

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

In the Matter of

Promoting Investment in the 3550-3700 MHz
Band

GN Docket No. 17-258

COMMENTS OF QUALCOMM INCORPORATED

Dean R. Brenner
Senior Vice President, Spectrum Strategy &
Technology Policy

John W. Kuzin
Vice President & Regulatory Counsel

1730 Pennsylvania Avenue, NW
Suite 850
Washington, DC 20006
202.263.0020

December 28, 2017

CONTENTS

INTRODUCTION	1
DISCUSSION	3
I. The FCC Should Adopt Qualcomm’s Technically Superior Proposal To Revise The 3.5 GHz Band Emissions Limits To Support 20 to 40 MHz Wide Channels	3
A. Qualcomm Applauds The Commission’s Recognition That The Current Emissions Mask Needs to Be Revised.....	3
B. Qualcomm’s Proposed Emissions Mask Is Technically Superior To The Graduated Mask Because It Requires Substantially Less Power Backoff.....	4
C. The FCC Should Revisit The -40 dBm/MHz Additional Protection Level Requirement for 3.5 GHz Band Operations Above 3720 MHz When It Opens the 3.7-4.2 GHz Band For Mobile Use	8
CONCLUSION.....	10

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

In the Matter of

Promoting Investment in the 3550-3700 MHz
Band

GN Docket No. 17-258

COMMENTS OF QUALCOMM INCORPORATED

QUALCOMM Incorporated (“Qualcomm”) is pleased to submit these comments in support of the Commission’s proposal in the instant Notice of Proposed Rulemaking to make a much-needed revision to the 3550-3700 MHz band (the “3.5 GHz Band”) technical rules.¹ For the reasons explained herein, the FCC should adopt Qualcomm’s proposal to revise the emissions limits for 3.5 GHz Band operations as soon as possible, so this important mid-band spectrum can be used for wider bandwidth 4G LTE Advanced and 5G New Radio (“NR”) mobile broadband operations to provide consumers much faster and more robust mobile broadband. Quick action in this docket — coupled with progress on other ongoing FCC, NTIA, and other federal government activities to open up additional mobile spectrum bands — will help drive economic growth and positively impact virtually every facet of American life.

INTRODUCTION

Qualcomm believes that the 3.5 GHz band rules should use a proven licensing framework and set emissions limits that enable channels wider than 10 MHz, as proposed in the NPRM.

¹ See *Promoting Investment in the 3550-3700 MHz Band*, GN Docket No. 17-258, Notice of Proposed Rulemaking and Order Terminating Petitions, FCC 17-134 (Oct. 24, 2017) (the “NPRM”).

These changes are crucial to maximizing the band’s potential for 4G and 5G. Qualcomm agrees with the FCC that “the 3.5 GHz Band will play a significant role as one of the core mid-range bands for 5G network deployments throughout the world.”² The FCC’s 3.5 GHz Band rules need to “keep up with technological advancements, create incentives for investment, encourage efficient spectrum use, support a variety of different use cases, and promote robust network deployments in both urban and rural communities,”³ so minor revisions to some rules are needed.

Qualcomm explained that current 3.5 GHz Band rules penalize operations with channel bandwidths of 20 MHz and greater by requiring 4G LTE and 5G NR devices using these channel bandwidths to engage in power backoff (so-called Additional-Maximum Power Reduction or A-MPR), which diminishes the quality of mobile broadband service that could otherwise be provided to consumers.⁴ As explained herein, Qualcomm’s proposal will best enable channels of 20 MHz and wider, which are used widely in other bands today by 4G LTE Advanced and which will be crucial for both 4G and 5G NR mobile operations in both the Priority Access License (“PAL”) and General Authorized Access (“GAA”) tiers of the CBRS band.

Qualcomm is very excited by the possibility of deploying small cells and user devices that support the 3.5 GHz Band because small cells will play a core role in enabling better, faster mobile broadband for consumers. Updating the emissions limits as we proposed will help promote U.S. investment in the 3.5 GHz band and help the U.S. continue its global leadership as 5G begins to launch commercially around the world next year. Qualcomm requests that the FCC

² NPRM at ¶ 2.

