Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	
Expanding Flexible Use of the 12.2–12.7 GHz Band	)	WT Docket. No. 20-443
	)	
Expanding Flexible Use in Mid-Band Spectrum Between 3.7-24 GHz	)	GN Docket No. 17-183

REPLY COMMENTS OF ONEWEB

July 7, 2021

TABLE OF CONTENTS

REPLY COMMENTS OF ONEWEB

WorldVu Satellites Limited ("OneWeb") hereby replies to the comments filed in response to the Federal Communications Commission's (the "Commission" or "FCC") Notice of Proposed Rulemaking in the above-captioned proceeding.[1]

INTRODUCTION AND SUMMARY

The FCC launched the current proceeding in an effort to determine "how best to maximize efficient use of" the 12.2-12.7 GHz band ("12 GHz band").[2] The Commission additionally seeks to determine whether widespread terrestrial mobile services can be introduced into the 12 GHz band without creating harmful interference to incumbents.[3] It is clear from the record that 1) the 12 GHz band is being put to its highest and best use by the incumbent non-geostationary, fixed-satellite services ("NGSO FSS") licensees and market access grantees, and 2) terrestrial mobile in the 12 GHz band will create harmful interference to these incumbents. Not only have the Multichannel Video Data and Distribution Service ("MVDDS") licensees failed to show that their proposed changes to the spectrum allocations in this band would not cause harmful interference to incumbents, the study they commissioned[4] shows the opposite, at least with respect to NGSO FSS systems: NGSO FSS would experience harmful interference if the Commission introduces terrestrial mobile into the 12 GHz band.

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[1] *Expanding Flexible Use of the 12.2-12.7 GHz Band*, Notice of Proposed Rulemaking, 36 FCC Rcd 606 (2021) ("*NPRM*").

[2] *Id*. ¶ 1.

[3] *Id*. ¶ 2.

[4] *See* Comments of RS Access, LLC, WT Docket No. 20-443 (filed May 7, 2021) ("RS Access Comments").

The Commission further asks, in the event it could introduce a terrestrial mobile allocation without creating harmful interference to incumbent licensees, whether such a reallocation would promote or hinder the deployment of next-generation services in the band.[5] This question need not be reached since the record is now clear that harmful interference to NGSO operators would occur by introducing a terrestrial mobile allocation.[6] However OneWeb and other commenters illustrate a number of ways in which next-generation deployments would be hindered by introducing a terrestrial mobile allocation in the 12 GHz band.

Finally, the loudest proponents for introducing terrestrial mobile into the 12 GHz band are a handful of parties whose business plans have proved fruitless for nearly two decades, led by two who now see an opportunity for a financial windfall. These MVDDS parties, such as DISH Network ("DISH"), have either squatted on their MVDDS licenses since these were awarded[7] or, like RS Access, LLC ("RS Access"), recently acquired their MVDDS licenses in a move that is reminiscent of its gamesmanship in the 600 MHz incentive auction where it briefly acquired broadcast licenses and extracted payment to relocate.[8] It is difficult indeed to imagine another rationale for these parties' proposal given that, together, they have built and operated exactly

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[5] *NPRM* ¶ 2.

[6] RS Access Comments, Appendix A.

[7] Comments of OneWeb, WT Docket No. 20-443, at 3–4, 22–25 (filed May 7, 2021) ("OneWeb Comments"); Comments of Space Exploration Holdings, LLC, WT Docket No. 20-443, at 13–16 (filed May 7, 2021) ("SpaceX Comments").

[8] SpaceX Comments at 16–17; Thomas Gryta, *Michael Dell Makes Millions in FCC's Airwaves Auction*, WALL STREET JOURNAL, (Apr. 13, 2017), https://www.wsj.com/articles/michael-dell-makes-millions-in-fccs-airwaves-auction-1492124196.

zero terrestrial mobile networks to date.[9] By contrast, an operator with decades of experience building and operating terrestrial mobile networks has confirmed that a terrestrial mobile allocation in the 12 GHz band will create harmful interference for incumbents.[10]

Arguments in support of introducing a terrestrial mobile allocation into a spectrum band with comparatively poor terrestrial propagation characteristics ignore the fact that such an allocation would only serve consumers who currently have many terrestrial mobile options in the areas where they live, work, and play. If the Commission chooses to introduce a terrestrial mobile allocation into the 12 GHz band, it will be helping the rich get richer—quite literally, and in more ways than one—while preventing NGSO FSS operators from using the band to deliver on America's near-century long goal of providing universal service for *all* its people.

I. THE RECORD SHOWS NGSO FSS OPERATORS ARE MAXIMIZING THE EFFICIENT USE OF THE 12 GHZ BAND

A. NGSO FSS Operators Are Building Low Earth Orbit ("LEO") Constellations That Will Provide Coverage To Every Inch Of America

In the *NPRM*, the FCC noted its longstanding commitment "to ensuring that spectrum is put to its highest and best use."[11] Today, the record clearly shows that NGSO FSS operators are putting 12 GHz band spectrum to its highest and best use.[12]

[9] Although DISH has announced that it is in the process of constructing a terrestrial mobile network, the fact remains that any forthcoming terrestrial mobile network will be its first.

[10] *See generally* Comments of AT&T Services, Inc., WT Docket No. 20-443 (filed May 7, 2021) ("AT&T Comments").

[11] *NPRM* ¶ 19.

[12] *See e.g.*, OneWeb Comments at 5–10.

1. For Almost A Century, It Has Been A Policy Goal To Provide Communications Coverage To All Americans, First For Voice And Now Broadband

Since the Communications Act of 1934 in the early 20th century, policymakers have worked to promote connectivity to all Americans through various iterations of the universal service principle. Today, a quarter-century after the Telecommunications Act of 1996 expanded the universal service principal to increase competition and facilitate service to unserved and underserved areas, many Americans still lack reliable network connectivity, even at a basic level. Furthermore, broadband access—a modern necessity— is only a dream for Americans in areas that have repeatedly been ignored by terrestrial telecommunications companies.

Despite the promise of cellular technology as a more efficient means to deliver connectivity to the unconnected, terrestrial mobile services have not provided universal service, even with decades of access to high propagating, low-band spectrum—first 850 MHz, followed later by 800 MHz, 900 MHz, 700 MHz, and now 600 MHz, spectrum[13]—and billions upon billions of capital expenditures, including many billions in subsidies from various iterations of the Universal Service Fund. Today, America still lacks full and complete coverage to residences and businesses in many areas throughout the country, much less the highways, byways, and other places that Americans work and play. If terrestrial mobile operators have not been able to cover all Americans using better propagating spectrum, billions of dollars, and decades of time to build networks, then access to the 12 GHz band—with more unfavorable propagation characteristics than low-band spectrum—is certainly not the solution.

[13] *NPRM* ¶ 14.

2. NGSO FSS Constellations Are The Only Systems That Can Provide Ubiquitous Broadband Service In This Band

In contrast to the limitations of terrestrial networks, NGSO FSS operators can provide universal coverage throughout the United States by using the 12 GHz band. OneWeb's system design incorporates satellites orbiting at 1200 km which gives each satellite a broad field of view over large portions of the earth. Each transmitting beam from a OneWeb satellite provides exponentially more coverage than a macro cell site, and a single OneWeb satellite (with multiple transmitting beams) provides a broader coverage area than the entire wireless network of all but the very largest terrestrial mobile networks. Any location in America with a line of sight to the sky will be able to receive coverage from OneWeb's LEO constellation. It is simply not feasible for terrestrial mobile operators to provide the same amount of geographic coverage as NGSO FSS operators, and the addition of 12 GHz spectrum to their spectrum stockpiles would not change this.

