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

COMMENTS OF THE NATIONAL CABLE & TELECOMMUNICATIONS ASSOCIATION

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I. INTRODUCTION

The tremendous success of unlicensed technologies, and of Wi-Fi in particular, is attributable to the talents of America's innovators and enormous investments by manufacturers and network operators. But underlying this achievement is a history of careful and collaborative stewardship of shared frequency bands by the unlicensed community through the standards-setting bodies of the Institute of Electrical and Electronics Engineers ("IEEE"). This system led to worldwide Wi-Fi standards that include sharing mechanisms that allow hundreds of millions of consumers to coexist in unlicensed bands. The efficacy of this system of self-governance thus far has allowed the Commission to rely on the IEEE standards-setting process to protect the public interest in place of regulation.

But a small set of manufacturers and licensed mobile carriers are now pressing to deploy Licensed Assisted Access ("LAA") and LTE-Unlicensed ("LTE-U") technologies outside of this collaborative process, and doing so without regard to the impact on millions of Wi-Fi consumers. LAA and LTE-U will cause debilitating interference to other unlicensed services unless they incorporate effective sharing mechanisms, and will do so while minimizing the impact of this interference to LAA/LTE-U licensees by isolating critical control messaging in a licensed band. LTE-U and LAA proponents are threatening the Commission's ability to rely on self-governance of unlicensed bands by doing an end-run around IEEE's open standards-setting process, refusing to adopt industry-standard sharing mechanisms, and intentionally designing their protocols so that they are available only to licensed mobile carriers. These actions have spurred IEEE, the Wi-Fi Alliance, the European Telecommunications Standards Institute, consumer advocates, and a diverse set of unlicensed manufacturers and service providers to raise red flags.

NCTA supports the opening of a docket to address this unprecedented situation. It is important for the Commission to seek comments on the technical implications of these technologies for consumers, the state of standards setting, and possible coexistence strategies. But, the Commission must gather this information and act quickly either to ensure that the standards process produces effective sharing, or to explore regulatory options. A group of LTE-U proponents has spurned even the non-inclusive 3GPP standards process and is planning to launch non-standard technology this year without effective sharing mechanisms that could result in the degradation of American consumers' Wi-Fi service.

Therefore, NCTA hopes that the Commission will be able to protect the public interest through careful supervision of the standards-setting process. Specifically, we recommend that the Commission: (1) convene a meeting of the Chief of the Office of Engineering and Technology and a representative group of licensed carriers and the unlicensed community to initiate a process to establish effective sharing mechanisms; (2) establish a working group composed of Commission staff and engineers from interested parties to carry forth this work after this initial meeting in weekly meetings; (3) seek monthly status reports from IEEE and 3GPP on the progress of coordination between these bodies on establishing effective sharing; and (4) ensure that licensees do not launch non-standard versions of LTE-U until these processes have been completed to the Commission's satisfaction. If this effort does not result in the changes needed to protect consumers, the Commission must be prepared to take regulatory action.

II. WI-FI AND OTHER UNLICENSED TECHNOLOGIES ARE CRITICAL TO CONSUMERS, DRIVE ECONOMIC GROWTH, AND FOSTER INNOVATION

The unlicensed bands have become an indispensable part of the nation's telecommunications infrastructure, and an important driver of economic growth. A substantial degradation to unlicensed services, particularly to Wi-Fi and Bluetooth, will therefore harm consumers and slow the pace of technological innovation in the United States.

Wi-Fi technology is now ubiquitous. Earlier this year, the Wi-Fi industry shipped its 10-billionth Wi-Fi device, with the number of Wi-Fi devices currently in operation estimated to easily exceed 4 billion.[1] Among these billions of devices are the Wi-Fi access points currently found in over 70 million American homes,[2] and the eleven Wi-Fi devices found in the average American household.[3]

Wi-Fi devices are not only found in nearly every home and pocket, but they also dominate the mobile telecommunications landscape. Mobile Wi-Fi devices carried approximately half of all mobile data in 2014, and the share of mobile data transmitted over Wi-

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[1] WI-FI ALLIANCE, *Total Wi-Fi® device shipments to surpass ten billion this month* (Jan. 5, 2015), http://www.wi-fi.org/news-events/newsroom/total-wi-fi-device-shipments-to-surpass-ten-billion-this-month.

[2] TELECOM ADVISORY SERVS., LLC, *Assessment of the Economic Value of Unlicensed Spectrum in the United* States, at 11 (Feb. 2014), *available at* http://www.wififorward.org/wp-content/uploads/2014/01/Value-of-Unlicensed-Spectrum-to-the-US-Economy-Full-Report.pdf ("Telecom Advisory Servs. Feb. 2014 Final Report").

[3] STRATEGY ANALYTICS, *US Wi-Fi Households to Own Average of 11 Wi-Fi Devices in 2017 says Strategy Analytics*, Press Release (May 19, 2014), https://www.strategyanalytics.com/strategy-analytics/news/strategy-analytics-press-releases/strategy-analytics-press-release/2014/05/19/us-wi-fi-households-to-own-average-of-11-wi-fi-devices-in-2017-says-strategy-analytics.

Fi is projected only to increase with time.[4] In absolute terms, Wi-Fi carried 24.2 exabytes (*i.e.*, 24.2 billion bytes) of data in 2014 alone—more than twenty-four times the volume of data transmitted over the entire global Internet in the year 2000.[5] By 2019, Wi-Fi is expected to carry more than 24 exabytes of data *every month*.[6] And these statistics do not even include the countless Bluetooth devices, cordless telephones, garage door openers, keyless entry systems, RFID tags, and other unlicensed technologies that consumers rely on every day.

These staggering statistics drive a similarly remarkable contribution to the U.S. economy. Economists estimate that, in the year 2013 alone, the unlicensed bands generated $222 billion in added value to the United States economy.[7] This includes $36 billion in value from in-home Wi-Fi, and $12.6 billion in added value from offloading traffic from licensed carriers' mobile networks.

Wi-Fi and other unlicensed technologies are both ubiquitous and essential to American consumers. Not only do Americans depend on Wi-Fi at home, but they frequently choose their hotels, shopping destinations, and even airline flights on the quality of a venue's Wi-Fi network.[8]

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4 CISCO, *Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2014–2019*, White Paper, at 2, 22 (2015), *available at* http://www.cisco.com/c/en/us/solutions/collateral/service-provider/visual-networking-index-vni/white_paper_c11-520862.pdf.

5 *Id.* at 1-2.

6 *Id*. at 22.

7 Telecom Advisory Servs. Feb. 2014 Final Report at 11.

8 Greg Beato, *How Many Stars for the Wi-Fi*, NEW YORK TIMES (May 06, 2015), *available at* http://www.nytimes.com/2015/05/07/business/how-many-stars-for-the-wi-fi.html; Cihan Cobanoglua et al., *The Impact of Wi-Fi Service in Restaurants on Customers' Likelihood of Return to a Restaurant*, J. OF FOODSERVICE BUSINESS RESEARCH (Sept. 4, 2012), *available at* http://dx.doi.org/10.1080/15378020.2012.706194; HONEYWELL, *Honeywell 2014 In Flight Connectivity Survey* (July, 22, 2014), https://aerospace.honeywell.com/about/media-

In fact, surveys have shown that Americans would rather go without tea or coffee in the morning than without Wi-Fi.[9]

Unlicensed spectrum, and unlicensed technologies like Wi-Fi, also support new businesses and stimulate technological innovation. Given the limited quantity of licensed spectrum, unlicensed spectrum lowers barriers to entry and ensures that all businesses have the spectrum resources they need to build innovative new wireless technologies. Indeed, industry analyses have concluded that the iPad might never have come to market if Wi-Fi had not existed and consumers were only able to use licensed spectrum to get online wirelessly.[10]

In addition, as the Commission has recognized, Wi-Fi plays a crucial role in education in the 21st century. Wi-Fi allows teachers "to assess their students' work in real-time and offer more individually-focused instruction tailored to each student's strengths and weaknesses."[11] Wi-Fi in the classroom "fundamentally changes the classroom from one that is static and restrictive to one that is dynamic and expansive, giving both teachers and students new ways to engage and learn."[12] Accordingly, the Commission has recently modernized its E-Rate program,

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resources/newsroom/honeywell-2014-in-flight-connectivity-survey; Scott McCartney, *To Tweet From 30,000 Feet: Picking Planes Wired for Wi-Fi*, THE WALL ST. J. (Mar. 21, 2012), *available at* http://www.wsj.com/articles/SB10001424052702303812904577295622065558432.

