

**Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554**

In the Matter of)	
)	
Unlicensed Use of the 6 GHz Band)	ET Docket No. 18-295
)	
Expanding Flexible Use in Mid-Band Spectrum)	GN Docket No. 17-183
Between 3.7 and 24 GHz)	
)	

REPLY COMMENTS OF WI-FI ALLIANCE

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March 18, 2019

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Wi-Fi Alliance submits these reply comments in the above-referenced proceedings in which the Commission proposes rules covering use of the 5.925-7.125 GHz (“6 GHz”) band by unlicensed devices.^{1/} The record supports Wi-Fi Alliance’s request that the Commission adopt rules allowing unlicensed operations, including low-power, indoor-only (“LPI”) devices, access to the entire 6 GHz band and allowing standard-power operations in designated segments of the band subject to automatic frequency coordination (“AFC”). The need for additional spectrum capacity to meet the nation’s demand for Wi-Fi connectivity is acute and the 6 GHz band is uniquely able to satisfy that need. Wi-Fi Alliance and others have convincingly demonstrated that the 6 GHz band can be effectively shared between unlicensed devices and important authorized services, now and in the future.

I. INTRODUCTION AND SUMMARY

There is no disagreement that more spectrum capacity is needed to meet the rapidly growing demand for Wi-Fi. Increased capacity requirements are unsurprising based on the

^{1/} *In the Matter of Unlicensed Use of the 6 GHz Band*, ET Docket No. 18-295, FCC 18-147 (rel. Oct. 24, 2018) (“*NPRM*”).

central role that Wi-Fi plays in the telecommunications infrastructure, a role that is only expected to intensify as more and new use cases for Wi-Fi and other unlicensed technologies develop.

Based on those demands and current spectrum policies that foster spectrum sharing and utilization, the Commission has correctly proposed that unlicensed operations share the 6 GHz band with licensed spectrum users. The record amply demonstrates that this approach is technically and operationally sound and is based on real-world – not extreme corner case – assumptions, with harmful interference potential at far below acceptable levels. In particular, transmissions from LPI devices, very low power portable devices, and standard-power devices employing an AFC system will not adversely affect incumbent operations in the 6 GHz band.

The record also demonstrates that repurposing portions of the 6 GHz band for licensed services is impractical and would be counter to the Commission’s broadband connectivity and wireless innovation objectives. Finally, other commenting parties support the following modifications to the use of the 6 GHz band proposed by Wi-Fi Alliance –

- LPI devices should be permitted to operate in the U-NII-5 and U-NII-7 bands.
- Client devices should be permitted to operate at the same power level as their controlling access point (“AP”).
- Mobile and transportable operations should be permitted.
- Higher gain point-to-point operations should be permitted alongside standard-power operations.
- Standard power operations should be permitted in the U-NII-8 band.
- There should be no multi-stakeholder process in the Commission’s evaluation of AFCs.
- Probe requests should be permitted throughout the 6 GHz band.

II. THE RECORD REFLECTS BROAD AGREEMENT ON THE NEED FOR ADDITIONAL SPECTRUM FOR WI-FI

Commenters agree – demand for Wi-Fi has never been higher.^{2/} Parties noted the growth of data-intensive Wi-Fi use cases, coupled with the shortage of available unlicensed spectrum.^{3/} As Charter observed, “the country is now approaching exhaust conditions in the existing unlicensed spectrum bands that support Wi-Fi.”^{4/} Indeed, comments reflect the consensus that hundreds of megahertz of additional unlicensed spectrum must be made available in the near term if Wi-Fi is to meet current and future demands.^{5/}

Comments show that these capacity requirements are being driven by a diverse set of current and emerging Wi-Fi-supported applications. Consumers, businesses, schools, warehouses, farms, and libraries increasingly rely on unlicensed spectrum for their connected needs because Wi-Fi provides cost-effective, high-quality connections for dozens of devices over

^{2/} See, e.g., *Comments of Cisco*, ET Docket No. 18-295 at 3-8 (Feb. 15, 2019) (“Cisco Comments”); *Comments of Los Angeles, CA*, ET Docket No. 18-295 at 2-4 (Feb. 15, 2019) (“LA Comments”); *Comments of Dynamic Spectrum Alliance*, ET Docket No. 18-295 at 1 (Feb. 15, 2019) (“DSA Comments”); and *Comments of Hewlett Packard Enterprise Company*, ET Docket No. 18-295 at 3-7 (Feb. 15, 2019) (“HPE Comments”). See also CISCO, VNI Complete Forecast Highlights Tool, North America, United States, Wired Wi-Fi and Mobile Growth (2018), http://www.cisco.com/c/m/en_us/solutions/service-provider/vni-forecasthighlights.html (select “United States” from the “North America” drop-down menu, select “2022 Forecast Highlights” and expand “Wired Wi-Fi and Mobile Growth.”) (finding that “fixed/Wi-Fi was 50.4% of total Internet traffic in 2017, and will be 56.6% by 2022.”).

^{3/} See, e.g., *Comments of the Friday Institute for Educational Innovation at North Carolina State University*, ET Docket No. 18-295 at 2 (Feb. 14, 2019) (“Friday Institute Comments”); *Cisco Comments* at 2-3; and *HPE Comments* at 3-7.

^{4/} *Comments of Charter Communications*, ET Docket No. 18-295 at 2 (Feb. 15, 2019) (“Charter Comments”).

^{5/} *Charter Comments* at 2; *Comments of GE Healthcare*, ET Docket No. 18-295 at 1, 5 (Feb. 15, 2019) (“GE Healthcare Comments”) (“unlicensed use has continued to grow at a breakneck pace, increasing the likelihood of interference on congested airwaves.”); *Cisco Comments* at 2 (“The country will need significantly more unlicensed spectrum in order to meet consumer demand for these advances.”); *Comment of Wireless Internet Service Providers Association*, ET Docket No. 18-295 at 5 (Feb. 15, 2019) (“WISPA Comments”) (“Access to an additional 1200 megahertz of unlicensed spectrum proximate to the 5 GHz band will alleviate growing congestion in that band.”).

a wide area.^{6/} Wi-Fi is also key to delivering services for cable companies.^{7/} Wi-Fi supports and improves the fidelity of services such as indoor smart phone use and gaming, and powers burgeoning technologies including augmented or virtual reality, in-home video distribution at 4K/8K levels, and Internet of Things (“IoT”) applications.^{8/} Modern homes offer automated features that increasingly rely on unlicensed spectrum for Wi-Fi and IoT applications.^{9/} And as commenters explained, Internet service providers can also use unlicensed spectrum to meet the demand for home Internet access through wireless broadband options.^{10/}

Attempts by some commenters to portray Wi-Fi use cases as mere “toys” are disappointing and misguided.^{11/} Wi-Fi Alliance recognizes the critical nature of public safety and utilities communications licensed to operate in the 6 GHz band.^{12/} But fast and reliable Wi-Fi networks also support important communications functions. For example, Wi-Fi boosts rural economies by powering e-commerce and smart farming, and provides vital connectivity in critical capacity-strained facilities such as military bases, hospitals, and educational

^{6/} *Comments of Open Technology Institute at New America, American Library Association, Consumer Federation of America, COSN – Consortium for School Networking, Public Knowledge, and Access Humboldt*, ET Docket No. 18-295 at 5 (“Feb. 15, 2019”) (“Public Interest Commenters”) and Charter Comments at 1.

^{7/} *Comments of Midcontinent Communications*, ET Docket No. 18-295 at 1 (Feb. 15, 2019) (“MidCo Comments”).

^{8/} See *NPRM* at ¶ 59; see also *Cisco Comments* at 2-8.

^{9/} *Comments of the Leading Builders of America*, ET Docket No. 18-295 at (Feb. 15, 2019) (“Leading Builders Comments”).

^{10/} See *WISPA Comments* at 5; *Comments of Starry*, ET Docket No. 18-295 at 1 (Feb. 15, 2019) (“Starry Comments”); *Comments of Cambium Networks*, ET Docket No. 18-295 at 1 (Feb. 15, 2019) (“Cambium Comments”); *Comments of Facebook*, ET Docket No. 18-295 at 1-2, 7-8 (Feb. 15, 2019) (“Facebook Comments”).

^{11/} *Comments of Atkins Wireless Consulting*, ET Docket No. 18-295 at 1 (Feb. 15, 2019) (“Atkins Comments”).

