

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

In the Matter of

Unlicensed Use of the 6 GHz Band

Expanding Flexible Use in Mid-Band Spectrum
Between 3.7 and 24 GHz

ET Docket No. 18-295

GN Docket No. 17-183

COMMENTS OF QUALCOMM INCORPORATED

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February 15, 2019

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Qualcomm strongly supports the Commission’s Notice of Proposed Rulemaking proposing to authorize unlicensed broadband operations in the 5.925 - 7.125 GHz (“6 GHz”) band.¹ The FCC should open this critically important, 1.2 GHz-wide, swath of mid-band spectrum as soon as possible, so it can be used for 5G and Wi-Fi technologies to enable faster, better mobile broadband connectivity for Americans. The pressure on existing mobile spectrum bands is ever-increasing, driven by the universal adoption of mobile technology, so maintaining a steady stream of new spectrum for mobile services is vitally important.

Opening the 6 GHz band for unlicensed use, in a manner that protects incumbent point-to-point microwave links and other licensed users, will drive economic growth over the coming years and positively impact virtually every facet of American life. This band can support multiple wideband channels and ultra-high-speed connections required by new consumer and business applications and services, using state-of-the-art 5G and Wi-Fi technologies.

¹ See *Unlicensed Use of the 6 GHz Band*, Notice of Proposed Rulemaking, FCC 18-147, ET Docket No. 18-295 (rel. Oct. 24, 2018) (“NPRM”).

INTRODUCTION & SUMMARY

The 6 GHz NPRM rightly recognizes the explosive growth in wireless communications services that have driven the American economy and the concomitant need to make additional mid-band spectrum available for next generation technologies.² To deliver the highly-reliable, ultra-low latency, multi-gigabit connectivity that 5G portends, spectrum for 5G services needs to include low-, mid-, and high-bands, and implement licensed, unlicensed, and shared regulatory paradigms. Qualcomm strongly supports timely FCC action to open the 6 GHz band for unlicensed wireless broadband use. The 6 GHz band and other mid-band spectrum, together with low-band (sub-1 GHz) and high-band (millimeter wave) spectrum, will play a core role in the deployment of 5G technology, and the federal government's ongoing efforts to maintain a steady stream of spectrum flowing is essential to achieving and maintaining American leadership in 5G.

The 6 GHz band presents a prime opportunity to deploy next generation 5G and Wi-Fi technologies in unlicensed spectrum. As the Commission rightly recognizes, the Part 15 U-NII rules governing broadband operations in the 5 GHz band, which unleashed unprecedented innovation and development of both broadband Wi-Fi and Gigabit LTE networks, can serve as a useful regulatory framework to extend unlicensed broadband access into the 6 GHz band.³ Using this framework, the 6 GHz band can support next-generation Wi-Fi, *i.e.*, IEEE 802.11ax and 802.11be (EHT), and the 5G NR variants under rapid development for unlicensed spectrum, 5G NR in unlicensed spectrum ("5G NR-U"), as well as future technologies that further improve overall system throughput, reliability, and network responsiveness. As the NPRM explains, this can be accomplished while protecting all incumbent 6 GHz licensed services from interference.

² See, *e.g.*, NPRM at ¶¶ 4, 7.

³ See NPRM at ¶ 2; *id.* at ¶ 6 (noting that LTE operations in unlicensed spectrum are successfully complementing licensed spectrum resources to provide improved service).

Qualcomm encourages the FCC to move forward to open the entire 6 GHz band for unlicensed use, according to the recommendations in these Comments. *First*, the FCC should permit Low Power Indoor (“LPI”) unlicensed operations at 30 dBm total EIRP and 21 dBm/MHz Power Spectral Density (“PSD”) throughout the 6 GHz band, that is, in each of the 6 GHz sub-bands identified in the NPRM: U-NII-5 (5.925–6.425 GHz), U-NII-6 (6.425–6.525 GHz); U-NII-7 (6.525–6.875 GHz); and U-NII-8 (6.875–7.125 GHz). As explained below and as detailed in the comments submitted today by the multi-company coalition that includes Qualcomm and ten other technology companies,⁴ LPI unlicensed operations can be allowed in the entire 6 GHz band. Low transmit power levels and a 20 - 30 dB reduction in RF signal power due to building materials provide sufficient protection from interference to outdoor fixed incumbent licensed operations and all other incumbents that operate exclusively outdoors. The NPRM recognizes that indoor unlicensed communication needs and spectrum demands will continue to grow as business and consumer IoT demands expand.⁵ LPI unlicensed operations throughout the 6 GHz band is critically important to serving this need.

Second, in order to protect licensed incumbent fixed point-to-point links from unlicensed devices operating at standard U-NII power levels (*i.e.*, 36 dBm total EIRP and 27 dBm/MHz PSD) indoors and outdoors, FCC rules for the proposed Automated Frequency Coordination (“AFC”) system can be, and need to be, simple and flexible and should not require unlicensed system registration, database coordination, or aggregate interference calculations because it is not necessary to protect incumbent links. The flexible AFC system approach described herein

⁴ See Comments of Apple, Broadcom, Cisco Systems, Facebook, Google, Hewlett Packard Enterprise, Intel, Marvell Semiconductor, Microsoft, Qualcomm, and Ruckus Networks (Feb. 15, 2019) at 17-35.