9 Rik Fairlie, *Coffee, TV or Wi-Fi?*, GATGETWISE – THE NEW YORK TIMES BLOG (Oct. 8, 2010), http://gadgetwise.blogs.nytimes.com/2010/10/08/coffee-tv-or-wi-fi/.

10 Telecom Advisory Servs. Feb. 2014 Final Report at 53.

11 FED. COMMC'NS COMM'N, *Modernizing E-Rate: Providing 21st Century Wi-Fi Networks for Schools and Libraries across America*, at 1 (July 1, 2014), *available at* https://apps.fcc.gov/edocs_public/attachmatch/DOC-327993A1.pdf.

12 *Id*. at 2.

with the goal of funding "the deployment of high-speed Wi-Fi in classrooms and libraries nationwide."[13] The cable industry has played a leading role in bringing consumers the incredible value offered by the unlicensed bands. The industry has deployed millions of Wi-Fi routers in customers' homes, untethering the Internet from the Ethernet cable—a key factor in the explosion of Internet usage by consumers. In addition to in-home Wi-Fi, the cable industry has spearheaded efforts to deploy carrier grade out-of-the-home Wi-Fi, which is designed to give consumers seamless high-speed connectivity wherever they go. And unlike licensed mobile service, use of cable operators' outdoor Wi-Fi networks typically is included in the cable television and Internet packages that consumers already purchase.

Industry-wide, the cable industry has deployed more than 10 million Wi-Fi hotspots. Cable continues to invest in and expand these networks every single day.

III. LTE-U DEPLOYMENTS WITHOUT ADEQUATE COEXISTENCE MECHANISMS WOULD BE DISASTROUS FOR CONSUMERS, BUSINESSES, AND SCHOOLS

Work on a version of LTE to allow operation in unlicensed bands is proceeding on two tracks. First, carriers are developing a variant of LTE, called LAA, through 3GPP. 3GPP, unlike the broad-based IEEE which has historically set standards for unlicensed technologies, is dominated by licensed carriers and their suppliers. This technology will be included as a part of LTE revision 13, which is set to be finalized in March 2016.

Second, a small set of carriers and suppliers is pursuing a related technology called LTE-U. These companies have side-stepped standards setting altogether, and have created a new ad

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[13] *Modernizing the E-rate Program for Schools and Libraries*, WC Docket No. 13-184, Report and Order and Further Notice of Proposed Rulemaking, 29 FCC Rcd 8870, 8875, ¶7 (2014).

hoc group called the LTE-U Forum to execute their plans in the United States. LTE-U will likely comprise an assortment of features bolted on top of the existing LTE revision 12 protocol.

Work on both technologies is proceeding at breakneck speed, and is occurring outside the traditional standards-setting processes and institutions for unlicensed technologies, leading to proposals that will cause significant interference to other services unless these groups change course and include effective sharing mechanisms. Although both groups have paid lip service to the need to share spectrum fairly with other unlicensed technologies that consumers rely on, neither LAA nor LTE-U currently requires a carrier to employ any sharing mechanism at all, and most of the optional mechanisms being considered would not protect Wi-Fi users. On the contrary, as discussed below in more detail, research demonstrates that both LTE-U and LAA would severely decrease the performance of any nearby Wi-Fi network. Widespread deployment of LTE-U or LAA would therefore harm American consumers, schools, and innovators by dramatically reducing the utility of the unlicensed bands for everyone but the companies that already hold licensed spectrum.

A. The 3GPP Process Has Failed to Produce Effective Sharing Mechanisms for LAA

At 3GPP, carriers have indicated that they are considering four optional approaches to sharing spectrum with existing unlicensed consumers. Unfortunately, three of these approaches would not protect consumers at all, and the fourth would be only partially effective.

An understanding of Wi-Fi's robust approach to spectrum sharing provides valuable context when considering LAA's approach. Wi-Fi includes two key sharing features.[14] First, it

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[14] *See supra* p. 15.

ensures that other users are not transmitting in a channel before transmitting itself—a feature known as "listen before talk" or "LBT." Second, whenever a Wi-Fi device detects such a signal, it waits before trying to transmit again, and, importantly it exponentially increases the time it will wait before attempting to transmit again each time it finds another user in a channel. This ensures that devices share the channel equitably by transmitting less and less frequently as the channel becomes more congested—a feature known as "exponential back-off."

Although both of these technologies are well known, widely implemented, and proven to enable fair spectrum sharing, only one of the four co-existence approaches 3GPP is examining even considers them, and none of 3GPP's approaches would mandate their use. The first sharing approach, Category 1, appears to include no sharing technologies at all. The relevant 3GPP documents describe this option only as including "no LBT procedure," meaning that it will not even include basic listen-before-talk functionality.[15]

The second approach, Category 2, would include a strategy proponents have described as being a listen-before-talk feature, but in reality is merely a deterministic—*i.e.*, fixed—back-off period. In other words, although an LAA device employing Category 2 coexistence would listen for other transmissions, it would still transmit after a short delay, the length of which will not increase in proportion to the quantity of other traffic in the band.[16] Wi-Fi's exponential back-off features, by contrast, minimize interference by ensuring that each individual device transmits less frequently as congestion in the channel increases.

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[15] 3GPP, *Study on Licensed-Assisted Access to Unlicensed Spectrum*, Study Item Rapporteur, at 11 (May 10-15, 2015), *available at* https://mentor.ieee.org/802.19/dcn/15/19-15-0042-00-0000-study-on-licensed-assisted-access-to-unlicensed-spectrum.pdf.

[16] *Id.*

Category 3 coexistence would be similar to Category 2, except the LAA device would wait a random amount of time within a fixed period known as a "contention window" instead of always transmitting at the end of that fixed period.[17] This would have little advantage over Category 2, except that it would reduce the chances that the device would transmit at the same time as another device using a fixed contention window (which would include virtually no widely deployed unlicensed technology, except LAA itself). Furthermore, as with Category 2, Category 3 coexistence would not adjust the size of that contention window—and thus the frequency of transmission—in proportion to the amount of traffic congestion in the channel.

Finally, 3GPP's proposed Category 4 coexistence proposal would make both a random back-off period and a contention window that can increase in proportion to the amount of congestion in the channel optional settings for LAA.[18] While a specific mechanism for increasing this contention window is not prescribed, this approach, in conjunction with additional sharing features, could support effective coexistence if the window is required to increase exponentially with congestion in the channel, as explained in detail below.[19] But it would be critical that the 3GPP standard mandate the use of these two elements of the Category 4 approach, rather than allowing carriers to turn it off when they choose not to share spectrum. Unfortunately, there is no indication of whether 3GPP intends to require such parameters, and it has made no commitment to adopt any form of Category 4 coexistence.

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[17] *Id.*

[18] *Id.*

[19] *See infra* at 12.