^{12/} See, e.g., *Comments of City of Austin, TX*, ET Docket 18-295 (Feb. 15, 2019); *Comments of Nassau County, NY Police Department*, ET Docket 18-295 (Feb. 15, 2019); *Comments of National Public Safety Telecommunications Council*, ET Docket 18-295 (Feb. 15, 2019).

institutions.^{13/} And, as GE Healthcare explained, wireless technology and Wi-Fi-enabled devices in hospitals save lives by powering patient monitoring devices and sensors, lowering the risk of infection, and drastically increasing the efficiency of hospital staff.^{14/}

The story is similar in schools. The Friday Institute reminded the Commission that most students no longer have either Ethernet-enabled devices or access to wired connections in classrooms, and many schools are “masonry-walled” and unlikely to receive cellular coverage inside the classroom, making Wi-Fi the perfect connection technology for educational use cases.^{15/} Wi-Fi must also meet the demands of student dormitories, where large numbers of users access Wi-Fi APs in relatively small physical spaces.^{16/} And Wi-Fi service is key for “panic buttons” and other emergency communications systems in schools that ensure 911 connectivity for children and staff (especially now that voice funding is no longer available in the E-rate program).^{17/}

Many commenters noted that they are able to use Wi-Fi to meet these and other vital needs because it is easy-to-deploy and cost-effective. Wi-Fi provides a “barrier-free means of spectrum access.”^{18/} Therefore, and as noted below, in making the 6 GHz band available, the Commission should not impose unnecessary burdens or barriers to Wi-Fi deployment that could “potentially negate many benefits of the Commission’s stated objective”^{19/} by making devices difficult to deploy and use. Commenters noted that, if significant compliance mechanisms are

^{13/} See Charter Comments at 1.

^{14/} GE Healthcare Comments at 3-4.

^{15/} Friday Institute Comments at 3-4.

^{16/} *Id.*

^{17/} *Id.*

^{18/} Starry Comments at 1.

^{19/} Friday Institute Comments at 4.

adopted, many schools, libraries, and small businesses, will be unable to take advantage of the promise of unlicensed 6 GHz devices due to prohibitive deployment and maintenance costs.^{20/} Indeed, unnecessary restrictions on unlicensed devices are likely to produce inefficient results and reduce overall spectrum use.^{21/}

Similarly, rules governing the use of the 6 GHz band for unlicensed devices must be technology neutral and avoid requirements that are best addressed by standards bodies. For that reason, the Commission should reject suggestions by commenters who seek to impose unnecessarily specific rules relating to device and system implementation or design, including those by commercial wireless interests^{22/} to have 6 GHz band spectrum, specifically the U-NII-7 band,^{23/} effectively set-aside for specific wireless technologies. Despite claims of fostering technological neutrality, these commenters are in fact asking the Commission to do the opposite – pre-determine the technology that will operate in this spectrum, rather than allowing the market and international standards-setting bodies to determine the best use of that spectrum. This is contrary to the public interest and to longstanding Commission and Congressional policy and should be rejected.^{24/} There is no reason to set aside unlicensed spectrum specifically for certain technologies. Instead, the Commission should do what it has always done with its unlicensed

^{20/} *Id.*

^{21/} Charter Comments at 4.

^{22/} See *Comments of Qualcomm*, ET Docket No. 18-295 at 22-23 (Feb. 15, 2019) (“Qualcomm Comments”); *Comments of CTIA*, ET Docket No. 18-295 at 21-22 (Feb. 15, 2019) (“CTIA Comments”); and *Comments of Verizon*, ET Docket No. 18-295 at 11-12 (Feb. 15, 2019) (“Verizon Comments”).

^{23/} See *Qualcomm Comments* at 22-23.

^{24/} See, e.g., *In the Matter of the Commercial Mobile Alert System*, First Report and Order, 23 FCC Rcd 6144 at ¶ 33 (2008) (noting the Commission’s “well-established policy of technologically-neutral regulation” of wireless technologies); *In the Matter of Inquiry Concerning the Deployment of Advanced Telecommunications Capability to All Americans*, Report, 14 FCC Rcd. 2398 at ¶ 74 (1999) (noting Congress’s intent that Commission regulations be technology neutral).

device rules – impose minimum technologically-neutral requirements that are designed to ensure incumbent protection and efficient use of spectrum, and then allow the market to determine how the band is deployed.

III. WI-FI CAN PROTECT INCUMBENT OPERATIONS

Throughout its history, Wi-Fi and other technologies built on IEEE 802.11 standards have demonstrated their ability to protect other spectrum users. As commenters pointed out, these protections are built into the DNA of Wi-Fi, and are critical to its efficient operation in unlicensed spectrum.^{25/} The 6 GHz band will be no exception, and full incumbent protection is inherent in the proposed unlicensed operations.

6 GHz band Fixed Service (“FS”) incumbent licensees emphasized their use of highly reliable point-to-point microwave links that support a variety of critical communications.^{26/} They also explained the lack of other spectrum bands available for these operations and why transitioning to wireline solutions is not a feasible alternative for many links.^{27/} Wi-Fi Alliance recognizes and appreciates incumbent licensees’ concerns. That is exactly why unlicensed operations, operating on a non-interference basis with an obligation to fully protect incumbents from harmful interference, are well-suited for this spectrum. With an appropriate set of

^{25/} See Comments of Apple, Broadcom, Cisco, Facebook, Google, Hewlett Packard Enterprise, Intel, Marvel, Microsoft, Qualcomm, and Ruckus, ET Docket No. 18-295 at 11 (Feb. 15, 2019) (“RLAN Group Comments”); *Comments of IEEE 802*, ET Docket No. 18-295 at 3-4 (Feb. 15, 2019).

^{26/} See, e.g., *Comments of Fixed Wireless Communications Coalition*, ET Docket No. 18-295 at 2 (Feb. 15, 2019) (“FWCC Comments”); *Comments of AT&T*, ET Docket No. 18-295 at 2 (Feb. 15, 2019) (“AT&T Comments”); and *Comments of the Utilities Technology Council, the Edison Electric Institute, the American Public Power Association, the National Rural Electric Cooperative Association, the American Petroleum Institute, and the American Water Works Association*, ET Docket No. 18-295 at i (Feb. 15, 2019).

^{27/} See, e.g., Atkins Comments at 1; *Comments of the Critical Infrastructure Coalition*, ET Docket No. 18-295 at 9 (Feb. 15, 2019); and *Comments of Idaho Power Company*, ET Docket No. 18-295 (Feb. 14, 2019).

regulatory constraints, unlicensed operations will preserve and protect the important base of the 6 GHz band's incumbent users while delivering critically needed broadband connectivity.

A. Opposition to Sharing Is Based on Outdated Views on Spectrum Management

Opposition to the Commission's 6 GHz spectrum sharing proposal is premised on the unrealistic expectation that spectrum policy should be driven by the most extreme corner cases. The growing significance of spectrum – and the countless public interest benefits it supports – has made this view obsolete. The Commission should avoid policy decisions that are premised on extreme and unrealistic worst-case predictions. Instead, the Commission should seek to maximize public benefits by formulating practical interference mitigation solutions taking into account the latest spectrum management techniques and capabilities.

The type of restrictive operations that certain incumbent licensees support is also inconsistent with Congressional and Commission policies designed to promote more intense spectrum use where feasible. As Wi-Fi Alliance detailed in its comments, Congress has made clear that it expects the Commission to find sharing opportunities in the mid-band spectrum for unlicensed operations,^{28/} and the Commission itself has also shown that it recognizes the need for more mid-band spectrum for Wi-Fi.^{29/} The mid-band spectrum is finite – in order for unlicensed devices to gain needed access, a 21st century spectrum sharing approach *must* be implemented.

Consistent with those policies, the Commission should look to the sound, statistical analysis of what will happen in evaluating potential shared spectrum use, as demonstrated by the

^{28/} *Comments of Wi-Fi Alliance*, ET Docket No. 18-295 at 6 n.18, 19 (Feb. 15, 2019) (“Wi-Fi Alliance Comments”) (listing Congressional actions demonstrating a commitment to increasing unlicensed spectrum through sharing).

^{29/} *Wi-Fi Alliance Comments* at 6-7 n.20, 21 (showing that the Commission, and individual commissioners, have consistently supported making more spectrum available for Wi-Fi through sharing).

Commission’s own Technical Advisory Committee’s (“TAC”) work on interference risk analysis. In its recent Spectrum Policy Recommendations, the TAC presented a series of spectrum management principles that generally urged the Commission to shift its focus away from preventing “exceptional events” that *could* happen, to instead rely on quantitative, statistical analyses to determine what is *likely to actually* happen.^{30/} In-line with the TAC’s recommendations, Wi-Fi Alliance and others have offered extensive evidence and approaches that will open the 6 GHz band for unlicensed access without compromising incumbent operations.

B. Low Power Indoor Operations in the U-NII-5 and U-NII-7 Bands Will Not Cause Harmful Interference

1. Concern About LPI Interference is Based on Extreme Corner Cases

The Commission should not restrict operation of LPI devices in any of the 6 GHz sub-bands because LPI devices will not cause harmful interference to fixed operations. The Fixed Wireless Communications Coalition’s (“FWCC”) concerns notwithstanding, before LPI device interference potential is even considered, it requires simultaneous alignment of five unlikely scenarios:

- The LPI device must be within the main beam of the receiver. This is unlikely because of height disparities^{31/} and the fact that microwave links are intentionally designed to avoid obstacles (*e.g.*, buildings).

^{30/} Federal Communications Commission TAC, *Basic Principles for Assessing Compatibility of New Spectrum Allocations*, White Paper (Dec. 11, 2015).

^{31/} See Letter from Alex Roytblat, Senior Director of Regulatory Affairs, Wi-Fi Alliance, to Marlene H. Dortch, Secretary, FCC, GN Docket No. 17-183 at Appendix (Aug. 8, 2018).

