

**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

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SUMMARY

Qualcomm welcomes the Commission's timely release of the *Notice of Proposed Rulemaking* to open millimeter spectrum bands above 24 GHz for 5G mobile broadband services and encourages the agency to move forward with authorizing the proposed flexible use of the 28 GHz, 37 GHz, and 39 GHz licensed bands and the 64-71 GHz unlicensed band as soon as possible so consumers can reap the benefits of this spectrum. While these new spectrum bands will provide an important part of the 5G solution, lower bands below 5 GHz will be essential for highly reliable and robust wide area 5G network coverage. Without a doubt, 5G services will use low-band, mid-band, and high-band spectrum, all in concert with one another, to deliver unparalleled forms of connectivity, not just in terms of capacity, data rates, and latency, but also in terms of the mode of connectivity, *e.g.*, device to device, machine-to-machine, mesh, relay hubs, and traditional cellular, which will be key to supporting new devices, like robots, unmanned vehicles, and different industrial machines, as well as innovative applications in areas such as healthcare, energy, and smart cities. Qualcomm fully expects 5G networks to enable use cases not presently imaginable as supportable by traditional wireless technologies.

The millimeter wave bands offer large contiguous blocks of spectrum to help meet today's surging mobile broadband data demands, particularly in major metropolitan areas and event venues where large numbers of users are often densely concentrated. 5G services, however, will need to use more than just these millimeter wave bands to support a superior and more uniform quality of user experience with ultra-low latency and ultra-high throughput across all locations and to all devices. In addition to the millimeter wave bands, more sub-5GHz spectrum will be needed. Thus, while this *NPRM* proposing to open up millimeter wave bands for mobile use is important, it is equally important that the agency redouble its efforts to work

with NTIA, the many federal agencies with spectrum needs, the U.S. Congress, and the wireless industry, to repurpose much more spectrum below 5 GHz for mobile broadband.

Qualcomm and its wireless industry partners are actively developing millimeter wave technology that can operate in the bands above 24 GHz. This higher band spectrum will generate a significant return in terms of providing torrents of throughput in areas where demand is surging. We strongly support the FCC's proposals to adopt flexible service rules in these bands. Qualcomm believes that the Commission 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. In the 37 GHz band, the FCC should implement the same Economic Area ("EA") license sizes that apply to the 39 GHz band and not impose a hybrid licensing scheme because it will lead to unresolvable interference problems between the building occupants and external licenses. Also, the FCC should define spectrum blocks within these three bands that are at least 200 MHz wide to support the technologies that Qualcomm and other wireless companies are developing. Licenses should include the same terms that have spurred innovation in the mobile bands below 3 GHz, such as a 10-year term and a renewal expectancy, to encourage innovation and investment in these new mobile bands.

At the same time, the FCC should authorize its proposed unlicensed operations in the 64-71 GHz band to extend the existing 57-64 GHz unlicensed band and further spur the exciting 802.11ad WiGig operations that are currently operating here. Mobile devices with 60 GHz technology are presently providing extreme data rates and remarkable user applications.

In sum, the FCC should promptly enable licensed mobile operations in the 28 GHz, 37 GHz, and 39 GHz bands and extend the 57-64 GHz unlicensed band to 71 GHz. These bands can support new wireless technologies and spur deployment of innovative 5G services.

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INTRODUCTION

QUALCOMM is pleased to submit these comments in response to the Commission’s *NPRM* to open use of spectrum bands above 24 GHz for 5G mobile broadband services.¹ The 5G wireless communications services being designed to operate in these millimeter wave bands will enrich existing use models and applications, connect new industries and device types, and enable wholly new user experiences. Because it is currently unclear which use models and applications will be successful, Qualcomm supports the FCC’s proposed “flexible rules” to “accommodate a wide variety of current and future technologies” and “encourage innovation in the development of advanced wireless services.”²

As the Commission works to open up these millimeter bands for mobile broadband use, the agency needs to continue its important work to free up more spectrum below 5 GHz for mobile broadband because this lower band spectrum will continue to be essential in the successful delivery of 4G and 5G services coast-to-coast.

5G services will use low-band, mid-band, and high-band spectrum to transform societies and industries to an even greater extent than previous wireless service generations. 5G networks will deliver much more than multi-gigabit per second data rates. They will enable brand new services, industries, and devices, and empower wholly new user experiences via support of ultra-low latency, ultra-low power, ultra-high reliability and ultra-high security devices that operate with flawless connectivity. Over the next ten years during which 5G services begin to be released, devices will be transformed into a wider variety of form factors and capabilities at a much quicker pace. As a result, when compared to 4G services, 5G services will introduce much

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*”).