⁵ See NPRM at ¶ 7.

will support different deployment models and allow a range of AFC operators and, most importantly, low cost unlicensed system deployments.

Third, Qualcomm requests that the FCC adopt technology-neutral rules that allow for the successful implementation of new spectrum access techniques that are being standardized in 3GPP (*i.e.*, 5G NR in unlicensed spectrum or 5G NR-U) and in IEEE (*i.e.*, 802.11be (EHT)). Far more efficient use of the 6 GHz band can be realized where unlicensed wireless systems are time synchronized to one another and use spatial sensing techniques. Working together with many industry stakeholders in 3GPP and in IEEE, Qualcomm is developing sharing techniques that enable much more efficient and intensive spectrum use, and we are excited by the possibilities these enhanced tools offer in enabling better and faster mobile broadband. We therefore request the FCC to adopt technology-neutral sharing rules covering a portion of the 6 GHz band, *e.g.*, the U-NII-7 band, as described herein, so 5G NR-U technology and 802.11be Extremely High Throughput (“EHT”), an upcoming version of Wi-Fi under active development, can be deployed to provide enhanced broadband connectivity for all users via advanced techniques of time synchronization and spatial sensing. The proposal detailed in Section IV herein would not prohibit the use of UNII-7 by equipment that is not synchronized, but instead allow synchronized unlicensed technologies to be successfully deployed.

Fourth, Qualcomm recommends that the FCC adopt its proposed -27 dBm/MHz limit on 6 GHz out-of-band emissions (“OOBE”) into the licensed 5.9 GHz Intelligent Transportation Service (“ITS”) spectrum, consistent with the rules that apply to most of the 5 GHz U-NII bands.⁶ In addition, the lowest U-NII-5 channel of operation should be limited to indoor operations; in other words, this lowest channel should not be available for use by Access Points

⁶ See NPRM at ¶ 82.

(“APs”) installed outdoors, fixed outdoor stations, or mobile hotspots operating outdoors. The uppermost 20 MHz portion of the 5.9 GHz band, which has been targeted by the 5G Automotive Association (“5GAA”) for the pending deployment of Cellular Vehicle-to-Everything (“C-V2X”) peer-to-peer communications that require highly reliable, low latency connections to improve traffic flow and substantially enhance roadway safety, would be adversely impacted by outdoor use of the lowest U-NII-5 channel even if the proposed -27 dBm/MHz is adopted.

Fifth and finally, Qualcomm encourages the FCC to adopt technical rules as proposed herein. 6 GHz client devices should be allowed to operate at the same maximum transmit power that is permitted for APs and access nodes in the same product class; for example, both LPI APs, access nodes, and clients should be permitted to operate with 30 dBm total EIRP and 21 dBm/MHz PSD. There also is no need for the FCC to impose intra-band emission limits for unlicensed operations that straddle two or more of the U-NII-5, -6, -7, and -8 sub-bands. In addition, professional installation of unlicensed equipment should be allowed, but it should not be mandated for all installations of equipment that operates in the 6 GHz band. There are a number of technical tools, such as GPS, that can be used to provide accurate geolocation information for unlicensed APs.

Qualcomm is very excited by the opportunities the proposed unlicensed band offers for improving services to consumers and businesses across America. Unlicensed operations in the proposed 6 GHz band would enable multiple wideband channels and ultra-high-speed connections in homes, businesses, schools, universities, and libraries across America.

DISCUSSION

I. The FCC Should Open The Entire 6 GHz Band For Unlicensed Broadband

The 1.2 GHz swath of unlicensed spectrum in the proposed 6 GHz band can provide much-needed additional broadband channels to continue the successful growth of unlicensed wireless broadband access across America. Multiple studies have shown the growth in use and deployment of unlicensed communications systems will soon exhaust the available spectrum capacity in the 5 GHz band.⁷ And because the 1200-MHz-wide 6 GHz band is just above the 5 GHz unlicensed workhorse bands, it offers an ideal means of enabling connectivity for new unlicensed broadband services that require wide channels. Qualcomm strongly supports FCC action to open the band for unlicensed broadband use to further feed the wireless connectivity innovation pipeline.

The Commission's technical rules should account for the fact that future broadband access will operate with bandwidths significantly wider than 20 MHz. Wideband unlicensed channels that are 80 MHz, 100 MHz, 160 MHz, and 320 MHz-wide will become increasingly important for the state-of-the-art applications and services that will use IEEE 802.11ax and 802.11be (EHT), 4G LTE in unlicensed spectrum, and 5G NR in unlicensed spectrum technologies. Next generation unlicensed services are using wide channelization to provide high-throughput applications like ultra-HD video streaming and gaming to augmented and virtual reality experiences. In addition, the use of wide-channel operations (e.g., 160 MHz) in residential Wi-Fi networks is required to deliver Gigabit coverage everywhere in the home or apartment

⁷ See Rolf De Vegt, *et al.*, Qualcomm Incorporated "A Quantification of 5 GHz Unlicensed Band Spectrum Needs," (Sept. 2016); *see also* Wi-Fi Alliance, "Spectrum Needs Study" (Feb. 2017). The Qualcomm study found that there is a need for more than 1.2 GHz of spectrum near the 5 GHz band in order to support multiple additional 160 MHz-wide channels in dense environments.

building. Today's mesh Wi-Fi systems are solving longstanding coverage challenges, but these systems do require multiple wider bandwidth channels to deliver high data rates. The current 5 GHz unlicensed band supports a limited number of 160 MHz channels that these new applications need. Opening the 6 GHz band to unlicensed usage offers a substantial amount of new bandwidth to support the growth of current applications and completely new and currently unforeseen uses that require wide, high-capacity channels.

