

**Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554**

In the Matter of)	
)	
Unlicensed Use of the 6 GHz Band)	ET Docket No. 18-295
)	
Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz)	GN Docket No. 17-183
)	

REPLY COMMENTS OF VERIZON

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Verizon strongly supports both licensed and unlicensed spectrum opportunities in the United States as a platform for 5G and other advanced wireless services. We will turn up our 5G Ultra Wideband mobility service in Chicago and Minneapolis on April 11, and will launch more than 30 markets this year.¹ Millimeter wave spectrum serves as the cornerstone of the network, which will provide download speeds that are significantly faster than 4G and carry a massive amount of data for a large number of simultaneous users and use cases.² Wide-area licensed spectrum is fundamental to Verizon’s multibillion-dollar investment in 5G, and mid-band spectrum will be a key element given its coverage capabilities and wide channelization. As highlighted in our comments, unlicensed spectrum is also a vital and growing part of our network

¹ Press Release, Verizon, *Verizon 5G Mobility Service and Motorola 5G smartphone are here* (Mar. 13, 2019), <https://www.verizon.com/about/news/verizon-5g-mobility-service-and-motorola-5g-smartphone-are-here>.

² Press Release, Verizon, *Verizon adds third 5G smartphone in 2019* (Feb. 24, 2019), <https://www.verizon.com/about/news/verizon-adds-third-5g-smartphone-2019>; Kyle Malady, Verizon News, *There’s 5G, then there’s Verizon 5G Ultra Wideband* (Sept. 11, 2018), <https://www.verizon.com/about/news/theres-5g-then-theres-verizon-5g-ultra-wideband>.

and our customers' wireless experience. We recently achieved a 1.45 Gbps wireless connection in a live commercial environment using a combination of licensed and unlicensed spectrum.³

The record demonstrates that the 6 GHz band offers the Commission a unique opportunity to promote both licensed and unlicensed use of this valuable mid-band spectrum. Verizon agrees with those commenters who support an exclusive-use licensing regime in the upper portion of the 6 GHz band to help address the growing need for more licensed mid-band spectrum and favors a spectrum sharing regime in the lower portion of the 6 GHz band that permits unlicensed operations while protecting incumbent licensed services. With 1,200 megahertz of spectrum in the 6 GHz band, the Commission can provide meaningful new opportunities for both licensed and unlicensed spectrum use while ensuring that incumbent licensed services are protected or relocated, as appropriate.

I. INTRODUCTION AND SUMMARY

Mid-band spectrum is imperative for 5G because it combines favorable propagation characteristics with the potential for wider channel bandwidths. Spectrum in the 6 GHz band affords opportunities to introduce unlicensed operations *and* address the dearth of licensed mid-band spectrum for 5G and other next-generation services in the United States. The Commission should pursue both in this proceeding.

To address the critical need for additional mid-band licensed spectrum, Verizon urges the Commission to build on the record in this proceeding by issuing a *Further Notice of Proposed Rulemaking* to license spectrum in the upper 600 megahertz portion of the 6 GHz band (6.525-

³ Press Release, Verizon, *Verizon, Nokia and Qualcomm use LTE Advanced technology of six carrier aggregation to reach 1.45 Gbps* (Sept. 27, 2018), <https://www.verizon.com/about/news/verizon-nokia-and-qualcomm-use-lte-advanced-technology-six-carrier-aggregation-reach-145-gbps>.

7.125 GHz). A *Further Notice* need not delay FCC action on a spectrum sharing regime that introduces unlicensed opportunities in the lower portion of the band while protecting incumbents. While the recent proposal to repurpose spectrum in the 3.7-4.2 GHz band for licensed use is an important step, it alone does not reduce the urgent need for additional licensed mid-band spectrum to support 5G services.

In a licensed framework, auction winners would compensate incumbents for relocation to comparable facilities, pursuant to the Commission's *Emerging Technologies* policies. The Commission has decades of experience relocating incumbent licensees to new spectrum. The FCC should work with NTIA and include in the *Further Notice* the band above 7.125 GHz, currently allocated to federal use only, as a potential relocation band, as several commenters propose.

At the same time, Verizon agrees that spectrum sharing and unlicensed opportunities are important pieces of the wireless puzzle, as they can free more spectrum for commercial use than would otherwise be available and advance yet more innovation. But they can do so only as long as incumbent operations in the band are protected. The key to promoting unlicensed use in the 6 GHz band is a sharing model that protects incumbents through a cloud-based, IP-connected Automated Frequency Coordination ("AFC") manager. The record shows that active AFC management of unlicensed access points by necessity will impose some costs to ensure incumbent protection, but, when coupled with registration requirements, they will also enable greater security and protection and allow for higher powered unlicensed use.

Proposals that would allow some devices to operate without AFC control present unacceptable interference risks. In particular, the Commission should refrain from adopting the proposal to allow low power indoor ("LPI") devices to operate without AFC in any 6 GHz sub-

bands, or to allow “very-low-power” devices to operate indoors or outdoors without AFC control. Such device operations would risk interference to licensed fixed point-to-point backhaul and electronic news gathering incumbents and would not be the best use of valuable mid-band spectrum.

By advancing licensed and unlicensed uses in the 6 GHz band, the Commission can promote widespread and varied innovation and investment. Both approaches will help ensure that the United States continues to lead the world in 5G and next generation wireless technologies and services.

II. THE COMMISSION SHOULD PURSUE LICENSED OPPORTUNITIES IN THE UPPER PORTION OF THE 6 GHz BAND TO HELP MEET THE CRITICAL DEMAND FOR MID-BAND SPECTRUM

Verizon agrees with those commenters that identify 6 GHz spectrum as a unique opportunity—and one of the only viable options—for mid-band licensed spectrum.⁴ Even as we explore new opportunities for unlicensed use, the record confirms that the United States must quickly introduce a significant amount of mid-band spectrum for flexible, exclusive-use licenses to win the race to 5G.⁵ In this case, that means issuing a *Further Notice of Proposed Rulemaking* to consider a licensed framework in the upper portion of the 6 GHz band.⁶ As the Commission has found, “it is optimal to include a balance of licensed rights and opportunities to operate on an

⁴ Comments of CTIA, ET Dkt. 18-295, at 5-7 (Feb. 15, 2019) (“CTIA Comments”); Comments of Ericsson, ET Dkt. 18-295, at 13 (Feb. 15, 2019) (“Ericsson Comments”).

