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EX PARTE VIA ELECTRONIC FILING

Ms. Marlene H. Dortch, Secretary
Federal Communications Commission
445 Twelfth Street, S.W.
Washington, D.C., 20554

Re: Unlicensed Use of the 6 GHz Band, ET Docket No. 18-295; 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 itself and affiliates and subsidiaries of AT&T Inc. (collectively, "AT&T"), files this *ex parte* letter to discuss certain errors in the draft order circulated by Commission in the 6 GHz proceeding.[1] In particular, this letter addresses the flawed technical determinations made in the *Draft Order* in permitting the deployment of unlicensed "low-power indoor" ("LPI") radio local area network ("RLAN") devices at a power spectral density ("PSD") limit of 5 dBm/MHz throughout the 6 GHz fixed microwave service ("FS") band.

AT&T does not oppose the unlicensed use of RLAN devices so long as they include automated frequency coordination ("AFC") mechanisms that can prevent harmful interference. AFC can be included in these unlicensed devices at modest cost, thereby ensuring widespread deployment of a promising new class of equipment (primarily Wi-Fi) without risking disruption to critical communications infrastructure. AFC is the only way to enforce the longstanding legal prohibition on harmful interference, *i.e.*, it is the only mechanism capable of guiding and, if necessary, shutting down an unlicensed LPI device once it is sold in the stream of commerce. Unfortunately, the *Draft Order* declines to mandate AFC for unlicensed LPI devices on the basis of the following profoundly flawed determinations:

- It relies on technical studies that are not in the record while disregarding record evidence demonstrating that unlicensed LPI devices without AFC will cause harmful interference, even with the "restrictions" adopted by the Commission;

- It subjects the parameters of static case studies in the record to major modifications that are technically indefensible and that, without explanation, reverse prior Commission policy;

[1] Unlicensed Use of the 6 GHz Band, *Draft Report and Order and Further Notice of Proposed Rulemaking*, FCC-CIRC2004-01 (rel. Apr. 2, 2020) ("*Draft Order*").

- It disregards interference effects from outdoor client devices associated with purportedly indoor LPI access points;

- It redefines "harmful interference" in a manner inconsistent with prior practices, precedent, and applicable legal requirements; and,

- It disregards the need for testing to ascertain the validity of theoretical claims of non-interference *before* the deployment of LPI devices is authorized.

Each of these errors is discussed in detail below.

The Draft Order Improperly Relies on Unfiled and Unproven Monte Carlo Simulations

To conclude that unlicensed LPI devices without AFC will not harmfully interfere with incumbent FS users, the *Draft Order* relies heavily on "a Monte Carlo simulation submitted by CableLabs," which the *Draft Order* finds "provides a strong basis for reaching that conclusion."[2] The CableLabs simulation, however, has never been filed on the record and, because its details are unknown, remains immune to serious scrutiny by the Commission or interested parties.[3] For example, the Commission has failed to review the full simulation results, explore the assumptions made within the simulation, examine the details of the methodology that was implemented, engage in any sensitivity analysis of the simulation, or consider the impact of eleventh-hour changes to the proposed LPI device rules on the interference probabilities in the simulations.[4]

Because the Commission apparently has not conducted any independent simulations of its own, the *Draft Order* can conclude merely that "[a]dvocates of indoor low-power operations *claim* that fixed microwave links will not experience harmful interference from the unlicensed devices."[5] Furthermore, although the *Draft Order* implies derogatory self-interest on the part of

[2] *Id*. ¶ 114.

[3] The Commission references "several technical studies submitted by advocates of indoor low-power operations," but "find[s] the CableLabs study the most significant." *Id*. Notably, none of the other Monte Carlo simulations has been filed on the record, either.

[4] For example, as CTIA has observed, all of the duty cycle data in the CableLabs study is derived from Broadcom, which has acknowledged that the data only "describes measurements over a ten-day period obtained by Broadcom from one of its customers." Moreover, the underlying data has not be filed, the customer has not been identified, and no analysis has been presented of whether the ten-day period (or breadth of the study in other respects) was representative of the broader simulation population. Letter from Scott K. Bergmann, Senior Vice President, Regulatory Affairs, CTIA, to Marlene H. Dortch, Secretary, Federal Communications Commission, ET Docket No. 18-295, GN Docket No. 17-183 at 10 (dated Apr. 14, 2020) ("*CTIA Apr. 14, 2020 Ex Parte*").

[5] *Draft Order* ¶ 114 (emphasis added).

licensed incumbents with regard to the studies they submit, it imputes no such self-interest to the "claim" of non-interference by RLAN proponents.[6]

The simulations reported by CableLabs and other RLAN proponents are black boxes to all but the simulators themselves, and thus the Commission has no evidentiary basis for placing substantial reliance on them.[7] Its decision to do so anyway is, in fact, the precise defect that resulted in a reversal in *ARRL v. FCC*.[8] As the D.C. Circuit stated there, it is "a fairly obvious proposition that studies upon which an agency relies in promulgating a rule must be made available during the rulemaking in order to afford interested persons meaningful notice and an opportunity for comment."[9] As the court also added, "[w]here, as here, an agency's determination is based upon a complex mix of controversial and uncommented upon data and calculations, there is no APA precedent allowing an agency to cherry-pick a study on which it has chosen to rely in part."[10]

Moreover, AT&T, other licensees, and all other interested parties are independently entitled to evaluate the methodology used and the key inputs and variables that drove the results, but the black-box nature of this unsubmitted study has precluded them from doing so. A Monte Carlo analysis attempts to derive overall probabilities of a particular event—such as harmful interference—occurring when there are multiple independent factors at work—each having its own probability. The types of Monte Carlo analyses purportedly run by RLAN proponents, for example, create a series of chances that they argue characterize LPI devices and their usage patterns—a certain distribution of devices in an area, across radio channels and a range of powers, as well as factors like a certain probability that the device is on a particular floor or transmitting at a given time. Then, by means akin to "rolling dice," they create hypothetical devices operating in a possible snapshot in time and space, and determine if any of the devices cause harmful interference to licensed FS incumbents based on licensing data for real systems.

The reliability of such a Monte Carlo analysis depends critically on: (i) whether the actual results conform to distributions that are the input parameters; (ii) whether the input parameters reasonably model reality (*e.g.*, how devices will actually be distributed, deployed, and used; what client devices will be used and how); and (iii) whether the simulation evaluates a sufficient number of scenarios to derive statistically valid conclusions about the final results. As an

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[6] *Id.* ¶ 231 (asking "are we correct to surmise that these are worst case scenarios (as would be suggested by the incentives of those introducing these scenarios into the record)"?).

[7] If the RLAN proponents' simulations are trivial and involve no engineering or modeling expertise or judgment, then the Commission, as an expert agency, should have had no difficulty in producing its own models and relying on those, instead.

[8] *American Radio Relay League, Inc. v. FCC*, 524 F.3d 227 (D.C. Cir. 2008) ("*ARRL v. FCC*").

[9] *Id.* at 237.

