Edison Electric
INSTITUTE

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General Counsel and Corporate Secretary

March 20, 2020

Via Electronic Filing

Marlene H. Dortch, Secretary
Federal Communications Commission
445 Twelfth Street, SW
Washington, DC 20554

Re: Ex Parte Notice: In the Matter of Unlicensed Use of the 6 GHz Band (ET Docket No. 18-295) and In the Matter of Expanding Flexible Use in the Mid-Band Spectrum Between 3.7 and 24 GHz (GN Docket No. 17-183)

Dear Ms. Dortch:

The Edison Electric Institute ("EEI"), the American Gas Association ("AGA"), the American Public Power Association ("APPA"), the American Water Works Association ("AWWA"), the National Rural Electric Cooperative Association ("NRECA"), the Nuclear Energy Institute ("NEI"), and the Utilities Technology Council ("UTC"), each representing their respective critical infrastructure industry ("CII") members, hereby respond to the technical critique submitted by Apple, et al. about the "Impact of Proposed Wi-Fi Operations on Microwave Links At 6 GHz" study (the "CII User Study" or "Study") submitted into the record in the above-captioned dockets on January 13, 2020.[1]

The purpose of this response is to clarify and correct misconceptions concerning the technical parameters used in the CII User Study, submit updated engineering analysis responding to the technical discussion in the dockets, and illustrate that, even after modifying calculations to further tailor the assumptions to mirror real-world application, the CII User Study demonstrates that indoor deployment without Automated Frequency Coordination ("AFC") will degrade 93% of licensed microwave point-to-point victim receivers in Houston in excess of the -6

[1] Roberson & Associates, LLC, *Impact of Proposed Wi-Fi Operations on Microwave Links at 6 GHz* (2019) (*CII User Study*). *See also* Letter from EEI, AGA, APPA, AWWA, NRECA, NEI, and UTC to Marlene H. Dortch, Secretary, FCC Docket Nos. 18-295, 17-183 (Jan. 13, 2020) (*CII Letter*). For the critique submitted by Apple, et al., see Letter from Apple, Inc., Broadcom, Inc., Cisco Systems, Inc., Facebook, Inc., Google, LLC, Hewlett Packard Enterprise, Intel Corporation, Microsoft Corporation, NXP Semiconductors, and Qualcomm Incorporated to Marlene Dortch, Secretary, FCC, in GN Docket No. 17-183 (Feb. 7, 2020) (*Apple, et al. CII User Study Critique*).

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dB I/N limit.[2] That level of interference is unacceptable for purposes of protecting the functionality of our members' critical infrastructure networks.

The CII User Study Appropriately Responds to the FCC's Request for Forward-looking, Realistic Projections About Potential Unlicensed Wi-Fi Deployment in the 6 GHz Band.

As evident in the discussion throughout the docket, appropriately accounting for widespread use of Wi-Fi devices is one of the most challenging yet critical technical assumptions informing assessments of interference in the 6 GHz band. The Notice of Proposed Rulemaking ("NPRM") seeks stakeholder input in the development of a realistic framework to accommodate the anticipated expansion of Wi-Fi devices.[3] Proper analysis thus necessitates using realistic assumptions of future Wi-Fi use that account for what all stakeholders acknowledge will be ever-accelerating Wi-Fi deployment and use.

In responding to the goals of the NPRM, the CII User Study and the elaboration below are intentionally robust and forward-looking as to how broadly Radio Local Area Networks ("RLANs") will be deployed. This includes multiple phases of Wi-Fi deployment, including graduated expansion over time, as well as an accelerated use over the later part of the next ten years. The critique that the analysis overstates deployment and should use more modest figures, arguments which are not realistic or credible from stakeholders who intend to sell an ever-increasing number of devices that will rely on unlicensed spectrum, are responded to immediately below in the next section of this response. Relying on downgraded or even moderately more modest projections is not only inconsistent with nearly every stakeholders' assertion about the ubiquity and importance of Wi-Fi use going

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[2] The new engineering analysis is explained in detail throughout this filing, however a summation of the calculations and their impact on the analysis contained in the original CII User Study is included in Table 1 on page 15.

[3] *Unlicensed Use of the 6 GHz Band*, GN Docket No. 17-183, Notice of Proposed Rulemaking, FCC 18-147 at ¶ 3-7 (Oct. 24, 2018) (*NPRM*). The NPRM explains the "explosive demand for unlicensed spectrum" due to the rapid development of innovation. The expansion of unlicensed Wi-Fi routers provides the backbone for this development, and the Commission notes that the foundation is in progress: globally, the number of Wi-Fi hotspots is expected to grow six-fold by 2021—with more than 200 million expected in North America alone. Predictions indicate that between 2016 and 2022 the data traffic generated by smartphones will increase by a factor of six, and the growth of the Internet of Things (IoT) will provide more than 1 billion low-cost home devices in the U.S. by 2023. The NPRM acknowledges that IoT innovation in particular could be even greater than some expectations, as Ericsson estimates that there will be more than 15 billion short-range IoT devices by 2022 that will be designed to use unlicensed standards.

forward, they belie the history of unlicensed use where deployment has always greatly exceeded even the most aggressive projections.