B. LTE-Unlicensed, as Currently Conceived, Includes No Effective Sharing Mechanisms

The situation is even worse for LTE-U. The few details that the LTE-U Forum has made public regarding its sharing plans raise serious concerns. In particular, not only are the basic sharing principles disclosed by the LTE-U Forum inadequate, they also depend on crucial configuration details that remain undisclosed. According to the LTE-U Forum, LTE-U will include three mechanisms that purportedly will result in effective spectrum sharing so that consumers of other unlicensed technologies are not disadvantaged. Unfortunately, these three features are inadequate.

First, LTE-U will attempt to use the clearest channel available.[20] Selecting a clear channel has obvious benefits for the LTE-U operator. Indeed, the technical report issued by the LTE-U Forum describes this feature in terms of selecting the "least interfering channel" to LTE-U—*i.e.*, the channel in which LTE-U operators will be subject to the least interference from each other, not where it will cause the least interference to other technologies using the band. The report specifically notes the need to "[a]void the channel with strong LTE-U link(s) of other operator [sic] as much as possible."[21] But in densely populated areas, typically every available channel is used heavily by multiple Wi-Fi networks. Thus, in situations where it matters most, selecting the "least interfering" channel will do nothing to prevent interference to Wi-Fi. To share effectively, an unlicensed technology must minimize its interference to other co-channel

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[20] LTE-U FORUM, *LTE-U Technical Report—Coexistence Study for LTE-U SDL*, at 42-43, (2015), http://www.lteuforum.org/uploads/3/5/6/8/3568127/lte-u_forum_lte-u_technical_report_v1.0.pdf ("LTE-U 2015 Technical Report").

[21] *Id*. at 42.

services, not merely attempt to avoid them. Unlicensed services like Bluetooth and Wi-Fi have successfully met these challenges since their introduction more than a decade ago.

Second, the LTE-U Forum states that LTE-U carriers *may* put the unlicensed secondary cell known as an "SCell" in "OFF-state when SCell is not needed such as no UE in SCell coverage or there is no data in buffer for users in SCell coverage."[22] In other words, LTE-U can be configured not to transmit when there is no data to send, or no user to receive it. But LTE-U would not require carriers to refrain from transmitting when there is no data to send. Carriers could occupy a channel and continuously transmit to dominate the channel and be in full compliance with LTE-U. Even if a carrier does cease transmissions in some situations, the fact that LTE-U will not interfere with other services *while it is not in operation* can be of little comfort to other unlicensed operators. Assuming LTE-U cells are deployed efficiently, they can be expected to enter this "OFF state" infrequently. Thus, while an LTE-U cell's ability to minimize interference while not in use is welcome, this feature does little to address interference concerns, particularly in the high-density urban areas where interference would be most acutely felt.

Finally, LTE-U may include a variable "SCell duty cycle."[23] This means that an LTE-U cell *may* rapidly switch on and off, with a period ranging in the "10s to 100s" of milliseconds. However, this description leaves out crucial details, and is unlikely to promote coexistence with other unlicensed services no matter how it is configured. Most glaringly, the proposed range of duty cycling periods of "10s to 100s" of milliseconds is incredibly wide—presumably between

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[22] *Id*. at 43.

[23] *Id*. at 42-43.

10 to 999 milliseconds. The precise period is marked "Proprietary" in the LTE-U technical report.[24] Other crucial details remain undisclosed as well, such as the portion of each 10-to-999-millisecond period during which the cell will transmit. In other words, not only is it unknown whether the cell will turn on and off every 10 milliseconds, every 999 milliseconds, or somewhere in between, but it is also unknown whether the cell will be active for 1 percent of this period, or 99 percent.

It is also possible that this period will be variable. If this is the case, the LTE-U Forum has provided no information about how the period will be determined. Worse still, although some combinations of these parameters will share more or less effectively with other unlicensed services, the basic duty cycling approach is far too primitive to share the band with other technologies using more robust, industry-standard coexistence mechanisms. Duty cycling may be an effective means for one LTE-U cell to share with another LTE-U cell, since the operators of those two cells can collaborate to synchronize their cells' duty cycles. But, as we explain in further detail below, it is almost totally ineffective as a means of avoiding interference with existing unlicensed technologies.

Despite these serious flaws and the risk to millions of Wi-Fi consumers, T-Mobile and Verizon Wireless have indicated that they plan to deploy this non-standard technology as soon as this year,[25] well before 3GPP is scheduled to have completed its technical work on the LAA protocol. Given this rush to deploy LTE-U by U.S. carriers, it is unclear whether these carriers

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[24] *Id*. at 9.

[25] LIGHTREADING, *T-Mobile Plans LTE-U With ALU, QUALCOMM* (Mar. 2, 2015), http://www.lightreading.com/mobile/small-cells/t-mobile-plans-lte-u-with-alu-qualcomm/d/d-id/714122.

would ever deploy 3GPP LAA in the United States even if 3GPP were to institute reliable sharing mechanisms. It seems implausible that carriers will migrate rapidly to LAA hardware soon after having invested in LTE-U equipment, and the early deployment of LTE-U may further lock in LTE-U use at the expense of LAA by spurring an LTE-U-only U.S. handset market. In fact, LTE-U Forum documents explicitly note that LTE-U is specifically designed for markets, such as the United States, that impose no politeness requirements for technologies in the unlicensed bands.[26] The European Union specifies a basic, listen-before-talk protocol.[27] Device manufacturers must either comply with these "adaptability" requirements, or be "subject to certain restrictions with respect to using the medium . . . in order to ensure sharing with other equipment."[28] This EU rule would therefore protect European Wi-Fi consumers from LTE-U as it is being developed in the U.S.

C. Without a Dramatic Change of Course, Both LTE-U and LAA Will Gravely Harm the Unlicensed Ecosystem

Although LTE-U and LAA proponents claim that these technologies will share spectrum fairly with Wi-Fi and other unlicensed technologies, their claims are supported only by selective testing that ignores numerous, important real-world factors. The truth is that while Wi-Fi includes robust sharing features, LTE-U and LAA do not. The limited sharing features that LTE-U and LAA may include are demonstrably inadequate, as discussed in detail below. When appropriate real-world factors are taken into account, research clearly shows that LTE-U and

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[26] LTE-U 2015 Technical Report at 42-43.

[27] *See* ETSI EN 300 328 (V 1.9.1) § 4.3.2.6.

[28] *Id.* § 4.2.2.

LAA will cause significant interference. Moreover, the ineffective features that LTE-U and LAA may include will be further undermined by numerous undisclosed implementation details, and carriers' opportunity and incentive to reconfigure these settings in the field to undermine even the minimal sharing that they claim will protect consumers. The inevitable result is immense harm to American consumers, innovators, and schools as the unlicensed bands—starting with the 5 GHz band—are degraded for everyone except the licensed carriers.

1. LTE-U and LAA Proponents Base Their Coexistence Claims on Flawed Simulations

LTE-U and LAA proponents claim that LAA and LTE-U will share spectrum effectively with Wi-Fi. But their assertions depend on badly flawed coexistence simulations. Most importantly, LTE-U proponents do not measure the probable impact of LAA and LTE-U on even moderately dense Wi-Fi deployments. The LTE-U demonstration staged by Qualcomm at the Consumer Electronics Show, for example, used a Wi-Fi network with only eight network nodes.[29] This does not even offer an adequate estimate of the impact on the average home Wi-Fi network, which supports an average of eleven devices,[30] or a multiple dwelling unit with many dozens of devices, let alone a carrier-grade Wi-Fi network, or any other popular Wi-Fi hotspot.