[10] *Id.* (internal quotation marks omitted; citing *Solite Corp. v. EPA*, 952 F.2d 473, 500 (D.C. Cir. 1991); *Weyerhaeuser Co. v. Costle*, 590 F.2d 1011, 1031 (D.C. Cir. 1978)); *see Kent County, Del. Levy Court v. EPA*, 963 F.2d 391, 396 (D.C. Cir. 1992); *Indep. U.S. Tanker Owners Comm. v. Lewis*, 690 F.2d 908, 926 (D.C. Cir. 1982); *Sierra Club v. Costle*, 657 F.2d 298, 334, 398 (D.C. Cir. 1981)).

example, a Monte Carlo analysis can be used to determine how often a "12" will occur with two rolled dice. But the results would not accurately depict reality if one die used in the simulation were weighted incorrectly so that it usually shows a "1." And the simulation would draw the wrong conclusion ("'12' will never occur") if the dice were rolled only twice and show, respectively, a "6" and a "7." Yet, because the CableLabs and other Monte Carlo simulations have never been filed on the record, AT&T and other interested parties have been deprived of the crucial opportunity to scrutinize whether the simulations suffer from these and other errors that can easily occur in such simulations (even if not tainted by self-interest).

Given the RLAN proponents' failure to put their studies into the record, there is no evidentiary support for several of the key findings in the *Draft Order*. The *Draft Order* acknowledges that new unlicensed operation can cause harmful interference to licensed incumbent operations and, indeed, that protections to prevent such harmful interference are necessary.[11] But instead of imposing AFC on unlicensed LPI devices, as the law and sound public policy requires, the *Draft Order* "adopt[s] three restrictions [nominally] designed to prevent harmful interference."[12] Specifically, devices must be: "(1) limited to indoor operation; (2) required to use a contention-based protocol; and (3) subject to low-power operation [at 5 dBm/MHz PSD rather than the 8 dBm/MHz PSD sought by RLAN proponents]."[13]

Whether "low power" operation (at 5 dBm/MHz PSD) or contention-based protocols will serve to lower the risk of interference is an engineering question that requires careful analysis and cannot be determined on the basis of guesswork. Critically, these parameters were not incorporated into the Monte Carlo simulations reported by the unlicensed RLAN proponents, and so even if those simulations were available for review, they could not be used to test the impact of the *Draft Order*'s asserted "protections." Indeed, the Commission has identified no basis whatsoever for choosing 5 dBm/MHz as the appropriate number, rather than some lower figure—itself a violation of the Administrative Procedure Act.[14] In short, the Commission has no record basis for concluding that these "restrictions" will make any meaningful difference to the probability of harmful interference arising from LPI operation.

In fact, the record indicates the Commission's three "restrictions" are highly unlikely to prevent interference.

- RLAN proponents have long argued that unlicensed devices, which includes LPI access points, already adjust their power dynamically and typically employ a statistical range of powers. More recently, however, these same parties have argued that the PSD in the *Draft Order*—5 dBm/MHz—is low enough that it will substantially limit the range of

[11] *Draft Order* ¶ 112.

[12] *Id.* ¶ 101.

[13] *Id.*

[14] *See, e.g., U.S. Tel. Assôn v. FCC*, 188 F.3d 521, 524-26 (D.C. Cir. 1999) (invalidating insufficiently supported choice of 6.0% "X factor" used to adjust price caps); *WorldCom, Inc. v. FCC*, 238 F.3d 449, 461 (D.C. Cir. 2000) ("Like any agency, the FCC must provide a rational basis when setting a number for a standard.").

LPI devices. This argument supports the inference that the distribution of powers used by LPI devices would be substantially different, and weighted more to power levels closer to the maximum power, than the distributions modeled for a higher maximum power. For that reason, even apart from the others noted below, the actual interference amelioration of lowering the PSD limit by 3 dB from what was originally modeled by CableLabs is dubious at best.

- Contention-based protocols cannot protect microwave receivers. Because contention-based protocols are based on the ability of a device to "listen" before seizing a channel, and because LPI devices are unable to detect distant microwave transmissions,[15] the requirement to implement contention-based protocols will not offer any material protection to incumbent licensees. The *Draft Order* does not address the value of a contention-based protocol in directly protecting microwave services, but does state that a contention-based protocol will lower the duty cycle of RLAN devices and therefore limit the time periods during which interference could occur. Although contention-based protocols may work well for the universe of unlicensed RLAN devices in a highly localized immediate area (*e.g.*, a single home), the sources of interference to licensed microwave systems in the 6 GHz band can be multiple homes surrounding the incumbent microwave receiver, and therefore a contention-based protocol appears to provide no relief in lower duty cycles from these different transmission sources.[16]

In short, the *Draft Order* presumably reduced the PSD limit by 3 dB and required contention-based protocols because the Commission perceived some threat from LPI devices operating at 8 dBm/MHz without a contention-based protocol. But no evidence exists to support the conclusion that those measures actually reduce the perceived threat.

Although the RLAN proponents failed to disclose and validate their Monte Carlo simulations, it is clear that they relied on a key distribution variable that substantially understates interference from LPI devices and thus is patently improper.[17] In particular, the *Draft Order* makes much of "duty cycle," or the amount of time that a transmitter is actually transmitting, which may be less than 100% if there is no data to transmit. Indeed, the *Draft Order* repeatedly asserts that

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[15] Microwave receivers rely on very high gain and highly directional antennas to resolve transmissions from tens of miles away. LPI and other unlicensed devices, on the other hand, have very low gain antennas and are designed only to receive signals at very short ranges. As noted in the *Draft Order*, unlicensed devices can sense signals at -62 dBm, which is a much higher field strength than the -96 dBm (-99 dBm Noise +3 dB Noise Figure) the Commission itself utilizes when modeling fixed microwave links. *Compare Draft Order* ¶¶ 164, 129.

[16] Given that the LPI channels in the 6 GHz band are wider than prior Wi-Fi systems (up to 360 MHz) and that power is fixed at 5 dBm/MHz (and therefore bandwidth dependent), the chances of co-channel and adjacent channel emissions appears to increase the probability of aggregate interference. In a reversal of precedent, the *Draft Order* dismisses aggregate interference. *See infra*, n.45.

[17] The *Draft Order* also implies, incorrectly, that these distributions should have been considered by AT&T's static cases. *See infra* (discussing AT&T's static case analysis).

unlicensed LPI devices have a duty cycle of 0.4%.[18] By taking a snapshot in time that will find unlicensed LPI devices "off" 99.6% of the time, however, Monte Carlo studies are under-representing the probability of interference.

Because the duty cycle of an unlicensed LPI device is measured over milliseconds, using a duty cycle of 0.4% means that the simulation is dividing the world into millisecond time slices. But the *Draft Order* identifies no reason for taking that approach rather than another, such as looking at time slices of, say, seconds. And looking at time slices of seconds would likely produce a different variable to consider—whether the LPI device is active at any point during any one-second period, a probability that will be far closer to 100% than to 0.4%. The *Draft Order* states that the "impact of a 25% duty cycle interference source is 6 dB lower than the same interference source with 100% duty cycle"; in other words, a 1/4 duty cycle has 1/4 the interference because 6 dB is a factor of 4. So, by this math, a 1 watt device looks like a 1/4 watt device if it has a 25% duty cycle.