Unlicensed spectrum also is critically important to supporting Gigabit LTE connectivity. Currently throughout the globe, 45 operators, including the four major U.S. operators, are deploying Gigabit LTE in 26 countries. These operators are achieving Gigabit LTE speeds using LTE in unlicensed spectrum, an innovation pioneered by Qualcomm Technologies. In addition, the IEEE already has extended the IEEE 802.11ax standard to the entire 5.925-7.125 GHz band.⁸

In addition, 3GPP is developing 5G NR-U for the existing 5 GHz and proposed 6 GHz unlicensed bands. Given the importance and significant number of licensed incumbent users that require protection throughout the 6 GHz band,⁹ opening up the entire 1.2 GHz swath of spectrum will ensure that there are at least several wide-band channels throughout the country for unlicensed operations to use. As the NPRM properly recognizes, today's unlicensed broadband

⁸ See IEEE, *P802.11ax PAR Modification*, Abstract (July 12, 2017) available at <https://mentor.ieee.org/802.11/dcn/17/11-17-0913-02-00ax-par-modification-to-support-6-ghz-band.docx>.

⁹ See NPRM at ¶ 9 (“[H]ighly reliable point-to-point microwave links that support a variety of critical services such as public safety (including backhaul for police and fire vehicle dispatch), coordination of railroad train movements, control of natural gas and oil pipelines, management of electric grids, long-distance telephone service, and backhaul for commercial wireless providers such as traffic between commercial wireless base stations and wireline networks” use the 6 GHz band).

systems can operate seamlessly within the interstices of the existing licensed 6 GHz band incumbents.¹⁰

Notably, the 6 GHz band is an unlicensed greenfield as there currently are no unlicensed broadband operations in the band. As explained in these Comments, through working collaboratively with the wireless industry, standards organizations, and other stakeholders, the FCC has a prime opportunity to enable more effective spectrum utilization in a portion of the 6 GHz band for unlicensed operations that are time synchronized and share certain transmission parameters with other users of the band for coordination purposes. The FCC should enable such spectrum utilization optimization techniques in a portion of the 6 GHz band, thereby achieving greater capacity gains and improved mobile broadband performance for consumers than is possible today.

II. New Wi-Fi and 5G NR-U Technologies Will Use Low-Power Indoor Operation (LPI) And Automated Frequency Coordination (AFC) To Protect Licensed Incumbents

Opening the band to unlicensed access does not require the imposition of any restrictions on the tens of thousands of point-to-point licensees in the 6 GHz band or other licensed incumbent users. Indeed, the framework described in the NPRM can be used to protect incumbent operations, and allow their continued use and expansion in the band.¹¹ Part 15 unlicensed devices are a perfect fit as they are legally required to share spectrum with licensed services on a non-interference basis.¹² In contrast, authorizing licensed mobile operations in the

¹⁰ See NPRM at ¶¶ 25, 26.

¹¹ See NPRM at ¶ 23. Qualcomm agrees with the FCC's tentative conclusion that FSS earth stations operating in the 6 GHz band need not be considered by the AFC system as new unlicensed uses pose a negligible interference risk. *Id.* at ¶¶ 24, 55.

¹² See 47 C.F.R. § 15.5.

6 GHz band would be challenging and take many years due to the high number, heavy use, importance, and variety of licensed incumbents that would have to vacate the band.

The FCC NPRM relies upon the RKF Study that Qualcomm and other members of the wireless industry submitted in this proceeding when proposing to open the 6 GHz band to unlicensed use.¹³ Notably, the RKF Study, which demonstrates that unlicensed operations can operate in the band without causing harmful interference to licensed services, purposefully did not take into account various additional real-world sources of attenuation, and, thus overestimates the likelihood of RLAN interference to point-to-point links. Moreover, the FCC's approach in the NPRM is overly conservative for it is possible to allow LPI unlicensed operations throughout the 6 GHz band and also permit higher-power unlicensed operations with AFC in the U-NII-8 sub-band the FCC did not propose to include in the NPRM.

A. Low-Power Indoor Unlicensed Operations Should Be Permitted Throughout The 6 GHz Band

The FCC should allow Low Power Indoor (“LPI”) unlicensed operations throughout the 6 GHz band at levels up to 30 dBm total EIRP and 21 dBm/MHz PSD because such operations, which use very low power levels and take advantage of 20 to 30 dB of additional RF signal losses that buildings provide, will protect outdoor fixed incumbent licensed operations and all other 6 GHz licensed incumbent users from harmful interference. Thus, the FCC proposal to allow LPI operations in U-NII-6 and U-NII-8, only the 350 MHz of spectrum, but not in U-NII-5 and U-NII-7¹⁴ should be revisited. LPI unlicensed use should be allowed in the entire band.

¹³ See, e.g., NPRM at ¶ 62, n.143.

