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March 26, 2018

Ms. Marlene T. Dortch, Secretary
Federal Communications Commission
445 Twelfth St, SW
Washington, D.C. 200554

Re: *Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz*, GN Docket No. 17-183

Dear Ms. Dortch:

AT&T Services, Inc., on behalf of its affiliated entities ("AT&T"), is filing this *ex parte* to provide its comments on the filed report in the above-captioned docket titled "Frequency Sharing for Radio Local Area Networks in the 6 GHz Band," prepared by RKF Engineering Services, LLC ("RKF Report").[1] The RKF Report purports to demonstrate that Radio Local Area Networks ("RLANs") can share with Fixed Microwave Service ("FS") systems with only negligible interference to the FS licensees. The RKF Study, however, contains a number of flawed assumptions that drastically undermine the study's conclusion:

- The probabilistic model used by RKF is inherently inappropriate because it appears to rely on a significant amount of averaging that may smooth out variations likely to create real world interference situations. RKF's study purports to study "worst case" scenarios, but the cases identified by RKF are randomly drawn, not worst case

- RKF's supplemental study of its self-defined "worst case" scenarios appear to incorrectly vary parameters in order to conclude that no significant interference will result.

- RKF's study underestimates interference to FS systems by using conservative propagation and antenna models.

- RKF's study does not correctly determine link availability metrics.

- And, RKF's study contains several assumptions that are incorrect, including assumptions regarding outdoor RLAN deployments, , growth of FS systems, , distribution of RLAN devices, and other factors.

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[1] "Frequency Sharing for Radio Local Area Networks in the 6 GHz Band," RKF Engineering Services, LLC (Jan. 2018 (prepared for Apple Inc., Broadcom Limited, Cisco Systems, Inc., Facebook Inc., Google LLC, Hewlett-Packard Enterprise, Intel Corporation, Microsoft Corporation, MediaTek Inc., and QUALCOMM Incorporated) attached to Letter from Paul Margie to FCC, GN Docket No. 17-183 (dated Jan. 26, 2018).

AT&T discusses each of these points in the attached document that details why the RKF study does not support the introduction of RLANs into the 6 GHz bands.

Pursuant to Section 1.1206 of the Commission's rules, a copy of this letter is being filed in ECFS. Should any questions arise concerning this ex parte, please contact the undersigned at 202-457-2290.

Respectfully submitted,

Stacey Black

cc: Julius Knapp
Michael Ha
Jamison Prime
John Kennedy
Karen Rackley
Nick Oros
Don Stockdale
Nese Guendelsberger
Dana Shaffer

Attachment: AT&T Analysis

Analysis of RKF Engineering Services, LLC submission in Docket 17-183 entitled, "Frequency Sharing for Radio Local Area Networks in the 6 GHz Band,"

AT&T Services Inc.

March 26, 2018

INTRODUCTION:

The RKF Report purports to demonstrate that Radio Local Area Networks ("RLANs") can share with Fixed Microwave Service ("FS") systems with only negligible interference to the FS licensees. The RKF Study, however, contains a number of flawed assumptions that drastically undermine the study's conclusion:

• The probabilistic model used by RKF is inherently inappropriate because it appears to rely on a significant amount of averaging that may smooth out variations likely to create real world interference situations. RKF's study purports to study "worst case" scenarios, but the cases identified by RKF are randomly drawn, not worst case.

• RKF's supplemental study of its self-defined "worst case" scenarios appear to incorrectly vary parameters in order to conclude that no significant interference will result.

• RKF's study underestimates interference to FS systems by using conservative propagation and antenna models

.• RKF's study does not correctly determine link availability metrics.

• And, RKF's study contains a number of several assumptions that are incorrect, including assumptions regarding outdoor RLAN deployments, growth of FS systems, distribution of RLAN devices, and other factors. In combination, these factors make the RKF study an unreliable predictor of interference between RLAN and FS systems. Nor has RKF addressed other fundamental problems with RLAN deployment in the 6 GHz bands, including mechanisms for determining interference, identifying interferers, and rectifying interference.

