with DoD and the FCC to ensure these facilities can continue to support the development of shipborne radars in the 3.5 GHz Band.

Ground-Based Radar Protections. Similarly, NTIA revisited the protection zones around ground-based radar operations. The new model also uses Monte Carlo analysis techniques to statistically vary the technical, deployment, and environmental parameters used to compute the exclusion zone distances to commercial small cell systems. The result of the analysis is that a protection zone of 3 kilometers (reduced from 40 to 60 kilometers recommended in the *Fast Track Report*) is required around the perimeter boundary of each DoD installation listed in Enclosure 2 where these ground-based radars are deployed.¹⁴ Frequency assignments for these ground-based radars are authorized on a location-by-location basis. To the extent that the underlying frequency assignments change, we will notify the FCC and SAS providers accordingly. As noted above, we anticipate that sensing of these incumbent radar signals could be accomplished by positioning sensors near the established exclusion zones rather than on a nationwide basis.

¹² This procedure would apply to non-routine, non-coastal/ inland waterway port visits other than homeport visits. For example, it would not be used in the following major homeport areas already protected by the coastal exclusion zones: Norfolk, VA; Jacksonville, FL; Seattle/Puget Sound, WA; and San Diego, CA.

¹³ The following DoD and contractor test sites are used by 3.5 GHz Band shipborne radars: Saint Inigoes, MD; Wallops Island, VA; Yuma, AZ; White Sands, NM; China Lake, CA; Dahlgren, VA; McKinney, TX; Sudbury, MA; and Moorestown, NJ.

¹⁴ GIS shapefiles for most military installations are publicly available at <https://catalog.data.gov/dataset/tiger-line-shapefile-2012-series-information-file-for-the-nation-military-installation-nationalc303a>.

Protection of Commercial Operations

In the *Fast Track Report* analysis, NTIA considered interference to and from the commercial systems in establishing the initial recommended exclusion zones. The distances used to establish the exclusion zones were based on the protection of commercial systems from federal radar systems.¹⁵ The analysis performed by NTIA for the *Fast Track Report* considered small-signal interference (*e.g.*, degradation of receiver noise floor, reduction of data throughput rates, increases in block error rates) and high-power interference effects to commercial receivers.¹⁶ High-power interference is the term used to describe the impact of extremely high levels of interference on receiver performance. These effects include permanent electrical damage that may occur to receiver components (often referred to as receiver “burnout”), as well as temporary performance degradation such as receiver overload and receiver saturation.

NTIA believes that a principal element of the CBRS regulatory regime in the 3.5 GHz Band is that the licensees must accept harmful interference from federal operations and must take all practical measures to implement their systems to overcome or avoid such interference in the event that it occurs. In the *3.5 GHz Band FNPRM*, the FCC stated that PA and GAA tier users should take reasonable measures to protect their CBSD receivers from radar high-power interference effects.¹⁷ NTIA agrees with the FCC that high-power interference effects could cause permanent damage to CBSD receivers under certain conditions and needs to be addressed. NTIA will work in conjunction with the FCC and the DoD to conduct further analysis to determine areas where high-power interference effects to CBSD receivers could potentially occur based on current and future radar operations. The results of this analysis will be publicly distributed to inform CBRS licensees of the potential impact to their operations.

Airborne Radar Operations

The analysis performed by NTIA in the *Fast Track Report* did not address airborne radar operations in the 3.5 GHz Band.¹⁸ In the *3.5 GHz Band FNPRM*, the FCC proposed a prohibition on federal use of airborne radar systems in the 3.5 GHz Band.¹⁹ In lieu of a blanket prohibition on such systems, we recommend a different approach to preserve federal flexibility similar to the FCC’s approach recently taken in advance of the 1755-1780 MHz Advanced Wireless Services (AWS-3) auction. In the 1755-1780 MHz bands, commercial operations will accept interference

¹⁵ In the *Fast Track Report*, analysis for Time Division Duplex systems with a 10 megahertz channel bandwidth and a maximum allowable interference power threshold of -107.2 dBm was used for the base stations and -105.2 dBm was used for the user equipment. See *Fast Track Report* at 4-9.

¹⁶ See *Fast Track Report* at Appendix G.

¹⁷ See *3.5 GHz Band FNPRM* at 4317 ¶ 143.

¹⁸ NTIA analyzed airborne radar operations below 3550 MHz in the *Fast Track Report*.

