Before the
Federal Communications Commission
Washington DC 20554

In the Matter of	)	
	)	
Expanding Flexible Use in Mid-Band	)	GN Docket No. 17-183
Spectrum Between 3.7 and 24 GHz	)	

REPLY COMMENTS OF THE FIXED WIRELESS COMMUNICATIONS COALITION

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The Fixed Wireless Communications Coalition, Inc. ("FWCC")[1] files these reply comments on the Notice of Inquiry in the above-captioned docket.[2]

A. SUMMARY

Our first-round comment set out these facts:

- The 6 GHz bands are home to 94,000 links (now 95,000 links) in the Fixed Service (FS).
- Many of these links carry communications that are critical to the safety of life and property.
- 6 GHz links typically operate at 99.999% or 99.9999% availability—*i.e.*, total outages per year not to exceed five minutes or thirty seconds, respectively.

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[1] The FWCC is a coalition of companies, associations, and individuals actively involved in the fixed services—*i.e.*, terrestrial fixed microwave communications. Our membership includes manufacturers of microwave equipment, fixed microwave engineering firms, licensees of terrestrial fixed microwave systems and their associations, and communications service providers and their associations. The membership also includes railroads, public utilities, petroleum and pipeline entities, public safety agencies, cable TV providers, backhaul providers, and/or their respective associations, communications carriers, and telecommunications attorneys and engineers. Our members build, install, and use both licensed and unlicensed point–to–point, point–to–multipoint, and other fixed wireless systems, in frequency bands from 900 MHz to 95 GHz. For more information, see www.fwcc.us.

[2] *Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz*, GN Docket No. 17-183, Notice of Inquiry, FCC 17-104 (released Aug. 3, 2017) ("NOI").

- An unlicensed device operating at a minimally useful 10 milliwatts will cause unacceptable interference anywhere within 5.5 miles from the front of an FS receiver.

- To avoid such interference, the power level of an unconstrained, unlicensed device cannot exceed the present (very low) Part 15 limit: -41.3 dBm/MHz (75 nanowattts/MHz).[3]

- Unlicensed devices at higher powers would need database-driven, automatic frequency coordination at reliability levels in excess of 99.9999%—a technology that does not exist.

- Very long links cannot operate in the bands above 6 GHz, due to free-space attenuation and rain fade.

- With no lower-frequency bands available, it is not feasible to relocate long links out of 6 GHz.

Unlicensed devices at useful powers in the 6 GHz bands would have unacceptable consequences. The proponents of unlicensed operation ignore these facts and brush off the problem of interference to the FS. Their purported solutions are not only inadequate, but show a failure to understand the problem. Our own technical analyses show that only one approach is even theoretically workable: automatic frequency coordination having better than 99.9999% reliability. But no deomstrated technology can deliver this kind of performance.

Proposals to relocate FS out of the 6 GHz bands overlook why designers accepted the expense and constraints of large antennas to choose 6 GHz in the first place: namely, the ability to cover tens of miles in a single hop. That is not achievable in any other available band. Subdividing 6 GHz links into shorter hops, apart from being unacceptably expensive, is often

[3] 47 C.F.R. §§ 15.209(a) (general Part 15 limit), 15.250 (wideband), 15.511-19 (ultra-wideband). An Appendix to our first-round comment shows another calculation that reaches a similar result. *See also* Comments of the National Spectrum Management Association at 12-14 (single 250 mW unlicensed device operating 3 km from FS receiver needs 46.5 dB of terrain obstruction loss and antenna discrimination to avoid causing interference).

impractical as well, as many links span rough terrain, large bodies of water, or urban development that precludes tower construction.

Entities that provide critical services over 6 GHz fixed links—public safety agencies and associations, utilities and associations, and telecommunications providers—filed comments to express alarm about interference from unlicensed devices.

In short, despite its superficial appeal, the idea of adding unlicensed devices to the 6 GHz bands won't work.

B. UNLICENSED OPERATION AT 6 GHZ POSES RISKS TO CRITICAL SERVICES.

Multiple parties that use 6 GHz FS links for safety-critical services filed to alert the Commission that unlicensed use in the band would put life and property at risk.

