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

In the Matter of	)	
	)	
Current Trends in LTE-U and LAA Technology	)	ET Docket No. 15–105
	)	

To: Office of Engineering and Technology
Wireless Telecommunications Bureau

REPLY COMMENTS OF ERICSSON

Ericsson submits these reply comments in the above-captioned proceeding and, in particular, responds to the comments of Google and its associated white paper, *LTE and Wi-Fi in Unlicensed Spectrum: A Coexistence Study*, by Nihar Jindal and Donald Breslin ("Google Study" or "study"). As an initial matter, Ericsson concurs with broad principles Google puts forth, such as:

- "[A]ccess to both unlicensed and licensed spectrum has enabled tremendous innovation in wireless devices and services."[1]
- "In keeping with its restrained regulatory approach to unlicensed use, the Commission has established straightforward technical rules for unlicensed spectrum, while leaving the development of coexistence mechanisms to industry cooperation rather than regulatory intervention."[2]
- "Interest in deploying the Long-Term Evolution (LTE) standard over unlicensed spectrum is further evidence of the success of the Commission's light-tough approach, and a further demonstration that unlicensed frequencies support innovation."[3]

However, the Google Study applied a limited methodology to assess the impact of LTE-Unlicensed ("LTE-U") and Licensed Assisted Access Using LTE ("LAA") on Wi-Fi. The study only focuses on whether LTE-U has an impact on Wi-Fi, and not on whether LTE-U has a

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1 Google Comments, ET Docket No. 15-105, at 2 (June 11, 2015).
2 *Id.* at 1.
3 *Id.*

different level of impact on Wi-Fi devices than another Wi-Fi signal would. In fact, the LTE-U Forum has shown that LTE-U is as good, or better, a neighbor to Wi-Fi than Wi-Fi is. Google's assertions are not reflective of the operational scenarios experienced in the industry today and do not adequately address fair timesharing. The imperfect methodology applied, along with other issues discussed herein, raise substantial questions about findings drawn from the study.

I. THE STUDY METHODOLOGY'S LIMITATIONS UNDERMINE ITS CONCLUSIONS

Google asserts that the study shows that LTE-U "coexists poorly with Wi-Fi in the 5 GHz band" in many circumstances, but its methodology has flaws. The study compares throughput of a Wi-Fi access point ("AP") and a Wi-Fi device operating on an empty channel with that same signal in the presence of an LTE-U signal. However, the study does not compare the impact of the LTE-U signal with that of a second Wi-Fi AP, instead of the LTE-U signal. The introduction of a second co-channel signal, be it LTE-U *or* Wi-Fi, will degrade the performance of an interference-free Wi-Fi signal. Google only showed that some Wi-Fi devices did not achieve its test performance objective in the presence of LTE-U, but these same devices would likely experience similar co-existence with another Wi-Fi device under the same test conditions. A methodology that focuses only on the impact of LTE-U leads to faulty findings.

To render this analysis, the study ignored today's market reality that mobile carriers use Wi-Fi APs to offload data traffic from their radio access networks and licensed spectrum. According to Cisco, in 2014 46 percent of total mobile data traffic was offloaded onto fixed

networks through Wi-Fi or small cells.[4] As such, a meaningful review of LTE-U or LAA should assess its impact as compared to a mobile carrier's current use of Wi-Fi, not in a vacuum.

A properly constructed test would compare whether LTE-U has a larger impact on said devices than another Wi-Fi AP would. Indeed, the LTE-U Forum already engaged in an analysis comparing the impact of LTE-U on a Wi-Fi AP, *as compared to the impact of a second Wi-Fi AP*. That report found that "LTE-U behaves as a comparable or slightly better neighbour . . . to Wi-Fi compared to Wi-Fi as a neighbour, while LTE-U significantly outperforms Wi-Fi."[5] By not quantifying how well certain Wi-Fi devices coexist with other Wi-Fi devices as the proper baseline, the study does not shed light on whether said devices encounter more coexistence issues with LTE-U than with another Wi-Fi system.