² *Id.* at ¶ 3.

broader dimensions of improvements to meet our growing connectivity needs. While 4G LTE and LTE Advanced will continue evolving to their full potential and be deployed well into the next decade, industry and regulators alike need to move forward with 5G efforts so that this next generation wireless technology interface can be deployed as soon as possible.

5G services will use multiple spectrum bands to seamlessly deliver the technologies that are part of today's 4G ecosystem, such as LTE Broadcast, device to device connectivity via LTE Direct, and LTE in unlicensed spectrum, while providing significant performance improvements across all topologies.³ To achieve this vision, 5G services need extreme flexibility, ultra-high throughput, scalability, and adaptability across a wide variation of use cases — from mission-critical applications like unmanned vehicles and remote medical procedures to Internet of Everything (“IoE”) support of sensors and other machine-to-machine (“M2M”) devices to ultra-reliable, multi-gigabit-per-second mobile broadband connectivity to better support the applications, services and devices that consumers are increasingly relying upon.

Qualcomm expects that 5G services will use a unified air interface and enable low-cost, highly energy efficient operation by accessing all spectrum bands — including the 28 GHz, 37 GHz, 39 GHz and 64-71 GHz bands in the *NPRM*. Thus, Qualcomm encourages the Commission to move forward to enable the proposed mobile operations in these millimeter wave bands in accordance with the Comments provided herein.

³ See *NPRM* at ¶ 8 (5G calls for “the development of new system architectures that, unlike current technologies, would necessarily include heterogeneous networks capable of delivering service through multiple, widely-spaced frequency bands and diverse types of radio access technologies, including macrocells, microcells, device-to-device communications, new component technologies, and unlicensed as well as licensed transceivers.”).

DISCUSSION

I. The FCC And Other Federal Government Stakeholders Should Continue Working To Free Additional Spectrum Below 5 GHz For Mobile Use While All Wireless Stakeholders Work To Enable Mobile Use Of The Millimeter Wave Bands

The Commission's important work to open up additional spectrum bands above 24 GHz for mobile broadband use should proceed in parallel with intensified efforts to clear additional spectrum below 5 GHz for mobile use by working with Congress, NTIA and other federal agencies. Federal agencies that use or manage spectrum below 5 GHz should expedite their efforts with the U.S. Congress and industry to free up additional spectrum for mobile broadband. Specific means of freeing up more spectrum for exclusive commercial use may involve more intensive sharing among federal users in less spectrum by using wireless technologies with greater spectral efficiency. All reasonable approaches to providing additional licensed spectrum below 5 GHz for mobile use should be on the table.

Indeed, the highly successful AWS-3 auction, which raised tens of billions of dollars for the U.S. Treasury last year, demonstrates the high value of exclusively licensed spectrum, which is precisely what the upcoming 600 MHz incentive auction is relying upon. Much more exclusively licensed sub-5 GHz mobile broadband spectrum is needed to successfully support the expected 1000x increase in mobile broadband data demand over the coming decade.⁴

A. 5G Services And Applications Will Be Supported By A New Network Design

Qualcomm believes that 5G services and applications need to be supported by a new kind of network with much greater reliability and a very high level of redundancy by leveraging multiple communications access paths that use a broad collection of spectrum bands that include

⁴ See, e.g., Qualcomm website, "1000x Data Challenge," available at <https://www.qualcomm.com/invention/technologies/1000x> (last accessed Jan. 26, 2016).

the millimeter wave bands. 5G services will connect everything from simple sensors to complex robots, and they will need scalability and adaptability across an extreme variation of use cases. To be clear, 5G will extend well beyond providing higher peak data rates.

The fundamental building block for 5G services will be a new air interface that scales across all services and use cases, and supports all spectrum bands and types of spectrum access rights, in both licensed and unlicensed spectrum, with both exclusive use spectrum and shared spectrum. All available spectrum bands will be used to ubiquitously provide new services; from the sub-5 GHz bands that provide excellent wide coverage to bands above 5 GHz that provide more capacity to the millimeter wave bands that can support targeted capacity needs in concentrated areas with high demand.

