

Before the
Federal Communications Commission
Washington, D.C. 20554

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

NOTICE OF PROPOSED RULEMAKING

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I. INTRODUCTION

1. Today, we propose rules that will promote new opportunities for unlicensed use in portions of the 1200 megahertz of spectrum in the 5.925-7.125 GHz (6 GHz) band while ensuring that licensed services operating in the band continue to thrive. Unlicensed devices that employ Wi-Fi and other unlicensed standards have become indispensable for providing low-cost wireless connectivity in countless products used by American consumers. The broad spectrum swaths that we propose making available in this frequency band could promote new technology and services that will advance the Commission's efforts to make broadband connectivity available to all Americans, especially those in rural and underserved areas. The ability of unlicensed devices to use this band may also complement new licensed 5G services by allowing providers to offer a full range of services to consumers and helping to secure U.S. leadership in the next generation of wireless services.

2. Recognizing that a variety of incumbent licensed services occupy different portions of the 6 GHz band, we propose tailored rules that will support compatibility of unlicensed operations in each portion of the band. Our proposals draw from, and are consistent with, the existing technical rules applicable to Unlicensed National Information Infrastructure (U-NII) devices that already operate in the 5 GHz band.¹ In general, unlicensed devices capable of providing increased Internet connectivity on a low-cost basis would be permitted to operate in portions of two sub-bands (totaling 850 megahertz of spectrum), subject to their use of an equipment-based frequency coordination mechanism that would prevent the unlicensed devices from transmitting on frequencies where such transmissions could cause harmful interference to incumbent services.² Meanwhile, lower powered indoor operations—which we anticipate will be dominated by devices deployed ubiquitously inside homes and businesses—would be permitted to operate in two other sub-bands (totaling 350 megahertz of spectrum).³ Although we seek to more effectively populate this band with unlicensed uses, we emphasize our commitment to preserve and protect the important base of incumbent users in these frequency bands.

II. BACKGROUND

A. The Explosive Demand for Unlicensed Spectrum

3. When the Commission first made the 2.4-2.4835 GHz and 5.725-5.850 GHz bands available for unlicensed use under our Part 15 rules in 1985, few could have anticipated the explosion of innovation that followed.⁴ These bands have become the focal points for wireless standards—such as Wi-Fi, Bluetooth, and Zigbee—that enable seamless communication among and between countless wireless devices. Wi-Fi, in particular, has become indispensable for providing high data rate local area network connections for smart phones, tablets, mobile computers, and other devices to interconnect and access the Internet. Wi-Fi has also enabled the offloading of data from commercial wireless networks as consumers increase use of smart phones for applications such as streaming video and gaming, and it has provided a means for devices throughout the home to wirelessly interconnect. Unlicensed consumer devices such as cordless phones, video gaming consoles, security systems, home appliances, garage door openers, and baby monitors have proliferated in these bands since the Part 15 rules were adopted.

4. America's appetite for wireless broadband connections can seem insatiable. This is placing high demand on commercial networks as well as systems that rely on unlicensed devices to

¹ For a description of these 5 GHz U-NII bands, see *Revision of Part 15 of the Commission's Rules to Permit Unlicensed National Information Infrastructure (U-NII) Devices in the 5 GHz Band*, Notice of Proposed Rulemaking, 28 FCC Rcd 1769 (2013) (*5 GHz U-NII NPRM*).

² These sub-bands are 5.925-6.425 GHz and 6.525-6.875 GHz.

³ These sub-bands are 6.425-6.525 GHz and 6.875-7.125 GHz.

⁴ *Authorization of Spread Spectrum and other Wideband Emissions Not Presently Provided for in the FCC Rules and Regulations*, GN Docket No. 81-413, First Report and Order, 101 FCC 2d 419, 426-27, paras. 24-26 (1985); *Revision of Part 15 of the Rules regarding the operation of radio frequency devices without an individual license*, GN. Docket No. 87-389, First Report and Order, 4 FCC Rcd 3493, 3502, paras. 55-60 (1989).

deliver data to consumers. According to Cisco, North American mobile traffic, including traffic offloaded onto unlicensed Wi-Fi devices and small cell networks, grew 44 percent in 2016 and is projected to grow at a near 35 percent compound annual growth rate through 2021.⁵ To address this demand, the Commission has initiated several rulemaking proceedings to make more spectrum available for licensed as well as unlicensed usage.⁶

5. Unlicensed Wi-Fi wireless routers provide the crucial link between many users' devices and the Internet. The worldwide installed base of Wi-Fi devices is 9.5 billion,⁷ and 76 percent of North America broadband households use Wi-Fi routers as their primary connected technology.⁸ Most areas where people gather—restaurants and bars, hotels and shopping centers, and even parks and stadiums—are now covered by multiple Wi-Fi hotspots.⁹ Globally, the number of Wi-Fi hotspots is expected to grow six-fold by 2021—with more than 200 million expected in North America alone.¹⁰ In addition, many cable companies and wireless carriers have established networks of Wi-Fi hotspots that give their customers access to high-speed data connections when away from home.¹¹

6. Moreover, Ericsson predicts that between 2016 and 2022 the data traffic generated by smartphones in North America will increase by a factor of six.¹² Global mobile offload traffic comprised 60% of all mobile data traffic in 2016, significantly exceeding cellular traffic, and is expected to rise to 63% by 2021.¹³ In addition to Wi-Fi, versions of LTE, the 4G protocol used by wireless carriers, have also been developed for use on an unlicensed basis and are being used to complement existing licensed spectrum resources by relieving congestion on commercial mobile networks.¹⁴

⁵ Cisco Systems Inc., Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2016-2021 at 4, 18, 33 (Feb. 7, 2017, updated Mar. 28, 2017) <https://www.cisco.com/c/en/us/solutions/collateral/service-provider/visual-networking-index-vni/mobile-white-paper-c11-520862.html> (Cisco VNI).

⁶ See, e.g., *Expanding Flexible Use of the 3.7 to 4.2 GHz Band*, GN Docket No. 18-122, Order and Notice of Proposed Rulemaking, FCC 18-91 (July 13, 2018) (*3.7-4.2 GHz NPRM*); *Use of Spectrum Bands Above 24 GHz for Mobile Radio Services*, GN Docket No. 14-177, Third Report and Order, Memorandum Opinion and Order, and Third Further Notice of Proposed Rulemaking, FCC 18-73 (June 8, 2018); *Spectrum Horizons*, Notice of Proposed Rulemaking, 33 FCC Rcd 2438 (2018); *5 GHz U-NII NPRM*, 28 FCC Rcd 1769.

⁷ Wi-Fi Alliance, *Wi-Fi Alliance Publishes 2018 Wi-Fi Predictions* (Jan. 5, 2018), <https://www.wi-fi.org/news-events/newsroom/wi-fi-alliance-publishes-2018-wi-fi-predictions>.

⁸ Security Sales & Integration, *Large Majority of Broadband Households Use WiFi as Primary Connection, Study Finds* (Jan. 24, 2018), <https://www.securitysales.com/research/majority-broadband-households-wifi-connection/>.

⁹ The Economist, *When Wireless Worlds Collide* (November 17, 2014), <https://www.economist.com/science-and-technology/2014/11/17/when-wireless-worlds-collide> (last visited Oct. 1, 2018).

¹⁰ Cisco VNI at 20-21.

¹¹ AT&T, *Wi-Fi from AT&T*, <https://www.att.com/wi-fi/> (last visited Oct. 1, 2018); Xfinity, *Xfinity WiFi Hotspot Overview*, <https://www.xfinity.com/support/articles/about-xfinity-wifi-internet> (last visited Oct. 1, 2018).

¹² Ericsson, *Future Mobile Data and Traffic Growth*, <https://www.ericsson.com/en/mobility-report/future-mobile-data-usage-and-traffic-growth> (last visited Oct. 1, 2018).

¹³ Cisco VNI at 18.

¹⁴ Chaim Gutentberg, *T-Mobile Rolls Out LTE-U Support in Six Cities* (June 26, 2017), <https://www.theverge.com/2017/6/26/15876884/t-mobile-lte-u-support-six-cities-licensed-assisted-access>; Monica Allevan, *AT&T more than Halfway to Enabling LAA in 24 Markets this Year* (July 23, 2018), <https://www.fiercewireless.com/wireless/at-t-more-than-half-way-to-enabling-laa-24-markets-year>; Martha DeGrasse, *Verizon Starts Nationwide LAA Deployment* (Aug. 4, 2017), <https://www.rcrwireless.com/20170804/carriers/verizon-starts-nationwide-laa-deployment-tag4>.

7. The expected growth of the Internet of things (IoT) will also place increased demands on spectrum usage, including by unlicensed devices.¹⁵ IoT devices are expected to include appliances, machines, meters, wearables, and other consumer electronics.¹⁶ One forecast predicts that there will be more than 1 billion smart home devices in the U.S. by 2023, and projects that annual spending on manufacturing IoT solutions will reach \$450 billion.¹⁷ Because many IoT devices are expected to be low-cost devices that intermittently send small amounts data, they are a natural fit for use on an unlicensed basis. According to Ericsson, there will be more than 15 billion short-range IoT devices by 2022 that will be designed to use Wi-Fi, Bluetooth, Zigbee, and other unlicensed standards.¹⁸

B. Incumbent Services in the 6 GHz Band

8. The 6 GHz band is exclusive non-federal spectrum and is host to several incumbent services operating on a primary basis, including fixed point-to-point services, Fixed-Satellite Service (FSS), Broadcast Auxiliary Service, and Cable Television Relay Service. A query of FCC databases shows 47,695 unique call signs between 5.925 and 7.125 GHz.¹⁹ Figure 1 below shows the density of assignments per megahertz in the FCC databases for the terrestrial services (excluding FSS).²⁰

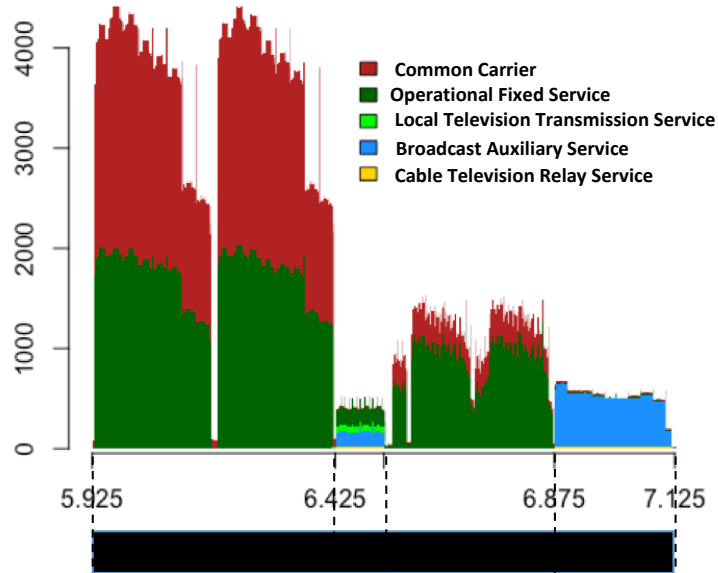


Figure 1. Assignment Density

¹⁵ IoT refers to the ever-growing network of physical objects that feature an IP address for Internet connectivity, and the communication that occurs between these objects and other Internet-enabled devices and systems.

¹⁶ Ericsson, *The Connected Future: Internet of Things Forecast*, <https://www.ericsson.com/en/mobility-report/internet-of-things-forecast> (last visited Oct. 1, 2018).

¹⁷ Shelagh Dolan, *How the Internet of Things will Transform Consumerism, Enterprises, and Governments over the Next Five Years* <https://www.businessinsider.com/7-26-2018-iot-forecast-book-2018-7> (last visited Oct. 1, 2018).

¹⁸ Ericsson, *The Connected Future: Internet of Things Forecast*, <https://www.ericsson.com/en/mobility-report/internet-of-things-forecast> (last visited Oct. 1, 2018).

¹⁹ Based on query of the Commission's licensing databases on of June 22, 2018. See Appendix A for a more detailed list of call signs by service in each sub-band.

²⁰ FSS assignment not shown in this figure. See Table in Appendix A for number of FSS call signs.

9. The fixed service is used for highly reliable point-to-point microwave links that support a variety of critical services such as public safety (including backhaul for police and fire vehicle dispatch), coordination of railroad train movements, control of natural gas and oil pipelines, management of electric grids, long-distance telephone service, and backhaul for commercial wireless providers such as traffic between commercial wireless base stations and wireline networks.²¹ The 5.925-6.425 GHz (U-NII-5) and 6.525-6.875 GHz (U-NII-7) bands are the most heavily used by the common carrier fixed point-to-point microwave service and private operational fixed point-to-point microwave service.²² In the 6.875-7.125 GHz (U-NII-8) band, fixed service links are restricted from intersecting with the service areas of television pick up stations which effectively limits the use of the band by common carrier and operational fixed point-to-point microwave services.²³

10. The Broadcast Auxiliary Service and the Local Television Transmission Service are licensed under Part 74 and Part 101.²⁴ Broadcast Auxiliary Service television pick-up stations typically operate under the mobile allocations in the 6.425-6.525 GHz (U-NII-6) and 6.875-7.125 GHz (U-NII-8) bands. Television pick-up stations are used to transmit programming material from special events or remote locations, including electronic news gathering, back to the studio or other central receive locations.²⁵ Transmitters in the television pick-up service are often licensed to operate over an area defined by a point-radius or other wide-area basis (including nationwide) and across the entire frequency band to allow maximum flexibility for coordination and sharing the spectrum among multiple licensees in any given area.²⁶ Broadcast related services, such as television studio transmitter links, television intercity relay links, and television translator relay links, operated in the U-NII-8 band, are primarily one-way (not duplex) point-to-point links.²⁷ Additionally, the Low Power Auxiliary Station service is authorized in the U-NII-8 band and these licensed stations are used for wireless microphones, cues, and backstage communications.²⁸ Local television transmission service stations can be authorized to provide fixed links on a common carrier basis under Part 101 in the U-NII-5, U-NII-6, and U-NII-8 sub-bands, either on a permanent or temporary fixed basis; or mobile service on a common carrier basis in the U-NII-6 band. Often licenses in the local television transmission service authorize temporary-fixed or mobile operation across the entire sub-band for large areas of operation to facilitate flexibility in coordinating operations.²⁹

11. The Cable Television Relay Service operates under Part 78 rules with similar uses and technical requirements as Broadcast Auxiliary Service. Cable Television Relay Service links are licensed in the U-NII-6 and U-NII-8 bands and are often licensed for the entire frequency range to facilitate local

²¹ See CTIA Reply Comments at 7; Fixed Wireless Communications Coalition Comments at 3.

²² See Appendix A.

²³ 47 CFR § 101.147(a) (Note 34).

²⁴ See 47 CFR §§ 74.602(i), 101.147(j), 101.803(a).

²⁵ See 47 CFR § 74.631. Airborne television pick-up stations should use the 7.075-7.125 GHz band wherever possible. 47 CFR § 2.106 footnote NG 172.

²⁶ 47 CFR § 74.631 and review of ULS TV pickup license frequencies and areas of operation.

²⁷ 47 CFR § 74.631 and review of ULS TV Studio Transmitter (TS), TV Intercity Relay (TI), and TV Translator Relay (TT) licenses.

²⁸ Wireless microphone users may operate on a licensed basis under Part 74 in the 6875-7125 MHz band, where eligibility is limited to broadcasters, broadcast network entities, and large venue owners/operators or professional sound companies that routinely operate 50 or more wireless microphones for major events/productions. See *Promoting Spectrum Access for Wireless Microphone Operations*, Report & Order 30 FCC Rcd 8739, 8789-90, paras. 131-132 (2015).

²⁹ Per review of ULS Local Television Transmission Service license frequencies and area of operation.

coordination during special events.³⁰ Cable Television Relay Service links operate similar to television pick-up service links with fixed or mobile transmitters located at special events used to transmit video and audio back to a receive point.³¹

12. FSS earth stations and space stations are licensed under the Part 25 rules in the Earth-to-space direction across all four sub-bands, except for the 150 megahertz at the top of the U-NII-8 band.³² FSS operations are heaviest in the U-NII-5 band, which is paired with the 3.7-4.2 GHz space-to-Earth frequency band to comprise the “conventional C-band.” Predominant FSS uses of these frequencies include content distribution to television and radio broadcasters, including transportable antennas to cover live news and sports events, cable television and small master antenna systems, and backhaul of telephone and data traffic.³³ The 7.025-7.075 GHz portion of the U-NII-8 band also hosts feeder uplinks to satellite digital audio radio service space stations. Additionally, a space-to-Earth allocation exists in portions of the U-NII-7 and U-NII-8 bands for mobile-satellite service (MSS) feeder links between 6.700 and 7.075 GHz. However, in the 7.025-7.075 GHz band this allocation is limited to three grandfathered locations.³⁴

13. There are existing provisions in Part 15 across the U-NII-5, U-NII-6, U-NII-7, and U-NII-8 bands for unlicensed wideband systems such as sensor/tag systems used for the real-time location of objects under Section 15.250.³⁵ In addition ultra-wideband systems are permitted in these bands under Part 15 Subpart F.³⁶ All Part 15 devices/systems operate on a non-interference basis,³⁷ including devices that will operate under the proposals we make herein.

C. Inquiries Regarding Unlicensed Use in the 6 GHz Band

14. In the 2017 *Mid-Band NOI*, the Commission began an evaluation of whether spectrum between 3.7 and 24 GHz can be made available for wireless broadband services, including unlicensed use in the 6 GHz band.³⁸ The Commission noted the 5.925-6.425 GHz band’s proximity to spectrum designated for U-NII use and stated that it might be possible and technically beneficial for U-NII devices to also operate in this band.³⁹ Observing that such use could permit unlicensed devices to operate with

³⁰ Per review of Cable Television Relay Service licenses in COALS database.

³¹ 47 CFR § 78.11.

³² 47 CFR § 2.106.

³³ The Commission adopted a Notice of Proposed Rulemaking in July 2018, to identify potential opportunities for additional terrestrial use of the 3.7-4.2 band. *Expanding Flexible Use of the 3.7 to 4.2 GHz Band*, GN Docket No. 18-122, Order and Notice of Proposed Rulemaking, FCC 18-91 (July 13, 2018). The outcome of that NPRM may impact the use of the paired spectrum in the 5.925-6.425 GHz U-NII-5 band for Earth-to-space transmission.

³⁴ 47 CFR § 2.106 footnotes NG172 and 5.458B. The space-to-Earth allocation is limited to use by non-geostationary mobile-satellite service feeder links and earth stations receiving in this band are limited to locations within 300 m of coordinates in Brewster, WA, Clifton, TX, and Finca Pascual, PR.

³⁵ 47 CFR § 15.250.

³⁶ 47 CFR pt. 15 subpt. F. For both the wideband and ultra-wideband systems permitted under the unlicensed rules, the maximum EIRP allowed is – 41.3 dBm/MHz except for certain vehicular radar systems which are restricted to an EIRP of – 61.3 dBm/MHz. See 47 CFR § 15.250 and Subpart F.

³⁷ 47 CFR § 15.5(b).

³⁸ *Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz*, Notice of Inquiry, 32 FCC Rcd 6373 (2017) (*Mid-Band NOI*). Given that ET Docket 18-295 focuses on potential unlicensed use of the 6 GHz band, with the issuance of the instant Notice of Proposed Rulemaking, we limit the scope of the *Mid-Band NOI* docket, GN Docket No. 17-183 to exclude further consideration in that Docket of the potential uses of 6 GHz band. We incorporate into this proceeding those filings to date in GN Docket No. 17-183 that relate to the 6 GHz band.

³⁹ *Mid-Band NOI*, 32 FCC Rcd at 6382, para. 26. U-NII devices are unlicensed devices that currently operate in the 5.15-5.35 GHz, 5.47-5.725 GHz, and 5.725-5.85 GHz bands under the Part 15 rules. 47 CFR §§ 15.401-407. Like all unlicensed devices, U-NII equipment operates on a non-interference basis—that is, it shall not cause, nor claim

wider channel bandwidths and higher data rates with increased flexibility,⁴⁰ the Commission asked if unlicensed use either under the U-NII framework or under other provisions could be implemented within the 5.925-6.425 GHz band under the Part 15 rules.⁴¹ The *Mid-Band NOI* noted that unlicensed devices would need to protect the existing licensed services in the band and identified fixed service and FSS (Earth-to-space) operations as heavy users of the band.⁴² The Commission also asked if the band would be suitable for licensed fixed and mobile wireless broadband services.⁴³

15. In the 6.425-7.125 GHz band, the Commission noted the wide range of incumbent users—including fixed service, FSS, and fixed and mobile broadcast auxiliary services—in various subsets of the band and sought comment on the potential for more intensive fixed or mobile use of the band.⁴⁴ The Commission also asked whether the 6.425-7.125 GHz band, or specific subsets of this band, would be a viable expansion opportunity for U-NII or other unlicensed operations.⁴⁵

16. In response to the *Mid-Band NOI*, many commenters supported expanding use of the 6 GHz band to allow new unlicensed uses.⁴⁶ Nevertheless, filers representing incumbent interests uniformly emphasized the need to protect those incumbent operations, with individual filers expressing differing levels of optimism as to whether successful sharing mechanisms could be established.⁴⁷ Responding to the idea that new fixed and mobile licensed services might be introduced into the band by relocating incumbent users, many parties emphasized the need to continue their existing use of the band and claimed that they lacked practical relocation options.⁴⁸

17. Parties have since continued to discuss the 6 GHz band and have filed numerous *ex parte* presentations—many with detailed technical evaluations—that evidence a good-faith effort to work toward finding areas of potential agreement on accommodating shared use.⁴⁹ Commenters have also refined their proposals for how the band can be used. For example, in response to the concerns expressed by fixed wireless incumbent users, a group of companies that initially filed joint reply comments supporting expanded unlicensed use of the band have continued to work together, modifying their original position seeking unlicensed use throughout the band without restriction to a more nuanced position that would require automated frequency coordination (AFC) for all outdoor and some indoor devices.⁵⁰ In

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protection from, harmful interference, vis-à-vis allocated radio services and authorized users. 47 C.F.R. § 15.5(b)-(c).