⁵ See CTIA Comments at 3-4; Ericsson Comments at 2, 8; Comments of Verizon, ET Dkt. 18-295, at 2-3, 12-14 (Feb. 15, 2019) (“Verizon Comments”); see also Comments of AT&T, ET Dkt. 18-295, at 20 (Feb. 15, 2019) (“AT&T Comments”) (supporting FCC efforts to “develop a spectrum pipeline that will allow licensed and unlicensed broadband services to keep pace with the explosive growth in consumer and business data demands”).

⁶ See CTIA Comments at 9-10.

unlicensed basis in order to meet the country’s wireless broadband needs.”⁷ This general approach should guide the Commission’s consideration of the 1,200 megahertz of 6 GHz spectrum, especially in light of the dearth of mid-band spectrum options.

A. The Record Shows that the Upper Portion of the 6 GHz Band Is Ideally Suited to Address U.S. Requirements for More Licensed Mid-Band Spectrum for 5G.

The Commission should seize the opportunity in this proceeding to address the scarcity of licensed mid-band spectrum, as the race for 5G warrants further consideration of whether to make a portion of the 6 GHz band available for licensed use. First, the record confirms that mid-band spectrum is important for next-generation wireless services like 5G given the combination of favorable propagation characteristics and the opportunity for wider channelization in mid-band frequencies.⁸ Mid-band spectrum delivers much higher peak data rates than low band spectrum. And while mid-band spectrum does not offer the capacity available with millimeter wave frequencies, it does provide more coverage.

Second, nations around the world are outpacing U.S. efforts to make licensed mid-band spectrum available.⁹ For example, Japan, South Korea, Spain, and the United Kingdom have auctioned or assigned substantial amounts of mid-band spectrum since 2018—with South Korea auctioning almost 300 megahertz of mid-band spectrum in June 2018 and Japan committing 500

⁷ See *Use of Spectrum Bands Above 24 GHz For Mobile Radio Services*, Report and Order and Further Notice of Proposed Rulemaking, 31 FCC Rcd 8014, 8062 (2016) (“*Spectrum Frontiers R&O and FNPRM*”).

⁸ See CTIA Comments at 3; Verizon Comments at 12-13; see also *Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz*, Notice of Inquiry, 32 FCC Rcd 6373, 6375 ¶ 6 (2017) (“*Mid-Band NOI*”).

⁹ See Verizon Comments at 13 (citing CTIA, *The Global Race to 5G*, at 7-8 (Apr. 2018) (“*Global Race Report*”), <https://api.ctia.org/wp-content/uploads/2018/04/Race-to-5G-Report.pdf>); CTIA Comments at 4-5; Ericsson Comments at 7-8.

megahertz of mid-band spectrum to 5G this spring.¹⁰ Other countries, including China, Australia, and Germany, will assign additional mid-band spectrum by June 2019; China has committed to release nearly 500 megahertz of mid-band spectrum and Germany plans to designate 400 megahertz in the first half of 2019.¹¹ The U.S., by comparison, is now in sixth place out of ten countries in terms of mid-band spectrum availability.¹² To avoid falling behind in 5G, the Commission should waste no time in making similarly large swaths of mid-band spectrum available for licensed 5G services.

Third, the FCC needs to identify additional licensed mid-band spectrum beyond the 3.5 GHz and 3.7-4.2 GHz bands. While Verizon is committed to optimizing the opportunity in the 3.5 GHz band, a maximum of 40 megahertz of licensed spectrum is available to a single provider in each market, and the three-tiered spectrum access regime severely restricts power levels for wide-area 5G deployment.¹³ Further, as the 3.7-4.2 GHz rulemaking examines how much of that band can be repurposed for licensed use, the incumbent satellite operators at present are proposing to make available just 180 megahertz for licensed services.¹⁴

Ultimately, the 6 GHz band is so important because—apart from the efforts underway in the 3 GHz band—there are no other clear licensing options available in the spectrum from 3 to

¹⁰ See David Abecassis et al., *Mid-Band Spectrum Global Update*, Analysys Mason, at 1-2 (Nov. 2018) (“Analysys Report”), attached to Reply Comments of CTIA, GN Dkt. No. 18-122 (Dec. 11, 2018).

¹¹ Analysys Report at 1-3.

¹² See Global Race Report at 11.

¹³ See CTIA Comments at 6 (citing *Commercial Operations in the 3550-3650 MHz Band*, Report and Order and Second Further Notice of Proposed Rulemaking, 30 FCC Rcd 3959, 3982 ¶ 67 (2015)); Ericsson Comments at 2.

¹⁴ See Ericsson Comments at 8 (citing C-Band Alliance Proposal Fact Sheet: October 22 Update, at 1 (Oct. 2018), <https://c-bandalliance.com/wp-content/uploads/2018/10/20181022-200-MHz-FactSheet-Clean-and-Final.pdf>); CTIA Comments at 6.

24 GHz. As Ericsson has explained, “[p]resently, there is *no* large swath of mid-band spectrum available for licensed macro 5G service in the U.S.”¹⁵

Identifying additional licensed mid-band spectrum represents a tremendous economic opportunity for the United States. The record shows that making 400 megahertz of mid-band spectrum available over seven years will produce \$150 billion in wireless investments and 1.3 million new jobs, while also adding \$274 billion to the Nation’s gross domestic product.¹⁶ The Commission must not forego the 6 GHz licensing opportunity.

