Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
	)	
Office of Engineering and Technology and Wireless	)	ET Docket No. 15-105
Telecommunications Bureau Seek Information on	)	
Current Trends in LTE-U and LAA Technology	)	

COMMENTS OF WI-FI ALLIANCE

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June 11, 2015

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SUMMARY

Wi-Fi Alliance, the industry trade association and recognized authority for certification of interoperable Wi-Fi devices, appreciates the efforts of the Office of Engineering and Technology and the Wireless Telecommunications Bureau to review the use of unlicensed spectrum by LTE technologies ("Unlicensed LTE"). Today, there is insufficient information about how LTE-Unlicensed ("LTE-U") and Licensed Assisted Access ("LAA") protocols will manage coexistence with Wi-Fi and other devices that operate in unlicensed spectrum.   The information available about LTE-U's coexistence techniques is discouraging, and LAA standards remain under development by 3GPP. There have only been limited and preliminary efforts to foster stakeholder agreement on appropriate spectrum sharing characteristics; further work and collaboration is necessary. Wi-Fi Alliance welcomes cross-industry cooperation to ensure coexistence among different uses of unlicensed spectrum, and remains hopeful that LTE-U and LAA will ultimately include appropriate sharing mechanisms. However, if such consensus cannot be reached, or if there is inadequate collaboration, the Commission must be prepared to act so that the introduction of new Unlicensed LTE technologies does not impede the continued robust development of Wi-Fi and other existing technologies that are so critical to our nation's economy and communications ecosystem.

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Wi-Fi Alliance submits these comments in response to the Public Notice issued by the

Commission's Office of Engineering and Technology and Wireless Telecommunications Bureau seeking

information on LTE-Unlicensed ("LTE-U") and Licensed Assisted Access ("LAA") technologies, and the

techniques they will implement to share spectrum with existing unlicensed technologies such as Wi-Fi

that are widely used by the public.[1/] As noted below, there is insufficient information about how both

LTE-U and LAA will co-exist with Wi-Fi and other uses of unlicensed spectrum. The Commission must

therefore continue to monitor developments to ensure that there is sufficient dialogue and

consideration to how unlicensed spectrum — particularly at 5GHz where unlicensed LTE is expected to

deployed first — will be shared fairly, so that the introduction of LTE-U and LAA does not impede the

continued robust development of Wi-Fi and other technologies that operate therein.

[1/]   *See Office of Engineering and Technology and Wireless Telecommunications Bureau Seek Information on Current Trends in LTE-U and LAA Technology*, Public Notice, ET Docket No. 15-105, DA 15-516 (rel. May 5, 2015) ("*Public Notice*").

I. BACKGROUND AND INTRODUCTION

Wi-Fi Alliance is a global, non-profit industry association of more than 600 leading companies from dozens of countries, including 213 from the United States, who are devoted to a vision of "Connecting everyone and everything, everywhere." With technology development, market building, and regulatory programs, Wi-Fi Alliance has enabled widespread adoption of Wi-Fi worldwide, certifying thousands of Wi-Fi products each year. The Wi-Fi Alliance mission is to provide a highly effective collaboration forum for stakeholders, deliver excellent connectivity experiences through interoperability, embrace technology innovation, promote the adoption of our technologies worldwide, advocate for fair worldwide spectrum rules, and to lead, develop, and embrace industry-agreed standards.

Since its inception in 1999, Wi-Fi has seen continued advancements, with today's most advanced Wi-Fi devices delivering data exceeding one gigabit per second when communicating with other current-generation technologies.[2] With these continual technological achievements has come increased adoption: about two and a half billion Wi-Fi devices were sold in 2014 alone, and more than four billion are expected to be sold in 2020.[3] Today, Wi-Fi hotspots number more than five million worldwide and are expected to reach 10 million by 2018, while more than 725 million households around the world are expected to have a Wi-Fi connection this year.[4] Through innovation in unlicensed spectrum Wi-Fi has enabled anyone, anytime, and anyplace to set up an affordable network that simply works — and this utility has benefited the world and delivered hundreds of billions of dollars of economic value. The ubiquity of Wi-Fi connectivity has spurred substantial benefits for the economy,

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[2]   Wi-Fi Alliance, *Discover Wi-Fi, 15 Years of Wi-Fi*, http://www.wi-fi.org/discover-wi-fi/15-years-of-wi-fi (last visited Feb. 3, 2015).