⁴⁰ *Mid-Band NOI*, 32 FCC Rcd at 6382, para. 26.

⁴¹ *Id.* at 6382-83, para. 29.

⁴² *Id.* at 6381-82, paras. 24-25, 29-30.

⁴³ *Id.* at 6383-84, para. 31.

⁴⁴ *Id.* at 6384-85, paras. 32-36.

⁴⁵ *Id.*

⁴⁶ Wi-Fi Alliance Comments at 6; Wireless Broadband Alliance Comments at 13; Dynamic Spectrum Alliance Comments at 10; Broadcom Comments at 9.

⁴⁷ A handful of filers, most notably those representing fixed services in the public safety and critical infrastructure fields, did not support any expanded unlicensed use in the bands where they currently operate. *See* Alliance of Automobile Manufacturers Comments at 1; Fixed Wireless Communications Coalition Comments at 14; National Public Safety Telecommunications Council Comments at 9.

⁴⁸ Association of American Railroads Reply at 2; Fixed Wireless Communications Coalition Comments at 2.

⁴⁹ Apple Inc., Broadcom Corporation, et al. Jan. 25, 2018 *Ex Parte*, at 53-54 (RKF Technical Study); Fixed Wireless Communications Coalition Mar. 13, 2018 *Ex Parte* at 16.

⁵⁰ In reply comments, a group of several companies—which included Apple, Broadcom, Cisco Systems, Facebook, Google, Hewlett Packard Enterprise, Intel, Mediatek, Microsoft, and Qualcomm—was created. Apple Inc., Broadcom Limited, et al. Reply Comments. Companies in this group continued to file joint comments in this

response, a lead group representing fixed microwave incumbents, the Fixed Wireless Communications Coalition (FWCC), appears to be more open to the possibility of finding successful shared use mechanisms in the band than it had been.⁵¹

18. Congress also recently addressed the pressing need for additional spectrum for wireless broadband, including both mobile and fixed services, in the FY 2018 omnibus spending bill, which includes the MOBILE NOW Act under Title VI of RAY BAUM'S Act.⁵² The MOBILE NOW Act directs the FCC and the National Telecommunications and Information Administration (NTIA) to identify additional spectrum for wireless broadband,⁵³ which will help maintain America's leadership in communications services. More specifically, Section 603(a)(1) of the MOBILE NOW Act requires that no later than December 31, 2022, the Secretary of Commerce, working through NTIA, and the Commission "shall identify a total of at least 255 megahertz of Federal and non-Federal spectrum for mobile and fixed wireless broadband use."⁵⁴ Of this amount, at least "100 megahertz below the frequency of 8000 megahertz shall be identified for use on an unlicensed basis"; at least "100 megahertz below the frequency of 6000 megahertz shall be identified for use on an exclusive, licensed basis for commercial mobile use," subject to certain conditions; and at least "55 megahertz below the frequency of 8000 megahertz shall be identified for use on either a licensed or unlicensed basis, or a combination of licensed and unlicensed."⁵⁵

III. DISCUSSION

19. We propose to expand unlicensed use in both the 5.925-6.425 GHz and 6.425-7.125 GHz bands, which together constitute the 6 GHz band. We focus on unlicensed use due to the band's proximity to the U-NII bands, which have hosted extensive unlicensed device innovation and deployment. The rules we are proposing are intended to provide an opportunity for devices such as smartphones, Wi-Fi routers, and IoT devices to be economically designed to operate across both the 6 GHz and U-NII bands. We are encouraged by the fact that the 6 GHz band shares virtually identical propagation properties to the U-NII bands, which have proven suitable for many unlicensed applications. Furthermore, devices that employ newer standards that use wider bandwidths and provide higher data rates are well poised to make use of expanded spectrum for unlicensed devices to deliver broadband services to the American public.⁵⁶

20. The new unlicensed use opportunities we propose are designed to protect important incumbent licensed services that operate (and continue to grow) in various sub-bands of this spectrum. Under the proposed rules, we believe that unlicensed use of the band will be compatible with these incumbent licensed services. To do this, we propose dividing the 6 GHz band into four sub-bands, each

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proceeding, though over time the particular composition of companies jointly filing ex parte comments changed at times (including certain additional companies while excluding others). *Compare* Apple Inc., Broadcom Corporation, et al. Jan. 25, 2018 *Ex Parte*, at 53-54 (RKF Technical Study) and; Apple Inc., Broadcom Corporation, et al. Jan. 26, 2018 *Ex Parte with Apple Inc., Broadcom Inc., et al.* June 15, 2018 *Ex Parte*, at 3.

⁵¹ FWCC July 17, 2018 *Ex Parte*, at 5.

⁵² See Consolidated Appropriations Act, 2018, P.L. 115-141, Division P, the Repack Airwaves Yielding Better Access for Users of Modern Services (RAY BAUM'S) Act. Title VI of the RAY BAUM'S Act is the Making Opportunities for Broadband Investment and Limiting Excessive and Needless Obstacles to Wireless Act or MOBILE NOW Act (Act). *Id.*

⁵³ *Id.* § 603(a)(1).

⁵⁴ *Id.* § 603(a)(1).

⁵⁵ *Id.* § 603(a)(2).

⁵⁶ IEEE Std 802.11™-2016, IEEE Standard for Information technology— Telecommunications and information exchange between systems Local and metropolitan area networks— Specific requirements Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications, IEEE December 2016, at 661; Afaqui et al., IEEE 802.11ax: Challenges and Requirements for Future High Efficiency WiFi, IEEE Wireless Communications, June 2017, at 133, 136.

based on the prevalence and characteristics of the incumbent services that operate in that spectrum. The 5.925-6.425 GHz and 6.525-6.875 GHz sub-bands of the 6 GHz band (totaling 850 megahertz) are heavily used by point-to-point microwave links, including critical links that must maintain a high level of availability. In these parts of the 6 GHz band, we propose to permit only “standard-power access points”—using power levels permitted for unlicensed use in the U-NII-1 and U-NII-3 bands⁵⁷—to operate only on frequencies determined by an AFC system. Other portions of the 6 GHz band, specifically the 6.425-6.525 GHz and 6.875-7.125 GHz sub-bands (totaling 350 megahertz), are used by mobile stations where the locations of the incumbent receivers are not necessarily known or cannot be easily determined from existing databases. Because the lack of location information on mobile stations makes an AFC approach impractical, we propose to allow only indoor “low-power access point” operation in these sub-bands—using lower, more restricted power levels applicable to operations in the U-NII-2 band.⁵⁸ We also propose to permit client devices⁵⁹ to operate across the entire 6 GHz band while under the control of either a standard-power access point or a low-power access point.⁶⁰ Our proposals seek to create an enhanced ecosystem of unlicensed use in the 6 GHz band and the nearby U-NII bands while protecting the licensed services that operate in the 6 GHz band. We tentatively conclude that this two-class approach can expand unlicensed use without causing harmful interference to the incumbent services that will continue to be authorized to use this spectrum.

21. The two-class approach provides options that accommodate the varied needs and use cases expressed by the community of unlicensed users.⁶¹ Permitting both outdoor and indoor use will allow users, regardless of location, to off-load data from smartphones, laptops, and other mobile devices, freeing up capacity of commercial wireless systems for applications more suitable for licensed systems. We anticipate that cable companies and commercial entities will use standard-power access points to deploy outdoor high-power Wi-Fi access points or to deploy variants of LTE to expand their capacity where needed. Similarly, stadiums, convention centers, shopping malls, or other facilities could install standard-power access points to provide wireless access to consumers. Conversely, low-power access points will be ideal for use in residences and businesses for lower power Wi-Fi and other low power unlicensed uses. Client devices will be allowed to connect with both standard-power access points and low-power access points and permitted to operate across the entire band which should encourage the widespread availability of client devices.⁶² In addition, the low entry barriers associated with unlicensed use provide flexibility for innovators to design and deploy new types of devices, applications and services to meet the public’s evolving needs. Our proposed framework for the 6 GHz band is summarized in the table below:

Band (GHz)	Primary Allocations	Reference used	Devices
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⁵⁷ The U-NII-1 band is the 5.15-5.25 GHz band, while the U-NII-3 band is the 5.725-5.85 GHz band. *Revision of Part 15 of the Commission’s Rules to Permit Unlicensed National Information Infrastructure (U-NII) Devices in the 5 GHz Band*, First Report and Order, 29 FCC Rcd 4127, 4128-4129, para. 4 (2014).

⁵⁸ The U-NII-2 bands include the 5.25-5.35 GHz (U-NII-2A) and 5.47-5.725 GHz (U-NII-2C) bands. *Id.*

⁵⁹ A U-NII device whose transmissions are generally under the control of an access point and that is not capable of initiating a network. *See* 47 CFR § 15.403(g) of the proposed rules.

⁶⁰ *See* discussion *infra* paras. 53-54, 71 (seeking comment on proposals to prevent client devices from causing harmful interference to incumbent licensed operations).

⁶¹ Apple, Broadcom, et al. Jan. 25, 2018 *Ex Parte* (RKF Technical Study) at 18 includes both indoor and outdoor access points.

⁶² While our proposal will permit client devices to operate across the entire 6 GHz band, it will not require that they have this capability.

		in this NPRM ⁶³	
5.925-6.425	Fixed Service FSS	U-NII-5	Standard-Power Access Point
6.425-6.525	Mobile Service FSS	U-NII-6	Low-Power Access Point
6.525-6.875	Fixed Service FSS	U-NII-7	Standard-Power Access Point
6.875-7.125	Fixed Service Mobile Service FSS ⁶⁴	U-NII-8	Low-Power Access Point

A. Unlicensed Operation in the U-NII-5 and U-NII-7 Bands

22. We propose to make the 5.925-6.425 GHz and 6.525-6.875 GHz bands, referenced herein as the U-NII-5 and U-NII-7 bands respectively, available for unlicensed operations under rules consistent with the existing rules for unlicensed device operations in the nearby U-NII-1 and U-NII-3 bands (5.150-5.250 GHz and 5.725-5.850 GHz bands, respectively). Under this proposal, the power levels permitted for the standard-power access points would be the same as the power levels already permitted for unlicensed device operations in the nearby U-NII-1 and U-NII-3 bands. The U-NII-5 and U-NII-7 bands are heavily used for point-to-point fixed links, which support a variety of critical services. The U-NII-5 and U-NII-7 frequencies are also allocated to the fixed-satellite service. The framework we are proposing today seeks to balance the incumbents' concerns for reliable fixed service or fixed-satellite service links and the increasing need for spectrum for innovative use.

23. The proposed framework for U-NII-5 and U-NII-7 prohibits unlicensed devices from operating co-channel with any fixed link within that link's defined exclusion zone. Thus, for example, if a fixed service receiver is receiving a specific channel, then unlicensed devices operating in the defined exclusion zone of this receiver must use a different channel. We seek comment on this proposal. Similar to the licensing of new fixed links, which require frequency coordination to protect existing links,⁶⁵ we propose to implement a frequency coordination process for unlicensed devices in these bands to ensure that these new unlicensed devices do not cause harmful interference to fixed service incumbents. As with the procedures we have adopted for other shared-use bands, such as white spaces and the Citizens Broadband Radio Service, this process would be automated.⁶⁶ Prior to operating in these bands, a standard-power access point⁶⁷ would determine or receive a list of permissible operating frequencies and restrict operation to those frequencies. Similarly, client devices⁶⁸ would have to obtain a list of permissible operating frequencies from a standard-power access point and restrict operation to those

⁶³ For convenience, in the following discussion we refer to these four sub-bands as numbered U-NII bands consistent with the filings of Apple Inc., Broadcom Ltd., et al. and the Wi-Fi Alliance. Apple Inc., Broadcom Ltd., et al. Comments at 16; Wi-Fi Alliance Reply at 12.

⁶⁴ There is no FSS allocation in the 7.075-7.125 GHz portion of the band.

⁶⁵ 47 CFR § 101.103.

⁶⁶ White space and Citizens Broadband Radio Service devices are required to access a database system that determines the available frequencies at a device's location prior to operation. 47 CFR §§ 15.711(c)(2), 96.39(c) 96.59(a). A device may transmit only on frequencies that the database system indicates are available for use. *Id.* The proposed requirements for the AFC system are discussed below.

⁶⁷ 47 CFR § 15.403(a).

⁶⁸ A U-NII device whose transmissions are under the control of an access point and that is not capable of initiating a network. See 47 CFR § 15.403(g) of the proposed rules.

frequencies. We seek comment on this proposal. Are there any alternative methods to ensure protection of incumbent services? What are the costs and benefits of any proposed alternative?

24. Additionally, we tentatively conclude that a similar coordination process is not needed to protect incumbent FSS operations because incumbent operations are limited to Earth-to-space transmissions in the 6 GHz band. As such, any interference from unlicensed devices would be experienced at the space station receivers and the particular location of the standard-power access point would in most case have a negligible effect. Since there will be no interference to FSS earth stations, they would not be considered by the AFC system. We seek comment on this proposal and on whether there would be any benefits in including satellite earth station information in the AFC system at this time.⁶⁹

1. Determining Permissible Frequencies of Operation

25. To determine whether an individual unlicensed device can transmit at a particular location on a given frequency, we propose that standard-power access points be required to obtain a list of permissible frequencies from an AFC system prior to transmitting or a list of prohibited frequencies in which it cannot transmit. We envision the AFC system to be a simple database that is easy to implement. We seek comment on this proposal. What capabilities should be incorporated into the AFC system? Should it be a centralized model where all data and computations are in a central location or the cloud? In this case, the standard-power access point will establish a connection with the AFC system, provide its location and technical details, and the AFC system will communicate the list of permissible frequencies (or a list of prohibited frequencies) back to the standard-power access point. Or should the AFC system's architecture be a de-centralized model where the standard-power access point maintains a local database and performs the necessary computations to determine which frequencies are permissible? Under such a model, how would the local database within the standard-power access point be kept up to date? What are the trade-offs, including the costs and benefits, between a centralized versus a decentralized model in terms of efficiency, device complexity, and ability to protect fixed service stations?

26. *Determining Available Frequencies.* Should the AFC system determine frequency availability using the maximum permissible power for a standard-power access point, or should it determine frequency availability at power levels less than the maximum, and calculate a list of available frequencies and the maximum power permitted on each one?⁷⁰ If the AFC system calculates the maximum power for each frequency, how would it control the power levels of standard-power access points to ensure that they operate at permissible levels? How should frequency availability information be reported to standard-power access points? Should the AFC system report availability for discrete frequency bands, e.g., 10 or 20 megahertz channels, or should it simply report the range or ranges of available frequencies? Alternatively, should the AFC simply list the range or ranges of unavailable frequencies?

27. *Device Registration.* Under a registration requirement, a standard-power access point would transmit identifying information along with its location to the AFC system before receiving a list of permissible channels.⁷¹ Alternatively, a device under a centralized system architecture could provide only its location data and the AFC system would provide it with the list of permissible channels for that location. Under a decentralized system architecture, registration is not necessarily required as the device only needs periodic updates of the local fixed service operating environment.

⁶⁹ For example, we note that this information could potentially be used to inform standard-power access point when they are near an FSS transmitting earth station and might be subject to interference from the earth station.

⁷⁰ The white space database system determines the list of available channels and the maximum power permitted on each one at a device's location. 47 CFR §§ 15.711(c)(2)(i)-(ii), 15.715(e).

⁷¹ Fixed white space devices and Citizens Broadband Radio Service Devices are required to register certain information with the white space database or Spectrum Access System, including the device's location, antenna height above ground, device identification information, and contact information for the device's operator. 47 CFR §§ 15.713(g), 96.39(c).

28. We seek comment on whether device registration in the AFC database is necessary. What are the advantages and disadvantages of each approach? Would a registration requirement increase cost or complicate design and operations of devices and the AFC? Would a registration requirement be beneficial for determining the source if a fixed service station were to experience harmful interference? If device registration is required, what information should be provided? Should the information be limited to a device identifier, location, and some basic technical information? Or should device ownership data and contact information also be required? We also seek comment on how registration information should be entered into the AFC system. Should it be entered manually by a person, such as a professional installer or the equipment user, or should we require automated entry of some or all of the information? We additionally seek comment on whether there are methods that can be used when a device registers and/or operates to verify its location and operating parameters. For example, could a two-step verification process be used such that registrants must certify as to the accuracy of the information entered into the AFC system?

29. *Updating frequency availability information.* We recognize that, because licensed use of these bands is not static, the AFC system must be designed to ensure that unlicensed operations protect new and modified licensed operations. Although the incumbent services in the bands where we are proposing to allow unlicensed standard-power access point operation are at fixed locations, the addition of new links or receive sites and changes to the frequency band of operation, receiver location, antenna type/directivity, and similar technical parameters will impact the list of frequencies the AFC system provides to standard-power access points.

30. We propose to adopt a requirement that devices periodically verify whether frequency availability has changed. Is a periodic re-check interval the most appropriate method to determine changes in frequency availability information and, if so, what should the maximum permissible interval for verifying frequency availability be? Would an alternative method be more appropriate, such as requiring the AFC system to have the capability to direct devices to change frequencies? Should we adopt a general performance rule instead of specifying a particular re-verification mechanism? We also seek comment on what should happen when a device and the AFC system are temporarily unable to communicate during the frequency re-verification/update process. Should we, for example, allow the device to temporarily continue operating for a period before requiring it to cease operations?

31. *Security Requirements.* We seek comment on the types of security requirements that would be necessary for standard-power access points in the U-NII-5 and U-NII-7 bands to ensure that the interference mitigation regime is not thwarted. White space devices and databases, as well as Citizens Broadband Radio Service Devices and the Spectrum Access System, are required to incorporate security measures to ensure that devices communicate only with authorized databases, that all communications and interactions between a database and devices are accurate and secure, and that unauthorized parties cannot access or alter a database or the list of available frequencies sent to a device.⁷² They are also subject to requirements that communications between devices and the database, and between different databases, must be secure to prevent corruption or unauthorized interception of data, and that databases be protected from unauthorized data input or alteration of stored data.⁷³

32. Are similar requirements necessary or appropriate for devices and the AFC in the U-NII-5 and U-NII-7 bands? Are any additional requirements necessary? Do we need to specify security requirements for devices to ensure that the software within them cannot be easily modified to enable operation on frequencies other than those indicated as available by the AFC system?⁷⁴

33. *AFC System Operators.* We propose that the Commission designate multiple entities to

⁷² 47 CFR §§ 15.711(j), 96.61.

⁷³ *Id.* §§ 15.711(j)(1), 96.61(b).

⁷⁴ 47 CFR § 15.407(i).

operate AFC systems.⁷⁵ We seek comment on this proposal. Should we require that devices have the capability to communicate with all AFC systems or should they only be required to have the capability to communicate with a subset of the designated AFC systems? For example, should a manufacturer be allowed to operate an AFC system that serves only devices that it produces? Should we allow the functions of an AFC system, such as a data repository, registration, and query services, to be divided among multiple entities, or should we require all functions of a single AFC system to be performed by a single entity? Can each AFC system operate autonomously or is there a need for them to communicate any information with each other? If so, what information would need to be exchanged? Given the potential complexity of multiple AFC system operators needing to coordinate, should the Commission instead designate only a single AFC system operator?

34. *AFC System Certification.* We seek comment on the procedures that should be used to test and validate the capabilities of the AFC and to designate AFC system operators. For example, should we follow procedures similar to those the Office of Engineering and Technology (OET) used for designating white space database administrators?⁷⁶ If not, what certification procedure should be implemented? Additionally, we note that parties have suggested that a multi-stakeholder group could administer AFC system requirements and standards through interaction with AFC system operators.⁷⁷ We seek comment on this suggestion, and on the appropriate mechanism for ensuring Commission oversight of such a multi-stakeholder group.

35. *AFC System Operator Requirements.* We propose that an AFC system operator be required to serve for a five-year term which can be renewed by the Commission based on performance during the operating term. We also propose that if an AFC system ceases operation, it provides a minimum of 30-days' notice to the Commission and it transfer its registration data, if registration is required, to another AFC system operator. We seek comments on these proposals. Are there other functions an AFC system operator should be required to perform?

