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Via ECFS

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

Re: Office of Engineering & Technology and Wireless Telecommunications Bureau Seek Information on Current Trends in LTE-U and LAA Technology — ET Docket No. 15-105

Dear Ms. Dortch:

Qualcomm is submitting this letter to respond to misleading or outright incorrect statements in various reply comments filed recently in this docket. LTE Unlicensed, in all forms, will both improve the user experience on mobile broadband for consumers and fairly share unlicensed spectrum with Wi-Fi. It is undisputed that LTE Unlicensed will comply with the FCC's Part 15 rules, which govern unlicensed spectrum and have proven successful in encouraging new technologies to come to market for consumers, while respecting incumbent technologies. LTE Unlicensed falls squarely within this highly successful FCC policy. The balance of this letter sets the record straight on several topics relating to LTE Unlicensed.

First, contrary to the claims of several commenters and as Qualcomm has explained now in three filings, Qualcomm has worked, and is continuing to work, with the entire wireless industry directly and via industry bodies to ensure that LTE Unlicensed coexists well with Wi-Fi. Any assertion to the contrary — that Qualcomm and others have not or are not working collaboratively on LTE Unlicensed/Wi-Fi coexistence — is simply untrue.[1] Most recently, on July 14th, Qualcomm and Verizon gave a detailed technical presentation on LTE-U/Wi-Fi coexistence to the IEEE 802.19 Wireless Coexistence Working Group. A copy of that presentation is filed in this docket.[2] On May 28th, the LTE-U Forum hosted a Technical Workshop attended by 96 people from 29 companies and associations covering the full scope of the wireless industry, including the Wi-Fi Alliance, the IEEE 802, the cable industry, Wi-Fi equipment vendors, chip vendors, OS vendors, and service providers. Many of the companies who have made filings in this docket expressing concern were present, such as Microsoft, Broadcom, Ruckus, Aruba, Google, and Cisco. Copies of the detailed technical presentations given that day are posted on the LTE-U Forum's website.[3] Prior to that, on March 9th, for

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1 *See, e.g.*, Qualcomm July 15, 2015 Ex Parte filing. *See also* Qualcomm Comments and Reply Comments (filed June 11 and June 25, 2015).

2 *See id.*

3 *See* http://www.lteuforum.org/workshop.html

example, Verizon and Qualcomm gave a presentation on LTE-U to the Wi-Fi Alliance, and earlier in March, Qualcomm and other companies publicly demonstrated LTE-U at the Mobile World Congress in Barcelona. Additionally, for over a year now, there have been countless one-on-one and group meetings on LTE-U to provide technical information, answer questions, and discuss coexistence. All of these efforts are continuing and will not stop.

Second, claims by NCTA and others that LTE-U's and LAA's coexistence features are vague and undefined[4] are false. To put these claims in perspective, Wi-Fi has no coexistence specification. The Wi-Fi Alliance merely has an interoperability specification and is currently studying whether to adopt a Wi-Fi coexistence specification. By contrast, LTE-U was built from the ground up to coexist well with Wi-Fi and to ensure that there will be no adverse impact on Wi-Fi. To that end, unlike Wi-Fi, the companies involved in developing LTE-U have adopted and will follow the very extensive coexistence specifications and testing requirements that have been published at www.lteuforum.org. The latest version of the coexistence specification is available here: http://www.lteuforum.org/uploads/3/5/6/8/3568127/lte-u_forum_lte-u_sdl_coexistence_specifications_v1.2.pdf.

Moreover, as explained in our filings (and at the May 28th LTE-U Forum Technical Workshop and in a July 14 technical presentation to the IEEE 802.19 Wireless Coexistence Group and elsewhere), both LTE-U and LAA include specific coexistence features that ensure fair spectrum sharing with Wi-Fi. LTE-U will employ a listen-before-talk type technique to find vacant channels or the least occupied channel, an adaptive duty cycle mechanism called Carrier Sense Adaptive Transmission ("CSAT") to fairly share spectrum when no vacant channels are available, and an "on/off" switch that gives Wi-Fi users complete access to the unlicensed channel when LTE-U operation is not needed.[5] LTE-U's coexistence specifications prevent it from transmitting for more than 50 milliseconds, and LTE-U transmissions will include periods of "off-time" of at least 1 millisecond at a time to support spectrum sharing with latency-sensitive Wi-Fi applications.

LAA will incorporate the so-called Category 4 Listen-Before-Talk ("LBT") mechanism that includes random backoff and variable contention windows to ensure fair spectrum sharing with Wi-Fi. Notably, CableLabs was at the 3GPP meeting in mid-June where 3GPP decided that LAA will incorporate Category 4 LBT. Nevertheless, NCTA's reply comments filed after that meeting state that the "LAA standard currently being considered by 3GPP requires no meaningful coexistence mechanisms" and that "3GPP is considering several different coexistence mechanisms for LAA, but [] it has not committed to include any of these in its standard."[6] These statements are untrue. In fact, NCTA's own reply filing cites to the 3GPP Meeting Report during which Technical Report 36.889 recommending the adoption of the Category 4 LBT mechanism was approved,[7] but the NCTA reply filing ignores that fact and still makes these incorrect statements.