Today, universal service from LEO constellations is a reality. NGSO FSS operators are using the 12 GHz band to serve rural and remote areas, which is the only viable way this spectrum will ever be utilized in most of the country.[14] The limited propagation characteristics of 12 GHz spectrum mean that its terrestrial mobile use is as a capacity band—a role already filled by many millimeter wave ("mmWave") spectrum bands such as 28 GHz, 37 GHz, 39 GHz, 47 GHz, among others. While additional terrestrial mobile capacity is a laudable goal, it is one which can be achieved with the vast mmWave spectrum bands already licensed for that purpose.

By contrast, NGSO FSS operators such as OneWeb do not have many spectrum bands from which to choose. The 12 GHz band is an essential piece of NGSO FSS operators'

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[14] *See* OneWeb Comments at 8–9; *see also* SpaceX Comments at 18–19.

systems.[15] The 10.7-12.7 GHz Ku-Band is the space-to-Earth band for downlink to user terminals from NGSO FSS satellites but, given the in-band and adjacent band operations for the Ku-Band, the portion in which satellite operations are most feasible is the 12 GHz band. The Ku-band spectrum in 10.7-11.7 GHz holds thousands of terrestrial fixed point-to-point links that risk interfering with ground-based NGSO FSS terminals. That portion of the Ku-band is likely to be limited to satellite user terminals located on board aircraft, ships at sea, and in lesser-developed countries where there are significantly fewer terrestrial stations. That leaves another 500 MHz within 11.7-12.2 GHz which is comparable to the 12 GHz band, but that spectrum has its own limitations such as ITU Radio Regulations covering operational and EPFD limits that reduce its usefulness for NGSO FSS deployments. Furthermore, the large numbers of terrestrial fixed stations immediately below 11.7 GHz in the Ku-band may create out-of-band interference into nearby NGSO FSS user terminals in the 11.7-11.2 GHz range. The mistaken claim that NGSO FSS has access to thousands of MHz of spectrum[16] ignores the realities of the Ku-band specifically and reveals a lack of understanding of NGSO FSS deployments generally.[17]

Further revealing a lack of understanding of NGSO FSS deployments, some commenters attempt to justify a terrestrial mobile allocation in 12 GHz based on the higher allowed power in smartphones as compared to certain incumbent base stations.[18] Although the signals from NGSO

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[15] *See* OneWeb Comments at 8–9.

[16] *See e.g.*, Letter from Jeffrey H. Blum, EVP, External and Legislative Affairs, DISH Network L.L.C., to Marlene H. Dortch, Secretary, FCC, RM-11768, at 5, Attachment (filed July 14, 2020).

[17] *See* OneWeb Comments at 17–19.

[18] *See* Comments of Competitive Carriers Association, WT Docket No. 20-443, at 3–4 (filed May 7, 2021) ("CCA Comments").

FSS satellites reach user terminals on Earth at very low power levels relative to terrestrial technologies, the power level is perfectly adequate for NGSO FSS services. Although power levels are an irrelevant metric for justifying a particular service allocation in a spectrum band, the incompatibility that results from the difference in power levels clearly illustrates how higher-power terrestrial mobile operations are a threat to NGSO FSS operations and other incumbents in the 12 GHz band.

Universal connectivity has been an important policy goal of our country for decades, and NGSO FSS operators are now beginning to deliver a solution that has long eluded policymakers. Even though OneWeb only received its authorization to operate in the Ku-Band four years ago, [19] it has already begun putting this spectrum to productive use with 254 satellites in orbit, service above the 50th parallel—including Alaska—set to begin later this year, and service throughout the rest of the United States and its territories to commence in 2022.[20] Further, this will not be basic connectivity but high-speed, broadband connectivity.[21] This is a rare example in which a decades-long policy goal will be achieved in the coming months if policymakers simply maintain the 12 GHz spectrum allocations that are currently in place, and is clear evidence that NGSO FSS operators are putting this spectrum to its highest and best use.[22]

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[19] *See WorldVu Satellites Limited, Petition for a Declaratory Ruling Granting Access to the U.S. Market for the OneWeb NGSO FSS System*, Order and Declaratory Ruling, 32 FCC Rcd 5366 (2017); *see also* OneWeb Comments at 4–10.

[20] *See* Chris Forrester, *OneWeb heads for North Pole*, ADVANCED TELEVISION, (June 24, 2021), https://advanced-television.com/2021/06/24/oneweb-heads-for-north-pole/; *see also* Jonathan Amos, *OneWeb lays path to commercial broadband services*, BBC NEWS, (Jul. 1, 2021), https://www.bbc.com/news/science-environment-57674882.

[21] OneWeb Comments at 5–6.

[22] *Id*. at 5–10.

B. MVDDS Licensees Have Done Nothing With The Spectrum And Should Not Be Rewarded For Squatting On It—In Fact, They Should Be Removed From The Band

The MVDDS licensees' self-interest in reallocating the 12 GHz band for terrestrial mobile use is understandable[23] but should not be rewarded. In contrast to the way that NGSO FSS operators and direct broadcast satellite ("DBS") operators are putting the 12 GHz spectrum to use, the MVDDS licensees have done nothing with the spectrum other than 1) complain that they cannot use it in accordance with its longstanding allocation, and 2) petition to allocate another service in the band which happens to have the highest potential for MVDDS licensees to receive a financial windfall for their commercial failures.[24]

1. DISH Has Done Nothing To Deploy A Valid MVDDS Service In 12 GHz And Has Not Met Its Substantial Service Requirements

Commenters recognized the length of time in which DISH has held its MVDDS licenses without commencing substantial commercial service.[25] Even now, the service that DISH has launched in 12 GHz is a weak attempt to satisfy its minimal substantial service obligations, with some commenters noting that the service is not available in all places that DISH claims to offer it and that DISH sales representatives actively discourage customers from purchasing the service.[26] Despite holding these licenses for many years, DISH's MVDDS licenses are just another in the

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[23] *See supra* n. 8.

[24] OneWeb Comments at 22–25.

[25] *Id.*; SpaceX Comments at 7–8.

[26] Letter from Michael P. Goggin, AT&T Services, Inc., to Marlene H. Dortch, Secretary, FCC, RM-11768, at 6 (filed Oct. 16, 2020); SpaceX Comments at 10–13.

long list of licenses they hold for which they have a history of seeking buildout extensions[27] and/or making minimal investments in order to retain their licenses.

2. RS Access Has Previously Used A "Buy And Flip" License Strategy For Which It Has Already Been Richly Rewarded Once

Unlike DISH, which has held MVDDS licenses for many years, RS Access is a recent licensee in this spectrum.[28] It is unclear how RS Access intends to deploy service using its licenses, if at all, particularly since the record notes that RS Access runs an impossibly small organization for a business that is expected to provide services using this spectrum.[29] However, RS Access is adequately staffed if its business plan is merely to flip its MVDDS licenses should they be reallocated for two-way terrestrial mobile use. In fact, RS Access's investors previously executed a very lucrative strategy to do just that in the 600 MHz incentive auction.[30] Simply put, the Commission should not allow RS Access to profit from clear spectrum speculation at the expense of unserved and underserved consumers and the incumbents who can now connect them.

3. Unlike BSS/DBS And NGSO FSS, There Is No Demand For MVDDS Services

The one point on which disparate parties appear to agree is that MVDDS is a failed service and its co-primary spectrum allocation should be removed from the U.S. Table of Frequency Allocations.[31] The demand for this service is so low that three MVDDS licensees lost

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[27] SpaceX Comments at 15.

[28] OneWeb Comments at 9, 24.

[29] SpaceX Comments at ii (noting the RS Access website "boasts only one employee").

[30] SpaceX Comments at 17.