[3]   Wi-Fi Alliance News Release, *Wi-Fi Alliance® Celebrates 15 Years of Wi-Fi®* (Sept. 8, 2014), http://www.wi-fi.org/news-events/newsroom/wi-fi-alliance-celebrates-15-years-of-wi-fi.

[4]   *See* Wi-Fi Alliance, *Wi-Fi Alliance, Connect Your Life: Wi-Fi and the Internet of Everything*, at 4 (Jan. 2014), *available at* http://www.wi-fi.org/system/files/wp_Wi-Fi_Internet_of_Things_Vision_20140110.pdf; *see also* ABI Research News Release, *Global Wi-Fi Hotspots Will Grow to 7.1 Million in 2015 as a Method to Offload Traffic* (May 8, 2014), https://www.abiresearch.com/press/global-wi-fi-hotspots-will-grow-to-71-million-in-2.

with the combined value of future proliferation of current Wi-Fi technologies amounting to more than

$547 billion in economic value and nearly $50 billion in contribution to the gross domestic product.[5/]

Unlicensed spectrum is a valuable complement to licensed wireless services. For example,

consumers and service operators increasingly rely on Wi-Fi technologies for access to the Internet on

mobile devices, with Wi-Fi embedded in 99 percent of all smartphones today.[6/] Licensed providers have

instituted "Wi-Fi offloading"[7/] and continue to do so at a rapid rate, which allows them to deliver higher

quality service to consumers.[8/] Wi-Fi is a particularly attractive means of offloading large amounts of

mobile data traffic since it is cost effective, widely available, and easily integrated into mobile core

networks.[9/] Additionally, Wi-Fi calling has also been marketed by major wireless carriers as a way for

consumers to call and text virtually anywhere.[10/] Indeed, Wi-Fi has been so effective as a connectivity

service that it has given rise to a new "Wi-Fi First" type of service operator.[11/]

[5/]   *See* Telecom Advisory Services, LLC, *Assessment of the Future Economic Value of Unlicensed Spectrum in the United States*, at 9 (Aug. 2014), *available at* http://www.wififorward.org/wp-content/uploads/2014/01/Katz-Future-Value-Unlicensed-Spectrum-final-version-1.pdf ("WifiForward Unlicensed Spectrum Study").

[6/]   *See* ABI Research, *Carrier Wi-Fi and Mobile Offload* (2012), *available at* https://www.abiresearch.com/market-research/product/1009515-carrier-wi-fi-and-mobile-offload/; *see also Terrestrial Use of the 2473-2495 MHz Band for Low-Power Mobile Broadband Networks; Amendments to Rules for the Ancillary Terrestrial Component of Mobile Satellite Service System*, Notice of Proposed Rulemaking, 28 FCC Rcd. 15351, ¶ 13 (2013).

[7/]   Licensed carriers often "offload" traffic that would otherwise be on their cellular networks onto Wi-Fi links.

[8/]   WifiForward Unlicensed Spectrum Study at 9.

[9/]   Cisco, *Architecture for Mobile Data Offload Over Wi-Fi Access Networks* (2012), *available at* http://www.cisco.com/c/en/us/solutions/collateral/service-provider/service-provider-wi-fi/white_paper_c11-701018.pdf.

[10/]   *See* T-Mobile, *Wi-Fi Calling*, http://www.t-mobile.com/offer/wifi-calling-wifi-extenders.html (last visited Feb. 3, 2015); *see also* Sprint, *FAQs About Sprint Wi-Fi Calling*, http://support.sprint.com/support/article/FAQs_about_Sprint_WiFi_calling/173e331f-8423-453e-93cb-4688f6a91f67 (last visited Feb. 3, 2015); Phil Goldstein, *Verizon Wireless Plans to Launch Wi-Fi Calling in Mid-2015*, FIERCEWIRELESS (Sept. 17, 2014), http://www.fiercewireless.com/story/verizon-wireless-plans-launch-wi-fi-calling-mid-2015/2014-09-17; Roger Cheng, *AT&T Plans to Offer Wi-Fi Calling in 2015*, CNET (Sept. 12, 2014), http://www.cnet.com/news/at-t-plans-to-offer-wi-fi-calling-in-2015/.