But that is clearly not always true in the relevant engineering sense: if an LPI device were on for one second and then off for three seconds, it would have a 25% duty cycle, but that 1 second period would be experienced by a microwave link as *1 watt of interference*, not 1/4 watt. For the *Draft Order* to conclude properly that the duty cycle of an LPI device is material, it would have had to have considered whether short, bursty transmissions present themselves as interference to microwave links as full power interference sources or as some kind of time-averaged interference source. There is no record evidence, however, that microwave systems are somehow relatively immune to bursty interference. To the contrary, microwave engineering principles indicate that short duration interference can negatively impact microwave transmissions, and rigorous testing should have been conducted before the Commission effectively disregarded the impact of short duration interference.[19]

The record also is clear that, even if a Monte Carlo simulation shows only a very tiny probability of harmful interference from an unlicensed LPI device to a microwave link, the sheer number of unlicensed devices—estimated by the unlicensed device proponents at nearly a billion—

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[18] *Id.* ¶¶ 103, 131, 141, 141 n.361, 153, 153 n.357, 157, 157 n.404, 208, 208 n.599, 115 n.276, 118, 119, 119 n.299, 120.

[19] As a matter of basic engineering, short duration interference can cause the receiver to lose carrier lock in just *micro*seconds, which can take several milliseconds to recover. This creates a situation where the receivers are randomly going into reframe and causing the short duration degradation of transported digital traffic. These random disruptions will also be unpredictable, making their cause and location difficult to discern. In addition, there is no way to generalize broadly about 6 GHz microwave systems' response to bursty interference—the 6 GHz band is home to systems of varying age utilizing a variety of transmission protocols and built, using a range of propriety transmission schemes (which change from time to time), by a wide range of different radio manufacturers. Moreover, as a historic matter, the fixed service radio vendors have had no need to test their equipment against the bursty interference threatened by unlicensed RLAN devices. Interferers in the licensed fixed service bands were other fixed service radios, which are constantly transmitting. So while data exists as to how these radios react when suffering continuous interference, AT&T—which operates over a thousand fixed service links—is not aware of any studies relating to the effects of bursty interference.

combined with an installed base of nearly 100,000 microwave links, means that actual harmful interference events become a statistical certainty. Indeed, The Fixed Wireless Communications Coalition calculated that, even if the probability of harmful interference from a single unlicensed device were a miniscule one-in-ten-million (0.00001%), there would be a 99% probability that, at any instant, RLAN devices would be harmfully interfering with 100 or more fixed service links.[20]

Indeed, the record shows that even these seemingly extreme estimates actually understate the problem. In contrast to Monte Carlo simulations, a static analysis looks at a real world scenario and deterministically calculates the potential for harmful interference. In AT&T's static studies, AT&T took actual microwave links it has in service and built scenarios around possible (and expected) unlicensed LPI device deployments.[21] AT&T's Example 2 in Batavia, NY (which is discussed in the *Draft Order*), looked at an actual microwave link and modeled what would happen if unlicensed LPI devices were deployed in a house that was found using Google Maps and was located approximately two miles from the receiver. This is not a probabilistic model in that AT&T picked neither a random microwave link nor a random house. But the example is nonetheless highly probative because it is entirely foreseeable that, with a forecast of nearly a billion unlicensed devices in the band, the house found by AT&T (or a similarly situated house) might well contain one of those devices.[22]

If it is reasonable to assume that an unlicensed LPI device might be deployed at the house in question—and no party has indicated otherwise—then a deterministic case can be modeled that

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[20] Letter from Donald Evans, counsel to the Fixed Wireless Communications Council, to Marlene H. Dortch, Secretary, Federal Communications Commission, ET Docket No. 18-295, GN Docket No. 17-183 at 3 (dated July 25, 2019). In all events, as this letter demonstrates, the *Draft Order*'s so-called "restrictions" will not appreciably diminish the likelihood of harmful interference, and thus the law of large numbers will still apply, meaning there will almost certainly be harmful interference even if the likelihood of interference by any particular device is relatively low.

[21] Letter from Michael P. Goggin, AT&T Services, Inc., to Marlene H. Dortch, Secretary, Federal Communications Commission, ET Docket No. 18-295, GN Docket No. 17-183 at 4-8, Att. (dated Nov. 12, 2019) ("*AT&T Nov. 12, 2019 Ex Parte*").

[22] The *Draft Order* implies that AT&T selected the scenarios in its static study of links as "worst case" in a self-interested manner. *Draft Order* ¶ 231. Although AT&T did select the links in question, AT&T has stated on the record that, because they appeared so readily, the geometries involved in the examples are not likely to be uncommon. *AT&T Nov. 12, 2019 Ex Parte* at 4, 8 (noting that "the examples in Exhibit A of harmful interference to operations in AT&T's FS portfolio were readily identified after reviewing the specifics of only a few dozen (out of thousands) of licensed facilities" and thus the chosen examples reflect "a common situation with FS links backhauling traffic from rural cell sites"). As a mobile operator and microwave licensee, AT&T had some idea of the types of geometries that could be problematic, and looked for situations meeting those parameters. AT&T then used Google Maps to determine whether, given the geometry, there was any likelihood of residences or building being in problematic locations. This did not require AT&T to review a large number of cases to find the six it presented. These are, accordingly, not "worst cases," as AT&T has examined only a tiny subset of its microwave portfolio. As previously explained, AT&T's incentives are to open the 6 GHz band for unlicensed devices—AT&T has tens of millions of customers who use unlicensed spectrum to access our networks—but to do so in a way that is environmentally responsible, using smart unlicensed devices to preserve the spectrum ecosystem for incumbent networks as well..

uses the physical parameters dictated by what is actually known. It is illogical, for example, to use an "average" or distribution for a parameter that can easily be determined. Yet the *Draft Order* improperly concludes it is appropriate to use a value for building entry loss ("BEL")—a factor that considers how signal power is lost as it travels through building walls and windows—that counterfactually finds that there is a 30% probability that the old, rural farmhouse depicted from a Google Maps photograph in one of AT&T's case studies is constructed of modern building materials like metalized glass and foil-backed panels.

Instead, the appropriate approach is the one taken by AT&T. It modeled BEL as a distribution function because there is no way to determine, even if you assume that an unlicensed LPI device is located at the house, where in the house the device is located and whether the building structure presents a large or negligible impediment to signal transmission. All are quite possible and, indeed, likely, given expected deployment scenarios. AT&T has captured the expected range of BEL in likely deployment scenarios, while the *Draft Order*'s approach artificially increases BEL (and thus understated interference) by effectively eliminating a range of likely deployment scenarios in locations that have substantially below average BEL.