[31] SpaceX Comments at 7–18; CCA Comments at 3–4; Comments of T-Mobile USA, Inc., WT Docket No. 20-443, at 3, 10 (filed May 7, 2021) ("T-Mobile Comments"); *MVDDS 5G Coalition Petition for Rulemaking to Permit MVDDS Use of the 12.2-12.7 GHz Band for Two-Way Mobile Broadband Service*, RM-11768, at 6 (filed Apr. 26, 2016).

their licenses by failing to satisfy their minimal substantial service showing.[32] OneWeb agrees with SpaceX that the Commission should simply terminate the MVDDS licenses that the current MVDDS license holders have failed to build out according to the terms of those licenses.[33] Indeed, without the MVDDS licensees, the question of introducing terrestrial mobile into the 12 GHz band would not be before the Commission. The Commission should not allow MVDDS licensees—who have failed to deploy a viable commercial service over nearly two decades—to create regulatory uncertainty for licensees who are actively putting the 12 GHz band to use for unserved and underserved Americans.

II. THE COMMISSION'S FUNDAMENTAL QUESTION IS WHETHER MOBILITY CAN BE INTRODUCED INTO 12 GHZ WITHOUT CAUSING HARMFUL INTERFERENCE TO NGSO OPERATORS

As noted above, the NPRM asks if terrestrial mobile can be introduced into the band without creating harmful interference to incumbents.[34] It is clear from the record that terrestrial mobile in the 12 GHz band will create harmful interference to incumbent NGSO operators. Until just recently, even the MVDDS parties themselves agreed that it was impossible for terrestrial mobile to coexist with incumbents in 12 GHz.[35] The flawed study put forward by RS Access and speculative statements about the capabilities of incumbents' systems does nothing to change that fundamental reality.

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[32] OneWeb Comments at 24.

[33] SpaceX Comments at 7–18.

[34] *NPRM* ¶ 2.

[35] OneWeb Comments at 11–13.

A. The Record Confirms NGSO FSS Services Cannot Coexist With Terrestrial Wireless Services In The 12 GHz Band

A cross-section of key stakeholders confirms that coexistence is not possible in the 12 GHz band.[36] The record is so replete and emphatic in this regard that it need not be rehashed here. Only a single technical submission by RS Access claims to refute this well-established conclusion of incompatibility, and as explained below, this study is so laden with errors and shortcomings that it should be dismissed.

B. The RS Access Study Is Fatally Flawed

RS Access submitted into the record a technical study prepared by RKF Engineering Solutions, LLC ("RKF").[37] The RKF study relies on a probabilistic analysis in an effort to demonstrate that "coexistence in the 12 GHz band between 5G and NGSO FSS is readily achievable."[38] As explained below, the study severely underestimates the harmful interference, both in level and in likelihood, that a potential terrestrial mobile deployment in the 12 GHz band would create for NGSO FSS systems—including OneWeb's. Key parameters used in the RKF study, such as the NGSO user terminal characteristics and terrestrial mobile deployments, are not representative of real-world scenarios. Propagation models are misused, and the time-domain dimension is absent from the study, all of which provide a distorted picture of a real-world, dynamic interference environment.

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[36] *See, e.g.*, Letter from Ruth Pritchard-Kelly, Senior Advisor, OneWeb *et al.*, to Marlene H. Dortch, Secretary, FCC, RM-11768, at 4 (filed Oct. 20, 2020); SpaceX Comments at 20–24; Comments of TechFreedom, WT Docket No. 20-443, at 12–15 (filed May 7, 2021); Comments of the MVDDS 5G Coalition, RM-11768, Tom Peters MVDDS 12.2-12.7 GHz Co-Primary Service Coexistence Study, Attachment I at 2 (filed June 8, 2016).

[37] RS Access Comments, Appendix A.

[38] *Id*. at iii.

Despite these significant and fatal flaws that provide the most favorable scenario for terrestrial mobile, the study still demonstrates that if terrestrial mobile networks are deployed in the 12 GHz band, they will cause harmful interference into the user terminals of NGSO systems. In an attempt to validate its analysis, RKF claims there are "qualitative factors" which "account for the highly favorable coexistence environment in the 12 GHz band."[39] However, these factors are either largely quantitative and already considered in the study (*e.g.*, satellite terminals operating at high elevation angles, terrestrial mobile base stations with low or negative elevation angles, use of downtilt, beamforming, deployment of 5G in densely populated areas whereas satellite terminals are mostly located in rural areas, etc.) or are extremely vague (*e.g.*, RKF asserts that "systems are designed to operate in – and mitigate – an interference-prone environment"[40]).

In addition, RKF states that "case-by-case site coordination" could be used.[41] This option is not relevant to either terrestrial mobile or NGSO FSS systems, which both fundamentally need to serve their customers wherever they are, with the same quality of service. Finally, RKF mentions vague "mitigation measures" without specifying which measures would be applicable.[42] The RKF study is actually a clear demonstration that the only effective mitigation measure would be geographical separation. For the study to arrive at its claimed low probability of interference, more than 90% of the Starlink terminals in the RKF simulation had to be deployed outside of the visibility of terrestrial mobile base stations. This assumption may or may

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[39] *Id*.

[40] *Id*.

[41] *Id*. at ii.

[42] *Id*. at ii, 2.

not be correct with respect to Starlink, but it is not representative of other NGSO FSS operators' commercial plans. Furthermore, as explained below, the satellite terminals that are deployed in the vicinity of terrestrial mobile base stations will suffer from harmful interference when the correct parameters and models are used.

1. The RKF Study's NGSO FSS Deployment Model Is Wrong

The deployment model for NGSO user terminals is a key assumption in the RKF study. The study states that a deployment of 2.5 million Starlink terminals is "generous" and that it is representative of the ongoing deployment of the various NGSO FSS systems licensed in the 12 GHz band.[43] This foundational belief is flawed and underestimates the impact of terrestrial mobile networks on the multiple NGSO FSS systems either licensed or authorized in the United States for several reasons.

First, the total number of terminals to be deployed by all NGSO FSS operators in the United States is vastly underestimated, which leads to a low probability of interference. OneWeb alone is currently licensed for 1.9 million fixed user terminals. The number of OneWeb user terminals deployed across the United States is expected to grow significantly as the OneWeb constellation commences service in 2021 and achieves full deployment of its first generation of satellites by the end of 2022.

In addition, the NGSO FSS user terminal distribution model that is used in the study assumed that the majority of the terminals will be deployed in the unserved Rural Digital Opportunity Fund ("RDOF") blocks and in rural areas outside of the RDOF blocks. This is not a representative deployment model for OneWeb, which did not participate in the FCC's RDOF auction (Auction 904). OneWeb will initially focus its services on enterprise customers, federal,

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[43] *Id*. at 16, 19, 21.

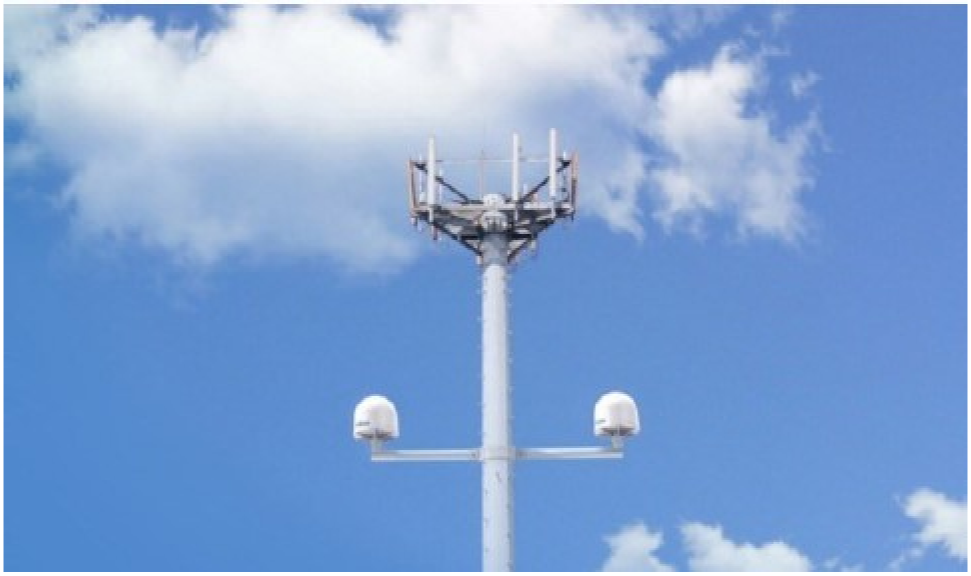
state, and local government users, and Mobile Network Operators. These customers will include businesses with multiple locations in various geographic areas and government users that need connectivity in metropolitan as well and rural and remote areas, all of whom will expect to be served with the same quality of service wherever their NGSO FSS user terminals are deployed in the United States. Eventually, NGSO FSS operators will provide service to aviation customers even while on the ground, maritime customers even in ports, and emergency responders transiting to and from disasters and while on-site. By disregarding these use cases and assuming that nearly all of the NGSO FSS user terminals will be deployed in RDOF areas, RKF's user terminal distribution model naturally leads to a low probability of interference. Clearly, the actual interference environment will be fundamentally different than that assumed in the RKF study, and this is particularly true when OneWeb's deployment is added to the analysis as well as future NGSO FSS use cases.

