

carrier networks. The Public Notice also repeats the FCC's principled goal of ensuring that its rules are technology neutral, while at the same time noting that various parties have raised concerns about the possible impact of LTE-U/LAA operations on other technologies that are utilizing unlicensed bands today.

Cisco's goal is for both Wi-Fi and LTE-U/LAA to utilize the band without significant negative consequences to users of either technology. We believe in technology neutral rules, and allowing new technologies to utilize unlicensed bands. In fact, Cisco plans on building unlicensed technology targeted for service providers because such technology will be important to helping wireless broadband access providers meet the difficult demand challenges that lie ahead. Our "build it all" perspective means that we want technologies to access spectrum fairly so that the unlicensed bands can continue to be a place where innovative technologies can operate. In our comments below, Cisco highlights our understanding of the status of LTE-U and LTE-LAA, and focuses the Commission on a very brief list of questions that it might consider exploring with parties under the umbrella of this docket. However, Cisco does not recommend new etiquette regulations for unlicensed bands. It is our hope that the record here will enable private industry to discuss and resolve reasonable coexistence mechanisms.

II. Importance of industry-led solutions and technology neutral rules

As an initial matter, Cisco supports technology neutral rules for unlicensed bands. This view springs from the company's deeply held view that vendor adherence to a particular technology can be foolhardy. Technologies evolve and new ones are

introduced. Manufacturers cannot sit still or “will” the market to stop changing. And just as manufacturers cannot remain aligned to particular technologies, regulations should not operate to limit change, either. Regulations, while not etched in stone, are difficult to change. As a result, we support the Commission’s view that limiting regulatory constraints on wireless technology to key radio emissions parameters, and stopping short of calling out a technology, is the best policy for innovation.

At the same time, it is important to understand how a new technology might impact an existing one, particularly when the two will share spectrum, as is the case here. While there are several unlicensed technologies in the 5 GHz band, the predominant one is Wi-Fi. Our data tells us that Wi-Fi is the workhorse of the Internet – 50% of all Internet traffic begins or ends on Wi-Fi.² As an Internet access platform, Wi-Fi is important – carrying more traffic than wired access platforms and a significantly larger share of traffic than mobile LTE.³ This indicates a widespread investment in Wi-Fi throughout the service provider community and their customers, the business community, and a large extended base of “internet of things” connections that is arguably the fastest-growing category of Wi-Fi today. Indeed, the very importance of Wi-Fi to the Internet means that regulators also have a stake in the successful outcome

² Mobile VNI 2015 <http://www.cisco.com/c/en/us/solutions/service-provider/visual-networking-index-vni/index.html#~vniforecast>

³ Mobile VNI 2015. In the US, Fixed/Wi-Fi was 54.7% of total Internet traffic in 2014, and will be 65.5% of total Internet traffic in 2019. http://www.cisco.com/web/solutions/sp/vni/vni_forecast_highlights/index.html
A total of 66% of the United States's mobile data traffic will be offloaded by 2019. http://www.cisco.com/c/dam/assets/sol/sp/vni/forecast_highlights_mobile/index.html#~Country

of the sharing debates, and need to inform themselves of the issues, as the Commission is doing here. The runaway success of Wi-Fi must be considered by all parties to the debate. Because Wi-Fi is such a critical ingredient in broadband delivery in so many diverse ways, it is important to carefully think through how a new unlicensed small cell technology might impact the success of a nearby Wi-Fi transmission.

Although we are strong proponents of Wi-Fi, we welcome new uses of unlicensed spectrum. In fact, Cisco plans on building unlicensed technology targeted for service providers because such technology will be important to helping wireless broadband access providers meet the difficult demand challenges that lie ahead. Our “build it all” perspective means that we want technologies to access spectrum fairly – and then let the market reveal the technology that best addresses the market’s needs.

III. Status of Standards Development

Cisco has been actively participating in many of the standards organizations that are, to various degrees, engaged on LTE-U/LAA issues - 3GPP, IEEE 802 and the European Telecommunications Standards Institute (ETSI) BRAN (Broadband Radio Access Network committee). In our view, industry standards conversations have the promise of enabling band sharing between unlicensed technologies. If these discussions among interested parties can deliver on the promise, and if all views are heard and incorporated into a consensus outcome, then in our experience the resulting technology will be the better for it.⁴ Moreover, if changes need to be made going forward, the ability to alter technology remains within the grasp of the private sector

⁴ Proprietary implementations of technology, to the extent they deviate from the ultimate standard adopted, miss the benefit of robust industry give-and-take.

through its participation in standards processes. For this reason, Cisco has not been a vocal proponent of “etiquette” regulations adopted by national regulators. From a technology perspective, such rules run a high risk of being backward-looking, tend to act as a brake on technology evolution, and carry a risk of unintended consequences. Cisco believes industry standards forums are the best place to resolve co-existence problems between unlicensed technologies that will use the shared resource of radio spectrum. For LTE-U/LAA, we want to engage in the technical debates and understand the consequences both as a Wi-Fi manufacturer and a manufacturer of LTE technology. Our goal is for both Wi-Fi and LTE-U/LAA to utilize the band without significant negative consequences to users of either technology.

