

**Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554**

In the Matter of

Use of Spectrum Bands Above 24 GHz For
Mobile Radio Services

GN Docket No. 14-177

Establishing a More Flexible Framework to
Facilitate Satellite Operations in the 27.5-28.35
GHz and 37.5-40 GHz Bands

IB Docket No. 15-256

Petition for Rulemaking of the Fixed Wireless
Communications Coalition to Create Service
Rules for the 42-43.5 GHz Band

RM-11664

Amendment of Parts 1, 22, 24, 27, 74, 80, 90,
95, and 101 To Establish Uniform License
Renewal, Discontinuance of Operation, and
Geographic Partitioning and Spectrum
Disaggregation Rules and Policies for Certain
Wireless Radio Services

WT Docket No. 10-112

Allocation and Designation of Spectrum for
Fixed-Satellite Services in the 37.5-38.5 GHz,
40.5-41.5 GHz and 48.2-50.2 GHz Frequency
Bands; Allocation of Spectrum to Upgrade
Fixed and Mobile Allocations in the 40.5-42.5
GHz Frequency Band; Allocation of Spectrum
in the 46.9-47.0 GHz Frequency Band for
Wireless Services; and Allocation of Spectrum
in the 37.0-38.0 GHz and 40.0-40.5 GHz for
Government Operations

IB Docket No. 97-95

REPLY COMMENTS OF QUALCOMM INCORPORATED

Dated: February 26, 2016

Dean R. Brenner
John W. Kuzin
1730 Pennsylvania Avenue, N.W.
Washington, D.C. 20006
202.263.0020

INTRODUCTION & SUMMARY

The overwhelming majority of commenting parties is encouraging the FCC to move forward with authorizing flexible use operations in the 28 GHz, 37 GHz, and 39 GHz licensed bands and unlicensed use of the expanded 60 GHz band so consumers can reap the benefits of these new spectrum bands as soon as possible.¹ Virtually all commenters recognize that the millimeter wave bands offer very large contiguous spectrum blocks that can help meet today's surging mobile broadband data demands, initially where large numbers of mobile users are densely concentrated and then more broadly as millimeter wave technologies evolve. As Qualcomm and others note, while opening up these millimeter wave bands for mobile use is important, it is crucial that the Commission redouble its efforts to work with NTIA, the federal agencies with spectrum needs, the U.S. Congress, and the wireless industry, to repurpose substantially more spectrum below 5 GHz for mobile broadband because this spectrum will be a core component of successful 5G deployments.

As detailed in these Reply Comments, a majority of commenters agree that the FCC should not set county-sized licenses, but instead maintain the current larger geographic service area licenses currently in place in the 28 GHz and 39 GHz bands. This will allow licensees to develop and deploy millimeter wave systems that provide reliable access, backhaul connections, and fronthaul connections over areas large enough to support new deployment models. County-sized licenses would restrict potential 5G use cases and implementations. Many of these same commenters want the Commission to implement the same Economic Area ("EA") license sizes that apply to the 39 GHz band in the 37 GHz band and not impose the hybrid licensing proposal

¹ See Use of Spectrum Bands Above 24 GHz For Mobile Radio Services, GN Docket No. 14-177, *Notice of Proposed Rulemaking*, FCC 15-138 (rel. Oct. 23, 2015) ("*NPRM*").

at 37 GHz because it will lead to unresolvable interference problems between the building occupants and external licenses. Most commenters also encourage the agency to implement spectrum licenses with a 10-year term with a renewal expectancy — the same terms that have spurred decades of innovation and investment in the mobile bands below 3 GHz.

Furthermore, the FCC should extend the existing 57-64 GHz unlicensed band as proposed in the *NPRM* to enhance the budding 802.11ad WiGig services and applications beginning to operate here. In fact, the Commission should extend the unlicensed band to 72.6 GHz to allow for seven discrete 802.11ad channels, as Microsoft requests. 802.11ad devices are supporting extreme data rates and brand new user applications. This expanded unlicensed band will support even greater levels of service and brand new applications.