B. The Commission Should Launch a Rulemaking to Make Licensed Use Available in the Upper Portion of the 6 GHz Band.

Given this record evidence, the Commission should pursue flexible, exclusive-use licensing in the upper 600 megahertz portion of the 6 GHz band—specifically, 6.525-7.125 GHz—to make more mid-band spectrum available for mobile broadband and 5G. To do so, Verizon agrees with CTIA and Ericsson that the Commission should promptly issue a *Further Notice of Proposed Rulemaking* in this proceeding.¹⁷

The question of flexible-use licensing in the 6 GHz band is not new, as stakeholders raised the issue in response to the 2017 *Mid-Band NOI* as well as in the comment record here. While the *NOI* generally focused on licensed use in the 3.7-4.2 GHz band and unlicensed use in the 6 GHz band, it identified the potential for licensed broadband services in the 6 GHz band.¹⁸

¹⁵ See Ericsson Comments at 2 (emphasis in original); see also Comments of Ericsson, GN Dkt. No. 17-183, at 10 (Oct. 2, 2017) (“Ericsson NOI Comments”) (“There are at present limited opportunities for non-federal mobile allocations between 7- 24 GHz, and so the Commission should take a close look at the 6.425-7.125 GHz band for mobile service.”).

¹⁶ See CTIA Comments at 3-4.

¹⁷ See *id.* at 9-10; Ericsson Comments at 4, 13.

¹⁸ See *Mid-Band NOI*, 32 FCC Rcd at 6383-84 ¶ 31 (seeking comment on how the 5.925-6.425 GHz band “could be used for licensed fixed and mobile broadband services”).

Commenters responded by calling for licensing in the upper portion of the band. T-Mobile, for example, explains that “[w]hile the 3.7-4.2 GHz is an important first step to support licensed mobile wireless broadband, additional spectrum is needed to support 5G services,” and thus the Commission should consider “making some or all of [6.425-7.125 GHz] band available for licensed mobile broadband use.”¹⁹ Indeed as CTIA observes,²⁰ the Mid Band Spectrum Coalition—a group of licensed and unlicensed stakeholders—expressly noted that there were multiple viewpoints on the upper portion of the 6 GHz band, with some coalition members believing it is best suited for licensed use and others favoring unlicensed.²¹ The need for more flexible use licensed spectrum in the mid-band is more apparent than ever before, and the Commission can rely on the *NOI* record to launch another rulemaking, just as it did with the instant *Notice*.

Importantly, Verizon agrees that a licensed initiative in the 6.525-7.125 GHz portion of the band should not delay progress on introducing unlicensed opportunities in the lower portion of the band. As CTIA notes, while the FCC explores new licensed use cases for the upper portion of the 6 GHz band in a *Further Notice*, it can “move ahead and adopt a new spectrum sharing regime in the lower portion ... that allows unlicensed operations while protecting incumbent licensed uses.”²²

¹⁹ Comments of T-Mobile USA, Inc., GN Dkt. No. 17-183, at 18 (Oct. 2, 2017) (“T-Mobile NOI Comments”); *see also* Reply Comments of the Competitive Carriers Association, GN Dkt. No. 17-183, at 7-8 (Nov. 15, 2017) (joining “numerous commenters encouraging the Commission to explore licensed use of the [6.425-7.125 GHz] band,” including “whether some or all of the band should be reserved for licensed mobile broadband services”).

²⁰ *See* CTIA Comments at 8.

²¹ *See* Comments of the Mid-Band Spectrum Coalition, GN Dkt. No. 17-183, at 14 (Oct. 2, 2017).

²² *See* CTIA Comments at 9-10.

C. Commenters Recognize that New Wide-Area Licensees Must Relocate Incumbents or Otherwise Ensure Their Interests Are Accommodated.

Unlike the spectrum sharing regime envisioned for unlicensed access in the 6 GHz band, an exclusive-use licensing framework with wide-area licenses requires new entrants either to clear and relocate incumbent licensees or otherwise show that new wide-area services will not affect the remaining incumbents' services. Commenters calling for licensing in the 6 GHz band correctly recognize that incumbent licensees must be "made whole."²³

For example, Verizon concurs with CTIA and Ericsson that Fixed Service ("FS") point-to-point incumbent licensees and Broadband Auxiliary Service ("BAS") and Cable Television Relay Service ("CARS") incumbents in the band would need to be relocated, a process the Commission has overseen before pursuant to the existing *Emerging Technologies* policy.²⁴ Under that policy, winning auction bidders fund relocation of incumbent users to comparable facilities in different frequencies or transmission media.²⁵ The *Further Notice* should explore how winning auction bidders can relocate and accommodate FS, BAS, and CARS licensees to comparable facilities.

Separately, there also are limited Fixed Satellite Service ("FSS") licensed uses in the upper portion of the band that likely would not require relocation. As CTIA notes, the FSS

²³ *Id.* at 10-13; *see* Ericsson Comments at 14.

²⁴ *See* CTIA Comments at 2, 10-12 ; Ericsson Comments at 14.