Cisco’s due diligence begins with our participation in the relevant standards groups, and includes examining materials posted to LTE-U Forum website, our own meetings with companies proposing LTE-U/LAA use, and our own engineering analysis of the coexistence questions. We are not among the group of companies that initiated the LTE-U/LAA concept. As a result, many of the questions raised in the Public Notice about how LTE-U/LAA has been designed to operate are ones that Cisco is not best-positioned to answer at this time.

In response to the Public Notice’s questions about coexistence mechanisms, Cisco cannot provide a final view, essentially because LTE-LAA is not “finished” as a 3GPP standards matter, and less information is publicly available with respect to the

proprietary version of the technology, known as LTE-U. Our work and analysis has been a part of a moving stream of information that has developed over the past nine months. As we understand it, the state of play on coexistence within industry groups is as follows –

- 3GPP –This group is developing a standard for LTE-Licensed Assisted Access. Based on meetings held during the last week of May, there is now a working agreement to use a sharing mechanism using “listen before talk” with exponential back-off to resolve contention with other transmissions in the channel. Cisco views this as a very positive development and will continue to support the work in 3GPP.
- LTE-U proponents of proprietary deployment – the sharing mechanisms of LTE-U appear to be significantly different than the sharing technology currently being discussed for standardization in 3GPP, as will be highlighted below. Two US carriers have announced they will bring LTE-U to market, possibly in 2016. LTE-U proponents have recently engaged stakeholders in a process of education and understanding, which Cisco welcomes and strongly supports.
- ETSI – ETSI Broadband Radio Access Network (BRAN) committee has approved a work item to devise a set of minimum “fairness” requirements as part of its standard (EN 301 893) for “5 GHz high performance wireless access systems” in Europe. The standard is scheduled to be completed by the end of 2015.

Because standards development remains in progress, and given the likelihood that proprietary LTE-U technology could be brought to market first, the balance of Cisco’s comments reflect our knowledge of LTE-U.

IV. LTE-U Coexistence with Wi-Fi

If the coexistence issue is not carefully managed, there could be substantial consequences to Wi-Fi packets transmitted or received near LTE-U transmitters. In subsequent industry conversations, we have learned that some firms developing or planning to use LTE-U have in fact thought through many of the same concerns that

Cisco has identified as required to ensure fair access to radio spectrum, although solutions for some of the issues may not be available in early LTE-U deployments.

Cisco believes that the Commissions' understanding of the coexistence issues would be improved by examining the following questions—

- The LTE-U specification does not specify the use of “Listen Before Talk” technology. We expect some of the early implementations will not have LBT. Subsequent iterations of the technology may include LBT, which should improve coexistence. How widespread will non-LBT equipment deployments be?
- The length of a single transmission for LTE-U can be set to more than 50 milliseconds, which is the result of specific design choices made to maximize LTE-U's average throughput capabilities. By comparison, Wi-Fi transmissions are generally less than 1 millisecond, and usually no more than 4-5 milliseconds, putting an emphasis on fairness over performance. When the two systems are in use in proximity to one another, certain applications (e.g., voice, video and gaming) on Wi-Fi are likely to be adversely affected (e.g., dropped frames, disrupted beacons, increased delay and jitter and reduced “power save” performance). Are there LTE-U design approaches that could be considered to bring the LTE-U time of transmission to a quantity on a par to Wi-Fi?
- The range of Wi-Fi deployments in the US is very broad, ranging from a simple wireless access point in the consumer's home, to deployments with thousands of managed access points operated by enterprises and service providers. In addition, loads on the network can be highly dynamic, depending on time of day or applications users are running. The simulations demonstrating fair access to spectrum in the presence of LTE-U and Wi-Fi have focused on simpler and less dynamic use cases. Do the algorithms used to derive the sharing simulations take into account the diversity of Wi-Fi deployment scenarios?
- In Wi-Fi, the “medium access control protocol” or “MAC” is standardized in IEEE 802.11. Given that LTE-U is a proprietary technology, and each vendor and operator can differentiate, should LTE-U vendors develop an open certification system, or similar process of disclosure, which encourages the use of some minimal set of parameters that promote fairness?
- When a scheduled system (like LTE-U) attempts to interact with a carrier sense system (like Wi-Fi), there is a temptation to “pre-reserve” the wireless medium for the scheduled system by transmitting unneeded energy to

essentially hold the channel until the start of scheduled transmissions. This mechanism stops other users from using the channel, despite the scheduled system not using it for legitimate transmissions. Does LTE-U ensure that when it reserves the channel that useful information (e.g. necessary pilots, necessary sync information, or user data) fills up the channel so that the channel does not go underutilized?

Cisco appreciates the work done by LTE-U developers to create a variety of mechanisms that will help LTE-U work harmoniously with Wi-Fi. Cisco believes the Commission's mandate of "good engineering design"⁵ incorporates the concept that all technologies must have a fair and reasonable opportunity to contend for unlicensed spectrum. When developing a new generation of wireless technology, the commercial reality is that coexistence with unlike technologies (e.g., competing technologies) is typically one of the lowest design priorities. To promote discussions within standards

⁵ 47 C.F.R. Section 15.15(a).

fora on coexistence and fairness, regulations promoting good engineering design can help by encouraging a reasonable level of coexistence and fairness. The FCC's interest in, and examination of, these critical issues in the context of LTE-U and Wi-Fi is important to help ensure both of these technologies are aligned with this mandate. Like many parties in this proceeding, it is Cisco's hope that this record helps private industry reason together to find the optimal set of answers.

Respectfully submitted,

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