DISCUSSION:

RKF's Probabilistic Model Is Inherently Flawed. RKF has attempted to simulate RLAN interactions with FS systems to determine the degree of potential harmful interference, but in so doing, it has generalized the RLAN environment in a way that minimizes the potential for interference to occur. In assessing interference between RLANs and FS, RKF stated the first step was "to characterize aggregate potential interference into FS receivers from a nationwide deployment of RLANs," which it purportedly accomplished by performing "[t]en CONUS-wide simulations . . . corresponding to more than 910,000 different RLAN-to-FS interference morphologies and time instances."[2] While that initially seems like a significant amount of work, RKF appears to be saying it has looked for interference to "the more than 91,000 FS links" from 10 possible national RLAN deployments that were randomly generated. But this methodology relies on a substantial amount of averaging that inherently smooths out variations that may be most likely to create actual interference.

[2] RKF Study at 5. One initial question is when RKF varies the scenarios to create different "time instances," what time instances are used in each scenario. AT&T would question the validity of any of the scenarios that are not being conducted during the RLAN busy hour.

For example, one of RKF's summary conclusions is that "individual RLANs situated on high floors, at close range, through a window, or other corner case geometries do not pose a harmful interference risk to FS receivers" because "the rate of occurrence of such geometries is extremely low—on the order of two-tenths of one percent" and "the cumulative statistical effect of such occurrences does not cause any FS links in CONUS to fall below its availability design target." But discounting the potential for these types of interference scenarios based on statistical weighting—the average number of urban buildings above a certain number of floors, the average number of users per floor—ignores localized morphologies that impact both the distribution of RLANs and the potential impact on FS systems. In simple terms, in an area dominated by single and two-story buildings, FS links are likely to be at lower antenna heights and more impacted by RLAN devices on the first and second stories. On the other hand, with a building morphology like downtown Manhattan, RLANs have a much, much higher probability of being deployed on higher floors where they are more likely to impact rooftop FS receivers, and FS links are also more likely to be located on rooftops or RLAN could be located indoor inside the adjoining building with line of sight to the FS receiver

RKF's Study Incorrectly Purports To Identify "Worst Case" Scenarios. RKF states that its 10 simulations demonstrate "that approximately 99.8% of the FS stations within CONUS had aggregate interference levels from RLAN operations below the target interference-to-noise (I/N) criteria of -6 dB." But it is unclear how RKF selected the 165 FS links or why the links are considered worst case, since it seems unlikely that in 10 different random RLAN deployments that the same 165 FS links would be interfered with.

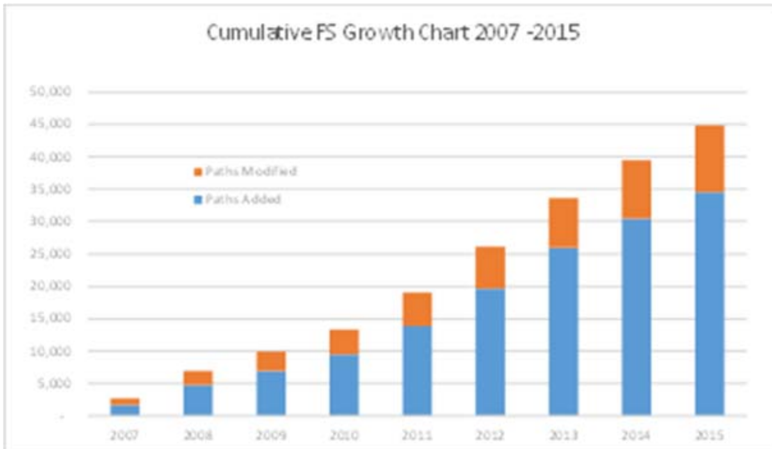
RKF's Supplemental Analysis of the "Worst Case" Scenarios Is Flawed. For the "165 links" that did experience I/N over -6 dB, RKF states further investigation showed that the interference was "caused by a single or small number of dominant interferers proximate to, or operating in the main beam of, the FS receiver." RKF also performed "1,000 additional RLAN interference simulations" ("165,000 RLAN-to-FS interference morphologies and time instances") and concluded that "an I/N greater than -6 dB occurred just 1,052 times (or 0.64%) with 1,025 of those instances caused by single entry interference." This seems to imply that RKF created a number of additional RLAN random distributions localized to 165 FS links and evaluated the potential for interference under each of those scenarios, but without stating which parameters are being varied. And, this can obviously result in a flawed conclusion—if interference is generally dominated by "single entry interference," then if an RLAN interferer is located in a position where it will interfere with an FS link, it will likely occur whenever the device transmits. And, while RLAN devices and APs might be initially placed using some randomized distribution mechanism, real-world experience suggests APs will not be moved and that end user devices are likely to be operated in the same places consistently. If RKF's additional 1,000 iterations per FS link vary parameters that include the location of the RLAN device, they do not seem to reflect real-world operating conditions.