³ *Id.*

⁴ *Id.* at ¶ 52.

promptly revise the technical rule addressed herein so this important band can be put to use as soon as possible.

DISCUSSION

I. The FCC Should Adopt Qualcomm’s Technically Superior Proposal To Revise The 3.5 GHz Band Emissions Limits To Support 20 to 40 MHz Wide Channels

Qualcomm supports the FCC’s proposal generally to revise the 3.5 GHz band emissions limits to appropriately support 4G LTE and 5G NR channels wider than 10 MHz.⁵ As Qualcomm has explained, the current 3.5 GHz band emissions limits require significant signal attenuation outside the channel of operation and thus force mobile devices using a 20 MHz channel bandwidth to implement approximately 4 dB A-MPR to comply.⁶ Reducing the transmit power level for 20 MHz operations by more than half significantly diminishes signal coverage, service quality, and overall usefulness of the band for mobile operations. 30 MHz-wide and 40 MHz-wide operations under the existing emissions mask also would suffer this penalty, without any corresponding benefit.

A. Qualcomm Applauds The Commission’s Recognition That The Current Emissions Mask Needs to Be Revised

Qualcomm applauds the FCC’s recognition that “relaxation of the current emission limits ... would promote innovation and investment in the band and allow operators to make use of wider channels without reducing their transmit power.”⁷ Indeed, the 3.5 GHz Band will serve a

⁵ See NPRM at ¶¶ 51-55.

⁶ See Qualcomm Comments in Wireless Telecommunications Bureau and Office of Engineering and Technology Seek Comment on Petitions For Rulemaking Regarding The Citizens Broadband Radio Service, GN Docket No. 12-354, RM-11788, RM-11789 (filed July 24, 2017).

⁷ NPRM at ¶ 54.

core role in the networks of tomorrow — both 4G LTE Advanced and 5G NR — that use channels greater than 10 MHz wide.

In the NPRM, the Commission seeks comment on these two alternative proposals to relax the emissions limits to enable 20 MHz and wider channelization:

- i. Qualcomm’s proposal would:
 - apply the -13 dBm/MHz limit from 0 to 100% of channel bandwidth “B” megahertz;
 - apply the -25 dBm/MHz limit beyond 100% of B megahertz; and
 - maintain the -40 dBm/MHz limit specified in Section 96.41(e)(2) below 3530 megahertz or above 3720 megahertz.
- ii. A more graduated, and thus more complex, mask that adds a -20 dBm/MHz step, as follows:
 - -13 dBm/MHz from 0 to B/2 (*i.e.*, 50% of B) megahertz from the channel edge;
 - -20 dBm/MHz from B/2 to B (*i.e.*, 100% of B) megahertz from the channel edge;
 - -25 dBm/MHz beyond B megahertz from the assigned channel edge, down to 3530 megahertz and up to 3720 megahertz;
 - maintain the -40 dBm/MHz limit specified in Section 96.41(e)(2).

As explained below, the Qualcomm emissions mask proposal offers the best means of enabling wider bandwidth operations without impacting the maximum power allowed; the graduated mask would require substantial power reduction without offering much practical impact in terms of efficient channel assignments.

B. Qualcomm’s Proposed Emissions Mask Is Technically Superior To The Graduated Mask Because It Requires Substantially Less Power Backoff

Qualcomm thoroughly analyzed the two alternative proposals, running an exhaustive series of operational simulations. We simulated every power waveform and assessed the impacts

on each under the Commission's current mask, Qualcomm's proposed mask, and the more complex graduated mask.