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[29] Joey Jackson, *CES 2015: Qualcomm takes on Wi-Fi with LTE-U*, RCR WIRELESS News (Jan. 6, 2015), http://www.rcrwireless.com/20150106/network-infrastructure/ces-2015-qualcomm-demonstrates-lte-u-tag20.

[30] David Watkins, *US Wi-Fi Households to Own Average of 11 Wi-Fi Devices in 2017 says Strategy Analytics*, STRATEGY ANALYTICS (May, 19 2014), https://www.strategyanalytics.com/strategy-analytics/news/strategy-analytics-press-releases/strategy-analytics-press-release/2014/05/19/us-wi-fi-households-to-own-average-of-11-wi-fi-devices-in-2017-says-strategy-analytics#.VWn7gM9Vhsh.

Furthermore, existing LTE-U and LAA simulations and comparisons also typically rely on dated Wi-Fi technology, overlooking versions of the 802.11 protocol in use today in addition to those that will be widely available by the time LTE-U comes to market.[31] By only studying the interference impact of LTE-U and LAA on older, slower versions of Wi-Fi, these studies underestimate the performance impact of the interference that LTE-U and LAA will cause. In addition, by ignoring current versions of Wi-Fi, these simulations reach inaccurate and misleading conclusions about Wi-Fi's own politeness to other Wi-Fi networks, and the relative advantages of LTE-U and LAA.

Finally, LTE-U proponents' simulations only attempted to evaluate the effect of LTE-U on Wi-Fi throughput. The LTE-U Forum has ignored other crucial performance metrics, such as latency. Even if LTE-U and LAA would not severely reduce Wi-Fi throughput (which they will), a significant increase in latency alone will make Wi-Fi less usable for applications like voice calling, real-time video, and gaming. By willfully ignoring these metrics, LTE-U and LAA proponents paint a rosy coexistence picture without considering some of the most important risks.

More thorough studies that take each of these factors into account reveal that LTE-U and LAA, as currently proposed, will severely degrade consumers' Wi-Fi experience, rendering unusable many services that are widespread today, to say nothing of the innovative new uses currently on the horizon. In fact, the LTE industry has long understood that LTE is unlikely to share spectrum fairly with Wi-Fi. In the words of a 2013 study by Nokia, "Wi-Fi is significantly

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[31] *See, e.g.*, HUAWEI, *U-LTE: Unlicensed Spectrum Utilization of LTE*, at 3, www.huawei.com/ilink/en/download/HW_327803 ("Huawei U-LTE: Unlicensed Spectrum Utilization of LTE").

impacted by LTE transmissions . . . [in the presence of LTE] Wi-Fi user throughput decreases from 50% to ~100% depending on the scenario."[32]

2. LTE-U and LAA Lack Industry-Standard Sharing Mechanisms

The difference between the ineffective LTE-U/LAA sharing approach and the effective Wi-Fi approach arises from a basic difference in the sharing philosophies of the two protocols. Simply put, Wi-Fi and other unlicensed protocols are designed to cope with the fact that, due to the large number of potentially interfering signals in the unlicensed bands, and the lack of central coordination, any packet of data can be lost to interference. LTE, on the other hand, was not designed to address either of these concerns because it operates in licensed spectrum that is totally controlled by a single operator and guaranteed to be interference free. Consequently, because LTE-U and LAA do not need to share in order to avoid self-interference, these technologies have not instituted effective sharing and—unlike every other user of unlicensed spectrum—have no incentive to do so.

a. Wi-Fi Includes Listen Before Talk and Exponential Back Off

Wi-Fi addresses the unique interference challenges of the unlicensed band using two important techniques: (1) listen before talk, and (2) exponential back off. These two simple techniques combine to provide a highly robust interference avoidance technology, allowing Wi-Fi devices to both avoid interference to their own signals and minimize interference to others.

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[32] Andre Cavalcante et al., *Performance Evaluation of LTE and Wi-Fi Coexistence in Unlicensed Bands*, IEEE Vehicular Technology (Spring 2013) (abstract available at http://research.nokia.com/publication/12644).

First, and most basically, Wi-Fi devices do not transmit data while there is another detectable signal of any sort active in the band. This behavior is intuitively referred to as "listen before talk."[33] However, even with listen before talk, there is always a chance that two devices will start transmitting at the same time, causing both devices to suffer harmful interference. This is called a "collision."

Wi-Fi's second important sharing mechanism, exponential back off, is designed to minimize these collisions. Wi-Fi devices carefully monitor for collisions and, when they occur, each Wi-Fi device will wait for a random amount of time within a contention window before transmitting again. If, after this wait, there is another collision, a Wi-Fi device will double the contention window and wait another random period of time within that interval. This process repeats with an exponentially growing contention window until the transmission succeeds.[34]

Exponential back off is not simply a clever feature—it is a necessary means of coping with interference in a band without centralized control. Every additional user in the band increases the odds that more than one of these users will transmit data at a given time, and, because there is no central coordination in unlicensed bands, the behavior of other users is unpredictable from the perspective of a device seeking to transmit a packet of data. Under these challenging circumstances, exponential back off is an important, decentralized mechanism for each Wi-Fi device to estimate for itself the amount of other, potentially interfering traffic in the band, and to behave accordingly. And if all, or a significant number, of those other users also

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[33] IEEE, *Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications*, IEEE 802.11 § 9.19.2.3 (2012), *available at* http://eclass.uoa.gr/modules/document/file.php/D428/%CE%91%CF%81%CE%B8%CF%81%CE%B1/WiFi/Standard_802.11-2012.pdf ("IEEE Specifications").

[34] *Id.* § 9.19.2.5.

observe the same exponential back-off protocol, they can jointly schedule their transmissions in a way that minimizes the risk of mutual interference. This ensures that the probability that any given transmission will be lost to interference remains limited, even as congestion in the band increases. Because the loss of any packet of data, and control data in particular, has a significant effect on performance, delaying transmissions in this way maximizes the aggregate utility of the band.

b. Without Listen Before Talk and Exponential Back Off LTE-U and LAA Will Undermine Consumer Use of Wi-Fi Devices

An LTE-U or LAA coexistence protocol that incorporates only duty cycling, or only listen before talk, will cause significant degradation in the performance of Wi-Fi and other unlicensed technologies. If LAA is deployed with listen before talk but a fixed contention window that does not grow exponentially with the amount of traffic in the band, the risk that any given packet of data will be lost to interference grows rapidly as additional users enter the band. This interference will disproportionately affect Wi-Fi and other unlicensed-only technologies for three reasons. First, LTE-U operators can coordinate amongst themselves to prevent interference between one another.[35] Second, Wi-Fi is at disproportionate risk of harmful interference from LTE-U because of the 802.11 listen-before-talk approach to coexistence, which makes it inherently deferential to other signals in the band. And third, primary LTE-U control and data signals will remain sheltered in a licensed band; unlicensed transmissions are secondary in LTE-U and LAA, but represent the only means of communication for Wi-Fi.

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[35] *See, e.g.*, Huawei U-LTE: Unlicensed Spectrum Utilization of LTE at 14-15.

An LTE-U deployment using only a duty cycling approach to interference, as described above,[36] would have a similarly dramatic effect on Wi-Fi performance, though for different reasons. LTE-U's duty cycling approach would, in effect, turn Wi-Fi's own politeness against it, causing Wi-Fi devices to conclude that there is significantly more traffic in the band than there truly is. If an LTE-U cell is configured to transmit for 250 out of every 500 milliseconds, for example, then the consumer Wi-Fi devices in the band will repeatedly attempt to transmit, sense the interference in the band, and back off during the 250 milliseconds while the LTE-U device is transmitting. And because that back-off period doubles every time a consumer's Wi-Fi device senses interference, it is possible, or even likely, that most Wi-Fi devices will have an increased back-off period to cover more than the entire period during which the LTE-U device is silent.