While 5G networks will take advantage of new spectrum bands and use a new air interface, these networks also will work in conjunction with today's 4G, 3G, LTE-Unlicensed, and Wi-Fi investments through a new network architecture that supports simultaneous multi-band, multi-mode connectivity in devices that handle a much greater number of bands than is possible today. Thus, 5G services will provide broader enhancements such as scalability and reliability in addition to improving technical dimensions like data rates, capacity, and latency, as well as business dimensions like dynamic subscriptions, deployment, and network sharing models that could include new modes of third party access. 5G services will likely involve new forms of connectivity well beyond just smartphones and tablets. Accordingly, flexible service rules, such as those the FCC has proposed in the millimeter wave *NPRM*, will be essential to supporting a broad collection of use cases and access models.

New and different service models will be needed to support the massive number of connected things and mission critical services. These service models will open up new business

opportunities for 5G providers to host new services and provide a platform for new markets and novel subscription models. The 5G network platform will scale for a wide range of services — from traditional wide area deployments to support for enterprises, hotspots at stadiums, residential deployments, and support a broad collection of innovative applications and device-types. As noted above, flexible service rules are key to enabling a successful 5G world.

B. 5G Services In Bands Above 24 GHz Will Supplement 5G Operations In Lower Bands To Provide Ultra-High-Speed Broadband Where Data Demands Are High

5G operations in spectrum bands above 24 GHz will be used to provide ultra-high-speed service in specific areas, supplementing 5G services that use sub-5 GHz spectrum to provide coast-to-coast connectivity. Qualcomm and others in the wireless industry are investing heavily in the development of advanced wireless technologies, and they believe that wide channels available in these higher millimeter wave spectrum bands will be needed to support growing traffic demands, particularly in dense urban areas and event venues, both indoors and outdoors.

Each new wireless generation must provide significant improvements over the previous generation, and, because of this, 5G services will look beyond today's trends and device capabilities to define new services and use models that drive requirements beyond what 4G technologies can do. 5G must support communications among a massive number of connected things — perhaps in the trillions — that we expect will be online by 2025.

5G services need to scale up as needed to provide much higher data rates and support much greater capacity to provide a very high quality user experience to each device a user relies upon every day. The addition of proximal and contextual awareness to wireless devices will create additional value to the mobile broadband user experience. Mobile operations in bands above 24 GHz offers multiple dimensions to introducing more capacity through network densification, advanced receiver designs, and spatial multiplexing techniques that can leverage

the wide swaths of spectrum available in these new mobile bands. And, as noted above, to support these innovative 5G services and applications, wireless connectivity in spectrum bands above 24 GHz will need to work alongside operations in bands below 5 GHz to support highly reliable and secure, ultra-low latency, ultra-low power, and low-cost device applications.

C. Qualcomm Supports The FCC’s Proposed Technology Neutral Path To 5G Services — The Same Path That Has Enabled 4G Services To Flourish

Qualcomm applauds the FCC’s stated approach to apply to 5G services the same highly successful regulatory principles that it has applied to mobile broadband services in the sub-3 GHz spectrum bands. Specifically, the Commission recognizes that flexible service rules and technology-neutral regulations have let innovation and market competition drive rapid technology advances for 4G and previous generations of wireless interfaces.⁵ Qualcomm strongly supports the FCC’s proposal to use this same regulatory approach in the millimeter wave bands. Indeed, designing service rules specific to a given technology would constrain innovation because rules locked in to a particular standard would quickly become outdated. Thus, technology neutrality must be a key aspect of the FCC’s rules given that 5G millimeter wave technologies are “evolving rapidly, ‘at Internet speed,’ much faster than the timescales used in administrative law and rulemakings.”⁶

II. Qualcomm Supports The Commission’s Proposed Flexible Use Rules And Exclusive Licensing Of The 28 GHz, 37 GHz, and 39 GHz Bands

Qualcomm encourages the FCC to adopt its 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.*,

⁵ See *NPRM* at ¶ 24 (FCC believes that “creating a flexible regulatory framework would be consistent with the Commission’s general policy of technological neutrality, which has wide support among commenters.”).

⁶ *Id.* at ¶ 24 n.56 (citations omitted).

