Joint Reply Comments Regarding Technical Comments on the Reed Study
GN Docket No. 18-122

Introduction

WISPA, Google, and Microsoft hereby address specific technical comments made regarding the Reed Engineering Study ("Reed Study") of shared use of C-band spectrum between fixed-satellite service (FSS) earth stations and co-channel point-to-multipoint (P2MP) systems. No commenter has provided any valid technical arguments that alter the conclusions of the Reed Study. Moreover, as a separate addendum to this filing clearly shows, shared use of C-band between broadband systems and FSS earth stations is already occurring in close proximity, thereby proving the conclusions of the Reed Study.

P2MP Shared Use Of The C-band Will Not Complicate Or Encumber Repacking, Or Adversely Affect Frequency Use Of Remaining FSS Earth Stations

Commenters' claims that sharing remaining C-band spectrum with P2MP services will complicate repacking or harm spectrum use by repacked FSS earth stations are incorrect.[1]

The Reed Study assumes *co-channel* sharing between P2MP systems and FSS earth stations throughout. The co-channel interference assumption provides the "worst case" for analyzing the potential for harmful interference to FSS, and is independent of the amount of repacking and the more dense use by satellite ground stations of the remaining C-band earth station spectrum. The only pertinent information is the location of C-band terminals, information which has been improved due to the Commission's actions to refresh the C-band registration database.[2] All 18,000+ previously-existing, new, and pending earth station locations were considered in the study. Repacking earth stations from the lower part of C-band to the upper part of the band has

[1] Separate comments of C-Band Alliance (CBA), CTIA, National Association of Broadcasters, T-Mobile, and Verizon, FCC proceeding 18-122, filed August 7th, 2019
[2] FCC DA 18-398, April 19, 2018

no effect on the study's conclusions. Claims that P2MP shared use of the band would encumber the repacking process are therefore invalid.

Of course *non-co-channel* use of remaining C-band satellite frequencies would be possible in some areas where co-channel use is not possible, and the extent of such frequency availability would be reduced by repacking. But that goes beyond the Reed study, which showed that even *co-channel* use is possible with much shorter spacing than previously considered.

The Study's Propagation Model Is Realistic And Its Input Parameters Are Appropriate

CTIA incorrectly claims that the height range used in the Reed Study's analysis is out of range for the rural macrocell non-line-of-sight model (ITU-R M.2135[3]) and its associated line-of-sight probability formula because the models are only valid for a user terminal height (h_{UT}) of 1.5 m.[4] The height range for the model is specified in the last cell of the last row of table A1-2 in the ITU-R M.2135 Recommendation. CTIA interpreted the notation of h_{UT} = 1.5 m as meaning that the formula only applies for that height. However, 1.5 m is simply the default value; h_{UT} is an *input parameter* in the loss equation, and different values from the default can be used. Reading further down in that cell, the notation says that "the applicability ranges for… h_{UT} are same as UMa NLoS." Referencing the last cell of the urban macrocell non-line-of-sight model (UMa NLoS) four rows above in the table, the specified range is 1 m < h_{UT} < 10 m. The Reed Study used h_{UT} = 7 m for Customer Premise Equipment (CPE) height in its simulations, which is well within the 1-10 m applicability range.

The Reed Study's simulations effectively assume that the FSS earth station is the "base station" and the CPE is the user terminal. The applicability range for base stations in the M.2135 rural non-line-of-sight model is 10-150 m, which is more than enough to capture the height of any FSS antenna. Because the CPE and FSS heights are well within the applicability range of the propagation model, CTIA's concerns are unfounded.

In the case of interference from a P2MP base station (considered as a base station in the M.2135 model) into an FSS terminal, there may be some limited cases where one of the two ends is technically out-of-range for the model. However, there are relatively few FSS earth stations whose height is greater than 10 m. Only about 18% of the listed earth stations in IBFS

[3] ITU-R Recommendation M.2135, "Guidelines for evaluation of radio interface technologies for IMT-Advanced," available at https://www.itu.int/dms_pub/itu-r/opb/rep/R-REP-M.2135-1-2009-PDF-E.pdf
[4] CTIA comments at pp. 14-15.

have antenna height above ground level of greater than 10 m, and only about 9% above 15 m. These low percentages include several clearly nonsensical data entries, such as an earth station being listed as 2623.1 m above ground level, and many others being listed as hundreds of meters above ground level.

CTIA argues that the model was used beyond its intended range of 5 km. CTIA itself points out that the model is designed to predict coverage of mobile networks. Its use outside of its designed range is as likely to over-predict signal strength as it is to under-predict it. Despite disagreements on the nuances of the applicability range in the model, or the model's applicability for interference modeling vis-a-vis coverage modeling, we refer to p. 16 of the Reed Study where Reed Engineering compared several different models evaluated for use in the analysis.[5] The 3GPP/ITU-R M.2135 RMa NLOS model is approximately equivalent in loss to several other models, and has even less loss than one other, at a distance of ~10 km, which is the key distance governing the results of the analysis. Using any other model (with the exception of free space loss) would have had little to no impact on the results. Notably, if Reed Engineering had used the empirical model that is based directly on actual measurements, the average exclusion zone distance would have been *even less* than 10 km.