In these Reply Comments, Qualcomm explains that we are studying the appropriate out-of-band emissions levels for the Commission to use in these millimeter wave bands. Because millimeter-wave mobile devices will incorporate multiple element antenna arrays, new measurement techniques are likely needed.

Broadly speaking, virtually all commenting parties agree with the FCC that 5G wireless communications services will further enrich existing use cases and support novel deployment scenarios that connect new industries and device types and enable wholly new user experiences. There is unanimous agreement that 5G services will use multiple spectrum bands — low band, mid band, and millimeter wave spectrum — to seamlessly deliver wireless technologies that have become part of today's 4G ecosystem, such as device to device connectivity via LTE Direct, LTE Broadcast, and LTE in unlicensed spectrum, while providing significant performance improvements across all topologies.² Because we do not yet know which 5G use models and

² See, e.g., *NPRM* at ¶ 8.

applications will prove successful, Qualcomm and many other commenting parties strongly encourage the FCC to provide as much regulatory flexibility as possible in these new millimeter wave bands. The FCC should move forward without delay to enable the proposed flexible use operations in accordance with Qualcomm’s recommendations that are supported by many others.

DISCUSSION

I. Nearly All Commenting Parties Support The FCC’s Proposed Flexible Use Rules And Exclusive Licensing Of The 28 GHz, 37 GHz, and 39 GHz Bands

There is near unanimous support for the FCC’s proposal to auction exclusive, flexible use licenses to the areas in the 28 GHz, 37 GHz and 39 GHz that do not have active LMDS (*i.e.*, 28 GHz) or 39 GHz licenses.³ These parties recognize the best way to encourage investment in the millimeter wave bands is to establish a “flexible regulatory framework that accommodates as wide a variety of services as possible.”⁴ The Commission should therefore “permit the full array of Fixed and Mobile Service offerings without undue regulatory restraint ... [to] allow the business judgments of individual applicants and licensees in these bands to shape the nature of the services offered pursuant to their licenses.”⁵

³ See 4G Americas Comments at 3-5; CTIA Comments at 10, 11; *see also* EchoStar Satellite, Hughes Network Systems, and Alta Wireless Comments at 14 (noting that FCC proposal is consistent with agency precedent when it added mobile rights to the 2.5 GHz band initially licensed only for fixed services); Ericsson Comments at 5; Fixed Wireless Comms. Coalition Comments (“FWCC”) at 4; Intel Comments at 3-4, 7-8; Mobile Future Comments at 9; Nokia Comments at 15; Qualcomm Comments at 6-7; Straight Path Comms. Comments at 14-17; TIA Comments at 17-18; Verizon at 2, 6. Many of these parties agree that auctioning separate overlay rights would unnecessarily overcomplicate deployments.

⁴ *NPRM* at ¶ 23.

⁵ *NPRM* at ¶ 182.

Most parties also agree that the Commission should grant full, flexible use rights to existing licensees in the 28 GHz and 39 GHz bands.⁶ Doing so provides the most efficient path forward because the alternative of licensing a separate overlay of mobile rights on existing LMDS and 39 GHz licenses will create deployment challenges and lead to interference issues that delay deployment and deter investment in these bands.⁷ Allowing a single licensee to deploy both fixed and mobile infrastructure gives the licensee the ability to examine and manage the tradeoffs between different uses and enable successful deployments.⁸

Virtually all commenting parties want the FCC to keep the same size market areas currently authorized for the 28 GHz and 39 GHz bands.⁹ The 28 GHz band should be licensed in Basic Trading Areas (“BTAs”) and the 39 GHz band in Economic Areas (“EAs”). And because the 37 GHz band is adjacent to the 39 GHz band, it too should be licensed in EAs. These larger geographic license areas will best support the types of services currently expected to be deployed in the bands. 5G mobile service ranges and backhaul link distances may reach miles, and the substantially smaller, county-sized service areas the FCC proposed would inhibit technology development and constrain use cases. Maintaining the existing service areas will

⁶ See CTIA Comments at 14-15 (noting the FCC contemplated providing such rights when the licenses were first granted); see also Ericsson Comments at 5-7; Mobile Future Comments at 10; Huawei Comments at 11; Qualcomm Comments at 10-11; Straight Path Comms. Comments at 14; TIA Comments at 15; T-Mobile USA Comments at 9; Verizon Comments at 5-6.