Finally, the RKF study assumed that 80% of the user terminals are installed on the ground and the remaining 20% on rooftops with a respective height of 1.5m and 4.5m, and that the user terminals are connected directly to consumers' homes.[44] These assumptions are not representative of the installation of OneWeb's user terminals as OneWeb will not serve consumers directly but will be serving enterprise and government customers. Most of OneWeb's terminals will be positioned at 1m above the installation surface of rooftops (Picture 1) and atop masts or towers (Picture 2). These user terminals will provide critical services and business owners will want to safeguard them by moving them to secure and less accessible locations to protect them and to not present an RF hazard. In addition, businesses' roofs are typically higher than most American homes. As explained below, the height of user terminals has a critical

[44] *Id*. at 22.

impact on the assessment of interference produced by terrestrial mobile networks. As a result of the incorrect modelling of the terminals' antenna height, the RKF study very significantly underestimates the harmful interference caused by terrestrial mobile systems into OneWeb user terminals and any other NGSO FSS operator using a similar deployment plan for their user terminals' installation.

Picture 1: enterprise rooftop-mounted OneWeb user terminals



Picture 2: MNO tower-mounted OneWeb user terminals

In conclusion, key assumptions made in the study regarding the number of user terminals, their geographical distribution and their height are not representative of the OneWeb user terminal deployment, and likely are not representative of other NGSO FSS operators' plans. These incorrect assumptions cause RKF to severely underestimate the interference that could be produced by terrestrial mobile base stations and devices into OneWeb's user terminals.

2. Terrestrial Wireless Deployment Assumptions Are Incorrect

The RKF study assumes the following deployments in the 12 GHz band if the band were to be allocated to terrestrial mobile service and be designated for flexible-use or terrestrial mobile applications:

- 49,997 terrestrial macro-cell base stations
- 89,970 fixed small-cell base stations
- 1,949,760 simultaneously active mobile devices, and
- 6,999 point-to-point backhaul links across CONUS[45]

[45] *Id*. at i.

The RKF study states that the model is consistent with a multi-band 5G deployment model,[46] however, the basis for these assumptions is not explained in the document. The study claims that terrestrial facilities are generally deployed in high population density areas[47] and uses three classifications that the authors define as urban, suburban, and rural based on population density census statistics.[48] These authors appear to use these same definitions to skew the deployment of Starlink terminals in a rural-deployment weighting. Introducing flexible use services means a variety of deployments could occur according to each operators' business plan, while the RKF study only considered a single, population weighted, random distribution for a certain given number of base stations. The conclusions of the study are, therefore, only applicable to the specific terrestrial mobile 5G deployment that was used and cannot be applied to other types of deployments that would occur under a terrestrial mobile or flexible use framework.

The RKF study also assumes that 12 GHz base stations will be installed on the same towers as the 2 GHz deployment,[49] which may be a good starting point for large terrestrial mobile network operators, but would be inadequate for a full representation of the deployments likely to occur at 12 GHz for the very reasons cited by RKF: the 12 GHz band will likely be a capacity band for terrestrial mobile operators, and many 2 GHz facilities are specifically intended for and better suited for larger coverage areas, including along roads and other areas

[46] *Id*. n. 1.

[47] *Id*. at 6 (stating "[t]he 12 GHz band has a large available bandwidth of 500 megahertz and is especially well-suited to providing high-capacity service in areas of high population density. Therefore, the 5G deployment is weighted to the high population density areas within PEAs.").

[48] *Id*. at 6–7.

[49] *Id*. n. 57.

with little population nearby which may not be suitable for Ku-band deployments. Also, it is not clear whether footnote 57 of the RKF study actually indicates that there was an effort made to site the 12 GHz base stations on the same towers as the current 2 GHz deployment, and if so, which ones.[50]

Another troubling aspect of this study is that RKF seems to have greatly underestimated the number of small-cell base stations. RKF assumed not quite twice as many small cells as macro-cells, but this is not even apparent in the maps contained in Figure 2-11 as compared to 2-12, where there seems to be many more macro-cell base stations than small-cell base stations.[51] This could be because the small-cell base stations are closer together in areas of high population density, and the smaller towns and cities are not expected to make frequent use of such deployments, so Figure 2-12 only appears less dense. Nevertheless, the total amount of small cells quoted in the study is alarmingly low. It is likely that 12 GHz terrestrial mobile deployments, should they be allowed, would mostly be on small-cell base stations like the C-band and Ka-band flexible-use deployments for in-fill where more capacity is desired.

According to the CTIA web site, up to 800,000 small cells could be deployed within the next 5 years, and this is likely to continue growing, so Ku-band NGSO FSS operators would likely witness a much larger deployment within their first-generation constellation lifetime than predicted in this study if the Commission were to authorize such deployments. Figure 1 below illustrates the key facts presented by CTIA. It is difficult to predict how many of the 800,000 small cells would use the 12 GHz band, but if even half of these included the 12 GHz band it would represent a five-fold increase over the RKF study's small-cell deployment assumptions.

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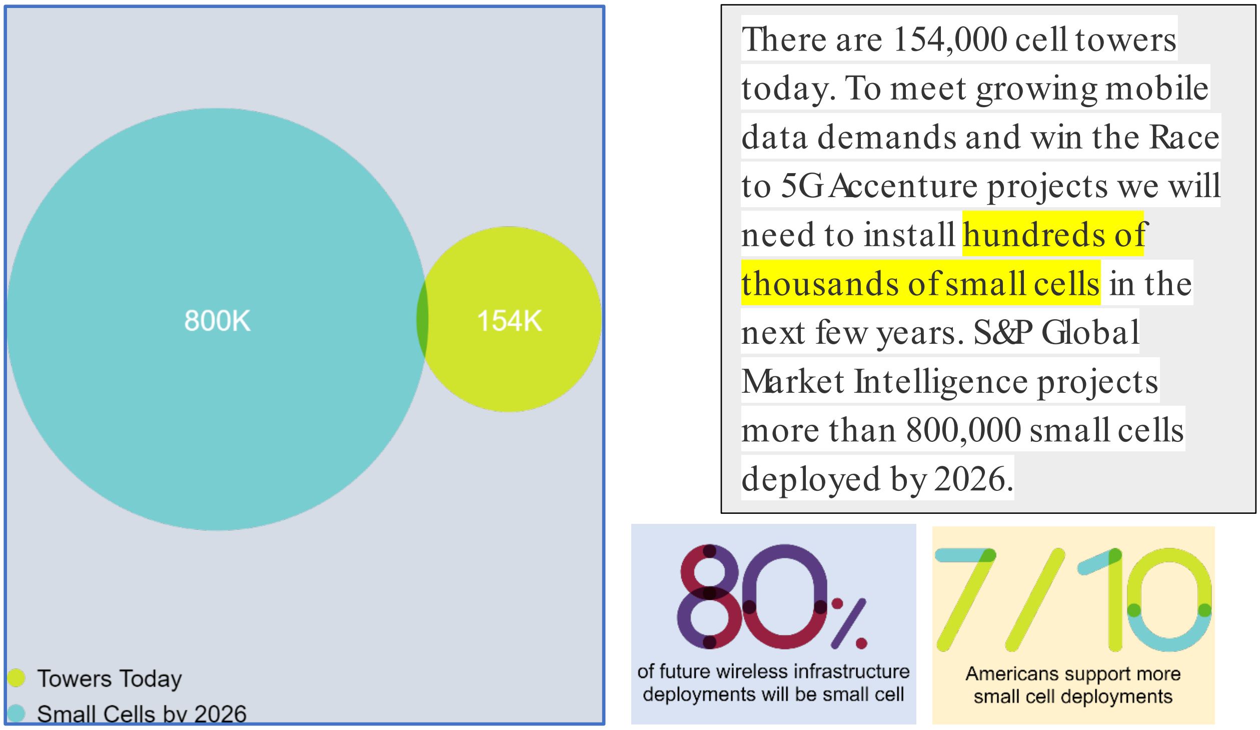
[50] *Id*.