²⁵ *See, e.g., Redevelopment of Spectrum to Encourage Innovation in the Use of New Telecommunications Technologies*, First Report and Order, 7 FCC Rcd 6886 (1992); Second Report and Order, 8 FCC Rcd 6495 (1993); Third Report and Order, 8 FCC Rcd 6589 (1993); Memorandum Opinion and Order, 9 FCC Rcd 1943 (1994); Second Memorandum Opinion and Order, 9 FCC Rcd 7797 (1994); *aff'd* *APCO v. FCC*, 76 F.3d 395 (D.C. Cir. 1996); *Plan for Sharing the Costs of Microwave Relocation*, First Report and Order, 11 FCC Rcd 8825 (1996); Second Report and Order, 12 FCC Rcd 2705 (1997); Memorandum Opinion and Order on Reconsideration, 15 FCC Rcd 13999 (2000); *see generally* 47 C.F.R. §§ 101.69-82.

incumbents are largely licensed for earth-to-space operations that would not be affected by nearby commercial mobile and fixed services,²⁶ and new Commission rules could establish protection zones around the few space-to-earth operations licensed in the band.²⁷ While some commenters have expressed concern about the potential effect of aggregate interference from 5G devices to satellites,²⁸ the Commission considered similar issues in the *Spectrum Frontiers* proceeding and concluded, “[w]e do not believe that aggregate interference from UMFUS transmitters will ever reach a level that harms the operations of the 28 GHz satellite systems.”²⁹

In sum, although incumbent uses of the upper portion of the 6 GHz band vary, the Commission can employ time-honored approaches to accommodate these uses while optimizing the amount of upper 6 GHz band spectrum made available for flexible-use licenses. Doing so will help unlock investment and innovation, benefit consumers, accelerate economic growth, and strengthen U.S. global competitiveness.

D. The Commission Should Explore Adding a Non-Federal Allocation to the 7.125-8.5 GHz Band as a Potential Relocation Band.

As proposed by CTIA and Ericsson, the Commission should consider whether incumbent licensees in the upper portion of the 6 GHz band can be accommodated (by updating the Table of

²⁶ See CTIA Comments at 13; see also Ericsson Comments at 16.

²⁷ See CTIA Comments at 13.

²⁸ See, e.g., Comments of Globalstar, ET Dkt. 18-295, at 11 (Feb. 15, 2019); Comments of Intelsat License LLC and SES Americom, Inc., ET Dkt. 18-295, at 1-2, 5-8 (Feb. 15, 2019) (“Intelsat/SES Comments”); Comments of NCTA, ET Dkt. 18-295, at 5 (Feb. 15, 2019); Comments of Sirius XM Radio Inc., ET Dkt. 18-295, at 10-11, 18-20 (Feb. 15, 2019).

²⁹ *Spectrum Frontiers R&O and FNPRM*, 31 FCC Rcd at 8117 n.775. The Commission noted that any increase in noise level due to aggregate interference would develop “over a period of years as UMFUS systems are deployed,” and that stretch of time would allow satellite operators to monitor the noise level at the satellite receivers “and inform the Commission before the satellite receiver performance is impacted.” *Id.* The same is true with respect to the deployment of 5G devices in the upper 6 GHz band.

Allocations) in the spectrum band starting at 7.125 GHz.³⁰ Non-federal access to the 7 GHz allocation is not a new issue. The Fixed Wireless Communications Coalition (“FWCC”) filed a petition for rulemaking in 2010, seeking non-federal, shared use of 7125-8500 MHz for fixed applications, which remains pending before the Commission.³¹ More recently, while the *Mid-Band NOI* focused on bands allocated for exclusive non-federal or shared use, commenters nonetheless called for adopting new shared use of 7.125-8.5 GHz.³² Building on this record, the Commission should engage with NTIA and other stakeholders to explore new licensed shared use of 7.125-8.5 GHz, including as a potential relocation band for licensed operations cleared from the upper portion of the 6 GHz band.

The record explains that the 7.125-8.5 GHz band is particularly well suited to accommodate non-federal FS operations. As CTIA observes, this federal-only band is currently underutilized, as demonstrated by an NTIA study of federal use of the band in specific markets.³³ Further, non-federal FS “could be easily coordinated to operate” because “there is no difference in the technical parameters of non-federal FS stations as compared to the federal FS stations.”³⁴

³⁰ See CTIA Comments at 13-16; Ericsson Comments at 15.

³¹ Fixed Wireless Communications Coalition, Petition for Rulemaking, RM-11605 (Mar. 16, 2010).

³² See, e.g., Comments of AT&T Services, Inc., GN Dkt. No. 17-183, at 18-19 (Oct. 2, 2017) (“AT&T NOI Comments”) (recommending that the FCC consider 7.125-8.4 GHz as an alternative to 6 GHz for licensed/unlicensed mobile broadband); Ericsson NOI Comments at 9-10 (proposing that the 7.125-8.5 GHz band be shared with non-federal point-to-point links); T-Mobile NOI Comments at 21 (encouraging the FCC to focus on fixed service in 7.125-8.4 GHz); Reply Comments of CTIA, GN Dkt. No. 17-183, at 13-14 (Nov. 15, 2017) (urging the FCC to work with NTIA to make 7.125-8.4 GHz spectrum a shared band, including for point-to-point microwave operations); Reply Comments of PacifiCorp, GN Dkt. No. 17-183, at 8-9 (Nov. 15, 2017) (advocating that the FCC take steps to allow public safety and point-to-point systems in the 7 GHz band).

³³ CTIA Comments at 13-14.

³⁴ *Id.*; see also Ericsson Comments at 15.

It is possible that some antennas may only have to be retuned rather than replaced. And in the event relocated incumbent antennas must be replaced, it is likely more a matter of swapping out antennas rather than having to find new intermediate hops (as might be the case if relocating to higher bands, like 11 and 14 GHz).

III. THE RECORD SUPPORTS UNLICENSED USES IN THE LOWER 6 GHz PORTION OF THE BAND, SUBJECT TO AN AUTOMATED FREQUENCY COORDINATION REGIME THAT PROTECTS INCUMBENTS

As we explained in our initial comments, Verizon is also committed to opening up unlicensed opportunities in the 6 GHz band, subject to an AFC-driven spectrum access framework that will protect incumbent licensed services. As discussed below, that framework necessarily imposes some costs to provide for the secure protection of incumbent licensed services, but it offers tangible benefits as well—namely, allowing new unlicensed devices to operate at higher power levels for more intense and efficient spectrum use. The Commission should reject proposals to allow some unlicensed devices to operate in the band without AFC control, which would increase interference risk.