RKF Incorrectly Assesses Impact on Link Availability. RKF then goes on to state that it calculated the impact of these 165 interferers on FS link availability, incorrectly concluding that "[e]ven for these worst-case scenarios, the resulting impact on FS availability and quality of service delivered over these FS links from the introduction of RLAN devices falls within the existing availability design margin and does not cause harmful interference." While RKF attempts examples with seconds of outage each year, it has missed the fundamental point—if the FS system is designed for no more than some number of seconds of outage each year, adding additional seconds of outage time, by definition, no longer "falls within the design margin" and harmful interference is the result. Furthermore, the study employs a link margin that assumes fade margins based on a bit error rate ("BER") of 1 x 10-3, which is not in accord with industry standard practices. Typical industry practice is to calculate fade margins based on a BER of 1 x 10^{-6}. In practice, performance degradation starts once the BER degrades to 1 x 10^{-5} and therefore, fade margins should be calculated based on a BER of 1 x 10^{-6}.

RKF's Study Makes a Number of Incorrect Simulation Assumptions. Given the lack of correlation between the FS sites interfered with in RKF's 10 runs, and its conclusion that interference was "caused by a single or small number of dominant interferers proximate to, or operating in the main beam of, the FS receiver," the logical conclusion is that RKF's study is highly dependent upon how close the random distributions of RLANs are to real-world RLAN implementations. And, as discussed further below, there is ample reason to believe that RKF's distribution of RLAN devices, and other assumptions about the effects on FS links, are incorrect or inappropriate:

First, in AT&T's view, RKF has also understated the potential use of, and physical parameters for, outdoor RLANs. In Table 3.6, RKF states its assumption that 60% of outdoor APs will be "low power" and in Table 3.11, RKF details its assumption that 95% of outdoor RLAN deployments will be at heights of 1.5 m or less. Most outdoor RLANs, however, will be commercial deployments, which typically use much higher antenna heights and higher power. Based on AT&T's LAA deployments, AT&T has found that the average distance between LAA sites is around 330 feet in downtown San Francisco, 900 feet in downtown Chicago, 500 feet in downtown Indianapolis, and 1000 feet in downtown Los Angeles. The average antenna heights are also greater than assumed by RKF—approximately 30 feet for San Francisco, Los Angeles, and Chicago, with around 21 feet in Indianapolis. The sites would also all be uniformly classified as "high power" APs by the standards in RKF's analysis—currently AT&T uses the highest allowable LAA transmit power permitted in the 5 GHz band. There is no basis to believe that LAA or other commercial, outdoor RLAN networks would utilize anything other than 4W power levels. Thus, the assumption by RKF that only 2.83% of outdoor RLAN devices will operate at 4W cannot be correct. And, AT&T's anticipated growth far exceeds that modeled by RKF—AT&T has approximately 200 LAA sites on air today, but has 4,000 in progress with deployment dates in 2018 and 2019. AT&T would expect that outdoor RLANs would have a significantly greater impact on FS services than RKF's model suggests.