A group of electric utilities says:

> [I]nterference from expanded use of the band by new entrants could threaten the safety of life, health and property, if first responders cannot communicate, if 911 services are affected, if utility protective relay systems fail to operate, or gas or water valves malfunction. Therefore, whatever marginal benefit that might be gained by expanding uses of the 6 GHz bands would be outweighed by the risk to the essential services that are provided over incumbent microwave systems within the bands.[4]

Multiple other utilities have similar messages.[5]

APCO International's 30,000+ members consist primarily of state and local government employees who manage and operate public safety communications systems. The group's comment explains the reliance of public safety communications systems on 6 GHz FS links and concludes,

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[4] Utilities Technology Council and the Edison Electric Institute at 10.

[5] Duke Energy Corporation; Lower Colorado River Authority; Southern Company Services, Inc.; Tucson Electric Power Company.

> Public safety spectrum bands are not the appropriate arena to deploy new, untested spectrums sharing and frequency coordination methods.[6]

Several other public safety agencies and organizations agree.[7]

The National Public Safety Telecommunications Council recounts the unhappy experience of public safety users first attempting to share spectrum at 2 GHz with new entrants, and then being forced to vacate the band entirely.[8] The group understandably fears a similar sequence of events at 6 GHz, but with a critical difference: where 2 GHz users could relocate to 6 GHz with (in most cases) no loss of performance, there is no suitable alternative to 6 GHz.

AT&T gives a plain-language explanation of why the many 6 GHz links used for telecommunications would be vulnerable to interference from unlicensed devices—and why that interference would be hard to identify.[9] Other telecommunications providers have similar concerns.[10]

Additional safety-critical applications that make heavy use of 6 GHz fixed links include synchronizing the movement of railroad trains and the control of petroleum and natural gas pipelines.

A comment from the National Spectrum Management Association includes an analysis showing

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6 APCO International at iii-iv (footnote omitted).

7 National Public Safety Telecommunications Council; City of Mesa, Arizona; Los Angeles County, California, the City and County of Denver, Colorado, the City of Kansas City, Missouri, Ozaukee County, Wisconsin and the Government Wireless Technology Communications Association.

8 National Public Safety Telecommunications Council at 4-5.

9 AT&T Services, Inc. at 15-17.

10 CenturyLink, Inc.; Unites States Cellular Corporation.

> [i]t would be a significant engineering challenge to somehow ensure that interference from co-channel mobiles in the vicinity did not degrade the performance of point-to-point microwave systems.[11]

Introducing new classes of devices into the band risks damage to a radio-based infrastructure essential to the protection of life and property. Proponents of unlicensed operation that argue it can be done safely should have the burden of proving their case—one they have so far not met.

C. THE FWCC FAVORS DETAILED ENGINEERING STUDIES OF PROPOSED NEW OPERATIONS IN THE BAND.

Nokia says:

> [I]t is … critical that the Commission recognize that rigorous engineering analysis of potential interference into incumbent FS operations is required before introducing any new services, including unlicensed services.[12]

Several other commenters concur.[13]

The FWCC supports such studies, with these qualifications:

1. To ensure objectivity in study design, execution, and analysis, Commission engineers should participate throughout.

2. To ensure that studies accurately reflect FS systems' technical characteristics, FWCC member engineers should also participate.

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11 National Spectrum Management Association at 13-14.

12 Nokia at 16.

13 CTIA at 16 (imperative that parties seeking to use this band for unlicensed use provide a comprehensive, engineering-based demonstration that any interference protection solution can, in fact, protect point-to-point operations from interference); Comsearch at 5 (for sharing to be successful, sufficient detail must be presented on mitigation mechanisms and detailed engineering analysis to show that licensed incumbents will be protected); Alphabet Access and Google LLC at 13 (NPRM should seek detailed studies that examine the compatibility of any new services with the incumbent services, as well as methods that could be used to mitigate the potential for harmful interference); Mid-Band Spectrum Coalition at 12-13 (the NPRM should request information on a variety of mitigation mechanisms and associated detailed engineering analysis that will enable the Commission to conclude that the proposed unlicensed operations will not cause harmful interference into incumbent services).

3. Because radio-frequency signals often behave differently in the real world than on paper and in the lab, studies should include field testing with typical installed FS equipment used for long links.