A. Spectrum Sharing between Licensed Incumbent and Unlicensed Uses Requires an Interference Protection Regime that Necessarily Imposes Costs on Unlicensed Stakeholders.

A spectrum sharing regime in the 6 GHz band represents a vastly different model than the Industrial, Scientific and Medical (“ISM”) bands—900 MHz, 2.4 GHz, and 5.8 GHz—where unlicensed exploded onto the scene with only sparse deployment of licensed uses requiring protection. In those bands, innovative, inexpensive devices emerged and flourished, subject only to minimal Part 15 technical parameters. Here, however, mission-critical microwave operations are extensive, and new unlicensed uses must bear the burden of protecting important licensed incumbent operations from harmful interference. To move forward, unlicensed proponents

should embrace the AFC mechanism and positive control as a means to open the exciting spectrum opportunity that is 6 GHz. Doing so is the price of admission to the 6 GHz band.

As it did for the 3.5 GHz Citizens Broadband Radio Service (“CBRS”),³⁵ the FCC should embrace a spectrum access regime that exerts positive control on all non-licensed operations (General Authorized Access (“GAA”) in 3.5 GHz or unlicensed in 6 GHz). This is not to say that the complex Spectrum Access System (“SAS”)/Environmental Sensing Capability (“ESC”) coordination process for 3.5 GHz is warranted in the 6 GHz band. As Verizon explained in its comments, the complexity of that approach was driven by factors *not* present in the 6 GHz band (notably, the complicated issues associated with protecting the Navy radar operations and the need to coordinate incumbent uses with two classes of new entrants).³⁶ Rather, it is an example where the Commission imposed checks on new entrants to facilitate sharing with incumbents, and these checks impose costs.

Some unlicensed proponents, however, balk at this paradigm and argue that imposing AFC coordination requirements on indoor and/or low power unlicensed devices is unnecessary and more costly. Boeing, for example, states that U-NII-5 and U-NII-7 devices should be allowed to operate indoors without the use of AFC because “[s]uch action would substantially reduce the costs” of devices that are designed solely for indoor use.³⁷ But as CTIA explains, “If

³⁵ See *Commercial Operations in the 3550-3650 MHz Band*, Order on Reconsideration and Second Report and Order, 31 FCC Rcd 5011 (2016).

³⁶ See Verizon Comments at 9-10.

³⁷ Comments of the Boeing Company, ET Dkt. 18-295, at 6 (Feb. 15, 2019); see Comments of the Friday Institute for Educational Innovation at North Carolina State University Comments, ET Dkt. 18-295, at 4 (Feb. 15, 2019); Comments of HP, Inc., ET Dkt. 18-295, at 3-4 (Feb. 15, 2019); Comments of Open Technology Institute at New America, American Library Association, Consumer Federation of America, Consortium for School Networking, Public Knowledge, and Access Humboldt Comments, ET Dkt. 18-295, at 2, 17 (Feb. 15, 2019) (“Public Interest

the cost of designing and manufacturing indoor access points increases as a result of the AFC requirements, this is simply the nature of the requirement that unlicensed devices not cause harmful interference to licensed services. The costs and burdens of protecting incumbents must be borne by the unlicensed use.”³⁸

B. Many Commenters Agree that Positive AFC Control Will Protect Incumbents While Enabling Higher Powered Unlicensed Access Points.

The record demonstrates that, if done properly, an AFC control system can manage unlicensed operations while protecting 6 GHz incumbents from harmful interference. An AFC should, at a minimum: (i) be a positive, centralized controller able to select the appropriate channel allocation and/or power level for a requesting access point; (ii) apply across all portions of the band made available for unlicensed use regardless of outdoor or indoor location; and (iii) require access point registration necessary to receive channel assignments, protect against interference, and enable enforcement if required. The record also shows that positive AFC control allows for higher powered unlicensed use, with technical rules based on power spectral density (“PSD”). Each of these is discussed below.

Commenters support using a closed-loop control system to manage unlicensed use in the 6 GHz band. The record shows that the key to promoting unlicensed use in the 6 GHz band is a sharing model that protects incumbents through a cloud-based, IP-connected AFC manager. Unlike traditional unlicensed approaches that involve free-standing unmanaged devices, the AFC

Organizations Comments”); *see also* Comments of the Computing Technology Industry Association, ET Dkt. 18-295, at 2 (Feb. 15, 2019).

³⁸ CTIA Comments at 20.

should use a “closed loop” network framework that positively controls unlicensed radio access to the band and thereby protects incumbent operations.³⁹ Other commenters share this view.

Sony, for example, explains that the AFC system should use a centralized model where all data are located and computations occur in a central location or the cloud, rather than distributed among access points.⁴⁰ Motorola similarly indicates that cloud-based AFC mechanisms should be employed to effectively share the spectrum and allow timely and universal updates.⁴¹ And Ericsson concurs that any AFC system should maintain positive control of frequency usage, such that every co-channel unlicensed access point obtains a list only of available frequencies and permitted transmit power from the AFC, informed by the given access point’s location and the locations of the incumbent licensed receivers and their technical parameters.⁴²

AFC centralization affords a number of advantages and benefits, including the capability to update and standardize propagation models and standoff distances; the potential to include aggregate interference calculation effects; fewer items for the Commission to test and certify; and the ease of upgrades and continued compliance over time. These benefits would be lost under a decentralized approach with many autonomous access points running their own firmware/software, where each access point manufacturer has its own engines and upgrades. We expand on these points with respect to unmanaged indoor and very-low-power unlicensed proposals in Section III.C below.

³⁹ Verizon Comments at 4-5. Verizon also recommended that the FCC test and certify AFC designs to ensure positive control capabilities, such that unlicensed devices may operate only under the command of the AFC. *See id.* at 7.

⁴⁰ Comments of Sony Electronics Inc., ET Dkt. 18-295, at 2-4, 5 (Feb. 15, 2019).

⁴¹ Comments of Motorola Solutions Inc., ET Dkt. 18-295, at 2-3 (Feb. 15, 2019).