The *Draft Order* also implies AT&T should have considered the duty cycle—presumably to reach the conclusion that 0.4% of the time the device will be on and causing harmful interference and 99.6% of the time off and not causing harmful interference—even though the ultimate conclusion should be that an unlicensed LPI device located at the house is an interference problem. In such regards, harmful interference 0.4% of the time would obviously have a critical impact on microwave links that are routinely engineered for 99.999% and 99.9999% reliability. The fact that the device will be off most of the time is irrelevant to the fact that, when it is on, which it will be, the device will cause interference, potentially to links where reliability is considered critical.[23]

The Criticisms of AT&T's Static Case Studies in the Draft Order Are Not Well-Founded in Law or Engineering

Apart from its improper reliance on black-box Monte Carlo simulations and meaningless "restrictions," the *Draft Order* also erroneously cites AT&T's own static case studies as support for a determination of no harmful interference. The *Draft Order* can make that claim only by profoundly distorting AT&T's studies by improperly altering some of the key parameters. Although some of these alterations are the result of conforming with the rules as set forth in the *Draft Order* (*e.g.*, 5 dBm/MHz PSD, 24 dBm/80 MHz EIRP), several of them are technically indefensible and dwarf in magnitude the proposed 8 to 5 dBm/MHz power-level reduction—in particular: (i) clutter loss (-18.4 dB); (ii) Building Entry Loss ("BEL", ~12 dB) and, (iii) "RLAN/FS Antenna Mismatch" (-5 dB). As explained below, those changes erroneously made

[23] *See* Letter from Donald J. Evans, counsel to the Fixed Wireless Communications Council, to Marlene H. Dortch, Secretary, Federal Communications Commission, ET Docket No. 18-295, GN Docket 17-183 at Att., p. 9 (dated Dec. 20, 2019) (noting that a short burst of instantaneous power can be an order of magnitude higher than time averaged RLAN power).

in the *Draft Order* are improper, and correcting them underscores the grave interference dangers that unlicensed LPI devices pose to the nation's microwave-based communications infrastructure. Indeed, in each case, using the *appropriate* values, rather than the flawed values the *Draft Order* uses, shows there will be harmful interference.[24]

- ***Clutter Loss***. "Clutter loss," in this context, describes the potential absorption of radio energy by objects in the transmission path, such as terrain, buildings, and vegetation. The *Draft Order*'s revisions of AT&T's Example 2 include incorporating -18.4 dB of clutter loss, relying on an industry statistical model. Because of the way that interference analyses are conducted, -18.4 dB of clutter loss is equivalent to using a transmitter power that is approximately 1/70th of the actual power. AT&T, in this example, included 0 dB of clutter loss based on its determination that the microwave path was near line-of-sight—that the microwave receiver was directly visible from the house where the hypothetical unlicensed LPI device was located and therefore that there was very little impeding the microwave receiver from being exposed to the full power of the interfering transmitter. As shown in Attachment 1, the elevation profile AT&T extracted for the path demonstrates that the path has nearly a clear line of sight, which means that, although some small diffraction loss may be present, no clutter should be added at all. At most, at the worst (highest) point in the elevation profile, the path might pass through some trees if the trees were 12 m or higher. But this is a factor—seeing the actual path—where a deterministic conclusion can be made that there is minimal clutter (if any), instead of relying on some statistically-based clutter model. Even assuming—incorrectly—that the path did go through a small grove of trees, an appropriate deterministic value for clutter loss in this case would be in the range of 10 dB, not the 18.4 dB "average" value used in the *Draft Order*. Even worse, in the Phoenix example, where the *Draft Order* coincidentally uses the same 18.4 dB of clutter loss, the profile elevation and terrain photographs demonstrate there is nothing—no structures and no trees—between the microwave receiver and the house modeled (or, for that matter, other houses in the same subdivision).[25] In that case, the clutter loss should be zero, not 18.4 dB.

- ***Building Entry Loss***. The *Draft Order* also applies a -20.62 dB BEL, which is akin to using 400 times less transmitter power. In AT&T's case studies, AT&T presented BEL as calculated from the case geometry using an industry standard—P.2109, a standard that all

[24] As the *Draft Order* notes, AT&T modeled BEL "by introducing a probability distribution." *Draft Order* ¶ 124. Even though the *Draft Order* concludes that this improves the static analysis undertaken by AT&T, the *Draft Order* finds "this step does not fully remedy the limitation of a static link budget analysis." *Id*. But the *Draft Order* itself goes on, inexplicably, to model BEL as a *static* number, notwithstanding its conclusion that representing BEL through a probability distribution is more informative. *Id*. ¶ 128. Even worse, the *Draft Order* implies that AT&T believes a static BEL of -17 dB is appropriate by including that value in a comparison chart under a column labeled "AT&T." *Id*. ¶ 127. That is a mischaracterization of AT&T's analysis, as AT&T has never suggested that a static BEL of -17 dB is appropriate and, for the reasons explained above, in many cases it can be much lower.

[25] *AT&T Nov. 12, 2019 Ex Parte* at Att., p. 5 (showing large subdivision at selected interferer location).

parties seem to agree is the correct model for BEL.[26] Under AT&T's formulation, the case study results showed that harmful interference would occur in some percentage of cases based on where the unlicensed LPI device was located within the house. The *Draft Order*, while acknowledging that this improves the validity of the case study results, does exactly the opposite and uses a single "50%" value rather than a distribution. But use of a 50th percentile—an average value—means that in fully half of cases where an unlicensed LPI device is located in the house, the signal loss from traveling through the building structure will be *overstated*. Compounding this error, the Commission's selected average relies on assuming "a 70% traditional construction/30% energy efficient construction mix of building types."[27] In other words, the value used in the *Draft Order* implicitly and improperly assumes a 30% possibility that the old farmhouse pictured in one of AT&T's examples is constructed of modern "energy efficient" materials, including "metallised glass [and] foil-backed panels,"[28] As a result of this averaging, over half the time the "static case" in the *Draft Order* will underestimate the impact of the LPI device on the microwave receiver.

As AT&T has previously pointed out, the use of a 50th percentile value in this context is inconsistent with prior Commission precedent.[29] That is because the Commission's practice has not been to protect licensed systems from "average" interference cases, but rather to protect them even in unusual (but foreseeable) cases—not just 50% of the cases, but rather 90% of the cases. In a remarkably similar situation, the Commission was evaluating the potential interference to incumbent services by unlicensed garage door openers, and the garage door opener manufacturers argued that a large loss factor should be applied to the interfering signal based on the blockage calculated for the body of the vehicle—effectively a "vehicle entry loss" instead of a "building entry loss," but otherwise an identical situation.[30] The Commission noted in its order that the "[manufacturer proponent] interprets its data to say that on the average the vehicle attenuation is 15, [but] this data must also be interpreted to say that about 50% of the vehicles exhibit less than 15 dB of attenuation."[31] The Commission instead applied an attenuation factor "represent[ing] the attenuation observed in at least 90% of the vehicles" in order to protect incumbents.[32]

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[26] The Commission, on its own motion, entered the P.2109 document into the record.

[27] *Draft Order* ¶ 128.

[28] Prediction of building entry loss, ITU-R, Recommendation ITU-R P.2109-1 at 2 (Aug. 2019) ("ITU-R P.2109-1") (describing "thermally-efficient building" class).

[29] Letter from Michael P. Goggin, AT&T Services, Inc., to Marlene H. Dortch, Secretary, Federal Communications Commission, ET Docket No. 18-295, GN Docket No. 17-183 at 5 n.26 (dated Jan. 23, 2020).

[30] *Amendment of Part 15 of the Commission's Rules, To Provide for the Operation of Radio Door Controls*, FCC 71-314, 21 R.R.2d 1633, 28 FCC 2d 198 (1971).

[31] *Id.* ¶ 7.

[32] *Id.*

The Commission also uses the 90th percentile values in other interference contexts as well. In broadcasting services, for example, FM and TV service contours are calculated using F(50,50) curves[33]—indicating a signal strength is exceeded at 50% of receiver locations 50% of the time. But interference contours, which are used to determine whether another station's signal might cause interference, are calculated using F(50,10) curves[34]—indicating a signal strength is exceeded at 50% of receiver locations 10% of the time. In other words, the Commission considers a signal to be receivable for media services if it is available 50% of the time, but interfering even if measurable only 10% of the time—the 90th percentile value. The Commission has identified no reason for abruptly departing from that approach here.

