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

In the Matter of	)	
	)	
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
	)	

FOURTH REPORT AND ORDER AND THIRD FURTHER NOTICE OF PROPOSED RULEMAKING

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By the Commission: Chairman Carr and Commissioner Trusty issuing separate statements.

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I. INTRODUCTION

1. Unlicensed devices operating under standards such as Wi-Fi are an indispensable part of everyone's life, enabling people to connect, access information, and conduct research anywhere within range of a hotspot. Recognizing the growing impact of unlicensed devices, the Commission adopted rules in 2020 to provide more flexibility for unlicensed devices accessing 1200 megahertz of spectrum across the 6 gigahertz (GHz) band (5.925-7.125 GHz), resulting in increased unlicensed device usage. In 2020, the Commission authorized two types of 6 GHz unlicensed devices: standard-power devices and low power indoor (LPI) devices. Standard-power devices operate at fixed locations under the control of automated frequency coordination (AFC) systems which protect incumbent licensed services in the 6 GHz band from receiving harmful interference. LPI devices are restricted to indoor operation and operate at lower power to protect licensed incumbent users. Recognizing additional benefits for consumers, the Commission adopted rules in 2023 for a third type of 6 GHz band unlicensed device, very low power (VLP) unlicensed devices, which operate at even lower power levels than LPI devices but can be used anywhere without the need for an AFC system. These rules have unleashed a torrent of devices taking advantage of the new Wi-Fi 6E standard to provide users across the U.S. with a better Wi-Fi user experience.

2. To build upon this foundation of innovation, we now authorize a new category of unlicensed devices in the 6 GHz band known as geofenced variable power (GVP) devices. GVP devices promise to overcome technical and regulatory constraints on LPI and VLP devices. For one, GVP devices offer data rates suitable for reality/virtual reality, short-range hotspots, automation processes, and indoor location and navigation because they operate at significantly higher power than VLP devices. For another, GVP devices need not be restricted indoors, as is the case with LPI. These benefits are possible by restricting GVP devices from operating in exclusion zones on certain frequencies to protect incumbent licensed services from any significant risk of harmful interference. Exclusion zones will be calculated consistent with the protection methodology being used by the AFC systems and GVP devices will obtain that information to avoid causing any significant risk of harmful interference to incumbent licensed users.

3. We also issue a Third Further Notice of Proposed Rulemaking to seek comment on proposals that could provide more utility for unlicensed devices in the 6 GHz band. Specifically, we seek comment on a proposal to allow composite standard-power/LPI access points that operate under the control of an AFC system to operate with additional power under certain circumstances. Because these access points are restricted to indoor operations, they will be able to operate at higher power than what an AFC would allow for outdoor standard-power access points at the same location without presenting a significant risk of harmful interference. The additional power will enable composite standard-power/LPI access points to increase indoor coverage and provide more versatility to American consumers. We also seek comment on a proposal to permit LPI access points to operate on cruise ships. Although the Commission prohibited the operation of LPI access points on boats in the *6 GHz First Order*, we note that the risk of harmful interference to Earth Exploration Satellite Service operations could be reduced because of the limited number of cruise ships and the fact that transmissions from within cruise ships would be significantly attenuated by the thick metal walls of the ship. We also note that cruise ships need more spectrum for unlicensed device operation because they have thousands of passengers within a relatively small footprint.

II. BACKGROUND

4. The 6 GHz band is allocated for the Fixed Service, Mobile Service, and Fixed Satellite Service (FSS) across four sub-bands.[1] These four sub-bands—which we refer to as U-NII-5, U-NII-6, U-NII-7, and U-NII-8, respectively—are delineated based on the prevalence and characteristics of the incumbent licensed services that operate in each sub-band as denoted in Table 1.[2] Fixed microwave service licensees, specifically those operating point-to-point microwave links that support a variety of critical services provided by utilities, commercial and private entities, and public safety agencies, are the largest user group in the 6 GHz band[3] and make significant use of the U-NII-5 and U-NII-7 bands as well as limited use of the U-NII-8 band.[4] The microwave links provide backhaul for commercial wireless providers (such as traffic between commercial wireless base stations and wireline networks), coordinate railroad train movements, control natural gas and oil pipelines, manage electric grids, as well as carry long-distance telephone calls.[5]