4. Those who promote unlicensed operation should bear the costs (and the burden of proof).

D. PROPONENTS OF UNLICENSED OPERATION UNDERESTIMATE THE DIFFICULTY OF PREVENTING INTERFERENCE.

All of the comments favoring unlicensed Part 15 operation acknowledge the need to protect FS links. But most then dismiss the issue as a non-problem, or as easily soluble, in simplistic, unsupported statements like this one:

> [I]n the 6 GHz band, FS operations are outdoor, largely high power, highly directional, utilize fixed transmitters, and have known emissions characteristics. This pairs well with Wi-Fi operations, which are mostly indoor, and operate at lower EIRP.[14]

Such positions may sound reasonable, until someone actually does the math. None of the commenters bothered. We did.[15] Notwithstanding the proponents' confident assertions, the numbers show that FS receivers are susceptible to interference from Wi-Fi-type operations from tens of miles away.

The proponents' filings offer—but do not evaluate—several purported solutions to the interference issue. Here we briefly review those, and their shortcomings.

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[14] All Points Broadband, Amplex Internet, Apple, Blaze Broadband, Broadcom, Cambium Networks, Cisco Systems, Cypress Semiconductor, Dell, Extreme Networks, Facebook, Fire2wire, Google, Hewlett-Packard Enterprise, HP, Intel, Joink, Mediatek, Metalink Technologies, Microsoft, New Wave Net, Pixius Communications, Qualcomm, Rise Broadband, Ruckus, a Unit of Brocade, Snappy Internet, Sony Electronics, Western Broadband, Wireless Internet Service Provider Association, Wisper ISP at 11

[15] *See* Comments of the Fixed Wireless Communications Coalition at 8-12 & Appendix. *See also* Comments of the National Spectrum Management Association at 12-14.

1. Rule against non-interference

Several parties note that Part 15 rules bar an unlicensed device from causing harmful interference to a licensed service. "These [rule] features would ensure that unlicensed operations do not abridge the rights of existing licensees …."[16] The fact of the rule being printed in the C.F.R. does not stop an unlicensed device from actually causing interference. At best, it gives the victim rights against the interferor. But an interfered-with FS operator has no way of identifying, tracking down, and turning off the offending device.[17] Even a brief interference event will quickly use up years' worth of allowable outage.

In practice the Commission does not rely on this rule in approving new kinds of unlicensed equipment, but rather sets technical limits calculated to eliminate most risk of interference. If that is not possible, the Commission declines to authorize the operation. It should do so here.

2. Track record of non-interference

Several parties note, correctly, that Part 15 devices in other bands coexist with licensed services. "Wi-Fi has a long history of operating in frequency bands with other users – both licensed and unlicensed – and can replicate that success in the 6 GHz band."[18] Again, however, that track record owes its success to the careful technical regulation of Part 15 equipment. Proponents assume that adequately protective regulation is possible here, but no one shows how it can be accomplished.

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[16] Dynamic Spectrum Alliance at 14. *Similarly*, Hewlett Packard Enterprise Company at 11-12; Wi-Fi Alliance at 8; Wireless Broadband Alliance at 13.

[17] *See* AT&T Services, Inc. at 16-17.

[18] Wi-Fi Alliance at 7. *Similarly*, NCTA at 10; Hewlett Packard Enterprise Company at 11; Microsoft Corporation at 11.

3. Present 6 GHz coexistence

One commenter notes that

> [U]nlicensed operations – ultra wideband and ground-level radars permitted under Part 15 of the Commission's rules – already successfully co-exist with licensed operations in the 5.925-7.125 GHz frequency band.[19]

All such operations share an extremely low power limit: -41.3 dBm/MHz (equivalent to 75 nanowatts/MHz).[20] The FWCC did not oppose the introduction of these devices, recognizing that low power levels and prohibited outdoor infrastructure keep the risk of interference very small.[21] The services under consideration here would need substantially higher power levels, making the present coexistence with Part 15 devices irrelevant.

4. Technical limits

Some proponents list the technical constraints that provide adequate protection for services in other bands, and assume they will work equally well here:

> Regulatory solutions that have been mandated and implemented in the 5 GHz U-NII bands, including transmit power limits, antenna gain masks, and other operational constraints can be adopted for Wi-Fi operations in the 5.925-7.125 GHz band.[22]

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19 Wi-Fi Alliance at 8.