Second, RKF sets out its assumptions for the universe of FS links but, notwithstanding the anticipated launch of mobile services in a variety of new bands and the advent of 5G, RKG assumes zero growth in FS deployments by 2025. The analysis does not even assess the microwave capacity reserved by existing licensees with frequency coordinators, which represents very probable deployments in the near term. Based on data from Commscope, and as shown in the figure below, over the last 10 years, there has been an average of almost 4,000 paths added in the 6 GHz bands annually. That would imply approximately one-third again as many links as modeled by RKF in 2025.



Third, the WINNER II Model C2, for Urban Macro ("UMa") environments, used by RKF significantly overstates losses as compared to the 3GPP 3D UMa model that is more typically used by the mobile industry for modeling RLANs. In *Figure 1*, AT&T compared the results of modeling using the two methodologies, looking at pathloss as a function of distance (up to 1 km)[3] between FS stations (at 25 m height) and RLAN user equipment (variable height) for outdoor, indoor, LOS and non-LOS conditions:

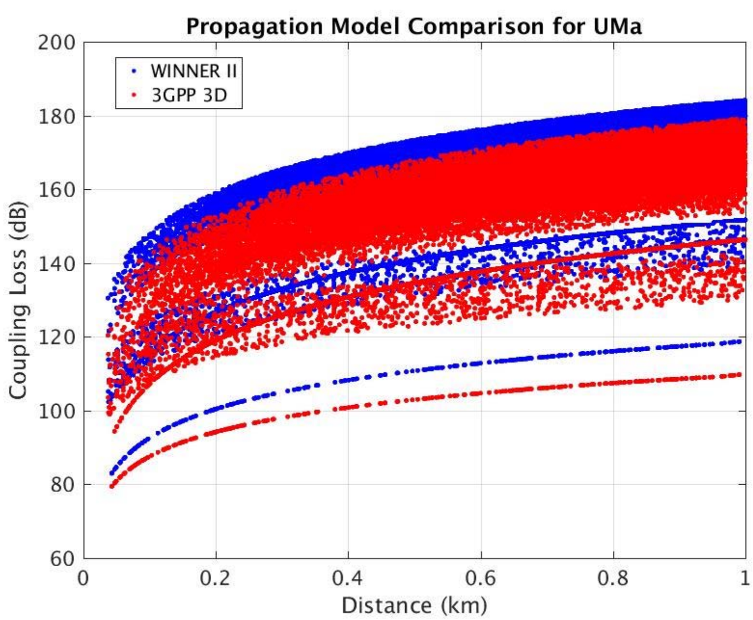


Figure 1: Pathloss Comparison for WINNER II and 3GPP 3D UMa Models

[3] At distances greater than 1 km, RKF utilized the ITU P.2108 model. AT&T has not attempted to compare P.2108 with 3GPP models for larger distances.

AT&T assumed 80% of users are indoors and at variable heights going up to 8 floors (3 m floor height), per 3GPP specifications (TR36.873). As shown in *Figure 1*, the propagation model used by RKF overstates loss by over 10 dB as compared to the 3GPP model.

Fourth, RKF's use of ITU-R Recommendation F.1245 to model FS antenna sidelobe performance overestimates discrimination at the receive antenna, underestimating potential interference.[4] According to AT&T's calculations, the F.1245 model is incorrect for some angles near boresight on all three of the FS antennas used by AT&T (UHX6-59, PARX6-59 and VHLPX4-59) and, away from boresight, while the model is functional for the UHX antennas (as in the RKF example of the UHX6-59), it under estimates the discrimination of the PARX6-59 antenna for discrimination angles ranging from about 10 degrees to 90 degrees. Given that the FCC's rules specify compliance with a mask, and that the FCC rules should protect all licensed microwave instead of just the 83% that exceed Category A requirements (much less those that merely comply with the Category B requirements), RKF's study should have assumed only the discrimination required by rule. AT&T has compared, in Figure 2 and Figure 3, the boresight and away from boresight discrimination based on RKF's F.1245 assumption with the FCC's mask for Category A antennas, as well as the manufacturer-reported specifications for the PARX6-59 antenna in horizontal (PARX6 HH) and vertical (PARX6 VV) configurations:

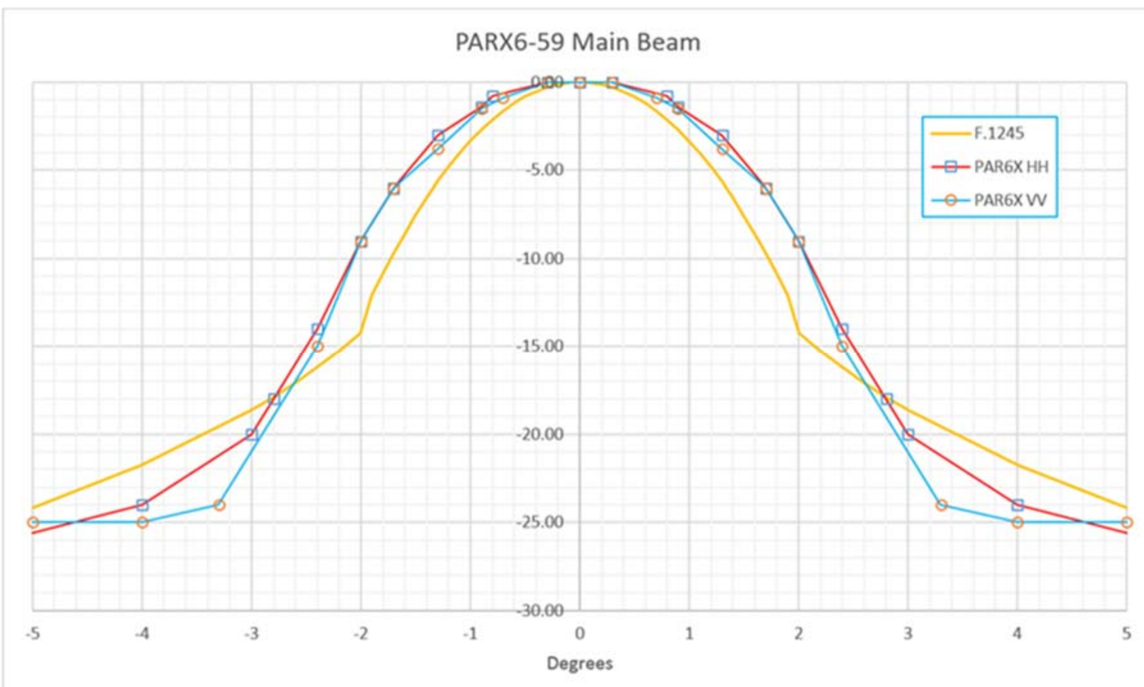


Figure 2: Comparison of F.1245, PAR6X Antenna Discrimination for Boresight Angles

[4] The ITU-R has released a newer (January 2018), more conservative model in recommendation F.699-8, which RKF has ignored. *See* https://www.itu.int/dms_pubrec/itu-r/rec/f/R-REC-F.699-8-201801-I!!PDF-E.pdf.

