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Ms. Marlene H. Dortch, Secretary
Federal Communications Commission
445 12th Street SW
Washington DC 20554

Re: ET Docket No. 18-295, *Unlicensed Use of the 6 GHz Band*
GN Docket No. 17-183, *Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz*
***Ex Parte* Communication**

Dear Ms. Dortch:

The Fixed Wireless Communications Coalition submits the attached study by George Kizer in the above-referenced dockets.

Respectfully submitted,

Donald J. Evans
Mitchell Lazarus
Counsel for the Fixed Wireless
Communications Coalition

Overview of 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

George Kizer

A proponent of unlicensed RLANs in the 6 GHz band filed a slide deck[1] with excerpts from ECC Report 302,[2] arguing the report shows low power RLANs without automated frequency coordination ("AFC") control are compatible with incumbent fixed and satellite operations. An opponent of 6 GHz RLANs filed the same report to show the opposite: that AFC is needed for all RLANs to prevent interference to Fixed Service (FS) receivers.[3]

Here we analyze the report to show the RLAN opponent was correct: all RLANs whether indoors or outdoors threaten FS interference unless under AFC control.

Propagation Models

As is common in these studies, propagation models are used to facilitate simulations. The models used were Urban and Rural[4].

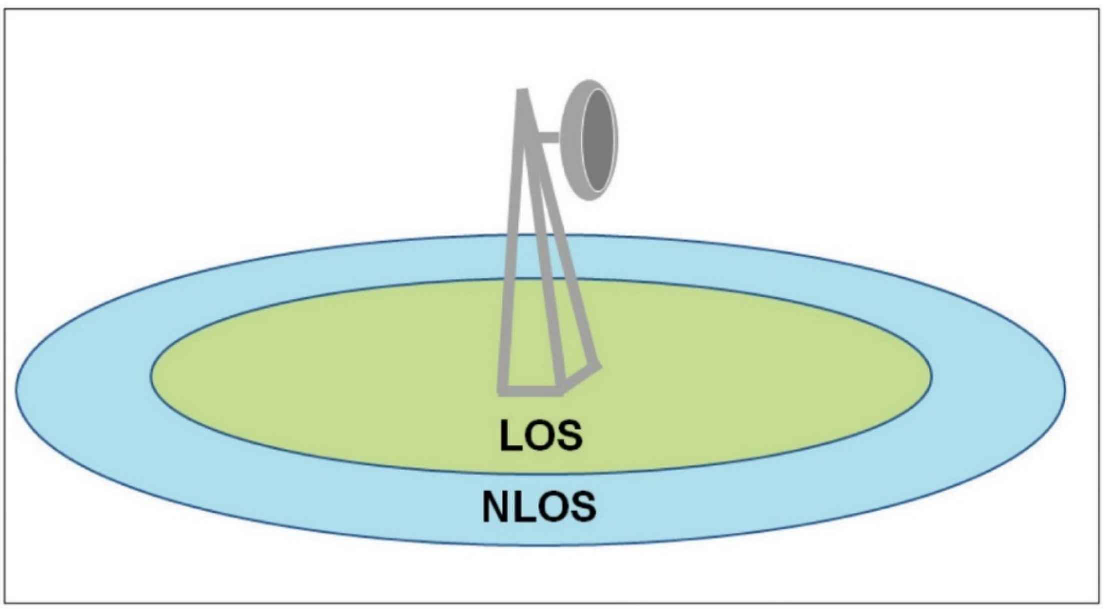

Figure 101: Illustration of LOS and NLOS areas
ECC Report 302, page 163

[1] Letter from E. Austin Bonner, Counsel to Broadcom Inc., to Ms. Marlene H. Dortch, Secretary, FCC (filed Aug. 13, 2019) (with attachment).
[2] https://www.ecodocdb.dk/download/cc03c766-35f8/ECC%20Report%20302.pdf
[3] Letter from Michael P. Goggin, AT&T, to Marlene H. Dortch, Secretary, FCC (filed Aug. 2, 2019 (with attachment).
[4] ECC Report 302, pages 37-398 and 162-168.

(This figure from the report is potentially misleading in making Non-Line of Sight (NLOS) distances look short, where in practice they can be much longer than Line of Sight (LOS) distances.)

Urban:

For distances between the RLAN and the FS antenna of less than 1000 meters, propagation is Line of Sight (LOS) per ITU-R P.1411-9. There is no clutter. Building penetration loss (if applicable) is per ITU-R P.2109-0.

For distances between the RLAN and the FS antenna of at least 1000 meters, propagation is Non-Line of Sight (NLOS) per ITU-R P.452-16. Clutter is per ITU-R P.2108-0. Building penetration loss (if applicable) is per ITU-R P.2109-0.