[11/]   *See, e.g.*, Scratch Wireless, *Wi-Fi First Mobile Service: Free Wi-Fi First Smartphone Plan*, http://www.scratchwireless.com/pad/s/wi-fi-first/ (last visited June 7, 2015).

Wi-Fi Alliance has already expressed its concerns about the ability of devices using 802.11 technologies to co-exist in unlicensed spectrum with those devices operating in connection with licensed LTE systems.[12] Accordingly, it applauds the Commission for issuing the *Public Notice,* which will inform the Commission about the steps, if any, necessary to ensure that all technologies have fair access to unlicensed spectrum, including in the 5 GHz band, and is pleased to have the opportunity to submit the following comments.

II.   COMMENTS

The *Public Notice* references both LTE-U and LAA, and an important first step in addressing coexistence is agreement on the meaning of those terms. Unfortunately, the term "LTE-U" is used both (i) to refer to "unlicensed LTE in general" (which may or may not also include or use LAA), and (ii) to describe the specific systems currently being developed by the LTE-U Forum companies. The industry has converged on the term LTE-U to refer to the technology and systems defined by the LTE-U Forum. Therefore, we use the phrase "Unlicensed LTE" when referring to the general concept of using LTE within unlicensed bands. We limit the use of the term LTE-U for the specific approach for Unlicensed LTE promulgated by the LTE-U Forum, and the term LAA for the specific approach to be developed by 3GPP. This is consistent with how these technologies are referred to within IEEE, 3GPP and by the majority of stakeholders.[13] We encourage the FCC to adopt this terminology.

Based on this understanding, it is inaccurate for the *Public Notice* to characterize LTE-U as something that "could operate in conjunction with licensed commercial wireless services using a technique called Licensed Assisted Access."[14] LAA is the nascent open standard being developed within

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[12]   *See* Letter from Edgar Figueroa, President and CEO, Wi-Fi Alliance, to Marlene H. Dortch, Secretary, FCC, GN Docket No. 12-354 (filed Apr. 10, 2015).

[13]   *See, e.g.*, LTE-U Forum, *LTE-U Industry Workshop*, at 5 (May 28, 2015), *available at* http://lteuforum.org/uploads/3/5/6/8/3568127/lte-u_introduction_may_28_2015.pdf.

[14]   *See Public Notice* at 1.

3GPP for Unlicensed LTE, targeted for inclusion within LTE Release 13.[15/] In contrast, LTE-U is a

proprietary system developed privately by a few companies, and it is anticipated to be first deployed in

the United States prior to the availability of devices using LAA. Among other differences, LTE-U employs

carrier sensing adaptive transmission ("CSAT") technology that is not under consideration by 3GPP.[16/]

This lack of an industry standard implementation of CSAT means that its impact on other users of shared

spectrum will be variable and unpredictable.

LTE-U is based on the existing generation of deployed LTE and may continue to operate in some

carrier networks even after 3GPP finalizes LAA.[17/] 3GPP has already explicitly excluded LTE-U from LAA

by excluding the CSAT access method from consideration as part of the LAA standard, and therefore, no

LAA system will use the LTE-U CSAT method.[18/]

The Public Notice states that parties have asserted that LTE-U and LAA are more efficient than

other currently available unlicensed technologies and that consumers will ultimately benefit from

increased access to spectrum.[19/] Wi-Fi Alliance disagrees with those assertions. *First,* the purported

efficiency of LTE technologies when operating within unlicensed bands is unproven. There is currently

no LTE-U or LAA equipment publicly available that would facilitate a proper assessment of the

operational efficiency of these systems by interested stakeholders.   In addition, there is likely to be a

wide range of variability in implementations of Unlicensed LTE by the various vendors and operators,

with widely varying levels of efficiency. In fact, it appears likely that the effectiveness of Unlicensed

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[15/]   *See* 3GPP, *Evolution of LTE in Release 13* (Feb. 18, 2015), http://www.3gpp.org/news-events/3gpp-news/1628-rel13.