[51] *Id*. at 33–34.



https://www.ctia.org/infrastructure-channel

Figure 1 – CTIA Key Facts Infographics

Therefore, RKF's conclusion that there is a very small probability of interference is significantly underestimated in the case of small-cell base stations. Even if the results are taken at face value, the number of affected Starlink terminals could be 9 times higher than predicted for the small-cell base stations, and of course a commensurate increase in the corresponding number of terrestrial mobile devices. If OneWeb user terminals are considered, the probability of interference would be much greater than the study assumed because OneWeb will be providing service to enterprise users everywhere, including in dense urban areas.

3. The RKF Study Is Plagued By Other Technical Flaws

a. RKF Used the Wrong Propagation Models in the Study

Table 3-1 summarizes the propagation models used in the RKF study.[52] A closer examination shows that the models used in this interference study significantly underestimate the interference received by satellite terminals.

First, the models used in the RKF study are models that are typically used for the design of terrestrial radio networks. These models compute the *maximum* propagation losses in order to assess the *minimum* level of wanted signal that is received by the terrestrial mobile end user. They are inappropriate for assessing terrestrial mobile interference into other services such as NGSO FSS. In this study, the maximum level of interference received from terrestrial mobile systems based on the minimum propagation losses is the model that should be used.

Second, the models use clutter losses, which are inherently dependent on the height of the satellite terminal relative to clutter "obstacles" in the models. The study conveniently assumes that 80% of the satellite terminals will have a height of 1.5 m above ground level ("AGL"),[53] and therefore associated clutter losses, which lead to significantly greater path losses for the vast majority of the satellite terminals assumed to be installed on the ground, are overstated. As explained above, the majority of OneWeb terminals are expected to be mounted on rooftops or masts and will therefore experience lower losses on the interference path and, as a result, significantly higher interference than that assessed in the RKF study.

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[52] *Id*. at 45.

[53] *Id*. at 22.

b. **It was Incorrect for RKF to Use the 3GPP 38.901 Model**

The purpose of the 3GPP propagation models is to predict path loss on the *wanted* path, *e.g.*, between the terrestrial mobile base station and the terrestrial mobile user equipment to ensure reliability of the terrestrial mobile network. They are used for the prediction of the user equipment EIRP which exercise power control. As the terrestrial mobile models are used to ensure the performance of the network, they are inherently conservative and predict losses in excess of the median such that predicted losses will exceed the experienced path loss for all but a small percentage of time and locations. Accordingly, the 3GPP channel models are properly used for the sizing (range) of the terrestrial mobile sites and inter-site distances. Misapplying the 3GPP channel models to the interference path will over-predict interference path losses *but under-predict the level of interference into NGSO FSS user terminals*.

The channel models used for determining the loss on the interference path from the terrestrial mobile base station or user equipment to the Starlink receiving terminals are provided in Table 3-1 of the study.[54] In Table 3-1, for the distances of 30 m to 1 km, the study uses the 3GPP 38.901 terrestrial mobile propagation models to predict losses between the terrestrial mobile user equipment and the Starlink terminal.[55] On this interference path, the loss that would be experienced by the 5G signal is predicted to be higher (i.e. less interference into the Starlink terminal) than that which would be predicted by using an appropriate interference path propagation model such as ITU-R Rec. P.452.

[54] *Id*. at 45.

[55] *Id*.

c. **RKF Used the ITM Model Improperly**

The RKF study provides the following explanation regarding use of the ITM model: "For distances above 1 kilometer (for urban/suburban 12 GHz Tx) or 5 kilometers (for rural 12 GHz Tx), the Irregular Terrain Model (ITM) is used. ITM is a general-purpose radio propagation model for frequencies between 20 MHz and 20 GHz that can be applied to a large variety of engineering problems.[56] The model, which is based on electromagnetic theory and statistical analyses of both terrain features and radio measurements, predicts the median attenuation of a radio signal as a function of distance and the variability of the signal in time and in space."[57] As explained above regarding use of the 3GPP 38.901 model, the purpose of a propagation model on an interference path is for the prediction of losses not exceeded for smaller percentages of time (*i.e.*, minimum losses), as opposed to the median losses assessed by the ITM model. Use of median losses in the RKF study overestimates interference path losses experienced by the terrestrial mobile 5G signal and thereby underestimates harmful interference into NGSO FSS user terminals.

In addition, the ITM model requires input on the percentage of time the loss is not exceeded. It is unknown whether and for what percentage of time the ITM model was applied. As explained in Section VI below, it is unclear if any time aspect was taken into account in these simulations.

[56] *Id*. at 46.

[57] *Id*.

d. **An Incorrect Modelling of Antenna Height Leads to Overestimated Clutter Losses and Underestimated Interference Into OneWeb**

Table 3-1 indicates that clutter losses were used for urban/suburban areas (ITU-R P.2108) and rural areas (ITU-R P.452, village center clutter) in combination with the ITM model for antenna heights of 1.5 m.[58]

To assess the impact of satellite terminal height and clutter on propagation losses, OneWeb ran a comparison of losses on the interference path between a terrestrial mobile base station that is 25m AGL to a receiving satellite terminal, assuming a "smooth earth", at various heights, with the results in Figure 2 below.