Table 1: Predominant Licensed Uses of the 6 Gigahertz Band

Sub-band	Frequency Range (GHz)	Primary Allocation	Predominant Licensed Services
U-NII-5	5.925-6.425	Fixed FSS	Fixed Microwave FSS (uplinks)
U-NII-6	6.425-6.525	Mobile FSS	Broadcast Auxiliary Service Cable Television Relay Service FSS (uplinks)
U-NII-7	6.525-6.875	Fixed FSS	Fixed Microwave FSS (uplinks/downlinks)
U-NII-8	6.875-7.125	Fixed Mobile FSS	Fixed Microwave Broadcast Auxiliary Service Cable Television Relay Service FSS (uplinks/downlinks) (6.875-7.075 GHz only)

[1] *Unlicensed Use of the 6 GHz Band; Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz*, Notice of Proposed Rulemaking, 33 FCC Rcd 10496, 10499-501, paras. 8-13 (2018) (*Notice*); *Unlicensed Use of the 6 GHz Band; Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz*, Report and Order and Further Notice of Proposed Rulemaking, 35 FCC Rcd 3852, 3855, para. 7 (2020) (*6 GHz First Order*), *rev'd in part, aff'd in part, and remanded*, *AT&T Servs. Inc. v. FCC*, 21 F.4th 841, 853-54 (D.C. Cir. 2020) (affirming *6 GHz First Order* and reversing and remanding to address issue of whether to "reserve a sliver of the 6 GHz band for licensed mobile operation").

[2] *Notice*, 35 FCC Rcd at 10499-501, 10503-04, paras. 8-12, 20.

[3] *Notice*, 35 FCC Rcd at 10499, para. 8, fig.1.

[4] As of August 5, 2025, , the FCC databases indicate that there are 32,050 call signs for fixed microwave links in U-NII-5, 355 in U-NII-6, 16,180 in U-NII-7, and 5,166 in U-NII-8. The predominant usage in the U-NII-5 and UNII-7 bands is common carrier, industrial/business pool, and public safety pool fixed point-to-point links. The UNII-6 band is dominated by mobile industrial/business pool and public safety pool microwave and TV Pickup operations. The predominant usage in the U-NII-8 band is TV intercity relay stations and TV studio-to-translator links. There are also 311 mobile stations (304 TV mobile pickup and 7 Broadcast Auxiliary Service low power stations) in the UNII-8 band.

[5] *6 GHz First Order*, 35 FCC Rcd at 3855, para. 7 (citing Fixed Wireless Communications Coalition Comments at 3 (filed Oct. 2, 2017)).

5. The Broadcast Auxiliary Service (BAS) and Cable Television Relay Service (CARS) operate in the U-NII-6 band on a mobile basis, and in the U-NII-8 band on both a fixed and mobile basis.[6] Licensees use BAS and CARS pick-up stations to transmit programming material from special events or remote locations, including electronic news gathering, back to the studio or other central receive locations.[7] Television broadcast related microwave links, such as television studio transmitter links, television inter-city relay links, and television translator relay links, operate primarily one-way point-to-point systems in the U-NII-8 band.[8] Additionally, Low Power Auxiliary Stations (i.e., wireless microphones), which operate on an itinerant basis, are authorized to operate in the U-NII-8 band on a secondary basis for uses such as portable cameras, wireless microphones, cues, and backstage communications.[9]

6. The Fixed Satellite Service (FSS) is allocated in the Earth-to-space direction across the entire 6 GHz band, except for the 7.075-7.125 GHz portion of the U-NII-8 band.[10] FSS operations are heaviest in the U-NII-5 band, which is paired with the 4.0-4.2 GHz frequency band in the space-to-Earth direction to comprise the "conventional C band."[11] Predominant FSS uses 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 telephone and data backhaul traffic.[12] 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.[13] Additionally, portions of the UNII-7 and U-NII-8 bands are allocated for FSS space-to-Earth operations for Mobile-Satellite Service feeder links between 6.700 GHz and 7.075 GHz.[14] However, no such earth stations are currently licensed in the U-NII-7 band, and the U-NII-8 allocation (7.025-7.075 GHz) is limited to two grandfathered satellite systems with three grandfathered earth station locations.[15]

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[6] 47 CFR §§ 74.602(a), (i), 78.18(a)(5), 78.18(a)(7). We also note that, although less prevalent, the rules permit mobile private operational, common carrier, and local television transmission service operations in these bands. *See id.* §§ 101.101, 101.147, 101.801, 101.803.