¹⁴ See NPRM at ¶¶ 59, 69.

Fixed licensed incumbent operations in U-NII-5 and -7 will be protected from interference the same way they will be protected in U-NII-6 and -8, the bands in which the NPRM proposes to allow LPI. Also, all other 6 GHz incumbent users, *i.e.*, fixed and mobile broadcast auxiliary services (BAS), Low Power Auxiliary Service (LPAS), and public safety licensees, similarly will be protected from interference via low unlicensed transmit power levels and substantial building losses. An AFC System is not needed to protect incumbent operations from unlicensed LPI operations.¹⁵ In addition, the deployment of unlicensed systems typically will be at ground levels and in relatively contained areas, while nearly all licensed point-to-point links are mounted atop towers and buildings and thus operate at well over 100 feet above ground level and use highly directional beams (with substantial off-axis rejection) that are pointed away from buildings where unlicensed systems may be operating.

To the extent the Commission is concerned about ensuring LPI unlicensed devices are only used indoors, the agency can require “indoor use only” labeling and use of a local power source. A professional installation requirement for LPI equipment should not be implemented as these low-power devices most often will be installed by consumers much like today’s APs and other internet-connected devices like TV sets, computers, and countless other IoT devices.

The NPRM’s proposed approach to permit in alternating 6 GHz sub-bands standard-power unlicensed devices under AFC control and LPI devices would hinder investment in the 6 GHz band. It would prevent LPI devices from being able to access wider channel sizes that straddle multiple U-NII sub-bands to facilitate higher speeds and thus reduces the potential for global harmonization with other jurisdictions that permit LPI in U-NII-5 should the FCC not do

¹⁵ See NPRM at ¶ 73.

so. The FCC should allow LPI unlicensed operations throughout the 6 GHz band because the potential global harmonization would provide economies of scale and lower-cost devices.

B. AFC Will Enable Unlicensed Operations Only In Locations That Do Not Create A Risk Of Harmful Interference To Incumbents

Qualcomm supports the FCC proposal to permit standard power unlicensed operations in the 6 GHz band using Automated Frequency Coordination (“AFC”), subject to necessary restrictions to protect adjacent channel ITS operations operating in the 5.9 GHz band.¹⁶ AFC can enable standard power unlicensed operations at levels up to 36 dBm total EIRP and 27 dBm/MHz PSD in U-NII-8 as well as in the U-NII-5 and-7 sub-bands proposed in the NPRM.

The AFC system will protect licensed fixed services in the 6 GHz band by ensuring no single unlicensed interference source increases the noise at the fixed receiver to a level of harmful interference, which will be determined using information each licensee is required to provide to the FCC in its license applications and is made publicly available on the FCC’s Universal Licensing System (“ULS”) database. The AFC system will use the information associated with each fixed service receiver in the ULS database in conjunction with a robust propagation model — that effectively protects all potentially affected fixed receivers — to ensure no unlicensed operations are activated that exceed a specified interference threshold at any incumbent licensee’s receiver.¹⁷ The interference protection determination by the AFC system can be and should be simple and flexible and does not require any unlicensed system registration, database coordination, or any aggregate interference calculation because none of

¹⁶ Outdoor operations should not be permitted in the lowermost channel of the 6 GHz band in order to protect adjacent channel ITS operations in the 5.9 GHz band, as explained in Section III.A, *infra*.

¹⁷ See NPRM at ¶¶ 39-41.

that is needed to protect incumbent links. A flexible AFC framework will support simple unlicensed deployment models and allow for multiple AFC architectures and operators, providing for low-cost unlicensed deployments.

All this means that the FCC regulatory framework for the AFC system should be performance-based. It should describe the performance criteria and protection needs, rather than impose a prescriptive set of rules. Prescriptive rules would dictate a particular implementation and undoubtedly limit innovation and cost-effective solutions in this new regulatory space.¹⁸ In this regard, requiring AFC registration of all unlicensed devices or imposing professional installation rules would be counter-productive to AFC system innovation and cost-effectiveness, and they are not needed to protect licensed incumbent users of the 6 GHz band.¹⁹

To be clear, the development and testing of an AFC system likely will need several years before consumers would experience the benefits of AFC-controlled devices. On the other hand, LPI unlicensed equipment not subject to AFC would be available to consumers much more quickly, within 12-18 months of Commission issuance of an enabling Report and Order. Thus, allowing unlicensed LPI operations (without AFC) as soon as possible will allow unlicensed operations to use this band very quickly.

III. Certain FCC Technical Proposals Should Be Revised To Enable Next Generation Use Cases, Applications, and Services, Including C-V2X Operations In The 5.9 GHz Band

A. The 5.9 GHz Licensed ITS Band Must Be Protected From Harmful Interference Caused By New 6 GHz Unlicensed Operations

Qualcomm supports the FCC's proposed out-of-band emissions ("OOBE") level of -27 dBm/MHz EIRP, consistent with virtually all of the 5 GHz U-NII band rules, and requests

¹⁸ See NPRM at ¶ 30 (discussing performance-based regulations).