The summary of Qualcomm's analysis, which is presented in Tables 1A and 1B below, shows that the graduated mask imposes a further power reduction beyond the Qualcomm proposal of as much as 2.5 dB for 20 MHz channels, 1.3 dB for 30 MHz channels, and 0.8 dB for 40 MHz channels. This across-the-board power reduction overrides the potential benefit that the graduated mask potentially may offer in terms of less interference to unsynchronized adjacent channel operations. Indeed, synchronizing adjacent channel operations allows for improved systemwide performance and overall efficient spectrum usage. Synchronized adjacent channel operations are thus preferable regardless of the emissions mask that the FCC adopts. The wireless industry is well aware of the benefits of synchronized operations, and is working this issue in 3.5 GHz Band industry groups, *e.g.*, the WinnForum and CBRS Alliance.

Table 1A presents the analysis for channels located within the 3.5 GHz band, *i.e.*, located between 3600 and 3650 MHz. Table 1B presents the analysis for channels located at the band edge. Table 1B shows that channels at the band edge are dominated by the -40 dBm/MHz limit, which currently is needed to protect incumbent operations in the adjacent bands below 3550 MHz and above 3700 MHz. Thus, revision of the emissions limits as proposed in the NPRM would not impact these adjacent band operations.

Table 1A. Power backoff (in dB) required for channels within the 3.5 GHz Band

3.5 GHz Operations Analyzed	Original mask	Qualcomm proposal	Graduated mask
Single carrier, 20 MHz (low resource allocation)	3.8	0	1.8
Single carrier, 20 MHz (high resource allocation)	2.2	1	1
Single carrier, 20 MHz (non-contiguous resource blocks (RBs), low resource allocation)	11	6	8.5
Uplink Carrier Aggregation (UL CA) contiguous RB allocation, 10+20 MHz (low resource allocation)	3.8	0.5	1.8
UL CA contiguous RB allocation, 10+20 MHz (high resource allocation)	3.8	2.2	2.2
UL CA contiguous RB allocation, 20+10 MHz (low resource allocation)	3.8	0.5	1.8
UL CA contiguous RB allocation, 20+10 MHz (high resource allocation)	3.8	2.2	2.2
UL CA contiguous RB allocation, 20+20 MHz (low resource allocation)	3.8	1	1.8
UL CA contiguous RB allocation, 20+20 MHz (high resource allocation)	3.8	2.2	2.2

Table 1B. Power backoff (in dB) required for channels located at the 3.5 GHz Band edge

3.5 GHz Operations Analyzed	Original mask	Qualcomm proposal	Graduated mask
Single carrier, 20 MHz (high resource allocation)	4.2	4.2	4.2
Single carrier, 20 MHz, non-contiguous RB allocation	14.5	14.5	14.5
UL CA contiguous RB allocation, 10+20 MHz	12	12	12
UL CA contiguous RB allocation, 20+10 MHz	12	12	12
UL CA contiguous RB allocation, 20+20 MHz	12	12	12

The simulations were run using Quadrature Phase-Shift Keying (QPSK) digital modulation (which is equivalent to 4 QAM - Quadrature Amplitude Modulation), and 23 dBm/10 MHz EIRP (*i.e.*, the maximum permitted power for 3.5 GHz Band user devices). While the analysis used the QPSK 4G LTE waveform, we expect to receive the same results with 5G NR. Note that 4G LTE uses Single-Carrier Frequency-Division Multiple Access (SC-FDMA) in the uplink direction (*i.e.*, user device to small cell),⁸ while 5G NR uses SC-FDMA as well as CP-OFDM in the uplink direction. For the CP-OFDM waveform, especially in the general sense where non-contiguous allocations are allowed, the required power backoff would be greater (*i.e.*, similar to the backoff required for non-contiguous allocations for LTE).

The analysis summarized above demonstrates three critical points.

First and foremost, there is no question that the current 3.5 GHz emissions mask needs to be changed. Wider bandwidths are important for 4G LTE Advanced operations, and they are key for 5G operations. The current emission limits force 3.5 GHz licensees deploying 20 MHz channels (and greater) to engage in power reduction, which will threaten coverage, diminish the utility of the band, and undermine an operator's ability to offer wider bandwidths and thus limit widescale deployment. A relaxed emission mask would enable wider bandwidth operations and promote innovation and investment in the band as the Commission acknowledges.