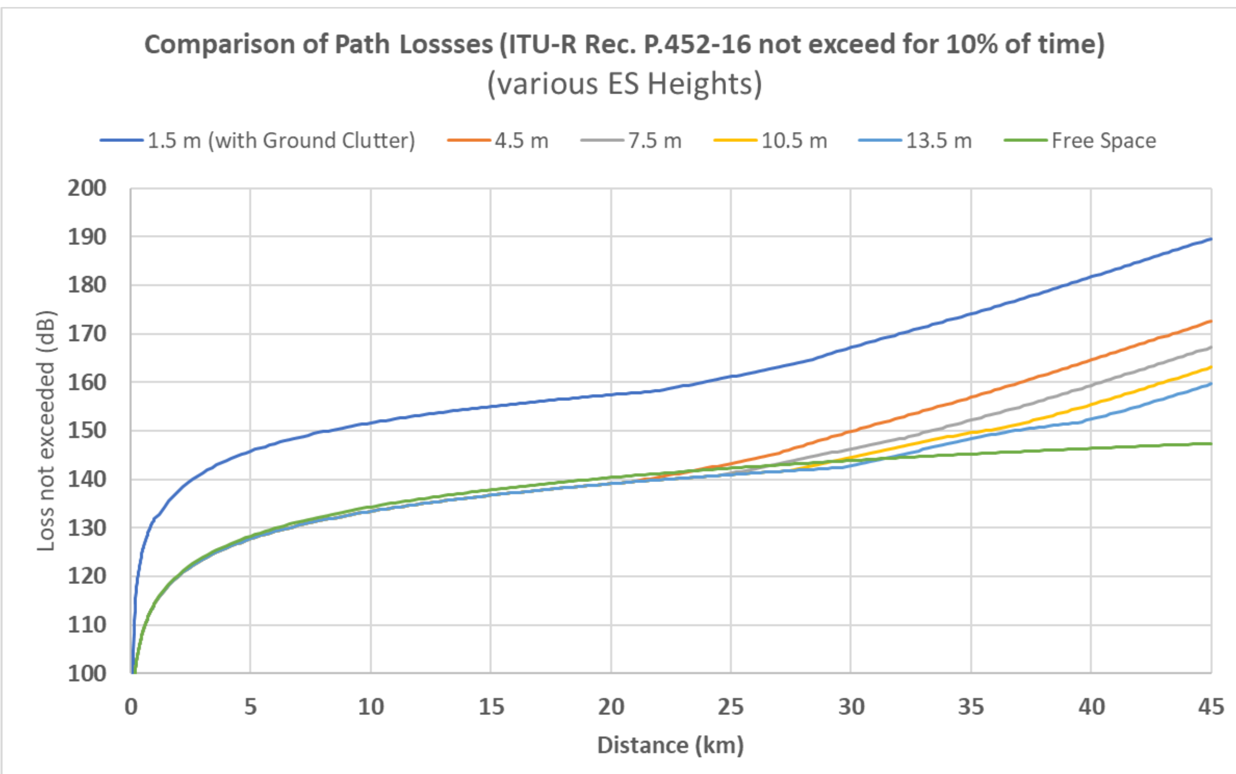

Figure 2: Comparison of Free Space Loss with loss predicted by Rec. ITU-R P.452 not exceeded for 10% of the time for various receiving satellite terminal heights (AGL) (Note: terrestrial mobile BS assumed to be at 25 m AGL as per "Suburban" configuration)

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58 *Id*. at 45.

This graph reveals the significant impact of the RKF study's assumption that 80% of terminals are ground mounted (*i.e.*, 1.5 m AGL) and the associated clutter obstacle assumptions. In fact, for all distances greater than 500 m, the loss on the interference path for the 1.5 m height user terminal is consistently more than 17 dB higher than that for all other higher terminals that are not affected by the clutter obstacle assumptions. For distances beyond 22 km, this difference increases with distance and also increases with the terminal height above ground, relative to the free space loss propagation model. As explained above, the vast majority of OneWeb user terminals are expected to be mounted on enterprise rooftops and telecom masts and will experience a significantly higher interference than that assessed in the RKF study due to the reduced loss on the interference path.

4. The RKF Study Demonstrates Incompatibility Between Terrestrial Mobile and NGSO Operations

The RKF study does not seem to consider any temporal probability, only a location-based heuristic deployment scenario.[59] As a result, the CDF results would seem to be those corresponding to I/N experienced for an unknown percentage of time, but for a certain percentage of Starlink terminals based on the authors' stated deployment scenario.

The CDF I/N results in Figure 4-1 of the study[60] are defined as Probability of I/N exceeding x-axis; and this term "probability" seems to represent only a Monte-Carlo location-based probability, which would be fine when assessing the probability that a Starlink user location following the model used by RKF would receive I/N levels exceeding an I/N criterion of -8.5 dB. Since this is considered a long-time criterion, this would be adequate for assessing the

[59] *Id*. at 11.

[60] *Id*. at 50.

probability of a location receiving harmful interference if the source of interference was static. However, that would not be the case here, at least for the transmissions from terrestrial mobile 5G macro-cell base stations to the terrestrial mobile user devices. The terrestrial mobile user devices are regularly in motion (*i.e.*, mobile by definition) which means that the study does not assess the change in interference levels into a given Starlink terminal over a day, a week, or more. There are two variables for each of the 1000 iterations of this study that really matter, but at each iteration, both the terrestrial mobile device's location and the Starlink terminal location is set to a new place (and possibly a random pointing angle for the NGSO terminal). Therefore, there are no statistics on the interference environment for a given Starlink terminal over time.

Similarly, the macro-cell base stations are "dropped" into their location at the beginning of the simulation and seem to remain there for all 1000 iterations. That is as expected, but what would change quickly in a real deployment—perhaps on a milli-second basis—are the directions of the beams from the terrestrial mobile base stations which must track moving terrestrial mobile user devices. The issue is that, by using 1000 iterations, where for each iteration both the Starlink terminal and the macro-cell base station pointing vectors are randomly pointed, the study does not give the range of I/N any terminal would experience over time.

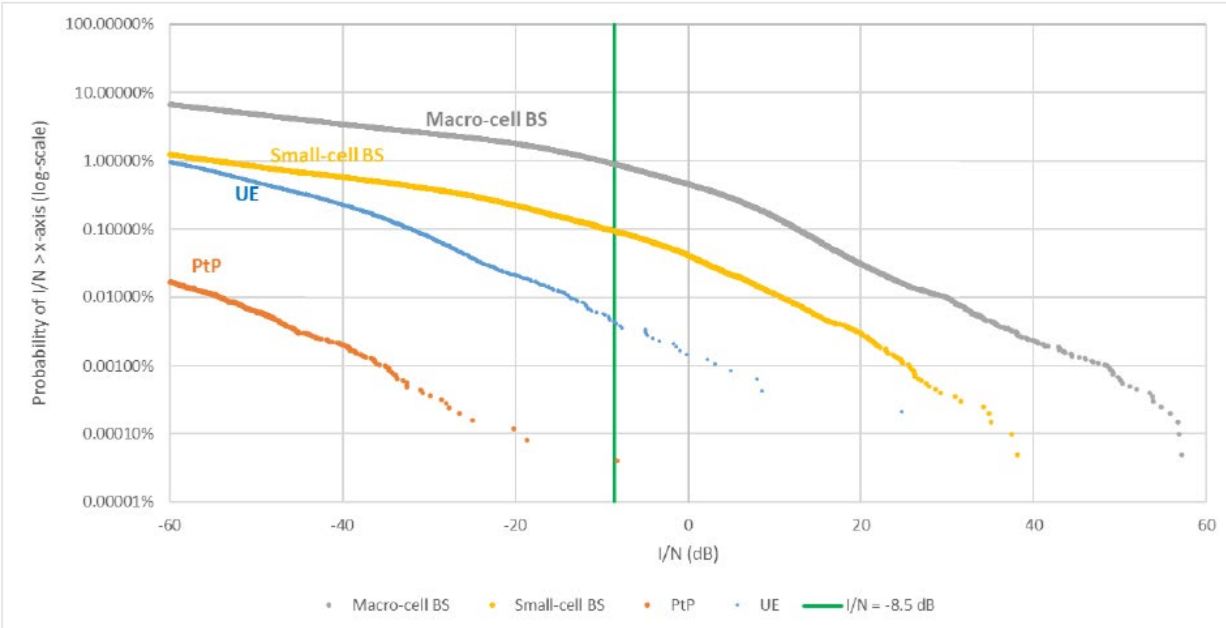
Based on RKF's own results, reproduced in Figure 3 below, almost 10% or so of Starlink terminals are predicted to have I/N values above -60 dB.[61] In addition, there are 10% of these affected receivers that are predicted to suffer from I/N values above the -8.5 dB criterion. It is safe to assume that, in areas where there could be terrestrial mobile signals "visible" to the NGSO FSS terminal, 10% of these units will suffer excess interference and half of these could be receiving harmful interference where I/N values are above 0 dB. In the worst cases predicted by

[61] *Id*. at 50.

RKF, the I/N value could be as high as 58 dB[62], creating the potential for overload and possible damage to the NGSO FSS user terminal.

There do not seem to be any time-domain statistics to the results in Figure 3, which could mean that such high levels of interference are present 100% of the time at the Starlink terminals thus making such locations unusable for satellite services. Even those terminals that are shown as having I/N below -8.5 dB could occasionally, and perhaps very often, experience much higher I/N values when terrestrial mobile user equipment displacement and macro-cell base station beam steering vary, but this is not captured in the RKF study.