28 GHz) or 39 GHz licenses. To encourage the necessary investment in the millimeter wave bands, it is particularly “important to establish a flexible regulatory framework that accommodates as wide a variety of services as possible.”⁷ Therefore, Qualcomm strongly supports the Commission’s proposed flexible framework to “permit the full array of Fixed and Mobile Service offerings without undue regulatory restraint ... that will allow the business judgments of individual applicants and licensees in these bands to shape the nature of the services offered pursuant to their licenses.”⁸

The Commission also should grant full, flexible use rights to existing licensees in the 28 GHz and 39 GHz bands. It should not license a separate overlay of mobile rights on top of existing LMDS and 39 GHz licenses because that will create deployment challenges and insurmountable interference issues and deter investment in these bands.⁹

A. The FCC Should Maintain The Same Size Market Areas That It Originally Authorized For The 28 GHz and 39 GHz Bands

Qualcomm respectfully requests that the Commission license the identified millimeter spectrum bands using the same size market areas that were originally authorized for fixed services in the LMDS (*i.e.*, 28 GHz) and 39 GHz bands. The 28 GHz band should be licensed in Basic Trading Areas (“BTAs”) and the 39 GHz band should be licensed in Economic Areas (“EAs”). Because the proposed 37 GHz band is adjacent to the 39 GHz band, the FCC should license that spectrum band in EAs as well.

To best enable the development and deployment of 5G mobile services in the millimeter wave bands, the Commission should rely upon the existing geographic license areas because they

⁷ *NPRM* at ¶ 23.

⁸ *Id.* at ¶ 182.

⁹ *Id.* at ¶ 97.

will best support the types of services expected to flourish in the bands. They will help to ensure a thriving ecosystem by incentivizing investment in new technologies that will be deployed here.

To the extent licensees want to use smaller geographic areas, the FCC should permit license partitioning and disaggregation.¹⁰ This flexibility would facilitate the “efficient use of spectrum by enabling licensees to make offerings directly responsive to market demands for particular types of services;” it will increase “competition” and expedite the “provision of services that might not otherwise be provided in the near term.”¹¹ The Commission also should apply its secondary market policies to these new bands, which also will “promote more efficient, innovative, and dynamic use of the spectrum, expand the scope of available wireless services and devices, enhance economic opportunities for accessing spectrum, and promote competition among providers.”¹²

However, the FCC should not impose a hybrid licensing scheme in the 37 GHz band. It should instead apply the same rules that are applied to the 39 GHz band. The millimeter wave spectrum bands offer an important opportunity to aggregate significant blocks of contiguous spectrum, and promulgating similar technical and service rules for the 37 GHz and 39 GHz bands would be a much more effective way to realize the deployment efficiencies in these new mobile bands.

This licensing approach would firmly rest upon the successfully framework that the FCC has used for countless other mobile services. In contrast to the agency’s proposal to divide the

¹⁰ See *NPRM* at ¶¶ 232-34

¹¹ *Id.* at ¶ 232.

¹² *Id.* at ¶ 238 (“Thus, our proposal to permit spectrum leasing in the 28 GHz, 39 GHz, and 37 GHz services is consistent with our determination above to permit partitioning and disaggregation in these spectrum bands.”).

band into county-sized licensed areas, maintaining the existing geographic areas increases certainty and mitigates the interference management complexity in the border regions that would be created were the FCC to license the band on a county-sized basis. Larger geographic areas, such as BTAs and EAs, provide investment certainty that new mobile licensees need to innovate, develop, and deploy new 5G capabilities in these new mobile bands.

Most importantly, licensing these bands on an exclusive basis will allow licensees to provide a very high quality of service and outstanding user experience.¹³ It also will enable quick remediation in the unlikely event licensed mobile operations cause interference to other users of the band. In sum, exclusive use licensing assigns rights in a way that maximizes the utility of the spectrum, minimizes the potential for interference among co- and adjacent-channel users, and allows flexibility for licensees to meet the needs of end users.

**B. The Commission’s Hybrid Licensing Proposal
At 37 GHz Would Create Unresolvable Interference Issues**

The proposed hybrid licensing plan for the 37 GHz band — where the FCC would grant indoor operating rights to building owners and tenants and outdoor rights to FCC licensees — would lead to many interference problems, impairing the spectrum and undermining the Commission’s own objectives. It is not possible to completely block signals originating indoors from traveling outdoors and vice-versa.¹⁴ In many cases, the demarcation point between indoor and outdoor environments is muddied by building entranceways, doorways, windows (both closed and open), balconies, rooftop lounges, and indoor and outdoor atriums — all places where

¹³ Qualcomm supports the proposal to resolve all applications and license assignments in regions without an active licensee through competitive bidding. *See NPRM* at ¶ 245.

