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Federal Communications Commission  
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Washington, D.C. 20554

Reference: Comments to ET Docket 15-105, "LTE-U and LAA Technologies"

Aruba Networks, an HP company, is a leading provider of 802.11 standards based Wi-Fi equipment. We have monitored the development of LTE-U (LTE operation in unlicensed bands) and LAA (License Assisted Access) and we understand that these technologies, and other emerging technologies, have the potential to provide some spectral efficiency improvements in the unlicensed bands over time. In our view, any technology that has the potential to provide greater spectral efficiency is worth serious consideration by both industry and the Commission. However, we are concerned that LTE-U, as presently defined in the proprietary standards being developed by the LTE-U Forum, along with other similar new technologies in the unlicensed bands, have the potential to introduce co-existence challenges to existing and pervasive technologies that utilize proven spectrum sharing and listen-before-talk (LBT) techniques, such as Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA) used by IEEE 802.11 standards based Wi-Fi networks.

Spectral efficiency improvements have been a key part of the historical success of unlicensed band technologies, and in particular Wi-Fi. The desire for faster speeds has been realized through 3 major revisions of the IEEE 802.11 Wi-Fi standard (802.11a/b/g, 802.11n, 802.11ac). These revisions introduced new modulations and MIMO techniques, while maintaining backward compatibility to the very first generation devices. Throughout these revisions spectral efficiency has increased dramatically from 2.7 bits/s/Hz (using 802.11a, 64-QAM in a 20 MHz channel in 1999) to over 40 bits/s/Hz in the current generation 802.11ac standard. This increase was primarily achieved by higher modulation rates (256 QAM) and the introduction of MIMO, which supports multiple spatial streams (up to eight) in the same spectral bandwidth in the current revision of 802.11. Meanwhile, increases in speed and efficiency for Wi-Fi have all been maintained without sacrificing the underlying LBT spectrum sharing mechanism of CSMA/CA.

Based on this experience, we believe that "fair" use of the unlicensed spectrum has been proven to be a compatible goal with improved user experience and increased spectral efficiency. We welcome any new technology that has the potential to improve spectral efficiency, but we do

not want this to be at the expense of fairness. In our view, LTE-U or similar technologies could eventually be just another implementation, or next generation, of IEEE 802.11 based Wi-Fi, and the advantages provided by proprietary LTE-U Forum standards could be realized in a future IEEE 802.11 open standard implementation. However, due to differences in the understanding of “fairness” or “fair use”, we believe there are significant risks in the near term for the co-existence of LTE-U as defined by the proprietary LTE-U Forum standards. We believe co-existence may eventually be possible for LTE-U, but there is no framework or agreed upon minimum definition of co-existence in place at the present time between those developing the proprietary LTE-U standard and those incumbent in the space that have historically demonstrated effective mechanisms for co-existence. More directly, there are no standard tests or evaluations for co-existence that have been agreed upon outside of the proprietary LTE-U forum, and no assurances in the present FCC requirements or device approval procedures that any individual LTE-U device implementation or LTE-U operator will utilize the spectrum in a way that would be considered fair by other users of the unlicensed bands.

We believe LTE-U, as a technology, has the potential to co-exist in the unlicensed bands. We have seen demonstrations of individual LTE-U implementations that exhibit compatible behavior with Wi-Fi. However, these demonstrations are based on somewhat friendly implementations of LTE-U and test conditions, and there are inadequate controls in the proposed LTE-U Forum standards to preclude individual device and operator implementations from differing significantly from the implementations used in various LTE-U to Wi-Fi co-existence demonstrations. As an example, an LTE-U device can be implemented with varying LTE duty cycle algorithms controlling the ratio of transmit on times vs. off times. Without specific duty cycle definitions and requirements in place for LTE-U co-existence, the duty cycle algorithms chosen for any individual LTE-U device or operational implementation may vary significantly, including implementations that would fully exclude other technologies from sharing the same unlicensed spectrum for extended periods of time. Under the present FCC Part 15 rules, a single device in the unlicensed band can actually occupy 100% of the available airtime, to the practical exclusion of all other devices within radio range. This is not how Wi-Fi CSMA/CA or other “Listen Before Talk” compliant technologies typically work, but there is nothing in the present regulatory framework or device approval process to prevent LTE-U devices, and therefore LTE-U network operators, from supporting duty cycles that will effectively exclude all other users in the band.