In fact, research shows that these dynamics cause LAA and LTE-U to degrade consumer Wi-Fi just as the theoretical analysis above predicts. In the case of LAA with listen before talk and a fixed contention window (even a very long contention window of 640 milliseconds), analysis shows that Wi-Fi transmission success rate will decrease by 77 percent with fifteen nearby consumer Wi-Fi devices, and by 88 percent with twenty nearby consumer devices.[37]

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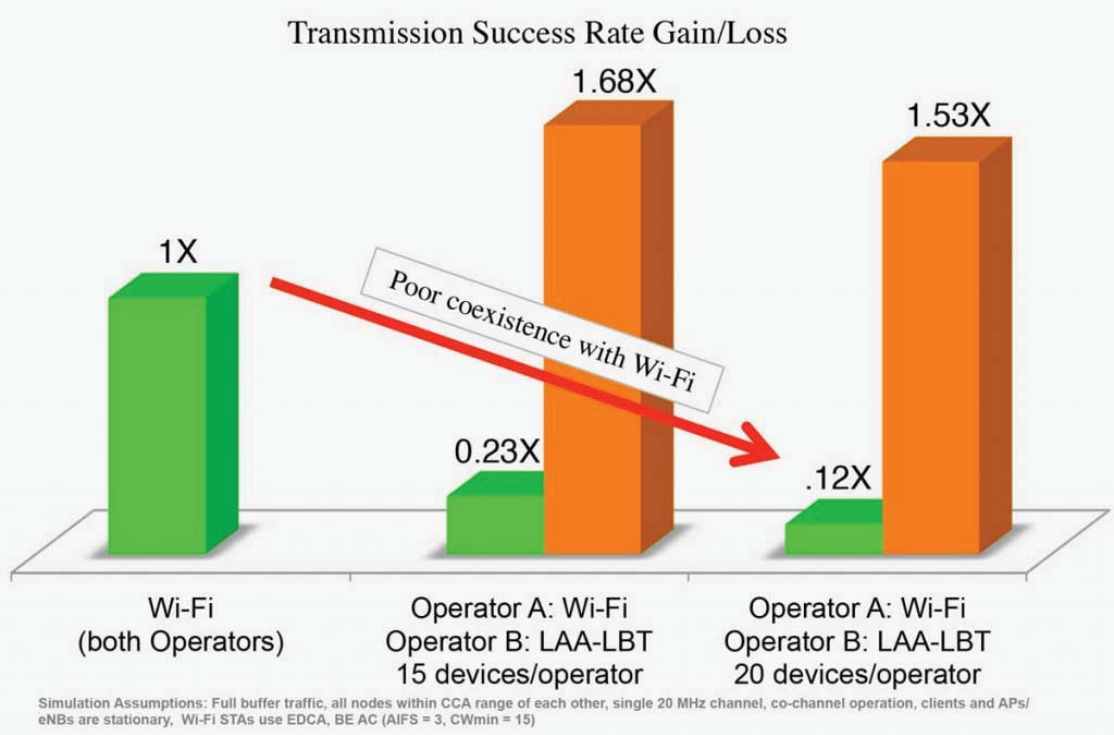
[36] *See supra* at 8.

[37] Joey Padden, *Wi-Fi vs EU LBT: Houston, We have a Problem*, CABLELABS, http://www.cablelabs.com/wi-fi-vs-eu-lbt-houston-we-have-a-problem/.



Results are similarly alarming in the case of LTE-U with duty cycling. In the example above, where LTE-U uses the band for 50 percent of every 500-millisecond cycle (*i.e.*, 250 milliseconds on, and 250 milliseconds off), analysis shows that Wi-Fi throughput is reduced by more than 50 percent.[38] Other scenarios are even worse, with Wi-Fi throughput decreased by almost 100 percent if LTE-U claims 50 percent of each 10-millisecond period.[39]

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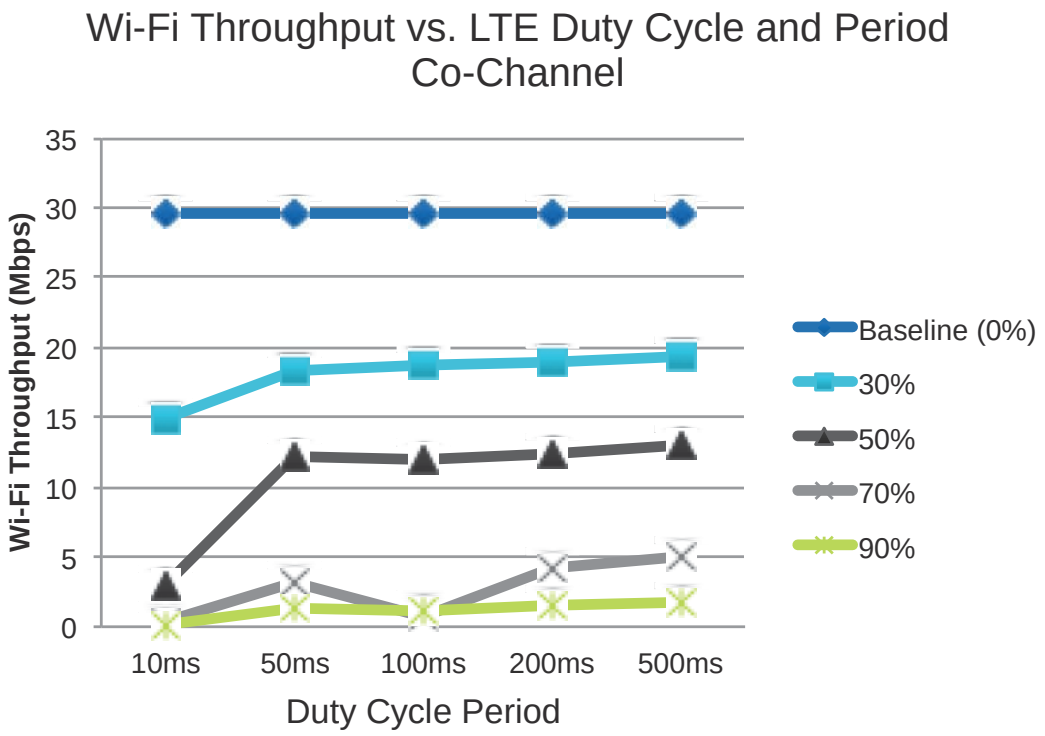
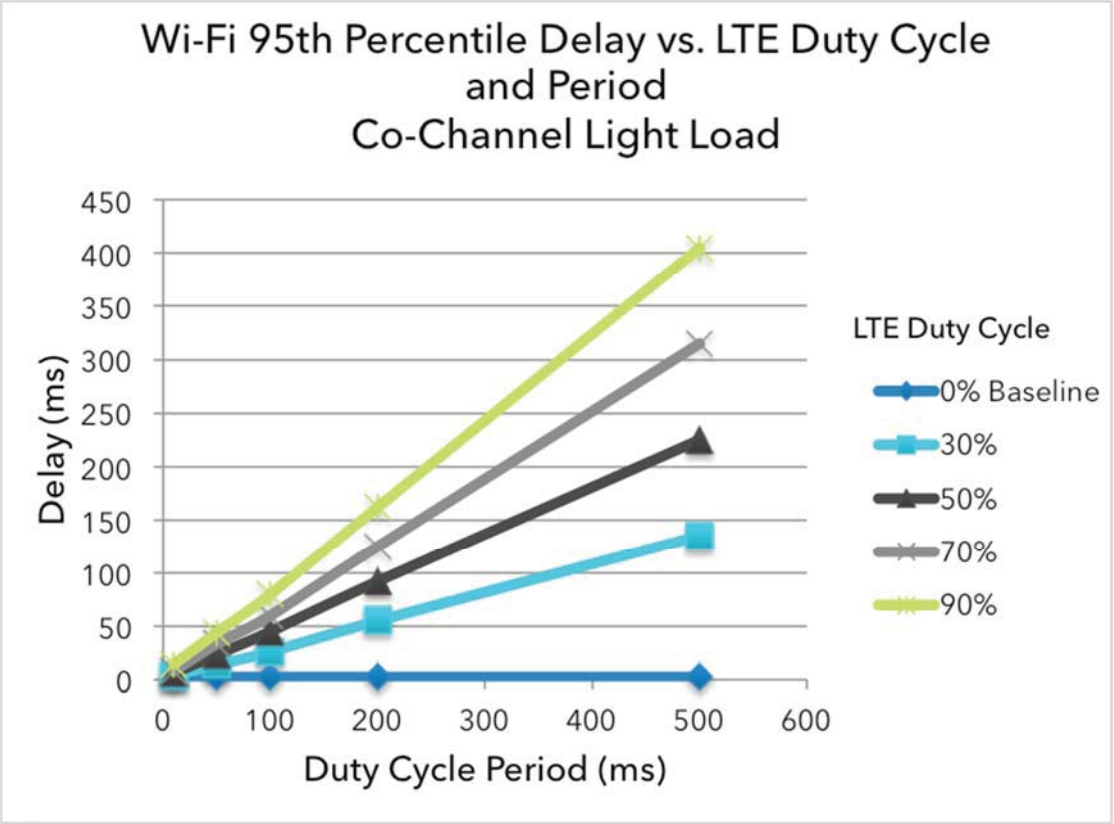
[38] IEEE, *Impact of LTE in Unlicensed Spectrum on Wi-Fi*, at 9, https://mentor.ieee.org/802.19/dc20n/14/19-14-0037-02-0CUB-impact-of-lte-in-unlicensed-spectrum-on-wi-fi.pptx.