Rural:

For distances between the RLAN and the FS antenna of less than 4017 meters, propagation is Line of Sight (LOS) per ITU-R P.452-16. There is no clutter. Building penetration loss (if applicable) is per ITU-R P.2109-0.

For distances between the RLAN and the FS antenna of at least 4017 meters, propagation is Non-Line of Sight (NLOS) per ITU-R P.452-16. Clutter is per ITU-R P.452-16. Building penetration loss (if applicable) is per ITU-R P.2109-0.

As noted in the report[5], these models are very similar to the Winner II models[6]. The Winner II model (Table 4.4, pages 44 and 45) has the following propagation break points for 6 GHz:

Urban (C2): 3000 meters
Suburban (C1): 960 meters
Rural (D1): 3840 meters

They appear to be in reasonable agreement with the ITU-R values of 1000 for urban and 4017 for rural, given the differences in city layouts.

These models are different from the RLAN proponents' RKF models[7] which did not use LOS when the distance between the RLAN and the FS antenna was short (distance less than the break point). This significantly influenced the RKF results to understate interference from the RLANs – and is contrary to normal practice[8].

[5] ECC Report, pages 164-167.

[6] WINNER II Channel Models, Information Society Technologies, September 30, 2007, Updated February 4, 2008, pages 43-45, https://www.cept.org/files/8339/winner2%20-%20final%20report.pdf

[7] *Frequency Sharing for Radio Local Area Networks in the 6 GHz Band January 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 33-35 (filed Jan. 26, 2018). (RKF Study). The RLAN proponents attempted to use the WINNER II model, but neglected to include the LOS portion of the model.

[8] ITU-R Recommendation P.1411-9, Propagation data and prediction methods for the planning of short-range outdoor radiocommunication systems and radio local area networks in the frequency range 300 MHz to 100 GHz, 2017, page 13, Figure 4

Key Radio Parameters

Point-to-Point Fixed Service (PP FS) Radios[9]:

64 and 128 QAM
30 and 40 MHz Bandwidth
+19 to + 32 dBm Transmit Power
38 to 45 dBi Antenna Boresight Gains
4 to 5 dB Noise Figure
15 to 110 meter Antenna Heights AGL
10 to 80 km Path Lengths
Protection Requirement: I/N = -10 or -20 per ITU-R F.758, Table 4

WAS/RLAN Radio Transmitters[10]:

Indoor (enterprise): +23.6 dBm peak EIRP
Indoor (consumer): +23.8 dBm peak EIRP
Indoor (high performance): +29.9 dBm peak EIRP
Indoor/Outdoor: +18.5 dBm peak EIRP
Outdoor: +24.1 dBm peak EIRP
Outdoor (high power): +29.9 dBm peak EIRP
Indoor/Outdoor (High Power): 30 dBm peak EIRP
Antenna Patterns[11]: Essentially Omnidirectional
Channel Bandwidths[12]: 20, 40, 80 and 160 MHz

As point of comparison, the RKF study suggests RLAN powers ranging from 18.5 to 35.3 dBm EIRP[13]. More recently, proponents have suggested non-AFC-controlled indoor RLANs at +30 dB EIRP, and non-AFC-controlled outdoor RLANs at +14 dBm EIRP. Like the ECC report, RKF proposes omnidirectional antennas and similar channel bandwidths.

Sharing [Studies] Between WAS/RLAN and Fixed Service

Historically European agencies use an I/N criterion of -20 dB for single inter-system interference cases where multiple cases of simultaneous interference are expected. The criterion of -10 dB is used for single inter-system interference cases where only one interference case is expected. The criterion -6 dB is used when only one case of intra-system interference is expected.

[9] ECC Report 302, Table 17, page 31
[10] ECC Report 302, Table 3, page 17, and last paragraph on page 17.
[11] ECC Report 302, pages 149-151
[12] ECC Report 302, Figure 1 and Table 11, page 22.
[13] RKF Study at 18, Table 3-4..

In North America the less stringent criterion of -6 dB is used for all single cases of interference. FS operators do not expect multiple simultaneous cases of RLAN interference. Nevertheless, the European -10 dB I/N results should provide at least general guidance relative to cases where the North American -6 dB I/N is used.

Study A: MCL Analysis of Interference from WAS/RLAN into FS[14]

This study determines the Minimum Coupling Loss (MCL) between an RLAN and an FS receive antenna. The result determines the minimum separation distance between a single RLAN and an FS receive antenna in which the I/N does not exceed -10 dB (blue line) or -20 dB (red line). Bald earth (no clutter) and line of sight are assumed. See Figures 6 through 15[15] for examples with a range of equipment parameters. In these cases, separation distances for I/N of -10 dB ranged from 400 to 28,200 meters. Separation distances for I/N of -20 dB ranged from 900 to 36,000 meters.