[7] 47 CFR §§ 74.631, 78.11(e).

[8] Most systems are comprised of a single point-to-point link without a corresponding return link. 47 CFR § 74.631 and review of ULS licensing records for TV Studio Transmitter (TS), TV Intercity Relay (TI), and TV Translator Relay (TT) licenses.

[9] 47 CFR §§ 74.802(a)(1), 74.803(c). Wireless microphone users may operate on a licensed basis under part 74 in the 6.875-6.9 GHz and 7.1-7.125 GHz bands. *See Promoting Spectrum Access for Wireless Microphone Operations; Expanding the Economic and Innovation Opportunities of Spectrum through Incentive Auctions*, Report and Order, 30 FCC Rcd 8739, 8789-90, paras. 131-32 (2015).

[10] 47 CFR § 2.106.

[11] 47 CFR § 25.103. While the Commission's rules currently define the conventional C-band as the U-NII-5 band and the 3700-4200 MHz band, the Commission has transitioned satellite services out of the lower portion of the 3.7–4.2 GHz band and into the upper 200 megahertz of the band (i.e., 4.0–4.2 GHz). *Upper C-band (3.98 to 4.2 GHz)*, GN Docket No. 25-59, Notice of Inquiry, FCC 25-13, at 1-2, paras. 3-4 (Feb. 28, 2025).

[12] *Notice*, 33 FCC Rcd at 10501, para. 12.

[13] 47 CFR § 25.214(c)(5).

[14] 47 CFR § 2.106(b)(458)(ii) (International footnote 5.458B) (providing that space-to-Earth satellite use of 6700-7075 MHz is limited to feeder links for non-geostationary satellite systems of the mobile-satellite service).

[15] 47 CFR § 2.106(b)(458)(ii), (d)(172) (international footnote 5.458B and non-governmental footnote NG172). The space-to-Earth allocation is limited to non-geostationary Mobile-Satellite Service feeder links, and earth stations receiving in this band are limited to locations within 300 meters of coordinates in Brewster, WA, Clifton, TX, and Finca Pascual, PR. *Id.* § 2.106(d)(172).

7. In addition to these licensed incumbent services, the table of frequency allocations requires that we take "all practicable steps" to protect the radio astronomy service in the 6.650-6.6752 GHz range from harmful interference.[16] Finally, low-power unlicensed ultra-wideband (UWB) and wideband systems operate in the 6 GHz band under our part 15 rules.[17] Like all other part 15 devices, UWB and wideband devices operate on a non-interference basis—i.e., they must not cause harmful interference and must accept interference.[18]

8. On April 23, 2020, the Commission adopted a Report and Order and Further Notice of Proposed Rulemaking (*6 GHz First Order*) that expanded unlicensed operations in the 6 GHz band (5.925-7.125 GHz).[19] The *6 GHz First Order* adopted rules for two categories of unlicensed operations—standard-power operations and low-power indoor (LPI) operations.[20] Standard-power access points and fixed client devices are limited to two portions of the 6 GHz band—the U-NII-5 band (5.925-6.425 GHz) and the U-NII-7 band (6.525-6.875 GHz)—and are required to operate under the control of an automated frequency coordination (AFC) system.[21] Low-power indoor access points can operate across the entire 6 GHz band, but at lower power levels than standard power operations, and must incorporate a contention-based protocol.[22] Client devices operate under the control of either a standard-power or low-power indoor access point and communicate using power levels that are 6 dB below the authorized power for the type of access point to which they are connected.[23]

9. On November 1, 2023, the Commission released a Second Report and Order that allowed unlicensed very low power (VLP) devices to operate in the U-NII-5 and U-NII-7 portions of the 6 GHz band (*6 GHz Second Order*).[24] VLP devices are authorized to operate anywhere, indoors and outdoors,

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[16] 47 CFR § 2.106(c)(342) & tbl.17 ("In making assignments to stations of other services to which the bands in table 17 to paragraph (c)(342) of this section are allocated . . ., all practicable steps must be taken to protect the radio astronomy service from harmful interference."); *see also id.* § 2.106(b)(458)(i) (international footnote 5.458A) ("In making assignments in the band 6700-7075 MHz to space stations of the fixed-satellite service, administrations are urged to take all practicable steps to protect spectral line observations of the radio astronomy service in the band 6650-6675.2 MHz from harmful interference from unwanted emissions.").