Our research into LTE-U emerging technologies suggests that individual device and operator implementations of LTE-U can and will vary dramatically with respect to duty cycle and other

key characteristics that have the potential to negatively affect co-existence with other technologies. There are no requirements, definitions, framework, tests, or standards in place to prevent unfriendly implementations of LTE-U from coming to market. And, there is performance to be gained by individual LTE-U device and operator implementations being less friendly to other users of the unlicensed bands. The lack of a framework or minimum standard for co-existence creates an environment where any individual LTE-U device or network operator has a performance incentive to exploit, and potentially even abuse, the historically successful co-existence technologies such as CSMA/CA, by taking an unfair time based share for exclusive use of the spectrum by this new technology.

As a result of the conflict between potential benefits and risks, we believe that it is time for the technical requirements for co-existence to be defined and incorporated into the 47 CFR FCC Parts 2 and 15 device approval procedures. Since there are multiple interests and parties involved, notably the LTE-U Forum, 3GPP, and IEEE 802.11 participants, we would prefer that the task of defining the technical requirements and co-existence qualification tests for LTE-U and LAA be prepared through a recognized standards body that is neutral to all technologies, and provides an opportunity for all parties to contribute in an open and non-proprietary manner. We note that ANSI accredited standards committee C63 already has initiated some similar work on this subject (ANSI C63.27-draft "American National Standard for Evaluation of Wireless Coexistence" ), and that the FCC laboratory has relied in the past on C63 to help establish fair and uniform technical requirements, including in some cases co-existence requirements. For example, qualification requirements for unlicensed PCS band devices subject to 47 CFR FCC Part 15, Subpart D must follow the procedures described in ANSI C63.17. We believe standard tests or requirements for device approvals, developed by C63, or a similar accredited consensus process, are appropriate to establish some minimum standards for coexistence and fairness in other bands.

Until such time that specific co-existence criteria can be published by a neutral standards body such as C63 and adopted by the FCC as a uniform minimum standard for co-existence, we would recommend against new device approvals in the unlicensed bands for technologies that can not demonstrate compliance to an already accepted co-existence methodology. To facilitate approvals while the difficult task of developing new minimum technical requirements is taking place, we suggest that the FCC publish a list of technologies it already considers conforming to a reasonable minimum standard for co-existence that the FCC envisions for the unlicensed bands. This may include CSMA/CA and other technologies that exhibit LBT, and/or other low

duty cycle, limited power, or limited bandwidth technologies that pose an especially low risk for co-existence problems.

With respect to LTE-U, we believe this poses a special concern. LTE-U has the potential for widespread and rapid adoption without any agreed upon or enforced co-existence evaluation taking place during the device approvals process. If adopted by even a single U.S. carrier, new endpoint devices (smartphones) with this technology could number in the tens of millions within the first year, followed by tens of millions more in each subsequent year as more carriers may adopt the technology. Meanwhile the expected number of Wi-Fi enabled devices will continue to grow at a similar pace in terms of station counts. Both LTE-U and Wi-Fi are high bandwidth, high duty cycle technologies, and typically are capable of utilizing the highest power levels approvable in the unlicensed bands. As a result, without any standard definitions, tests, or qualifications required to demonstrate a minimum level of co-existence, each vendor of an LTE-U device and network operator can implement their understanding of co-existence with Wi-Fi differently. We believe the FCC should adopt a basic minimum requirement for demonstrating co-existence during the device approval process for unlicensed band devices (47 CFR Parts 2 and 15 procedures). We further recommend that the detailed requirements, including test standards and procedures, be developed by a neutral third party standard committee, such as ANSI accredited standards committee C63, which has successfully assisted the FCC laboratory in the past with difficult technical challenges, and utilizes an ANSI accredited open and consensus based process in which all interested parties can participate.

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