Finally, SIA notes that the earlier BAC/Google study used the Irregular Terrain Model (ITM) and deduced a 60-75 km co-channel setback between P2MP and FSS earth stations.[6] ITM does not take clutter into account and typically vastly under-predicts losses. For example, Google previously filed general results of 3.5 GHz propagation measurements that showed that ITM *under-predicts* losses by as much as 50-60 dB because it doesn't account for clutter.[7] Consider, for example, that ITM pictures the island of Manhattan as a vast flat meadow, as opposed to the extreme urban environment that it really is. In rural areas, ITM lacks knowledge of forests and other clutter that are highly attenuating at C-band frequencies. As part of the study, Reed Engineering examined more appropriate models that statistically incorporate the effects of clutter to provide a more realistic examination of the necessary exclusion zones required, on average, to protect FSS. When adding even 10 dB to ITM, the initial 60-75 km results of the BAC/Google study reduce to distances similar to those derived in the Reed Study.

[5] Comments of the Wireless Internet Services Providers Association, Google LLC, and Microsoft Corporation, FCC 18-122, submitted July 15th, 2019.
[6] Comments of the Satellite Industry Association, FCC 18-122, submitted August 7th, 2019, at p. 6.
[7] See Amendment of the Commission's Rules with Regard to Commercial Operations in the 3550-3650 MHz Band, GN Docket 12-354, comments of Google Inc., filed Feb 16, 2016; specifically Fig. 4 of Clegg Declaration.

The Analysis Assumes Full-Band/Full-Arc

Multiple commenters were confused regarding whether the Reed Study considered earth stations' use of full-band/full-arc. It does.

The Reed Study's analysis assumed co-channel frequency use between P2MP and FSS, thereby implementing the assumption of full-band utilization for each and every earth station.

The analysis used earth station antenna pattern envelopes, assumed the antenna was pointing at a low elevation angle (10 deg), and moved the antenna around to all relative azimuths towards the P2MP system. This effectively implements consideration of full-arc, because all reasonable relative geometries of the earth station off-axis angle and the P2MP system were considered. In the plots on pages 34, 36, and 38 of the study, for instance, each geographic point shows the predicted interference to an earth station pointing at 10 deg elevation to the east (right), at all surrounding distances and azimuths to the P2MP system, while assuming the Section 25.209(a)(1) FSS antenna pattern envelope applies.

P2MP Beam Patterns Are Taken Into Account

The Content Companies claim that "point-to-multipoint transmissions necessarily emit high-powered signals in many directions, which greatly increases the difficulty of frequency coordination and the potential for harmful interference to existing C-band usage."[8] The P2MP antenna beam patterns were specifically taken into account in the study on pages 21 and 30, which deal with the P2MP base station beam pattern. As stated on page 21 of the Reed Study, "P2MP antennas are directional and are designed to place energy where it's desired (toward customers), and to greatly reduce emissions in directions where they are not desired (toward earth stations)."

Aggregate Interference From Other P2MP Or Flexible Use Systems Is Unlikely To Be A Significant Factor, But Can Be Incorporated In P2MP Network Planning If Necessary

We don't expect a large number of P2MP deployments within the immediate vicinity of a given FSS earth station. Typically, P2MP links will be deployed in areas with limited population. The P2MP systems, moreover, will likely be deployed by only one or a very small number of operators in a given area. The operators can incorporate aggregate interference considerations involving multiple P2MP systems during network planning.

[8] Comments of the Content Companies, FCC 18-122, filed on August 7th, 2019, at p. 14.

We believe that out-of-band emissions (OOBE) from flexible use systems 50 MHz or more away will be insignificant. Many of the P2MP deployments will be in areas that are un- or under-served by traditional mobile broadband providers, including those using whatever C-band spectrum is reallocated for such use. In addition, the amount of interference coming from OOBE from such systems should be exceedingly small. For example, Nokia has proposed a tight OOBE limit of -60 dBm/MHz for base stations that would apply more than 50 MHz outside the flexible use band, and therefore would apply in whatever portion of C-band shared for P2MP, assuming at least a 50 MHz guard band between flexible use and FSS. This is an extremely low limit, about 19 dB *below* the general background of spurious emissions allowed in the C-band by each and every Part 15 electronic device,[9] which would number in the millions or billions. The impact of C-band flexible use base stations would be of no significance in relation to the general background noise of spurious emissions from all devices in the area, assuming Nokia's tight OOBE limits are adopted. With regard to user terminals, we agree with Nokia that "there are network management techniques available such as power control, putting users on a different band in proximity of the FSS earth stations, etc. that could be considered to mitigate any potential interference from UEs to the FSS earth stations."[10]

The Study Calls For Site-Specific Analysis

Recognizing differences in environments surrounding individual earth stations, and the necessity of a wide range of deployment models for P2MP, we reiterate the Reed Study's explanation that each P2MP deployment must be analyzed in detail against site-specific considerations in order to fully protect FSS earth stations. In some situations, exclusion zones larger than 10 km will be needed, while in others, exclusion zones of less than 10 km may suffice.

-129 dBm/MHz Is The Appropriate Interference Objective

After careful consideration, the Commission adopted -129 dBm/MHz for the C-band FSS interference criterion in the immediately adjacent CBRS band.[11] There is no technically significant difference between earth station characteristics in 3550-3700 MHz compared to

[9] Part 15 allows spurious emissions of -41.2 dBm/MHz; see 47 CFR 15.209.
[10] Comments of Nokia, FCC 18-122, filed August 7th, 2019, at p. 2.
[11] 47 CFR 96.17

3700-4200 MHz, and therefore no technically valid reason to use a different criterion between the two bands, as suggested by CBA.[12]

Conclusion

No commenter has provided any valid technical arguments that alter the conclusions of the Reed Study.

Respectfully submitted,

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August 14, 2019

[12] CBA comments at p. 21.