[17] 47 CFR § 15.250; *id.* pt. 15, subpt. F. Unlicensed UWB operations are permitted in many frequency bands. *See id.* pt. 15, subpt. F. Wideband operations are mostly limited to the 6 GHz band. *Id.* § 15.250 (limiting wideband operations to the 5.925-7.250 GHz band). For both wideband and ultra-wideband systems permitted under the part 15 rules, the maximum EIRP allowed is –41.3 dBm/MHz, except for certain vehicular radar systems, which are restricted to –61.3 dBm/MHz EIRP. *See id.* §§ 15.509(d), 15.510(d)(3), 15.511(c), 15.513(d), 15.515(d), 15.517(c), 15.519(c), 15.250(d)(1).

[18] 47 CFR § 15.5(b) ("Operation of an intentional, unintentional, or incidental radiator is subject to the conditions that no harmful interference is caused and that interference must be accepted that may be caused by the operation of an authorized radio station, by another intentional or unintentional radiator, by industrial, scientific and medical (ISM) equipment, or by an incidental radiator.").

[19] *6 GHz First Order*.

[20] *Id*. at 3860, paras. 17-18.

[21] 47 CFR §§ 15.403, 15.407(k)(1); *6 GHz First Order*, 35 FCC Rcd at 3860, 3862, 3923, paras. 17-18 & tbl.3, 22, 192. Only standard-power and fixed-client 6 GHz unlicensed devices are required to operate pursuant to an AFC system. 47 CFR § 15.407(k)(1). Standard-power devices may operate both outdoors and indoors at power levels above the low-power indoor device power limits. *6 GHz First Order*, 35 FCC Rcd at 3862, para. 22; *see id.* § 15.407(a)(4). A fixed client device is "intended as customer premise equipment that is permanently attached to a structure, operates only on channels provided by an AFC, has a geolocation capability, and complies with antenna pointing angle requirements." 47 CFR § 15.403.

[22] *6 GHz First Order*, 35 FCC Rcd at 3860, 3889-90, paras. 18, 101, 103.

[23] *Id.* at 3860, para. 18.

[24] *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, Second Report and Order, Second Further Notice of Proposed

(continued….)

without being under the control of an AFC system.[25] VLP devices are limited to power levels that allow them to coexist with incumbent operations in the band: 14 dBm EIRP and -5 dBm/MHz EIRP power spectral density.[26] Additionally, VLP devices are required to employ a transmit power control mechanism that has the capability to operate at least 6 dB below the -5 dBm/MHz EIRP PSD level and are required to employ a contention-based protocol.[27] VLP devices are prohibited from operating as part of a fixed outdoor infrastructure, such as poles or buildings.[28] Also, VLP devices are required to prioritize operations above 6.105 GHz prior to operating on frequencies between 5.925 GHz and 6.105 GHz to ensure that services below the U-NII-5 band are protected from potential harmful interference.[29] VLP devices in the U-NII-5 and U-NII-7 bands are required to comply with the transmission emission mask adopted in the *6 GHz First Order*.[30] The power spectral density must be suppressed by 20 dB at one megahertz outside of an unlicensed device's channel edge, suppressed by 28 dB at one channel bandwidth from an unlicensed device's channel center, and suppressed by 40 dB at one and one-half times the channel bandwidth away from an unlicensed device's channel center,[31] At frequencies between one megahertz outside an unlicensed device's channel edge and one channel bandwidth from the center of the channel, the limits must be linearly interpolated between the 20 dB and 28 dB suppression levels.[32] At frequencies between one and one and one-half times an unlicensed device's channel bandwidth from the center of the channel, the limits must be linearly interpolated between the 28 dB and 40 dB suppression levels[33]. Emissions removed from the channel center by more than one and one-half times the channel bandwidth, but within the U-NII-5 and U-NII-7 bands, must be suppressed by at least 40 dB.[34] For emissions limits at the edge of the U-NII-5 and U-NII-8 bands, 6 GHz VLP devices must comply with a -27 dBm/MHz EIRP limit at frequencies below the bottom of the U-NII-5 band (5.925 GHz) and above the upper edge of the U-NII-8 band (7.125 GHz).[35] Consistent with the rules adopted in the *6 GHz Second Order* for LPI and standard power devices, VLP devices are prohibited from operating in low flying aircraft and unmanned aircraft systems.[36] For aircraft above 10,000 feet, VLP devices can operate across the 5.925-6.425 GHz band.[37] Consistent with the *6 GHz Second Order*, VLP devices are prohibited from operating on oil platforms but are permitted to operate on boats.[38]

10. In the Second Further Notice of Proposed Rulemaking (*6 GHz Second FNPRM*) adopted concurrently with the *6 GHz Second Order*, the Commission proposed to expand VLP operation to the

(Continued from previous page)
Rulemaking, and Memorandum Opinion and Order on Remand, 38 FCC Rcd 10523, 10532, para. 18 (2023) (*6 GHz Second Order* or *6 GHz Second FNPRM*).