In sum, the CII User Study uses reasonable assumptions and demonstrates that the magnitude of harm that would result from the surge in demand for unlicensed operations in the 6 GHz band would cripple the integrity of CII communications infrastructure. Further, any assessment of interference must take into account the irreversible impact of allowing widespread, uncontrolled unlicensed operations in the 6 GHz band. The direct and consequential damage from widespread deployment of unlicensed devices in the band, with many millions of unregistered devices operating on an unlicensed and geographically unlimited basis, cannot be undone if the potential of interference even remotely approximates the Study's projections.

The CII User Study Accounted for Projected Wi-Fi Density and Usage.

The 1 RLAN per PoP assumption is supported and appropriate.

The 1 RLAN per PoP density figure used in the CII User Study is technically appropriate, supported by the intent of the NPRM, and consistent with the unlicensed advocates' own statements and behavior.

- Wi-Fi advocates acknowledge the explosive demand anticipated for Wi-Fi access across all user groups as their technical study projects 958 million RLAN devices in the 6 GHz band alone, a density of 2.9 RLANs per PoP.[4]
- An RLAN deployment density value approaching 1 RLAN/PoP is well-established in the technical community as representative across a combination of urban and rural areas. The 2019 ECC RLAN Sharing Study utilized an RLAN density for unlicensed spectrum of 0.9 RLAN/PoP.[5] Studies of aggregate interference by the ITU's Radiocommunication Sector (ITU-R) introduced a value of 0.55 RLAN/PoP in 2015.[6] Considering the growth of RLAN deployments since 2015 and the unlicensed industry projection of 2.9 RLANs/PoP cited above, utilizing a value of 1 RLAN/PoP is justified and appropriate. Taking into account the distribution of RLANs across all unlicensed bands, the RLAN deployment density for 6 GHz spectrum utilized in the CII User Study is 0.2 RLAN/PoP (350 MHz / 1720 MHz).
- The anticipated widespread deployment of Wi-Fi devices in the near term has been acknowledged by industry and Commission leadership alike. Commissioner Michael O'Reilly quoted the Cisco VNI Forecast, which noted that total internet traffic is expected to triple from 2016 to 2021.[7] Almost 52% of this traffic is expected to be carried by wireless connections.[8]

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[4] *Frequency Sharing for Radio Local Area Networks in the 6 GHz Band*, (2018) attached to Letter from Paul Margie, Counsel to Apple Inc., et al., to Marlene Dortch, Secretary, FCC, in GN Docket No. 17-183 at 12, Table 3-1 (filed Jan. 26, 2018).

[5] ECC Report 302, *Sharing and Compatibility Studies Related to Wireless Access Systems including Radio Local Area Networks (WAS/RLAN) in the Frequency Band 5925-6425 MHz*, at 23, Table 13 May 2019 (*ECC Report*).

[6] Annex 11 to Document 5A/1065-E, Working Party 5A Chairman's Report, *PRELIMINARY DRAFT NEW REPORT ITU-R M. [RLAN SHARING 5 150-5 250 MHz] Sharing and Compatibility Studies of WAS/RLAN in the 5 150-5 250 MHz Frequency Range*, at 44, Table A-1, 13 (May 2019) (*ITU-R Sharing Study*).

[7] Statement of Commissioner Michael O'Reilly, attached to *NPRM* at 50.

[8] *Id.*

- Any argument that the RLAN ratio should be limited to one per household is further contradicted by RLAN mesh network products offered for sale today by Google and other vendors.[9] Deployment of mesh networks implies one or more RLAN repeaters in a household, in addition to a "base" unit. Repeaters have the effect of multiplying both the channel utilization and the effective duty cycle necessary to complete a user transaction by the number of hops necessary to reach the client device.
- If anything, the 1 RLAN per PoP figure is likely overly conservative for determining the future real-world impact of shared use. Actual impact of density in the band would likely be even higher because the 1 RLAN per PoP figure solely accounts for RLAN access points; multiple responsive client devices utilizing the RLAN access point at the same time, which certainly will be even more numerous, are not counted at all. Multiple active client devices will increase the RLAN duty cycle as well.
- By contrast, Apple, et al.'s lower market penetration assumption, with a per household RLAN device count instead of the per person calculation used in our CII User Study, contradicts both the stated goals of the NPRM and the best available public forecasting data on RLAN deployment.[10]

The 4% duty cycle assumption is supported and appropriate.

We also stand by the CII User Study's use of the 4% duty cycle. In their attack on that figure, Apple, et al. argue that the limited availability of streaming 4K content and the projections that the dominant RLAN video type will be HD, instead of 4K, through 2030 necessitate a lower duty cycle assumption. According to Apple, et al., 4K video will become dominant after 2030, or in about 10 years.