- The LPI and the FS link transmissions must overlap in frequency. This is also unlikely since the FS channels are only 10 to 30 megahertz within the 1200 megahertz range of the 6 GHz band.
- A LPI AP's signal power (*i.e.*, its power spectral density) must be concentrated on the fixed receiver channel – an unlikely occurrence based on industry plans to operate wider (*e.g.*, 80 megahertz and 160 megahertz) channels.
- A LPI AP can only potentially interfere when it is transmitting. A Wi-Fi device's on-air duty cycle is less than 1%, making it unlikely that it will interfere with FS reception.^{32/}
- Finally, the interference event must occur during the multipath fading conditions when FS link margins are at a minimum – recognizing that multipath fading occurs late at night or during early morning hours,^{33/} precisely when Wi-Fi use, particularly in tall office buildings, is minimal.

And, even with the “perfect alignment” of these unlikely conditions, for harmful interference to occur, the LPI transmission would need to overcome building entry loss, clutter loss, and polarization loss. Such a confluence of factors represents an extreme corner case scenario. This “interference lottery,” as Hewlett Packard Enterprise called it,^{34/} is not a sound basis for spectrum regulatory policy.

^{32/} HPE Comments at 12-14.

^{33/} *NPRM* at ¶ 46.

^{34/} HPE Comments at 15.

2. *The Record Reflects a More Realistic Assessment of the Lack of Interference from LPIs*

In contrast to these unrealistic assumptions, Wi-Fi Alliance detailed that LPI devices, whether APs or client devices under an AP's control, will not cause harmful interference to incumbent operations.^{35/} Because of the nature of their operations, the vast majority of an LPI device's signal will be attenuated before it reaches the outdoors, and what remains will be unable to cause interference to high-powered FS transmissions. These conclusions are based on extensive research and testing performed by regulatory bodies around the world, whose work the Commission recognized in the NPRM.^{36/}

As noted by other commenters, the extensive analysis performed by RKF Engineering supports the conclusion that harmful interference to FS operations from LPI operations is unlikely. RKF Engineering found that only 0.2% of FS links would have aggregate interference levels above -6 dB I/N from RLANs operating in the 6 GHz band.^{37/} One commenter, a coalition of 11 companies advocating for access to the 6 GHz band for unlicensed devices (the "RLAN Group"),^{38/} pointed out that even this finding is overly conservative because the RKF analysis

^{35/} Wi-Fi Alliance Comments at 10-19.

^{36/} See, e.g., NPRM at ¶ 70 (discussing ITU studies of clutter loss and BEL).

^{37/} RLAN Group Comments at 19; *Comments of Broadcom*, ET Docket No. 18-295 at 6 (Feb. 15, 2019) ("Broadcom Comments"); HPE Comments at 15; and Qualcomm Comments at 9. See also RKF Engineering, *Frequency Sharing for Radio Local Area Networks in the 6 GHz Band*, at 12, attachment to Letter from Paul Margie, Counsel to Apple, Inc., Broadcom Corporation, Facebook, Hewlett Packard Enterprise, and Microsoft Corporation, to Marlene H. Dortch, Secretary, FCC, GN Docket No. 17-183 at Section 5.2.6 (filed Jan. 25, 2018) ("RKF Report") (noting that "The study found that across all runs, approximately 99.8% of the FS stations within CONUS had aggregate interference levels from RLAN operations below -6 dB I/N. For the 0.2% of remaining FS stations, the study found that FS links designed to 99.999% availability (i.e., approximately 315 seconds of downtime per year) incurred approximately an additional 8 seconds per year of outage, and links designed to 99.9999% availability (i.e., approximately 31.6 seconds of downtime per year) incurred approximately an additional 0.8 seconds per year of outage.").

^{38/} The RLAN Group includes Apple, Broadcom, Cisco, Facebook, Google, Hewlett Packard Enterprise, Intel, Marvell Semiconductor, Microsoft, Qualcomm, and Ruckus.

was not limited to LPI devices, but instead included outdoor and higher-powered devices.^{39/} Nor did it account for polarization mismatch.^{40/} Wi-Fi Alliance noted these factors in its comments as important sources of protection for FS incumbents.^{41/} And as outlined below, there are even more factors that suggest that the RKF analysis was overly conservative in overstating the likelihood of interference.

3. Other Factors Will Limit Interference Potential from LPI Devices

Signal Absorption. The RKF Report’s conclusions outlined above mirror the Commission’s tentative conclusion that harmful interference from LPI devices is unlikely because the vast majority of an LPI device signal’s energy will be absorbed by the people and furnishings inside of a building, as well as interior and exterior walls and windows, meaning there is no real risk of harmful interference to an FS link.^{42/} Commenters supported this analysis, but noted that the Commission’s use of an assumption of a 20 dB building entry loss (“BEL”) – the absorption of a device’s signal before it exits the structure containing it – fails to reflect the full impact of BEL on LPI transmissions.^{43/}

In fact, commenters noted, increased energy efficiency standards, especially those applicable to high-rise buildings (which would be the only ones likely to contain an LPI device within the beam of an FS link) would result in even higher BEL rates of 30 dB or more.^{44/} This

^{39/} RLAN Group Comments at 19.

^{40/} See, e.g., Broadcom Comments at 12-14; HPE Comments at 10; and RLAN Group Comments at 25.

^{41/} Wi-Fi Alliance Comments at 11-15.

^{42/} *NPRM* at ¶ 61 (“By restricting such devices to low power, indoor use, we anticipate that incumbent licensed services would be protected from harmful interference, in part due to significant building attenuation and clutter losses for transmissions originating from indoor devices.”).

^{43/} See, e.g., Qualcomm Comments at 9; Broadcom Comments at 10-11; RLAN Group Comments at 23-25.

^{44/} See, e.g., RLAN Group Comments at 23; HPE Comments at 19; and Broadcom Comments at 11.

is further supported by the Leading Builders of America, which notes that modern insulation techniques, including thicker insulation, metal foil barriers, and double-paned or metal-coated windows, are being increasingly incorporated in *all* construction, not just high-rise buildings, meaning these higher BEL rates will be found in an ever-increasing number of buildings around the country.^{45/} This means that, as 6 GHz LPI devices are deployed over the next few years, the average BEL of the buildings in which they are installed will also be steadily increasing above the Commission’s estimate of 20 dB towards the higher 30 dB level. In fact, because building codes are updated regularly to increase energy efficiency, historical determinations of BEL are already out of date and too low.

FS Antenna Directionality. Another factor that will reduce potential interference from LPIs is the degree of directionality of modern FS antennas, which are extremely efficient at focusing their beams and are designed to reject incidental, “off-axis” signals.^{46/}

Excess Fade Margin. Some commenters questioned the RKF report’s inclusion of excess fade margin in its calculations.^{47/} As the Commission has explained, FS links are engineered to incorporate a buffer in their calculations in order to account for potential interference.^{48/} The Commission noted that these fade margins generally exceed what is needed for the link to operate, and this provides additional protection in the event that an RLAN might otherwise interfere with an FS link.^{49/} A typical fade margin for a 99.999% or 99.9999% availability link

^{45/} See Leading Builders Comments at 7-11.

^{46/} See, e.g., RLAN Group Comments at 20 and Qualcomm Comments at 10.

^{47/} FWCC Comments at 17 (rejecting the concept of “excess” fade margin).

^{48/} NPRM at ¶¶ 45-48.

^{49/} *Id.*

in the 6 GHz band is 37-40 dB.^{50/} RKF found that the average margin in the band was around 50 dB; this means that a typical link could exceed an I/N of -6 by over 12 dB and still achieve the 4.4 bits/sec/Hz regulatory minimum,^{51/} even in the presence of deep fade.^{52/}

The Commission can and should consider these excess fade margins. Hewlett Packard Enterprise demonstrated why fade margin can “be reduced to zero” without causing interference to well-designed systems.^{53/} This is in part because, as the Commission noted, the time when multipath fading tends to be at its highest (*i.e.*, at night) is when RLAN usage is at its lowest, especially in high-rise buildings (which are often commercial).^{54/} While the entirety of FS links’ excess fade margin will not be expanded to overcome potential RLAN interference, the existence of this protection in FS systems will ensure that even in the extremely unlikely event that an LPI might otherwise interfere with an FS link, actual harmful interference will not occur.

Link Design. The RKF analysis similarly did not assume the best-practice FS engineers employ to avoid designing links that pass through a building, further reducing the chances of an unlicensed device transmitting directly within the beam of a link.^{55/} Because, as FS incumbents have noted, it is this “line of sight” interference that presents the greatest concern,^{56/} these factors

^{50/} National Telecommunications and Information Administration, *Interference Protection Criteria Phase 1 - Compilation from Existing Sources*, NTIA 05-432, Oct. 1, 2005, [https://www.ntia.doc.gov/files/ntia/publications/ipc phase 1 report.pdf](https://www.ntia.doc.gov/files/ntia/publications/ipc_phase_1_report.pdf).

^{51/} 47 C.F.R. § 101.141(a)(3)

^{52/} See RKF Report at Section 5.2.4.

^{53/} HPE Comments at Appendix 2, p. 5.

^{54/} *NPRM* at ¶ 46.