[16/]   *See* 3GPP RAN1, *Response LS on LAA-802.11 Coexistence (R1-152183)*, at 2-3 (Apr. 24, 2015), *available at* http://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_80b/Docs/R1-152183.zip ("3GPP RAN1 Response LS").

[17/]   *See* Qualcomm, *R10-based LTE-U Supports Early Launches of LTE in 5 GHz Unlicensed Spectrum with Wi-Fi Coexistenc*e, https://www.qualcomm.com/invention/research/projects/lte-unlicensed/r10-based-lte-u (last visited June 7, 2015).

[18/]   *See* 3GPP RAN1 Response LS at 2-3.

[19/]   *See Public Notice* at 1.

LTE's ability to share spectrum with Wi-Fi will vary from operator to operator. In the case of LTE-U, the LTE-U Forum itself has documented the sensitivity of sharing effectiveness on the specific algorithm used,[20] and yet LTE-U will allow for wide operator discretion in the implementation. In the case of LAA, the algorithms being currently considered within 3GPP are highly parametrized, which could mean that one operator may achieve effective sharing with Wi-Fi while another does not, even if both claim to conform to the LAA standard. This practice works well in licensed spectrum where operators control their spectrum and are free to configure their equipment as they see fit consistent with the FCC's rules. However, unlicensed spectrum relies heavily upon implementers following detailed standards to ensure adequate fairness.

It is also still possible that a bandwidth-*inefficient* access method could be selected for LAA, independent of the underlying physical layer-level efficiency, which would decrease spectrum availability for all users. 3GPP has made progress on a listen-before-talk ("LBT") mechanism for downlink traffic through the completion of the LAA Study Item phase,[21] but as this work moves into 3GPP's Work Item phase there are other important aspects that still need to be defined, such as LBT for uplink and for multi-channel operation greater than 20MHz.

Second, rather than benefitting them, Unlicensed LTE may harm consumers. The efficient use of unlicensed spectrum by technologies such as Wi-Fi is due in large part to the fact that unlicensed technologies were designed from the start to operate in such an unpredictable, unmanaged, radio environment. In contrast, LTE uses a highly predictable and tightly managed network over which it has full control. No additional spectrum is being made available to consumers through either the LTE-U or the LAA initiatives. These technologies are simply new entrants to the existing spectrum that is heavily

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[20]   *See* LTE-U Forum, *LTE-U Technical Report: Coexistence Study for LTE-U SDL V1.0*, at 41-42 (Feb. 2010), *available at* http://www.lteuforum.org/uploads/3/5/6/8/3568127/lte-u_forum_lte-u_technical_report_v1.0.pdf.

[21]   *See* 3GPP, *3GPP TR 36.889: Feasibility Study on Licensed-Assisted Access to Unlicensed Spectrum* (June 4, 2015), *available at* http://www.3gpp.org/DynaReport/36889.htm.

relied upon by millions of Wi-Fi users. So, without proper sharing protocols, this static pool of

unlicensed spectrum will be required to support additional use by LTE operators. The number of Wi-Fi-

only devices exceeds the number of licensed mobile devices — in fact, over 1.1 billion Wi-Fi-only devices

were shipped in 2014.[22/] Also, the proliferation of Wi-Fi-only devices will accelerate with the growing

market for Wi-Fi Internet of Things applications. If Unlicensed LTE lacks proper coexistence mechanisms

these Wi-Fi-only devices will be unfairly impacted, along with those users who are unable or unwilling to

pay subscription fees for Unlicensed LTE services.

