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VIA ELECTRONIC FILING

Ms. Marlene Dortch
Secretary
Federal Communications Commission
445 12th Street, SW
Washington, DC 20554

***Re: Expanding the Economic and Innovation Opportunities of Spectrum Through
Incentive Auctions — GN Docket No. 12-268***

Dear Ms. Dortch:

This letter responds to the materials filed by QUALCOMM Incorporated (“Qualcomm”) on August 5, 2014.¹ Throughout this proceeding, Qualcomm has made numerous claims regarding Broadcom Corporation’s (“Broadcom”) analysis that ignore or mischaracterize Broadcom’s filings. Qualcomm’s August 5 filing is no different.

Broadcom’s filing on July 22, 2014 provides detailed analysis that clearly demonstrates that it is possible for unlicensed devices to operate in the duplex gap/guard bands in the 600 MHz band. This filing also clearly articulates Broadcom’s assumptions.

Rather than provide detailed counter-analysis to this or previous analyses, Qualcomm has been content, again and again, to submit filings that: (1) fail to clearly explain its assumptions regarding filter loss and moderate proximity loss, (2) continue inappropriately to focus only on standards that are far exceeded by devices in the actual market place (including their own devices), and (3) describe completely unrealistic Wi-Fi-to-LTE interference scenarios. Tellingly, if Qualcomm were to apply its unrealistic filter assumption to an interference analysis from television broadcast into LTE, it would yield harmful interference levels that are also continuous in time and cover wide geographical areas.

In its August 5 filing, Qualcomm attempted to distract the Federal Communications Commission (“FCC” or “Commission”) from the fact that the filing contained inadequate factual responses by claiming that Broadcom no longer has a vested business interest in ensuring the successful performance of LTE in the 600 MHz band. That claim is not only irrelevant to the engineering matters at issue, but is also simply untrue. Broadcom continues to derive meaningful revenue from best-in-class Infrastructure and Networking (“ING”) and Broadband and Connectivity (“BCG”) devices that are required to build out a healthy LTE ecosystem (*e.g.*, small cells, infrastructure chips). Because of Broadcom’s leadership in these areas, as mobile

¹ Letter from Dean R. Brenner, Senior Vice President of Government Affairs, Qualcomm Inc., to Marlene H. Dortch, Secretary, FCC, GN Docket No. 12-268 (Aug. 5, 2014)(“August 5 Qualcomm Letter”).



Internet traffic increases over licensed and unlicensed airwaves, its chip business grows. Broadcom clearly continues to have a strong interest in a successful auction and in a band plan design that optimizes the consumer experience and avoids harmful interference from end devices using licensed and unlicensed spectrum.

Although Qualcomm's most recent filing primarily rehashes generalities rather than providing any new technical analysis, Broadcom provides below a detailed response to the *August 5 Qualcomm Letter*:

- First, Qualcomm incorrectly argues that Broadcom's filings contain "continually changing calculations and assumptions," and incorrectly characterizes Broadcom's most recent filing as claiming that "unlicensed devices can operate with more than double the transmit power level previously discussed . . . , within a guard band that is 30% smaller than what Broadcom previously claimed."² In fact, Broadcom's January 30 and July 22 filings demonstrated that powers exceeding 40 mW at gaps between licensed and unlicensed device operation (hereafter "Gaps") of 4 MHz and greater are possible without harmful interference to LTE.³ Qualcomm's assertion that Broadcom's analysis would permit 100 mW transmit powers in a guard band of 7 MHz is completely inaccurate. Broadcom's filings, which are technically consistent, instead demonstrate the relationship between power and Gaps—and both filings make it clear that higher transmit powers should only be allowed where the Gaps are larger.
- Second, Qualcomm incorrectly claims that "Broadcom seeks to more than double the unlicensed transmit power level from 40 mW to 100 mW EIRP, even though the lower power levels Broadcom originally proposed are unjustified."⁴ In fact, Broadcom demonstrated that transmit powers exceeding 40 mW are technically appropriate given sufficient Gaps, as described initially in Broadcom's January filing.⁵ Qualcomm appears to ignore this filing.
- Third, Qualcomm incorrectly claims that Broadcom lacks technical support for its analysis that unlicensed devices can operate 1 MHz from LTE devices without causing harmful interference.⁶ As Broadcom has consistently made clear, unlicensed device transmit powers are based on the size of the Gaps between LTE and unlicensed device operation. Broadcom's studies have considered Gaps ranging in size from 0 MHz to 6 MHz. Broadcom's technical findings are consistent and clear—larger Gaps can accommodate higher transmit powers, and Gaps of 1 MHz are possible with low power limits.

² *August 5 Qualcomm Letter* at 1.

³ Letter from Google Inc. and Broadcom Corporation, to Marlene H. Dortch, Secretary, FCC, Broadcom Appendix at page 6, GN Docket No. 12-268 (filed Jan. 30, 2014) ("January Broadcom Analysis"); Letter from Broadcom Corporation, to Marlene H. Dortch, Secretary, FCC, Appendix at page 9, GN Docket No. 12-268 (filed July 22, 2014) ("July 22 Broadcom Analysis").

⁴ *August 5 Qualcomm Letter* at 1.

⁵ *January Broadcom Analysis*, Broadcom Appendix at 5.

⁶ *August 5 Qualcomm Letter* at 1-2.