^{55/} RLAN Group Comments at 21-22; Broadcom Comments at 8-9.

^{56/} See Letter from Cheng-yi Liu and Mitchel Lazarus, Counsel, Fixed Wireless Communications Coalition, to Marlene H. Dortch, Secretary, FCC, GN Docket No. 17-183 at 11 (Mar. 13, 2018) (noting that interference “from obstructed signals is nearly always insignificant. Actual interference comes from the comparatively infrequent case of an emitter that happens to line up with a microwave receiver over an unobstructed path”).

will provide important additional protections for FS operations. FS links are also designed to reject interference through forward error correction, low-noise amplifiers, and orthogonal frequency-division multiplexing, and incorporate fade margin (as discussed above), meaning even otherwise harmful interference will be rejected by well-designed, modern equipment.^{57/} That is why even in the “edge case” provided by FWCC in its analysis of LPI interference, the Commission’s already conservative I/N=-6 dB criteria – a criteria accepted by FWCC – is still satisfied when using real-world propagation calculations (*i.e.* WINNER II rather than a free space path loss model).

4. LPI Devices Will Remain Indoors

Some commenters express concern that LPI devices will not remain indoors and will cause harmful interference to FS links.^{58/} These concerns are speculative. Commenters noted that there is no evidence that the Commission’s rules governing indoor devices in the 5 GHz U-NII bands and indoor-only ultra-wideband (“UWB”) devices have been unsuccessful, despite a lack of active measures to restrict installations.^{59/} There is no reason to believe that users of 6 GHz LPI devices would be any less willing or able to follow the Commission’s rules. The RLAN Group also described in detail why consumers and enterprise customers are unlikely to choose to install an indoor device outdoors.^{60/}

^{57/} See, *e.g.*, HPE Comments at 15; Facebook Comments at 6.

^{58/} *Comments of Leikhim and Associates*, ET Docket No. 18-295 at 1 (Dec. 17, 2018) (“Leikhim Comments”); *Comments of the National Association of Broadcasters*, ET Docket No. 18-295 at 12 (Feb. 15, 2019) (“NAB Comments”); and *Comments of APCO International*, ET Docket No. 18-295 at 15 (Feb. 15, 2019) (“APCO Comments”).

^{59/} RLAN Group Comments at 31; HPE Comments at 20.

^{60/} RLAN Group Comments at 30-31.

Several commenters agreed with Wi-Fi Alliance that there are simple, cost-reasonable measures the Commission can adopt to further decrease the risk of improper outdoor use of LPI devices. For example, Hewlett Packard Enterprise noted that while there is little incentive for users to deploy LPI devices outdoors when the cost of making an indoor device appropriate for outdoor operation is actually more than the cost of an outdoor device, the Commission could mandate fully integrated antennas for LPI devices, adopt “indoor only use” labeling, and require AC power connections (no use of batteries) for LPI APs.^{61/} Qualcomm agreed, noting that labeling and a power source requirement should be sufficient to effectively guarantee indoor-only operation.^{62/} Together, these measures would be sufficient to ensure indoor-only use of LPIs.

C. LPI Devices Must Have Full Access to the 6 GHz Band

As shown below, under the Commission’s current proposal to limit U-NII-5 and U-NII-7 bands only to standard-power access points,^{63/} the majority of the 6 GHz band would be subject to an AFC requirement regardless of power level,^{64/} and because of the configuration of the U-NII sub-bands, only a single 160 megahertz channel would be available without AFC.^{65/}

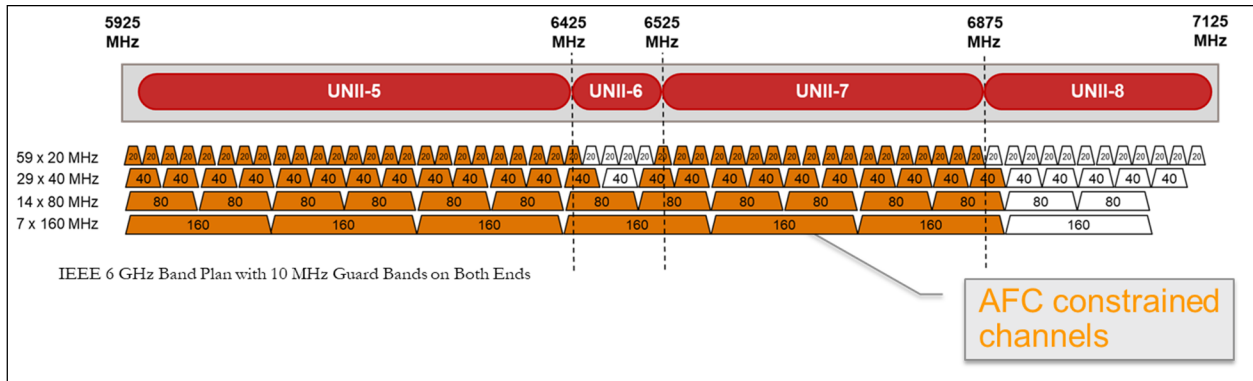
^{61/} HPE Comments at 20-21. Power-over-Ethernet deployments should still be permitted.

^{62/} Qualcomm Comments at 9-10.

^{63/} *NPRM* at ¶ 20.

^{64/} The U-NII-5 and -7 bands make up 850 of the 1,200 megahertz in the 6 GHz band, whereas the U-NII-6 and -8 bands make up only 350 megahertz.

^{65/} In contrast, the full 6 GHz band can host *seven* 160 megahertz channels.



This is not sufficient to meet immediate unlicensed mid-band spectrum needs, especially as devices with Wi-Fi 6, which is designed to take advantage of wider channels,^{66/} are already being introduced.^{67/} As commenters noted, functioning AFC system(s) will not be available immediately, meaning there will be no unlicensed device access to most of the 6 GHz band in the near-term.^{68/} In contrast, Cisco estimates that LPI devices able to run on 6 GHz spectrum could become available within a year of final rules being adopted.^{69/}

Moreover, the imposition of AFC on all unlicensed devices in the U-NII-5 and U-NII-7 bands is not costless. Mandatory use of all devices through an AFC will limit widespread, rapid deployment of unlicensed operations. Particularly at its outset, deployment of AFC-equipped systems is likely to come with significant expense and logistical difficulty. As discussed above, this is especially problematic for smaller entities with limited budgets, such as schools and universities, because systems that include AFC are unlikely to be operated, at least in the near

^{66/} See Wi-Fi Alliance, Discover Wi-Fi: Wi-Fi 6, <https://www.wi-fi.org/discover-wi-fi/wi-fi-6>.

^{67/} Jacob Kastrenakes, *Samsung's Galaxy S10 has Wi-Fi 6 and Faster LTE*, THE VERGE (Feb. 20, 2019) (<https://www.theverge.com/2019/2/20/18232366/samsung-galaxy-s10-wifi-6-lte-speed>). The Galaxy S10 became available on March 8.

^{68/} See, e.g., RLAN Group Comments at 33-35; HPE Comments at 4; and *Comments of Microsoft Corp.*, ET Docket No. 18-295 at 5-11 (Feb. 15, 2019) (“Microsoft Comments”).

^{69/} Cisco Comments at 9.

term, by already overwhelmed information technology staffs.^{70/} Precluding LPI deployment in the U-NII-5 and U-NII-7 bands might also conflict with expected regulations in other countries, resulting in a confusing patchwork of regulations that will impede unlicensed harmonization around the world.^{71/} If the Commission is serious about making broadband connectivity available to all Americans by creating new opportunities for unlicensed use in the 6 GHz band,^{72/} then it must allow LPI operations in the U-NII-5 and U-NII-7 bands.

D. AFCs Can Protect FS Incumbent Operations from Standard-Power Unlicensed Operations

Commenters generally agreed with the Commission’s proposal that AFCs would utilize data contained in the ULS to determine permissible frequencies for unlicensed devices.^{73/} The underlying principles of this system are widely supported by commenters, including those that operate FS links.^{74/} While the Commission must address details related to AFC design and implementation, commenters recognize that the Commission’s proposal is an effective way of allowing standard-power RLAN operations in the 6 GHz band while still protecting incumbent operations.

1. Opposition to the AFC Proposal Arises from an Outdated View of AFC Capabilities

Critics of the Commission’s proposal rely mainly on conclusory arguments about the risks of harmful interference and doubts as to the feasibility of the AFC. Groups such as the

^{70/} Friday Institute Comments at 5.

^{71/} Facebook Comments at 4.

^{72/} *NPRM* at ¶ 1.

^{73/} *NPRM* at ¶¶ 25-26.

^{74/} See, e.g., FWCC Comments at 3; *Comments of Baltimore County, Maryland*, ET Docket No. 18-295 (Feb. 12, 2019) (agreeing with the position of FWCC that AFC can adequately protect incumbent operations) (“Baltimore Comments”).

coalition led by the Utilities Technology Council (“UTC *et al.*”)^{75/} dismiss the Commission’s and Wi-Fi advocates’ careful analysis of sharing (including the RKF report discussed above) and detailed explanation of how the AFC will function, and simply assert that this work is insufficient.^{76/} They raise questions about the exact nature of RLAN deployments and ask how an AFC will accommodate specific deployment variations, but ignore analyses showing that these variations do not change the AFC’s functionality or interference realities.^{77/} Other filers point to past interference issues between U-NII devices and incumbents, only noting in passing that these interference issues stemmed from illegally modified or otherwise non-compliant equipment,^{78/} or describe AFC as an “experiment,” ignoring the Commission’s extensive work on spectrum sharing geolocation-databases in the Citizens Broadband Radio Service and the TV White Spaces.^{79/} In fact, both of these databases are more complex than the proposed AFC.