¹⁹ See NPRM at ¶¶ 3, 19. See also fn 175 re interference resolution.

that the FCC also restrict to indoor use the lowest channel in the U-NII-5 band to protect the 5.9 GHz Intelligent Transportation Service (“ITS”) band that supports roadway safety applications, such as Vehicle-to-Vehicle (“V2V”) and Vehicle-to-roadway Infrastructure (“V2I”) communications, that require highly-reliable, low-latency connections.²⁰

1. The 5GAA Petition To Deploy C-V2X Technology Has Broad Support From The Automotive And Wireless Industries

The FCC is currently receiving public comment on the 5G Automotive Association (“5GAA”) Petition for Waiver to allow Cellular Vehicle-to-Everything (“C-V2X”) technology in the uppermost 20 MHz portion of the ITS band.²¹ 5GAA is a global cross-industry organization of more than 100 automotive and wireless technology companies working together to develop end-to-end connectivity solutions for intelligent transportation, future mobility systems and smart cities. Qualcomm is one of the founding companies of the 5GAA.

Waiver of the current 5.9 GHz ITS rules is necessary to enable commercial deployment of C-V2X technology and bring all the corresponding benefits of the technology to the public because current FCC rules, which were adopted years and years before anyone could have imagined the invention of C-V2X, preclude deployment of commercial C-V2X in the U.S. Last week, Qualcomm filed Comments strongly supporting the 5GAA Petition and requesting that the FCC approve the request as soon as possible so America’s cities and states, vehicle manufacturers, and millions of American drivers, passengers, and pedestrians can reap the safety

²⁰ See NPRM at ¶ 82.

²¹ See FCC Public Notice, “Office of Engineering and Technology and Wireless Telecommunications Bureau Seek Comment On 5GAA Petition For Waiver To Allow Deployment Of Cellular Vehicle-To-Everything (C-V2X) Technology In The 5.9 GHz Band,” DA-18-1231, GN Docket No. 18-357 (Dec. 6, 2018); see also 5GAA Petition For Waiver to Allow Deployment of Intelligent Transportation System Cellular Vehicle to Everything (C-V2X) Technology, GN Docket No. 18-357 (filed Nov. 21, 2018).

benefits provided by this advanced connected vehicle communications technology. Comments filed by major vehicle manufacturers demonstrate that a significant segment of the auto industry is asking the FCC to grant the 5GAA Petition expeditiously to remove the current regulatory obstacle and enable commercial deployment of C-V2X technology to bring substantial benefits to the American public.²²

2. The FCC Must Adopt The Proposed -27 dBm/MHz Level And Limit The Lowest U-NII-5 Channel To Indoor Use To Protect ITS Operations

To protect ITS operations in the 5.9 GHz band, the OOB limit from new U-NII-5 unlicensed operations into the 5.9 GHz ITS band should be no greater than the -27dBm/MHz level proposed in the NPRM, and the lowest U-NII-5 channel should be limited to indoor operations. 6 GHz unlicensed equipment using channels with $f_c < 5925 \text{ MHz} + \text{BW} \cdot 3/2$, where f_c is the center frequency of the unlicensed channel of operation and BW is the unlicensed channel bandwidth, should not be permitted for APs installed outdoors, fixed outdoor stations (or client devices), or mobile hotspots operating outdoors (including inside vehicles).

Without including these protective measures, OOB from outdoor unlicensed operations in the lower portion of the proposed U-NII-5 band can significantly degrade ITS safety-of-life operations. APs mounted outdoors or operating in vehicles as well as outdoor fixed unlicensed stations may be just meters away from moving vehicles with active ITS transceivers, compromising ITS functionality.

While this proposal does not prevent all conceivable interference to ITS operations, it would prevent the most likely interference events. Any possible interference from outdoor client

²² See BMW of North America Comments (Jan. 18, 2019); Ford Comments (Jan. 24, 2019); Jaguar Land Rover Comments (dated Jan. 18, 2019) in GN Docket No. 18-357; and see American Honda Motor Co. Comments (Jan. 25, 2019); Daimler North America Corp. Comments (Jan. 18, 2019) in GN Docket No. 18-357.

devices operating with an indoor AP serving a sidewalk café, for example, should be short-lived as the affected vehicle travels by. But, without the restrictions described herein that limit the lowest unlicensed U-NII-5 channel to indoor use, interference from new U-NII-5 operations could be persistent and risk harmful interference to ITS safety-of-life communications.

B. Intra-Band Emissions Limits Are Not Needed To Protect 6 GHz Incumbents

As explained in Section III.A above, Qualcomm supports the Commission's proposal to impose a -27 dBm/MHz OOB limit at the edges of the 6 GHz band with additional restrictions on outdoor use of the lowest U-NII-5 channel. However, the FCC should not specify any emission limits between the 6 GHz U-NII sub-bands. There is very limited diversity in protection needs for the licensed incumbent services in the 6 GHz sub-bands that require such limits, in contrast to the need to protect the adjacent 5.9 GHz ITS band.

There also is no need to regulate the transmit mask of new 6 GHz unlicensed devices to protect incumbent services operating on adjacent channels within the 6 GHz band²³ because the adjacent channel emissions from these devices will be orders of magnitude lower than licensed 6 GHz incumbents such as fixed point-to-point links that operate with much greater power.