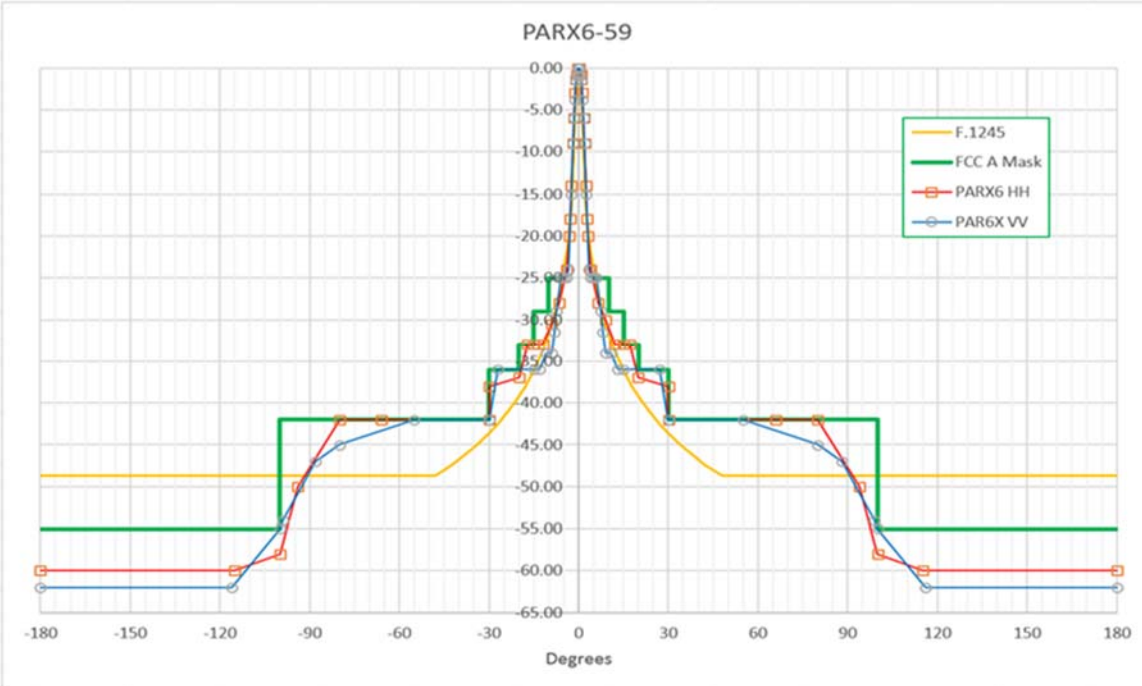


Figure 3: Comparison of F.1245, FCC Mask for Category A Antennas, and PARX6 Discrimination Away from Boresight

Fifth, RKF appears to have distributed its hypothetical RLAN network based on the population density, but it does not indicate the resolution of the grid it used to distribute the RLAN devices. In Fig. 3.3, they do cite to a 60 arc second resolution, which amounts to a grid size of approximately 1.2 km x 1.8 km. Given that they purport to use U.S. Census Bureau ("USCB") data, it is unclear why they have apparently chosen to remap population to this framework instead of using Census Blocks, which, in urban areas, are considerably smaller than they size RKF appears to have used. By averaging densities from Census Blocks to a much larger grid, the impact of high density deployments is understated.

Sixth, RKF's assumption about the percentage of RLANs operating in the 6 GHz bands is severely flawed. They assume 3.47B RLAN devices in 2024, with a market penetration of 45% for 6 GHz capable devices. They then "assum[e] spectrum loading will be even across all the contemplated channels in the unlicensed bands, [meaning] 68% of 6 GHz enabled RLANs are estimated to be using the 6 GHz band." This is plainly incorrect. They assume 45% of RLAN devices will be 6 GHz capable, but they then distribute those devices across all bands, meaning that only 30.7% of RLAN devices will be using 6 GHz frequencies at any given time. Effectively, then, 30.7% of devices will be using the 1200 MHz of spectrum in the 6 GHz band and the remaining 69.3% of devices will be packed into the 560 MHz of 2 GHz and 5 GHz spectrum—meaning that the density of devices in the lower bands is 5 times higher. If they really assumed an even distribution of use across the band, then 68% of the devices would be using 6 GHz spectrum and 32% would be using 2 and 5 GHz—but if only 45% of the devices are 6 GHz capable, then the 6 GHz use would be capped at 45% of devices. Either way, the 68% multiplier should be ignored, meaning that RKF should have assumed nearly 50% more RLAN devices in the network at any given time.