[62] The RKF study states that the minimum separation distance between the 5G base station and the Starlink terminal permitted in the simulation could be as low as 5 meters. However, at this distance, the I/N from a macro-cell base station pointing its beam towards the UT would have been 25 dB greater than the highest level in Figure 4-1 of the study, for a satellite terminal with minimum gain in Figure 2-6, while a small-cell base station would cause 16 dB higher I/N than reported in the study for that same separation distance.



Source: RKF study, page 50 (figure 4-1-bottom)

Figure 3 – Probability of Aggregate I/N exceeding x-axis at Starlink Terminal Locations over CONUS (log-scale)

To illustrate this problem, an example based on a typical OneWeb deployment was considered, as shown on Figure 4 below. An NGSO FSS user terminal could be providing backhaul—primary or backup—to Operator B on their facility (directly on the small-cell base station) and there is a 12 GHz terrestrial mobile Operator A on an adjacent facility, some 50m away across the street serving terrestrial mobile devices in the same area.

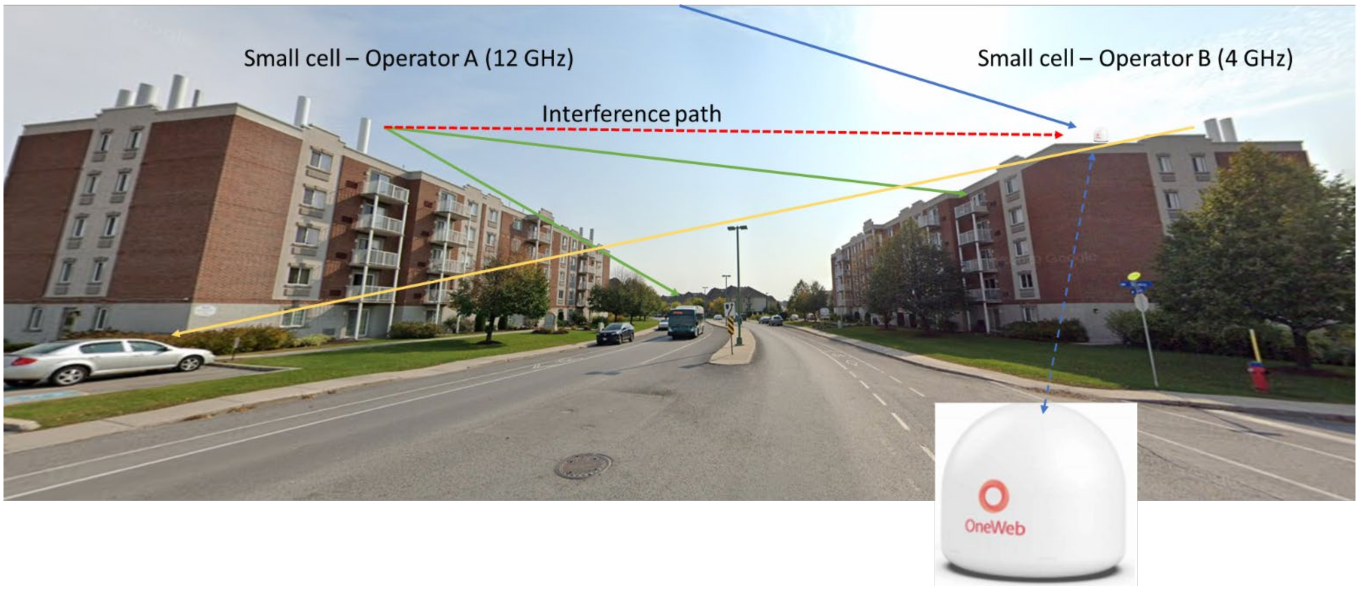


Figure 4: Representation of terrestrial mobile interference into nearby NGSO FSS satellite receivers

The range of I/N values experienced by the NGSO FSS receive terminal from the small-cell base station would range from a low of +7.2 dB, when the base station points to a device located at a large angle away from the satellite terminal, like the bus in Figure 4, up to +47.2 dB, if the base station points a beam directly towards the receive NGSO FSS terminal to serve a terrestrial mobile user device in that vicinity, such as on the balcony of the adjacent building.[63]

In this example it would be impossible for OneWeb to provide backhaul service to Operator B since harmful interference would be present 100% of the time. There could also be similar situations, with a slightly larger separation between the terrestrial mobile small-cell and the OneWeb user terminal, where the I/N varies between a value below the -8.5 dB threshold and

[63] The 7.2 dB I/N value corresponds to a small-cell base station transmitting 45 dBm per 100 MHz, but with 25 dB antenna discrimination towards the OneWeb terminal, the best that can be achieved by Rec. ITU-R F.1336, with an added 3.8 dB to account for the 240 MHz NGSO bandwidth, and the gain towards horizon of the OneWeb terminal set at -5 dBi, when the separation distance is 50m. The extreme 47.2 dB I/N value would be into a OneWeb terminal if it is located in the main beam of a transmitting small-cell base station (15 dBW/100 MHz EIRP) with the other assumptions unchanged.

values corresponding to much a higher level of interference, also making the OneWeb terminal unusable. The RKF study does not capture such situations as it does not include any time-domain statistics.

Finally, as explained above, the lack of temporal probability also impacts the correct use of propagation models. The ITM model requires percentages of time as an input, so it is unclear how that model was used in the study. Similarly, it is not possible without a time dimension to take into account anomalous propagation conditions like those found in the Radio Regulations Appendix 7 (Mode 2), or Recommendation ITU P.452, which both require a percentage of time as an input. The propagation models that were incorrectly applied to interference paths in the study resulted in higher interference path losses and underestimated interference levels from the terrestrial mobile base station to the NGSO FSS user terminal, which leads to almost 90% of Starlink user terminals experiencing no interference (I/N < -80 dB), but this still only reflects the scenario in this study where the Starlink terminals are located well outside the signal range of the terrestrial mobile base stations and their user devices.

III. UNLIKE 12 GHZ SATELLITE OPERATORS, TERRESTRIAL WIRELESS OPERATORS HAVE SIGNIFICANT HOLDINGS OF FALLOW SPECTRUM

OneWeb agrees with an observation made by the Public Interest Organizations ("PIOs") comments regarding "fallow" spectrum; the PIOs recognize that some licensed spectrum is indeed fallow.[64] There certainly is fallow spectrum in areas licensed for terrestrial mobile, however the PIOs are incorrect with respect to 12 GHz spectrum being fallow.[65] In fact, unlike terrestrial mobile deployments—including unlicensed deployments of the type that the PIOs

[64] Comments of New America's Open Technology Institute, *et al.*, WT Docket No. 20-443, at 12 (filed May 7, 2021).

[65] *Id*. at 12–13.

support—NGSO FSS operators are the only service providers who will offer full and complete broadband coverage throughout the United States. Because of its NGSO FSS allocation, the 12 GHz band will be a spectrum band with no "white spaces" because NGSO FSS satellites will be transmitting over all of the United States.

A. The Record Shows, Contrary to MVDDS Licensees' Repeated Incorrect Claims, Satellite Operators Do Not Have Abundant Spectrum Options

As OneWeb made clear in its comments[66] and in Section I above, NGSO FSS satellite operators are limited in the usable spectrum available to them. Additionally, because satellite operators do not have exclusive spectrum rights, they must coordinate between themselves for the use of frequencies.

Unlike terrestrial networks, the nature of satellite constellations makes it impossible to change spectrum bands once satellites are built for a particular range of frequencies and put into orbit. The hardware on terrestrial mobile base stations is constantly being modified to move the position of the radio on the tower, change the antenna arrays, add or remove frequencies, introduce new air interface technologies, and the list goes on. By contrast, when satellites are put on a rocket *and launched into space*, there is no opportunity to modify the hardware. OneWeb alone has hundreds of satellites in orbit that use the 12 GHz band for communication to Earth-based user terminals. Obviously, there is no option to send a tower climber to swap equipment on these satellites or those of other NGSO FSS operators with satellites in orbit.