¹⁴ In fact, when designing a robust outdoor or indoor system, it is important to improve coverage, yet this creates additional leakage — from the outdoor environment indoors and vice-versa. Because wireless signals propagate by reflection and diffraction (and may be temporary or permanent) it will be particularly challenging to sufficiently isolate the two systems.

people congregate and will want to access mobile broadband, but signals from the building owner's system and the outdoor licensee will intermix and create connectivity issues.¹⁵ The FCC should instead apply the same licensing and auction rules to the 37 GHz band that it proposes to apply to the 39 GHz band.

Moreover, licensees who want to deploy networks indoors will have access to 14 GHz of unlicensed spectrum at 57-71 GHz, once the Commission expands the existing 60 GHz unlicensed band, and building owners can use this band to support highly reliable, multi gigabit-per-second connectivity indoors.

C. The FCC Should Grant Existing LMDS And 39 GHz Licenses The Right To Deploy Both Mobile And Fixed Services In Their Licensed Service Areas

Qualcomm agrees with the Commission that the quickest means of enabling expanded use of the 28 GHz LMDS and 39 GHz bands is to provide current active licensees flexible use rights that include mobile rights to allow them to immediately deploy mobile and fixed services throughout the geographic areas covered by their licenses.¹⁶

By contrast, allowing separate bundles of “fixed” and “mobile” rights in the same geographic area would create troubling interference issues that would make the deployment of mobile services unduly complex. Qualcomm agrees with the FCC that a single point-to-point link in a metropolitan region could preclude mobile use of the spectrum in that region. A single

¹⁵ The Commission itself raises many questions with regard to managing the usage and operating rights under its hybrid licensing proposal, *see NPRM* at ¶ 102, which unfortunately only further illustrates the many problems with the proposal. *See also id.* at ¶ 294.

¹⁶ *See id.* at ¶ 95.

license that covers both fixed and mobile rights avoids this issue and provides the licensee with the ability to evaluate the tradeoffs between different uses and manage successful deployments.¹⁷

D. The FCC Should Define License Blocks That Are At Least 200 MHz Wide To Support The Millimeter Wave Technologies Qualcomm Expects To Deploy

The bands in the *NPRM* have very wide channel bandwidths that can support compelling mobile service throughputs. Importantly, the dynamic variations in link quality that results from mobile operations in the millimeter wave bands, particularly in non-LOS operation, can be compensated for by using higher burst rates that can support a high quality user experience. Thus, Qualcomm believes that it is very important to provide wide contiguous blocks of spectrum that are at least 200 MHz wide.¹⁸

The FCC should revisit its initial band plan proposals to provide for more contiguous spectrum blocks and limit the variances in the licensing and technical rules associated with this spectrum. The existing 39 GHz band plan should be recast to provide contiguous blocks of spectrum that are at least 200 MHz wide.

E. The FCC Should Provide A 10 Year License Term And A Renewal Expectancy

The Commission should adopt well-established license terms of 10 years and renewal expectancies for those licensees that provide substantial services, as Qualcomm recommended in its Comments on the *NOI*.¹⁹ This approach will be the most expedient path forward,²⁰ as it will

¹⁷ See *id.*; see also *id.* at ¶ 182 (“[O]ur goal is to maintain an open and flexible approach that will allow the business judgments of individual applicants and licensees in these bands to shape the nature of the services offered pursuant to their licenses.”).

¹⁸ See *id.* at ¶ 116-18.

¹⁹ See *id.* at ¶¶ 120-21.

²⁰ See *id.*

support wireless equipment technology innovation and investment in these bands given that the FCC plans to allow commercial mobile service along with fixed operations.

For those licensed areas that do not have an active LMDS or 39 GHz licensee, the FCC should auction that spectrum for flexible (*e.g.*, mobile) use straight away. The FCC should set a ten year license term for these licenses with reasonable construction requirements, as discussed in subsection F below, to ensure that these bands are put to use in a timely manner.