II. THE STUDY'S COEXISTENCE ANALYSIS IS DEFICIENT

In addition to the limited methodology discussed above, the study's analysis of the LTE-U duty cycling and its impact on a Wi-Fi AP does not account for a key LTE-U coexistence mechanism—"channel selection." Channel selection is the monitoring of candidate channels in order to select a cleaner channel on which no close-by Wi-Fi APs are operating, or operating on a channel with active Wi-Fi APs only when a channel with low received interference power cannot be found. The study ignores the effect of channel selection.

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[4] Cisco, *Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update 2014-2019 White Paper*, at 4 (Feb. 3, 2015), http://www.cisco.com/c/en/us/solutions/collateral/service-provider/visual-networking-index-vni/white_paper_c11-520862.pdf.

[5] LTE-U Forum, LTE-U TECHNICAL REPORT: COEXISTENCE STUDY FOR LTE-U SDL v1.0, at 22, 25, 28, 31, 34, 38 (Feb. 2015) ("Forum Technical Report"), http://www.lteuforum.org/uploads/3/5/6/8/3568127/lte-u_forum_lte-u_technical_report_v1.0.pdf; *see also id.* at 19, 41-42; *see also* Comments of Ericsson, ET Docket No. 15-105, at 11 (June 11, 2015).

The study assumes that an LTE-U eNodeB will begin using a channel already occupied by one or two Wi-Fi APs serving full-buffer traffic.[6] It thus proceeds to analyze a second coexistence mechanism—the use of a duty cycle—that will only be employed when the channel selection mechanism had failed to select a clean or less-congested channel.

In reality, the monitoring that is inherent in channel selection would select a cleaner channel over one that is carrying full-buffer Wi-Fi traffic, minimizing the need for the duty cycle mechanism. While there may be instances where no clean channel is available, the situation that the study chose to examine in isolation is a "worst case" scenario that will occur only under unusual circumstances for a limited time, rather than one that persists.[7] In recent years, the Commission has been critical of reliance only on worst-case analyses, preferring an approach that accounts for probabilities.[8]

Further, the study's use of an LTE-U simulator that does not incorporate channel selection as the first defense to ensure coexistence with Wi-Fi also applied a regimented duty cycle that is not representative of LTE-U operation. It does not appear to take into account the fact that an LTE-U eNodeB will change the duty cycle over time in response to the channel activity measured during the OFF cycle. The study acknowledges in an appendix that the LTE-U Forum "recommend[s] that the duty-cycling parameters be adaptively tuned, e.g., in response to Wi-Fi usage."[9] However, it elsewhere asserts that LTE-U employs a "fixed duty-cycle

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[6] Google Study at 6.

[7] Testing for the effect of LTE-U on a full-buffer Wi-Fi signal is an important element of a suite of tests that takes into account the multiple coexistence mechanisms involved in LTE-U, but this test alone is not an appropriate measure of the effect of LTE-U on Wi-Fi.

[8] *See, e.g.*, *Commercial Operations in the 3550-3650 MHz Band*, Report and Order and Second Further Notice of Proposed Rulemaking, 30 FCC Rcd 3959, 4046, 4089 (2015).

[9] Google Study at 22.

approach," and explains that its duty cycle tests employed a "fixed duty cycle of 50%."[10] The study provides no explanation for this discrepancy, thereby calling into question its duty cycle analysis.

In addition, the study acknowledges that there is tremendous variability among Wi-Fi devices with respect to their ability to share a channel with LTE-U. The chart of "Wi-Fi Throughput vs. LTE-U OFF Time" indicates that two of the five pairs of Wi-Fi devices tested received throughput equivalent to "fair timesharing" over the full range of LTE-U OFF times, while two other device pairs achieved considerably lower throughput.[11] It also acknowledges that Wi-Fi devices' performance is significantly affected by physical placement.[12] In other words, whether LTE-U and Wi-Fi can share a channel fairly does not solely relate to the LTE-U co-existence framework. The study does not explain whether and how its duty cycle testing controlled for these effects. In this connection, the reduced throughput it encountered in this testing[13] appears to be in tension with the fact that two of its device pairs were able to "effectively timeshare" with LTE-U for "the entire range of LTE-U OFF times."[14]

The extensive evaluations and tests performed in the LTE-U Forum and with various companies in 3GPP concluded that coexistence between current Wi-Fi devices and LTE-U/LAA devices was feasible with a variety of coexistence mechanisms.[15] The study does not discuss, or even acknowledge, the extent to which variability in Wi-Fi devices, in either timesharing

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[10] *Id.* at 9-10, 5.