As shown in Attachment 1, using the 90th percentile value for traditional construction for any of the AT&T examples yields a BEL of -9 dB, a difference of almost 12 dB from the value used in the *Draft Order*. That is tantamount to over a 14 times increase in the interfering power that LPI devices will generate.

- ***RLAN/FS Antenna Mismatch***. The *Draft Order* also includes a -5 dB adjustment for "RLAN/FS Antenna Mismatch," a factor that reduces modeled interference by over three times. As described in the *Draft Order,* this factor accounts for "real-world unlicensed device antenna patterns [that] would likely result in less gain toward the horizon," and the *Draft Order* determines that "a 5dB gain reduction is appropriate for analysis purposes" "based on typical EIRP patterns of indoor enterprise and consumer access points."[35] The theory of this reduction is that LPI device antennas radiate different amounts of power at different angles off horizontal, and that a line drawn between the unlicensed LPI device and the microwave receiver may not be on the horizontal plane. Yet, although acknowledging that the radiated power depends upon the angle off horizontal, the *Draft Order* nonetheless uses the same 5 dB adjustment regardless of the actual angle between the unlicensed LPI device and the microwave receivers in the examples—indeed, in AT&T's Example 2 and 3, the off-axis angles are less than one degree.[36] And the *Draft Order* applies this adjustment even though unlicensed LPI devices could be deployed at arbitrary orientations, so "horizontal" for the LPI device may not correspond with horizontal in the real world. Even worse, this factor suggests the use of a "ray tracing" type of methodology (drawing a line from the LPI device to the microwave receiver) that is explicitly rejected in the P.2109 industry document discussing BEL. The reality reflected in P.2109 is that a signal can (and will) penetrate the building in many ways and bounce around inside the structure, which

[33] 47 C.F.R. §§ 73.313, 73.612, 73.684.

[34] 47 C.F.R. §§ 73.509, 73.616.

[35] *Draft Order* ¶ 125.

[36] *AT&T Nov 12, 2019 Ex Parte* at Att., pp. 19, 22.

means that the calculations should not attempt to consider the orientation of the antenna inside the structure.[37]

Notably, the *Draft Order* provides no derivation of the 5 dB value used. In the relevant passage, the *Draft Order* cites only an Apple, Broadcom *et al*. *ex parte* of December 15, 2019, which summarily states—without citation—that "the record clearly shows that RLAN antennas do not exhibit significant gain towards the horizon."[38] The only other citation provided for this proposition in the *Draft Order* is a study provided by Apple, Broadcom *et al*., but that study does not mention or discuss a 5 dB reduction and, in fact, includes antenna patterns for certain indoor devices that appear to have nearly no gain reduction at the angles implicated in AT&T's studies.[39]

Attachment 1 also considers the cumulative impact of these changes on the static analyses conducted by AT&T and modified in the *Draft Order*. If BEL is reduced to 9 dB, reflective of 90th percentile values for the traditional construction evidenced in the examples, every single one of the case studies shows an I/N in excess of the -6 dB threshold. If clutter loss is then adjusted to 10 dB in the Batavia, NY, example and 0 dB for the Phoenix, AZ, example, and the 5 dB antenna mismatch is eliminated—the I/N values exceed the threshold for harmful interference by at least 10 dB (ten times) and by as much as 25 dB (over three hundred times).

The Draft Order Fails to Reflect Interference from Client Devices

Even if the Commission determines that BEL should be unrealistically high, the *Draft Order* suffers an additional, irremediable defect when considering the static scenarios advanced by AT&T. In particular, the *Draft Order* concludes that LPI operation should be permitted without AFC in part because "low-power access points must operate only indoors."[40] This "restriction" is given effect through rules that provide: (i) "access point devices cannot be weather resistant"; (ii) "low-power access points [must] have integrated antennas and prohibit the capability of connecting other antennas to the devices"; (iii) "low-power access points . . . [may not] operat[e] . . . on battery power"; and (iv) "access points [may only] be marketed as 'for indoor use only' and [must] include a label attached to the equipment stating that 'FCC regulations restrict to

[37] ITU-R P.2109-1 at 2 (stating that "[a]lthough techniques such as ray-tracing can provide useful site-specific predictions when coupled with detailed architectural data, such models will usually be inappropriate for generic applications such as spectrum sharing studies").

[38] *Draft Order* ¶ 125 n.317 (citing Apple, Broadcom et al. Dec. 16, 2019 *Ex Parte*, Attach. at 3).

[39] *Id*. ¶ 125 n.316 (citing Apple, Broadcom et al. Jan. 26, 2018 *Ex Parte*, GN Docket No. 17-183 (RKF Study) at 19).

[40] *Id*. ¶ 102.

indoor use only.'"[41] As other commenters have demonstrated, these restrictions will not, in fact, stop many consumers from using these devices outside.[42]

But the *Draft Order* makes an even more fundamental mistake: its rules facially apply only to "access points"—and not also to the client devices that communicate with those access points. For client devices, the *Draft Order*'s only protection is a requirement that the client device PSD be 6 dB lower than the limit for the associated access point. This means, as a practical matter, that any user could choose to take their client device (*e.g.*, laptop, VR goggles, Internet of Things devices) *outdoors*—it is entirely reasonable to foresee consumers utilizing connected devices on their balconies, on their decks and porches, or in their yards. In those cases, there would be no argument for applying any BEL, since the device is outdoors. And there is no record supporting off-axis gain reduction for client devices. So these devices would be modeled in the AT&T scenarios—as defined in the *Draft Order*—by subtracting 20.6 dB of BEL loss, 5 dB of antenna mismatch loss, and then adjusting for 6 dB lower power. Thus, client devices would have an interference profile—using the *Draft Order*'s figures—that is 19.6 dB higher than what is shown in the *Draft Order*, resulting in I/N thresholds well above -6 dB in every case.

The Draft Orderôs Attempts to Redefine Harmful Interference Are Contrary to Precedent and Sound Engineering

The *Draft Order* suggests that, even if AT&T's static analysis revealed that unlicensed LPI devices would generate interfering signals in excess of the -6 dB I/N threshold, such devices may still not cause "harmful" interference. As AT&T has previously discussed, for example, the *Draft Order* states that AT&T's static cases assume "the unlicensed device has a 100% duty cycle," suggesting, incorrectly, that duty cycle is relevant to the static case. But the *Draft Order* also takes the position that exceeding a -6 dB I/N, while a "conservative approach . . . to ensure that the potential for harmful interference is minimized," is not "a determination that any signal received with an I/N greater than -6 dB would constitute 'harmful interference.'"[43] This amounts to an unlawful and unexplained reversal of longstanding policy, given that: (i) -6 dB I/N has been used within the microwave services as a threshold for harmful interference as between themselves, and (ii) the Commission used -6 dB I/N as an interference threshold in the recently adopted C-band reallocation.[44]

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[41] *Id*. ¶ 109.

[42] *See, e.g., CTIA Apr. 14, 2020 Ex Parte* at 16-18.

[43] *Draft Order* ¶ 73.