The Commission should reject these objections and proceed with its proposal for standard-power APs with AFC. The overwhelming consensus across industries, even among incumbent licensees, is that AFC will be able to protect incumbent operations, as illustrated by

^{75/} This coalition also includes five other groups representing FS users.

^{76/} UTC Comments at 6-10.

^{77/} *Id.*

^{78/} See, e.g., *Comments of Portland General Electric*, ET Docket No. 18-295 (Feb. 15, 2019); *Comments of Southern California Public Power Authority*, ET Docket No. 18-295 (Feb. 15, 2019); and UTC Comments at 8.

^{79/} See DSA Comments at 3-6 (noting the connections between AFC and other similar database-based automatic spectrum coordination systems such as the TV White Spaces); and *Comments of Federated Wireless*, ET Docket No. 18-295 at 3-5 (Feb. 15, 2019) (arguing that the Commission’s experience in designing database-based frequency coordination systems can be applied to AFC).

the support for the Commission’s proposal from the FWCC^{80/} and other FS operators themselves.^{81/}

2. *The Commission Should Adopt the Vision of AFCs Articulated by Wi-Fi Advocates*

The structure that Wi-Fi Alliance and others have advocated remains the best way to implement AFC. It strikes the appropriate balance between avoiding harmful interference while minimizing burdens on device manufacturers and operators. In contrast, opponents of these proposals seek to impose additional requirements on AFCs and Wi-Fi that will delay or hinder deployment without providing any meaningful improvement in incumbent protection. The Commission must avoid being overly restrictive and not require protection from a risk of interference that, while theoretically possible, will not occur in the real world.

a. The Commission’s AFC Rules Should Provide for Maximum Flexibility in System Design

Some commenters proposed that the Commission require AFCs to have “positive control” over APs, meaning they would be able to direct APs to change frequencies in between scheduled permitted frequency checks.^{82/} In addition, or in the alternative, some commenters suggest that AFCs should be required to collect registration or channel assignment data from APs.^{83/} Wi-Fi Alliance strongly opposes such proposals.

Adopting these requirements will impose significant operational and logistical burdens on AFCs without providing any meaningful increase in protection for incumbent operations. As the

^{80/} FWCC Comments at 3 (noting that AFC-based protection of incumbent licensees is feasible).

^{81/} See, e.g., LA Comments at 2-3 (noting the city’s support for unlicensed deployments, including in the 6 GHz band, if incumbents are protected) and Baltimore Comments.

^{82/} CTIA Comments at 17-19 (Feb. 15, 2019); *Comments of Ericsson*, ET Docket No. 18-295 at 20 (Feb. 15, 2019) (“Ericsson Comments”); and Verizon Comments at 5.

^{83/} FWCC Comments at 14, *Comments of Southern Company Services*, ET Docket No. 18-295 at 13 (Feb. 15, 2019) (“Southern Company Comments”); and AT&T Comments at 18-19.

RLAN Group noted in its comments, these requirements would greatly reduce the appeal of 6 GHz devices and undermine the Commission’s goal of using this spectrum to alleviate the shortage of mid-band spectrum for Wi-Fi.^{84/} The RLAN Group also noted that Wi-Fi devices routinely change channels on their own in response to their local radiofrequency environments, and any requirement that AFCs track or retain control over channel assignments, including keeping some device channel history, would be immensely burdensome and costly and dramatically limit AFC design.^{85/}

In contrast, these proposals are unlikely to actually protect against interference. Interference, if it occurs, will be temporary and infrequent, not ongoing and consistent. In the exceedingly unlikely event that interference occurs, Wi-Fi Alliance and its members are fully committed to resolving it as quickly as possible. AFC operators and the unlicensed industry have significant incentives to work with FS operators to resolve interference on a case-by-case basis.

Similarly, the Commission should reject requests that it specify particular aspects of AFC systems as part of the AFC certification rules. These proposals include requiring centralized calculations,^{86/} mandating that there be only one AFC controlling all standard-power APs,^{87/} dictating that AFCs must provide channel permissions based on maximum permitted power,

^{84/} RLAN Group Comments at 65-66.

^{85/} *Id.*

^{86/} *Comments of the Association of American Railroads*, ET Docket No. 17-295 at 5-6 (Feb. 15, 2019) (“AAR Comments”); CTIA Comments at 20, *Comments of the City of New York*, ET Docket No. 18-295 at 3 (Feb. 15, 2019).

^{87/} *Comments of El Paso Electric Company*, ET Docket No. 18-295 at 3 (Feb. 15, 2019) (“El Paso Comments”).

rather than specifying the availability of some channels based on lower power levels,^{88/} and requiring inter-AFC communications.^{89/} None of these proposals will increase the protection provided by AFCs; they would simply add cost and complexity and/or reduce flexibility in AFC design,^{90/} undermining the Commission’s goal of maximizing the use of this valuable spectrum.

As many commenters explained, it is critical that the Commission allow innovative AFC implementation.^{91/} The RLAN Group noted that the Commission must not become involved in an AFC’s design beyond verifying its functional performance capability, or risk stymieing innovation and business models.^{92/} Hewlett Packard Enterprise similarly called on the Commission to retain maximum flexibility for AFC systems to serve a diversity of needs.^{93/} A group of public interest organizations led by Public Knowledge pointed out that a wide range of different types of entities may choose to implement their own AFC solutions, and the Commission’s rules must allow for this diversity of implementations.^{94/} Facebook similarly noted that prescriptive regulations would prevent the marketplace from determining the best AFC features for particular use cases.^{95/} Microsoft noted that a WISP in a rural area and an

^{88/} *Comments of Ubiquiti Networks*, ET Docket No. 18-295 at 2 (Dec. 21, 2018) (“Ubiquiti Comments”); *Comments of NE Colorado Cellular dba Viaero Wireless*, ET Docket No. 18-295 at 2 (Feb. 15, 2019).

^{89/} Midco Comments at 14.

^{90/} As noted by Hewlett Packard Enterprise, inter-AFC communications risk becoming a major logistical issue as more and more AFCs come online. In the future, a requirement for inter-AFC coordination could become a major barrier to entry, reducing competition and innovation. HPE Comments at 67.

^{91/} *See, e.g.*, RLAN Group Comments at 49; HPE Comments at 22; Public Interest Commenters at 27.

^{92/} RLAN Group Comments at 49.

^{93/} HPE Comments at 22.

^{94/} Public Interest Commenters at 27.

^{95/} Facebook Comments at 9.

urban university campus will have very different AFC needs, and should be given the flexibility to provide the needed protection with no added costs or administrative burdens.^{96/} If the Commission wishes to promote novel and exciting use-cases in this band, it must focus on performance-based rules that ensure protection of incumbents and nothing more. Any superfluous regulations could result in the suppression of valuable innovation.

The need for system flexibility means the Commission should avoid requiring professional installation for standard-power devices, and allow AFCs flexibility in addressing the height above ground level (“AGL”) of devices. Wi-Fi Alliance noted that there is no need for mandatory professional installation.^{97/} The consensus of commenters that addressed this issue supported the Wi-Fi Alliance approach. The RLAN Group and Qualcomm noted that advanced geolocation technologies will be able to provide sufficient information for most AFC calculations, and because most APs are installed in homes, a professional installation requirement would be extremely burdensome and undermine the Commission’s goal of promoting cost-effective wireless deployments in the 6 GHz band.^{98/} Allowing, but not requiring, professional installation will maximize system design flexibility while still guaranteeing protection of incumbent licensees.

Wi-Fi Alliance agrees that harmful interference from unlicensed devices to licensed systems in the 6 GHz band – as rare and exceptional as such interference may be – must be resolved in as close to real-time as possible. It would not be practical, however, for the Commission to require that AFCs be responsible for interference resolution. As discussed

^{96/} Microsoft Comments at 18.

^{97/} Wi-Fi Alliance Comments at 19.

^{98/} RLAN Group Comments at 6, 32; Qualcomm Comments at 5, 12.

above, an exceptional event of harmful interference will inevitably be unique to that particular case, and flexibility in resolution will be important. The Commission has wisely declined to take a prescriptive approach to interference resolution in the 6 GHz band in the past – FS frequency coordinators, for instance, are not obligated to identify and halt operations they previously coordinated in the event of harmful interference.^{99/} The Commission should proceed similarly with regard to AFCs. Layering additional complexity into the AFC process to deal with extremely uncommon cases of interference would only serve to inhibit unlicensed use of the band. As Apple correctly states, “unnecessary requirements for AFC systems will discourage investment in the 6 GHz band and, consequently, deployment of broadband and other innovative uses.”^{100/}

b. AFCs Should Only Be Required to Rely on ULS Data, With Other Sources of Information Available but Not Mandated

The Commission has correctly recognized that the primary source of information on FS deployments in the 6 GHz band is its ULS system, and proposed to mandate that as the basis for the AFC’s calculations.^{101/} Commenters generally agreed with this proposal, also noting the need for a fee-exempt opportunity for FS licensees to update and ensure the accuracy of their ULS entries.^{102/} Wi-Fi Alliance agrees. Having the most up-to-date, accurate information on spectrum usage in ULS is important for effective spectrum management and, therefore, is in the public interest. In fact, there is no legitimate reason for this information *not* to be available in a

^{99/} See 47 C.F.R. § 101.103 (detailing frequency coordination procedures for fixed services).