F. Current Licensees Should Be Allowed To Demonstrate Substantial Service Early Based Upon Today’s Requirements While The FCC Develops Additional Performance Metrics Based On Licensees’ Use Of The Band In A 5G World

The Commission should allow current LMDS and 39 GHz 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 the current LMDS and 39 GHz build-out requirements. This will incent current licensees to begin deploying new mobile and fixed services as soon as possible, and it will more quickly provide feedback to the FCC about how these bands will be utilized under a new flexible use regime.²¹ The FCC can then use real-world deployment information to define appropriate performance metrics to assess substantial service at the subsequent renewal date. This new metric also can be used to assess substantial service by licensees that receive new flexible use licenses in the 28 GHz, 37 GHz, and 39 GHz bands.²²

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. Indeed, because millimeter wave deployments will differ from traditional cellular deployments in significant ways, the FCC’s performance requirements

²¹ See *NPRM* at ¶ 207.

²² See *id.* at ¶¶ 193-98.

will need to reflect those differences. The Commission recognizes that “base stations in bands above 24 GHz will likely have very small coverage areas; will likely have limited geographic coverage even in the aggregate, and will most likely be integrated into networks that will provide wide area coverage and network coordination in lower bands.”²³ Millimeter wave deployments will focus, at least initially, on locations with a high density of users and devices where more capacity is needed, such as event venues and transportation hubs. The emergence of IoE applications will also lead to millimeter wave support of machine-type applications at industrial locations.

An entirely new metric should be developed for these millimeter wave deployments to more accurately assess the level of spectrum utilization. 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,²⁴ it is more appropriate to base a performance requirement for the millimeter wave bands upon usage or a level of service rather than on population coverage. Qualcomm believes that any new performance metrics should be as flexible as the underlying service rules to account for the broad range of 5G services, usage models, and applications.²⁵

²³ *NPRM* at ¶ 11. While macrocells can use beam steering to generate narrow, highly-focused millimeter wave beams in high dense environments, Qualcomm expects most mobile deployments in these bands to be densified collections of small cells. Relaying between small cells and mesh-like architectures will support both data and control planes. Device-to-device connectivity will expand coverage and support sharing of cached content among nearby users. Integrating these tools into 5G networks will improve system robustness.

²⁴ *See id.* at ¶¶ 193, 202.

²⁵ *See id.* at ¶¶ 204-05 & 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).”).

Furthermore, because we are in the early stages of mobile deployment in these bands, the FCC should not adopt “use it or share it” obligation because it is currently unknown how licensees will use their new flexible use rights.²⁶ Such an obligation would introduce uncertainty at this critical stage and could deter the investments necessary to make millimeter wave mobile deployments successful. Similarly, the Commission should not apply the 3.5 GHz band spectrum management model to these bands until that model is shown to successfully manage spectrum access in that band.²⁷ Qualcomm believes that tried and true techniques should be applied to the millimeter wave bands, particularly at this early stage of equipment development and service deployments.

III. Qualcomm Supports The FCC’s Proposal To Extend The 60 GHz Unlicensed Band Up To 71 GHz To Support Advanced 802.11ad Services

The Commission should promptly expand the current 60 GHz unlicensed band, at 57 to 64 GHz, to include the 64 to 71 GHz band.²⁸ The current 60 GHz band is useful for ultra-high-speed unlicensed uses, such as streaming Ultra HD audiovisual content across a large room. Support for this band is integrated into the latest suite of handsets that include Qualcomm’s latest Snapdragon chipset.²⁹

A. The FCC Should Use The Same Part 15 Rules That Apply From 57-64 GHz

The FCC should rely upon the same technical rules that govern Part 15 operations in the 60 GHz band for the additional 7 GHz of spectrum that lies directly above the current 57 to

²⁶ *NPRM* at ¶ 215-17.

²⁷ *See id.* at ¶ 222.

²⁸ *See id.* at ¶ 58.

²⁹ *See, e.g.*, Qualcomm Press Release “First Snapdragon 820 powered smartphone announced at CES” (Jan. 5, 2016) available [here](#) (*last accessed* Jan. 26, 2016) (announcing support for 802.11ad connectivity in the 60 GHz unlicensed band).

64 GHz unlicensed band. These rules are successfully supporting 802.11ad applications today, and having access to greater bandwidth will support even greater data throughput connectivity.