- Fourth, Qualcomm incorrectly claims that Broadcom’s use of a 3-meter separation distance for its analysis of interference from Wi-Fi access points (“AP”) “will make it impossible for anyone to use 600 MHz LTE in rooms where someone is using 600 MHz Wi-Fi.”⁷ This assertion is fundamentally wrong as the 3 meter refers to the AP and not ‘someone’. Broadcom has consistently based its analysis on 2 to 3 meters of separation in all of its filings. Broadcom’s handset-to-handset interference analysis is based on 2 meters of separation—consistent with the Commission’s previous rulings.⁸ Broadcom’s recent filing uses 3 meters of separation only with respect to AP-to-handset interference. AP density is far lower than handset density and Broadcom believes that a protection radius of 3 meters is conservative based on the typical AP installation locations in enterprises and homes and the probabilistic nature of such interference. In addition, Qualcomm incorrectly claims that Broadcom’s use of shadowing loss is not supported by recognized models. In fact, all practical propagation models include shadowing loss which is due to clutter and people even at short distances—especially when one of the communicating devices is an AP typically installed in hallways and corners.⁹ Furthermore, Qualcomm’s claim that Broadcom does not account for device operating variability is also incorrect because Broadcom used very conservative filter assumptions that are worse than practical filtering capabilities. For example, Broadcom assumed zero attenuation up to 3 MHz, and this is conservative because there will always be some attenuation below 3 MHz.¹⁰ Further, Broadcom conservatively used blocking performance numbers that are *only half* of what it measured in Broadcom and Qualcomm chipsets during testing.¹¹ Consequently, it is Qualcomm that has ignored real-world device performance.
- Fifth, Qualcomm incorrectly claims that “Broadcom continues to calculate filter attenuation based on point analysis, which overestimates signal loss,” apparently concluding that Broadcom’s model is inaccurate.¹² But Broadcom’s analysis is precise because it calculates the receive signal power based on average attenuation of an exact filter response.¹³ Qualcomm on the other hand has never provided a clear description of its filter or the calculations supporting its analysis. Qualcomm also makes incorrect references to Broadcom’s previous filter slopes.¹⁴ The slope of the filter in the *July 22 Broadcom Analysis* is based upon the FCC’s analysis (used for the calculation of TV broadcast to LTE interference) found in the May 15 Report and Order, which has a similar slope to Broadcom’s typical filter (B20).¹⁵

⁷ August 5 Qualcomm Letter at 2.

⁸ OET, *Advanced Wireless Service Interference Tests Results and Analysis*, Oct. 10, 2008, at 13.

⁹ T.S. RAPPAPORT, *WIRELESS COMMUNICATIONS: PRINCIPLES AND PRACTICE* page 139 (2d ed. 2001).

¹⁰ *July 22 Broadcom Analysis*, Appendix at 4.

¹¹ *July 22 Broadcom Analysis*, Appendix at 7.

¹² August 5 Qualcomm Letter at 2.

¹³ *July 22 Broadcom Analysis*, Appendix at 4.

¹⁴ August 5 Qualcomm Letter at 2.

¹⁵ *Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions*, Report and Order, FCC 14-63, 29 FCC Rcd. 6133 (2014).



- Sixth, Qualcomm incorrectly insinuates that all LTE devices must be tested or interference analysis based on anything other than 3GPP specifications would be “speculation.”¹⁶ In-band blocking as defined by 3GPP is a function of chipset performance and design. Broadcom tested in-band blocking performance of its own chipsets and those developed by Qualcomm and found that they exceeded the 3GPP in-band blocking specification by more than 20dB. Broadcom believes that the Commission could safely assume that other chipset providers will have similar in-band blocking performance, as any design regardless of technology type (*e.g.*, LTE, 3G, Wi-Fi) exceed the specification because companies design to exceed the minimum requirements. In this case, the designs are vastly better than the 3GPP specification because the 3GPP blocking specifications were designed for 3G and have not changed in many years. In addition, Broadcom demonstrated in its March 3 filing that US cellular operators mandate handset LTE blocking requirements that far exceed the strict 3GPP requirements, both in-band and out-of-band.¹⁷
- Seventh, Qualcomm makes absolute claims that Wi-Fi cannot coexist with LTE, and this is simply untrue. From an engineering perspective, interference is a matter of power levels and Gap size.
- Eighth, Qualcomm’s claim that an adjacent-band signal will “destroy the fungibility” of auctioned blocks is without merit and serves merely as a scare tactic.¹⁸ Qualcomm’s assertion that such a signal will make the proximate LTE band inferior to other LTE bands conveniently forgets that the LTE bands will operate adjacent to signals from licensed carriers, and therefore will operate in an environment that includes adjacent-channel interference.

Broadcom has provided and will continue to provide a conservative, engineering-based analysis that clearly displays its underlying assumptions. Qualcomm should hold itself to the same standard.

We look forward to addressing any questions the Commission may have about this filing, and we would welcome an opportunity to do so jointly with Qualcomm if the Commission would find such a presentation useful.

Sincerely,

/s/ DeAnn Work
Senior Vice President
Senior Deputy General Counsel

¹⁶ August 5 Qualcomm Letter at 2.

¹⁷ Letter from Broadcom Corporation, to Marlene H. Dortch, Secretary, FCC, Appendix at 3, GN Docket No. 12-268 (Mar. 4, 2014).

¹⁸ August 5 Qualcomm Letter, Appendix at 5.



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