⁷ See NPRM at ¶ 97.

⁸ See NPRM at ¶¶ 95, 182.

⁹ See 4G Americas Comments at 5-8; Consumer Technology Association Comments at 11-12; FWCC Comments at 4-5; Verizon at 10-11; XO Comms. Comments at 20; AT&T Comments at 17-19; Cisco Systems Comments at ii; Intel Comments at 9; Mobile Future Comments at 13; Nokia Comments at 18; Skyriver Communications at 7-11; Qualcomm Comments at 7-9; Straight Path Comms. Comments at 17-20; TIA Comments at 22-24.

provide licensees with the flexibility needed for successful experimentation and help establish a thriving ecosystem that incentivizes investment and successful deployments.

Nearly all commenters also request that the FCC not impose a hybrid licensing scheme in the 37 GHz band and instead apply the same rules it applies to the 39 GHz band.¹⁰ NCTA explains that property owners often lack the expertise needed to own and operate wireless networks and that the proposed hybrid scheme would curtail successful, ubiquitous deployments in the 37 GHz band.¹¹ Verizon, like Qualcomm, points out the viability of using the 60 GHz unlicensed band for indoor deployments instead of implementing a novel and unproven hybrid scheme in the 37 GHz band.¹² Boeing aptly notes that many entities are successfully using existing unlicensed bands for business processes within their facilities.¹³

Many commenters also ask the FCC to define license blocks that are at least 200 MHz wide to support the millimeter wave technologies Qualcomm and others are working to deploy in these bands.¹⁴ The dynamic variations in link quality that occur with millimeter wave mobile operations can be compensated for through operating with bandwidths 100 to 200 MHz wide (and even wider) that can support substantially higher burst rates.

¹⁰ See Consumer Technology Association Comments at 10-11; CTIA Comments at 11, 15-16; Ericsson Comments at 7-8; High Tech Spectrum Coalition Comments at 5. Information Technology Industry Council (“ITIC”) Comments at 5; Intel Comments at 13-14; Mobile Future Comments at 11; Nokia Comments at 16; Qualcomm Comments at 9-10; TIA Comments at 18-21; T-Mobile USA Comments at 4, 12-13.

¹¹ See NCTA Comments at 14.

¹² See Verizon Comments at 9; *see id.* at 3, 6-7.

¹³ See Boeing Comments at 12.

¹⁴ See CTIA Comments at 21-22; Ericsson Comments at 8-9; Samsung Comments at 14; Qualcomm Comments at 10; Straight Path Comms. Comments at 22-27; TIA Comments at 29-31; Verizon Comments at 7.

Most commenters also ask the FCC to use well-established 10 year license terms and a renewal expectancy for those licensees that provide substantial service.¹⁵ This reasonable, time-tested approach will best enable wireless innovation and investment in these bands.

Most agree that flexible performance requirements are needed to fuel innovation in these bands.¹⁶ The unique characteristics of the millimeter wave band deployments, particularly where they are used to support both mobile and fixed operations, will necessitate new thinking with regard to performance requirements. Recognizing that the core goal of a performance requirement is to ensure that wireless services are being provided (and that the spectrum does not lie fallow) while allowing for deployment flexibility, it would be most appropriate to base a performance requirement for the millimeter wave bands upon usage or a level of service rather than on population coverage.