^{100/} *Comments of Apple, Inc.*, GN Docket No. 17-183, ET Docket No. 18-295, at 12 (filed Feb. 15, 2019); see also Facebook Comments at 9 (stating that “registration, identification or tracking of AFC-controlled devices...would be burdensome...unnecessary and ineffective at mitigating interference”).

^{101/} *NPRM* at ¶¶ 39-41.

^{102/} See, e.g., AAR Comments at 7-8; El Paso Comments at 4; and APCO Comments at 10.

public database administered by the Commission. Wi-Fi Alliance enthusiastically supports calls for updating and maintaining the ULS.^{103/}

Some commenters note that third-party databases, usually operated by frequency coordinators, often contain specific information about FS deployments that may not be found in ULS,^{104/} and UTC *et al.* noted that some data missing from ULS should be incorporated into ULS by the Commission.^{105/} These comments highlight that some FS licensees have not met their obligations to accurately provide complete information about their operations to the Commission. These deficiencies should and must be rectified. Spectrum is a precious national resource; licensees have an obligation to maintain accurate records about how it is being used.

Wi-Fi Alliance agrees with commenters who assert that the use of third-party, non-public information should not be required by the Commission. As a detailed analysis by Hewlett Packard Enterprise shows, all necessary data for AFC calculations are found in ULS, although updates may be necessary, especially for FS links installed before the advent of GPS technology.^{106/} Private databases may be used by an AFC to improve the specificity of its calculations to allow operations on *additional* channels, but the Commission must not impose any requirement that involves the use of private databases.

Similarly, there is no need for the Commission to mandate constant re-checks by APs to obtain updated information on FS operations from their AFC, as some commenters requested.^{107/} Based on review of ULS records by the RLAN Group, an FS link almost never initiates

^{103/} See, e.g., Public Interest Commenters at 29; HPE Comments at 28.

^{104/} FWCC Comments at 28.

^{105/} UTC Comments at 12-13.

^{106/} HPE Comments at Appendix 2, p. 16.

^{107/} See, e.g., *Comments of Motorola Solutions*, ET Docket No. 18-295 at 2 (Feb. 15, 2019) (“Motorola Comments”); FWCC Comments at 13.

operation in under 30 days from the time the Commission adds it to ULS, meaning a 30 day re-check window will provide sufficient protection for even new FS operations.^{108/}

c. Interference Calculations Should be Based on Real-World Situations, Not on Theoretical, Worst-Case Scenarios

In order for AFCs to determine permissible frequency use, the Commission must decide the appropriate level of protection for incumbent operations. Wi-Fi Alliance agrees with commenters and with the Commission^{109/} who support a combination of the WINNER II model and a beyond-line-of-sight model derived from the Irregular Terrain Model and ITU-R P.2108 models, as this will most accurately represent actual real-world interference conditions.^{110/} Wi-Fi Alliance urges the Commission to ensure that applicable propagation models align with the real world environment.

When determining whether a particular AP can operate on a specific frequency in its location, an AFC should consider the actual characteristics of the device, including the antenna pattern, and any client devices that may be operating at or near the edges of its signal range. In other words, the overall contour of a standard power AP will vary with its specifics (meaning it may not be spherical),^{111/} and the AFC must take this into consideration. This will ensure that Wi-Fi deployments with unique characteristics do not interfere with incumbent operations, and also ensure that they are able to operate in the maximum number of locations and on the maximum number of frequencies.

^{108/} RLAN Group Comments at 42.

^{109/} *NPRM* at ¶ 48.

^{110/} *See, e.g.*, RLAN Group Comments at 43; HPE Comments at 28; and Broadcom Comments at 16.

^{111/} This is in contrast to the assertion by FWCC that AFCs should assume spherical contours of APs. FWCC Comments at 30.

Similarly, as discussed above, while standard power APs should not be permitted to absorb the entirety of an FS link's excess fade margin, the existence of this buffer provides additional protection in the extremely unlikely event of interference. In-depth analysis provided by Hewlett Packard Enterprise^{112/} and others shows that well-engineered FS links are more than capable of absorbing the relatively low-power signal of standard-power AP transmissions without experiencing any actual loss in performance. The Commission should evaluate how AFCs could take excess fade margin into consideration in making channel assignments.

Some commenters assert that AFCs should coordinate AP operations on channels adjacent to FS links.^{113/} The Commission correctly proposed to require only co-channel protections,^{114/} and Wi-Fi Alliance and others support this position.^{115/} As WISPA notes, U-NII devices concentrate their power to such a degree that emissions into an adjacent channel are extremely small; there is simply no way a far higher-power, licensed transmitter would experience interference from those emissions in the real world.^{116/} The Commission noted that its proposals already protect against adjacent channel interference and therefore there is no need to prevent adjacent-channel operations.^{117/} Requests for adjacent-channel or even second-adjacent channel protection should be rejected as overly conservative.^{118/}

^{112/} See HPE Comments at Appendix 2, p. 5.

^{113/} See, e.g., FWCC Comments at 25; Leikhim Comments at 2.

^{114/} NPRM at ¶ 44.

^{115/} See, e.g., WISPA Comments at 21; Broadcom Comments at 15 (noting that even theoretical interference from RLANs requires frequency overlap).

^{116/} WISPA Comments at 21. Even a higher-gain antenna of the sort used for Point-to-Point transmissions would see emissions of less than that of an LPI device at the adjacent channel.

^{117/} NPRM at ¶ 44.

^{118/} FWCC Comments at 25-28; *Comments of National Spectrum Management Association*, ET Docket No. 18-295 at 17-18 (Feb. 15, 2019).

Similarly, there is no need for out-of-band emission limits within the 6 GHz band, as opposed to at its edges, nor for any particular protections for operations directly above and below the band beyond what the Commission has proposed.^{119/} As Qualcomm noted, there is only minimal diversity in protection needs between 6 GHz incumbents, meaning existing protections for each sub-band will be sufficient to protect users in adjacent sub-bands.^{120/}

E. Other Incumbent Operations Do Not Require Additional Protections from Unlicensed Operations

The record makes clear that the Commission need not adopt additional protections for Fixed Satellite Service (“FSS”), UWB, Radio Astronomy Service (“RAS”), and Earth Remote Sensing (“ERS”) incumbents in the 6 GHz band.

FSS. Contrary to some commenters’ claims,^{121/} there is no need for the Commission to (i) manage U-NII interference to satellite receivers on an aggregate basis, (ii) adopt pointing restrictions or exclusion zones, or (iii) monitor for increases in the noise floor. As the RLAN Group explains, RLAN operations pose no risk of harmful interference to FSS uplinks, especially when compared to the high-power FS links that already operate in the band.”^{122/} This is in part because, as Wi-Fi Alliance’s analysis shows, of the substantial separation distances between ground-based U-NII transmitters and space-based satellite receivers.^{123/} Other commenters agree with this analysis.^{124/} There is currently no licensed use of FSS downlinks in

^{119/} *NPRM* at ¶ 82.

^{120/} Qualcomm Comments at 15.

^{121/} *See Comments of Intelsat License LLC and SES Americom, Inc.*, ET Docket No. 18-295 at 3-11 (Feb. 15, 2019) (“Intelsat Comments”); *Comments of NCTA*, ET Docket No. 18-295 at 5, 10 (Feb. 15, 2019) (“NCTA Comments”); *Comments of Sirius XM Radio, Inc.*, ET Docket No. 18-295, at 17-19 (Feb. 15, 2019) (“Sirius XM Comments”); and Midco Comments at 8.

^{122/} RLAN Group Comments at 5.

^{123/} *See Wi-Fi Alliance Comments* at 36, Annex.

^{124/} Facebook Comments at 9.

the band, and any hypothetical future user will most likely be in an isolated, secured area, thereby reducing the likelihood of interference.

Assertions by FSS operators that unlicensed operations in the 6 GHz band should be restricted because unlicensed operations in the U-NII-1 band have led to a rise in the noise floor are unfounded.^{125/} These claims are based entirely on an unsupported petition submitted by Globalstar, Inc., in which Globalstar fails to present sufficient evidence of the relationship between unlicensed U-NII-1 operations and the alleged detrimental changes to the noise floor, or any viable evidence that U-NII-1 unlicensed operations have caused actual harmful interference.^{126/} The Commission should therefore decline to monitor for increases in the noise floor and refrain from adopting unnecessary restrictions – including pointing restrictions, exclusion zones, and aggregate interference limits – on unlicensed operations in the 6 GHz band.