C. Portable Operations Also Should Be Permitted

Subject to the limitations to protect 5.9 GHz band ITS operations described in Section III.A above, the FCC should allow portable unlicensed operations under the control of an AFC system in the 6 GHz band.²⁴ The same tools the AFC system uses to prevent interference to licensed incumbents can also cover portable devices and in-vehicle use. For example, portable

²³ See NPRM at ¶ 83.

²⁴ See NPRM at ¶¶ 84-85.

AFC-controlled devices can be required to check the AFC system more often than a stationary AP to ensure operations do not cause harmful interference as the user moves about.

D. Power Levels For Clients and APs of Each Power Class Should Be The Same

The FCC should revisit its proposed rules limiting the transmit power level from client devices to 18 dBm and instead allow both client devices and APs to operate at the same higher power level for each class of unlicensed devices, *e.g.*, standard power and LPI.²⁵ All unlicensed client devices should be able to use the same transmit power level as the unlicensed AP with which they are communicating. Limiting client device transmit power levels as proposed in the NPRM would prevent client devices from attempting to communicate with APs at ranges for which the client can successfully receive communications from the AP but not be able to successfully transmit to the AP; this not only wastes precious client device battery power, but it also creates unbalanced links, greatly diminishing the utility of the band.

Increasing the client device transmit power levels to the same amount as the AP with which it is communicating will not increase the interference potential to licensed incumbents. AFC system design will account for the interference potential of a client device as it will do for the AP itself, by effectively increasing the size of the protection area. With regard to LPI operations, the same factors that limit the interference potential of the LPI AP will limit that of the associated client devices.

In addition, the FCC should increase its proposed power spectral density (“PSD”) limits to 27 dBm/MHz for standard-power AFC-controlled equipment, and to 21 dBm/MHz for LPI

²⁵ See NPRM at ¶ 78.

unlicensed equipment.²⁶ Future broadband access will use channel bandwidths wider than 20 MHz, and the Commission should account for that when setting transmit power and PSD requirements.

These increased PSD limits will not create any increased risk of interference to licensed incumbents as OFDMA operations used by most unlicensed technologies rarely use narrowband transmissions. Moreover, this allowance would enable efficient spectrum access in dense areas with large numbers of devices sharing spectrum. With regard to LPI unlicensed operations, the high levels of building loss indoor unlicensed signals will experience will provide adequate protection of licensed incumbent services.

E. Professional Installation Should Not Be Required For All AFC-Controlled APs

The FCC should not require every AFC-controlled device to be professionally installed because there are other reliable means by which the location of newly installed RF equipment can be determined.²⁷ While professional installation is one means of ensuring reliable geolocation information and should be allowed under any enabling regulations, GPS receivers, for example, also can reliably provide location information for outdoor equipment. Any location uncertainty can be taken into account by the AFC system to ensure even worst-case location determinations result in protected incumbent licensees.

²⁶ See *id.*; see also NPRM Appendix B, Proposed Rules, Proposed § 15.407 General technical requirements.

²⁷ See NPRM at ¶¶ 28, 52, 91.

IV. The 6 GHz Band Is An Ideal Home For Next Generation 802.11 And 5G NR-U Technologies That Use Synchronization To Greatly Improve Spectral Efficiency

Qualcomm has been actively participating in the development of next generation 802.11 Wi-Fi and 5G NR in unlicensed spectrum technologies in IEEE and 3GPP,²⁸ respectively, that enable extremely high throughput services and applications among multiple distinct users in the same location. 3GPP Release 16, which includes a Licensed Assisted Access (“LAA”) version of 5G NR-U and a stand-alone version of 5G NR-U,²⁹ will be finalized later this year. Qualcomm and others in the wireless industry are targeting greenfield unlicensed and shared spectrum to support the development of advanced spectrum sharing paradigms used by 5G NR-U and IEEE 802.11be (EHT) that deliver significant benefits in terms of increased spectral efficiency, superior throughput, and much improved Quality of Service (“QoS”). These new sharing approaches will support Industrial IoT applications and other novel applications and services that require ultra-low-latency, highly reliable links.

As explained in this section of our Comments, Qualcomm proposes that the FCC enable these technologies as well as future, still-to-be-invented, spectrum access techniques in a portion of the 6 GHz band, such as the proposed U-NII-7 band at 6.525 - 6.875 GHz, by adopting

²⁸ See, e.g., IEEE Project Authorization Request (PAR), Project Number: P802.11be, Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications Amendment: Enhancements for Extremely High Throughput (EHT), <https://mentor.ieee.org/802.11/dcn/19/11-19-0244-00-0eht-eh-par-document.docx>; 802.11 EHT Proposed PAR for an amendment to an existing IEEE Standard, <https://mentor.ieee.org/802.11/dcn/18/11-18-1231-04-0eht-eh-draft-proposed-par.docx>; 3GPP Rel-16 work item. [RP-181677](#) NR Rel-16 Enhanced ultra reliable low latency communications study item; [RP-182569](#) NR Rel-16 Industrial IOT study item.

²⁹ See, e.g., Lorenzo Casaccia, Qualcomm OnQ Blog, “3GPP Commits to 5G NR in Unlicensed Spectrum in its Next Release,” (Dec. 13, 2018) *available at* <https://www.qualcomm.com/news/onq/2018/12/13/3gpp-commits-5g-nr-unlicensed-spectrum-its-next-release>.

simple, technology-neutral rules that are optimized for synchronization-capable unlicensed systems, such as 5G NR-U and IEEE 802.11be (EHT).