B. The 57 GHz Coordination Channel Requirement Should Be Removed

Current rules specify that 57-57.05 GHz is a coordination channel, in which only spurious emissions and emissions related to coordination techniques are permitted. Qualcomm supports the FCC's proposal to remove this requirement, and we agree that specifications on coordination techniques better reside in industry standards. As the Commission rightly recognizes, removing this requirement also would add 50 MHz of spectrum for unlicensed communications.³⁰

IV. Qualcomm Supports Flexible Technical Rules For The New Millimeter Wave Bands

As explained above, Qualcomm agrees with the Commission that it is critically important at this stage to define technical rules that encourage development of millimeter wave technology and that the best means of achieving that goal is to propose regulations that allow for flexible equipment designs and service deployments.³¹

A. Qualcomm Expects TDD Operations To Predominate In These Bands

Time Division Duplex ("TDD") operations will likely predominate for mobile use of the millimeter wave bands for technical reasons.³² Advanced antenna designs, including beamforming, operate at peak efficiency in TDD modes where transmit and receive operations use the same channel. Also, while it is extremely challenging to build a duplexer that can support FDD operations in the millimeter wave bands, TDD operations do not need a duplexer.

³⁰ See *NPRM* at ¶ 312.

³¹ See *id.* at ¶ 266.

³² See *id.* at ¶ 268 (quoting Qualcomm's NOI comments describing the benefits of TDD operations).

In addition, the services these bands are expected to support will likely be asymmetric; this includes the streaming and downloading of audiovisual content as well as services that have heavy uplink needs, such as device docking and “second screen” operations. Each of these use cases would benefit from the flexible partitioning of the medium that TDD operation provides. Other benefits of using TDD include exploiting reciprocity for beamforming and supporting dynamic resource matching to traffic.³³

B. Qualcomm Supports The Proposed Power Levels And Asks The FCC To Set A Power Level For A Device That Serves As A Local Internet Access Hub

Qualcomm agrees with the FCC’s proposed transmit power levels, specifically 85 dBm EIRP for point-to-point operations and 43 dBm EIRP for mobile devices.³⁴ The FCC should define a power level for an additional device type, *e.g.*, a local hub, that is greater than the proposed 43 dBm EIRP level for mobile devices but less than the 62 dBm EIRP level allowed for a millimeter wave base stations. This device could be used: (i) on the rooftop of buildings to support point-to-multipoint broadband services; or (ii) for a mobile relay transceiver, *e.g.*, mounted atop a vehicle, that sends data between nearby user devices and remote millimeter wave base stations.

The FCC also should consider increasing the maximum transmit power level for base stations by 10-12 dB to account for increased propagation losses in these bands. Additional power would increase link reliability, particularly in dense urban areas and in higher-band spectrum during weather events.

Qualcomm also agrees that the FCC should use over-the-air measurement techniques to more accurately assess transmit power levels for millimeter wave equipment. For example,

³³ See *NPRM* at ¶ 269.

³⁴ See *id.* at ¶ 279.

over-the-air measurements may be the only practical means of measuring transmit power levels of millimeter wave devices.

C. Requiring All Mobile Devices Operating In These Bands To “Be Interoperable Using All Interfaces That The Equipment Utilizes” Will Negatively Impact 5G Experimentation, Equipment Design And Deployment

The FCC is proposing to require mobile equipment operating within each millimeter wave band to “be interoperable using all air interfaces that the equipment uses on the frequencies,” claiming that this is particularly important at 37 GHz where the agency is considering to license local area operations separate from outdoor operations.³⁵ This proposed interoperability requirement should not be enacted.

In the first place, the proposal makes it impossible for anyone to design a device for use in these bands because it is impossible to know in advance all the air interfaces that another device will use in these bands. Furthermore, the proposal would have a detrimental impact on millimeter wave experimentation, equipment development, and deployment. Requiring all mobile equipment to support all air interfaces is directly contrary to the FCC’s overarching goal of enacting flexible technical rules, and it would drive up costs and render non-compliant any existing equipment that does not support a new interface that is subsequently deployed.

The claim that the proposed interoperability requirement is particularly important at 37 GHz where the FCC is considering licensing indoor and outdoor rights separately is inapposite because such a licensing scheme is fraught with many problems, as we explained above.³⁶ The *NPRM* itself also raises a number of concerns with managing spectrum access

³⁵ See *NPRM* at ¶ 296.

³⁶ See Section II.B. *supra*.

where both indoor and outdoor signals overlap, highlighting even more problems with the hybrid licensing approach.³⁷

In sum, the proposed interoperability requirement is unworkable and will make it impossible for any device to be launched on this spectrum. Qualcomm urges the Commission not to adopt this proposal.