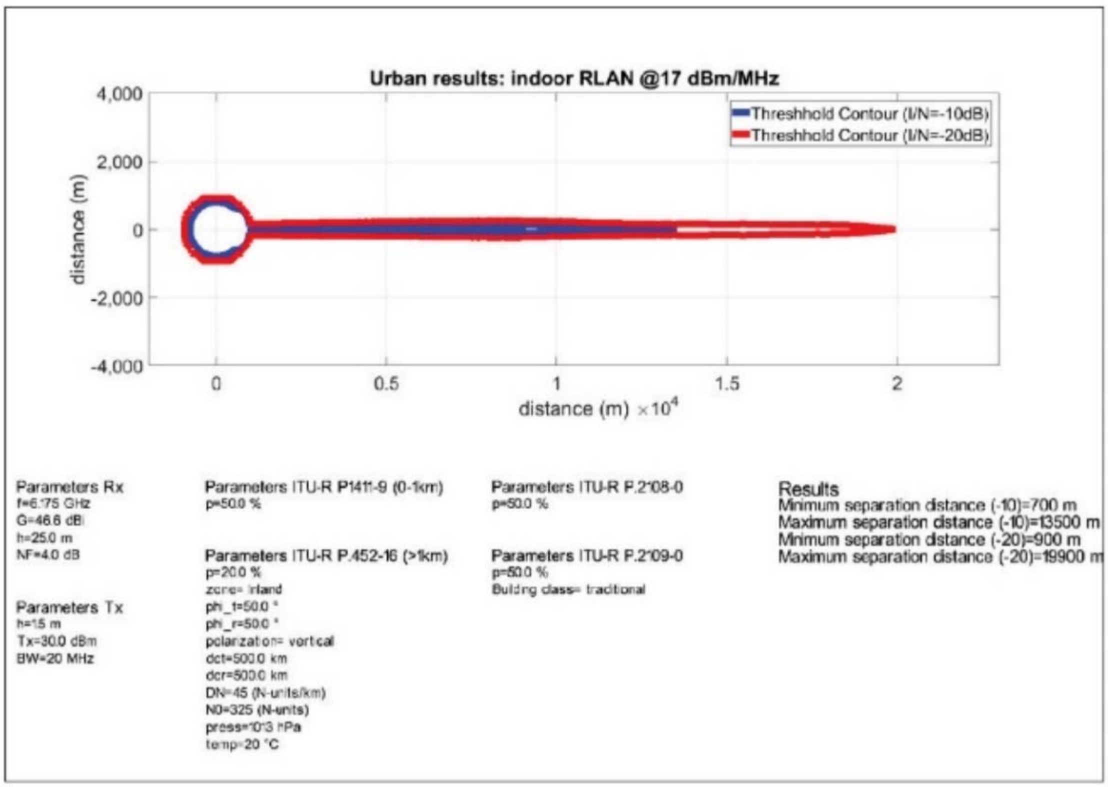

Figure 6: Urban results - indoor WAS/RLAN @ 17 dBm/MHz e.i.r.p.
ECC Report 302, page 47

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[14] ECC Report 302, pages 43-62
[15] ECC Report 302, pages 47-53