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4 *See* NCTA Reply Comments at 11-13; *see also* Broadcom Reply Comments at 1-2.

5 *See* Qualcomm Reply Comments at 5-6.

6 NCTA Reply Comments at 1, 12.

7 *See* 3GPP TR 36.889 V13.0.0 (2015-06), 3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Study on Licensed-Assisted Access to Unlicensed Spectrum; (Release 13) at 43 *accessible at:* http://www.3gpp.org/DynaReport/36889.htm.

It is noteworthy that the Category 4 LBT mechanism was the spectrum sharing mechanism that the IEEE itself recommended.[8] During the course of the 3GPP LAA project, 3GPP has also adopted some of the IEEE's recommended assumptions for LAA/Wi-Fi coexistence simulations in response to IEEE input received through Liaison Statements, which are the formal mechanisms of collaboration between 3GPP and the IEEE. When 3GPP has not adopted some recommendations from the IEEE as a result of 3GPP's technical work, 3GPP has clearly explained the reasons for its conclusions. This ongoing discussion between 3GPP and the IEEE is clearly documented in the Liaison Statements exchanged by the two groups.[9] Thus, NCTA's claims that there is no collaboration with the IEEE on coexistence algorithms and that the IEEE is being ignored[10] are untrue.

NCTA also makes misleading statements about the upcoming LAA Technical Workshop, which 3GPP is hosting on August 29, 2015. 3GPP invited representatives from the IEEE, WFA, WBA, ETSI, ETSI BRAN, GSMA, CCSA, FCC, and OFCOM. The meeting invitation is available here: RP-151095. In March, 3GPP began discussing the possibility of convening a technical workshop, and the logistics were finally decided at 3GPP's June meeting. The snippet quoted by NCTA[11] from the June 3GPP meeting minutes simply means that the workshop itself will not have authority to modify 3GPP specifications. That is unremarkable. The workshop will enable a thorough exchange of technical information and an open discussion of technical concerns and solutions on LAA. Qualcomm believes that the workshop can and should be an important occasion to have a constructive and useful technical discussion among interested organizations around the world. These discussions should be beneficial for LAA, and NCTA's insinuations to the contrary are meritless.

Third, NCTA's other claims that LTE Unlicensed advocates have failed to answer the questions in the Public Notice and that LTE-U and LAA do not share spectrum fairly with Wi-Fi[12] completely ignore the detailed filings that Qualcomm, Alcatel-Lucent, Ericsson, T-Mobile, Verizon, and others have made showing that LTE-U and LAA do share spectrum fairly. The record shows that Qualcomm, in the case of LTE-U, has conducted comprehensive testing in the

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8 *See* Follow-up Liaison Statement Regarding LAA (submitted May 18, 2015) at 2 *accessible at:* ftp://ftp.3gpp.org/tsg_ran/TSG_RAN/TSGR_68/Docs/RP-150566.zip.

9 *See* the list of Liaison Statements received by IEEE:
ftp://ftp.3gpp.org/tsg_ran/TSG_RAN/TSGR_67/Docs/RP-150024.zip
ftp://ftp.3gpp.org/tsg_ran/TSG_RAN/TSGR_68/Docs/RP-150543.zip
ftp://ftp.3gpp.org/tsg_ran/TSG_RAN/TSGR_68/Docs/RP-150566.zip
and the list of response Liaison Statements sent by 3GPP:
ftp://ftp.3gpp.org/tsg_ran/TSG_RAN/TSGR_67/Docs/RP-150454.zip
ftp://ftp.3gpp.org/tsg_ran/WG1_RL1/TSGR1_80b/Docs/R1-152183.zip
ftp://ftp.3gpp.org/tsg_ran/WG1_RL1/TSGR1_80b/Docs/R1-152182.zip
ftp://ftp.3gpp.org/tsg_ran/WG1_RL1/TSGR1_81/Docs/R1-153659.zip
ftp://ftp.3gpp.org/tsg_ran/TSG_RAN/TSGR_68/Docs/RP-151115.zip

10 NCTA Reply Comments at 16-17, 22.

11 *See* NCTA Reply Comments at 17.

12 *See* NCTA Reply Comments at 1-7, 11; *see also* Broadcom Reply Comments at 1-2; Cablevision Ex Parte at 1; WISPA Reply Comments at 1-3.

laboratory and in the field, demonstrating that LTE-U has no adverse impact on Wi-Fi, and in many cases actually improves throughput for nearby Wi-Fi users.[13] The same is true for LAA. Qualcomm and others have studied and tested LAA exhaustively, even before the 3GPP specifications had been adopted.