D. The FCC Should Let Use Cases Govern RF Exposure Compliance Determinations And Not Limit Power Levels Of All Devices

The Commission should not lower the allowed transmit power levels for all devices for purposes of complying with RF exposure regulations. The Commission should let the specific use cases govern RF exposure assessments because this will provide the necessary equipment design flexibility and allow equipment developers to lower power levels only in those cases where it is needed to comply with the RF exposure rules.³⁸

E. The Commission Should Align RF Exposure Assessment Techniques With Internationally Accepted Standards and Procedures

Mobile device operations in the millimeter wave bands will differ from mobile operations in bands below 5 GHz. Millimeter wave handsets will have multiple element antennas with adaptive beamforming where radiation patterns change with time depending on the multipath environment and transmission paths are optimized by aiming radiation away from the user's body. Also, because millimeter wave handsets will be designed for gigabit data transmission, handset transmissions will not be continuous. Therefore, it will be important to implement time

³⁷ See *NPRM* at ¶ 294 (highlighting coordination, priority of services, and other interference management issues).

³⁸ See *id.* at ¶ 324 (noting “that portable devices are likely to operate at conducted power levels much lower than the proposed maximum peak EIRP, due to antenna array gain and to effectively manage device power consumption among other reasons” and seeking “comment on whether to maintain our continued approach to allow portable devices to be authorized up to the maximum EIRP permitted by the rules, as long as our RF exposure limits are met”).

averaging and appropriately account for the effect of multiple element antennas when determining portable handset compliance with RF exposure rules in the bands above 24 GHz.³⁹

Qualcomm previously explained that modifications to the FCC's RF exposure assessment techniques are needed to enable portable device applications in the millimeter wave bands.⁴⁰ Specifically, for the bands identified for mobile use in the *NPRM*, assessment of RF exposure for smartphones, tablets, and other portable devices needs to be done in the near field. It is important that spatial averaging be used for a meaningful exposure assessment against the limit, as the power density distribution varies drastically in the near field, especially in close proximity of the source. The exposure time also should be taken into account to assess the heating effect (temperature rise) in tissue. ICNIRP and ANSI/IEEE have specified the power density limit over a defined spatial averaging area and specified a time window for time averaging.⁴¹ These standards should be used to assess RF exposure of millimeter wave handsets and other portables.

To realize the potential of these new millimeter wave bands, the Commission should revise the acceptable testing methodologies for demonstrating compliance consistent with these

³⁹ Qualcomm agrees with the FCC that “determining compliance with the RF exposure limit for portable devices (intended for use within 20 centimeters of the body of a user) operating above 6 GHz does present some unique technical challenges not addressed in [FCC] guidance documents and warrants some additional discussion.” *NPRM* at ¶ 322; *see also id.* at ¶ 323.

⁴⁰ *See* Qualcomm Ex Parte Letter in GN Docket No. 14-177 (filed Dec. 18, 2015); *see also* Qualcomm NOI Comments at 15-16 (filed Jan. 15, 2015). For fixed and mobile applications in the millimeter wave bands, the existing power density limits are applicable because the exposure is in the “far field.”

⁴¹ *See* ICNIRP Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz), International Commission on Non-Ionizing Radiation Protection (ICNIRP), Health Physics, Vol. 74, 494-522 (Apr. 1998); ANSI/IEEE C95.1- 2005, “Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz” (Apr. 2006); IEEE C95.1a- 2010, Amendment 1: Specifies Ceiling Limits for Induced and Contact Current, Clarifies Distinctions between Localized Exposure and Spatial Peak Power Density” (Mar. 2010).

established standards. Accordingly, Qualcomm respectfully requests that the FCC align its measurement procedures for portable devices that operate in these bands with the relevant ICNIRP guidance and ANSI/IEEE standards, which allow for spatial averaging and time averaging. We support the Commission's proposal to update its interim guidance to permit the approval of millimeter wave devices and once test procedures are stable, to consider formal guidance in the form of a KDB publication.⁴²

⁴² See *NPRM* at ¶ 322 n.563.

CONCLUSION

Qualcomm strongly supports the Commission's efforts to make additional spectrum resources in the millimeter wave bands available for mobile broadband. These bands will support an important piece of the 5G solution, and Qualcomm encourages the FCC to move forward to approve the proposed use in accordance with our comments.

As explained herein, it is equally important that the FCC, NTIA, other federal agencies that rely upon spectrum, and Congress redouble their efforts to free up additional sub-5 GHz spectrum for commercial mobile broadband use because these spectrum resources will be absolutely essential to successful, highly robust, and ubiquitous 5G mobile broadband deployments.

Respectfully submitted,

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