20 47 C.F.R. §15.250(d)(1) (wideband); 47 C.F.R. Part 15 subpart F (ultra-wideband). Level-probing radars in the 6 GHz band are allowed a higher limit of -33 dBm/MHz, but the antenna must point downward and have a minimum sideways attenuation of 22 dB, so the horizontal emissions cannot exceed -55 dBm/MHz (3.2 nanowatts/MHz). *See* 47 C.F.R. § 15.256.

21 Similarly, the FWCC did not oppose a waiver authorizing these same power levels into fixed outdoor antennas no more than 24 inches above the ground. *iRobot Corporation, Order*, 30 FCC Rcd. 8377 at ¶ 8 (2015).

22 Wi-Fi Alliance at 7 (citation footnote omitted). *See also* Qualcomm Incorporated at 9 (limits on antenna gain and conducted power).

None of the bands cited as examples carries FS communications. Our analysis in the first-round comment shows that these constraints, if used alone, would necessarily require unlicensed power levels that are too low for practical use.

5. Directional Antennas

Some commenters argue that the high directionality of FS receive antennas will facilitate non-interfering unlicensed operation.[23] But there is a corresponding disadvantage: the same directional properties that reduce sensitivity at the sides and back of the antenna also increase sensitivity at the front. Moreover, as we showed in our first-round comment, even a minimally useful 10 milliwatt unlicensed transmitter will cause interference to the side of an FS antenna from 1,000 feet away.[24]

6. Indoor/outdoor rules

One commenter believes that limiting unlicensed devices to indoor use will prevent interference.[25] This might be a solution at higher frequencies, but near 6 GHz, building materials

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[23] Dynamic Spectrum Alliance at 14 (6 GHz band particularly attractive in part because incumbents use highly directional equipment); All Points Broadband, Amplex Internet, Apple, Blaze Broadband, Broadcom, Cambium Networks, Cisco Systems, Cypress Semiconductor, Dell, Extreme Networks, Facebook, Fire2wire, Google, Hewlett-Packard Enterprise, HP, Intel, Joink, Mediatek, Metalink Technologies, Microsoft, New Wave Net, Pixius Communications, Qualcomm, Rise Broadband, Ruckus, a Unit of Brocade, Snappy Internet, Sony Electronics, Western Broadband, Wireless Internet Service Provider Association, Wisper ISP at 11

[24] Fixed Wireless Communications Coalition at 11.

[25] "Intel proposes that the Commission expeditiously enter the NPRM phase with a rebuttable presumption that rules can be crafted such that indoor Part 15 use could be feasible in all, or nearly all, geographic areas across the full 5925-7125 MHz band …." Intel at 16.

offer only 10-20 dB of attenuation[26]—far short of the 60+ dB needed.[27] Instances where the Commission relies on indoor-only operation for interference protection either occur at much higher frequencies or limit operations to minuscule power levels.[28]

7. Spectrum Access System

Several parties suggest that a Spectrum Access System (SAS), like that under development for the Citizens Broadband Radio Service, could allow operation at 6 GHz without causing interference to the FS.[29] We would not oppose reliance on an SAS if it were proven to be sufficiently reliable—that is, better than the FS systems it must protect, some of which operate at 99.9999%. Studies like those discussed in Part D, above, would have to evaluate performance.

At present, though, no SAS of any kind has been publicly demonstrated. Comparable development for the TV White Space environment, which should be much simpler, still has not produced any FCC-certified mobile units, nine years after the adoption of rules.[30] We ask the Commission not to rely on SAS technology until after SAS has been shown to be feasible at the required levels of reliability, under realistic conditions.

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[26] Furgin, G., Rappaport, T. S. and Xu, H., "Measurements and Models for Radio Path Loss and Penetration Loss In and Around Homes and Trees at 5.85 GHz", *IEEE Transactions on Communications,* pp. 1484-1495, November 1998.

[27] *See* National Spectrum Management Association at 13. The example assumes a 250 milliwatt unlicensed device at a distance of 300 meters from the front of an FS antenna.

[28] 47 C.F.R. § 15.257) (unlicensed 92-95 GHz); *SafeView, Inc.* Order, 21 FCC Rcd 8814 (2006) (24.25-30 GHz); 47 C.F.R. § 15.517 (-51.3 dBm/MHz). The Commission recently dropped an indoor-only limitation on the 5.15-5.25 GHz (U-NII-1) band. *Unlicensed National Information Infrastructure (U-NII) Devices,* First Report and Order, 29 FCC Rcd. 4127 at ¶ 34 (2014).