The *Public Notice* states that 3GPP, "which develops standards for commercial wireless

technologies, is developing the LTE-U and LAA standards."[23/] This statement is inaccurate. 3GPP is not

developing LTE-U. As noted above, 3GPP is developing LAA while the LTE-U Forum has developed the

proprietary LTE-U system. As also noted above, 3GPP has explicitly excluded LTE-U as part of the LAA

standard by excluding the CSAT access method employed in LTE-U from consideration in the LAA

standard. The distinction between the two is meaningful because, among other reasons, even if one of

these initiatives develops an acceptable coexistence methodology, it does not mean it will be adopted

by the other.

The *Public Notice* observes that the LTE-U Forum "is considering deployment of LTE-U/LAA using

a 'pre-standard' version of LTE-U/LAA."[24/] However, the Commission's reference to LTE-U as a "pre-

standard" version is also inaccurate. Referring to something as a "pre-standard" version typically

implies that it is based on an unapproved draft of a standard. However, this is not the case with LTE-U.

LTE-U is not a technology developed using standards-development processes that would allow for

transparency and peer review. Furthermore, the "pre-standard" language implies that LTE-U is in the

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[22/]   *See* ABI Research, *Wi-Fi (MD-WLAN-164)* (May 2015), *available at* https://www.abiresearch.com/market-research/product/1021330-wi-fi/.

[23/]   *See Public Notice* at 1.

[24/]   *See id.* at 2.

process of becoming a standard, or worse, it may be interpreted as LTE-U being the pre-standard version of LAA. Instead, LTE-U is a completely independent system from LAA that will also compete with LAA systems to use unlicensed spectrum. LTE-U is unlike an open technical standard because it was privately developed by a small subset of industry stakeholders. So, an assertion that the LTE-U Forum is developing a pre-standard version of LAA gives the LTE-U technology a perceived relationship with the LAA standard that simply doesn't exist.

The Commission asks about the status of coordination between 3GPP and the IEEE 802.11 Working Group on LTE-U and LAA, and the process for coming to agreement on appropriate sharing characteristics to ensure coexistence with the IEEE 802.11 family of standards.[25] As the industry trade association and recognized certification authority for Wi-Fi technology, Wi-Fi Alliance also has an active interest in ensuring appropriate sharing. We are eager to work collaboratively with 3GPP, IEEE 802, and others as needed to achieve this goal. In fact, there has already been some information sharing among stakeholders, including Wi-Fi Alliance. For example, Wi-Fi Alliance has hosted speakers from 3GPP to present on LAA, and Wi-Fi Alliance has participated on a number of technology roundtables and panels on Unlicensed LTE, including a recent LTE-U workshop hosted by Qualcomm and Verizon. However, further work and collaboration is needed to fully understand the impact of sharing mechanisms.   It is our understanding that 3GPP member companies will agree on sharing mechanisms and a definition of "fairness" without requiring agreement from stakeholders outside of 3GPP membership. Because Wi-Fi Alliance has the intention of performing simulations and testing related to Wi-Fi / LAA coexistence, Wi-Fi Alliance welcomes coordination with 3GPP and IEEE 802.

The LTE-U Forum's work is considered complete, and the LTE-U Forum is no longer active. To our knowledge, the LTE-U specification does not detail an access methodology, and this closed approach prevents the development of even a common understanding of the issue within the larger stakeholder

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[25]   *See id.*

community. For example, two implementations of LTE-U have been discussed publicly and they may have notably different effects on how they each share unlicensed spectrum. Wi-Fi Alliance continues to provide a forum for companies who participated in the LTE-U Forum and who are Wi-Fi Alliance participating members to engage in discussions about sharing considerations. However, this dialogue is not formally occurring with LTE-U Forum.

Similarly, the Public Notice asks about the anticipated technical characteristics (*e.g.*, bandwidth(s), LBT, transmission durations, etc.) of LTE-U and LAA. As noted above, there is insufficient information about the upcoming range of coexistence mechanisms in LTE-U equipment. For example, one system is known to use detailed information about 5GHz users to dynamically adapt its sharing behavior, while a second system publicly discussed uses only potentially insufficient energy detection thresholds to determine if the medium is available. What is publicly known is that LTE-U allows a range of non-LBT, duty-cycle-based unlicensed medium access mechanisms.[26] Meanwhile, 3GPP continues to develop LAA. 3GPP has considered both LBT and non-LBT.[27] At present the type of coexistence mechanism that 3GPP will require is unresolved. In addition, the specific additional technical characteristics of possible LBT mechanisms in LAA are still to be determined, including the manner in which it will be parametrized, whether there will be LBT for uplink traffic, and the specific details of LBT for multi-channel operation greater than 20MHz.