36. *Fees.* We propose that an AFC system operator be permitted to charge a fee for providing registration and channel availability functions. We note that fees could be charged on a transaction basis every time a device is registered or receives an update from an AFC system. We also

⁷⁵ We note that the Commission has designated multiple entities to operate white space databases and has solicited applications for multiple entities to operate Spectrum Access Systems in the Citizens Broadband Radio Service. *Office of Engineering and Technology Announces the Approval of Nominent UK's White Space Database System for Operation*, Public Notice, DA 18-966 (Sept. 19, 2018); *Office of Engineering and Technology Announces the Approval of LStelcom AG's TV Bands Database System for Operation*, Public Notice, 29 FCC Rcd 11687 (2014); *Office of Engineering and Technology Announces the Approval of Google, Inc.'s TV Bands Database System for Operation*, Public Notice, 29 FCC Rcd 10586 (2014); *Wireless Telecommunications Bureau and Office of Engineering and Technology Establish Procedure and Deadline for Filing Spectrum Access System (SAS) Administrator(s) and Environmental Sensing Capability (ESC) Operator(s) Applications*, Public Notice, 30 FCC Rcd 14170 (2015).

⁷⁶ In that designation process, OET issued a public notice inviting interested entities to apply and requesting that each applicant address how the basic components of a database would be implemented. *Office of Engineering and Technology Invites Proposals from Entities Seeking to be Designated TV Band Device Database Managers*, Public Notice, 24 FCC Rcd 14136 (OET 2009). After determining that the submitted database proposals met the requirements of the rules, OET conditionally designated the applicants as database administrators, subject to a requirement that each make a test database available for OET inspection, followed by a 45-day public trial of each database before giving an administrator final approval to operate. *Unlicensed Operation in the TV Broadcast Bands and Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band*, Order, 26 FCC Rcd 554 (2011).

⁷⁷ Apple Inc., Broadcom Inc., et al. Aug. 2, 2018 *Ex Parte*, at 3. We also note that the white space database providers formed their own multi-stakeholder group – the White Space Database Administrators Group and for Citizens Broadband Radio Service, the Winnforum Spectrum Sharing Committee brought all stakeholders together to develop standards, operating procedures and testing requirements. See, e.g., <https://www.cbrs.wirelessinnovation.org/>.

note that device manufacturers or a trade association could fund an AFC system as part of its business and that no individual transaction fees would be charged. We propose that any of these methods be permitted. Are there other funding mechanisms for AFC systems that should be permitted? What are the costs and benefits of each type of proposed funding mechanism?

2. Protecting Fixed Service from Harmful Interference

37. In general, fixed services use highly directional antennas where the energy transmitted and received is concentrated in a particular direction.⁷⁸ This directionality is used as the basis for sharing between different fixed service links and between fixed service links and FSS earth stations, as the required separation distance between co-channel transmitters of one system and receivers of another system or service can be greatly diminished when the antennas are not pointed toward each other.⁷⁹ This relationship suggests that unlicensed devices need only be excluded from a zone determined by the fixed service receive antenna pattern and the EIRP of the unlicensed device.⁸⁰ Using those parameters along with an appropriate propagation model would allow an AFC system to determine an exclusion zone, an area inside of which unlicensed devices would not be able to operate co-channel with fixed service systems. The size of the exclusion zone would be based on the specific interference protection criteria used.

38. *Fixed Services and Broadcast Auxiliary Services in ULS.*—The ULS is the consolidated database, application filing system, and processing system for all Wireless Radio Services, including the Fixed Microwave Services.⁸¹ The ULS contains extensive technical data for site-based licenses including transmitter and receiver locations, frequencies, bandwidths, polarizations, transmitter EIRP, antenna height, and the make and model of the antenna and equipment used.⁸²

39. We propose that the AFC system use data from ULS to facilitate access by unlicensed devices in the bands that are used for fixed service.⁸³ We recognize that aside from some validations ULS performs on submitted applications, licensees' technical data is not independently verified, and the accuracy and precision of the data contained within ULS is therefore only as good as the information supplied by licensees.⁸⁴ Nevertheless, we also do not believe it is necessary to propose a mandatory requirement on information collections that were previously voluntary in order to increase the efficacy of the AFC system.⁸⁵ Rather, we believe that licensees have significant incentives to maintain the continued

⁷⁸ 47 CFR § 101.115 (b); see https://en.wikipedia.org/wiki/Directional_antenna.

⁷⁹ FWCC March 13, 2018 *Ex Parte*, at 23. As shown in equation one, the sidelobe rejection term reduces the interference power, leading to a shorter separation distance.

⁸⁰ FWCC March 13, 2018 *Ex Parte*, at 23.

⁸¹ 47 CFR § 1.907 (definition of Universal Licensing System). Wireless Radio Services refers to all radio services authorized in parts 13, 20, 22, 24, 26, 27, 74, 80, 87, 90, 95, 97 and 101 of this chapter, whether commercial or private in nature. 47 CFR § 1.907 (definition of Wireless Radio Services).

⁸² See 47 CFR § 101.21.

⁸³ Proposed rule section 15.407(k)(2) uses the term “Commission databases” rather than “ULS” to avoid the use of a specific database name that could possibly be changed in the future. This is consistent with the white space and CBRS rules. 47 CFR §§ 15.715(b), 96.63(b).

⁸⁴ For example, among other things, ULS will validate certain parameters to ensure that they are within certain pre-determined acceptable ranges; will verify that geographic coordinates are within the boundaries of the county and state identified for a station location; and will ensure that certain relative data fields (e.g., azimuth) coincide with other data provided on the application (e.g., geographic coordinates).

⁸⁵ When the Commission has imported data from other licensing systems, it requested that licensees review the authorizations and report any discrepancies on a voluntary basis. See, e.g., *Wireless Telecommunications Bureau Makes Broadcast Auxiliary Radio Station License Databases Available for Review Prior to ULS Implementation*, Public Notice (WTB rel. May 7, 1999); *Wireless Telecommunications Bureau Makes Microwave and Coast and Ground Databases Available for Review Prior to ULS Implementation*, Public Notice (WTB rel. Sept. 4, 1998). In

accuracy of data in ULS to ensure that they are protected from harmful interference. We also note that licensees have an obligation to keep their information filed with the Commission current and complete.⁸⁶ We seek comment on this proposal.

40. Is there any additional technical data, not currently collected in ULS, that is necessary to facilitate automatic coordination? If so, should that information be collected by the Commission and stored in ULS, or can such supplemental information be reported to and stored in the AFC system? In cases of missing data, how should the AFC operate? Should we establish default values to be used to reach a reasonable assessment with a high degree of confidence that harmful interference will not occur? How should we handle a situation where harmful interference occurs to a fixed service station due to that station's failure to keep its ULS records up-to-date? Should the unlicensed device be required to switch channels? Should there be any obligation on the fixed service station to update its ULS records before it can seek remedy from the Commission?

41. We note that in certain circumstances fixed service licensees may be authorized to operate stations that are not individually licensed in ULS. Temporary fixed operations may be authorized by a blanket authorization, in which case the licensee is not required to obtain approval from the Commission prior to operating at specific locations or report the technical details of their operation to the Commission.⁸⁷ Similarly, fixed service applicants may operate a station prior to obtaining a grant of authorization so long as certain criteria are met, such as completing successful frequency coordination.⁸⁸ We seek comment on how should the AFC system take into consideration temporary fixed operations and/or stations operating under conditional authority. Should we require the operators of temporary fixed and/or stations operating under conditional authority to notify the Commission of the details of their operations (location, antenna height, antenna pattern, etc.)? Or can those details be reported directly to an AFC? In the latter case, does there need to be a requirement to share such data among AFCs? If so, how would such a sharing system be implemented in a centralized or decentralized AFC system architecture? Are there other methods of protecting temporary fixed operations? Should the AFC system account for filed applications in addition to licensed stations when determining a list of frequencies on which an unlicensed device can operate?

42. *Protection Criteria.*—Two possible metrics that we could use for specifying the interference protection criteria are the ratio of interference to noise power (I/N ratio) or the ratio of the carrier to interference power (C/I ratio),⁸⁹ where interference is the signal from unlicensed devices, the carrier is the signal strength of the received fixed service transmission and noise is background noise level. The I/N ratio is a simpler metric than the C/I. While both metrics require knowledge of the interfering signal power—the signal of the unlicensed device and the receive station's antenna pattern, the C/I ratio also requires knowledge of the fixed service station's characteristics, including transmitted signal power and path length. We seek comment on which metric we should adopt for specifying the interference protection criteria. We also seek comment on whether any other metrics could be used for

(Continued from previous page) _____

addition, rule changes have revised the type of data collected and submitting the new information was in some cases deemed voluntary. See, e.g., *Wireless Telecommunications Bureau Announces ULS Upgrade—Licensees of Television Pick-up Stations Now Have the Option to Identify Their Stationary, Receive-Only Sites on ULS to Aid Coordination with Other Services*, Public Notice, 23 FCC Rcd 6521 (WTB 2008); *Wireless Telecommunications Bureau Announces Effective Date of Requirement for 7 and 13 GHz TV Pickup Licensees to register Stationary Receive Sites, Provides Guidance on Complying with Requirement*, Public Notice, 28 FCC Rcd 978 (WTB 2013).

⁸⁶ The general filing requirements on FCC Form 601 states, "Information filed with the FCC must be kept current and complete. The Applicant must notify the FCC regarding any substantial and significant changes in the information furnished in the application(s). See Section 1.65 of the Commission's Rules."

⁸⁷ See 47 CFR § 101.31(a)(2).

⁸⁸ See 47 CFR § 101.31(b).

⁸⁹ The C/I ratio is used in TIA bulletin TSB-10-F. See TIA/EIA, *Interference Criteria for Microwave Systems*, Telecommunications Systems Bulletin TSB10-F, June 1994, 2-8.

specifying the interference protection criteria. What are the respective costs and benefits of each metric?

43. The interference protection criteria will be used by the AFC system to determine whether a standard-power access point would cause harmful interference to a fixed link receiver. For example, if we specify the interference protection criteria as an I/N of 0 dB, the AFC would calculate whether a standard-power access point will cause the I/N at each fixed link receiver to exceed 0 dB. An I/N of 0 dB means that the power of the signal from the standard-power access point (I) equals the noise power (N) at the fixed link receiver.⁹⁰ The standard-power access point would then be excluded from operating co-channel at locations where this occurs. The interference protection criteria we specify will in effect determine how close co-channel standard-power access points can operate to the fixed link receivers. A less stringent interference protection criteria will result in smaller separation distances and therefore allow a greater number of standard-power access points to be deployed in the band, but could potentially increase the risk of harmful interference occurring. We seek comment on the interference protection criteria we should adopt. Commenters are encouraged to provide technical analysis supporting the particular interference protection criteria that they advocate.

44. *Adjacent Channel Protection.*—We do not propose to protect fixed links operating on adjacent channels or second-adjacent channels as FWCC suggests.⁹¹ There are no technical showings to support such a proposal. Further, out-of-band emission (OOBE) limits will act to protect adjacent channel fixed service links. We invite parties who believe that specific adjacent or second-adjacent channels protection rules should be adopted to submit technical showings to support their position.

45. *Multipath Fading.*—Fixed microwave links may experience atmospheric multipath fading,⁹² which impacts the attenuation, delay and phase shift of their signal. To counteract the effects of fading, FWCC states that licensees design their fixed microwave systems with fade margins of 25-40 dB.⁹³ We seek comment on FWCC's characterization of the fade margin. What are the typical design criteria for fixed service station fade margins?⁹⁴ We also seek comment on whether and specifically how fading might affect the levels of the potentially interfering signal being transmitted from unlicensed devices. We would not expect to see fading of the interfering signal for short separation distances between the unlicensed device and the microwave receiver, but such an effect could occur for larger separations, which would seem to reduce risk of interference.

46. Outside low latitude coastal regions, atmospheric multipath fading occurs most often during humid seasons with low precipitation.⁹⁵ Such seasonal atmospheric multipath fading depends strongly on geographical location and local weather patterns.⁹⁶ Given that atmospheric conditions affect multipath fading, should the interference protection criteria be relaxed or other allowances made in areas where fades are not as prominent? How might this be accomplished? In addition, multipath fading also

⁹⁰ A C/I of 0 dB means that the signal from the fixed service transmitter received at the fixed service receiver (C) equals the power received from the standard-power access point (I). While a C/I of 10 dB means that the signal from the fixed service transmitter received at the fixed service receiver (C) is ten times greater than the power received from the standard-power access point (I).

⁹¹ FWCC July 17, 2018 *Ex Parte*, at 17.

⁹² Atmospheric multipath fading is caused when stable air masses, such as warm and humid air, lead to stratification of the atmosphere. See George Kizer, Digital Microwave Communication, 321-324 (2013).

⁹³ FWCC March 13, 2018 *Ex Parte*, at 3.

⁹⁴ Apple Inc., Broadcom Corporation, et al. argue that excess fade margin should be considered when determining the interference protection criteria. See Apple Inc., Broadcom Corporation, et al. Jan. 26, 2018 *Ex Parte*, at 33.

⁹⁵ See George Kizer, Digital Microwave Communication, 323 (2013).

⁹⁶ See George Kizer, Digital Microwave Communication, 321-323 (2013).

depends on the time of day and is generally most severe after midnight.⁹⁷ Should we consider the time of day fading occurs in conjunction with the relative busy hours for unlicensed traffic⁹⁸ when determining the interference protection criteria? To what degree? We note that FWCC and APCO have expressed concerns regarding even momentary interference, claiming that certain microwave systems can take up to 15 minutes to resynchronize.⁹⁹ Given that this type of loss of synchronization can occur even without the presence of any interference, can such events be attributed to atmospheric multipath fading? Thus, given the diurnal and seasonal nature of atmospheric multipath fading, are there mitigation strategies that can take advantage of this phenomenon to ensure the potential for causing harmful interference is minimized?

47. Figure 2 shows computed unlicensed device exclusion zones for six different commonly used fixed service antennas.¹⁰⁰ Each contour shows the locations, represented by X and Y distance (km) from a fixed service receiver, where co-channel operation of an unlicensed device reduces the receiver fade margin¹⁰¹ by a certain dB (*i.e.*, fade margin reduction contour)—in this case 10 dB (a 10 dB fade margin reduction is equivalent to an I/N of 9.5 dB).¹⁰² As fade margin reduction is a function of separation distance from the fixed serviced receiver; an unlicensed device located inside of the contours will result in a higher than nominal fade margin reduction (increasing I/N) and an unlicensed device located outside of the contours will result in a lower than nominal fade margin reduction (decreasing I/N). An unlicensed device would be prohibited from operating co-channel within the fade margin reduction contour and would be permitted to operate co-channel outside the contour. This allows computation of a list of permissible frequencies for any unlicensed standard-power access point location that excludes co-frequency operation with every fixed service receiver within the associated fade margin reduction contours.

⁹⁷ See George Kizer, *Digital Microwave Communication*, 322 (2013).

⁹⁸ See Apple Inc., Broadcom Corporation, et al. Jan. 26, 2018 *Ex Parte*, at 31 (arguing that since the access point busy hour is before midnight, access points only transmit when they have traffic, and multipath occurs primarily after midnight, a significant portion of the link fade margin can be used to relax, dB-for-dB).

⁹⁹ See FWCC March 13, 2018 *Ex Parte*, at 37; APCO March 29, 2018 *Ex Parte*, at 2.

¹⁰⁰ See FWCC March 13, 2018 *Ex Parte*, at 21. The contours of Figure 2 are computed based on these parameters: unlicensed device power spectral density of 20.23 dBm/MHz, fixed service receiver bandwidth of 30 MHz, fixed service receiver Interference Protection Criteria as defined by I/N of 9.5 dB, and an ad-hoc FWCC path loss model. *Id.* at 23. The shapes of these contours have been idealized and dubbed in the industry as keyhole shape because of the resemblance to upside down keyhole.

¹⁰¹ Fade margin is defined as the difference, in decibel, between received signal strength level and receiver sensitivity. See George Kizer, *Digital Microwave Communication*, 560 (2013).

¹⁰² Reduction in fade margin is equivalent to increase in nominal noise floor due to interference. It is given by

$$\text{Reduction in Fade Margin (dB)} = 10 \log_{10}(10^{N/10} + 10^{I/10}) - N$$

Where N and I are respectively the receiver noise and the interference power. See FWCC March 13, 2018 *Ex Parte* at 26 (equation 5).

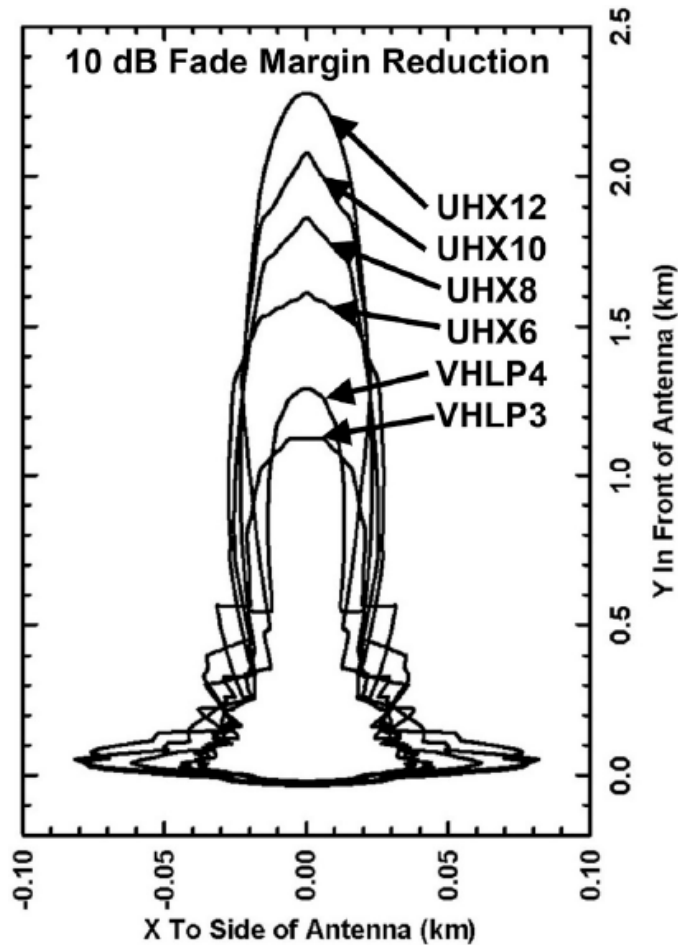


Figure 2 10 dB FMR Exclusion Zones

48. *Propagation Model.*—Several different propagation models can be used to determine the appropriate exclusion zones. FWCC claims that a free space path loss model should be used for every link because line-of-sight assumptions will be required unless the AFC incorporates terrain and/or building information that identifies line-of-sight cases with an extremely high degree of reliability.¹⁰³ Apple Inc., Broadcom Corporation, et al. argue for path loss models that relate to the propagation distance, identifying a combination of the WINNER II and ITM and ITU-R P.2108 models.¹⁰⁴

49. A free space path loss model would effectively assume worst case conditions for every link and likely overestimate the potential interference in most cases and unnecessarily restrict access to the spectrum for unlicensed use.¹⁰⁵ ITM, a well-known and widely used prediction tool,¹⁰⁶ calculates

¹⁰³ See FWCC June 25, 2018 *Ex Parte*, at 5. While FWCC uses the term “automatic coordination system,” the concept appears to be analogous to an AFC. For simplicity, we will use the term “AFC.”

¹⁰⁴ See Apple Inc., Broadcom Corporation, et al. Apr. 12, 2018 *Ex Parte*, at 10.

¹⁰⁵ See also FWCC Mar. 13, 2018 *Ex Parte*, at 23 (claiming that “microwave antennas have a strip of area in front of them in which they are sensitive to interference, from a few hundred meters to a few kilometers long – even in urban/suburban environments”). However, as FWCC also noted the Winner II model specification states that “Usually, even for the same scenario, existence of line-of-sight component substantially influences values of channel parameters. Regarding to this property, most WINNER scenarios are differentiating between line-of-sight and non-line-of-sight conditions. To enable appropriate scenario modelling, transitions between line-of-sight and non-line-of-sight cases have to be described. For this purpose, distance dependent probability of line-of-sight is used in the model.” *Id.* at 36.

transmission loss relative to free space loss over irregular terrain for frequencies between 20 MHz and 10 GHz.¹⁰⁷ However, this tool does not consider effects of buildings, foliage, or other man-made structures and is limited to distances greater than one kilometer. ITU-R P.2108 addresses some of the limitations of the ITM by providing an additive loss term that considers the effects of buildings and vegetation for distances greater than 0.25 kilometer.¹⁰⁸ However, ITU-R P.1411¹⁰⁹ and WINNER II,¹¹⁰ two short range propagation models, address clutter loss for distances shorter than 0.25 kilometers. We believe that in the first kilometer, an effective propagation model should include clutter loss in addition to both line-of-sight and non-line-of-sight conditions. Beyond the first kilometer, the propagation model should include a combination of a terrain-based path loss model and a clutter loss model appropriate for the environment. We seek comment on this approach, as well as the appropriate propagation models for this application. Following the WINNER II methodology, Apple Inc., Broadcom Corporation, et al. incorporate line-of-sight and non-line-of-sight propagation components into a single WINNER II combined urban/suburban model.¹¹¹ Can some of the propagation models for different conditions be combined into a single model? FWCC submitted a study that used curve fitting to combine propagation models of different ranges of applicability into a single model.¹¹² Is such an approach appropriate for this application? What are the costs and benefits of each propagation model? What other factors should be considered when choosing an appropriate propagation model?