[29] Motorola Solutions, Inc. at 3; Microsoft corporation at 9; Dynamic Spectrum Alliance at 8.

[30] *Unlicensed Operation in the TV Broadcast Bands,* Second Report and Order and Memorandum Opinion and Order, 23 FCC Rcd 16807 (2008).

8. Relocation

One commenter offers a fanciful scenario for clearing FS systems from the 6 GHz bands:

> [T]he Commission should consider market-based remedies to transition incumbent operations out of the band, either to another band or to fiber, with a particular focus transitioning uses in more urban and suburban areas. For instance an overlay auction could be conducted where winning bidders compensate fixed incumbents to move out of the band; use of mid/short range microwave in higher frequencies or fiber are obvious alternatives. The sparse point-to-point long range deployment should not block other valuable usages, such as 5G, in urban/suburban areas. The remaining links located in rural areas can either be transitioned in part or whole over time.[31]

Other parties disagree. In the words of AT&T,

> [T]he sheer magnitude of the relocation task seems insurmountable. The notion that these paths can simply be migrated to alternative media or higher bands misapprehends the reason why the 6 GHz bands are so intensively used today.[32]

Our first-round comment noted, "Most 6 GHz links cannot be relocated because they have nowhere to go."[33] AT&T explains that designers choose this band because it can accommodate long links: those in the next higher band, at 11 GHz, on average are only half as long.[34] AT&T continues:

> Independent of the financial feasibility of splitting the 100,000 links in the 6 GHz band into 200,000 links, the links may use 6 GHz because they traverse areas where intermediate hops are infeasible.[35]

—infeasible because the links traverse rough terrain, bodies of water, or built-up urban areas.

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31 Ericsson at 10.

32 AT&T Services, Inc. at 15.

33 Fixed Wireless Communications Coalition at 13.

34 AT&T Services, Inc. at 15.

35 AT&T Services, Inc. at 15.

Particularly unrealistic is Ericsson's expectation that "sparse" long range deployment will not block other uses in urban and suburban areas. A glance at the 6 GHz link map shows dense concentrations around population centers.[36]

Calling higher-frequency microwave and fiber "obvious alternatives" to 6 GHz likewise reflects a serious misunderstanding. To be sure, these do offer advantages over 6 GHz microwave: smaller, lighter, less expensive antennas at higher frequencies, and greater capacity using fiber. But higher-frequency microwave is limited to short links; and fiber is expensive, costing anywhere from 12 to 150 times the cost of microwave.[37] No rational designer would pick 6 GHz microwave if either alternative could do the job more economically. It follows that neither one can be a broadly applicable alternatives to 6 GHz microwave.

Neither the NOI nor Commissioner O'Rielly's contemporaneous blog post suggested clearing the 6 GHz band.[38] The Commission should dismiss the idea and not consider it further.

CONCLUSION

The 6 GHz band is particularly unsuited to unlicensed operation due to the confluence of critical communications, sensitive receivers, and the need for extreme reliability. The day may

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[36] *See* Fixed Wireless Communications Coalition at 13, Figure 2. *See also* AT&T Services Inc. at 13, Figures 3 & 4; National Spectrum Management Association at 3 & 4.

[37] A company that installs fiber puts the cost at $50k-100k per mile, depending on topography and other limitations. (In major urban areas the cost is above $100k per mile.) A major microwave manufacturer and engineering company reports the cost of microwave for a 30 mile link to be $20k-120k, and for a 60 mile link, $70-170k. The comparison:

Path Length	Fiber	Microwave	Cost Ratio
30 miles	$1.5M-$3M	$20-120k	12.5-150
60 miles	$3M-6M	$70-170K	18-86

[38] Michael O'Rielly, *A Mid-Band Spectrum Win in the Making* (July 10, 2017). https://www.fcc.gov/news-events/blog/2017/07/10/mid-band-spectrum-win-making Commissioner O'Rielly discussed repurposing only the 4 GHz FS band.

come when some form of SAS will allow interference-free sharing, but until then, the Commission must not allow new types of unlicensed devices in the band.

Respectfully submitted,

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