[39] *Id.*



The effect on Wi-Fi latency would be similarly dramatic. If, for example, an LTE-U cell allocates to itself 50 percent of every 500-millisecond period, Wi-Fi latency will skyrocket to more than 200 milliseconds. Real-time applications such as voice calling, which can tolerate latency of up to approximately 50 milliseconds, would become essentially unusable.



In addition to the parameters described above, LAA and LTE-U proponents have also provided no details on other important sharing details. For systems that use listen before talk, for instance, it is crucial to know how faint a signal the LTE-U or LAA device is capable of detecting in determining whether that implementation of listen before talk will be effective in sharing spectrum with other unlicensed services. LTE-U and LAA functionality will also exist alongside Wi-Fi within the same device, in the same way that today's smartphone supports both LTE and Wi-Fi simultaneously. Such close proximity requires special coexistence considerations. But LTE-U proponents have provided no information about whether these protocols will coexist with Wi-Fi, Bluetooth, and other unlicensed technologies within the same device.

c. Purported LTE-U and LAA Sharing Mechanisms Are All Optional and Carriers Have Little Incentive to Employ Them in an Effective Manner

LTE-U and LAA proponents have not committed to mandating the use of *any* sharing technologies described above, or to requiring the use of specific technical parameters for these general approaches that will support fair sharing. In fact, the only available evidence suggests that each of these parameters will be fully configurable by operators, permitting them to undo any coexistence protections that the LTE-U Forum claims will protect Wi-Fi consumers.[40] For example, the LTE-U Forum has provided no assurances that any standard will prevent carriers from simply turning off the duty cycling feature of their LTE-U equipment in the field if they wish to operate in a congested environment.

Importantly, carriers will have little incentive to use settings that minimize interference, or to configure them in an effective way even if they do use them, for the same reason that supporters of LTE-U and LAA have little reason to design a protocol that shares effectively in the first place.

Because the Wi-Fi 802.11 protocol is inherently polite, it will automatically back off and refrain from sending traffic when LTE-U or LAA is occupying the same channel. This makes Wi-Fi much more vulnerable to LTE-U and LAA interference in the band than LTE-U and LAA are to Wi-Fi. And since mobile operators can coordinate to avoid interference with one another, and fall back to licensed networks if needed, LTE-U and LAA are naturally much less vulnerable to interference in the unlicensed bands than other technologies that operate in unlicensed

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[40] LTE-U 2015 Technical Report at 9.

frequencies. Consequently, ineffective sharing injures Wi-Fi consumers far more than LTE-U/LAA carriers.

Of particular note, under the 802.11 protocol, loss of control information augments the impact of interference on Wi-Fi. When a sender sends a packet of data to a recipient, the recipient of data replies with a short confirmation message to verify that it has received all of the data it is supposed to have received. If the sender does not receive an expected confirmation, it can infer that there was a transmission error and re-send. Wi-Fi typically requires that the previous message, or group of messages, be affirmatively acknowledged by the recipient before the sender transmits more data.[41] A transmitting device will wait a specified period to ensure that the acknowledgement has adequate time to arrive, and then, if none is received, it will use the back-off procedure described above and re-transmit the unacknowledged data after the appropriate delay. Only when this process is complete, and when the device has confirmed that the data was sent successfully, will it attempt to transmit the next batch of data. Thus, the loss of one of these acknowledgement messages would therefore have a particularly serious impact on performance. Loss of an acknowledgement message will cause a Wi-Fi device to both erroneously trigger its back-off procedure, and needlessly re-transmit data that has already been successfully received.

Many Wi-Fi networks also use what is known as a "request-to-send/clear-to-send" ("RTS/CTS") system to minimize interference between so-called hidden nodes—Wi-Fi devices that are out of range of one another but are both in range of the same access point, and, therefore, may cause interference that cannot be avoided through the ordinary listen-before-talk

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[41] IEEE Specifications 802.11 § 9.3.2.8.

mechanism. Under this system, a device seeking to transmit requests explicit permission from the access point before sending, and the access point then confirms that it is clear to send, while simultaneously instructing other devices on the network not to send.[42] Loss of either of these messages would also cause serious performance degradation. If interference prevents an access point from receiving a request-to-send message sent by a client device, or if the client device does not receive the clear-to-send reply, then the client device will be left to wait a potentially significant period of time for successful transmission. Or, if interference prevents other devices from receiving the wait signal, they will not know to wait until the hidden node is finished transmitting, increasing the risk of still more interference. And this is to say nothing of the impact of losing more basic control messages to interference, such as those used to associate a device with an access point or those used to control authentication. The loss of these types of messages would also clearly cause significant harm.

Wi-Fi and other unlicensed technologies have solved these problems by adopting robust politeness features that minimize the risk of interference and maximize overall utility because they all must share the same resource. The standards process at the IEEE has served a crucial role in this process by providing a neutral forum in which engineers from various industry sectors, and with interests in different wireless protocols, can come together to tackle the coexistence challenge collaboratively. However, because LTE-U and LAA insulate critical control traffic in a licensed band, and retain the licensed network as primary, their mobile carrier proponents have far less reason to cooperate in this way with other interested parties. And, in fact, LTE-U and LAA take advantage of the politeness features of other unlicensed protocols like

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[42] *Id.* § 9.3.2.5.