4G Americas notes that “a more appropriate measure of adequate spectrum use might be whether it serves a meaningful quantity of connected devices, carried traffic, or session count.”¹⁷ Multiple parties agree that performance benchmarks need to be “sufficiently flexible” to “accommodate the considerable variety of 5G applications presently being discussed in the relevant standards bodies and industry fora.”¹⁸

¹⁵ See, e.g., CTIA Comments at 22-23; AT&T Comments at 20; Intel Comments at 23-24; Mobile Future Comments at 13-14; Nokia Comments at 19; Qualcomm Comments at 11-12; Straight Path Comms. Comments at 38; TIA Comments at 25.

¹⁶ See 4G Americas Comments at 10-11; AT&T Comments at 22-23; Cisco Systems Comments at 12, 14; Consumer Technology Association at 14; Intel Comments at 23-25; Mobile Future Comments at 15-16; Nokia Comments at 20; Qualcomm Comments at 12-13; Straight Path Comms. Comments at 13; TIA Comments at 25-28; Verizon Comments at 3-4 & 24-25.

¹⁷ 4G Americas Comments at 10-11. See also *NPRM* at ¶ 209 (There may well be “other non-population based technical metrics that should be considered in measuring performance (e.g., use of services associated with the link, capacity of the link).”); Nokia Comments at 20.

¹⁸ Cisco Systems Comments at 12.

To avoid restricting meritorious millimeter band business cases, the FCC should allow some time for the technology to evolve. For this reason, Qualcomm recommended that the Commission allow current licensees to make their substantial service showings to support their upcoming license renewals at any time prior to the next license renewal date based upon current rules to allow them to begin deploying new mobile and fixed services as soon as possible and provide necessary feedback the FCC can use to craft new, flexible performance requirements.¹⁹

II. Many Commenters Want The Commission To Double The Size Of The 60 GHz Unlicensed Band To Support Advanced 802.11ad Services

A large number of commenting parties encourage the FCC to double the size of the current 60 GHz unlicensed band.²⁰ They recognize that the current band supports ultra-high-speed unlicensed applications and expanding the unlicensed band to support more channels will unleash more exciting applications in consumers' homes, schools, parks, and libraries, and in businesses. The newest mobile devices containing Qualcomm's latest Snapdragon chipset has integrated support for this band.²¹

These same parties want the FCC to use the same technical rules that govern Part 15 operations in the 60 GHz band for the additional 7 GHz of spectrum that lies directly

¹⁹ See Qualcomm Comments at 17; *see also* Straight Path Comms. Comments at 38-39.

²⁰ See Boeing Comments at 11-13; Consumer Technology Association Comments at 8-9; Dynamic Spectrum Alliance ("DSA") Comments at 1; Facebook Comments at 2, 5-6; Google Comments at 6-7; IEEE 802 Comments at 4; Intel Comments at 17-18; Microsoft Comments at 5-6; NCTA Comments at 3-8; ITIC Comments at 5; Qualcomm Comments at 14; Skyriver Comms. Comments at 2 n.3; ViaSat Comments at 21-22; Wi-Fi Alliance Comments at 5-6.

²¹ See, e.g., Qualcomm Press Release "First Snapdragon 820 powered smartphone announced at CES" (Jan. 5, 2016) available [here](#) (*last accessed* Feb. 26, 2016).

above the current 57 to 64 GHz band.²² These rules are successfully supporting 802.11ad applications today, and greater bandwidth will improve these high-data rate use cases.

Qualcomm supports Microsoft's request to extend the unlicensed band to support an additional 802.11ad channel. Specifically, extending the band to 72.6 GHz would allow the 802.11ad standard to support a total of seven 2.16 GHz wide channels and enable full use of the expanded unlicensed band.²³

In addition, all parties who address the issue want the FCC to remove the coordination channel requirement as the agency proposed,²⁴ noting that specifications on coordination techniques better reside in industry standards.

III. Flexible Technical Rules & Measurement Procedures Will Best Serve The New Millimeter Wave Bands

Qualcomm agrees that the FCC should not implement the proposed $43 + 10\log_{10}(P)$ (*i.e.*, -13 dBm/MHz) attenuation level using the Effective Isotropic Radiated Power ("EIRP") metric. Qualcomm agrees with the commenters requesting that the Commission consider using alternate measurement procedures, such as Total Radiated Power ("TRP"), to assess compliance with

²² DSA Comments at 1; IEEE 802 Comments at 4; Qualcomm Comments at 14-15; ViaSat Comments at 22; Vubiq Networks Comments at 5; Wi-Fi Alliance Comments at 6-7.