- The CII User Study presumes that rules set now will still be in force in 10 years, and as a result the duty cycle used should be forward looking. Therefore, reasonable predictions about the prominence of 4K technology are necessary to define the appropriate duty cycle, as described in the CII User Study.[11]
- The 4% duty cycle is further reasonable when examined alongside other evaluations of duty cycle projections. One study measuring activity and

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[9] *See, e.g.*, *Google Wifi – Mesh Wifi Router*, Google, https://store.google.com/us/product/google_wifi_first_gen; *Mesh WiFi: VELOP Home WiFi System*, Linksys, https://www.linksys.com/us/c/whole-home-mesh-wifi/; *Shop eero Home Wifi Systems*, Eero, https://eero.com/shop; *The Best and Latest WiFi | 11AX WiFi 6*, Netgear, https://www.netgear.com/landings/best-wifi/.

[10] *NPRM* at ¶ 2 (emphasizing the FCC's "commitment to preserve and protect the important base of incumbent users in these frequency bands").

[11] *CII User Study* at 13, Table 1.

duty cycle to assess RF exposure has been published.[12] It measured average duty cycles from 1.57% to 87.41%, depending on the application, and notably only used 1080p in the case of a video application, compared to 4K video which is 2160p.

- Reducing the duty cycle to account for a graduated rollout of 4K technology not only underestimates future 4K use but also ignores that 4K technology is currently in use and will continue to grow over the next decade. Indeed, the CII User Study notes that 4K video is already available since television displays today use 4K technology and recent smartphone versions tout 4K video capability. Even higher resolution video is anticipated, and higher duty cycles have been previously measured with lower resolution video and with other common applications such as interactive gaming. Accordingly, the widespread use of 4K video technology is an appropriate assumption.
- In addition, there are numerous other technologies that stress the band similar to 4K video technology, such as medical telemetry, interactive gaming, and artificial intelligence that Apple, et al. ignore in assessing the appropriate duty cycle.
- Assigning an appropriate duty cycle depends on varied assumptions. Peaks in consumer interest around time-sensitive events, such as the Super Bowl or a local news emergency, can cause spikes of use well above the duty cycle calculation. The inherent variation and variance in interference, compounded with the anonymity of aggregate interference that makes the source difficult to pinpoint, necessitate the use of a duty cycle that realistically accounts for varied use.
- As noted above in the discussion of RLAN penetration, multiple active client devices connected to a home RLAN engaged in independent video streaming and interactive gaming will increase the RLAN utilization as well.
- Even in the unlikely event that the number of unlicensed devices using 4K and other high-data-rate technologies is limited and the resultant average duty cycle across deployed devices is halved to 2%, the impact of unacceptable interference persists as the cumulative probability distribution function ("CDF") of I/N is reduced by only 3 dB,[13] which does not impact the conclusions of the Study.

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[12] Wout, Joseph, et al., *Duty Cycles of Wireless Applications and Activities for WiFi Exposure Assessment* (2013), https://biblio.ugent.be/publication/4269550/file/4269577.pdf.

[13] A 3 dB reduction in the interference level across the 2325 fixed links studied in the Houston area does reduce the number of links experiencing I/N levels in excess of -6 dB. To ensure that *all* 2325 links do not experience I/N levels in excess of -6

The CII User Study's use of a 4% duty cycle is reasonable, again as an accurate, (albeit conservative) estimate of future RLAN use, especially given anticipated and certain growth in future demand.[14]

dB, however, 20.8 dB of interference reduction would be needed. For example, duty cycle would have to be reduced a factor of more than 100 to less than 0.02%, or power would have to be reduced under 2.5 mW. Since these kinds of regulations are unlikely, an AFC function is necessary to control interference for both indoor and outdoor devices.

[14] If there was a proposal for rules that would limit the average duty cycle of the future population of RLAN devices to 2% as a part of an AFC method in order to control aggregate interference, then it would be appropriate to utilize a 2% duty cycle for interference modeling.

The Updated CII User Study Analysis Applies a Path Loss Model Better Tailored to the Parameters of the Houston Metropolitan Area.