UWB. The Commission should reject arguments urging it to (i) impose restrictions – such as duty cycle requirements and reduced power limits – on new 6 GHz unlicensed operations to prevent interference to existing unlicensed UWB operations;^{127/} (ii) allow UWB operators to register their operations with the AFC system to receive protection;^{128/} and (iii) require a detect-and-avoid capability for new unlicensed devices based upon detection of a registered beacon

^{125/} See Intelsat Comments at 3-6; Sirius XM Comments at 10.

^{126/} *Opposition of Wi-Fi Alliance*, Docket No. RM-11808 (filed July 6, 2018).

^{127/} See, e.g., *Comments of Alteros*, ET Docket No. 18-295 at 10-13 (Feb. 15, 2019) (“Alteros Comments”); *Comments of Decawave*, ET Docket No. 18-295 at 5-8 (Feb. 15, 2019); *Comments of NXP USA*, ET Docket No. 18-295 at 3-4 (Feb. 15, 2019) (“NXP USA Comments”); *Comments of Ultra Wide Band Alliance*, ET Docket No. 18-295 at 3-4 (Feb. 15, 2019) (“UWB Alliance Comments”).

^{128/} See, e.g., *UWB Alliance Comments* at 8; *Comments of Zebra Technologies*, ET Docket No. 18-295 at 5 (Feb. 15, 2019).

fence signal.^{129/} The RLAN Group correctly noted that longstanding Commission precedent makes clear that unlicensed UWB devices are not entitled to protection from other unlicensed uses.^{130/} In any event, because of the localized nature of RLAN and UWB operations, any RLAN in the vicinity of a UWB device will likely be under the control of the UWB operator, which will be able to manage interference between the devices.

RAS and ERS. Protections for RAS and ERS can be managed via the AFC system.^{131/} Because RAS locations are fixed and known, they can be included in the AFC system and protected against standard-power operations, a solution that the National Academy of Sciences Committee on Radio Frequencies itself endorses.^{132/} The same solution can be employed to protect ERS facilities; the Commission should allow ERS operators to register with ULS or another database so that all relevant protection information is included in AFC.^{133/}

IV. THE COMMISSION SHOULD ADOPT OTHER MODIFICATIONS TO MAXIMIZE THE USE OF THE 6 GHZ BAND BY UNLICENSED DEVICES

Wi-Fi Alliance proposed several modifications to the Commission’s proposals for the 6 GHz band aimed at maximizing future use of the band while still ensuring full protection from

^{129/} See Alteros Comments at 13-15; UWB Alliance Comments at 8; NXP USA at 3. National Association of Broadcasters similarly suggested a “beacon fence” proposal in their comments, and this should also be rejected.

^{130/} See Letter from Apple Inc., Broadcom Inc., Cisco Systems, Inc., Facebook, Inc., Google LLC, Hewlett Packard Enterprise, Intel Corporation, Marvell Technology Group, Microsoft Corporation, Qualcomm Incorporated, and Ruckus Networks to Marlene H. Dortch, Secretary, FCC, ET Docket No. 18-295 at 5 (Oct. 15, 2019).

^{131/} *Comments of the National Academy of Sciences Committee on Radio Frequencies*, GN Docket No. 17-183, ET Docket No. 18-295 (Feb. 15, 2019) (“CORF Comments”) (expressing concern about interference to RAS and earth remote sensing).

^{132/} CORF Comments at 5-6.

^{133/} Contrary to the claims of CORF, there is no need to restrict probe requests or LPI operations to protect ERS.

harmful interference for incumbent operations. Other commenters echoed many of these proposals.

A. Power Levels for Client Devices.

Wi-Fi Alliance urged the Commission to allow client devices to operate at the same power levels as the AP controlling them.^{134/} Numerous parties echoed this suggestion,^{135/} noting that it would provide maximum flexibility to future system designers. Because, as discussed above, if an AFC can take into consideration the signal contours of an AP's client devices, there is no increased risk of harmful interference for standard-power operations. And, because LPI client devices will be operating in the same environment as their APs, there is no risk of harmful interference from client devices operating at LPI power levels.

Similarly, Wi-Fi Alliance suggested^{136/} that rules governing the 6 GHz band allow devices to focus their power spectral density as needed. Several commenters agreed,^{137/} noting that this flexibility will foster innovation and improved Wi-Fi service quality without increasing the risk of harmful interference.

No commenters opposed either of these proposals.

B. Additional Device Categories.

Wi-Fi Alliance urged the Commission to adopt a third category of U-NII in the 6 GHz band, in addition to LPI and standard-power operations – mobile/portable APs.^{138/}

^{134/} Wi-Fi Alliance Comments at 17.

^{135/} See Broadcom Comments at 37; Facebook Comments at 5; Microsoft Comments at 13; Netgear Comments at 3; RLAN Group Comments at 49; and Cambium Comments at 3.

^{136/} Wi-Fi Alliance Comments at 37.

^{137/} RLAN Group Comments at 49; Broadcom Comments at 33-36; *Comments of Netgear*, ET Docket No. 18-295 at 3 (Feb. 15, 2019) (“Netgear Comments”); Qualcomm Comments at 16-17.

^{138/} Wi-Fi Alliance Comments at 34-36.

Commenters agree that the Commission should not constrain future innovation in the 6 GHz band by prohibiting mobile and transportable unlicensed operations and unlicensed operations in moving vehicles.^{139/} Concerns that any such operations will create an unpredictable interference environment^{140/} can be easily addressed by limiting mobile, transportable, and vehicular AP operations to those that are managed by an AFC system or that pose no greater risk of harmful interference than low power indoor-only operations. Intelsat is incorrect that an AFC system cannot monitor standard-power mobile operations.^{141/} To the contrary, as Apple explains, an AFC system can determine the channels that are available even when devices are moving by accounting for velocity and geolocation accuracy.^{142/}

C. Higher Gain Point-to-Point Antennas.

Wi-Fi Alliance supported allowing point-to-point operations with higher-gain antennas alongside standard-power APs. Commenters across industries agreed, noting that the use of higher-gain antennas will be valuable for enterprise and wireless Internet service provider uses.^{143/} As Starry explained, allowing higher gain antennas increases the efficiency of spectrum use in a given area, and improves the quality of the wireless link between an access

^{139/} See, e.g., Facebook Comments at 5 (“The Commission should permit very-low-power devices, including portable devices, at radiated power levels less than 14 dBm”); Ubiquiti Comments at 5 (“Ubiquiti also proposes herein that devices operating at or below 24 dBm (EIRP) be deemed appropriate for Mobile applications, including hotspots, with perhaps some restrictions for aviation use.”); *Comments of Sony Electronics, Inc.*, ET Docket No. 18-295 at 9 (Feb. 15, 2019) (“Sony Comments”) (“Sony encourages the Commission to allow unlicensed devices in the U-NII-5 and U-NII-7 bands to operate as mobile hotspots and transportable devices.”); UWB Comments at 9 (“[A] more practical approach is to allow low power mobile hotspots based on typical use case.”).

^{140/} See Intelsat Comments at 12; Southern Company Comments at 18; El Paso Comments at 6.

^{141/} See Intelsat Comments at 12.

^{142/} See Apple Comments at 5; see also Sony Comments at 9 (stating that AFC control of mobile devices is technically feasible).

^{143/} See, e.g., RLAN Group Comments at 70; Broadcom Comments at 4; and Public Interest Commenters at 21.

point and client device.^{144/} While some commenters expressed concerns about point-to-point systems,^{145/} they failed to articulate why a well-designed AFC would be unable to accommodate them. In fact, even the FWCC noted that point-to-point systems can be accommodated by an AFC.^{146/} To facilitate deployment of the widest range of innovative unlicensed technologies, the Commission's rules should grant AFCs the flexibility needed to be specialized for particular use cases – thereby enabling some to accommodate higher-gain deployments, while others focus on omnidirectional standard-power access points.

D. Expanded U-NII-8 Band Use.

Wi-Fi Alliance suggested that the Commission consider allowing standard-power operations in the U-NII-8 band, in addition to the U-NII-5 and U-NII-7 bands.^{147/} Commenters agreed with Wi-Fi Alliance that standard-power operations, controlled by AFC, can be permitted in at least part of the U-NII-8 band. The RLAN Group pointed to the RKF analysis, which found that RLANs would have no material impact on 99% of Broadcast Auxiliary Service operations in that spectrum, and the remaining 1% would be easily able to remedy any interference issues.^{148/} Further, as Microsoft explained in its comments, uncertainty regarding the lower-end of the 6 GHz band means that at least some of the U-NII-8 band will be required to allow the maximum number of 80 and 160 megahertz channels for standard-power APs.^{149/}

^{144/} Starry Comments at 2.

^{145/} See, e.g., *Comments of Tucson Electric Power Company and UNS Electric*, ET Docket No. 18-295 at 24 (Feb. 15, 2019).

^{146/} FWCC Comments at 33. FWCC recommended that the Commission delay allowing point-to-point antennas until a later date, though a properly designed AFC should be able to accommodate such systems immediately.

^{147/} Wi-Fi Alliance Comments at 33.

^{148/} RLAN Group Comments at 46.

^{149/} Microsoft Comments at 13.