Wi-Fi to suppress those signals in the band, thus minimizing their own exposure to interference. In this way, through the use of a licensed control channel, LTE-U and LAA proponents have transformed the cooperation-promoting symmetrical interference risk in the unlicensed bands into an asymmetric risk where LTE-U and LAA operators benefit while imposing additional interference burdens on others. To put it another way, LTE-U/LAA carriers will have no incentive to engage in the score of efficiency-maximizing sharing behavior that Wi-Fi users have employed because, unlike Wi-Fi users, they can escape the problems they create by relying on their licensed spectrum.

d. The Damage LTE-U and LAA Could Cause to the 5 GHz Band May Only Be the Beginning of These Technologies' Negative Impact on Consumers and Competition

LTE-U and LAA proponents have currently disclosed plans to deploy in the 5 GHz unlicensed band. LTE-U and LAA in that band, without adequate sharing mechanisms, threaten to dramatically increase interference, undermining the Commission's efforts to relieve congestion in the unlicensed bands, including the 2.4 GHz band. But LTE-U and LAA could also expand from there. LTE-U and LAA could easily come to the 3.5 GHz band (where CTIA has already intimated that carriers will use LTE-U) and even the core 2.4 GHz band in the near future. Due to LTE-U and LAA's extremely poor coexistence with other unlicensed technologies, LAA and LTE-U would harm consumers operating in each of these bands as well. Most directly, consumers', businesses', and schools' investment in Wi-Fi would be further stranded as speeds plummet in multiple bands. Home Wi-Fi networks in proximity to LTE-U and LAA deployments—potentially including in-home pico cells or outdoor cells near the home—would likely become unable to support real-time applications such as gaming or real-time voice calling. Other in-home wireless technologies could also be adversely affected such as

wireless peripherals such as mice and gaming controllers, which can be especially latency-sensitive.

Public Wi-Fi hotspots, including carrier-grade Wi-Fi networks, would see severe performance degradation, as well as increased latency, potentially rendering them barely usable even for basic web browsing. And schools would be unable to rely on Wi-Fi for bandwidth-intensive rich educational experiences or latency-sensitive, remote-learning applications. Reduced speed and increased latency would also diminish consumers' ability to offload data traffic from their licensed carrier and onto Wi-Fi. As interference increases in the unlicensed bands, consumers' data traffic will be increasingly squeezed back onto paid data plans (which would now presumably include LTE-U/LAA), making it more costly and complex for Americans to connect.

Finally, decreased utility of the unlicensed bands due to widespread LAA and LTE-U deployments will raise new barriers to entry to innovators seeking to develop new wireless technologies. The unlicensed bands continue to offer innovators virtually unfettered access to wireless spectrum; to bring a new wireless product or service to market, a start-up need only purchase an inexpensive, off-the-shelf wireless module that is preconfigured to operate in the unlicensed bands and pre-certified to comply with the Commission's technical rules.[43] Thus, instead of the millions of dollars that a start-up would need to acquire usable spectrum, a start-up would only need a budget of a few dollars for a Wi-Fi module.[44] Increased interference from

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[43] 47 C.F.R. Part 15.

[44] *See, e.g.*, DIGIKEY, Manufacturer Part "Econais EC19W01-RL", http://www.digikey.com/product-detail/en/EC19W01-RL/1483-1020-2-ND/5001151 (offering for sale a pre-certified Wi-Fi module, FCC ID S67-EC19W01, for a unit price of $10.47).

LTE-U and LAA deployments, however, will reverse this trend, dramatically increasing barriers to entry by forcing high-bandwidth and latency-sensitive applications either out of the unlicensed band, or onto carrier-controlled LTE-U and LAA networks. In either case, LAA and LTE-U will take spectrum away from innovators, and instead place this crucial input for technological innovation firmly in the hands of licensed carriers.

Each of these effects will be especially pronounced in urban areas where licensed carriers can be expected to deploy LTE-U and LAA at the greatest density resulting in harm to a disproportionately large number of consumers by adding interference where it will cause the most damage.

IV. LTE-U/LAA PROPONENTS HAVE SHORT-CIRCUITED THE STANDARDS PROCESS

As explained above, the IEEE is the traditional forum for the development of new unlicensed wireless standards, as well as standards for many other types of service. It is the IEEE that developed and currently maintains the technical standards for Wi-Fi (IEEE working group 802.11), Bluetooth (802.15.1), ZigBee (802.15.4), WirelessHART (802.15.4), wireless body area networks (802.15.6), and WiMAX (802.16), as well as foundational wired technologies such as Ethernet (802.3). The IEEE also includes a standing technical advisory group on coexistence (802.19) which is specifically responsible for ensuring that wireless standards are designed to coexist with one another in unlicensed bands.[45]

Standards setting through the IEEE has, up to this point, been a great success. Because IEEE includes a diverse group of industry representatives with a common goal of minimizing

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[45] *See* IEEE, *IEEE 802.19 Wireless Coexistence Working Group*, http://www.ieee802.org/19/.

mutual interference, IEEE has been a successful steward of the unlicensed commons. However, as LTE-U and LAA have demonstrated, the IEEE standards model depends on this shared, symmetrical risk of mutual interference. When a technology does not suffer interference from other unlicensed technologies in proportion to the interference risk that it creates, its proponents have correspondingly weaker incentives to participate constructively in a body like IEEE. Instead, other factors may become dispositive, possibly leading entities to seek a standards-setting forum that caters more directly to a particular industry group.

In the absence of a symmetric interference risk, LTE-U and LAA proponents—and equipment manufacturers in particular—may also have been motivated to eschew the IEEE process due to IEEE's relatively strict policy regarding standard-essential patents. IEEE draft standards can only be submitted if the holders of any patents essential to the standard agree either to not enforce the patent against, or to license the patent at no cost to any entity "that practices the Essential Patent Claims for use in conforming with the IEEE Standard."[46] 3GPP, by contrast, requires only that a patent holder agree to license standard-essential patents "under reasonable terms and conditions that are demonstrably free of any unfair discrimination."[47]

Thus, although LTE-U and LAA would have been a natural fit for the IEEE standards process in, *e.g.*, working group 802.16—which focuses on large-scale metropolitan-area networks—proponents of these technologies chose instead to short-circuit the usual standards process, and instead proceed through 3GPP. With 3GPP's comparatively lax standard-essential

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[46] IEEE, *Standards Ass'n., Standards Board Bylaws*, Policies and Procedures § 6.2, http://standards.ieee.org/develop/policies/bylaws/sect6-7.html (last visited June 4, 2015).

[47] ATIS, *Operating Procedures for ATIS Forums and Committees*, § 10.4.2 (May 1, 2014), http://www.atis.org/legal/Docs/OP/atisop.pdf (establishing the patent policy of ATIS, the United States 3GPP Standards Development Organization).

patent policy, and total domination by licensed carriers and their suppliers, 3GPP likely presented an attractive forum for both LTE-U and LAA equipment vendors and carriers. There, licensed carriers could ensure that the final LAA standard would meet their particular needs, without the need to address objections from other industry groups who would be harmed by LAA's poor sharing characteristics, and in a manner that allowed interested parties to use the less restrictive patent policy to lock down the technology from widespread availability (or to drive up the cost on entry). In fact, some LTE-U backers have decided to proceed outside of even the 3GPP process, instead forming the ad hoc LTE-U Forum, further abandoning the formal standards process that has traditionally protected the unlicensed commons.

Although IEEE has no control over the standards-setting processes within 3GPP and the LTE-U Forum, it has made its concerns known through a series of liaison statements issued by the IEEE 802.19 coexistence advisory group, in which it explained that "IEEE 802 is still concerned about many aspects of LAA."[48] Due to the serious risk of interference, IEEE has asked 3GPP to confirm that Category 1 sharing, for instance, is only designed for evaluation purposes, and will not be deployed.[49] It also asked 3GPP to confirm that it intends to require operators to incorporate listen-before-talk functionality.[50]

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[48] E-mail to Dino Flore, 3GPP TSG RAN Chair, Qualcomm, et al. from Paul Nikolich Chairman, IEEE 802 LMSC (Mar. 13, 2015) https://mentor.ieee.org/802-ec/dcn/15/ec-15-0025-00-00EC-3gpp-march-2015-liaison-1-final.pdf (discussing the liaison statement regarding clarification of LBT categories).