The debate surrounding the appropriate path loss model for measuring potential interference in the CII User Study focuses on which model best accounts for the parameters of the Houston metropolitan area. Apple, et al. attack the CII User Study's application of the Free Space Path Loss ("FSPL") model and the resulting calculations, asserting that the interference calculated in the study overstates the risk of harmful interference to the point of exaggeration.[15] The attack is unwarranted. Nothing is overstated or exaggerated. The Study's model consists of a straightforward model derived from published sources, including M.2135, that facilitated the calculation of interference for all 2325 FS victim receivers for the interference scenario specific to the nine-county Houston area. [16]

The deviations from the M.2135 calculations were purposeful, intending to account for the characteristics of the Houston density and topography. Those parameters include antenna heights from 10 m to 150 m, distances from 0.1 km to 60 km, frequencies from 6 GHz to 7 GHz, and a mix of urban and suburban locations. Apple, et al.'s criticism of the model prompted a search for a single, established path loss model that would also reflect the Houston scenario parameters. 3GPP has published a standardized path loss model to fit these limits in TR-38.901, which has now been applied in the updated analysis contained in Table 1.[17] However, even when this revised path loss model is used to account for the parameters specific to the Houston market, the results still support the same conclusion reached in the original CII User Study. The results of the revised analysis, included in Table 1 below, show that indoor unlicensed deployments without AFC unacceptably degrade 93% of licensed microwave FS victim receivers in the nine-county Houston area. The conclusion of the initial study, that AFC is necessary for both indoor and outdoor deployment of unlicensed devices, is unchanged.

- All path loss models in TR-38.901, ITU-R Report M.2135, and WINNER II (used in analysis by unlicensed proponents) consist of both Line of Sight (LOS) and Non-Line of Sight (NLOS) components. The models assign a probability of LOS that is taken into account during the interference calculation. The complementary probability of NLOS is P[NLOS] = 1 – P[LOS].
- The probability of LOS is high for short distances and tapers down to zero at long distances according to the parameters in the model. This means that LOS is typically the limit for short distances, and NLOS is the limit for long distances.

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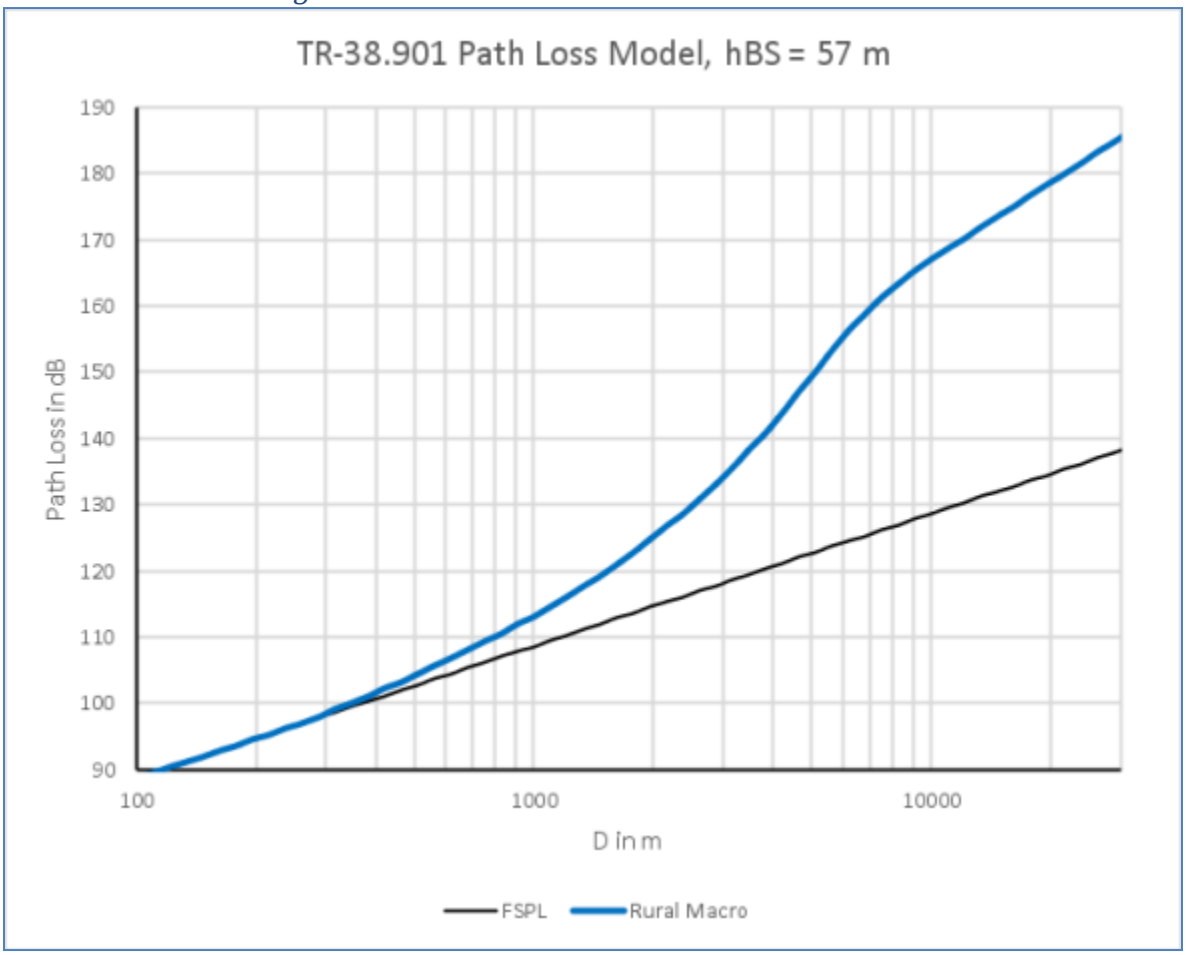
[15] *Apple, et al. CII User Study Critique* at 3.