The FCC should note that twelve major global operators have expressed in a joint 3GPP submission (3GPP R1-152374)[28] their belief that LAA should not be allowed to operate in a standalone

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[26]   *See* Joey Padden, *Wi-Fi vs. Duty Cycled LTE: A Balancing Act*, http://www.cablelabs.com/wi-fi-vs-duty-cycled-lte/ (last visited June 7, 2015), *citing* Qualcomm, *Qualcomm Research, LTE in Unlicensed Spectrum: Harmonious Coexistence with Wi-Fi*, at 7 (June 2014), *available at* https://www.qualcomm.com/media/documents/files/lte-unlicensed-coexistence-whitepaper.pdf.

[27]   *See* Dino Flore, *3GPP & Unlicensed Spectrum*, at 13 (Jan. 11, 2015), *available at* http://www.3gpp.org/ftp/Information/presentations/presentations_2015/2015_01_3GPP_unlicensed_Dino_Flore.pdf.

[28]   *See* 3GPP RAN1, *WF on Precluding Standalone Access of LTE on Unlicensed Carriers (R1-152374)* (Apr. 20, 2015), *available at* http://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_80b/Docs/R1-152374.zip.

mode, because it would mean the service operators could be disintermediated. This possibility for a higher degree of control of unlicensed bands is an example of Wi-Fi Alliance's concern regarding the likelihood that fair sharing mechanisms may not be deployed. We urge the FCC to continue to monitor further developments in this regard. If fair sharing is not achieved, there is a risk that Unlicensed LTE will become the only air interface protocol that works effectively in certain scenarios. In addition, if a stand-alone version of LAA is not developed (as has been proposed within 3GPP), then access to unlicensed spectrum would implicitly require access to licensed spectrum — thereby undermining the public benefit inherent in unlicensed spectrum and further concentrating this valuable resource in the hands of a small number of service providers.

Finally, the Public Notice asks about the tests or analyses that have been performed to understand the impact of LTE-U and LAA on the existing commercial wireless and unlicensed ecosystems.[29] In the case of LTE-U, LTE-U Forum members disclosed their own independent tests in webinars and videos at events such as the Mobile World Congress 2015 and the Verizon/Qualcomm workshop.[30] Wi-Fi Alliance has begun working on coexistence evaluations, and recently Qualcomm offered to work with Wi-Fi Alliance to enable Wi-Fi Alliance to understand the Qualcomm LTE-U sharing scheme, and to replicate and evolve some of the coexistence testing Qualcomm has already conducted. This is a step in the right direction and the kind of collaboration Wi-Fi Alliance believes is needed in order for the industry to continue to shepherd the best use of unlicensed spectrum autonomously and with minimal regulation. Wi-Fi Alliance welcomes the opportunity to collaborate with other LTE-U stakeholders in similar fashion to understand how different LTE-U implementations and Wi-Fi will coexist in unlicensed spectrum, including the 5GHz band. We stand ready to engage in that type of

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[29]   *See Public Notice* at 2.

[30]   *See* Mike Dano, *Verizon's LTE-U Forum Completes LTE Unlicensed Tests on Way Toward Carrier's 2016 Deployment in 5 GHz, 3.5 GHz*, FIERCEWIRELESS (Mar. 3, 2015), http://www.fiercewireless.com/tech/story/verizons-lte-u-forum-completes-lte-unlicensed-tests-way-toward-carriers-201/2015-03-03; LTE-U Forum, *LTE-U Workshop Documents*, http://lteuforum.org/workshop.html (last visited June 8, 2015).

cross-industry collaboration and ask that the Commission continue to monitor these efforts so that it may take any action necessary if they are unsuccessful.[31]