⁴² *See* Ericsson Comments at 3, 20.

Importantly, the record shows that requiring an AFC to operate as a centralized system will reduce the potential for malfeasance associated with some prior database efforts.⁴³ As Verizon has explained, those prior efforts include interference to Terminal Doppler Weather Radar (“TDWR”) systems from autonomous U-NII devices, despite rules that required those devices to incorporate an interference mitigation technique called Dynamic Frequency Selection (“DFS”).⁴⁴ In that case, third parties modified software configurations or hardware settings, or the original equipment manufacturers altered firmware or parameters, to enable operation in frequency bands other than those for which the devices had been certified or without properly implementing the mandated scanning protocols. Similarly, the television white space (“TVWS”) database remains more of a standalone registration process that is unable to prevent harmful interference.⁴⁵ These examples illustrate failure modes for autonomous radios that a closed-loop AFC would avoid.

The record confirms that unlicensed access points should be registered before receiving channel assignments. CTIA, for example, states that all access points must be required to register with the AFC by providing sufficient information—including FCC ID of the device, manufacturer’s serial number, geographic coordinates, antenna height, name of the device owner, and contact information—to ensure accountability in the event of harmful interference.⁴⁶ Registration with the AFC system helps assure certification, support security

⁴³ See CTIA Comments at 20.

⁴⁴ See Verizon Comments at 7-8.

⁴⁵ See *id.* at 8-9.

⁴⁶ CTIA Comments at 19; see also AT&T Comments at 18-19; Comments of APCO International, ET Dkt. 18-295, at 6 (Feb. 15, 2019) (“APCO Comments”); Comments of Viaero Wireless, ET Dkt. 18-295, at 2 (Feb. 15, 2019) (“Viaero Comments”).

methods, track down problems, and avoid spoofing and noncompliance.⁴⁷ Critically, registration with the AFC (and positive control) allows the AFC to vet the access point device for erroneous or false locations and, in the event of harmful interference, to aid in tracking down or turning off bad devices.⁴⁸ In contrast, unregistered devices would be much harder to identify, track down, and shut off if they become non-compliant or cause interference.

The record shows that use of the AFC system should apply across all portions of the band made available for unlicensed shared use—both outdoors and indoors. Numerous commenters share Verizon’s view that AFC should apply to all access points, whether located outdoors or indoors and regardless of power level.⁴⁹ Comsearch, for instance, explains that “coordinated control of all unlicensed devices in the 6 GHz band ... is necessary to effectuate sharing in a way that provides reliable protection to fixed microwave incumbents while making available new spectrum opportunities for unlicensed users.”⁵⁰ CTIA similarly indicates that the AFC should apply to all access points to ensure protection of incumbent FS operations, noting that the FWCC has shown that indoor devices even at very low power levels pose an interference

⁴⁷ See APCO Comments at 6; Verizon Comments at 5-6.

⁴⁸ See AT&T Comments at 18-19; Comments of the City of Los Angeles, ET Dkt. 18-295, at 13, 15 (Feb. 15, 2019) (“Los Angeles Comments”); Verizon Comments at 5-6; Viera Wireless Comments at 2; see also Comments of Comsearch, ET Dkt. 18-295, at 23 (Feb. 15, 2019) (“Comsearch Comments”) (recommending that AFC operators have “kill switch” authority).

⁴⁹ See, e.g., Comments of Alteros, Inc., ET Dkt. 18-295, at 13 (Feb. 15, 2019) (“Alteros Comments”); CTIA Comments at 20; Comsearch Comments at 1; Intelsat/SES Comments at 12; see also Comments of NXP USA, Inc., ET Dkt. 18-295, at 3 (Feb. 15, 2019) (stating that the FCC should designate a spectrum access mechanism for all unlicensed stations in the 6 GHz band to overcome interference to UWB); Motorola Comments at 6 (noting because there is no way to restrict the operating location of lower power devices in the U-NII-6 and U-NII-8 bands, they should be required to access an AFC function).

⁵⁰ Comsearch Comments at 1.

threat and that all devices therefore require coordination.⁵¹ The record also shows that after interference has been reported, the AFC must be able to shut down those operations or shift the unlicensed station to another channel.⁵² As noted above, the 3.5 CBRS rules do not allow indoor or low power GAA operations independent from the SAS/ESC framework, and the Commission should apply the same approach here.

The record confirms that active AFC management of unlicensed access points will allow for higher powered unlicensed use. Like Verizon, other commenters recognize that there is no need to restrict AFC-controlled access points to the current extremely low Part 15 power levels to avoid the threat of interference to other users (either licensed or unlicensed) in a shared band. CTIA, for example, urges the Commission to consider higher power levels for outdoor operations because of (i) the AFC's capabilities to control unlicensed operating parameters specific to interference protection for each individual incumbent licensee's operations, and (ii) the sophistication of directional antennas that may be deployed.⁵³ Similarly, public interest groups recognize that higher power limits for outdoor operations under the control of an AFC could promote rural broadband.⁵⁴

The record includes support for power limits defined by PSD, similar to 3.5 GHz/CBRS. In its comments, Verizon recommended that the FCC consider adoption of a PSD limit —e.g., 50 dBm/20 megahertz—rather than a single power level, explaining that a higher power spectral density limit will promote rural broadband and services that require coverage of

⁵¹ CTIA Comments at 20.

⁵² *See id.* at 19

⁵³ *See id.* at 20.

⁵⁴ *See* Public Interest Organizations Comments at 21; Comments of Starry, Inc., ET Dkt. 18-295, at 3 (Feb. 15, 2019) (recommending that the FCC permit higher power fixed client devices if under control of an access point coordinated through an AFC).

larger distances with larger throughput.⁵⁵ The use of a maximum PSD limit, combined with the use of the AFC, is sufficient for protection of incumbent systems. Indeed, limits on overall power tend to penalize devices that use wide bandwidths. Because deployment of broadband services is one of the objectives of this proceeding, the Commission should not adopt an overall power limit that would artificially constrain the ability to use wide bandwidths.