[16] *CII User Study* at 24-25.

[17] 3GPP TR 38.901, *Study on channel model for frequencies from 0.5 to 100 GHz*, Release 16, December 2019.

- Every path loss model eventually converges to FSPL if the distance is short enough. The distance for convergence is dependent on the antenna height, with higher antennas having longer distances for FSPL and higher levels of interference from more distant sources. The average antenna height for victim receivers in the Houston area is 57 m, and among available standardized path models, TR-38.901 Rural Macro model is the best fit with this height. The short-range path loss models in TR-38.901, in general, are designed for lower antenna heights, so they do not apply to the victim receivers in Houston.
- The 3GPP TR-38.901 path loss model is the same as WINNER II for the Rural Macro model. However, unlike WINNER II, TR-38.901 is validated for the relevant frequencies in the 6-7 GHz band, and for antenna heights up to 150 m while WINNER II has not been validated for these conditions.
- The model labels of "rural" and "urban" are convenient 3GPP labels for simulation work for cell sites in rural/suburban or urban conditions. The microwave links in Houston are long enough to straddle rural/urban boundaries so that many of the links have victim receivers in both conditions. In such conditions, the urban receiver is pointed to a rural area, and the rural receiver is pointed to an urban area, with interference possibly originating in both types of neighborhoods. The relevant determinant for selection of a model is therefore the victim antenna height, and this indicates that the "rural macro" model is the best match for analysis of FS interference in the Houston area. In other words, the designations of "rural" and "urban" can be seen simply as proxies for the distinction between antenna height.
- The NLOS part of the model accounts for clutter losses, including for distances under 1 km. The impact of clutter is randomly invoked according to the P[NLOS]=1-P[LOS] calculation and random Monte Carlo trials.
- The TR-38.901 path loss for the Rural Macro cell model (RMa) is plotted in Figure 1, on the following page, for comparison with a FSPL model that illustrates that the model converges to FSPL below 1 km. The probability of LOS was used in the calculation of the path loss for both models.

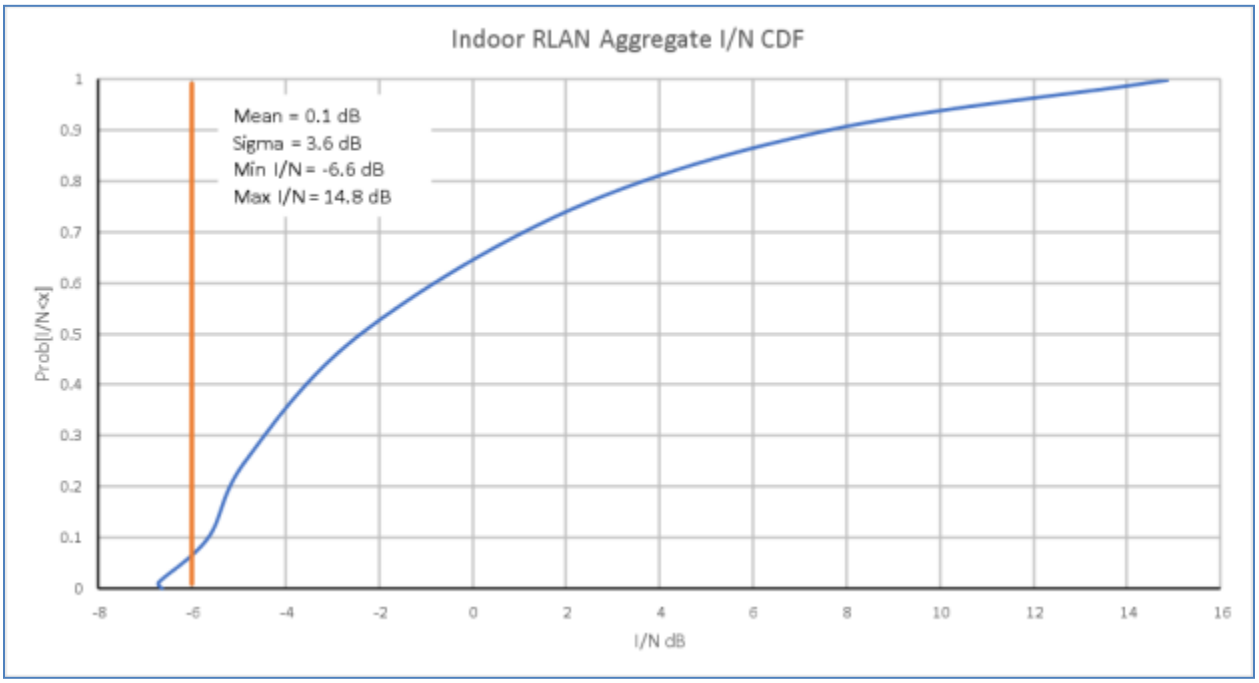
Figure 1 Standard TR-38.901 Path Loss Model



Employing a revised path loss model that reflects the FS parameters in the Houston area results in a new chart for the aggregate interference from indoor RLANs without AFC. See Figure 2, on the following page.[18]

[18] Note that the presentation here in Figure 2 includes adjustments to the analysis listed in Table 1 below.