²³ See Microsoft Comments at 5-7. The 802.11ad standard defines 4 channels based on the equation: $F_{cf} = 56.16 + i \cdot 2.16$ GHz; *i.e.*, $F_{cf} = 58.32, 60.48, 62.64, 64.8$ GHz. Also, the band edge of these channels is 2.64/2 GHz from F_{cf} . In the U.S. only the first three channels ($i=1, 2$ & 3) are available because unlicensed operations are currently permitted from 57-64 GHz. To support six channels total, the upper edge of the sixth channel would be 70.45 GHz, which would leave open the uppermost 0.55 GHz of the expanded band as proposed. By expanding the band to 72.6 GHz, the 802.11ad standard could support a total of seven 2.16 GHz wide channels.

²⁴ See NPRM at ¶ 312; and see IEEE 802 Comments at 5; Microsoft Comments at 10; Qualcomm Comments at 15; Vubiq Networks Comments at 5; Wi-Fi Alliance Comments at 9; ViaSat Comments at 22.

emissions limits.²⁵ However, because TRP measurement procedures are not currently defined for out-of-band emissions or for spurious emissions, the agency should remain open to allowing new measurement procedures via the FCC Laboratory's KDB process. As Ericsson, Nokia, and Samsung aptly recognize, we are in the early stages of 5G technology equipment designs and development, so it is difficult at this point in time to identify all of the potential compliance and measurement challenges.²⁶ Millimeter-wave devices are being designed with an array of multiple antennas employing dynamic beamforming and without an output port through which to measure transmitter conducted power; accordingly, these designs make verification of transmitter power, EIRP, and antenna gain quite challenging.

Based on our technical studies, Qualcomm believes that the FCC should define out-of-band emissions limits up to $\pm 250\%$ of the channel bandwidth, similar to what mobile systems use today, and that a stepped limit be implemented where one limit runs from $\pm 50\%$ to 150% and a second limit runs from $\pm 150\%$ to 250% of the channel bandwidth. We are actively studying this issue to determine the achievable emissions levels. Based on our simulations to date, the average interference from a mobile and a base-station/small cell with a steerable/selectable array is very different and variable when compared to a fixed link. With mobile operations, the interference impact differs from fixed links due to the dynamic nature of the antenna array, for it points in different directions as mobile users move and are served.

Qualcomm supports the FCC's proposal to vary the measurement bandwidth as frequency increases provided that the limit scales with the measurement.²⁷ The FCC should also

²⁵ See, e.g., Ericsson Comments at 13-16; TIA Comments at 32-33.

²⁶ See also Nokia Comments at 28; Samsung Comments at 19.

²⁷ See NPRM at ¶ 320.

allow measurements to be made using lower resolution bandwidths as needed so test equipment can achieve the necessary noise floor provided that the results are integrated to the limited defined bandwidth as permitted by other rule parts such as FCC Rule Section 27.53(a)(5).

CONCLUSION

The overwhelming majority of commenting parties are encouraging the Commission to promptly authorize the proposed flexible operations in the millimeter wave bands so that necessary work can occur for these bands to support next-generation mobile operations. Indeed, these bands will provide an important piece of the 5G solution, and Qualcomm encourages the FCC to move forward to approve the proposed uses in accordance with our Comments and these Reply Comments.

Respectfully submitted,

QUALCOMM INCORPORATED

By: 

Dean R. Brenner
Senior Vice President, Government Affairs

John W. Kuzin
Senior Director & Regulatory Counsel

1730 Pennsylvania Avenue, N.W.
Suite 850
Washington, D.C. 20006
202.263.0020

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Attorneys for QUALCOMM Incorporated