Seventh, RKF's assumptions regarding the distribution of RLAN devices and activity of RLAN devices does not make sense:

- In some places, RKF states that the conclusions in the study "appl[y] to all RLANs that comply with U-NII operating characteristics, including but not limited to Wi-Fi Access Points (AP) and stations." Presuming that "stations" is intended to refer to user equipment ("UE"), as opposed to APs, Table 3.1—which lists the technical assumptions for RLAN loading and operation—does not appear to consider the relationship of APs to UEs.[5]

- RKF states that "[i]t was assumed that on average every person in the CONUS is actively using one RLAN during the busy hour while owning an average of nine other RLANs that were not being actively used"—which correlates to the 10%/90% division in Table 3.1 between "high activity" devices and "low activity" devices. But the high and low activity devices must be communicating with something—the study appears to ignore the APs, which would have a load that supports the downlink communications for one "high activity" device and nine "low activity" devices and therefore has a much higher duty cycle. But there is no discussion of that type of use.

- RKF also assumes a "1:1 ratio of downlink to uplink traffic for corporate and public users, and a 2.3:1 ratio for home users," which seems substantially lower than the 1:6.6 uplink/downlink ratios AT&T has seen for mobile networks.[6]

- RKF's figures on RLAN loading seem very optimistic. RKF derives an average 0.44% duty cycle for "high activity" RLAN devices based on 2 GB/hr data use. Given that most usage is likely to occur within the 3 hour "busy" period, that roughly correlates with estimates that typical households consume 190 GB/mo.[7] But that assumes zero growth in data use between now and 2025, which hardly seems probable. The figures for corporate and public use seem similarly low.

As a final matter, RKF and the RLAN proponents fail to address one of the key issues with RLAN deployment in FS bands—the problem with identification and mitigation of interference. As AT&T has previously documented, and as RKF's study assumes, RLAN devices can be physically located almost anywhere geographically and vertically. Because FS systems are not, however, built to detect interference of this nature, the FS links will be unable to distinguish RLAN interference from fade caused by atmospheric or other naturally occurring conditions. While the systems are engineered to specifications accommodating such natural fading conditions, added RLAN interference will manifest itself through a performance decrease that is noticeable only as a statistical trend over time. Performance will degrade outside of engineering availability margins, but FS operators will have no ability to identify the RLAN, or collection of

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[5] In contrast, for outdoor RLAN devices, RKF assumes a 1:1 radio of client devices to APs.

[6] https://www.itu.int/dms_pub/itu-r/opb/rep/R-REP-M.2370-2015-PDF-E.pdf

[7] http://www.telecompetitor.com/igr-average-monthly-broadband-usage-is-190-gigabytes-monthly-per-household/

RLANs, that caused the interference, or even the times at which interference was RLAN-induced. Because the FS operators cannot determine whether harmful interference over time was caused by RLAN deployments, FS operators cannot identify the specific offending interferers and take steps to shut them down and restore performance.

CONCLUSION:

The RKF study does not support the introduction of RLANs into the 6 GHz bands. The 6 GHz FS band is the only band suitable for long distance transmission, routinely supporting paths between 10-50 miles and, in cases, even longer distances. Higher frequency bands above 10 GHz are simply not suitable for these types of links due to rain and atmospheric attenuation. As a result, these bands suffer more frequent short-term outage events as compared to the 6 GHz band. The introduction of unlicensed users will increase the cumulative amount of interference in the band nationwide, elevating the noise floor, degrading the performance of existing systems, and making it more and more difficult for network operators to implement new microwave routes or expand the capacity of existing paths. Indeed, frequency availability is already a problem at large microwave transmission hub. Maintaining adequate long haul and high reliability microwave will be critical for 5G and other advanced services. The FCC must continue to protect this resource as it has other bands where 3GPP-type services have been deployed.

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