These tests were designed to reflect real-world high-density environments, and they represent extreme operational scenarios when compared to what exists in typical installations — a key point that NCTA continues to contest without basis.[14] Qualcomm's most recent outdoor deployment study of LTE-U used eight Wi-Fi nodes deployed by Party A and eight LTE-U nodes deployed by Party B, with an average of four total nodes operating on each channel. The most recent indoor study utilized four Wi-Fi nodes for Party A, four LTE-U nodes for Party B, and 16 independent Wi-Fi nodes randomly deployed, with an average of six nodes on each channel.[15] Qualcomm has additionally studied LTE-U coexistence with latency-sensitive applications in dense scenarios. In its reply comments, Qualcomm presented results from LTE-U coexistence tests with five VoIP users and a full-buffer user operating over a single Wi-Fi AP,[16] and at the Mobile World Congress in March, Qualcomm tested LTE-U coexistence with ten Wi-Fi devices simultaneously streaming HD video from one Wi-Fi AP.[17]

Moreover, 3GPP has subjected LAA to extreme high-density spectral environments with a total of 48 contending nodes on each channel.[18] Each of these tests, like all the prior tests, showed that LTE Unlicensed: (i) shares spectrum fairly with Wi-Fi, (ii) provides better throughput than Wi-Fi, (iii) does not impair Wi-Fi any more than adding an additional Wi-Fi node would, and (iv) in many cases, actually improves Wi-Fi throughput.

Not one party opposing LTE Unlicensed can point to a Wi-Fi coexistence specification as a basis for comparison to LTE-U or LAA because — unlike LTE Unlicensed — there currently is no Wi-Fi coexistence specification. In other words, critics of LTE Unlicensed are downplaying the LTE-U and LAA coexistence tests even though these tests are far more extensive than any testing that Wi-Fi has defined or undergone.

The fact that LTE Unlicensed has already undergone such extensive coexistence testing, the results of which have been made public, should not be a surprise. Qualcomm and its wireless industry partners have designed LTE Unlicensed to share spectrum fairly with Wi-Fi because the companies developing and deploying this new unlicensed technology have every incentive to achieve such a result. Wi-Fi connectivity is in hundreds of millions of Qualcomm chips sold each year and embedded into the smartphones and tablets that service providers and

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13 *See generally* Qualcomm Comments and Reply Comments.

14 *See* NCTA Reply Comments at 14-16; Qualcomm Reply Comments at 16; *see also* Broadcom Reply Comments at 2-3.

15 *See* Qualcomm Reply Comments at A14, A16.

16 *See* Qualcomm Reply Comments at A21.

17 *See* Mobile World Congress LTE-U Demonstration Video at 3:04-3:46 *accessible at:* https://www.qualcomm.com/videos/lte-unlicensed-and-wi-fi-stress-test.

18 *See* 3GPP TR 36.889 V13.0.0 (2015-06), 3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Study on Licensed-Assisted Access to Unlicensed Spectrum; (Release 13) at 75-82 *accessible at:* http://www.3gpp.org/DynaReport/36889.htm.

manufacturers sell to consumers. The last thing Qualcomm and the other companies developing LTE Unlicensed would do is enable a new technology that causes harmful interference to Wi-Fi, an important unlicensed technology that these companies and their consumers heavily rely upon. Thus, assertions that service providers will deploy LTE Unlicensed with sharing mechanisms disabled[19] are illogical and baseless, as service providers themselves have explained.[20]

The record demonstrates that LTE Unlicensed has no adverse impact on Wi-Fi and that deployments will enable each of the coexistence mechanisms discussed in Qualcomm's filings. This unlicensed technology innovation and successful industry collaboration are a direct result of the FCC's technology neutral approach to unlicensed spectrum. Thus, NCTA's calls for FCC oversight are not only unnecessary, but they are designed to slow the deployment of an innovative technology that will provide improved services to mobile consumers.

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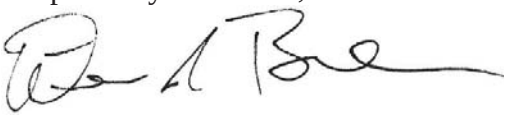
The public interest lies in the FCC following its rules, which allow LTE Unlicensed to come to market in unlicensed spectrum as just the kind of innovation that the FCC's Part 15 rules are designed to enable: a new technology that will offer tremendous benefits for consumers while respecting and protecting incumbent technologies from any adverse impact.

Respectfully submitted,



Dean R. Brenner
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19 *See* Broadcom Reply Comments at 2; NCTA Reply Comments at 11.

20 *See* T-Mobile Comments at 4-6; Verizon Comments and Reply Comments.