50. *Standard-Power Access Point Location.*—Standard-power access point location information must be accurate to ensure that unlicensed devices operate only outside the exclusion zones when co-channel with fixed links. If expressed in terms of latitude, longitude, and height, what is the required accuracy of the location of each standard-power access point to ensure fixed service protection?¹¹³ We note that the location accuracy of any geolocation tool generally depends on the deployment environment.¹¹⁴ For example, the observed accuracy of a GPS receiver can vary depending on signal blockage by manmade structures, buildings, bridges, and trees.¹¹⁵ Accordingly, rather than requiring a certain location accuracy for a standard-power access point, would it be more appropriate to assign an area of uncertainty around the computed location, based on the underlying technology and propagation environment, and then build the necessary processing into the AFC system to adjust its separation distance between the standard-power access point and fixed service receiver based on the area

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¹⁰⁶ See Caleb Phillips, et al., “The Stability of The Longley-Rice Irregular Terrain Model for Typical Problems”, University of Colorado at Boulder Technical Report CU-CS-1086-11, 1 (2011).

¹⁰⁷ See Theodore S. Rappaport, *Wireless Communications Principles and Practice*, 145-46 (2nd Ed. 2002).

¹⁰⁸ See ITU-R Recommendation P.2108, “Prediction of Clutter Loss”, Geneva: International Telecommunication Union, Radiocommunication Sector, June 2017, at 5-6.

¹⁰⁹ See ITU-R Recommendation P.1411, “Propagation data and prediction methods for the planning of short-range outdoor radiocommunication systems and radio local area networks in the frequency range 300 MHz to 100 GHz”, Geneva: International Telecommunication Union, Radiocommunication Sector, August 2017, at 1-2.

¹¹⁰ See *WINNER II Channel Models*, <https://www.cept.org/files/8339/winner2%20-%20final%20report.pdf>, at 2, 7, 14-20, 43-49.

¹¹¹ Apple Inc., Broadcom Corporation, et al. Jan. 26, 2018 *Ex Parte*, at 35-38.

¹¹² FWCC March 13, 2018 *Ex Parte*, at 29-30.

¹¹³ The protection criteria, i.e., the minimum required separation distances, for white space devices and devices in the Citizens Broadband Radio Service are based on a geo-location accuracy of +/- 50 meters. 47 CFR §§ 15.712, 96.39(a). White space devices that use less accurate geo-location methods are permitted, but the minimum required separation distances enforced by the white space database are increased by the amount that the location uncertainty of the white space device exceeds +/-50 meters. *Id.* § 15.712.

¹¹⁴ See Rajiv Netra, *How GPS, Cell Tower and Wi-Fi triangulation help in tracking location?* <https://www.safetrax.in/2017/09/05/gps-cell-tower-triangulation-help-tracking-location/>.

¹¹⁵ See <https://www.gps.gov/systems/gps/performance/accuracy/>.

of uncertainty?¹¹⁶ If so, who will determine such an assignment and how, particularly with respect to indoor deployment? How will the location accuracy information be shared with the AFC? Will it be part of the registration process? What are the costs and benefits of any proposed alternative?

51. *Standard-Power Access Point Height.*—Latitude, longitude, and height information for standard-power access points can be used to build a three-dimensional exclusion zone contour for every fixed service receiver. One approach to simplify height considerations may be to use a two-dimensional exclusion zone contour based on a typical installation height of standard-power access points. Typical installation heights of standard-power access points will likely be lower than current cellular network antennas because of the much lower power. We note that cellular tower heights generally range from 15 to 60 meters.¹¹⁷ As such, the typical installation height above ground of a standard-power access points should probably range from 5 meters to 30 meters. We seek comment on whether this estimate of typical standard-power access point heights is appropriate.¹¹⁸ If we allow the AFC system to use a typical installation height in determining frequency availability, we could limit the maximum standard-power access point installation height to prevent interference from devices installed above this height. Of course, imposing such a height limitation would prevent use of standard-power access points in taller buildings. We seek comment on whether we should limit the maximum installation height of outdoor standard-power access points. If so, should that limit be set to 30 meters? We expect such a requirement would lower the potential for line-of-sight cases and thus provide further certainty that incumbent users will not receive harmful interference. However, because frequency availability will depend on the height of standard-power access points, will the AFC system inherently address this matter by limiting the availability of permissible frequencies?

52. In general, obtaining the height of a standard-power access point may be more difficult than obtaining its' latitude and longitude. We note that the most popular geolocation tool, GPS, has a vertical accuracy that is 2-3 times poorer than its horizontal accuracy.¹¹⁹ As the installed height of a standard-power access point is one of the key operating parameters that affect the received interference,¹²⁰ it may be necessary to verify the installed height of each standard-power access point by means other than GPS. Accordingly, we seek comment on requiring that every standard-power access point be professionally installed. If we require professional installation, what mechanisms should be in place to ensure that a non-professional or unlicensed person cannot perform an installation? Should we rely on an industry-led process to develop professional installer accreditation standards as the Commission has done in similar situations?¹²¹ Should AFC system(s) be required to take steps to ensure that only standard-

¹¹⁶ See Apple, Inc., Broadcom Inc., et al. Aug. 2, 2018 *Ex Parte* at 7.

¹¹⁷ See FCC, *Human Exposure to Radio Frequency Fields: Guidelines for Cellular Antenna Sites* (Mar. 30, 2018), <https://www.fcc.gov/consumers/guides/human-exposure-radio-frequency-fields-guidelines-cellular-and-pcs-sites>.

¹¹⁸ We note that this estimate is consistent with building heights that were used in Apple Inc., Broadcom Corporation, et al.' filings (i.e. 1.5 to 28.5 meters). Apple Inc., Broadcom Corporation, et al. based this height range on commercial and residential building heights and assumptions about the distribution of access points between the different types of buildings and within the buildings. Apple Inc., Broadcom Corporation, et al. Jan. 25, 2018 *Ex Parte* at 37-28 (Section 3.2.3).

¹¹⁹ See Adena Schutzberg, *Ten Things you Need to Know About GPS* (June 18, 2012), <https://www.directionsmag.com/article/1777>.

¹²⁰ Apple Inc., Broadcom Corporation, et al. Jan. 26, 2018 *Ex Parte* at 20.

¹²¹ *Amendment of the Commission's Rules with Regard to Commercial Operations in the 3550-3650 MHz Band*, Order on Reconsideration and Second Report and Order, 31 FCC Rcd 5011, 5046, para. 126 (2016) (noting that the WinForum, an industry-led group, is developing a set of professional installation standards for CBRs); Section 4(f)(4)(D) of the Communications Act of 1934, as amended, authorizes the Commission to "to endorse certification of individuals to perform transmitter installation, operation, maintenance, and repair duties in the private land mobile services and fixed services (as defined by the Commission by rule) if such certification programs are conducted by organizations or committees which are representative of the users in those services and which consist of individuals who are not officers or employees of the Federal Government." 47 U.S.C. § 154(f)(4)(D). Following

power access points that have been professionally installed can receive a list of frequencies upon which to operate? If we adopt a professional installation requirement, should we exempt certain access points that are less likely to cause interference such as, for example, those installed indoors or that are below a specified height? Are there other measurement/geolocation tools, existing or on the horizon, that can complement GPS? If so, can they be used in lieu of professional installation? Should we require geolocation capability to be built into the standard-power access points? Are there other means of obtaining location information, such as street address and floor number?¹²² If so, how will this impact the contour calculations? What are the costs and benefits of any proposed alternative?

53. *Client Devices.*—We propose to require client devices that operate in the U-NII-5 and U-NII-7 bands to be under the control of a standard-power access point. This is currently the case for most similar operations, such as client devices accessing a wireless router in the home or an access point at a public location. This requirement will help prevent uncontrolled operation of client devices on a peer-to-peer basis that would pose a greater risk of causing harmful interference to microwave links. Notwithstanding this proposal, we seek comment on whether client devices should be allowed to transmit probe requests,¹²³ consistent with 802.11 standard,¹²⁴ as means for joining a network, prior to receiving a frequency assignment. If so, is there any way to allow such use without causing harmful interference to the incumbent users? We seek comment on what assumptions to make about the area in which a client device can operate.

54. FWCC points to the scenario where the master device is at a non-interfering location, but a client device may not be.¹²⁵ We believe this concern can be addressed by including an area of operation centered on the location of the standard-power access point.¹²⁶ All calculations regarding the list of permissible frequencies of operation should then be made in reference to this area. We seek comment on the typical or maximum operating radius for communications between a client device and a standard-power access point. How should the distance be incorporated into any frequency coordination computation to ensure incumbents are protected? Our proposed rules define a client device as “a U-NII

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the amendment of the Act to include this Section, the Commission eliminated the licensing requirement and “strongly endorse[d] and encourage[d] organizations or committees representative of users in the Private Land Mobile Radio and Private Operational-Fixed Microwave Services to establish a national industry certification program or programs for technicians,” but left the development of and details concerning such a program to the private sector. *See Amendment of the Commission’s Rules with Regard to Commercial Operations in the 3550-3650 MHz Band*, 30 FCC Rcd 3959, 4028-29, para. 222 (2015) (citing *Requirement for Licensed Operators in Various Radio Services*, GN Docket No. 83-222, *Report and Order*, 96 FCC 2d 1123, 1141-45, paras. 36-43 (1984)).

¹²² *See* Apple Inc., Broadcom Inc., et al. Aug. 2, 2018 *Ex Parte*, at 8.

¹²³ Before an 802.11 client device can send data over a WLAN network (i.e. joining a network) it goes through a three-stage process: probing, authentication, and association. The probing process includes two options, passive probing and active probing. In the passive probing the client device scans the channels and passively listens to beacon frames transmitted by the access points on the medium. While in the active probing the client device transmits probe request frames on each channel and listens to probe response frames, the contents of which are similar to beacon frames. *See*

https://www.cisco.com/c/en/us/td/docs/solutions/Enterprise/Borderless_Networks/Unified_Access/CMX/CMX_802_Fund.pdf.

¹²⁴ *IEEE Std 802.11™-2016, IEEE Standard for Information technology— Telecommunications and information exchange between systems Local and metropolitan area networks— Specific requirements Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications*, IEEE December 2016, at 237.

¹²⁵ FWCC June 25, 2018 *Ex Parte*, at 6.

¹²⁶ *See* Apple Inc., Broadcom Inc., et al. Aug. 2, 2018 *Ex Parte*, at 7.

device whose transmissions are generally under the control of an access point and that is not capable of initiating a network.”¹²⁷ We seek comment on this definition.

3. Preventing Aggregate Interference to Operations in the Fixed-Satellite Service

55. As noted above, we tentatively conclude that use of the AFC is not necessary to protect satellite receivers and that limits on radiated power will prevent interference to space station receivers from individual unlicensed devices. However, satellite interests have expressed concern that the cumulative energy from unlicensed operations will cause harmful aggregate interference to satellite space station receivers.¹²⁸ In response, the Wi-Fi Alliance suggests that “[y]ears of operational experience in [the] U-NII-1 band confirm that those rules should be more than sufficient to protect the FSS uplink operations.”¹²⁹ To limit the potential for interference to non-geostationary satellite receivers, the U-NII-1 rules reduce the EIRP permitted above an elevation angle of 30 degrees from 36 dBm to 21 dBm.¹³⁰ We note that Globalstar has recently filed a Petition for Notice of Inquiry regarding spectrum sharing between its satellite uplink operations and outdoor U-NII-1 devices.¹³¹ The Wi-Fi Alliance further suggests adopting an antenna pointing limitation similar to that employed by the fixed microwave services (antennas may not be aimed within 2 degrees of the geostationary orbit).¹³²

56. We expect that the standard-power access points that are most likely to be deployed in the U-NII-5 and U-NII-7 bands will be used to provide wide area coverage and will use omnidirectional or wide beamwidth antennas (such as 60 or 120 degrees) rather than the highly directional antennas employed by fixed microwave services.¹³³ In view of these expectations, we seek comment on whether a restriction on pointing toward the geostationary arc would be appropriate. In addition, we note that the

¹²⁷ See proposed § 15.403(g) in Appendix B. This proposed rule is consistent with the definition of client device in § 15.202.

¹²⁸ SIA Comments at 41-44; Sirius XM Comments at 9. The U-NII-1 band consists of 100 megahertz of spectrum at 5.15-5.25 GHz. *Revision of Part 15 of the Commission’s Rules to Permit Unlicensed National Information Infrastructure (U-NII) Devices in the 5 GHz Band*, First Report and Order, 29 FCC Rcd 4127, 4128-29, para. 4 (2014).

¹²⁹ Wi-Fi Alliance Reply at 20.

¹³⁰ 47 CFR § 15.407(a)(1); *Revision of Part 15 of the Commission’s Rules to Permit Unlicensed National Information Infrastructure (U-NII) Devices in the 5 GHz Band*, First Report and Order, 29 FCC Rcd 4127, 4138, para. 37 (2014). The U-NII-1 rules permit access points to operate with a conducted power of 1 watt (30 dBm) and a 6 dBi antenna, which is equivalent to a 36 dBm EIRP. The U-NII-1 rules have no restriction on indoor access points or client devices to protect the satellite receivers and permit point-to-point operation with up to a 23 dBi antenna with no reduction in power.

¹³¹ GlobalStar, Inc. Petition for Notice of Inquiry Regarding the Operation of Outdoor U-NII-I Devices in the 5 GHz Band, RM-11808 (filed May 21, 2018) (asking the Commission to initiate a proceeding to re-evaluate continued spectrum sharing between MSS and U-NII devices in the U-NII-1 band.).

¹³² Wi-Fi Alliance Aug. 8, 2018 *Ex Parte*, at 2-3. Wi-Fi Alliance also suggests that the elevation angle limitation imposed on the U-NII-1 band is unnecessarily burdensome because it was designed to protect non-geostationary orbit satellite systems. *Id.* We note that although there are no non-geostationary orbit satellite systems currently operating in this band, there is no limitation in our rules prohibiting such operations and that the Commission currently has before it an application proposing to operate a non-geostationary orbit satellite system in the 5.925-6.725 GHz (Earth-to-space) band on file. See Application of New Spectrum Satellite, Ltd., IBFS File No. SAT-LOI-20170726-00111. 47 CFR § 101.145. *But see* Apple Inc., Broadcom Inc., et al. June 12, 2018 *Ex Parte*, at 4-5 (proposing to limit outdoor standard-power access point operation in the 6 GHz band by: (1) restricting radiated emissions of antennas pointing more than 30 degrees above the horizon to 1W or less; and (2) prohibiting fixed point-to-point outdoor devices from pointing within 2 degrees of the geostationary arc.).

¹³³ Because of the relatively low permitted EIRP levels, implementing long-distance point-to-point links under the proposed rules would not be practical.

currently operational satellites receiving in the U-NII-5 and U-NII-7 bands are in geostationary orbits approximately 36,000 kilometers above the equator while the satellites receiving in the U-NII-1 band are in non-geostationary orbits of approximately 1,400 kilometers. Because of the greater distance to the currently operating satellite receivers in the U-NII-5 and U-NII-7 bands, the potential for aggregate transmissions from unlicensed devices to cause harmful interference to the satellite receivers is reduced compared to the U-NII-1 band. However, we also recognize that due to the greater transmission distance the desired signal level will also be reduced at a geostationary satellite receiver when compared to non-geostationary satellite receivers at lower altitudes.

57. We seek comment on the potential for the satellite receivers in the U-NII-5 and U-NII-7 bands to receive harmful aggregate interference due to transmissions from unlicensed devices operating in these bands. Such comments should include a statistical analysis demonstrating the likelihood and severity of aggregate interference based on the technical characteristics proposed for unlicensed devices in these bands and the technical characteristics of satellite systems operating in these bands.¹³⁴ We also seek comment on methods that could be used to monitor aggregate interference to satellite receivers and potential remediation techniques in the event that such aggregate interference reaches levels that would require action. In this respect, we ask about the feasibility of developing monitoring techniques that would be agreeable for all parties involved and whether there is any role that unlicensed users could play with regard to such monitoring.

58. Although most satellite operations in the U-NII-5 and U-NII-7 bands are in the Earth-to-space direction, there is currently an allocation for space-to-Earth satellite use of the 6.7-6.875 GHz portion of the U-NII-7 band for feeder links for non-geostationary MSS systems.¹³⁵ However, no earth stations are currently licensed to use this allocation in the space-to-Earth direction. If this spectrum should be used for space-to-Earth links in the future, we propose that the AFC system could be used to prevent harmful interference to the earth station receivers by excluding standard-power access point from operating in this spectrum near the associated earth stations. We seek comment on how the AFC system might be used to protect any future receiving satellite earth stations. In particular, we ask what interference protection criteria and propagation models might be appropriate.

B. Lower Power Indoor Unlicensed Devices in the U-NII-6 and U-NII-8 Bands

59. We propose to allow unlicensed devices to operate in the 6.425-6.525 GHz and 6.875-7.125 GHz, referenced herein as the U-NII-6 and U-NII-8 bands respectively, under two specific conditions: (1) unlicensed devices are limited to the lower power levels applicable to unlicensed operations in the U-NII-2 bands and (2) such devices are restricted to indoor operation. We believe this framework would protect incumbent licensed services, while creating new unlicensed use opportunities. Our proposals for the 350 megahertz available in these two bands would support high throughput and low latency applications for residences and businesses. Such applications could include augmented or virtual reality, in-home video distribution at 4K/8K levels, and IoT applications.

60. The U-NII-6 band is used extensively by broadcast stations, programming networks, and video production companies for electronic news gathering and wireless video links.¹³⁶ This band also has an FSS (Earth-to-space) allocation, but no fixed service allocation.¹³⁷ The U-NII-8 band has a mobile service, fixed service, and FSS (Earth-to-space and space-to-Earth) allocation; however, fixed service access to the U-NII-8 band by common carrier fixed point-to-point microwave, private operational fixed point-to-multipoint microwave, and public safety microwave is restricted because fixed service links may

¹³⁴ The relevant technical characteristics of the satellite systems for this analysis include the satellite receive antenna pattern (i.e. footprint), signal polarization, earth station transmitted power, and earth station antenna gain.

¹³⁵ 47 CFR §§ 2.106 footnote 5.458B, 25.288, 25.208(n).

¹³⁶ IEEE Broadcast Technology Society Comments at 2, NAB Comments at 8.

¹³⁷ 47 CFR §2.106 also Appendix A.

not intersect with the service areas of TV pick-up stations.¹³⁸ Broadcasters use the U-NII-8 band for fixed point-to-point links as well as temporary fixed operations.¹³⁹ That band can also be used by large venue owners/operators or professional sound companies for licensed Low Power Auxiliary Station, including wireless microphones.¹⁴⁰ We expect that Low Power Auxiliary Station will typically be licensed for a large area and full band. In many cases, in both bands, electronic news gathering, and Cable Television Relay Service stations are also licensed across the entire band and over large operating areas to facilitate flexibility in coordinating operations.¹⁴¹

61. Many incumbents in the U-NII-6 and U-NII-8 bands conduct mobile operations. Because exclusion zone calculations require knowledge of the incumbent receiver location and antenna orientation, we do not believe that an AFC system would be feasible in these bands. Instead, we propose technical rules for unlicensed devices designed to minimize the potential harmful interference to incumbent operations in these bands. We believe our proposal would facilitate the deployment of less complex (and, thus, potentially less expensive) low-power unlicensed devices. 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. We recognize that our assessment that there is a low likelihood that indoor low power devices will cause harmful interference depends in part on the assumptions that are made with respect to the number and density of these devices and assumptions about the incumbent services interference protections. We propose to adopt power limits that are based on the existing rules in the U-NII-2C band.¹⁴² However, to ensure that we strike the right balance between operational flexibility for unlicensed devices and protection of incumbent operations, we encourage parties to submit detailed sharing studies showing how new unlicensed devices can share the band with incumbent services.

62. We also seek comment on the compatibility between unlicensed indoor low power devices and Low Power Auxiliary Station services which may operate indoors in the U-NII-8 band. Commenters should provide all study assumptions, including appropriate propagation models, availability requirements, receiver sensitivity, noise figure, antenna patterns, and fade margins, between indoor low power unlicensed devices anticipated under our proposals and mobile and fixed links in these bands. We believe the same conditions that protect incumbents from harmful interference from a single U-NII device will also protect those same incumbents from aggregate interference.¹⁴³ Nevertheless, we request that commenters address this assumption. We encourage parties to employ statistical models to evaluate the risk of harmful interference.

63. *Mobile Service Protection.*—Usage and deployment configurations of mobile assignments are, by definition, variable. To establish a mobile link, operators make engineering decisions to ensure that the link is sustainable in its operating environment (e.g., increase power, raise antenna height, change modulation or move locations). This discretion allows operators to take environmental conditions, including potential interference, into consideration when establishing a mobile link. Given the uncertainties inherent in establishing mobile links and the attenuation of the signals due to building and

¹³⁸ 47 CFR §101.147 note 34; *see also* FWCC Comments at 8.

¹³⁹ Based on review of BAS licenses in ULS. *See also* Appendix A.

¹⁴⁰ As of June 22, 2018, no Low Power Auxiliary Station licenses were listed in the 6875-7125 MHz band in ULS.

¹⁴¹ While licenses authorize operation across the entire band, for any specific event most licensees only use a single channel.