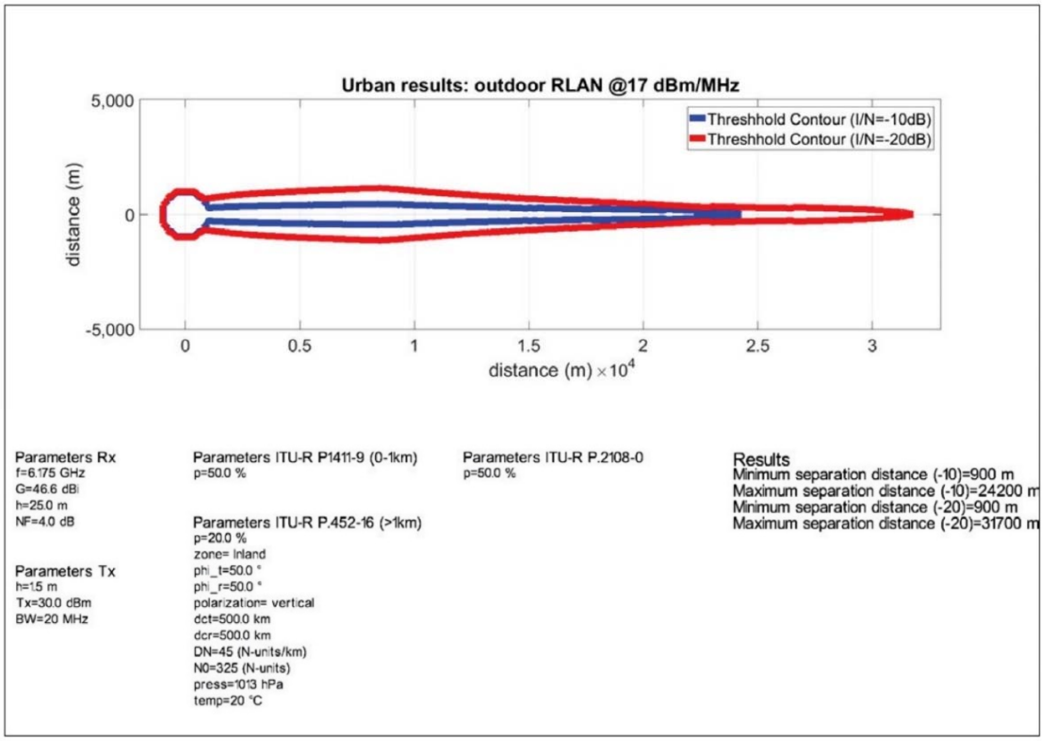

Figure 8: Urban results - outdoor WAS/RLAN @ 17 dBm/MHz e.i.r.p.

ECC Report 302, page 48

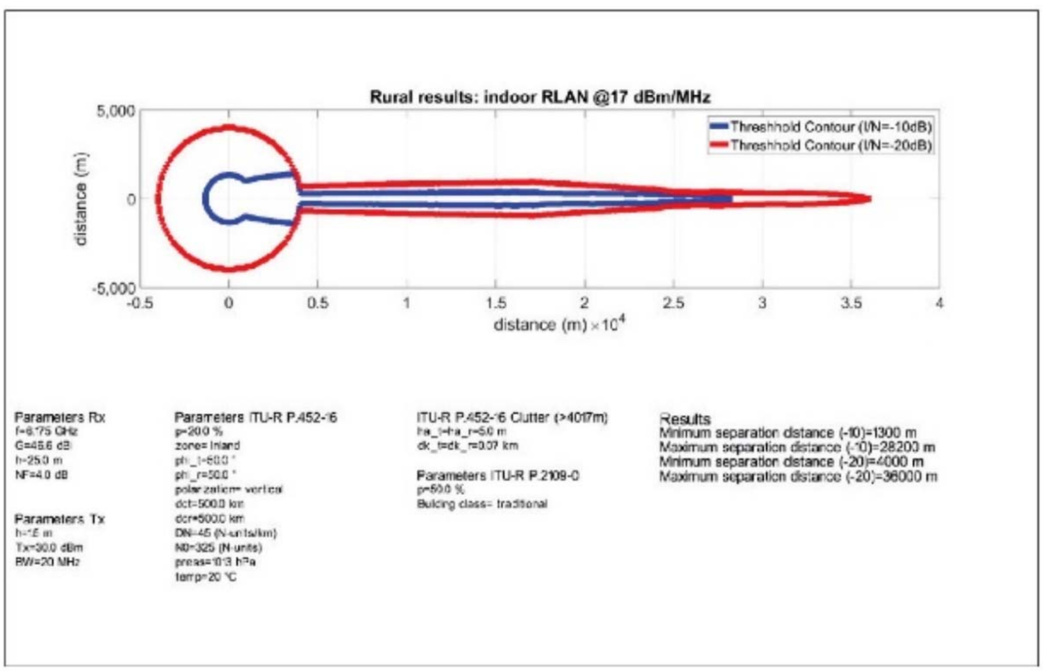

Figure 11: Rural results - indoor WAS/RLAN @ 17 dBm/MHz e.i.r.p.