¹⁹ See *3.5 GHz Band FNPRM* at 4308 ¶ 116.

from the incumbent federal operations, including airborne systems.²⁰ This is based in part on the transient and intermittent nature of the signals from airborne systems, where if interference did occur it would be of short duration, which can be tolerated by the commercial digital receivers without impacting their performance as shown in measurements performed by NTIA.²¹ Moreover, at the altitudes at which the airborne radars operate the received signal levels on the ground are low enough where high-power interference effects to CBSD receivers will not be a problem. NTIA recommends that the approach used in the AWS-3 bands be used in the 3.5 GHz Band and that the FCC not prohibit the use of airborne radar systems. NTIA believes that a clear statement in the rules that the airborne radars will not seek protection from the CBSD transmitters would be necessary.

Treatment of 3650-3700 MHz Sites

The FCC's rules for the 3650-3700 MHz band established an 80 kilometer exclusion zone around three federal government radiolocation facilities (Saint Inigoes, MD; Pascagoula, MS; and Pensacola, FL).²² Non-Federal operations within these exclusion zones required coordination with NTIA. If the FCC adopts its "Supplemental Proposal" in the *3.5 GHz Band NPRM* to incorporate the 3650-3700 MHz band in the Citizens Broadband Radio Service, we believe that it is possible to include these federal sites in the two-phased sharing framework outlined above.

Additionally, one correction needs to be made to the 3650-3700 MHz federal site protections. On November 2012, the FCC removed the Pascagoula, MS, site from the rules (and renumbered US348 as US109 in the U.S. Table of Frequency Allocations).²³ Even though the Naval Station in Pascagoula, MS, was closed, DoD informed NTIA that the Navy still has an active assignment (N882989) for 3590-3700 MHz that it uses at this location on a regular basis and therefore requires protection.²⁴ Accordingly, NTIA requests that footnote US109 of the

²⁰ See Auction of Advanced Wireless Services (AWS-3) Licenses Scheduled for November 13, 2014, Notice and Filing Requirements, Reserve Prices, Minimum Opening Bids, Upfront Payments, and Other Procedures for Auction 97, *Public Notice*, DA 14-1018 at ¶¶ 76-78 and attachment G (Jul. 23, 2014).

²¹ See NTIA Technical Report 14-506, *Effects of Radar Interference on LTE (FDD) eNodeB and UE Receiver Performance in the 3.5 GHz Band* (July 2014), available at <http://www.its.bldrdoc.gov/publications/2759.aspx>; see also NTIA Report 13-499, *Effects of Radar Interference on LTE Base Station Receiver Performance* (Dec. 2013), available at <http://www.its.bldrdoc.gov/publications/2742.aspx>.

²² See 47 C.F.R. § 2.106 at US348 (2012); see also *id.* § 90.1331(b)(1) (2012); see also Amendment of the Commission's Rules with Regard to the 3650-3700 MHz Government Transfer Band, *First Report and Order and Second Notice of Proposed Rule Making*, ET Docket No. 98-237 and WT Docket No. 00-32, 15 FCC Rcd 20488, 20556 (2000); Wireless Operations in the 3650-3700 MHz Band, *Report and Order*, ET Docket No. 04-151 and WT Docket No. 05-96, 20 FCC Rcd 6502, 6529 and 6546 (2005).

²³ See Amendment of Parts 1, 2, 15, 74, 78, 87, 90, and 97 of the Commission's Rules Regarding Implementation of the Final Acts of the World Radiocommunication Conference (Geneva, 2007) (WRC-07), Other Allocation Issues, and Related Rule Updates, *Notice of Proposed Rulemaking and Order*, ET Docket No 12-338, 27 FCC Rcd. 14598, 14659 ¶ 167 (Nov. 19, 2012) ("NTIA has informed us that one of these sites – Naval Station Pascagoula – has been closed. Accordingly, we amend US348 and Section 90.1331(b)(1) to remove the unused Federal site.")

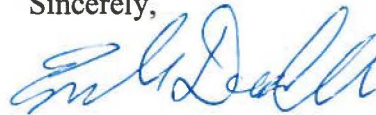
²⁴ See *Fast Track Report* at 3-31; see also, NTIA Comments in ET Docket No. 02-380, *Additional Spectrum for Unlicensed Devices Below 900 MHz and in 3 GHz band* at 7, Table 2 (May 7, 2003).

allocation table be corrected to reflect the text of footnote US348 (pre-2012) and that Section 90.1331 of the FCC's rules be corrected to include the Pascagoula, MS, site identical to the proposed rule set forth in the 3.5 GHz FNPRM.²⁵

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NTIA looks forward to our further collaborative efforts in this important proceeding. If you have any questions, please contact me or Edward Drocella, Chief, Spectrum Engineering and Analysis Division, Office of Spectrum Management at edrocella@ntia.doc.gov or (202) 482-2608.

Sincerely,



For

Paige R. Atkins
Associate Administrator
Office of Spectrum Management

Enclosures

²⁵ See 3.5 GHz Band FNPRM at 4352, App. B; see also 3.5 GHz NPRM, 27 FCC Rcd at 15604-05, n. 61.