[44] Expanding Flexible Use of the 3.7 to 4.2 GHz Band, GN Docket No. 18-122, FCC 20-22 ¶ 325 (rel. Mar. 3, 2020). In fact, in the C-band proceeding, the Commission also allotted an additional 4 dB for aggregate effects of widely dispersed fixed and mobile uses in order to protect highly directional incumbent licensees—a position similarly reversed in the *Draft Order*. *Draft Order* ¶ 75.

The *Draft Order* also implies that unlicensed LPI device impingement on the microwave "fade margin" should not be considered "harmful interference."[45] Atmospheric fading describes a naturally occurring phenomenon where a sharp difference in atmospheric layers—layers of hot and cold air—cause microwave frequencies to "duct," or travel in a path that is altered by these environmental conditions. These fades act like interference, and microwave links are typically engineered with a "fade margin" to ensure that the link provides adequate service even when these conditions occur, which is not predictable and varies by the hour, by the day, and by the season. The *Draft Order* makes the finding that "[a]tmospheric multipath fading is . . . most prevalent during the 8-hour period after midnight—which does not overlap the 7-11 PM Wi-Fi access point peak usage time,"[46] suggesting that the microwave links might not experience faults because LPI interference is overcome by the fade margin engineered into the link. But "most prevalent" does not mean "exclusively," and AT&T has submitted evidence in the record showing significant fades recorded in the 10 pm timeframe that overlap with peak Wi-Fi usage.[47] And although "peak" usage for Wi-Fi may occur between 7 and 11 pm, Wi-Fi can have significant peaks outside that period,[48] and fade conditions can last for minutes, or even hours, so even low duty cycles and low activity levels of LPI usage could result in significant interruptions to critical links as intermittent LPI usage stacks on top of atmospheric fade.

In the Absence of Any Practical Enforcement Mechanism, the Commission Must, at a Minimum, Require Testing to Ensure that Harmful Interference Will Not Result from Unlicensed LPI Deployment

As a final matter, AT&T agrees with the National Spectrum Managers Association, Southern Company, and others that lab and field tests must occur *prior* to any commercial deployment of unlicensed LPI devices without AFC.[49] If such devices are deployed without AFC, the Commission's ability to enforce a non-interference rule is illusory. As AT&T has explained, it is unlawful for the Commission to authorize devices under Part 15 of the Commission's rules that create a significant threat of harmful interference to licensed users without any practical mechanism for eliminating interference. In response, the *Draft Order* merely states that "as

[45] *Id.* ¶ 143.

[46] *Id.*

[47] Letter from Michael P. Goggin, AT&T Services, Inc., to Marlene H. Dortch, Secretary, Federal Communications Commission, ET Docket No. 18-295, GN Docket No. 17-183 at 7 (dated Aug. 8, 2019).

[48] Letter from City of New York to Marlene H. Dortch, Secretary, Federal Communications Commission, ET Docket No. 18-295, GN Docket No. 17-183 at 2 (filed Nov. 7 2019).

[49] Letter from George Kizer, President, National Spectrum Management Association to Marlene H. Dortch, Secretary, Federal Communications Commission, ET Docket No. 18-295, GN Docket No. 17-183 at 1-2 (dated Apr. 14, 2020); Letter from Joseph Sandri, Member, Board of Directors, National Spectrum Management Association to Marlene H. Dortch, Secretary, Federal Communications Commission, ET Docket No. 18-295, GN Docket No. 17-183 at 1-2 (dated Apr. 6, 2020); Letter from Coy Trosclair, Director of Telecom Services, Southern Company Services, to Marlene H. Dortch, Secretary, Federal Communications Commission, ET Docket No. 18-295, GN Docket No. 17-183 at 5-6 (dated Apr. 9, 2020) ("*Southern Company Apr. 9, 2019 Ex Parte*").

AT&T correctly points out, once interference to a protected service crosses the relevant threshold specified in section 15.3(m) for harmful interference, it is immediately actionable for enforcement purposes."[50] The *Draft Order* also states that "under our long-established rules, Part 15 devices are not permitted to cause harmful interference."[51] But those observations offer no comfort to the inevitable victims of harmful interference and no answer to AT&T's legal argument.

As parties have shown on the record, in the absence of AFC there is no mechanism for sources of interference to be identified or exclusion zones implemented to prevent reoccurrence.[52] In fact, because microwave links are not engineered to triangulate on potential sources of interference, and because there are naturally occurring periods of fade, microwave licensees will only be able to identify harmful interference as a statistical phenomenon manifested over time and, even if they can rapidly prove that harmful interference is occurring, there are no records of unlicensed LPI activity—time and location—that would assist them in identifying the operator of an unlicensed LPI device that is violating the "no harmful interference" rule. The bare assertion in the *Draft Order*, therefore, that the agency can correct instances where individual unlicensed LPI devices are in violation of its rules is an empty promise.

Because there is no practical *ex post* remedy for harmful interference, it is arbitrary and unjustified for the Commission to throw open the gates for the deployment of one billion unlicensed devices without actual testing and trials beforehand. Indeed, when proponents of new technologies sought approval to test LAA devices in Wi-Fi bands, Broadcom—one of the unlicensed LPI proponents in this proceeding—stated that it "believes that LAA devices can coexist with Wi-Fi given proper planning and the incorporation of robust coexistence mechanisms," but cautioned that "[t]his belief is based on [Broadcom's] understanding of the technology and reasonable assumptions, *but there is no substitute for actual testing, and such tests may reveal results that are not contemplated by the parameters in our simulations*."[53] Broadcom also argued that "[a]dditional . . . coexistence work remains critical prior to mass

[50] *Draft Order* ¶ 146.

[51] *Id.*

[52] *See, e.g.*, Letter from Michael Goggin, AT&T Services, Inc. to Marlene H. Dortch, Secretary, Federal Communications Commission, ET Docket No. 18-295, GN Docket No. 17-183 (dated Aug. 8, 2019) (discussing minimal AFC requirements and role in mitigation); Letter from Donald Evans, counsel to the Fixed Wireless Communications Council, to Marlene H. Dortch, Secretary, Federal Communications Commission, ET Docket No. 18-295, GN Docket No. 17-183 at Att., p. 8 (dated June 28, 2019) (noting "when [non-controlled RLANs] . . . cause interference, they cannot be turned off").

[53] Letter from Christopher Szymanski, Director Global Regulatory Affairs, Broadcom Corporation, to Marlene Dortch, Secretary, Federal Communications Commission, ET Docket No. 15-105 at 1 n.2 (dated June 11, 2015) (emphasis added).

deployment."[54] These same considerations predominate here—mass deployment and factors that may not have been contemplated by the parameters in simulations.

Although AT&T generally supports the overall thrust of the test plan set forth in Southern Company's recent *ex parte*,[55] testing should also include the measurements and analyses discussed in Attachment 2. The proposed tests would provide some security that the parameters modeled in Monte Carlo simulations—and parameters that the *Draft Order* suggests should be applied to static modeling—have some basis in the real world.

Should any questions arise concerning this *ex parte*, please do not hesitate to contact me at (202) 457-2055.

Sincerely,

/s/ Michael P. Goggin

Michael P. Goggin

[54] Letter from Christopher Szymanski, Director, Product Marketing and Global Affairs, Broadcom Corporation, to Marlene H. Dortch, Secretary, Federal Communications Commission, ET Docket No. 15-105 at Att., p. 15 (dated Mar. 15, 2016).