B. Terrestrial Wireless Operators Have Access to Plentiful Low-, Mid-, and High-Band Spectrum

By contrast, terrestrial mobile operators have access to vast spectrum holdings for coverage, capacity, and a combination of the two. As the Commission notes in the *NPRM*, a

[66] OneWeb Comments at 17–19.

tremendous amount of spectrum has been allocated to terrestrial use just in the years since the rulemaking petition was filed.[67] Within just the last year,[68] terrestrial mobile was given access to even more spectrum in "hybrid," mid-band frequencies to fill the void between wide coverage (*i.e.*, low band) and very high capacity (*i.e.*, mmWave) bands. The recently concluded C-band auction (Auction 107), resulted in an additional 280 MHz of spectrum allocated for terrestrial mobile. This allocation is roughly the same amount as the combined spectrum available for terrestrial mobile between 850 MHz and 2.1 GHz, which is widely held by large and small cellular operators and about 50% more than Sprint's holdings in the 2.5 GHz BRS band.[69]

C. Terrestrial Wireless Carrier Comments Have Not Demonstrated a Strong Interest in the 12 GHz Band

Notably, terrestrial mobile carriers are divided on whether this spectrum is necessary or even useful to their operations. If the 12 GHz spectrum is as valuable to wireless operators as the MVDDS licensees claim, one would expect those operators to unanimously support introducing terrestrial mobile into the band. That is not what the record in this proceeding reflects.

AT&T, one of the largest terrestrial mobile operators, correctly noted that the Commission must protect existing users of the 12 GHz band and expressed again how two-way terrestrial mobile service in the 12 GHz band:

> would obliterate the carefully tailored interference protection framework in the band, severely threaten to undermine the services provided by DBS licensees, and harm millions of DBS subscribers (as well as incipient NGSO services) all to unjustly enrich a

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[67] *NPRM*, Statement of Commissioner Geoffrey Starks (noting the Commission has "repeatedly expanded the number of spectrum bands available for terrestrial wireless service").

[68] *See e.g.*, *Expanding Flexible Use of the 3.7 to 4.2 GHz Band*, Report and Order and Order of Proposed Modification, 35 FCC Rcd 2343 (2020).

[69] US terrestrial mobile operators share 50 MHz of cellular, 90 MHz of AWS and 130 MHz of PCS spectrum in the 800 MHz, 1.7/2.1 GHz and 1.9 GHz bands. This is in addition to all of the 600 MHz and 700 MHz spectrum available for terrestrial mobile use.

single class of incumbents—who have invested the least and have provided little to no service in the band.[70]

AT&T is uniquely positioned as a major terrestrial mobile operator as well as a DBS operator.[71] If AT&T believed that terrestrial mobile services could be introduced into the 12 GHz band without jeopardizing the operations of existing users—be they DBS or NGSO FSS—surely they would support the conversion of this spectrum to terrestrial mobile use. Instead, AT&T continues to recognize the incompatibility of terrestrial two-way services and satellite services in the 12 GHz band.[72]

In fact, the only wireless operator independently supporting terrestrial mobile in the 12 GHz band is T-Mobile, and their illogical proposal is simply to evict NGSO FSS operators from the band.[73] T-Mobile fails to acknowledge that satellite operators are the only parties capable of providing ubiquitous coverage in this band. Oddly, T-Mobile questions whether it is in the public interest for NGSO operators to continue using the 12 GHz band.[74] Yet T-Mobile fails to justify how it might possibly be in the public interest to remove the only service—NGSO FSS—that is capable of providing ubiquitous coverage to the United States in the 12 GHz band,

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[70] AT&T Comments at 5.

[71] DISH, while a DBS operator and an aspiring terrestrial mobile operator, is merely a Mobile Virtual Network Operator with no experience operating its own terrestrial mobile network and, thus, unable to consider, test, or fully appreciate the significant harm that an actual high-powered, terrestrial mobile network would inflict on lower-powered, co-primary services in a common spectrum band.

[72] *See generally* AT&T Comments.

[73] Another major wireless operator is notable for its absence in the comment round: Verizon. Verizon Wireless chose not to submit comments, thus further calling into question the demand for 12 GHz spectrum by terrestrial mobile network operators.

[74] T-Mobile Comments at 4–9.

so that it can be provided to terrestrial mobile operators who consistently fail to provide full coverage throughout their licensed areas and will only use the 12 GHz spectrum to add terrestrial coverage where it already exists. Further underscoring T-Mobile's erroneous arguments, they propose ejecting NGSO FSS operators while simultaneously identifying two similar spectrum bands—13 GHz and 17 GHz—in which terrestrial mobile might be introduced with far less disruption to incumbents and the users of their services.[75]

Even the Competitive Carriers Association ("CCA")—while dutifully supporting the interests of its two largest members, T-Mobile and DISH—acknowledges that terrestrial mobile has been blessed in recent years with allocations in many new bands of spectrum.[76] The CCA shows a remarkable lack of awareness of non-cellular developments in the 12 GHz band by claiming that the current rules have "inhibited investment and innovation in this 500-megahertz swath of spectrum."[77] In fact, NGSO FSS operators have invested billions of dollars in developing innovative satellite systems[78] with the ability to cover the entire United States using high-band spectrum that terrestrial mobile operators 1) do not need, 2) will not deploy in unserved areas, and 3) cannot use for years *because it lacks a terrestrial mobile ecosystem* (and may never have one).[79]

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[75] *Id*. at 1.

[76] CCA Comments at 2–3.

[77] *Id*. at 1.

[78] *See e.g.*, OneWeb Comments at 4–10.

[79] *See e.g.*, Comments of Microsoft Corporation, WT Docket No. 20-443, at 18 (filed May 7, 2021) (requesting the FCC "consider whether manufacturers are ever likely to produce unlicensed 12 GHz equipment even if the Commission authorizes some form of service" as the 12 GHz band is isolated and "will be many gigahertz away from any other major unlicensed band").

IV. CONCLUSION

OneWeb appreciates the Commission's interest in ensuring that limited spectrum resources are being put to their highest and best use, and its approach in this proceeding to honor its obligations under the Communications Act and only allow flexible use operations if they would not result in harmful interference to incumbents.[80] However, OneWeb wholeheartedly agrees with Commissioner Starks who questioned the timing of a proceeding on this issue,[81] particularly given the disruption it has caused as well as its potential to completely upend the operations of incumbent NGSO FSS operators who are providing services in this band.

The record clearly shows that the 12 GHz band is being put to its highest and best use by NGSO FSS operators who are poised to solve a connectivity problem that has plagued American policymakers for nearly a century. To the extent the band is not being used by other licensees for whatever reason, the solution is simply to remove those licensees from the band—not grant a new authorized use for those licensees because the original intended service is not in demand or because they have opportunistically acquired licenses in recent years.

The record also makes clear that introducing terrestrial mobile service into the 12 GHz band will cause harmful interference for incumbent NGSO FSS operators. In fact, all parties initially agreed on this basic truth until last year when the proponents of a terrestrial mobile allocation in the band suddenly changed their position.

Fortunately for the incumbents who are currently operating in the band and who continue to expand services, policymakers have noted that "Commission policies must always further protect and encourage providers who have and continue to expeditiously deploy service in the

[80] *See* 47 U.S.C. § 303(y).

[81] *NPRM*, Statement of Commissioner Geoffrey Starks.

band."[82] The record makes it clear that allowing terrestrial mobile service into the 12 GHz band would do neither.

Americans deserve to have broadband connectivity whether they live in densely-populated urban areas, sparsely-populated rural areas, or anywhere in between. Additionally, incumbents in the 12 GHz band deserve to operate with the regulatory certainty on which they relied when commencing their service.

Accordingly, OneWeb requests that the Commission maintain the current regulatory framework for the 12 GHz band.

Respectfully submitted,

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[82] *NPRM*, Statement of Commissioner Nathan Simington.