This approach would allow synchronized systems in the same geographic area to use the same piece of spectrum at the same time without mutually blocking each other, which can occur with asynchronous systems in dense environments. This approach would, for example, enable reliable support of industrial IoT and other applications that require a certain QoS. Enabling Commission regulations would not mandate use of any specific technology, but rather would allow any and all new technologies that use synchronization to coexist successfully in a portion of the new 6 GHz unlicensed band in a much more spectrally efficient manner, as described here.

A. 5G NR-U Uses Revolutionary Spectrum Sharing Techniques To Support Highly Reliable Unlicensed Operations And A Defined QoS

Qualcomm has demonstrated how 5G NR-U technology can provide multi-gigabit connectivity to multiple users in the same area using new spectrum sharing techniques such as spatial division multiplexing (“SDM”) and coordinated multipoint sharing (“CoMP”) and the 6 GHz band is a perfect home for this technology.³⁰ 5G NR-U technology takes advantage of the extremely fast 5G new radio, the multiple antennas and advanced spectrum access techniques, to enable 5G to transmit in a highly selective manner, utilizing interference management techniques and synchronized access nodes, so multiple co-located users can simultaneously operate on the same swath of spectrum — a feature that is not commercially available today.

³⁰ See, e.g., Qualcomm Press Release, “Qualcomm Demonstrates the Next Phase of 5G NR Technology Roadmap to Expand the Mobile Ecosystem — Advanced 5G NR Technologies for Autonomous Vehicles, Industrial IoT, and Spectrum Sharing Showcase the Company’s Continued 5G NR Leadership,” Feb 14, 2018 *available at* <https://www.qualcomm.com/news/releases/2018/02/14/qualcomm-demonstrates-next-phase-5g-nr-technology-roadmap-expand-mobile>

Use of multiple antennas is becoming increasingly common in wireless systems that operate in increasingly higher frequency bands. These multi-antenna systems allow transmission links to become highly selective in space, and this spatial selectivity can be exploited to significantly improve spectrum reuse and greatly increase overall system capacity. For instance, spatial division multiplexing (“SDM”) and coordinated multipoint sharing (“CoMP”) techniques allow for the creation and steering of highly selective beams in specified directions. These techniques enable multiple radio links to simultaneously communicate on the same channel and in the same geographical area, not only for the radio nodes of a single system but also for radio nodes of additional operators that overlap in time and in frequency. The system performance of the baseline time non-synchronized system and the benefits of time synchronization with and without CoMP are illustrated in Figure 1.

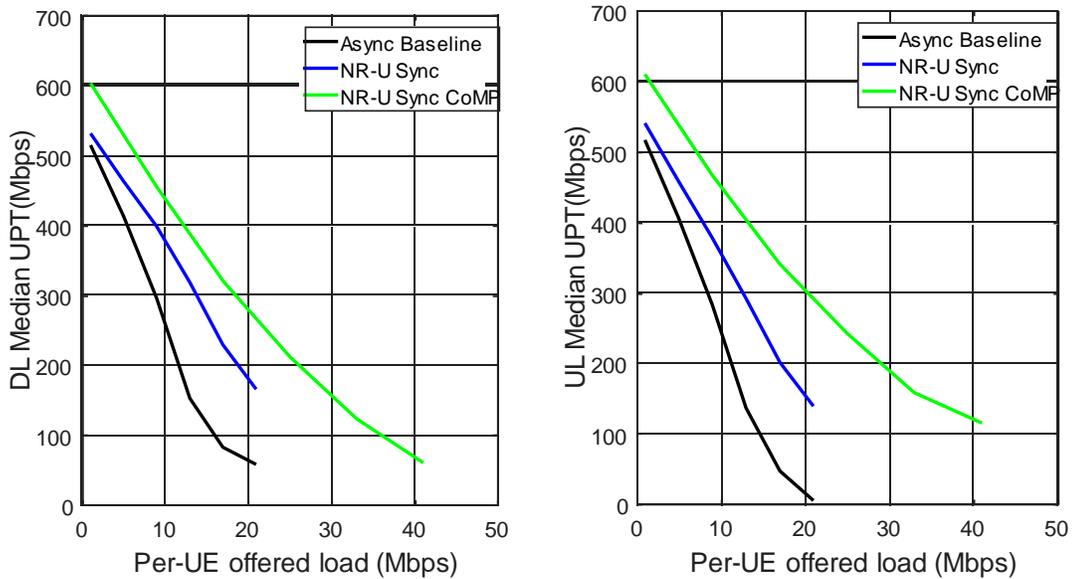


Figure 1. Performance comparison of asynchronous contention baseline and synchronous contention without and with CoMP for 3GPP outdoor simulation scenario operating in 40 MHz and using 4x4 MIMO

The x axis in Figure 1 represents per client device (or UE) offered averaged load, and the y axis overall client (UE) perceived throughput (“UPT”). The two graphs in Figure 1, depicting downlink throughput on the left and uplink traffic on the right, show the improved throughput of NR-U synchronized and further improved performance of NR-U synchronized with CoMP, both compared to the NR-U asynchronous baseline. For example, for a Per-UE offered load of 20 Mbps, the downlink UPT for asynchronous NR-U baseline is 75 Mbps while the performance of NR-U synchronized is about 175 Mbps and NR-U synchronized with CoMP is even better at 280 Mbps. The benefit of synchronized operation also can be seen through improved system capacity, or offered load, for the same UPT. For example, for a downlink median UPT of 200 Mbps, the capacity of the asynchronous baseline is about 11.5 Mbps in terms of a Per-UE offer load basis. The capacity increases to about 18.5 Mbps for NR-U synchronized and about 26 Mbps for NR-U synchronized with CoMP.