Power limits defined by PSD are consistent with the FCC's approach in the 3.5 GHz CBRS band. There, the Commission adopted power limits based on the maximum EIRP in any 10 megahertz bandwidth; in other words, the power limits are based on power spectral density. In that situation, the devices are required to support transmit power control capability to limit the maximum EIRP for both base station and end user devices in response to instructions from a SAS.⁵⁶ Likewise, 6 GHz unlicensed devices must be able to adjust output power levels in response to commands from the AFC. Accordingly, it makes sense to define power limits in a similar way, and Verizon reiterates that the PSD of any unlicensed device in the 6 GHz band should be limited to a maximum EIRP of 50 dBm in any 20 megahertz bandwidth, and must be able to reduce that power level upon demand of the AFC.

C. The Commission Should Reject Proposals to Allow Low Power Indoor or Very-Low-Power Unlicensed Devices to Operate without AFC Control.

Notwithstanding record support for centralized AFC control of unlicensed access points to enable higher powered operations, some commenters seek to allow low power indoor ("LPI") or very-low-power unlicensed devices to operate in the 6 GHz band without AFC control. The Commission should reject these proposals. Regardless of power level or location, proposals to

⁵⁵ Verizon Comments at 10-11.

⁵⁶ See 47 C.F.R. § 96.41.

allow such unlicensed devices to operate without AFC control present unacceptable risks to licensed incumbent uses.

The Commission should reject proposals to allow low power indoor devices to operate without AFC. Some commenters argue that LPI unlicensed devices are not likely to cause harmful interference and should therefore be allowed to operate in the band free of registration with the AFC.⁵⁷ The 6 GHz RLAN Group, for example, claims that LPI operations in parts of the 6 GHz band are “not vulnerable to interference” because LPI devices “would be subject to substantial building loss (i.e., they operate only indoors) and sharply limited radiated power (i.e., they would operate at a maximum of only one Watt (30 dBm) radiated power).”⁵⁸ The record, however, shows that these arguments are purely speculative and should be rejected, as the possibility of interference would impair incumbent operations.

Numerous commenters—including the FWCC, AT&T, the National Spectrum Management Association, Ericsson, CTIA, Alteros, Comsearch and others—emphasize that even indoor low power devices may cause harmful interference and should be required to coordinate with the AFC system.⁵⁹ There are several reasons why the AFC must control all devices, regardless of whether they are indoors or outdoors.

⁵⁷ See Comments of Apple Inc., Broadcom Inc., Cisco Systems Inc., Facebook, Inc., Google LLC, et al., ET Dkt. No. 18-295, at 3, 16-17 (Feb. 15, 2019) (“6 GHz RLAN Group Comments”); Comments of Broadcom, ET Dkt. No. 18-295, at 27-28 (Feb. 15, 2019) (“Broadcom Comments”); Charter Communications, Inc. Comments, ET Dkt. No. 18-295, at 3 (Feb. 15, 2019); Qualcomm Inc. Comments, ET Dkt. No. 18-295, at 10 (Feb. 15, 2019); Comments of Wi-Fi Alliance, ET Dkt. No. 18-295, at 10-11 (Feb. 15, 2019).

⁵⁸ See 6 GHz RLAN Group Comments at 3-4, 19.

⁵⁹ See, e.g., Comments of Fixed Wireless Communications Coalition, ET Dkt. No. 18-295, at 9-10 (Feb. 15, 2019) (“FWCC Comments”); AT&T Comments at 18-19; CTIA Comments at 20; Alteros Comments at 13-14; Comsearch Comments at 8-14; see also Comments of National Spectrum Management Association, ET Dkt. No. 18-295, at 32 (Feb. 15, 2019) (stating that there is “no evidence low powered unlicensed indoor transmitters pose no threat of interference to

First, there is no guarantee that any shielding from building penetration losses will be present in all indoor scenarios. Rather, losses will be based on the device location within a building, and the building construction and materials.⁶⁰ FWCC, for example, points to research showing that radio local area networks (“RLANs”) “used indoors even at low power can cause interference.”⁶¹ FWCC explains that, taking into account the width of the antenna boresight, an RLAN located just a few meters off the ground in a one- or two-story house can threaten interference, and therefore “attenuation from building walls may be insufficient to block” that interference.⁶² Likewise, the Association of Federal Communications Consulting Engineers demonstrates that the attenuation from building walls and windows is not a realistic barrier to prevent interference to broadcast licensees, noting that many BAS operations are conducted indoors.⁶³ More broadly, Comsearch emphasizes that “there is no assurance that unlicensed

licensed operations”); Comments of Federated Wireless, ET Dkt. No. 18-295, at 6 n. 7 (Feb. 15, 2019) (noting that “indoor and/or low power operation is not a panacea for effective incumbent protection”); Ericsson Comments at 20-21 (indicating that “uncontrolled indoor devices pose a serious interference threat to the interference-free operation of FS stations”).

⁶⁰ See, e.g., AT&T Comments at 10-11 (noting that factors such as the relative elevation of the antenna and the height of the building housing the unlicensed operations and its construction materials all complicate many assumptions made by RLAN advocates and the FCC, “falling far short of any justification for a *carte blanche* exception for low-power, indoor operations”); FWCC Comments at 21 (explaining that no realistic estimate of wall attenuation can be a single number, and the value will typically vary over at least 10-20 dB according to the details of construction and the geometry of the emitter relative to columns, joists, windows, etc.); Comments of the National Association of Broadcasters, ET Dkt. 18-295, at 11 (Feb. 15, 2019) (“NAB Comments”) (recognizing that building penetration losses are “a complex function of building material, arrival angle, relative location, frequency and other factors”).

⁶¹ FWCC Comments at 10, 19-22.