[49] *Id.*

[50] *Id.*

In addition, IEEE highlighted numerous flaws in 3GPP's method for simulating interference between LAA and Wi-Fi, including those discussed above. For example, IEEE pointed out that 3GPP:

- did not consider an adequate range of network load and device densities on Wi-Fi networks,
- did not consider the effect of LAA on total aggregate Wi-Fi performance across access points,
- did not consider the effect of LAA on the airtime efficiency of Wi-Fi (the ratio of amount of time on the air to total throughput over that period), and
- considered only an outdated version of Wi-Fi, ignoring the effects of numerous advanced Wi-Fi features found in modern networks. [51]

IEEE also criticized LAA for taking unilateral control over the unlicensed band, inviting licensed carriers to prioritize their own traffic over others' traffic, "which is clearly unacceptable for a community resource (unlicensed spectrum) that is supposed to be shared without preference."[52] IEEE emphasized the need to reform current LAA proposals in order to ensure that LAA is "designed to dynamically respond to the changing needs of all users,"[53] that important sharing characteristics of LAA are made open and non-proprietary, and that "the views

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[51] *Id.*

[52] E-mail to Dino Flore, 3GPP TSG RAN Chair, Qualcomm, et al. from Paul Nikolich, Chairman, IEEE 802 LMSC (Mar. 13, 2015) https://mentor.ieee.org/802-ec/dcn/15/ec-15-0025-00-00EC-3gpp-march-2015-liaison-1-final.pdf.

[53] *Id.*

of important stakeholders, such as IEEE 802 participants, [are] fully considered."[54] To address these issues, IEEE invited 3GPP to engage in a "joint collaborative activity with IEEE 802 and other stakeholders."[55]

In response, 3GPP has made no additional commitments to improve transparency or sharing. It provided little additional information about the LAA protocol, and took no action on IEEE's offer to collaborate on the important coexistence issues that IEEE and others have raised.[56] On the contrary, it indicated that it does not intend to add latency-sensitive applications to its coexistence simulations and does not intend to study LAA's impact on high-density Wi-Fi deployments.[57]

This signals an unprecedented, and unfortunate, turning point in standards setting in the unlicensed bands. Where previous standards have been set in a spirit of mutual cooperation—instilled by the shared challenges of unlicensed-only technologies—LAA and LTE-U proponents have strategically rejected this process in furtherance of their own parochial business interests. If these efforts are successful, future proponents of unlicensed technologies may well look to the LAA and LTE-U model of standards setting, discarding the model that has to date proven to be an effective steward of the unlicensed commons. Furthermore, the impact of this changed direction would undermine the Commission's ability to depend on an open and fair standards-

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[54] *Id.*

[55] *Id.*

[56] 3GPP, *Response LS on LAA-802.11 Coexistence* (Apr. 20-24, 2015).

[57] 3GPP, *Response LS on LAA-802.11 Coexistence*, at 2 (May 25-29, 2015).

setting process to protect the public interest, forcing it to consider regulation where self-governance had previously provided a better answer.[58]

V. PROPONENTS OF LTE-U HAVE BLOCKED CONSIDERATION OF A STANDALONE OPTION

Finally, it is striking that even if a version of LTE-U can be developed that effectively shares the unlicensed bands and does not harm Wi-Fi consumers, its use would be restricted to the small set of companies that control licensed spectrum. What this means is that LTE-U and LAA proponents not only threaten Wi-Fi and other unlicensed consumers, but have also actively worked to prevent these consumers from using LTE in unlicensed bands if they determine that its use would be as beneficial as proponents claim that it would be. Innovators, schools, unlicensed network operators, and individuals cannot choose to use LTE-U or LAA because the licensed carriers who back these technologies have made a conscious policy decision to prevent anyone other than holders of licensed spectrum from using LTE-U or LAA.

The decision to block access to LTE-U was based not on technical considerations but, rather, was dictated by the business goals of licensed carriers. Indeed, a document submitted to a recent 3GPP meeting in Belgrade, Serbia by T-Mobile, China Mobile, Ericsson, and others

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[58] The Commission has a history of interfacing with standards organizations in pursuit of the public interest. For example the Commission has directly engaged with regard to CALEA standard setting, *see Communications Assistance for Law Enforcement Act*, Third Report and Order, FCC 99-230, 14 FCC Rcd. 16794 ¶ 55 (1999), ANSI standard setting, *see* Accredited Standards Committee C63® - EMC, C63 Participant Contact Information, at http://www.c63.org/documents/rosters_public/roster_public.htm, and 3GPP, s*ee Promoting Interoperability in the 700 MHz Commercial Spectrum*, Report and Order and Order of Proposed Modification, FCC 13-136, 28 FCC Rcd. 15122 (2013).

provides an explicit roadmap for "precluding" standalone use of LTE by unlicensed carriers[59] because "[s]tandalone deployment in unlicensed spectrum implies drastically different business models from nowadays and might impact the value chain."[60] They explained that standalone LTE in unlicensed spectrum might send the "wrong message on the primacy of Licensed spectrum" and would risk the "possible disintermediation of cellular operators."[61] In other words, the carriers were concerned that a standalone mode would allow others to use LAA and might undermine their arguments to regulators about the spectrum needs of licensed carriers.

The presentation noted that, because of these considerations, 3GPP *had decided not to even study the possibility* that the LTE control channel could be located in unlicensed spectrum.[62] And this decision was reached in spite of the express acknowledgement that "the currently designed LAA mechanism does not preclude possible use of unlicensed carriers in standalone manner."[63] The licensed carriers, however, regarded this as a problem, rather than as a feature. To solve this "problem," the carriers then proposed a variety of technical changes in

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59 3GPP WORKING GROUP 1, *WF on Precluding Standalone Access of LTE on Unlicensed Carriers*, 3GPP TSG RAN WG1 Meeting (Apr. 20-24, 2015), http://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_80b/Docs/R1-152374.zip.

60 *Id.* slide 2.

61 *Id.*

62 *Id.* (noting that, under the LAA study item, "[users' devices] are not supposed to receive the current broadcasted system information on an [unlicensed secondary cell] and this Study Item shall keep this assumption.").

63 *Id.*

order to make an unlicensed standalone mode impossible.[64] In other words, they manufactured a barrier to entry.

This represents yet another unprecedented turn in the history of unlicensed standards setting. Not only have the licensed carriers skirted the standards process to avoid constructive input from other industry groups on how best to minimize interference, the carriers have intentionally created an unlicensed protocol that excludes non-licensees.

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[64] *Id*. slide 3-4.

VI. CONCLUSION

Proponents of LAA and LTE-U have deviated dangerously from the usual, proven process for standards setting in the unlicensed bands. On their current course, LAA and LTE-U threaten both to irreversibly damage the integrity of this important process and deploy a technology that will cause untold harm to consumers and innovators. NCTA therefore urges the Commission to ensure that development of LAA and LTE-U returns to a safer, more responsible course. To advance toward this goal, we recommend that the Commission: (1) convene a meeting of the Chief of the Office of Engineering and Technology and a representative group of licensed carriers and the unlicensed community to initiate a process to establish effective sharing mechanisms; (2) establish a working group composed of Commission staff and engineers from interested parties to carry forth this work after this initial meeting in weekly meetings; (3) seek monthly status reports from IEEE and 3GPP on the progress of coordination between these bodies on establishing effective sharing; and (4) ensure that licensees do not launch non-standard versions of LTE-U until these processes have been completed to the Commission's satisfaction.

Respectfully submitted,

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