Figure 2 Indoor RLAN Aggregate I/N Distribution



Although the I/N distribution changes slightly, Figure 2 shows that the overall conclusions of the CII User Study remain unchanged. Specifically, indoor unlicensed deployments without AFC will degrade 93% of licensed microwave FS victim receivers in the nine-county Houston area by exceeding the -6 dB I/N limit. AFC is therefore necessary for both indoor and outdoor deployment of unlicensed devices to mitigate harmful interference.

The Power Spectral Area Density ("PSAD") Calculations Account for the Conditions in the Houston Metropolitan Area.

Apple, et al. next incorrectly attack the PSAD figure used in the CII User Study to calculate Wi-Fi interference, asserting that the PSAD calculations overlook the hypothesis that population and FS link densities tend to be inversely correlated.

Using data from the FCC's own Universal Licensing System ("ULS") database for FS sites and links, the CII User Study applied an access point density based on the average population density over the entire nine-county Houston metropolitan area. The resulting access point density therefore resulted in minimizing the interference in high population density areas, such as central Houston, where the population density is significantly higher than the average. The Study also relies on a relationship between population density and access point density that has been accepted and is in use in the ITU-R, with the access points distributed across the total unlicensed spectrum available.[19] The Study also utilizes an appropriate method of accounting for the aggregated effect of the large number of Wi-Fi access points in the path of the FS links. FS links are 10's of kilometers in length, and the correct way to take into account the large number of Wi-Fi access points in these paths is to consider their aggregate effect.[20] The aggregation methods used in the Study rely on the density calculations adopted and in use by ITU-R[21]and ECC.[22]

Apple, et al. are nonetheless correct that the CII User Study does not make any assumption about correlations between population/RLAN distribution and FS site locations or densities, as any such assumption would rely on unproven hypotheticals. A commercial/business/shopping district could have a high density of RLANs, but a low population density. Similarly, the Study did not base assumptions on the unproven, qualitative assertion by unlicensed advocates that peak RLAN energy will generally not be in the direction of an FS receiver because preliminary documentation shows that RLAN energy in the elevation plane tends to be concentrated above or below the horizontal plane.[23] The CII study used a 0 dBi

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[19] *ITU-R Sharing Study* at 24, Figure 11.

[20] *See CII User Study* at 26 for Equation 13 which provides the horizon distance. The average distance to the horizon is 37 km. An arc of 20 degrees covers $(\theta/2)\ r^2 = 239$ km^2. For population density of 260 pop/km^2 and 1 RLAN/pop this comes to 62,000 RLANs in the coverage area of an average victim receiver. If 4% are active, there are 2485 transmitting RLANs that could generate interference. If 1/8 of these are using a 160 MHz channel that overlaps a victim receiver channel, then there would be 311 active transmitters to generate aggregate interference. For an ITU-R study, see reference in footnote 6.

[21] *ITU-R Sharing Study* at 44, Table A-1.

[22] *ECC Study* at 23, Table 13.

[23] We further challenge the relevancy of Apple, et al.'s suggestion that the directivity of emissions of consumer deployed RLANs can be predicted, let alone taken into

gain for indoor RLANs (uniform distribution of energy) and relied on the directivity of the victim's high-gain receiving antenna to reject interference from RLANs. The exclusion of theoretical assumptions that, at the present time, are not sufficiently established to inform a technical study intended to reflect realistic and reliable assumptions, further highlights the appropriate and credible nature of the Study's analysis.

Outdoor interference was considered in the CII User Study to respond to the NPRM and provide for comparative analysis.

There also seems to be confusion as to whether the assumption that 36 dBm EIRP outdoor devices will be controlled by an AFC system has been universally established. This critique reflects a misunderstanding of the CII User Study design. First, whether AFC should be applied to both outdoor and indoor RLANs is left as an item for consideration in the NPRM. Second, the Study calculated interference from indoor RLANs and outdoor RLANs *separately* so that the effect of each could be independently evaluated. No revised calculation for outdoor RLAN AFC requirements is therefore necessary. Furthermore, indoor devices are considered in the Study at a reduced power level, with no transmit antenna gain.[24] The CII User Study includes antenna gain or attenuation of the victim receiver as a function of the elevation angle, and it also includes the attenuation with azimuth angles.[25] The results show that interference to FS licensed systems in Houston in excess of the desired I/N limit of – 6 dB will occur from either indoor or outdoor RLANs if AFC is not used, and in particular, interference will occur from indoor RLANs without AFC even if outdoor RLANs are controlled so that their interference is avoided. The CII User Study therefore concludes that AFC is necessary for both outdoor and indoor deployments of unlicensed RLANs.