¹⁴² 47 CFR § 15.407(a)(2). The U-NII-2C band consists of 255 megahertz of spectrum at 5.47-5.725 GHz. *Revision of Part 15 of the Commission's Rules to Permit Unlicensed National Information Infrastructure (U-NII) Devices in the 5 GHz Band*, First Report and Order, 29 FCC Rcd 4127, 4129, para. 4 (2014).

¹⁴³ We note that the RKF Technical Study showed that the aggregate interference risk from unlicensed devices to fixed service receivers is not substantially different from the single-entry interference risk. *See* Apple Inc., Broadcom Corporation, et al. Jan. 26, 2018 *Ex Parte*, at 9.

clutter losses, we anticipate that low-power indoor operation will not increase the risk of harmful interference to mobile service incumbents. We seek comment on this assessment. We seek comment on factors that we have not accounted for in this analysis, including more detailed information on the specific mobile deployment configurations in these bands. Are Cable Television Relay Service and TV pickup mobile station deployment configurations largely similar? Are receive sites for the TV pickup and Cable Television Relay Service mobile assignments typically deployed at fixed locations? What are the typical fade margins for mobile links and what types of service are these fade margins required for? For the approximately 200 public safety or business/industrial pool assignments in these bands, do they operate on a mobile basis or are they temporarily fixed for longer periods of time when in use? How many mobile stations are typically associated with an assignment?

64. *Fixed Service Protection.*—To ensure the Commission has the most complete information regarding fixed use of the U-NII-6 and U-NII-8 bands, we seek comment on whether fixed service link requirements for the various fixed service services in these bands differ. For example, do Broadcast Auxiliary Service point-to-point links have the same design criteria regarding availability and fade margins as Private Operational Fixed public safety and business/industrial pool links or common carrier point-to-point links? How do these design criteria relate to the potential for indoor unlicensed devices in tall buildings to cause unacceptable degradation to the fade margin of a fixed service link? Fixed Service commenters have raised the possibility of indoor unlicensed devices in tall buildings causing unacceptable degradation to the fade margin of a fixed service link.¹⁴⁴ Under what conditions would such interference occur? How do these design criteria for fixed service links in these bands relate to the potential for such interference? Are there mitigation strategies that will reduce the potential for unlicensed devices to cause harmful interference under these conditions? Would unlicensed device operation in these bands have any detrimental effect on Broadcast Auxiliary Service operations, which are characterized by transmitting to strategically located receive sites?

65. *Satellite Service Protection.*—We believe that the technical characteristics proposed for indoor low-power access points in the U-NII-6 and U-NII-8 bands will protect FSS and that additional interference mitigation techniques are unnecessary. As an initial matter, there are only 20 Earth-to-space FSS earth stations in the U-NII-6 and six in the U-NII-8 bands and 21 space-to-Earth FSS earth stations clustered within 300 meters of five locations in the U-NII-8 band.¹⁴⁵ The most significant satellite services operating in these bands are the MSS feeder downlinks in portions of the U-NII-8 band¹⁴⁶ and the Satellite Digital Audio Radio Service feeder uplinks in the 7.025-7.075 GHz portion of the U-NII-8 band, but in both cases there are only a limited number of locations nationwide.¹⁴⁷

66. Concerning the feeder uplinks for the Satellite Digital Audio Radio Service systems, we note that the analysis filed by Sirius XM showing that its space stations would likely be subject to interference from unlicensed devices was premised on outdoor operations at high power levels.¹⁴⁸ However, we are proposing low-power, indoor-only unlicensed operations in the 7.025-7.075 GHz band. Because of the low power and low probability that an indoor unlicensed device will have a direct line of sight with the Sirius/XM satellites, we believe the risk of causing harmful interference to those satellites is low.

¹⁴⁴ FWCC June 25 2018 *Ex Parte*, at 6, Attach. 2.

¹⁴⁵ Based on a query of IBFS on June 22, 2018.

¹⁴⁶ These sites are located in Sebring, FL, Clifton, TX, Brewster, WA, Wasilla, AK, and Las Palmas, PR.

¹⁴⁷ These sites are located in Washington, DC; Ellenwood, GA; and Sussex, NJ.

¹⁴⁸ Sirius XM June 22, 2018 *Ex Parte*, at 9.

67. Regarding the limited number of MSS feeder downlinks in the U-NII-8 band, we tentatively conclude that MSS operations will be similarly protected by the limitations on unlicensed use proposed in this Notice, particularly given the small number and isolated nature of these locations.¹⁴⁹

68. We seek comment on these tentative conclusions, and on whether any additional mitigation techniques might be necessary to protect satellite services in these bands.

69. *Indoor Operations.*—We propose to restrict operation of unlicensed devices in the U-NII-6 and U-NII-8 bands to indoor operation. This restriction is designed to decrease the probability that the indoor unlicensed device will operate near the main beam of licensed outdoor receivers and to take advantage of the losses from building materials in order to minimize the potential for harmful interference. Broadcasters covering large venues such as sporting events and political conventions rely on the U-NII-6 and U-NII-8 bands for operations that may take place indoors.¹⁵⁰ Are there additional low-power device restrictions that the Commission should consider to prevent interference to broadcaster indoor operations in these bands? We also propose to require client devices that operate in the U-NII-6 and U-NII-8 bands to be under the control of low-power access point. This requirement will help prevent uncontrolled outdoor operation of client devices.

70. We believe that in most cases Broadcast Auxiliary Service operations will be between a mobile transmitter and a fixed location to which it will have a direct line of sight. In instances where there may be an intervening building, both Broadcast Auxiliary Service and fixed service links will be protected due to their relative higher signal power as compared to that of unlicensed devices as well as clutter and building entry losses which are especially relevant in ensuring compatibility between indoor low-power access points and licensed users in the U-NII-6 and U-NII-8 bands. ITU models give values for both building entry and clutter losses with some probability of occurrence.¹⁵¹ We note that the ITU model shows a median building entry losses of approximately 18 dB for traditional construction and 30 dB for thermally efficient construction for horizontal incidence, with increasing building entry losses at larger elevation angles.¹⁵² Are assumptions for building entry losses and clutter loss enough to overcome concerns of interference even when the unlicensed device might be in the main beam of the receiver? Are there other factors or models that should be considered when evaluating losses between indoor unlicensed devices and U-NII-6 and U-NII-8 incumbent services? Commenters should provide detailed link budgets along with all assumptions to support their positions on the potential of unlicensed devices causing harmful interference.

71. *Other Considerations.*—We also invite comment on how the Commission could ensure that low-power access points are restricted to indoor use. Previously, we have required that indoor devices have direct connection to a power outlet.¹⁵³ Should we adopt a similar requirement here? Are there other methods or equipment form-factors that would discourage outdoor usage of low-power access point unlicensed devices that we should consider? For example, noting that GPS signals generally do not penetrate very far into buildings, would it be feasible and cost effective to require low-power access points to monitor GPS satellite signals and to cease transmissions if a GPS signal is detected? Would it

¹⁴⁹ A review of Google Earth show that these receive earth stations are located apart from residential buildings and in open areas.

¹⁵⁰ NAB Oct. 17, 2018 *Ex Parte*, at 1.

¹⁵¹ ITU Recommendation P.2109 gives building entry losses for traditional building versus thermally efficient buildings for various incident angles. The Recommendation notes that the classification, of “thermally-efficient” and “traditional”, refers purely to the thermal efficiency of construction materials and makes no assumption regarding the year of construction, type (single or multi-floors), heritage or building method. ITU Recommendation P.2108 §3.2 gives a statistical clutter model loss for terrestrial based terminals and § 3.3 provides a statistical clutter model for Earth-space paths.

¹⁵² ITU Recommendation P.2109 at Figure 1.

¹⁵³ 47 CFR § 15.257(a)(1).

be better to set a GPS signal threshold rather than a detection threshold above which a low-power access point would be required to shut off to differentiate between clear-sky (outdoor) GPS satellite view and indoor detection? We note that the former case would discourage placement of indoor devices near windows where GPS detection is more likely and thus provide additional protection to incumbent operations. We seek comment on this and other methods of ensuring devices operate in accordance with the indoor-only restriction. Finally, given that client devices are even lower power (5 mW/MHz EIRP) and are required to only operate in the U-NII-6 and U-NII-8 bands after receiving an authorization from a low-power access point,¹⁵⁴ are there any other considerations we need to take into account to ensure these devices do not cause harmful interference to incumbent operations?

72. As mentioned above, there are existing provisions in Part 15 for unlicensed wideband and ultra-wideband systems throughout the 6 GHz band.¹⁵⁵ We do not propose to make changes to these rule sections as we expect such systems will continue to coexist with all other systems, both licensed and unlicensed, within the 6 GHz band. We note, however, that some existing unlicensed users and manufacturers have expressed concern that adding new types of unlicensed devices and use cases to the 6 GHz band could detrimentally change the overall RF environment in which they operate.¹⁵⁶ We seek comment from interested parties regarding the potential effect of our proposals on their existing unlicensed devices and use models. To the extent that parties believe new devices could adversely affect existing operations, they should suggest specific rules and mitigation strategies that would minimize such risk.

C. Other Unlicensed Operation Options

73. *Low Power Indoor Operation at U-NII-5 and U-NII-7.*—We seek comment on whether we should allow indoor low-power access point operations in the U-NII-5 and U-NII-7 bands under the same conditions as proposed for the U-NII-6 and U-NII-8 bands; *i.e.*, low power, indoor-only use without the need for authorization from an AFC system. As discussed above, the U-NII-5 and U-NII-7 band frequencies are dominated by common carrier, public safety, and business/industrial pool point-to-point microwave links and by FSS Earth-to-space links. Apple Inc., Broadcom Inc., et al. suggest that low-power devices may operate indoors at power levels sufficiently low that they pose no material risk of harmful interference to incumbent links.¹⁵⁷ FWCC states that indoor unlicensed devices in tall buildings could cause unacceptable degradation in the fade margin of a fixed service link. FWCC claims that all indoor devices must be subject to the same mechanism to avoid nearby fixed service microwave links as outdoor devices.¹⁵⁸ Could we permit low-power, indoor-only unlicensed devices to operate in the U-NII-5 and U-NII-7 bands without being under the control of an AFC system? If so, what power level could be permitted for such operation without increasing the risk of harmful interference to licensed services? Commenters should provide detailed analysis to support their position regarding whether such operation should or should not be permitted. Are there any other operational requirements, rules or mitigation techniques that would allow low-power access points to operate in the U-NII-5 and U-NII-7 bands without the use of an AFC system?

74. *High Power Operation at U-NII-6 and U-NII-8.*—We seek comment on whether there are any ways to protect incumbent mobile operations, if we were to allow unlicensed operations in the U-NII-6 or -8 bands at the same power levels as those proposed for U-NII-5 and U-NII-7 bands, both indoors and outdoors. The U-NII-6 and U-NII-8 bands have a significant number of mobile operations.

¹⁵⁴ See *infra* Appendix B (Proposed Sections 15.403(g), 15.407(a)(6)).

¹⁵⁵ 47 CFR § 15.250; 47 CFR pt. 15 subpt. F.

¹⁵⁶ See, e.g., Zebra Technologies Reply at 3-4; Ultra Wide Band Alliance Oct. 11, 2018 *Ex parte*, GN Docket No. 17-183, at 1-3.

¹⁵⁷ Apple Inc., Broadcom Inc., et al. Aug. 2, 2018 *Ex Parte*, at 9; Apple Inc., Broadcom Inc., et al. June 12, 2018 *Ex Parte*, at 3.

¹⁵⁸ FWCC June 25, 2018 *Ex Parte*, at 6, Attach. 2.

However, approximately 43% of assignments in U-NII-6 are mobile, while in U-NII-8, only 2% are mobile.

75. An AFC system, like the one we proposed for U-NII-5 and U-NII-7, makes interference calculations where the fixed link receivers or protected contours are known. Are a significant number of Broadcast Auxiliary Service and Cable Television Relay Service receive sites fixed, such that they could be protected by the AFC in the same fashion as fixed operations? Do fixed receive sites associated with mobile operations typically use fixed antennas or steerable antennas and could a protection contour be defined around a fixed receive site taking into consideration the characteristics of the receive antenna? Is it possible, for example, to dynamically update the permissible frequency list whenever mobile sites become active or when the information for these sites becomes available? Can push notifications serve as a means of informing affected standard-power access points that the permissible frequency list must be updated to protect the incumbents? Additionally, would our tentative conclusions regarding protections of satellite services in the U-NII-6 and U-NII-8 bands be undermined by permitting high power unlicensed operations in these bands.

76. *Mobile and Transportable Operation.* There are many applications where unlicensed devices operating under our Part 15 rules in other bands transmit without being associated with an access point. For example, many smartphones are capable of operating as mobile hotspots that provide Wi-Fi connections to other nearby devices.¹⁵⁹ There are also many unlicensed wireless applications that are unrelated to accessing the Internet such as in-home distributions of video, real-time gaming, and high fidelity audio.¹⁶⁰ Our intent in making proposals for the 6 GHz band is to not unnecessarily limit the potential uses of unlicensed devices. Thus, we seek comment on whether unlicensed devices in the U-NII-5 and U-NII-7 bands should be explicitly permitted to operate either as a mobile hotspot or as a transportable device.¹⁶¹ As with fixed access points in these bands, such operation would be under the control of an AFC system. Is such operation feasible under such a condition? Are there rules we can put in place to permit such operation while still ensuring that licensed services are protected from harmful interference. For example, the rules for Mode II personal/portable white space devices allow them to load channel availability information for multiple locations to define a geographic area in which the device can operate.¹⁶² Could a similar mechanism work in these bands? Are there specific capabilities that need to be included in the AFC to enable such operation? Should such operation be restricted to certain power levels? Are there other safeguards that could be implemented to permit such operation?

D. Technical Rules

77. The technical requirements for U-NII devices operating in these bands will depend ultimately on a determination of the types of unlicensed operations that can be supported while maintaining interference protection to incumbents. Nonetheless, because the types of incumbent services across the 6 GHz range share similar characteristics with the existing U-NII bands, we propose technical requirements for unlicensed devices based on the existing U-NII technical rules.

1. Power Limits

78. As previously stated and consistent with several commenters, we believe the 6 GHz band will support many of the same applications as the existing U-NII bands, and the use of this new band can be facilitated by expanding the range of existing U-NII equipment above 5.925 GHz. Based on the experience of the existing U-NII bands where unlicensed devices have been able to successfully operate

¹⁵⁹ Verizon, *How to use our Smartphone as a Mobile Hotspot*, <https://www.verizonwireless.com/articles/how-to-use-your-smartphone-as-a-mobile-hotspot/> (last visited Oct. 17, 2018).

¹⁶⁰ Apple Inc., Broadcom Inc., et al. Aug. 2, 2018 *Ex Parte*, at 9.

¹⁶¹ Transportable devices are not intended to be used in motion, but rather at stationary locations. See 47 CFR § 30.2.

¹⁶² 47 CFR § 15.711(d)(5).

without causing interference to authorized systems in the bands, we propose power levels similar to those rules. We believe these levels will provide the proper balance between allowing flexibility for unlicensed devices to deploy while still protecting incumbent systems.¹⁶³ Therefore, we propose maximum EIRP power spectral density limits of:

U-NII-5 and U-NII-7 Standard-Power Access Points. The maximum conducted output power is 1 watt and maximum power spectral density is 17 dBm in any 1 megahertz band. If a transmitting antenna with directional gain greater than 6 dBi is used, the maximum power and power spectral density shall be reduced by the amount in dBi that the directional gain is greater than 6 dBi.

U-NII-6 and U-NII-8 band Low-Power Access Points. The maximum conducted output power is 250 milliwatts and maximum power spectral density is 11 dBm in any 1 megahertz band. If a transmitting antenna with directional gain greater than 6 dBi is used, the maximum power and power spectral density shall be reduced by the amount in dBi that the directional gain is greater than 6 dBi.

Client Devices. The maximum conducted output power is 63 milliwatts and maximum power spectral density is 5 dBm in any 1 megahertz band. If a transmitting antenna with directional gain greater than 6 dBi is used, the maximum power and power spectral density shall be reduced by the amount in dBi that the directional gain is greater than 6 dBi.

79. The proposed limits above align with what the Commission has adopted for other U-NII bands, in terms of power and power spectral density limits. These proposed rules will allow the industry to benefit from economies of scale, by designing new lines of equipment or modifying existing lines of equipment that can operate across a wide swath of spectrum in both the 5 GHz and 6 GHz bands. We note that these limits are also similar to what certain commenters have proposed.¹⁶⁴ We seek comment on these proposed power limits. We note that while our proposal is rooted in the existing U-NII rules, there are specific differences; most notably, we are proposing no provisions for high gain antennas for unlicensed devices. However, to ensure we develop a complete record, we seek comment on whether higher power operations could be permitted in rural and underserved areas under certain conditions.¹⁶⁵ If so, should such operations be limited to only the U-NII-5 and U-NII-7 bands and only under the control of an AFC system? Commenters advocating for higher power should also address how much more power they believe is necessary to serve these areas and provide comment on how to define rural and underserved areas in this context. Additionally, commenters should address whether such operations should be limited to point-to-point operations (possibly with a minimum antenna gain) or if point-to-multipoint operations should be permitted.

80. We also seek comment on whether we should adopt power rules that are structured differently than the existing U-NII rules. For example, we could specify only a radiated power spectral density limit or a combination of a radiated maximum power and a radiated power spectral density limit. Commenters should provide specific reasoning as to why they support our proposals or any alternative. What are the benefits and drawbacks of each approach as it relates to equipment design and cost as well as maximizing the area over which unlicensed devices can operate and ensuring incumbents are protected

¹⁶³ 47 CFR § 15.407(a).

¹⁶⁴ Wi-Fi Alliance Aug. 8, 2018 *Ex Parte*, at 3. The proposed limits above also coincide with the peak power limits that were used in the technical study by RKF Engineering that was submitted by Apple Inc., Broadcom Corporation, et al. See RKF Technical Study at 17-18, Table 3-4. FCC staff reviewed the equipment authorization database and found the figures used in the table reflect the power levels found in equipment authorization applications. At these power levels, RKF Engineering concluded that the resulting impact on fixed service availability and quality of service delivered of these links from the introduction of access points will fall within the existing availability design margin and will not cause harmful interference. See RKF technical study at 53-54.

¹⁶⁵ See, e.g., Apple Inc., Broadcom Inc., et al. Oct. 12, 2018 *Ex Parte* at 1 (suggesting the Commission should solicit comments on how technical rules governing transmitters can promote rural broadband deployment in the 6 GHz band).

from harmful interference? In commenting on our proposal or alternatives, commenters should keep in mind that the maximum transmitted power in the existing U-NII bands was developed based on an assumed 20 megahertz channel bandwidth—i.e., a signal at the permitted power spectral density would meet the maximum transmitted power when transmitting across a 20 megahertz channel.¹⁶⁶ Commenters advocating a conducted power and antenna gain approach or a limit on maximum EIRP should consider whether 20 megahertz continues to be an appropriate basis on which to establish a maximum power limit; *i.e.* should we specify a maximum transmit power based on a 20 megahertz channel bandwidth in addition to the power and power spectral density limits described above? What are the benefits of such an approach? We note that specifying a maximum power in addition to the power spectral density would essentially reduce the maximum power when using wider channels. Would such a rule unnecessarily restrict devices to less efficient operational modes?¹⁶⁷ Should certain types of transmitters that employ electrically steerable, MIMO, or phased array antennas have special rules which allow the device to operate with higher power levels?¹⁶⁸

81. Additionally, we seek comment on our proposal to reduce the permitted transmitted power and power spectral density when using antennas with a directional gain greater than 6 dBi. Should we require that antennas be integrated with the device or can we permit users to choose an appropriate antenna for their application? If antennas are not integrated with the device, should an equipment authorization grantee be required to maintain a list of permissible antennas with its equipment authorization or in the manual or on a website? What effect will our proposal have on the equipment authorization process?

2. Unwanted Emissions Limits

82. We propose that for all unlicensed devices operating in the 6 GHz band under the proposals herein, all emissions below 5.925 GHz and above 7.125 GHz shall not exceed an EIRP of -27 dBm/MHz. We propose this out-of-band emission limit to be consistent with the rules that apply for most of the other U-NII bands, which have been successful in preventing harmful interference to services operating in adjacent bands.¹⁶⁹ We seek comment on this proposal. In addition, we seek comment on the need to specify out-of-band emission limits between the sub-bands of the 6 GHz band—i.e. between the U-NII-5, U-NII-6, U-NII-7 and U-NII-8 bands? What are the appropriate emission limits?

83. We also seek comment on the transmit emission mask that unlicensed devices should be required to meet to protect incumbent services operating on adjacent frequencies within the band. Is the

¹⁶⁶ The U-NII-1 rules allow a conducted power spectral density of 17 dBm/MHz and a maximum conducted power of 1 watt for access points. 47 CFR § 15.407(a)(1)(i)-(ii). A signal with a power spectral density of 17 dBm over a 20 megahertz bandwidth would have a power of 1 watt. We note that newer devices were implementing wider bandwidth channels in accordance with the IEEE 802.11ac standard which allowed 20 megahertz, 40 megahertz, 80 megahertz, and 160 megahertz channels. See Afaqui et al., *IEEE 802.11ax: Challenges and Requirements for Future High Efficiency WiFi*, IEEE Wireless Communications, June 2017, at 133, 136.