[25] *See id.* at 10, 39, paras. 18, 67.

[26] 47 CFR § 15.407(a)(9); *6 GHz Second Order,* 38 FCC Rcd at 10534, para. 24.

[27] 47 CFR § 15.407(d)(6), (d)(10); *6 GHz Second Order,* 38 FCC Rcd at 10556, 10561, paras. 56, 67.

[28] 47 CFR § 15.407(d)(8); *6 GHz Second Order,* 38 FCC Rcd at 10555-56, para. 55.

[29] 47 CFR § 15.407(d)(9); *6 GHz Second Order*, 38 FCC Rcd at 10572, para. 94.

[30] *6 GHz Second Order,* 38 FCC Rcd at 10568, para. 86

[31] *Id*.

[32] *Id.*

[33] *Id.*

[34] *Id.*

[35] *6 GHz Second Order*, 38 FCC Rcd at 10568-69, para. 87.

[36] *6 GHz Second Order*, 38 FCC Rcd at 10573, para. 97.

[37] *Id.*; 47 CFR § 15.407(d)(1)(iv).

[38] 47 CFR § 15.407(d)(1)(i); *6 GHz Second Order*, 38 FCC Rcd at 10573, para. 96.

U-NII-6 (6.425-6.525 GHz) and U-NII-8 (6.875-7.125 GHz) portions of the 6 GHz band, with no requirement that the devices be kept indoors or be under the control of an AFC system.[39] On December 13, 2024, the Commission released a Third Report and Order (*6 GHz Third Order*) that authorized VLP operation in the U-NII-6 and U-NII-8 bands.[40] The Commission adopted the same technical and operational requirements previously established for VLP devices in the U-NII-5 and U-NII-7 bands.[41] For example, VLP devices operating in the U-NII-6 and U-NII-8 bands must operate at the same power levels, employ a contention-based protocol, and implement transmit power control.[42]

11. The *6 GHz Second FNPRM* also proposed to permit VLP operation at higher power levels while under the control of a geofencing system.[43] The geofencing system would utilize Commission databases to create exclusion zones to protect incumbent licensed services.[44] In addition, because the current 6 GHz unlicensed rules prohibit direct communication between client devices,[45] the *6 GHz Second FNPRM* sought comment on allowing such communications between client devices to 6 GHz unlicensed low-power indoor access points.[46] In this Fourth Report and Order, we only address the *6 GHz Second FNPRM* proposal for VLP operation with a geofencing system in the U-NII-5 and U-NII-7 bands while deferring the remaining open issues from the *6 GHz Second FNPRM,* including operation of GVP devices in the U-NII-6 and U-NII-8 bands, to future Commission actions.[47]

12. The Commission received comments from numerous parties in favor of adopting rules for GVP devices, as well as from parties representing incumbent licensees that raise concerns about the proposed GVP device power levels and system architecture.[48] 6 GHz band unlicensed device proponents – including Apple, Broadcom, Google, Intel Corporation, Meta Platforms (Meta), Microsoft Corporation, Qualcomm, the Wi-Fi Alliance, the Wireless Broadband Alliance, and the Consumer Technology

[39] *6 GHz Second FNPRM*, 38 FCC Rcd at 10576, 10600-01, paras. 104, 173.

[40] *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, Third Report and Order, 39 FCC Rcd 13901, 13908, para. 12 (2024) (*6 GHz Third Order*).

[41] *Id.* at 13908, para. 13.

[42] *Id*.

[43] *6 GHz Second FNPRM*, 38 FCC Rcd at 10576, para. 104.

[44] *Id*. at 10583-84, paras. 121, 123.

[45] 47 CFR § 15.407(d)(5) (stating that "[c]lient devices are prohibited from connecting directly to another client device").

[46] *6 GHz Second Order*, 38 FCC Rcd at 10608-09, paras. 191-94.