[55] *Southern Company Apr. 9, 2019 Ex Parte* at Att..

ATTACHMENT 1
AT&T STATIC CASE TECHNICAL PARAMETERS

In Table 1 below, AT&T reproduced the data in Table 5 from the *Draft Order*, although modifying the final ñI/Nò row to calculate the value from the data in the table. AT&Tôs calculated values match those in the Draft Order with the exception of a 0.5 dB difference in Example 3:

	Example 1A	Example 1B	Example 2	Example 3	Example 4	Example 5
EIRP Power Spectral Density (dBm/MHz)	5	5	5	5	5	5
LPI Device Bandwidth (MHz)	80	80	80	80	80	80
EIRP (dBm)	24	24	24	24	24	24
RLAN Antenna Discrimination (dB)	-5	-5	-5	-5	-5	-5
BW Mismatch (80 MHz Chan.) (dB)	-4.26	-4.26	-4.26	-4.26	-4.26	-4.26
Polarization Loss (dB)	-3	-3	-3	-3	-3	-3
Propagation Model	Winner II Urban LOS	Winner II Urban LOS	ITM P2P	ITM P2P	Winner II Suburban LOS	Winner II Suburban LOS
Propagation Loss	-103.6	-99.5	-120.12	-122.7	-96.1	-83.6
Clutter Loss (dB)	0	0	-18.4	-18.4	0	0
MW Antenna Gain (dB)	43.2	43.2	37.9	38.3	41.3	38.8
MW Antenna Discrimination (dB)	-36	-38	-1.5	-0.9	-38	-40
Feeder Loss	-2	-2	0	0	-2	0
Building Entry Loss (70T/30E) 50th Percentile (dB)	-21.4	-21.9	-20.6	-20.6	-23.1	-24.0
Noise (dBm)	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0
Noise Figure (dB)	3	3	3	3	3	3
I/N	-12.06	-10.46	-15	-16.6	-10.2	-1.06

Table 1: Draft Order Values for AT&T Case Studies

As shown in *Table 1*, the *Draft Order* applies a Building Entry Loss (ñBELò) based on the 50th percentile from ITU-R P.2109-1, with a mix of 70% traditional construction and 30% energy efficient construction. As should be apparent from the photographs included with AT&Tôs

original case study submission, however, the building in the principle example analyzed in the *Draft Order* is plainly not outfitted with ñmetalized glassò and foil-backed panels:[1]

Figure 1: Residence in AT&T Case 2

If the BEL is adjusted to reflect a 90th percentile value and traditional construction, the conclusions from the *Draft Order* change markedly:

	Example 1A	Example 1B	Example 2	Example 3	Example 4	Example 5
EIRP Power Spectral Density (dBm/MHz)	5	5	5	5	5	5
LPI Device Bandwidth (MHz)	80	80	80	80	80	80
EIRP (dBm)	24	24	24	24	24	24
RLAN Antenna Discrimination (dB)	-5	-5	-5	-5	-5	-5
BW Mismatch (80 MHz Chan.) (dB)	-4.26	-4.26	-4.26	-4.26	-4.26	-4.26
Polarization Loss (dB)	-3	-3	-3	-3	-3	-3
Propagation Model	Winner II Urban LOS	Winner II Urban LOS	ITM P2P	ITM P2P	Winner II Suburban LOS	Winner II Suburban LOS
Propagation Loss	-103.6	-99.5	-120.12	-122.7	-96.1	-83.6
Clutter Loss (dB)	0	0	-18.4	-18.4	0	0

[1] Letter from Michael P. Goggin, AT&T Services, Inc., to Marlene H. Dortch, Secretary, Federal Communications Commission, ET Docket No. 18-295, GN Docket No. 17-183 at 4-8, Att. (dated Nov. 12, 2019) (ñ*AT&T Nov. 12, 2019 Ex Parte*ò).

MW Antenna Gain (dB)	43.2	43.2	37.9	38.3	41.3	38.8
MW Antenna Discrimination (dB)	-36	-38	-1.5	-0.9	-38	-40
Feeder Loss	-2	-2	0	0	-2	0
Building Entry Loss 90th Percentile, Traditional Construction (dB)	-9.0	-9.0	-9.0	-9.0	-9.0	-9.0
Noise (dBm)	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0
Noise Figure (dB)	3	3	3	3	3	3
I/N	0.34	2.44	-3	-5.0	3.9	13.94

Table 2: Revised I/N with BEL

With this one change, standing alone. every single one of the case studies show an I/N in excess of the -6 dB threshold for harmful interference.

However, the table in the *Draft Order* contains other serious errors as well. In both Example 2 and Example 3, the *Draft Order* applies a -18.4 dB clutter loss factor. Looking at the terrain profiles and land area for both examples, however, shows that in both cases the value applied is radically overstated. In Example 2, a Google Earth terrain profile shows no terrain obstructionsð remembering that the microwave receiver is located 27.4 m above ground level and, that while the terrain profile exaggerates height differences, the total height variation in the profile is only 24 feet:

Figure 2: Terrain Considerations for Example 2

With elementary geometry, even if a tree was located at the worst point in the terrain profile, it would have to be in excess of 12 m tall to affect the microwave signal. And even if a few trees did reach that height, 18.4 dB of attenuation is vastly overstated. At most, even in the worst case, 10 dB of attenuation would be conservative.

The application of -18.4 dB of clutter attenuation in Example 3 is even more egregious. The terrain profile, and the actual countryside, reveal clear line-of-sight and no vegetation beyond planted fields that are unlikely to even reach 1-2 m in growth height:

Figure 3: Terrain Considerations for Example 3

In this case, there is no reasoned argument for applying any attenuation due to clutter.

If Table 2 is adjusted to modify the clutter loss to rational values, the potential for interference becomes even more evident:

	Example 1A	Example 1B	Example 2	Example 3	Example 4	Example 5
EIRP Power Spectral Density (dBm/MHz)	5	5	5	5	5	5
LPI Device Bandwidth (MHz)	80	80	80	80	80	80
EIRP (dBm)	24	24	24	24	24	24
RLAN Antenna Discrimination (dB)	-5	-5	-5	-5	-5	-5
BW Mismatch (80 MHz Chan.) (dB)	-4.26	-4.26	-4.26	-4.26	-4.26	-4.26
Polarization Loss (dB)	-3	-3	-3	-3	-3	-3
Propagation Model	Winner II Urban LOS	Winner II Urban LOS	ITM P2P	ITM P2P	Winner II Suburban LOS	Winner II Suburban LOS
Propagation Loss	-103.6	-99.5	-120.12	-122.7	-96.1	-83.6
Clutter Loss (dB)	0	0	-10.0	0.0	0	0
MW Antenna Gain (dB)	43.2	43.2	37.9	38.3	41.3	38.8
MW Antenna Discrimination (dB)	-36	-38	-1.5	-0.9	-38	-40

Feeder Loss	-2	-2	0	0	-2	0
Building Entry Loss 90th Percentile, Traditional Construction (dB)	-9.0	-9.0	-9.0	-9.0	-9.0	-9.0
Noise (dBm)	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0
Noise Figure (dB)	3	3	3	3	3	3
Calculated Interference	-95.66	-93.56	-90.98	-82.56	-92.06	-82.06
FCC Interference Criteria	-96.00	-96.00	-96.00	-96.00	-96.00	-96.00
I/N	0.34	2.44	5	13.4	3.9	13.94

Table 3: Draft Order I/N Adjusted for BEL, Clutter Loss

In this case, the I/N values exceed the threshold for harmful interference by at least 6.34 dB, and by as much as 19.94 dB. And as AT&T has also argued, the ñRLAN Antenna Discriminationò is overstatedð the orientation of the LPI access point cannot be controlled and, in some examples, the off-axis angle is no more than 1 degree. Removing that adjustment would lead to I/N values in excess of the -6 dB harmful interference threshold by more than 10 dB and up to almost 25 dB.