¹⁶⁷ Radwin has submitted a petition for rulemaking requesting that we permit devices in the U-NII-1 and U-NII-3 bands to emit multiple sequential directional beams at the power levels allowed for point-to-point systems. Radwin Ltd. Petition for Rulemaking, RM-11812 (filed June 18, 2018).

¹⁶⁸ The U-NII-1 (5.15-5.25 GHz) rules specify both a power spectral density limit of 17 dBm/MHz and a maximum transmitted power of 1 watt (30 dBm) for outdoor access points. The access points may use up to a 6 dBi gain antenna without requiring a reduction in the transmitted power or power spectral density. 47 CFR § 15.407(a)(1)(i). In the U-NII-3 band (5.725-5.85 GHz), a maximum transmitted power of 1 watt (30 dBm) is permitted with a power spectral density of 30 dBm in any 500 kHz band. Devices may use up to a 6 dBi antenna gain without requiring a reduction in the transmitted power or power spectral density. In addition, in U-NII-3 fixed point-to-point devices may use higher gain antennas without reducing transmitted power or power spectrum density. 47 CFR § 15.407(a)(3).

¹⁶⁹ This limit applies for 5.15-5.25 GHz (U-NII-1), 5.25-5.35 GHz (U-NII-2A), and 5.47-5.725 GHz (U-NII-2C). 47 CFR § 15.407(b)(1)-(3). However, the U-NII-3 band has a more relaxed out-of-band emission limit. 47 CFR § 15.407(b)(4)(i).

emission mask suggested by RKF Engineering in the technical study submitted by Apple Inc., Broadcom Corporation, et al. appropriate for this purpose?¹⁷⁰ If not, what is the appropriate emission mask?

3. Prohibition on use in Moving Vehicles and Drones

84. We propose that unlicensed access points (both standard-power access point and low-power access point) be prohibited from operating in moving vehicles such as cars, trains, or aircraft. Our proposals are designed to provide protection to incumbent services and we believe that allowing access points in vehicles would not meet this goal. For operations in the U-NII-5 and U-NII-7 bands, it would be impractical for an AFC system to provide and update the list of available frequencies to a standard-power access point while it is in motion. In the U-NII-6 and U-NII-8 bands, where our proposed rules rely on the signal attenuation due to indoor operation to prevent interference, signal attenuation from the cars, trains, or aircraft is likely to be significantly less than from a building and low-power access points could potentially cause harmful interference. We are especially concerned about the interference consequences of allowing operation onboard aircraft because the longer line-of-sight distances from devices at typical aircraft altitude could result in interference over a wide area. We seek comment on this proposal and whether there are alternative, feasible proposals to use the band for moving vehicles.

85. Because we are concerned that airborne operation can cause interference over a wide area, we also propose that unlicensed devices, whether a standard-power access point, low-power access point, or client device, operating under these rules not be permitted for use with unmanned aircraft systems. This prohibition would apply to both communications used for control of the unmanned aircraft system and non-control radio communication from the unmanned aircraft systems, such as links used for the download of video or other data from the unmanned aircraft systems to ground stations. We seek comment on this proposal.

E. Additional Mitigation Measures

86. Although we believe that unlicensed device operation as discussed herein will not result in harmful interference to licensed services, we nonetheless ask whether any additional requirements are necessary to ensure that any instances of harmful interference that may occur can be resolved expeditiously.

87. *Digital Identifying Information.*—As part of its interference mitigation proposals, Apple Inc., Broadcom Inc., et al. propose that AFC-enabled standard-power access points be required to periodically transmit identifying information. Such transmissions would enable incumbents to identify any device that may cause harmful interference and notify the device operators.¹⁷¹ In response, FWCC expressed skepticism that such a requirement would effectively mitigate the effects of interference. Specifically, FWCC notes that, as interference is not detected until after a communications link fails, it would be very difficult to pinpoint the cause of the interference and fixed service operators would not be able to decode the standard-power access point identifying information.¹⁷²

88. In the context of unlicensed white space devices, the Commission's rules require such devices to transmit "identifying information" necessary to identify the specific device and its location.¹⁷³ At the same time, the Commission has also previously chosen not to impose a similar requirement on U-NII devices.¹⁷⁴ Nonetheless, given the specific characteristics of the spectrum associated with the new

¹⁷⁰ RKF Technical Study at 53.

¹⁷¹ Apple Inc., Broadcom Inc., et al. June 12, 2018 *Ex Parte*, at 4.

¹⁷² FWCC June 8, 2018 *Ex Parte*, at 16.

¹⁷³ See 47 CFR § 15.711(g).

¹⁷⁴ See *Revision of Part 15 of the Commission's Rules Regarding Operation in the 57-64 GHz Band*, 28 FCC Rcd 12517, 12534, para. 43 (2013) (modifying Part 15 rules to eliminate a transmitter ID requirement for all devices operating in the 57-64 GHz band); *Revision of Part 15 of the Commission's Rules to Permit Unlicensed National Information Infrastructure (U-NII) Devices in the 5 GHz Band*, 29 FCC Rcd 4127, 4144-45, para. 60 (2014)

services proposed, we seek comment on whether we should require standard-power access points in these bands to transmit digital identifying information. If so, should such a requirement be applied in all instances (standard-power access points and low-power access points and their associated client devices)? If, as proposed, low-power access point operation would be restricted to indoors and such devices would not have any identifying information in the AFC database, would there be any practical benefit to requiring low-power access points to transmit digitally identifying information? Would a specific format for such information need to be specified and would there be a need for specialized equipment to detect and decode the identifying information? If so, could this function be easily incorporated into new equipment or retrofitted to existing equipment? How much would adding this capability into equipment cost? Commenters supporting a digital identification requirement should explain how such information could practically be used to enable the resolution of interference and indicate what requirements should be specifically codified in our rules.

89. *Band In-Use Database.*—As an additional means to locate the source of harmful interference, we could require that the AFC record the actual frequency being used by each standard-power access point. The standard-power access point would notify the AFC of the frequency it selects from the list of permissible frequencies. This information could be useful for locating interference sources if it can be collected from every standard-power access point and stored in a relational database. Such a database could serve as an effective remediation tool. For example, if a fixed service receiver detects harmful interference to its operation, the frequency in use database could be employed to identify standard-power access points sharing the fixed service band in the nearby area of the fixed service site. We seek comment on this tool and other means for remediation of interference.

90. *Interference Resolution Process.*—The above proposals regarding unlicensed operations in these bands are intended to avoid the possibility of harmful interference to incumbent operations. Notwithstanding these proposals, we seek comment on whether it would be necessary to institute an interference resolution process beyond our existing rule for unlicensed devices.¹⁷⁵ For example, would it be necessary to establish an interference detection and identification procedure? If so, who will develop this procedure and who will be responsible for exercising it? Should the AFC system operator(s) be responsible for this task?

91. *Informational Requirements.*—We seek comment on whether the Commission should require manufacturers to provide consumers with information on any specific operational requirements applicable to devices operating in the U-NII-5 through U-NII-8 bands to prevent harmful interference. If so, what how should this information be conveyed, e.g., by device labeling or in the user's manual, and what information should be provided?¹⁷⁶ Depending on the types of operational requirements that the Commission adopts, examples of information that could be provided include that certain devices may be operated only indoors, may not be operated on board aircraft, require professional installation, or must update their location information with an AFC system when installed at a new location.

(Continued from previous page) _____
(declining to require U-NII devices in the 5.15-5.35 GHz and 5.47-5.850 GHz bands to transmit identifying information).

¹⁷⁵ Under our existing rule, the operator of an unlicensed radio frequency device shall be required to cease operating the device upon notification by a Commission representative that the device is causing harmful interference. Operation shall not resume until the condition causing the harmful interference has been corrected. 47 CFR § 15.5.

¹⁷⁶ The rules currently require Part 15 intentional radiators to be labeled with an FCC identification number and a statement that operation is subject to the conditions that the device not cause harmful interference and must accept any interference received. This information may be provided in electronic form. 47 CFR §§ 2.925(a), 2.935 and 15.19(a)(3). In addition, the user's manual, which may be provided electronically, must caution the user that unauthorized changes or modifications to a device could void the user's authority to operate it. 47 CFR § 15.21.

IV. PROCEDURAL MATTERS

92. *Paperwork Reduction Act Analysis.*—This document contains proposed new or modified information collection requirements. The Commission, as part of its continuing effort to reduce paperwork burdens, invites the general public and the Office of Management and Budget (OMB) to comment on the information collection requirements contained in this document, as required by the Paperwork Reduction Act of 1995, Public Law 104-13. In addition, pursuant to the Small Business Paperwork Relief Act of 2002, Public Law 107-198, *see* 44 U.S.C. § 3506(c)(4), we seek specific comment on how we might further reduce the information collection burden for small business concerns with fewer than 25 employees.

93. *Initial Regulatory Flexibility Analysis.*—As required by the Regulatory Flexibility Act,¹⁷⁷ the Commission has prepared an Initial Regulatory Flexibility Analysis (IRFA) of the possible significant economic impact on a substantial number of small entities of the proposals addressed in this Notice. The IRFA is found in Appendix C. We request written public comment on the IRFA. Comments must be filed in accordance with the same filing deadlines as comments filed in response to the NPRM and must have a separate and distinct heading designating them as responses to the IRFA. The Commission's Consumer and Governmental Affairs Bureau, Reference Information Center, will send a copy of this Notice, including the IRFA, to the Chief Counsel for Advocacy of the Small Business Administration, in accordance with the Regulatory Flexibility Act.¹⁷⁸

94. *Filing Requirements.*—Pursuant to sections 1.415 and 1.419 of the Commission's rules, 47 CFR §§ 1.415, 1.419, interested parties may file comments and reply comments on or before the dates indicated on the first page of this document. Comments may be filed using the Commission's Electronic Comment Filing System (ECFS). *See Electronic Filing of Documents in Rulemaking Proceedings*, 63 FR 24121 (1998).

- Electronic Filers: Comments may be filed electronically using the Internet by accessing the ECFS: <http://apps.fcc.gov/ecfs/>.
- Paper Filers: Parties who choose to file by paper must file an original and one copy of each filing. If more than one docket or rulemaking number appears in the caption of this proceeding, filers must submit two additional copies for each additional docket or rulemaking number.

Filings can be sent by hand or messenger delivery, by commercial overnight courier, or by first-class or overnight U.S. Postal Service mail. All filings must be addressed to the Commission's Secretary, Office of the Secretary, Federal Communications Commission.

- All hand-delivered or messenger-delivered paper filings for the Commission's Secretary must be delivered to FCC Headquarters at 445 12th St., SW, Room TW-A325, Washington, DC 20554. The filing hours are 8:00 a.m. to 7:00 p.m. All hand deliveries must be held together with rubber bands or fasteners. Any envelopes and boxes must be disposed of before entering the building.
- Commercial overnight mail (other than U.S. Postal Service Express Mail and Priority Mail) must be sent to 9050 Junction Drive, Annapolis Junction, MD 20701.
- U.S. Postal Service first-class, Express, and Priority mail must be addressed to 445 12th Street, SW, Washington DC 20554.

95. *People with Disabilities.*—To request materials in accessible formats for people with disabilities (braille, large print, electronic files, audio format), send an e-mail to fcc504@fcc.gov or call the Consumer & Governmental Affairs Bureau at 202-418-0530 (voice), 202-418-0432 (TTY).

¹⁷⁷ 5 U.S.C. § 603.

¹⁷⁸ 5 U.S.C. § 603(a).

96. *Availability of Documents.*—Comments, reply comments, and ex parte submissions will be publicly available online via ECFS.¹⁷⁹ These documents will also be available for public inspection during regular business hours in the FCC Reference Information Center, which is located in Room CY-A257 at FCC Headquarters, 445 12th Street, SW, Washington, DC 20554. The Reference Information Center is open to the public Monday through Thursday from 8:00 a.m. to 4:30 p.m. and Friday from 8:00 a.m. to 11:30 a.m.

97. *Ex Parte Presentations.*—The proceedings shall be treated as “permit-but-disclose” proceedings in accordance with the Commission’s *ex parte* rules.¹⁸⁰ Persons making *ex parte* presentations must file a copy of any written presentation or a memorandum summarizing any oral presentation within two business days after the presentation (unless a different deadline applicable to the Sunshine period applies). Persons making oral *ex parte* presentations are reminded that memoranda summarizing the presentation must (1) list all persons attending or otherwise participating in the meeting at which the *ex parte* presentation was made, and (2) summarize all data presented and arguments made during the presentation. If the presentation consisted in whole or in part of the presentation of data or arguments already reflected in the presenter’s written comments, memoranda or other filings in the proceeding, the presenter may provide citations to such data or arguments in his or her prior comments, memoranda, or other filings (specifying the relevant page and/or paragraph numbers where such data or arguments can be found) in lieu of summarizing them in the memorandum. Documents shown or given to Commission staff during *ex parte* meetings are deemed to be written *ex parte* presentations and must be filed consistent with rule 1.1206(b). In proceedings governed by rule 1.49(f) or for which the Commission has made available a method of electronic filing, written *ex parte* presentations and memoranda summarizing oral *ex parte* presentations, and all attachments thereto, must be filed through the electronic comment filing system available for that proceeding, and must be filed in their native format (e.g., .doc, .xml, .ppt, searchable .pdf). Participants in these proceeding should familiarize themselves with the Commission’s *ex parte* rules.

98. *Additional Information.*—For additional information on this proceeding, contact Nicholas Oros, OET, Nicholas.Oros@fcc.gov (202) 418-0636; or Michael Ha, OET, Michael.Ha, (202) 418-2099.

V. ORDERING CLAUSES

99. IT IS ORDERED, pursuant to the authority found in Sections 4(i), 201, 302, and 303 of the Communications Act of 1934, as amended, 47 U.S.C. §§ 154(i), 201, 302a, 303, and Section 1.411 of the Commission’s Rules, 47 C.F.R § 1.411, that this *Notice of Proposed Rulemaking* IS HEREBY ADOPTED.

100. IT IS FURTHER ORDERED that NOTICE IS HEREBY GIVEN of the proposed regulatory changes described in this *Notice of Proposed Rulemaking*, and that comment is sought on these proposals.

101. IT IS FURTHER ORDERED that the Commission’s Consumer and Governmental Affairs Bureau, Reference Information Center, SHALL SEND a copy of this *Notice of Proposed Rulemaking*, including the Initial Regulatory Flexibility Analysis, to the Chief Counsel for Advocacy of the Small Business Administration.

FEDERAL COMMUNICATIONS COMMISSION

¹⁷⁹ Documents will generally be available electronically in ASCII, Microsoft Word, and/or Adobe Acrobat.

¹⁸⁰ 47 CFR §§ 1.1200 *et seq.*

Marlene H. Dortch
Secretary

APPENDIX A

Incumbent Analysis

1. The table below shows the number of call signs by service type in each of the four sub-bands.¹ Note that each call sign may represent multiple stations. For example, there may be multiple hops included in a fixed microwave link. Broadcast Auxiliary Service TV Pickup licenses allow an unlimited number of mobile transmitters to operate within a specified region, which operate under a single call sign.

U.S. Table of Allocations		5.925	6.425	6.525	6.7	6.875	7.025	7.075	7.125
		FIXED		FIXED	FIXED	FIXED	FIXED	FIXED	FIXED
		FSS (Earth-to-space)	FSS	FSS	FSS	FSS	FSS	FSS	FSS
			MOBILE				MOBILE		
		Part 15 Ultra Wideband							
Number of Incumbent Call Signs:		UNII-5 (500 MHz)	UNII-6 (100 MHz)	UNII-7 (350 MHz)	UNII-8 (250 MHz)				
Service Type	Radio Service								
Common Carrier	CF	14,530	4	3,050					
OFS	MG	7,654	43	7,357					
	MW	6,619	140	7,045					
	WA	-	-	4					
LTTS	CT	6	61	-				37	
BAS	AB	-	-	-				-	
	AI	-	-	-				1	
	AS	-	-	-				1	
	LP	-	-	-				-	
	LV	-	-	-				-	
	RP	-	-	-				-	
	TB	-	-	-				6	
	TI	-	1	-				2,928	
	TP	-	137	-				346	
	TS	-	-	-				1,646	
	TT	-	-	-				205	
CARS	CARS	-	24	-				21	
SAT	FSS (Earth-to-space)	1,464	20	27				6	
	FSS (space-to-Earth)	-	-	-				21	

AB	Aural Microwave Booster	MG	MW Industrial/Business Pool
AI	Aural Intercity Relay	MW	MW Public Safety Pool
AS	Aural Studio Tx Link	OFS	Operational Fixed Service
BAS	Broadcast Auxiliary Service	RP	Broadcast Auxiliary Remote Pickup
CARS	Cable Television Relay Service	TB	TV Microwave Booster
CF	Common Carrier Fxd P2P MW	TI	TV Intercity Relay
CT	Local Television Transmission	TP	TV Pickup
FSS	Fixed Satellite Service	TS	TV Studio Transmitter Link
LTTS	Local Television Transmission Service	TT	TV Translator Relay
LP	Broadcast Auxiliary Low Power	WA	Microwave Aviation
LV	Low Power Wireless Assist Video Devices		

¹ The table reflects unique call signs in each sub-band. A call sign associated with assignments in multiple sub-bands is counted once in each sub-band. A query of FCC databases showed the following numbers of unique call signs between 5.925 and 7.125 GHz: (1) Universal Licensing System (ULS); 46,168 call signs on June 22, 2018, (2) International Bureau Electronic Filing System (IBFS); 1,498 call signs on June 22, 2018 and Cable Operations and Licensing System (COALS); 29 call signs on June 25, 2018. Grandfathered receive earth stations are permitted within 300 meters of a) Brewster, WA (48° 08' 46.7" N, 119° 42' 8.0" W) in the 7.025-7.075 GHz band; and (b) Clifton TX (31° 47' 58.5" N, 97° 36' 46.7" W) and Finca Pascual, PR (17° 58' 41.8" N, 67° 8' 12.6 W) in the 7.025-7.055 GHz band. 47 CFR § 2.106 footnote NG172. Space-to-Earth stations are permitted in 6.700-7.075 GHz limited to feeder links for non-geostationary satellite systems of the MSS. 47 CFR § 2.106 footnote 5.458B. IBFS shows one FSS space-to-Earth earth station on vessel (ESV) call sign in the U-NII-5 band, however, since no waiver was given for a receive earth station in this band, it is not counted in this table.

APPENDIX B**Proposed Rules**

Part 15 of Title 47 of the Code of Federal Regulations is proposed to be amended as follows:

PART 15 – RADIO FREQUENCY DEVICES

The authority citation for Part 15 continues to read as follows:

AUTHORITY: 47 U.S.C. 154, 302a, 303, 304, 307, 336, 544a, and 549.

1. Amend section 15.401 to read as follows:

§ 15.401 Scope.

This subpart sets out the regulations for unlicensed National Information Infrastructure (U-NII) devices operating in the 5.15-5.35 GHz, 5.47-5.725 GHz, 5.725-5.85 GHz, 5.925-6.425 GHz, 6.425-6.525 GHz, 6.525-6.875 GHz, and 6.875-7.125 GHz bands.

2. Amend section 15.403 by redesignating paragraphs (b) through (e) as (c) through (f), redesignating paragraphs (f) through (s) as (h) through (u), and adding new paragraphs (b) and (g) to read as follows:

§ 15.403 Definitions.

(a) * * *

(b) *Automated Frequency Coordination (AFC)* is a system that automatically determines and provides lists of which frequencies are available for use by access points operating in the 5.925-6.425 GHz and 6.525-6.875 GHz bands.

* * * * *

(g) *Client Device.* A U-NII device whose transmissions are generally under the control of an access point and that is not capable of initiating a network.

* * * * *

3. Amend section 15.407 by redesignating paragraphs (a)(4) as (a)(7) and revising paragraph (a)(5) and redesignating as paragraph (a)(8), adding new paragraphs (a)(4), (5), and (6), redesignating paragraphs (b)(5) through (8) as (b)(6) through (9), adding new paragraph (b)(5), revising paragraph (d) and adding a new paragraph (k) as follows.

§ 15.407 General technical requirements.

(a) * * *

(4) For an access point operating in the 5.925-6.425 GHz and 6.525-6.875 GHz bands, the maximum conducted output power over the frequency band of operation shall not exceed 1 W, provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

(5) For an access point operating in the 6.425-6.525 GHz, and 6.875-7.125 GHz bands, the maximum conducted output power over the frequency band of operation shall not exceed 250 mW, provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 11 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

(6) For client devices in the 5.925-6.425 GHz, 6.425-6.525 GHz, 6.525-6.875 GHz, and 6.875-7.125 GHz bands, the maximum conducted output power over the frequency band of operation shall not exceed 63 mW provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 5 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

* * * * *

(8) The maximum power spectral density is measured as a conducted emission by direct connection of a calibrated test instrument to the equipment under test. If the device cannot be connected directly, alternative techniques acceptable to the Commission may be used. Measurements in the 5.725-5.85 GHz band are made for a reference bandwidth of 500 kHz or the 26 dB emission bandwidth of the device, whichever is less. Measurements in the 5.15-5.25 GHz, 5.25-5.35 GHz, 5.47-5.725 GHz, 5.925-6.425 GHz, 6.425-6.525 GHz, 6.525-6.875 GHz, and 6.875-7.125 GHz bands are made for a reference bandwidth of 1 megahertz or the 26 dB emission bandwidth of the device, whichever is less. A narrower resolution bandwidth can be used, provided that the measured power is integrated over the full reference bandwidth.