The CII User Study assumptions account for variance in interference calculations.

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account. RLANs purchased in a consumer store and installed by consumers will radiate in all directions. Only professionally installed RLANs with directional antennas can concentrate or focus the power. MIMO technology currently provided in RLANs typically directs emissions in an azimuth direction, not in elevation. In contrast, P2P dish antennas can focus in a specific azimuth and elevation direction. The CII User Study does account for this effect on the interference power that is received by the victim. For example, RLANS under a victim antenna with elevation angles greater than 20 degrees would be attenuated by the victim's antenna, according to the curves given in the CII User Study. *See CII User Study* at Figure 5.

[24] *See CII User Study* at section 1, paragraph 1: "…low power for ubiquitous indoor installations (0.25 W, 0 dBi antenna)." *See also id.* at section 4.3.1, paragraph 2: "An antenna gain factor is also included; this study will use 0 dBi for indoor RLANs." This is repeated again in section 4.3.3.2.

[25] *See, e.g.*, *id.* at Figure 5.

The CII User Study also analyzes variations for Building Entry Loss ("BEL") and path loss. These resolve as mean values for interference power, such as the E[BEL] calculation given in Equation 9 of the CII User Study. Variations in other parameters, such as antenna heights and gains, are accounted for in the FCC database, but these values may differ in other metropolitan areas. This is described in section 7.7 of the CII User Study. The CII User Study also mentions several random variables that can *increase* interference in section 5.2.3. These further emphasize the need for AFC for both indoor and outdoor RLANs. Temporal variations in the interference due to interference dynamics of a population of RLANs were also taken into account in the CII User Study since the study calculates the *average* I/N of the population of the access points in the FS path, by which it is understood that I/N levels above and below the established minus 6 dB limit could occur. The Study did not calculate "peak" I/N levels or use peak I/N in reaching its conclusions that indoor as well as outdoor RLANs should incorporate an AFC mechanism. An average I/N level below -6 dB should be maintained to protect FS links from harmful interference.

The U-NII-2 band was justifiably excluded from interference calculations; however, its inclusion does not impact the CII User Study conclusion.

As we have previously identified for the record,[26] the limitations on the viability of wide deployment in the U-NII-2 band exist due to regulatory restrictions on the use of the band, as evidenced by fewer certifications in the Commission's database in U-NII-2 band than in U-NII-1 or U-NII-3. The U-NII-1 and UNII-3 bands are not subject to the same regulatory restrictions imposed on the U-NII-2 band. Nonetheless, to aid in the ongoing dialogue with Apple, et al., the analysis in this filing includes a revised calculation to include the U-NII-2 band. Even when U-NII-2 is included, however, the analysis reaches the same conclusions, as the decrease (improvement) in I/N is 10 log(1425/1780) or slightly less than 1 dB. This decrease is insignificant because the I/N distributions in the CII User Study for the point-to-point links in the nine-county Houston metro area indicate that 10% of the links have I/N levels a full 13.5 dB in excess of the desired -6 dB I/N level as a result of indoor RLANs. In other words, not including U-NII-2 only improves the I/N distribution by an analytically insignificant 1 dB. A significant majority of the RLANs in the Houston area still experience I/N levels greater than minus 6 dB.

[26] Letter from EEI, AGA, APPA, AWWA, NRECA, NEI, and UTC to Marlene H. Dortch, Secretary, FCC Docket Nos. 18-295, 17-183, 3 (Feb. 7, 2020).

Further Refinement of Building Entry Loss Calculations Do Not Alter the Original Study's Conclusion that AFC is Necessary for Both Indoor and Outdoor Deployment of Unlicensed Devices.

As an initial matter, there should be no reason for the CII User Study's calculations to include polarization mismatch loss. Polarization randomization is already fully accounted in the scattering resulting from building entry loss, path loss and in the log normal fading model. Measurements of interference by Globalstar in U-NII-1 have not shown any difference from polarization.[27] It is therefore inappropriate to include a separate factor for polarization discrimination. But even if it were included, an additional 3 dB reduction in interference does not change the conclusion of the Study that AFC is required for both indoor and outdoor RLANs.[28]