ECC Report 302, page 50

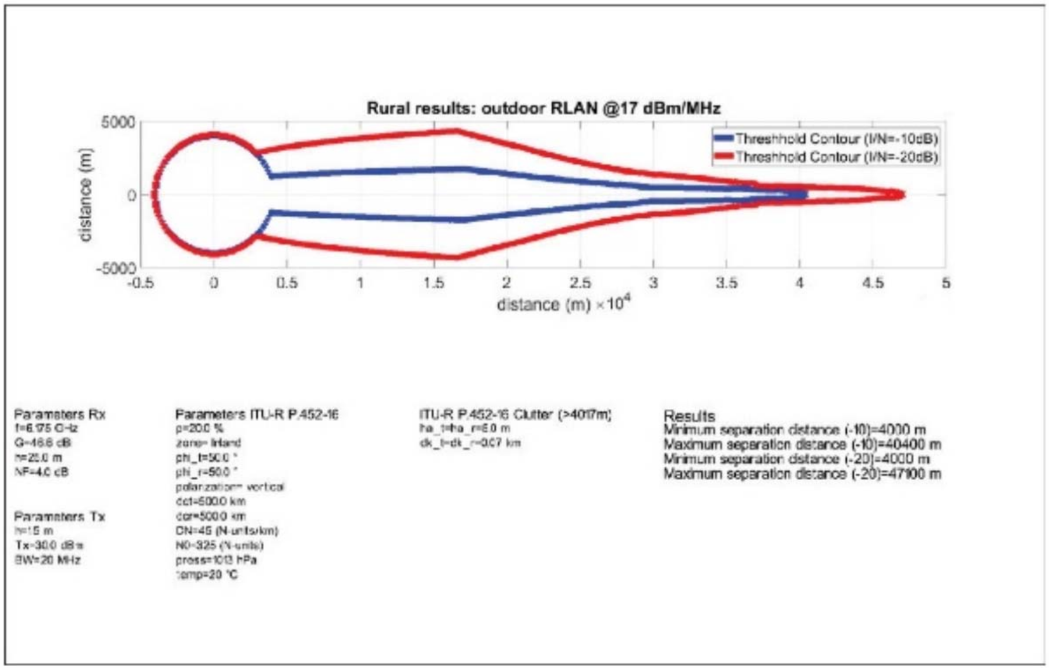

Figure 13: Rural results - outdoor WAS/RLAN @ 17 dBm/MHz e.i.r.p.
ECC Report 302, page 52

These results are similar to those provided by the FWCC[16] last year, except the FWCC MCLs (exclusion zones) were considerable smaller since they were based upon RKF's assumption of clutter between the RLAN and the FS antenna.

Studies for different FS antenna heights and different indoor RLANs were displayed in Figures 16 to 20. (MAGL in those plots is "meters above ground level".) Several other scenarios are provided in Tables 25 through 30.

Overall, these studies show interference is highly dependent upon the details of the situation. Because the greatest FS interface risk comes from a single, atypically located RLAN (see Monte Carlo results below), an AFC function is necessary to manage the variation.

Study B: Monte Carlo Analysis of Interference from WAS/RLAN into FS[17]

This study was a Monte Carlo simulation of hypothetical WAS/RLAN deployment within actual FS networks in the United Kingdom and the Netherlands. Two-hundred-and-fifty thousand (250,000) independent WAS/RLAN deployments were simulated for each FS station. Propagation models described above were used. Each WAS/RLAN device was assigned a random location, height, EIRP, building type, frequency and channel

[16] Letter from Cheng-yi Liu and Mitchell Lazarus, Counsel, FWCC to Marlene H. Dortch, Secretary, FCC in Docket 17-183 at 9, Figure 3 and attachment, Figure 4 (filed March 13, 2018).
[17] ECC Report 302, pages 62-76

bandwidth within a range of assumed possible values[18]. Interference power was computed. Interference for distances greater than 150 km and for WAS/RLANs located with the first Fresnel zone of the FS path were ignored.

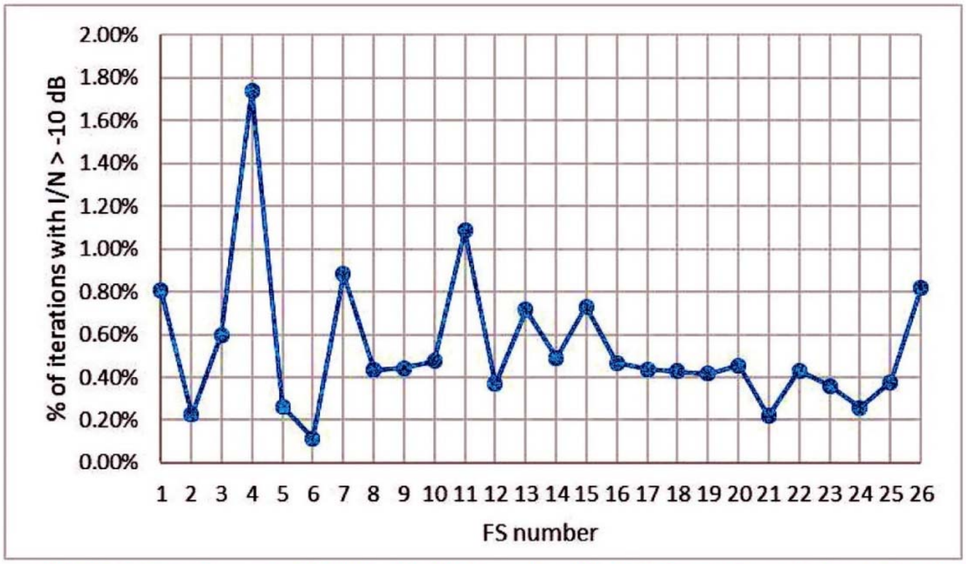

Figure 27: Statistics of aggregate I/N > -10 dB for each of the 26 FS receivers in the Netherlands
ECC Report 302, page 67