These advanced sharing techniques can effectively enable guaranteed spectrum access for services that require a given QoS, vastly increasing spectral efficiency and value. Thus, 5G NR-U technology can enable wireless system operators, including those with limited or no licensed spectrum, to offer fiber-like 5G experiences within new unlicensed or shared bands.³¹ In addition to the capacity benefits, synchronized operation can enable substantial power savings at the client device or UE. Since the contention, and thus medium access, is limited to predetermined synchronous contention windows, clients can transition to efficient power savings modes as soon as they determine that the serving node or AP has not gained the medium during the synchronous contention window.

³¹ See, e.g., Dean Brenner, Qualcomm OnQ Blog, “Wireless innovation — From LTE-U/LAA to 5G spectrum sharing,” (Mar. 29, 2018) available at <https://www.qualcomm.com/news/onq/2018/03/29/lte-u-5g-spectrum-sharing>.

B. Technology Neutral Regulations That Give Precedence To Synchronized Access Nodes And APs Can Enable 5G NR-U and 802.11be (EHT) Technologies As Well As Other Future Technologies

The proposed 6 GHz band — which is greenfield unlicensed spectrum — presents an excellent opportunity for the deployment of 5G NR-U technology and IEEE 802.11be (EHT), both of which can make use of synchronization to greatly improve spectrum utilization. This recommended approach of enabling synchronized operations uses the concept of preferred synchronized medium reservation windows, where the synchronization reference is common among cooperating nodes. The concept of the synchronous and periodic medium reservation period allows an access node, AP, or client (UE) to reserve the medium until the beginning of the next medium reservation period. The advantage of the synchronous contention period is that it enables effective control of hidden node and exposed node interference and supports QoS applications since all potential transmitters are required to monitor the medium at the same time.

Synchronous contention need not delay medium access, which typically is associated with slotted systems. Medium access outside the synchronized medium reservation period may be allowed if the medium is not reserved during the synchronous contention period. The only requirement is that the transmission ends before the start of the subsequent contention period to enable synchronous contention. The alignment of the medium reservation period, achieved via synchronization, is desired for fair coexistence among nodes in the system. If one node conforms to the synchronous medium access, all contending nodes should do the same. For that reason, each node that desires to ensure synchronous contention needs to periodically convey a time reference over the air for the synchronous contention period utilizing the signaling waveform understood by the intended receiving neighboring node. If over the air signaling is not detected within the given period, a node should be allowed to contend asynchronously (as is the case today with 802.11ac and 4G LTE LAA).

Time synchronization facilitates improved performance not only for the nodes that can maintain synchronization on their own, but also for nearby nodes that rely on periodic over the air signaling. And since time synchronization is not required for a node to access the medium in the absence of over the air signaling, the concept of preferred synchronous contention does not limit deployments of nodes that are not time synchronized.

The FCC should define simple technology neutral rules that implement this approach in a portion of the proposed 6 GHz band, such as the U-NII-7 band, because there are currently no unlicensed broadband communications operations in the 6 GHz band. Without doing so before any deployments occur, unlicensed access systems without the ability to synchronize using over the air techniques would be deployed throughout the 6 GHz band and prevent the enhancements synchronization offers from being deployed successfully anywhere within this important mid-band spectrum band.

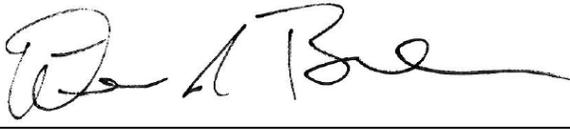
To be clear, we are requesting that the Commission implement a rule requiring each access node operating in the U-NII-7 portion of the 6 GHz band to listen for synchronized nodes, and, if the node detects synchronized operations, it would contend in a synchronized manner by utilizing over the air signaling from the synchronized nodes. This approach is technology neutral, as it will enable both 5G NR-U and next generation Wi-Fi-based EHT operations. Furthermore, it will ensure optimal use of the 6 GHz band for 5G NR-U and Wi-Fi-based EHT operations without prohibiting other technologies, as it gives precedence to synchronized operations in this portion of band but allows non-synchronized operations when no over the air synchronization timing reference signaling is detected.

CONCLUSION

Qualcomm encourages the FCC to promptly issue a Report and Order authorizing unlicensed operations in the 6 GHz band for wireless services in accordance with these Comments. There is no question that amending the Part 15 rules to permit flexible unlicensed broadband use of the 6 GHz band in support of industry standards by 3GPP and IEEE, with robust protection for incumbents' current and future operations, will enable improved broadband connectivity and highly useful industrial IoT and consumer applications, such as precision machine control, ultra-high-definition quality gaming, and virtual travel via AR/VR applications.

Respectfully submitted,

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February 15, 2019