[11] *See* Google Study at 11.

[12] *Id.* at 10-11 ("[E]ven small changes in the physical placement of Wi-Fi devices can significantly change timesharing efficiency. Sensitivity to physical placement and relative signal levels was observed for every device tested, meaning that no device that was tested always timeshared efficiently.")

[13] *Id.* at 9-10.

[14] *Id.* at 10.

[15] *See* Forum Technical Report; 3GPP Technical Report 36.889 v.13.0, http://www.3gpp.org/dynareport/36889.htm.

efficiency or physical placement, may play a role in the ability of LTE-U or LAA to coexist with Wi-Fi at received signal strengths below –62 dBm. We note that in its test of Wi-Fi/LTE-U coexistence below –62 dBm, it used only a single pair of Wi-Fi devices, despite the variability observed among devices in Section 3.1 of the study. Thus the results in Section 3.2 may not adequately represent an assessment of coexistence.

In addition, the study incorrectly suggests that a network incorporating LTE-U will employ unlicensed spectrum in preference to licensed.[16] In fact, as the study acknowledges in an appendix, LTE-U eNodeBs employ an ON/OFF switch to ensure no transmissions on unlicensed channels occur when traffic demand is met on licensed spectrum.[17] As Verizon observed in its comments, "[b]ecause LTE-U supplements an operator's licensed network on a secondary basis, it is used only when and where the licensed spectrum becomes congested. If there is not enough data traffic to warrant using unlicensed spectrum as a supplement, LTE-U transmits nothing on unlicensed spectrum, opening it up for others to use."[18]

III. THE RECORD CALLS FOR TECHNOLOGICAL NEUTRALITY AND INDUSTRY LEADERSHIP

The record reflects extensive support for unlicensed bands that are open to all technologies within broad parameters. Google itself, for example, supports "leaving the development of coexistence mechanisms to industry cooperation rather than regulatory intervention."[19] CTIA strongly supports maintaining a framework for unlicensed services that is strictly technology neutral: "So long as a technology satisfies the Commission's Part 15 rules, there should be no need for the Commission to be involved in dictating any more than minimal

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[16] *See, e.g., id.* at 1, 18-19

[17] *Id.* at 22.

[18] Verizon Comments, ET Docket No. 15-105, at 4 (June 11, 2015).

[19] Google Comments at 1.

technical standards or requirements."[20] And ATIS observes that "the Commission's policy of technology neutrality in the unlicensed spectrum bands . . . has worked well to foster innovation and competition."[21]

The Commission should not freeze technologies at their current level, which would deter continued innovation and investment in new technologies. Future improvements in efficient use of spectrum beyond current unlicensed technologies, including LTE-U/LAA, should be allowed as long as the technology conforms to neutral FCC rules. The Commission should not mandate, nor prohibit, particular technologies or standards. Further, there should be no requirement that would place a particular standards body in the position of gatekeeper for all innovation and development in the unlicensed bands.

Ericsson embraces a technology neutral approach permitting 802.11/Wi-Fi, Bluetooth, LAA/LTE-U, and other future technologies in the 5GHz band, the 3.5 GHz, the 2.4 GHz and other unlicensed bands. Ericsson supports continued innovation in unlicensed spectrum, including Wi-Fi, LTE-U and LAA, and encourages additional dialogue on these issues.

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[20] CTIA–The Wireless Association Comments, ET Docket No. 15-105, at 5 (June 11, 2015).

[21] Comments of the Alliance for Telecommunications Industry Solutions, ET Docket No. 15-105, at 6 (June 11, 2015).

Respectfully submitted,

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June 26, 2015