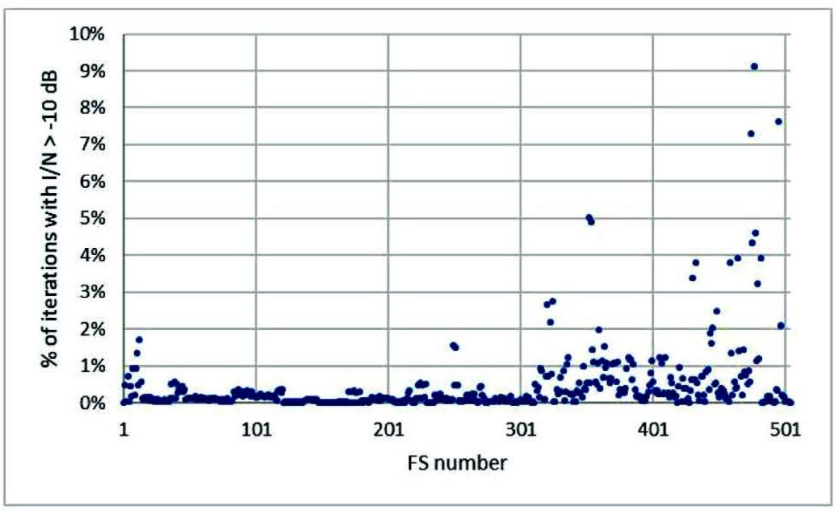

Figure 32: Statistics of aggregate I/N > -10 dB for each of the 505 FS receivers in United Kingdom
ECC Report 302, page 71

In the Netherlands [an average of] 0.540% of the WAS/RLAN cases had aggregate I/N exceeding -10 dB[19]. In the United Kingdom [an average of] 0.417% of the cases had aggregate I/N exceeding -10 dB[20]. The variation from path to path was large. In the

[18] ECC Report 302, Step 2, page 64.
[19] ECC Report 302, page 67
[20] ECC Report 302, page 71

threshold exceedance instances, most were dominated by a single WAS/RLAN device. This is typical for conventional frequency coordination in the United States today. Significant interference is generally dominated by a single transmitter.

Based upon an average of the above statistics and an approximate 100,000 FS 6 GHz links in the United States, the above results suggest approximately 478 United States FS links would experience I/N interference exceeding -10 dB. Unmanaged, the estimated aggregate interference would be unacceptable. An AFC function is needed.

Study C: Coverage Mapping and Monte Carlo Analysis of Interference from WAS/RLAN into FS[21]

This study was a Monte Carlo simulation of hypothetical WAS/RLAN indoor (24 dBm EIRP) and outdoor (30 dBm EIRP) transmitters within 70 km of three French FS links (Clermont, Dijon and Marseille). These are a subset of the overall WAS/RLAN parameters described earlier. The simulation parameters include low RLAN activity factor and significant bandwidth and channel location mismatch[22] which will lower the predicted interference. For the indoor transmitters, statistical building losses were used, with 50% of RLANs in "traditional" (low attenuation) buildings. Figures 39, 40 and 41 graph interference from the indoor and outdoor transmitters. Interference exceeding I/N = -10 dB was shown with color. Interference less than that was not shown.