[47] To be clear, we are not addressing the other open issues raised in the *6 GHz Second FNPRM*, and they remain open for resolution in this proceeding. For the reasons discussed in this Fourth Report and Order, we believe that the benefits of permitting higher power VLP operation in the U-NII-5 and U-NII-7 bands under the supervision of geofencing systems are clear enough at this time that such expansion should not be delayed pending resolution of other issues in this docket.

[48] Theodora Scarato has filed numerous scientific studies about the biological effects of radio frequency transmissions. *See, e.g.*, filings of Theodora Scarato on March 27, 2025 and February 26, 2025 in ET Docket No. 18-295. Because the Commission is addressing potential changes to its rules concerning radio frequency exposure in another proceeding, we are not addressing this issue here. *See Proposed Changes in the Commission's Rules Regarding Human Exposure to Radiofrequency Electromagnetic Fields; Reassessment of Federal Communications Commission Radiofrequency Exposure Limits and Policies; Targeted Changes to the Commission's Rules Regarding Human Exposure to Radiofrequency Electromagnetic Fields*, ET Docket Nos. 03-137, 13-84, and 19-226, Resolution of Notice of Inquiry, Second Report and Order, Notice of Proposed Rulemaking, and Memorandum Opinion and Order, 34 FCC Rcd 11687 (2019).

Association – support the Commission's proposals for authorizing unlicensed GVP devices.[49] They advocate that GVP can operate at higher power levels without increasing the risk of harmful interference.[50] They assert that these higher power levels would improve performance for a multitude of applications for the newly available VLP devices.[51] While they all agree on granting GVP devices higher power, they have varying recommendations over whether the geofencing system's architecture should be centralized, decentralized, or an alternative.[52]

13. Opponents claim that more time is required to observe current VLP device operations in real-world scenarios.[53] Additionally, they assert that any VLP expansion be adopted alongside additional or adequate protections for incumbents.[54] They express concern that higher power levels will increase what they argue is already a concerning harmful interference risk.[55] While there is no consensus among the GVP proponents on a single architecture for the geofencing system, the opposing comments all argue that a centralized architecture is the best approach for protecting incumbent microwave links.[56]

III. FOURTH REPORT AND ORDER

14. We adopt rules for GVP devices to operate in the U-NII-5 and U-NII-7 portions of the 6 GHz band at up to 11 dBm/MHz EIRP power spectral density (PSD) and 24 dBm EIRP.[57] GVP devices must work in tandem with a geofencing system to minimize the likelihood of a significant risk of harmful interference to licensed fixed microwave links and radio astronomy observatories. The geofencing systems will calculate exclusion zones in which the GVP devices will not be permitted to operate co-frequency with microwave links or in a portion of the U-NII-7 band used by radio astronomy. Each GVP access point will be required to have a geolocation capability to determine its location and avoid operating on prohibited frequencies within the exclusion zones. GVP client devices will operate under the control

[49] A group of companies that includes Apple Inc., Broadcom Inc., Google LLC, Intel Corporation, Meta Platforms, Inc., Microsoft Corporation, and Qualcomm Inc. made two comment filings on March 27, 2024. One filing contains their comments on a range of topics in the *6 GHz Second FNPRM*. We refer to these comments as the "Apple, Broadcom et al. Comments." The other filing addresses only direct communication between 6 GHz unlicensed client devices, which we refer to as the "Apple, Broadcom et al. C2C Comments." This group submitted several joint filings in this proceeding. Several of these companies also submitted individual filings on behalf of their companies. We note that, at times, joint filings made by Apple, Broadcom, and other companies include variations in the composition of the group, depending on the particular filing(s).

[50] *E.g.*, Apple, Broadcom et al. Comments at 30; Wireless Broadband Alliance Comments at 2-4; Wi-Fi Alliance Comments at 9-13.

[51] *E.g.*, Apple, Broadcom et al. Comments at 34-35; Letter from J. David Grossman, Rachel Nemeth, Consumer Technology Association, to Marlene H. Dortch, Secretary, FCC, ET Docket No. 18-295, at 2 (filed Mar 27, 2024) (CTA Letter); Wi-Fi Alliance Comments at 16; Wireless Broadband Alliance Comments at 2.

[52] Federated Wireless Reply at 10-11; Wi-Fi Alliance Comments at 4.