⁶² See *id.* at 10.

⁶³ See Comments of the Association of Federal Communications Consulting Engineers, ET Dkt. 18-295, at 1-2 (Feb. 15, 2019) (“AFCCE Comments”); see also NAB Comments at 9 (“Plainly, indoor BAS operations are squarely in the crosshairs for harmful interference from indoor unlicensed devices operating with similar power levels.”); *id.* at 11 ([T]he ineffectiveness of building shielding has already been shown to be a ruinous problem in the 2.5 GHz bands, where

devices operating indoors will not interfere with microwave services,” citing interference simulations demonstrating locations where LPI device deployment could cause interference into licensed microwave receivers across the entire 5.925-6.425 GHz band in Dallas.⁶⁴

Second, there is no real way to enforce indoor operations—nothing prevents a person from taking a device meant for indoor only operation and installing it in an outdoor location. As NAB and Engineers for the Integrity of Broadcast Auxiliary Services Spectrum (“EIBASS”) explain, there is “no guarantee” or “no easy way to ensure” that devices will only be operated indoors, and the mechanisms proposed by the FCC to ensure indoor operation can easily be defeated.⁶⁵ For example, requiring a direct connection to an AC outlet can be defeated with an extension cord, outdoor outlet, or battery-operated inverter.⁶⁶ Further, EIBASS notes that Part 15 devices have a long history of causing chronic interference to BAS operations.⁶⁷

And third, not all locations are clearly indoor or outdoor in nature. An above ground parking garage, for example, may have concrete ceilings and floors but sides that are open to the outside. Similarly, sports arenas and stadiums—where BAS services are often used⁶⁸—may include open seating and playing areas but covered concession and restroom areas.

LPI devices must be controlled by the AFC based on real-world conditions. The level of interfering signal that is present at a receiver is determined not only by the power level of the

BAS channels 8 and 9 ... overlap with or suffer from out-of-band emissions from Wi-Fi channels 9 and 10 ...”).

⁶⁴ Comsearch Comments at 8, 14.

⁶⁵ See Comments of the Engineers for the Integrity of Broadcast Auxiliary Services Spectrum, ET Dkt. 18-295, at 4-6 (Feb. 15, 2019) (“EIBASS Comments”); NAB Comments at 12.

⁶⁶ See EIBASS Comments at 5; NAB Comments at 12.

⁶⁷ See EIBASS Comments at 8.

⁶⁸ This includes video links that are used to broadcast sporting events, and wireless microphones that are used in concerts, or on-field interviews. See NAB Comments at 2.

transmitter, but also by the separation distance between the two. Even low power devices will cause interference when they are very close to a licensed receiver. As the City of Los Angeles notes, signal strengths at the limits of operational 6 GHz link ranges are significantly lower than at the emitter, and receivers on long-distance links are designed to be more sensitive to ensure they pick up these weaker signals.⁶⁹ “Excluding these access points from the AFC will result, particularly in dense urban environments like Downtown Los Angeles, in unlicensed 6 GHz access points operating in close proximity to sensitive existing 6 GHz links.”⁷⁰ As a result, they are more sensitive to interference and “may not be able to coexist with even lower-power access points.”⁷¹ Without AFC registration, there is no realistic means of tracking down such access points in the event of interference.⁷²

Second, the Commission should reject proposals to allow “very-low-power” devices to operate without AFC control. The 6 GHz RLAN Group, Apple, Broadcom and others have asked the FCC to authorize a category of very-low-power 6 GHz devices—at a maximum transmit power of 14 dBm EIRP—to operate without AFC control both indoors and outdoors, including in vehicles.⁷³ A number of these same parties have asked that these “very-low-power” devices be permitted to operate across all four proposed sub-bands.⁷⁴

⁶⁹ See Los Angeles Comments at 14.

⁷⁰ See *id.* at 15.

⁷¹ See *id.* at 14-15.

⁷² See *id.* at 15.

⁷³ See, e.g., 6 GHz RLAN Group Comments at 4, 35-38; Comments of Apple, Inc., ET Dkt. 18-295, at 7-9 (Feb. 15, 2019) (“Apple Comments”); Broadcom Comments at 27-30; Comments of Facebook Inc., ET Dkt. 18-295, at 5-6 (Feb. 15, 2019) (“Facebook Comments”); Comments of the Hewlett Packard Enterprise Company, ET Dkt. 18-295, at 7 (Feb. 15, 2019) (“Hewlett Packard Comments”).

⁷⁴ See Facebook Comments at 5-6; Hewlett Packard Comments at 7.

Verizon opposes creating a new very-low-power class of non-AFC controlled devices in the band. These “anywhere, at any point” devices risk interference to fixed point-to-point and BAS licensed uses. Indeed, there is no practical way to prevent the operation of such devices in moving vehicles or on a mobile basis, which increases the risk of interference without constant AFC review. As Southern explains, the risk is “far too great” that such devices will “come into range of licensed microwave receivers and cause interference before the location of the device can be identified and corrective action taken.”⁷⁵

Moreover, permitting a new very-low-power class of untethered unlicensed devices is not the best use of this valuable mid-band spectrum. Instead, the Commission should explore the potential to authorize such very-low-power devices in the 57-71 GHz band, which is ideal for low power applications.

⁷⁵ Comments of Southern Company Services, Inc., ET Dkt. 18-295, at 18-19 (Feb. 15, 2019).

IV. CONCLUSION

For the reasons stated above, the Commission should launch a *Further Notice* to consider flexible use licensing in the upper portion of the 6 GHz band, and it should apply a cloud-based, automated, IP-connected AFC management framework to enable unlicensed use in the lower portion of the 6 GHz band, while protecting incumbent licensed services. By acting now to make more mid-band spectrum available for both unlicensed and licensed uses, the Commission can promote continued innovation and investment needed to lead the world in 5G and next generation wireless technologies and services.

Respectfully submitted,

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