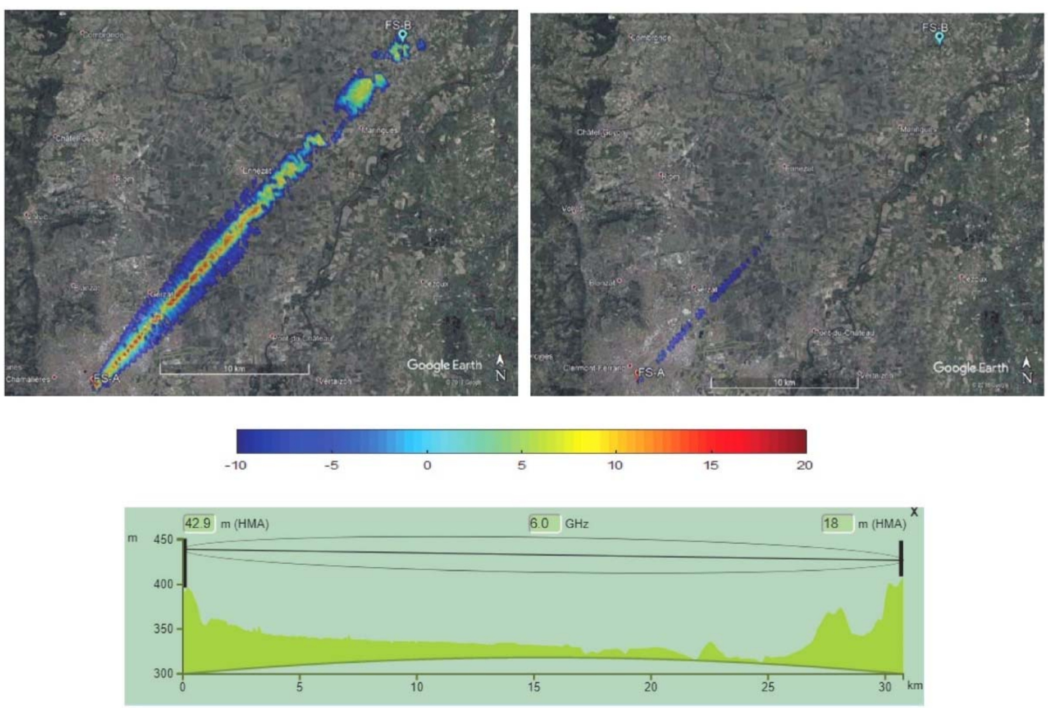

Figure 39: Fixed link 1 at Clermont-Ferrand. Top left: Outdoor WAS/RLAN impact on the fixed link, Top right: Indoor WAS/RLAN impact on the fixed link. Bottom: Fresnel zone and path profile
ECC Report 302, page 79

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[21] ECC Report 302, pages 76-82
[22] ECC Report 302, pages 77-78

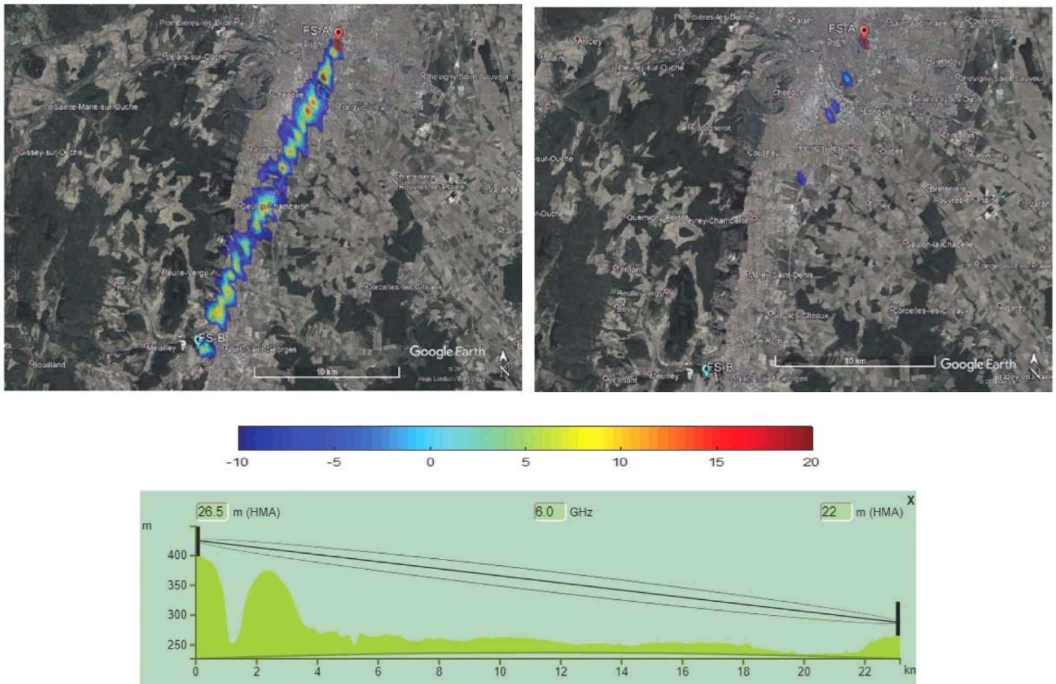

Figure 40: Fixed link 2 at Dijon. Top left: Outdoor WAS/RLAN impact on the fixed link, Top right: Indoor WAS/RLAN impact on the fixed link. Bottom: Fresnel zone and path profile