For LAA, 3GPP has established a set of simulation scenarios and associated evaluation criteria, and various companies have submitted simulation results.[32] Wi-Fi Alliance is concerned about the validity of the current approach to these simulations, and consequently we question the reliability of the conclusions they may draw. For example, the 3GPP simulations only look at 20 megahertz channels, do not consider video traffic, and give insufficient attention to voice over Wi-Fi traffic. Many features likely to be used by Wi-Fi devices at the time of LAA deployment have not been considered or simulated, such as explicit transmit beamforming and short guard interval. Likewise, we believe that higher density environments such as stadiums need to be considered, and there has been insufficient consideration within 3GPP of hidden station issues and uplink traffic considerations. To help address these deficiencies, Wi-Fi Alliance, through its Coexistence Task Group, has initiated an open-platform simulation initiative in collaboration with the University of Washington and the Centre Tecnològic de Telecomunicacions de Catalunya (CTTC).[33] This initiative will yield a range of simulations, and it will allow independent review and replication by any stakeholder. We expect industry-wide participation in this effort. Wi-Fi Alliance has already started to conduct these simulations. Wi-Fi Alliance has also started to benchmark how Wi-Fi networks coexist with other Wi-Fi networks, and to contrast this with how Unlicensed LTE coexists with Wi-Fi networks. This includes working with LTE-U vendors, and analysis of LAA as the development of LAA progresses. We encourage the 3GPP and LTE-U Forum

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[31]   *See* Monica Alleven, *Wi-Fi Alliance Stresses Need for Collaboration in LTE-U Standards Process*, FIERCEWIRELESS (May 25, 2015), http://www.fiercewireless.com/tech/story/wi-fi-alliance-stresses-need-collaboration-lte-u-standards-process/2015-05-25.

[32]   *See generally* 3GPP RAN1 Response LS**.** *See also, e.g.*, Cisco Systems, *Simulation Results for Coexistence of LAA and Wi-Fi* (Feb. 9, 2015), *available at* http://portal.3gpp.org/ngppapp/DownloadTdoc.aspx?contributionId=627165.

[33]   *See CTTC*, CTTC: Centre Tecnològic de Telecomunicacions de Catalunya, http://www.cttc.es/ (last visited June 9, 2015).

members to lend their expertise to this open source simulation project. We also intend for this open-platform simulation to address the deficiencies in the current 3GPP simulation scenarios and evaluation criteria identified above.

III.   CONCLUSIONS

Wi-Fi Alliance appreciates the efforts of the Office of Engineering and Technology and the Wireless Telecommunications Bureau to conduct an in-depth review of the use of unlicensed spectrum by Unlicensed LTE technologies.   Wi-Fi Alliance remains interested in maximizing the utility of unlicensed spectrum through innovation and with minimal regulations. However, it is not evident today how the range of Unlicensed LTE implementations will share spectrum fairly with Wi-Fi and with other unlicensed spectrum users. Early evidence shows that LTE-U implementations may not adequately consider other users of unlicensed spectrum. Similarly, there are as yet no assurances that any coexistence mechanism 3GPP adopts in LAA will coexist fairly with Wi-Fi.

Wi-Fi Alliance will continue to nurture dialogue and collaboration with all parties interested in unlicensed spectrum, including Unlicensed LTE stakeholders, and will lead the discussion about how unlicensed spectrum, including in the 5 GHz band, may be shared fairly with Wi-Fi. Among other things, we have formed a task group that is focused on coexistence and spectrum sharing, commissioned an open source spectrum sharing project, and hosted dialogue with a number of LTE-U and LAA stakeholders. Wi-Fi Alliance will work closely with interested vendors to understand via both tests and simulations how Wi-Fi and Unlicensed LTE will coexist. We are hopeful that final specifications for LAA will include appropriate sharing mechanisms and that LTE-U may yet evolve and adopt suitable sharing, if not within the LTE-U specification, then at least in real LTE-U implementations. In the event that such consensus cannot be reached, or if there is inadequate collaboration across industries, further FCC action must remain an option.

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Dated: June 11, 2015