Second, Qualcomm's emissions proposal offers the best means of improving the mask to allow wider bandwidth operations with minimal impact on the maximum allowed transmit power level. The analysis shows that Qualcomm's proposal allows for less power backoff than the

⁸ LTE uses the modulation format, OFDM (Orthogonal Frequency Division Multiplexing), adapted to provide a multiple access scheme using OFDMA and SC-FDMA.

graduated emissions proposal for low resource allocations, and that both proposals require similar power backoff where there is high resource allocation.

Third, the graduated mask does not offer much practical impact on interference due to the possible existence of unsynchronized operations in adjacent channels — either alternative in the NPRM can have issues with such unsynchronized operations. As noted above, the wireless industry is fully aware of this issue and is working closely to address the technical concerns. Accordingly, the Commission should adopt Qualcomm’s proposal to relax the emission masks.

C. The FCC Should Revisit The -40 dBm/MHz Additional Protection Level Requirement for 3.5 GHz Band Operations Above 3720 MHz When It Opens the 3.7-4.2 GHz Band For Mobile Use

Qualcomm’s analysis shows that 3.5 GHz Band operations in channels on the band edge would continue to be constrained by the -40 dBm/MHz additional protection level requirement designed to protect incumbents in adjacent bands. As detailed in Table 1B above, both the Qualcomm emissions proposal and the graduated emissions proposal are equally constrained by the -40 dBm/MHz additional protection level in Rule Section 96.41(e)(2).⁹

Qualcomm maintains its support of the FCC’s proposal to maintain the additional -40 dBm/MHz protection level to protect incumbent operations 20 MHz below and above the 3550-3700 MHz band.¹⁰ As explained above, however, these additional protection levels necessitate the use of A-MPR for channels operating near the lower and upper edges of the 3.5 GHz Band. We recognize that the Commission’s Mid-Band Notice of Inquiry is considering

⁹ See NPRM at ¶ 58.

¹⁰ See Qualcomm Comments in Wireless Telecommunications Bureau and Office of Engineering and Technology Seek Comment on Petitions For Rulemaking Regarding The Citizens Broadband Radio Service, GN Docket No. 12-354, RM-11788, RM-11789 (filed July 24, 2017).

opening the 3700-4200 MHz band for mobile operations.¹¹ When this occurs, the FCC should revisit the -40 dBm/MHz protection level that applies to 3.5 GHz Band operations above 3720 MHz. Relatedly, the FCC also should revisit the -40 dBm/MHz protection level that applies below 3530 MHz if and when the agency opens the band below 3550 MHz for mobile operations.


¹¹ See *Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz*, GN Docket No. 17-183, Notice of Inquiry, FCC 17-104, (rel. Aug. 3, 2017).

CONCLUSION

Qualcomm has analyzed the two 3.5 GHz Band emissions masks presented in the NPRM, as detailed herein, and we strongly recommend that the FCC adopt Qualcomm's proposed mask. Modification of the emissions limits for PAL and GAA operations pursuant to Qualcomm's proposal will permit wider bandwidth mobile operations that 4G LTE Advanced networks can use today and 5G NR networks will soon use to support Gigabit mobile broadband service. Qualcomm has done extensive work on small cell technology and on the spectrum access system set out in the FCC's 3.5 GHz Band rules, and we are very excited by the upcoming deployment of 4G and 5G technologies in the 3.5 GHz band.

Respectfully submitted,

QUALCOMM INCORPORATED

By: 

Dean R. Brenner
Senior Vice President, Spectrum Strategy &
Technology Policy

John W. Kuzin
Vice President & Regulatory Counsel

1730 Pennsylvania Avenue, NW
Suite 850
Washington, DC 20006
202.263.0020

Attorneys for QUALCOMM Incorporated

Dated: December 28, 2017