E. Multi-Stakeholder Process.

Wi-Fi Alliance opposed proposals for the Commission to mandate an official multi-stakeholder process in the Commission's development and evaluation of AFC standards. Contrary to some commenters' assertions,^{150/} there is no need for this additional layer of oversight and complexity. The Commission has more than sufficient expertise and resources necessary to certify the viability of AFC operations while retaining the flexibility necessary for a robust AFC ecosystem. An additional layer of review will simply delay implementation of AFC systems and deployment of standard-power unlicensed devices in the band. As discussed above, it is critical that the Commission streamline its work getting 6 GHz devices to market in order to make the most of this valuable spectrum – mandating a multi-stakeholder process as part of this work may be counterproductive.

F. Probe Requests.

A few parties expressed concern about interference from client device probe requests if they are allowed within the 6 GHz band.^{151/} These concerns are unfounded. As Hewlett Packard Enterprise highlights, such signals are extremely brief and occur infrequently, meaning they pose even less interference risk than LPI devices.^{152/} Allowing probe requests in the 6 GHz band will help ensure that client devices can join or rejoin networks quickly, preventing connection issues that could lead to lower adoption rates for devices in the band.^{153/} Moreover, because there will

^{150/} See, e.g., Ericsson Comments at 14; *Comments of Wireless Innovation Forum*, ET Docket No. 18-295 at 3-4 (Feb. 15, 2019); Motorola Comments at 4.

^{151/} See WISPA Comments at 16; El Paso Comments at 6; CORF Comments at 6.

^{152/} HPE Comments at 30.

^{153/} *Id.*

be client devices developed that are only able to operate in the 6 GHz band, the ability to make these requests in the same spectrum is essential.

V. THE ENTIRE 6 GHZ BAND IS REQUIRED FOR UNLICENSED USE

Some entities argued that the Commission should dedicate a portion of the 6 GHz band for licensed use.^{154/} Specifically, they contend that allocating some of the 6 GHz band for licensed use will better allow the band to meet consumer demand and promote efforts in U.S. 5G leadership.^{155/} Despite these arguments, the Commission should make the entire band available for unlicensed use.

First, while spectrum for licensed systems is important, spectrum for unlicensed operations is critical as well. As discussed above, Wi-Fi Alliance's *Spectrum Needs Study* and the record in this proceeding demonstrate the desperate need for additional spectrum for Wi-Fi. Making the full 6 GHz band available for Wi-Fi is necessary for it to meet the exponential growth in data demand and serve as an offload technology for 5G.

Second, there are limited opportunities for spectrum access for unlicensed devices. As Wi-Fi Alliance demonstrated, after years of consideration, the National Telecommunications and Information Administration ("NTIA") recently determined that unlicensed operation would not be permitted in the U-NII-2B band,^{156/} and testing to share the U-NII-4 band with Dedicated Short Range Communications remains in its early stages.^{157/} There are no other opportunities for Wi-Fi to access mid-band spectrum.

^{154/} CTIA Comments at 9-10; Ericsson Comments at 13; and Verizon Comments at 12-14.

^{155/} *Id.*

^{156/} *Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz*, Notice of Inquiry, 32 FCC Rcd 6373 ¶ 28 (2017) ("NOI").

^{157/} *See Office of Engineering and Technology Requests Comment on Phase I Testing of Prototype UNII-4 Devices*, Public Notice, ET Docket No. 13-49 (rel. Oct. 29, 2018); *Statement of Commissioner Michael O'Rielly on 5.9 GHz Phase I Testing Data* (rel. Oct. 29, 2018); *Statement of Commissioner*

Third, anything but full access to the entire 6 GHz band would also dramatically undermine the band’s potential as globally-harmonized unlicensed spectrum. International harmonization in the band will create economies of scope and scale and produce a robust equipment market, benefitting U.S. businesses and consumers.^{158/} As Hewlett Packard Enterprise noted, efforts to allow Wi-Fi in the 6 GHz band are already underway around the world.^{159/} The RLAN Group correctly notes that encouraging the U.S. to ensure that the 6 GHz band is internationally harmonized avoids “potentially forcing U.S. manufacturers to face a challenging patchwork of international spectrum availability.”^{160/} In order to ensure U.S. leadership in unlicensed technologies, and to avoid creating inconsistent band plans, the Commission must make the full 6 GHz band available for unlicensed operations like Wi-Fi, setting precedent that other countries will follow.

Fourth, there are other potential opportunities for the Commission to designate mid-band spectrum for licensed technologies. For example, the Commission has committed to making some or all of the 3.7-4.2 GHz band available for licensed terrestrial wireless use.^{161/} In the last year, the Commission also initiated a proceeding to update the framework for licensing spectrum

Jessica Rosenworcel on Phase 1 Test Report of Prototype U-NII-4 Devices, rel. Oct. 29, 2018; and Letter from Rick Chessen, NCTA, to Marlene H. Dortch, Secretary, FCC, ET Docket No. 13-49 (Oct. 16, 2018).

^{158/} See Qualcomm Comments at 11 (“The FCC should allow LPI unlicensed operations throughout the 6 GHz band because the potential global harmonization would provide economies of scale and lower-cost devices.”).

^{159/} HPE Comments at 12.

^{160/} RLAN Group Comments at 18.

^{161/} See *Expanding Flexible Use of the 3.7 to 4.2 GHz Band*, GN Docket No. 18-122, *et al.*, 33 FCC Rcd 6915 (2018); see also Michael O’Rielly, Commissioner, FCC, Remarks Before NAB State Leadership Conference, (Feb. 26, 2019), <https://docs.fcc.gov/public/attachments/DOC-356361A1.pdf> (“Please know that there is near certainty that C-Band reallocation will occur. While the particular details are still to be worked out, this debate has matured into finding the best mechanism for reallocation and determining how quickly it can occur.”).

in the 2.5 GHz band,^{162/} and it revised the rules for Priority Access Licenses in the 3.5 GHz band, enabling some of the spectrum to be auctioned for wireless broadband services.^{163/} And, most recently, the Commission announced a temporary freeze on non-federal radiolocation service applications in the 3.1-3.55 GHz band because the band is under consideration for possible repurposing for licensed wireless broadband.^{164/}

Fifth, as noted by Wi-Fi Alliance and others, Congress has increasingly recognized the importance of unlicensed spectrum and the need to make more unlicensed spectrum available quickly.^{165/} As discussed above, Congress has already made clear that it expects the Commission and NTIA to identify more unlicensed spectrum, particularly in the mid-band.^{166/} Because of the pressing need for more unlicensed spectrum to protect and foster critical Wi-Fi deployments, unlicensed spectrum can no longer be an afterthought.

Finally, as discussed above, only designating the full 6 GHz band for unlicensed devices can meet the Commission's stated goals of maximizing wireless broadband connectivity while simultaneously ensuring that licensed incumbent services operating in the 6 GHz band continue to thrive. Incumbent licensees detailed how the 6 GHz band is critical for their operations and must be protected, meaning that the 6 GHz band cannot be cleared for licensed wireless broadband. While unlicensed devices, including Wi-Fi, can successfully operate alongside these

^{162/} See *Transforming the 2.5 GHz Band*, Notice of Proposed Rulemaking, 33 FCC Rcd 4687 (2018).

^{163/} See *Promoting Investment in the 3550-3700 MHz Band*, Report and Order, GN Docket 17-258 (rel. Oct. 24, 2018).

^{164/} See *Temporary Freeze on Non-Federal Applications in the 3100-3550 MHz Band*, Public Notice, DA 19-105 (rel. Feb. 22, 2019). NTIA previously identified the 3450-3500 MHz portion of the band for potential wireless broadband use. David J. Redl, *NTIA Identifies 3450-3550 MHz for Study as Potential Band for Wireless Broadband Use*, NTIA (Feb. 26, 2018), <https://www.ntia.doc.gov/blog/2018/ntia-identifies-3450-3550-mhz-study-potential-band-wireless-broadband-use>.

^{165/} NCTA Comments at 6-8; RLAN Group Comments at 13; Broadcom Comments at 25.

^{166/} RLAN Group Comments at 13; HPE Comments at 6.

incumbent licensees, there can be no coexistence between new licensed use of the 6 GHz band and incumbent services; relocation of existing services would be required.^{167/}

VI. CONCLUSIONS

The record in this proceeding demonstrates the need to allow Wi-Fi access to the entire 6 GHz band. The spectrum shortage in the mid-band will only get worse as more devices transmit ever more data across networks occupying the same spectrum. The 6 GHz band, meanwhile, holds unique potential for sharing between licensed incumbents and unlicensed Wi-Fi operations.

Wi-Fi Alliance urges the Commission to move quickly to adopt final rules allowing unlicensed use, immediately allowing LPI devices to access the entire 6 GHz band and implementing rules and test procedures that will govern AFC systems for standard-power and higher-gain systems in the near future. By adopting its proposed rules, as modified by proposals from Wi-Fi Alliance and others, the Commission can open up 1,200 megahertz of spectrum for Wi-Fi without creating any meaningful risk of harmful interference to incumbent operations.

Respectfully submitted,

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March 18, 2019

^{167/} RLAN Group Comments at 12.