There is similarly no reason to modify the calculation to account for thermally efficient buildings. Apple, et al. recommend an additional corrective assumption that at least 30% of buildings are thermally efficient. The suggested 30% ratio overstates the prominence of thermally efficient buildings, both residential and commercial, in U.S. metropolitan areas. According to the P.2109 standard, older buildings are classified as traditional.[29] Modern thermally efficient buildings using metallized glass and foil backed panels would be classified as "thermally efficient." Notably, the "thermally efficient" label does not pertain to any thermal insulation rating, and in fact metallized glass has no thermal insulation value by itself since metal conducts heat. It also appears that thermally efficient buildings are further limited to largely only commercial buildings.[30] The prevalence of thermally efficient buildings in a metropolitan area like Houston is thus considerably lower than the 30% proposed by Apple, et al. But even if the CII User Study were adjusted to use 90/10 mix of traditional/thermally efficient buildings in

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[27] *See* Ken Zdunek, Alan Wilson, & Brad Passwaiter, *Measurements and Analysis of Aggregate Interference in Satellite-Terrestrial Spectrum Sharing, in* 2018 IEEE 88th Vehicular Technology Conference (VTC-Fall) (Aug. 2018). *See also* Globalstar Inc., Petition for Notice of Inquiry, RM-11808 (filed May 21, 2018).

[28] A 3 dB reduction in the interference level across the 2325 fixed links studied in the Houston area does reduce the number of links experiencing I/N levels in excess of -6 dB. To ensure that *all* 2325 links do not experience I/N levels in excess of -6 dB, however, 20.8 dB of interference reduction would be needed.

[29] *See* Compilation of Measurement Data Relating to Building Entry Loss, ITU-R Rec. P.2346 (2019). *See also* Prediction of Building Entry Loss, ITU-R Rec. P.2109 (2019).

[30] A review of windows from vendors such as Pella and Andersen do not show any metallized glass for residential uses and a review of metallized insulation only shows applications for fire resistance and moisture resistance. Metallized glass is also less common in retail environments since merchants with large display windows (e.g., automobile sales rooms and storefronts) intentionally avoid this feature in order to permit outdoor views inside a building.

the Houston area,[31] the E[BEL] value merely changes from 11.0 to 11.4 dB, which does not alter the conclusions of the initial study.[32]

The Original CII User Study Accounted for Noise and Feeder Loss, and Any Warranted Modifications Still Do Not Alter the Original Study's Conclusion that AFC is Necessary for Both Indoor and Outdoor Deployment of Unlicensed Devices.

The CII User Study accounted for feeder loss, which was grouped together with the noise figure.[33] In response to the comment from RigNet[34] and the others in the docket which assert that a more realistic noise figure would be 5 dB, this figure has been revised in the updated analysis, resulting in an overall 1 dB reduction in interference that is reflected, along with other revisions, in the I/N CDF in Figure 2. This insignificant reduction does not alter the conclusions of the original analysis.

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[31] Note that the results in Figure 2 include a 0.4 dB correction for a 90/10 mix of buildings.

[32] Calculated from 11.0 dB / 20.1 dB for traditional / thermally efficient E[BEL] at 6.5 GHz. The formula becomes:
-10 log10[0.90 * 10^(-0.1*11.0) + 0.10 * 10^(-0.1*20.1)] = 11.4 dB.

[33] Noise figure commonly includes effects of any gain or attenuation between the antenna and the demodulator in the receiver. Grouping the feeder loss and noise figure in the Study was therefore taken as a matter of convenience and was not meant exclude either one.

[34] *See* Reply Comments of RigNet Satcom Inc., GN Docket No. 17-183 (filed Feb. 15, 2019).

The Updated CII User Study Calculations Support the Original Study's Conclusion that AFC is Necessary for Both Indoor and Outdoor Deployment of Unlicensed Devices.

The following Table 1 lists the changes for comparison with the original CII User Study and summarizes the revisions and resulting calculations. Although changes in the analysis result in a slightly different I/N distribution, the overall conclusions of the original Study remain unchanged. Specifically, indoor deployment without AFC will degrade 93 percent of licensed microwave point-to-point victim receivers in the nine county Houston area by exceeding the -6 dB I/N limit. AFC is therefore necessary for both indoor and outdoor deployment of unlicensed devices to address harmful interference.

Table 1 Updated CII User Study Analysis

Parameter	Original Study	Revised	Adjustment
PSAD	45.6 mW/MHz-km^2	36.49 mW/MHz-km^2	-1.0 dB
Path Loss	Dual Slope	3GPP TR-38.901 RMa	
BEL	11.0 dB	11.4 dB	-0.4 dB
NF	4.0 dB	5 dB	-1 dB
I/N Results			
Mean	8.3 dB	0.1 dB	8.2 dB
Min	-0.5 dB	-6.6 dB	6.1 dB
Max	19.2 dB	14.8 dB	4.4 dB

We hope the foregoing clarifications are useful for the Commission and interested stakeholders to better understand the real-world risk from the current Commission proposal to allow unlicensed use of the 6 GHz band without any requirements for mitigation, especially to the broad cross-section of the nation's critical infrastructure and public safety users that depend daily on the 6 GHz band for essential and mission-critical communications.

Respectfully submitted,

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cc: Office of Engineering and Technology