(b) * * *

(5) For transmitters operating within the 5.925-7.125 GHz band: All emissions outside of the 5.925-7.125 GHz band shall not exceed an e.i.r.p. of -27 dBm/MHz.

* * * * *

(d) *Operational restrictions.*

(1) Operation of access points in the 5.925-6.425 GHz, 6.425-6.525 GHz, 6.525-6.875 GHz and 6.875-7.125 GHz bands is prohibited in moving vehicles such as cars, trains, and aircraft.

(2) Operation in the 5.925-6.425 GHz, 6.425-6.525 GHz, 6.525-6.875 GHz and 6.875-7.125 GHz bands is prohibited for control of or communications with unmanned aircraft systems.

(3) Operation in the 6.425-6.525 GHz and 6.875-7.125 GHz bands is limited to indoor locations.

* * * * *

(k) *Automated frequency coordination (AFC).*

(1) Access points operating in the 5.925-6.425 GHz and 6.525-6.875 GHz bands shall access an AFC system to determine the available frequencies at their geographic coordinates prior to transmitting. Access points may transmit only on frequencies indicated as being available by an AFC system.

(2) An AFC system shall obtain information on protected services within the 5.925-6.425 GHz and 6.525-6.875 GHz bands from Commission databases and use that information to determine frequency availability for access points based on protection criteria specified by the Commission.

(3) An AFC system operator will be designated for a five-year term which can be renewed by the Commission based on the operator's performance during the term. If an AFC system ceases operation, it must provide at least 30-days' notice to the Commission and transfer any registration data to another AFC system operator.

(4) An AFC system operator may charge fees for providing registration and channel availability functions.

APPENDIX C

Initial Regulatory Flexibility Analysis

1. As required by the Regulatory Flexibility Act (RFA) of 1980, as amended,¹ the Commission has prepared this present Initial Regulatory Flexibility Analysis (IRFA) of the possible significant economic impact on a substantial number of small entities by the policies and rules proposed in this Notice of Proposed Rulemaking (NPRM). Written public comments are requested on this IRFA. Comments must be identified as responses to the IRFA and must be filed by the deadlines for comments as specified in the NPRM. The Commission will send a copy of the NPRM, including this IRFA, to the Chief Counsel for Advocacy of the Small Business Administration (SBA).² In addition, the NPRM and IRFA (or summaries thereof) will be published in the Federal Register.³

A. Need for, and Objectives of, the Proposed Rules

2. In this NPRM, the Commission proposes to expand unlicensed use of the 5.925-7.125 GHz (6 GHz) band under our Part 15 rules. The Commission focuses on unlicensed use of this band due to the band's proximity to the Unlicensed National Information Infrastructure (U-NII) bands, which have hosted extensive unlicensed device innovation and deployment. The proposed rules are intended to provide an opportunity for devices such as smartphones, Wi-Fi routers, and IoT devices to be economically designed to operate across both the 6 GHz and the U-NII bands. We are encouraged by the fact that the 6 GHz band shares virtually identical propagation properties to the U-NII bands, which have proven suitable for many unlicensed applications.

3. The rules the Commission proposes in this NPRM are designed to protect important incumbent licensed services that operate (and continue to grow) in various sub-bands of this spectrum. Under the proposed rules, the Commission believes that unlicensed use of the band would be compatible with these incumbent licensed services. To do this, the Commission proposes to divide the 6 GHz band into four sub-bands based on the prevalence and characteristics of the incumbent services that operate in that spectrum. Unlicensed access points under the proposed rules would fall into two categories depending on the sub-bands in which they would operate:

- *5.925-6.425 GHz sub-band and 6.525-6.875 GHz sub-band (totaling 850 megahertz)* – unlicensed operations at the power levels permitted for unlicensed use in the U-NII-1 & -3 bands⁴—referenced herein as “standard-power access points”—with the operating frequencies determined by an automated frequency control (AFC) mechanism that protects the incumbent services in this spectrum from harmful interference; and
- *6.425-6.525 GHz sub-band and 6.875-7.125 GHz sub-band (totaling 350 megahertz)* – unlicensed operations at the lower more restricted power levels applicable to operations in the U-NII-2 bands⁵—referenced herein as “low-power access points”— limited to indoor operation (with no AFC requirement) to prevent harmful interference to the incumbent services in this spectrum.

¹ See 5 U.S.C. § 603. The RFA, *see* 5 U.S.C. §§ 601-612, has been amended by the Small Business Regulatory Enforcement Fairness Act of 1996, (SBREFA) Pub. L. No. 104-121, Title II, 110 Stat. 857 (1996).

² See 5 U.S.C. § 603(a).

³ See 5 U.S.C. § 603(a).

⁴ The U-NII-1 band is the 5.15-5.25 GHz band, while the U-NII-3 band is the 5.725-5.85 GHz band. *Revision of Part 15 of the Commission's Rules to Permit Unlicensed National Information Infrastructure (U-NII) Devices in the 5 GHz Band*, First Report and Order, 29 FCC Rcd 4127, 4128-4129, para. 4 (2014).

⁵ The U-NII-2 bands include the 5.25-5.35 GHz (U-NII-2A) and 5.47-5.725 GHz (U-NII-2C) bands. *Id.*

In addition, the proposed rules would permit client devices to operate across the entire 6 GHz band while under the control of either a standard-power access point or a low-power access point. This two-class approach can expand unlicensed use of the spectrum without causing harmful interference to the incumbent services that will continue to be authorized to use this spectrum.

4. The 5.925-6.425 GHz and 6.525-6.875 GHz sub-bands are predominantly used by fixed point-to-point microwave links and by the fixed-satellite service (FSS) for Earth-to-space transmissions. To protect the microwave links from harmful interference, the proposed rules would require that the standard-power access point obtain a list of frequencies upon which they may transmit from an AFC system. The AFC system would use information about the microwave links in the Commission's licensing database along with the location of the unlicensed standard-power access point to determine exclusion zones where the standard-power access point may not operate. To ensure that the AFC system would receive an accurate location of the unlicensed device, the NPRM seeks comment on whether to require that standard-power access points be professionally installed. Because the FSS in these sub-bands transmits in the Earth-to-space direction, the AFC system would not need to protect the satellite earth stations from interference from the unlicensed devices. However, the NPRM seeks comment on the potential for the satellite receivers to receive harmful interference due to the aggregate transmissions from unlicensed devices operating in these sub-bands.

5. The 6.425-6.525 GHz and 6.875-7.125 GHz sub-bands are used for mobile stations in the Broadcast Auxiliary Service and the Cable Television Relay Service as well as fixed point-to-point microwave links. Because these sub-bands have mobile operations, an AFC system would not be able to determine exclusion zones to protect all of these services. Instead, the proposed rules would allow the unlicensed operations at a lower power level and restrict their operations to indoors to prevent harmful interference to the services operating in these sub-bands.

6. Under the proposed rules the client devices would only be allowed to transmit under the control of a standard-power access point or low-power access point, depending on which sub-band they operate in, and would be restricted to operation at an even lower power than the low-power access point.

B. Legal Basis

7. The proposed action is authorized pursuant to Sections 4(i), 201, 302, and 303 of the Communications Act of 1934, as amended, 47 U.S.C. §§ 154(i), 201, 302a, 303.

C. Description and Estimate of the Number of Small Entities to Which the Proposed Rules Will Apply

8. The RFA directs agencies to provide a description of, and, where feasible, an estimate of the number of small entities that may be affected by the proposed rules and policies, if adopted.⁶ The RFA generally defines the term "small entity" as having the same meaning as the terms "small business," "small organization," and "small governmental jurisdiction."⁷ In addition, the term "small business" has the same meaning as the term "small business concern" under the Small Business Act.⁸ A "small

⁶ 5 U.S.C. § 603(b)(3).

⁷ 5 U.S.C. § 601(6).

⁸ 5 U.S.C. § 601(3) (incorporating by reference the definition of "small-business concern" in the Small Business Act, 15 U.S.C. § 632). Pursuant to 5 U.S.C. § 601(3), the statutory definition of a small business applies "unless an agency, after consultation with the Office of Advocacy of the Small Business Administration and after opportunity for public comment, establishes one or more definitions of such term which are appropriate to the activities of the agency and publishes such definition(s) in the Federal Register."

business concern” is one which: (1) is independently owned and operated; (2) is not dominant in its field of operation; and (3) satisfies any additional criteria established by the SBA.⁹

9. *Small Businesses, Small Organizations, Small Governmental Jurisdictions.* Our actions, over time, may affect small entities that are not easily categorized at present. We therefore describe here, at the outset, three broad groups of small entities that could be directly affected herein.¹⁰ First, while there are industry specific size standards for small businesses that are used in the regulatory flexibility analysis, according to data from the SBA’s Office of Advocacy, in general a small business is an independent business having fewer than 500 employees.¹¹ These types of small businesses represent 99.9% of all businesses in the United States which translates to 28.8 million businesses.¹²

10. Next, the type of small entity described as a “small organization” is generally “any not-for-profit enterprise which is independently owned and operated and is not dominant in its field.”¹³ Nationwide, as of August 2016, there were approximately 356,494 small organizations based on registration and tax data filed by nonprofits with the Internal Revenue Service (IRS).¹⁴

11. Finally, the small entity described as a “small governmental jurisdiction” is defined generally as “governments of cities, counties, towns, townships, villages, school districts, or special districts, with a population of less than fifty thousand.”¹⁵ U.S. Census Bureau data from the 2012 Census of Governments¹⁶ indicate that there were 90,056 local governmental jurisdictions consisting of general purpose governments and special purpose governments in the United States.¹⁷ Of this number there were 37,132 General purpose governments (county,¹⁸ municipal and town or township¹⁹) with populations of

⁹ 15 U.S.C. § 632.

¹⁰ See 5 U.S.C. § 601(3)-(6).

¹¹ See SBA, Office of Advocacy, “Frequently Asked Questions, Question 1 – What is a small business?” https://www.sba.gov/sites/default/files/advocacy/SB-FAQ-2016_WEB.pdf (June 2016).

¹² See SBA, Office of Advocacy, “Frequently Asked Questions, Question 2- How many small businesses are there in the U.S.?” https://www.sba.gov/sites/default/files/advocacy/SB-FAQ-2016_WEB.pdf (June 2016).

¹³ 5 U.S.C. § 601(4).

¹⁴ Data from the Urban Institute, National Center for Charitable Statistics (NCCS) reporting on nonprofit organizations registered with the IRS was used to estimate the number of small organizations. Reports generated using the NCCS online database indicated that as of August 2016 there were 356,494 registered nonprofits with total revenues of less than \$100,000. Of this number, 326,897 entities filed tax returns with 65,113 registered nonprofits reporting total revenues of \$50,000 or less on the IRS Form 990-N for Small Exempt Organizations and 261,784 nonprofits reporting total revenues of \$100,000 or less on some other version of the IRS Form 990 within 24 months of the August 2016 data release date. See <http://nccs.urban.org/sites/all/nccs-archive/html/tablewiz/tw.php> where the report showing this data can be generated by selecting the following data fields: Report: “The Number and Finances of All Registered 501(c) Nonprofits”; Show: “Registered Nonprofits”; By: “Total Revenue Level (years 1995, Aug to 2016, Aug)”; and For: “2016, Aug” then selecting “Show Results”.

¹⁵ 5 U.S.C. § 601(5).

¹⁶ See 13 U.S.C. § 161. The Census of Government is conducted every five (5) years compiling data for years ending with “2” and “7.” See also Program Description Census of Government <https://factfinder.census.gov/faces/affhelp/jsf/pages/metadata.xhtml?lang=en&type=program&id=program.en.CO G#>.

¹⁷ See U.S. Census Bureau, 2012 Census of Governments, Local Governments by Type and State: 2012 - United States-States. <https://factfinder.census.gov/bkmk/table/1.0/en/COG/2012/ORG02.US01>. Local governmental jurisdictions are classified in two categories - General purpose governments (county, municipal and town or township) and Special purpose governments (special districts and independent school districts).

¹⁸ See U.S. Census Bureau, 2012 Census of Governments, County Governments by Population-Size Group and State: 2012 - United States-States. <https://factfinder.census.gov/bkmk/table/1.0/en/COG/2012/ORG06.US01>. There were 2,114 county governments with populations less than 50,000.

less than 50,000 and 12,184 Special purpose governments (independent school districts²⁰ and special districts²¹) with populations of less than 50,000. The 2012 U.S. Census Bureau data for most types of governments in the local government category show that the majority of these governments have populations of less than 50,000.²² Based on this data we estimate that at least 49,316 local government jurisdictions fall in the category of “small governmental jurisdictions.”²³

12. *Fixed Microwave Services.* Microwave services include common carrier,²⁴ private-operational fixed,²⁵ and broadcast auxiliary radio services.²⁶ They also include the Upper Microwave Flexible Use Service,²⁷ Millimeter Wave Service,²⁸ Local Multipoint Distribution Service (LMDS),²⁹ the Digital Electronic Message Service (DEMS),³⁰ and the 24 GHz Service,³¹ where licensees can choose between common carrier and non-common carrier status.³² At present, there are approximately 66,680 common carrier fixed licensees, 69,360 private and public safety operational-fixed licensees, 20,150 broadcast auxiliary radio licensees, 411 LMDS licenses, 33 24 GHz DEMS licenses, 777 39 GHz

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¹⁹ See U.S. Census Bureau, 2012 Census of Governments, Subcounty General-Purpose Governments by Population-Size Group and State: 2012 - United States – States.

<https://factfinder.census.gov/bkmk/table/1.0/en/COG/2012/ORG07.US01>. There were 18,811 municipal and 16,207 town and township governments with populations less than 50,000.

²⁰ See U.S. Census Bureau, 2012 Census of Governments, Elementary and Secondary School Systems by Enrollment-Size Group and State: 2012 - United States-States.

<https://factfinder.census.gov/bkmk/table/1.0/en/COG/2012/ORG11.US01>. There were 12,184 independent school districts with enrollment populations less than 50,000.

²¹ See U.S. Census Bureau, 2012 Census of Governments, Special District Governments by Function and State: 2012 - United States-States. <https://factfinder.census.gov/bkmk/table/1.0/en/COG/2012/ORG09.US01>. [The U.S. Census Bureau data did not provide a population breakout for special district governments.](#)

²² See U.S. Census Bureau, 2012 Census of Governments, County Governments by Population-Size Group and State: 2012 - United States-States - <https://factfinder.census.gov/bkmk/table/1.0/en/COG/2012/ORG06.US01>; Subcounty General-Purpose Governments by Population-Size Group and State: 2012 - United States-States - <https://factfinder.census.gov/bkmk/table/1.0/en/COG/2012/ORG07.US01>; and Elementary and Secondary School Systems by Enrollment-Size Group and State: 2012 - United States-States. <https://factfinder.census.gov/bkmk/table/1.0/en/COG/2012/ORG11.US01>. [While U.S. Census Bureau data did not provide a population breakout for special district governments, if the population of less than 50,000 for this category of local government is consistent with the other types of local governments the majority of the 38, 266 special district governments have populations of less than 50,000.](#)

²³ *Id.*

²⁴ See 47 CFR Part 101, Subparts C and I.

²⁵ See 47 CFR Part 101, Subparts C and H.

²⁶ Auxiliary Microwave Service is governed by Part 74 of Title 47 of the Commission’s Rules. See 47 CFR Part 74. Available to licensees of broadcast stations and to broadcast and cable network entities, broadcast auxiliary microwave stations are used for relaying broadcast television signals from the studio to the transmitter, or between two points such as a main studio and an auxiliary studio. The service also includes mobile TV pickups, which relay signals from a remote location back to the studio.

²⁷ See 47 CFR Part 30.

²⁸ See 47 CFR Part 101, Subpart Q.

²⁹ See 47 CFR Part 101, Subpart L.

³⁰ See 47 CFR Part 101, Subpart G.

³¹ See *id.*

³² See 47 CFR §§ 101.533, 101.1017.

licenses, and five 24 GHz licenses, and 467 Millimeter Wave licenses in the microwave services.³³ The Commission has not yet defined a small business with respect to microwave services. The closest applicable SBA category is Wireless Telecommunications Carriers (except Satellite) and the appropriate size standard for this category under SBA rules is that such a business is small if it has 1,500 or fewer employees.³⁴ For this industry, U.S. Census data for 2012 show that there were 967 firms that operated for the entire year.³⁵ Of this total, 955 firms had employment of 999 or fewer employees and 12 had employment of 1000 employees or more.³⁶ Thus, under this SBA category and the associated size standard, the Commission estimates that a majority of fixed microwave service licensees can be considered small.

13. *Public Safety Radio Licensees.* As a general matter, Public Safety Radio Pool licensees include police, fire, local government, forestry conservation, highway maintenance, and emergency medical services.³⁷ Because of the vast array of public safety licensees, the Commission has not developed a small business size standard specifically applicable to public safety licensees. The closest applicable SBA category is Wireless Telecommunications Carriers (except Satellite) which encompasses business entities engaged in radiotelephone communications. The appropriate size standard for this category under SBA rules is that such a business is small if it has 1,500 or fewer employees.³⁸ For this industry, U.S. Census data for 2012 show that there were 967 firms that operated for the entire year.³⁹ Of this total, 955 firms had employment of 999 or fewer employees and 12 had employment of 1000 employees or more.⁴⁰ Thus, under this category and the associated size standard, the Commission estimates that the majority of firms can be considered small. With respect to local governments, in particular, since many governmental entities comprise the licensees for these services, we include under public safety services the number of government entities affected. According to Commission records, there are a total of approximately 133,870 licenses within these services.⁴¹ There are 3,121 licenses in the

³³ These statistics are based on a review of the Universal Licensing System on September 22, 2015.

³⁴ See 13 CFR § 121.201, NAICS code 517312.

³⁵ U.S. Census Bureau, *2012 Economic Census of the United States*, Table EC1251SSSZ5, Information: Subject Series, “Estab and Firm Size: Employment Size of Firms for the U.S.: 2012 NAICS Code 517210” (rel. Jan. 8, 2016). https://factfinder.census.gov/bkmk/table/1.0/en/ECN/2012_US/51SSSZ5//naics~517210.

³⁶ *Id.* Available census data do not provide a more precise estimate of the number of firms that have employment of 1,500 or fewer employees; the largest category provided is for firms with “1000 employees or more.”

³⁷ See subparts A and B of Part 90 of the Commission’s Rules, 47 C.F.R. §§ 90.1-90.22. Police licensees serve state, county, and municipal enforcement through telephony (voice), telegraphy (code), and teletype and facsimile (printed material). Fire licensees are comprised of private volunteer or professional fire companies, as well as units under governmental control. Public Safety Radio Pool licensees also include state, county, or municipal entities that use radio for official purposes. State departments of conservation and private forest organizations comprise forestry service licensees that set up communications networks among fire lookout towers and ground crews. State and local governments are highway maintenance licensees that provide emergency and routine communications to aid other public safety services to keep main roads safe for vehicular traffic. Emergency medical licensees use these channels for emergency medical service communications related to the delivery of emergency medical treatment. Additional licensees include medical services, rescue organizations, veterinarians, persons with disabilities, disaster relief organizations, school buses, beach patrols, establishments in isolated areas, communications standby facilities, and emergency repair of public communications facilities.

³⁸ See 13 CFR § 121.201, NAICS code 517312.

³⁹ U.S. Census Bureau, *2012 Economic Census of the United States*, Table EC1251SSSZ5, Information: Subject Series: Estab and Firm Size: Employment Size of Firms for the U.S.: 2012 NAICS Code 517210 (rel. Jan. 8, 2016). https://factfinder.census.gov/bkmk/table/1.0/en/ECN/2012_US/51SSSZ5//naics~517210.

⁴⁰ *Id.* Available census data do not provide a more precise estimate of the number of firms that have employment of 1,500 or fewer employees; the largest category provided is for firms with “1000 employees or more.”

⁴¹ This figure was derived from Commission licensing records as of June 27, 2008. Licensing numbers change on a daily basis. We do not expect this number to be significantly smaller today. This does not indicate the number of

4.9 GHz band, based on an FCC Universal Licensing System search of March 29, 2017.⁴² We estimate that fewer than 2,442 public safety radio licensees hold these licenses because certain entities may have multiple licenses.

14. *Satellite Telecommunications.* This category comprises firms “primarily engaged in providing telecommunications services to other establishments in the telecommunications and broadcasting industries by forwarding and receiving communications signals via a system of satellites or reselling satellite telecommunications.”⁴³ Satellite telecommunications service providers include satellite and earth station operators. The category has a small business size standard of \$32.5 million or less in average annual receipts, under SBA rules.⁴⁴ For this category, U.S. Census Bureau data for 2012 show that there were a total of 333 firms that operated for the entire year.⁴⁵ Of this total, 299 firms had annual receipts of less than \$25 million.⁴⁶ Consequently, we estimate that the majority of satellite telecommunications providers are small entities.