As a final matter, AT&T has provided a table below that considers the potential interference from client devices located outdoors for the scenarios detailed above. Such a client device is required to operate at a PSD 6 dB less than the associated access point, or -1 dBm/MHz. But if the client device is located outdoors, there would be zero BEL loss and, because there is no argument at all that the orientation of client devices could be controlled, the RLAN antenna discrimination factor should be eliminated:

	Example 1A	Example 1B	Example 2	Example 3	Example 4	Example 5
EIRP Power Spectral Density (dBm/MHz)	-1	-1	-1	-1	-1	-1
LPI Device Bandwidth (MHz)	80	80	80	80	80	80
EIRP (dBm)	18	18	18	18	18	18
RLAN Antenna Discrimination (dB)	0	0	0	0	0	0
BW Mismatch (80 MHz Chan.) (dB)	-4.26	-4.26	-4.26	-4.26	-4.26	-4.26
Polarization Loss (dB)	-3	-3	-3	-3	-3	-3

Propagation Model	Winner II Urban LOS	Winner II Urban LOS	ITM P2P	ITM P2P	Winner II Suburban LOS	Winner II Suburban LOS
Propagation Loss	-103.6	-99.5	-120.12	-122.7	-96.1	-83.6
Clutter Loss (dB)	0	0	-10.0	0.0	0	0
MW Antenna Gain (dB)	43.2	43.2	37.9	38.3	41.3	38.8
MW Antenna Discrimination (dB)	-36	-38	-1.5	-0.9	-38	-40
Feeder Loss	-2	-2	0	0	-2	0
Building Entry Loss 90th Percentile, Traditional Construction (dB)	0.0	0.0	0.0	0.0	0.0	0.0
Noise (dBm)	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0
Noise Figure (dB)	3	3	3	3	3	3
Calculated Interference	-87.66	-85.56	-82.98	-74.56	-84.06	-74.06
FCC Interference Criteria	-96.00	-96.00	-96.00	-96.00	-96.00	-96.00
I/N	8.34	10.44	13	21.4	11.9	21.94

Table 4: Impact of Outdoor Client Devices

As shown in Table 4, the I/N associated with these devices ranges from 14 dB to 25 dB over the -6 dB I/N threshold for harmful interference.

ATTACHMENT 2
6 GHz RLAN TEST CASES

At a minimum, pre-authorization testing of unlicensed radio local area network (ñRLANò) devices in the 6 GHz band should include:

1. RLAN interference impact on faded point-to-point microwave system:

   Tests should be performed on various 6 GHz point-to-point systems, transporting TDM and various frame size Ethernet payloads, operating at different channel bandwidths, with various static and adaptive modulation levels. The impact on these systems from RLAN devices, operating at different channel bandwidths and different throughputs (and presumably different activity factors) for different C/I levels should be investigated.

   These tests can be performed in a properly equipped lab with representative 6 GHz point-to-point systems and RLAN devices. See the cabling diagram below regarding how equipment under test could be configured.

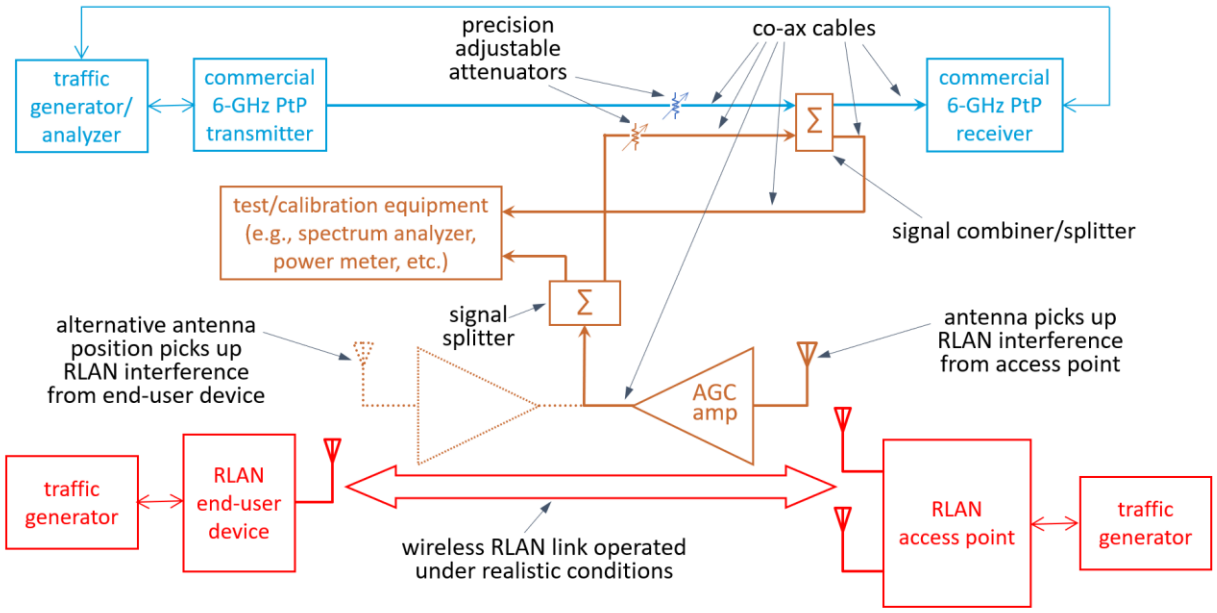

Figure 1: Possible lab set-up to determine the impact of RLAN interference to fixed service radios at 6 GHz

2. Victim antenna off-axis nearby interference power capture:

   Based on work of AT&T and other investigators, an important source of potential interference comes from. Tests should be performed on 6 GHz RLAN devices operating well off boresight but very near the victim antenna (within the ςȮ˙ j⎯ far field distance of the antenna).

This testing can be performed on an antenna test range or properly equipped anechoic chamber. The interfering source can be a 6 GHz RLAN device operating under known transmitting conditions or a broadband source transmitting at a known conducted power level into a standard gain antenna.

3. RLAN Building Entry Loss (BEL):

Currently the ITU-R P.2109 BEL model is being used to estimate the amount of building loss an indoor 6 GHz access point will be shielded from a victim antenna. That model is based on many studies performed with different equipment, in different buildings and at different bands. Some measurements of actual RLAN devices and their antenna systems, located at different positions in various types of buildings at 6 GHz, could be performed to confirm the validity of the P.2109 model for RLAN interference predictions.

This testing would need to be conducted in the field. RLAN devices could be set up at different locations in some different building types and the radiated emissions from the building be recorded outside by a nearby transportable measurement system. Care should be taken to include some RLAN device positions near exterior walls and windows.

Measurements could also be made to determine if end-user devices can operate outdoors from an indoor access point and under what conditions.