ECC Report 302, pages 79 and 80

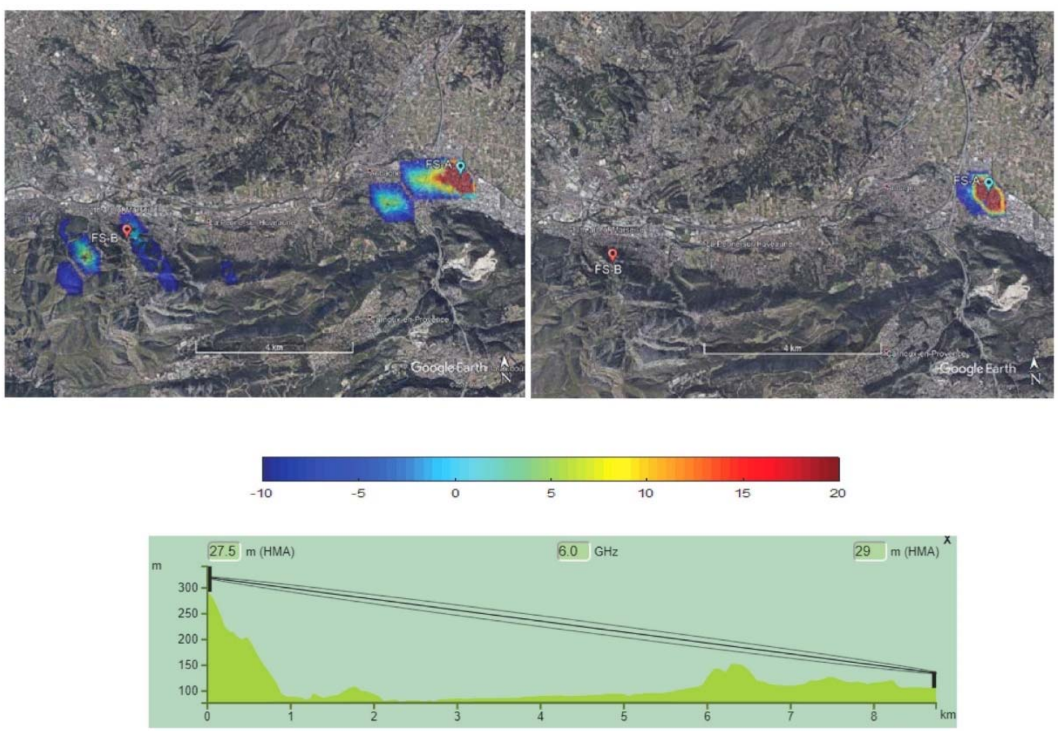

Figure 41: Fixed link 3 at Marseille. Top left: Outdoor WAS/RLAN impact on the fixed link, Top right: Indoor WAS/RLAN impact on the fixed link. Bottom: Fresnel zone and path profile

ECC Report 302, page 80

The report noted that the outdoor transmitters “could create interference from a large area around the FS link, depending on the terrain profile.” The need for an AFC function to prevent this interference is obvious.

Regarding indoor transmitters, the report states[23] “the possible interfering area is substantially reduced bringing the interference area within close proximity to the FS.” It continues[24] regarding indoor-only usage “Unfortunately, administrations have no way to control the client AP indoor/outdoor deployment, since they are unlicensed devices. Some additional techniques/restrictions may need to be applied in order to maintain the indoor usage or to mitigate the effect of accidental outdoor use, like a FS data base use for coordination, in particular, a geo-location methods [sic] that aims at detecting a spatial closeness between victim and interferer.” That is, the report supports an AFC function for indoor WAS/RLANs as well as outdoor units.

Conclusions:

Study A used subjective evaluation rather than pass/fail criteria. It showed that interference depends strongly on the unpredictable details of RLAN deployment. This in turn implies an unacceptably high risk of interference without an AFC system.

Study B (United Kingdom and the Netherlands)[25] had two criteria applied to 505 paths (receivers) in the United Kingdom and 26 paths in the Netherlands:

1. Long Term Criteria: I/N = -10 dB should not be exceeded more than 20% of the time (ITU-R Recommendation F.758). This criterion was met in all cases.

2. Fractional Degradation in Performance (FDP) < 10% (ITU--R Recommendation F.1094 as defined by ITU-R F.1108-4)

Fractional Degradation of Performance (FDP) is calculated for each FS receiver as follows:

$$FDP = \frac{1}{M}\sum_{i=1}^{M}(10^{(I/N)_i/10}),$$

where M is the total number of iterations of the Monte Carlo simulation and $(I/N)_i$ is the I/N (in dB) of the i-th iteration.

The FDP criterion basically states that the average I/N for all Monte Carlo runs for a given path must average -10 dB. This criterion was passed for all paths in the Netherlands and all but two of the 505 paths in the United Kingdom.

23 ECC Report 302, page 81
24 ECC Report 302, page 82
25 ECC Report 302, pages 71 to 76

But neither of the above criteria would be acceptable in North America. By U.S. law an unlicensed device may not cause harmful interference to a licensed service such as FS[26]. Failure for 20% of paths is not acceptable.

Study C (France)[27] had two criteria applied to three urban (worst case) paths (receivers):

1. Long Term Criteria: I/N = -10 dB should not be exceeded more than 20% of the time (ITU-R Recommendation F.758). This criterion was met in all three cases.

2. Short Term Criteria: I/N = +19 dB should not be exceeded more than 0.00045% (ITU-R Recommendation SF.1650-1). This criterion failed on two of the three paths (as noted in the report's Figure 42).

Once again, the above criteria are inappropriate for North American application.

The report nevertheless illustrates, as noted by Nokia Bell Labs[28], that all proposed forms of RLAN transmitters, low power or high, and indoor or outdoor, can cause interference into FS receivers unless controlled through AFC management.

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[26] 47 C.F.R. § 15.5.
[27] ECC Report 302, pages 80 to 82
[28] Comments of Nokia at 2 (filed Feb. 15, 2019), https://ecfsapi.fcc.gov/file/1021517912457/Nokia%206GHz%20Comments%20FINAL.pdf