15. *Wireless Telecommunications Carriers (except Satellite).* This industry comprises establishments engaged in operating and maintaining switching and transmission facilities to provide communications via the airwaves. Establishments in this industry have spectrum licenses and provide services using that spectrum, such as cellular services, paging services, wireless Internet access, and wireless video services.⁴⁷ The appropriate size standard under SBA rules is that such a business is small if it has 1,500 or fewer employees.⁴⁸ For this industry, U.S. Census Bureau data for 2012 show that there were 967 firms that operated for the entire year.⁴⁹ Of this total, 955 firms had employment of 999 or fewer employees and 12 had employment of 1000 employees or more.⁵⁰ Thus, under this category and the associated size standard, the Commission estimates that the majority of wireless telecommunications carriers (except satellite) are small entities.

16. The Commission’s own data—available in its Universal Licensing System—indicate that,

(Continued from previous page) _____

licensees, as licensees may hold multiple licenses. There is no information currently available about the number of public safety licensees that have less than 1,500 employees.

⁴² Based on an FCC Universal Licensing System search of March 29, 2017. Search parameters: Radio Service = PA – Public Safety 4940-4990 MHz Band; Authorization Type = Regular; Status = Active.

⁴³ U.S. Census Bureau, 2017 NAICS Definitions, “517410 Satellite Telecommunications”; <https://www.census.gov/cgi-bin/sssd/naics/naicsrch?input=517410&search=2017+NAICS+Search&search=2017>.

⁴⁴ 13 CFR § 121.201, NAICS code 517410.

⁴⁵ U.S. Census Bureau, *2012 Economic Census of the United States*, Table EC1251SSSZ4, Information: Subject Series - Estab and Firm Size: Receipts Size of Firms for the United States: 2012, NAICS code 517410 https://factfinder.census.gov/bkmk/table/1.0/en/ECN/2012_US/51SSSZ4//naics~517410.

⁴⁶ *Id.*

⁴⁷ U.S. Census Bureau, 2012 NAICS Definitions, “517210 Wireless Telecommunications Carriers (Except Satellite),” See <https://factfinder.census.gov/faces/affhelp/jsf/pages/metadata.xhtml?lang=en&type=ib&id=ib.en./ECN.NAICS2012.517210>.

⁴⁸ 13 CFR § 121.201, NAICS code 517312.

⁴⁹ U.S. Census Bureau, *2012 Economic Census of the United States*, Table EC1251SSSZ5, Information: Subject Series: Estab and Firm Size: Employment Size of Firms for the U.S.: 2012 NAICS Code 517210. https://factfinder.census.gov/bkmk/table/1.0/en/ECN/2012_US/51SSSZ5//naics~517210.

⁵⁰ *Id.* Available census data does not provide a more precise estimate of the number of firms that have employment of 1,500 or fewer employees; the largest category provided is for firms with “1000 employees or more.”

as of May 17, 2018, there are 264 Cellular licensees.⁵¹ The Commission does not know how many of these licensees are small, as the Commission does not collect that information for these types of entities. Similarly, according to internally developed Commission data, 413 carriers reported that they were engaged in the provision of wireless telephony, including cellular service, Personal Communications Service (PCS), and Specialized Mobile Radio (SMR) Telephony services.⁵² Of this total, an estimated 261 have 1,500 or fewer employees, and 152 have more than 1,500 employees.⁵³ Thus, using available data, we estimate that the majority of wireless firms can be considered small.

17. *Auxiliary, Special Broadcast and Other Program Distribution Services.* This service involves a variety of transmitters, generally used to relay broadcast programming to the public (through translator and booster stations) or within the program distribution chain (from a remote news gathering unit back to the station). Neither the SBA nor the Commission has developed a size standard applicable to broadcast auxiliary licensees. The closest applicable SBA category and small business size standard falls under Radio Stations and Television Broadcasting.⁵⁴ U.S. Census Bureau data for 2012 show that 2,849 radio station firms operated during that year.⁵⁵ Of that number, 2,806 firms operated with annual receipts of less than \$25 million per year, 17 with annual receipts between \$25 million and \$49,999,999 million and 26 with annual receipts of \$50 million or more.⁵⁶ For Television Broadcasting the SBA small business size standard is such businesses having \$38.5 million or less in annual receipts.⁵⁷ U.S. Census Bureau data show that 751 firms in this category operated in that year.⁵⁸ Of that number, 656 had annual receipts of \$25,000,000 or less, 25 had annual receipts between \$25,000,000 and \$49,999,999 and 70 had annual receipts of \$50,000,000 or more.⁵⁹ Accordingly, based on the U.S. Census Bureau data for Radio Stations and Television Broadcasting, the Commission estimates that the majority of Auxiliary, Special Broadcast and Other Program Distribution Services firms are small.

18. *Fixed Satellite Transmit/Receive Earth Stations.* Neither the SBA nor the Commission has developed a size standard specifically applicable to Fixed Satellite Transmit/Receive Earth Stations. The closest applicable category and SBA size standard is for Satellite Telecommunications which has a small business size standard of \$32.5 million or less in average annual receipts.⁶⁰ For this category, U.S.

⁵¹ See <http://wireless.fcc.gov/uls>. For the purposes of this IRFA, consistent with Commission practice for wireless services, the Commission estimates the number of licensees based on the number of unique FCC Registration Numbers.

⁵² See Federal Communications Commission, Wireline Competition Bureau, Industry Analysis and Technology Division, Trends in Telephone Service at Table 5.3 (Sept. 2010) (*Trends in Telephone Service*), https://apps.fcc.gov/edocs_public/attachmatch/DOC-301823A1.pdf.

⁵³ See *id.*

⁵⁴ 13 C.F.R. 121.201, NAICS codes 515112 and 515120.

⁵⁵ U.S. Census Bureau, Table No. EC1251SSSZ4, *Information: Subject Series – Establishment and Firm Size: Receipts Size of Firms for the United States: 2012* NAICS Code 515112, https://factfinder.census.gov/bkmk/table/1.0/en/ECN/2012_US/51SSSZ4/naics~515112.

⁵⁶ *Id.*

⁵⁷ 13 C.F.R. § 121.201; 2012 NAICS code 515120.

⁵⁸ U.S. Census Bureau, Table No. EC1251SSSZ4, *Information: Subject Series - Establishment and Firm Size: Receipts Size of Firms for the United States: 2012* (515120 Television Broadcasting), https://factfinder.census.gov/bkmk/table/1.0/en/ECN/2012_US/51SSSZ4/naics~515120.

⁵⁹ *Id.*

⁶⁰ 13 CFR § 121.201, NAICS code 517410.

Census Bureau data for 2012 show that there were a total of 333 firms that operated for the entire year.⁶¹ Of this total, 299 firms had annual receipts of less than \$25 million.⁶² Thus, under this category and the associated size standard, the Commission estimates that the majority of Fixed Satellite Transmit/Receive Earth Station licensees are small entities. There are approximately 4,303 earth station authorizations, a portion of which are Fixed Satellite Transmit/Receive Earth Stations. We do not request nor collect annual revenue information and are therefore unable to estimate the number of earth stations that would constitute a small business under the SBA definition. However, the majority of these stations could be impacted by our actions.

D. Description of Projected Reporting, Recordkeeping, and other Compliance Requirements for Small Entities

19. We expect that all the filing, recordkeeping and reporting requirements associated with the proposed rules would be the same for large and small businesses; however, we seek comment on any steps that could be taken to minimize any significant economic impact on small businesses. The proposed rules would require that standard-power access points use an AFC system to obtain a list of frequencies upon which they may operate. However, we believe that this rulemaking, by expanding the availability of unlicensed devices in the 6 GHz band, would provide an advantage to small entities, as these entities would benefit from being able to access this spectrum without the complication or cost of needing to obtain a license. On balance, this would constitute a significant benefit for small businesses.

E. Steps Taken to Minimize the Significant Economic Impact on Small Entities, and Significant Alternatives Considered

20. The RFA requires an agency to describe any significant, specifically small business, alternatives that it has considered in reaching its approach, which may include the following four alternatives (among others): “(1) the establishment of differing compliance or reporting requirements or timetables that take into account the resources available to small entities; (2) the clarification, consolidation, or simplification of compliance or reporting requirements under the rule for small entities; (3) the use of performance, rather than design, standards; and (4) an exemption from coverage of the rule, or any part thereof, for small entities.”⁶³

21. The reporting, recordkeeping, and other compliance requirements of the rules proposed in the NPRM would apply to all entities in the same manner. The Commission believes that applying the same rules equally to all entities in this context promotes fairness. The Commission does not believe that the costs and/or administrative burdens associated with the proposed rules would unduly burden small entities. The rules the Commission adopts should benefit small entities by giving them more options for gaining access to valuable wireless spectrum. We seek comment on whether any of burdens of the proposed rules can be further minimized for small businesses.

22. Many of the entities holding licenses for use of the 6 GHz band qualify as small entities. The proposed rules for unlicensed operation in this band are designed to prevent the unlicensed devices from causing harmful interference to the licensed services operating in the band. Consequently, we do not expect that the current and future licensees in the band, including small entities, would experience a significant economic impact from additional unlicensed use of the spectrum that would be permitted under the proposed rules.

23. Because users of devices operating under our Part 15 rules do not need to obtain a Commission license, we expect that small entities would find the unlicensed use of the 6 GHz bands

⁶¹ U.S. Census Bureau, *2012 Economic Census of the United States*, Table EC1251SSSZ4, Information: Subject Series - Estab and Firm Size: Receipts Size of Firms for the United States: 2012, NAICS code 517410 https://factfinder.census.gov/bkmk/table/1.0/en/ECN/2012_US/51SSSZ4//naics~517410.

⁶² *Id.*

⁶³ 5 U.S.C. § 604(a)(6).

under the proposed rules convenient and economical. In proposing these rules, we have sought to minimize the compliance burden to both small and large entities. For example, the proposed rules would allow for the deployment of low-power access point that do not require use of an AFC system in two sub-bands to provide an opportunity for deployment of unlicensed devices at lower cost in those portions of the spectrum where the current licensed uses make this practical.

F. Federal Rules that May Duplicate, Overlap, or Conflict with the Proposed Rules

24. None.

**STATEMENT OF
CHAIRMAN AJIT PAI**

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

If I asked you for 1989's great accomplishments, you might say the fall of the Berlin Wall, the launch of the Batman film series, and the beginning of the 2.4 and 5 GHz unlicensed bands . . . in that order.

And in the last three decades, unlicensed devices have proliferated (as have Batman movies). From Wi-Fi routers to connected home appliances to retro cordless phones for those of us who still have landlines, we use devices that connect via unlicensed spectrum every day. Indeed, they've become so popular that there is now a shortage of airwaves dedicated for their use.

So today, we address this problem by proposing to open up 1,200 megahertz of spectrum in the 6 GHz band for different types of unlicensed uses. And we seek to do so in a way that will protect incumbent licensed operations in the band.

This decision will help us meet the mandate set forth in RAY BAUM'S Act to make more spectrum available for unlicensed use. It is also part of our aggressive and balanced spectrum strategy: pushing more licensed and unlicensed spectrum into the commercial marketplace and including a mix of low-band, mid-band, and high-band spectrum. And with the massive amount of wireless traffic that is off-loaded to Wi-Fi, opening up this wide swath of spectrum for unlicensed use could be a big boost to our nation's 5G future.

We look forward to compiling a robust record and then acting quickly to make more 6 GHz spectrum available for unlicensed uses. Indeed, I'm optimistic that we should be able to get the job done before the next Batman movie is released.

Thanks to the staff who worked on this item. In particular, thanks to Bahman Badipour, Brian Butler, Rashmi Doshi, David Duarte, Michael Ha, Ira Keltz, Julie Knapp, Paul Murray, Nicholas Oros, Aspasia Paroutsas, Barbara Pavon, Siobahn Philemon, Jamison Prime, Karen Rackley, Hugh Van Tuyl, and Aole Wilkins El from the Office of Engineering and Technology; John Evanoff, David Furth, Lauren Kravetz, and Michael Wilhelm from the Public Safety and Homeland Security Bureau; Jose Albuquerque, Christopher Bair, and Jennifer Gilsenan from the International Bureau; Chris Andes, Stephen Buenzow, Lloyd Coward, Peter Daronco, Thomas Derenge, Ariel Diamond, Charles Mathias, Aalok Mehta, Roger Noel, Charles Oliver, Matthew Pearl, Paul Powell, Blaise Scinto, Jeffrey Tignor, Brian Wondrack, and Stephen Zak from the Wireless Telecommunications Bureau; Thomas Horan, John Wong, and Sean Yun from the Media Bureau; Maura McGowan from the Office of Communications Business Opportunities; and David Horowitz, Keith McCrickard, and Bill Richardson from the Office of General Counsel.

**STATEMENT OF
COMMISSIONER MICHAEL O'RIELLY**

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

Many people tout particular technologies and/or economic studies showing the value of new use cases to support allocating additional unlicensed spectrum. But, I have never focused intently on such points. While informative, I tend to agree with a previously quoted former employer that the beauty of unlicensed spectrum is that no one can predict what American innovators and creative geniuses will think up next. It's really up to them to turn our efforts into products, services, and endless possibilities for the benefit of our people.

Further, it is undisputed that the exponential growth of wireless data, especially over unlicensed networks, has led to severe congestion in our highly-prized unlicensed spectrum bands, primarily 2.4 and 5 GHz. Consider that total U.S. Internet traffic is estimated to increase three-fold between 2016 and 2021, and Wi-Fi networks will grow to carry almost 52 percent of this traffic.¹ For these reasons, I pushed early in my term to make additional bands available to the unlicensed community – a view also shared by Congress, including in the enacted MOBILE NOW Act. Accordingly, I was one of the first voices to advocate for allowing unlicensed use in 6 GHz and supporters have been able to cajole skeptics to jump on board and help move this Notice forward.

To be clear, this is a prime location for unlicensed services for multiple reasons, but particularly because it is adjacent to 5 GHz and compliments the forthcoming clearing efforts in the C-band downlink band (3.7-4.2 GHz). Moreover, studies in the record demonstrate that unlicensed spectrum at 6 GHz can likely be done without causing harmful interference to existing incumbents. Now, if we could only open up the 5.9 GHz Band for unlicensed use as well, for which I believe there are four solid votes in favor, we would really be on to something special, as it's the missing link between the 5 GHz and 6 GHz bands.

Since today's Notice takes a giant step to open a large swath of spectrum needed for increased capacity, higher speeds, and lower latency for unlicensed 5G or technologies not yet envisioned, it has my full support. I look forward to exploring the issues raised in it, including the best means to protect incumbents from harmful interference. I thank the Chairman for bringing this to a long-awaited vote and all my colleagues for agreeing to add questions at my request, such as those pertaining to low-power indoor use in the newly-minted UNII-5 and UNII-7 bands, including seeking comment on permitting such operations without an automatic frequency coordinator, and the use of portable devices. I know these ideas, and many others in the Notice, may raise initial concern from some, but these are discussions that need to be had and everyone will have an opportunity to express their views.

¹ Cisco, VNI Forecast Highlights Tool, United States, 2021 Forecast Highlights, https://www.cisco.com/c/m/en_us/solutions/service-provider/vni-forecast-highlights.html# (last visited Oct. 23, 2018).

**STATEMENT OF
COMMISSIONER BRENDAN CARR**

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

Drop it like it's hot ... spot.

Abraham Linksys.

John Wilkes Bluetooth.

Wu-Tang LAN.

Pretty Fly for a Wi-Fi.

These are some of the more creative (or at least punny) names you might see when searching for a Wi-Fi connection. And the sheer number of network names that pop up confirms what the data tell us. Your neighbors, your family, and nearby businesses are all competing for a relatively limited amount of unlicensed spectrum. And those spectrum bands are getting congested.

After all, Wi-Fi networks are the workhorses of our connected lives. We hear so much in telecom about the difficulty of connecting the "last mile." And when we are at home or at work the final few feet of that last mile are often spanned by Wi-Fi, Bluetooth, or another unlicensed technology. Few realize that without Wi-Fi and the unlicensed spectrum it uses, even the best commercial wireless networks would strain to keep up with consumer demand. In fact, a study out last week shows that even among Americans with unlimited mobile data plans, two-thirds of their data still rides on Wi-Fi.

And it's surprising that so much is done with so little. The 2.4 GHz band is home to some of the original Wi-Fi devices, cordless phones, baby monitors, and Bluetooth devices that came to market nearly 20 years ago. Two decades of devices send and receive information over just 83 MHz of spectrum in that band. The 5 GHz band, which is used to transmit at a faster rate and to relieve congestion in 2.4, adds only 150 MHz.

As we move towards 5G, demand on our unlicensed bands will only increase. From the Internet of Things to smart ag to new telehealth applications, we need more spectrum to connect billions of new devices to the Internet. That's why today's proceeding is so important. It proposes to add 1,200 MHz of prime mid-band spectrum for unlicensed use—that's five times the spectrum available today in the 2.4 and 5 GHz bands.

There are issues to be resolved in this proceeding, for sure. Would unlicensed use in the 6 GHz band cause harmful interference to incumbents? If so, how could we tailor protections that maximize use of the band? These are technical issues that require the input and engagement of all stakeholders. So I encourage parties to work with the Commission to develop appropriate rules. And we need to do so expeditiously. Few predicted how important the 2.4 and 5 GHz bands would be to the modern world when the FCC made them available more than 30 years ago. That history suggests the enormous potential value of the steps we take today.

So I want to thank the Office of Engineering and Technology and the Wireless Telecommunications Bureau for their work on this item. It has my support.

**STATEMENT OF
COMMISSIONER JESSICA ROSENWORCEL**

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

You may not know it, but your life runs on unlicensed spectrum. It might have been the laptop you popped open this morning to check your e-mail. Or it could have been the baby monitor you used to keep tabs on your little one last night. Maybe it was the fitness tracker you counted on to count your steps or the music you streamed through your phone to power you through a jog. Or it could have been the traffic application you checked before hitting the road for your daily commute after closing your garage door remotely with the press of a button. No matter who you are or where you live, the odds are good that you have benefited from unlicensed airwaves and Wi-Fi.

These conveniences are not the gifts of the spectrum gods. They are the byproduct of wireless policy choices that were made at the Federal Communications Commission more than three decades ago. A renegade band of engineers at this agency led the charge. They challenged the status quo by suggesting that spectrum that was not licensed to individuals could be useful for all. Instead of having the FCC dictate what could be done in certain bands, the agency would leave it up to the public. So the FCC opened a handful of underused frequencies—airwaves that were widely viewed as “garbage bands”—to anyone who followed some basic technical rules.

This was radical. It was edgy stuff. It was a bet that access to some airwaves by public rule rather than private license would lead to a whole new world of wireless uses.

It was a good bet. Because in time a standard was developed known as 802.11—and this is where Wi-Fi was born. Today, Wi-Fi adds more than \$500 billion to the United States economy every year—and \$2 trillion globally. It has democratized internet access, helped carriers manage their networks, and fostered all sorts of wild innovation. In fact, it’s the perfect sandbox for experimentation, because access does not require contract or permission.

As exciting as this is, it means the airwaves used by Wi-Fi are getting crowded. Already our current Wi-Fi bands are congested because they are used by more than 9 billion devices. By the end of the decade, we will see as many as 50 billion new devices connecting to our networks through the internet of things. Add this up. We’re going to need a significant swath of new unlicensed spectrum to keep up with demand.

Now is the time to do something about it. Earlier this year, Congress directed the FCC to increase the spectrum resources we devote to Wi-Fi. That opportunity could come from the 6 GHz band—the subject of our rulemaking today. It’s an ideal place to explore Wi-Fi expansion because it’s close to our existing Wi-Fi bands. It also offers an opportunity to introduce wider channels—channels that will be able to take advantage of the new 802.11ax or Wi-Fi 6 standard and deliver speeds even faster than 1 gigabit per second. In other words, this is how we develop next-generation Gigabit Wi-Fi.

I appreciate that my colleagues have made changes to this rulemaking at my request. In particular, I am grateful this effort now contemplates more opportunities for low-power, indoor Wi-Fi devices throughout the 6 GHz band. This will promote economies of scale and facilitate use of the same standards with the nearby 5 GHz band.

This last point is important. Because the demands on existing unlicensed airwaves are so great, we need an effort beyond the 6 GHz band. We need a fresh look at Wi-Fi opportunities in the 5.9 GHz band. This is overdue. It was back in 1999 when this agency set aside 75 megahertz of spectrum in this band for Dedicated Short Range Communications, or DSRC, which was designed to let cars talk to each other in real time to help reduce accidents. But in the nearly two decades since the FCC allocated this

spectrum, that has not happened. Testing on DSRC continues, but only a few thousand vehicles have DSRC on board out of the more than 260 million cars on the road. That's not surprising when you consider that autonomous vehicles have already moved on to newer technologies.

That's why the FCC committed to completing tests by January 15, 2017 to address the safe operation of Wi-Fi devices in this band. But nearly two years later this agency is silent. No results have been released. No decisions have been made. And in the intervening time the market has mostly moved past the test plan we developed. Given these facts, it is time for the FCC to take a fresh look at this band and update our efforts.

Wi-Fi is a powerful force in the economy. It can foster innovation without license. It can offer a jolt to the internet of things. It can make our lives more connected and more convenient every day. It's time for more of it—and the 6 GHz band and 5.9 GHz band are the right place to start. Let's get to it.