[53] API Comments at 5; AT&T Comment at 3-4; Evergy Reply at 3; FWCC Reply at 7; Letter from Jeffrey S. Cohen, Chief Counsel, APCO, to Marlene H. Dortch, Secretary, FCC, ET Docket No. 18-295, at 1-2 (filed May 20, 2024) (*APCO Ex Parte*).

[54] Evergy Reply at 10; Evergy Comments at 7; APCO Reply at 3.

[55] Evergy Comments at 4; UTC/EEI Reply at 7.

[56] AT&T Comments at 4; Evergy Reply at 10; UTC/EEI Reply at 10; Comsearch Comments at 2.

[57] We are referring to this new class of 6 GHz unlicensed devices as "geofenced variable power" (GVP) devices instead of "geofenced very low power" devices as was done in the *6 GHz Second FNPRM*. Apple, Broadcom et al. suggested this name change to avoid confusion because the new class of devices would have much higher power than VLP devices and would employ an access point/client hierarchy instead of the peer-to-peer configuration of VLP devices. Apple, Broadcom et al. Comments at 25. We agree that using a more distinct name will convey the unique characteristics of these devices and help avoid confusion.

of GVP access points at 6 dB less power than the authorized power of the controlling GVP access point. Using geofencing will enable GVP devices to operate at significantly higher power levels than the -5 dBm/MHz EIRP PSD and 14 dBm EIRP at which non-geofenced VLP devices are permitted to operate. At this time, we are limiting the GVP device operation to the U-NII-5 and U-NII-7 portions of the 6 GHz band and defer considering such action for the U-NII-6 and U-NII-8 bands.

Table 2: Authorized Unlicensed Devices in the 6 Gigahertz Band

Sub-band	Frequency Range (GHz)	Authorized Unlicensed Devices
U-NII-5	5.925-6.425	Standard power Low power indoor (LPI) Very low power (VLP) Geofenced variable power (GVP) Ultra-wideband (UWB)
U-NII-6	6.425-6.525	Low power indoor (LPI) Very low power (VLP) Ultra-wideband (UWB)
U-NII-7	6.525-6.875	Standard power Low power indoor (LPI) Very low power (VLP) Geofenced variable power (GVP) Ultra-wideband (UWB)
U-NII-8	6.875-7.125	Low power indoor (LPI) Very low power (VLP) Ultra-wideband (UWB)

A. Power Limits for GVP Access Points

15. In the *6 GHz Second FNPRM,* the Commission sought comment on the appropriate power limits for GVP devices in the U-NII-5 and U-NII-7 bands.[58] As an initial matter, the Commission noted that Apple, Broadcom et al. had requested that it permit VLP devices to operate at up to 1 dBm/MHz EIRP PSD and 14 dBm EIRP.[59] Based on the technical record, the Commission declined in the *6 GHz Second Order* to adopt this PSD level and instead limited VLP operations to a maximum of -5 dBm/MHz EIRP PSD and 14 dBm EIRP.[60] However, the Commission explained that it could allow GVP devices to operate at a higher PSD level if such devices are prohibited from operating co-channel and in close proximity to licensed microwave receive sites.[61] The Commission proposed that VLP devices be permitted to operate across the entire 6 GHz band—U-NII-5, U-NII-6, U-NII-7, and U-NII-8—at up to 1 dBm/MHz EIRP PSD and 14 dBm EIRP while under the control of a geofencing system to minimize the likelihood of harmful interference to licensed incumbent services.[62] Although the Commission expressly sought comment on these proposed power limits, it also asked whether it should allow GVP devices to

[58] *6 GHz Second FNPRM*, 38 FCC Rcd at 10576-77, paras. 105-07.

[59] *6 GHz Second FNPRM*, 38 FCC Rcd at 10576-77, para. 105; *see also 6 GHz Second Order*, 38 FCC Rcd at 10532, para. 20 (citing Apple, Broadcom et al. Comments, ET Docket No. 18-295, at 14 (rec. June 29, 2020)).

[60] *See 6 GHz Second Order*, 38 FCC Rcd at 10534, 10522, paras. 24, 50.

[61] *6 GHz Second FNPRM*, 38 FCC Rcd at 10577, para. 106.

[62] *6 GHz Second FNPRM*, 38 FCC Rcd at 10577, para. 106.

operate with higher PSD and EIRP limits.[63] The Commission sought comment on a range of power limits and specifically asked whether it could "allow a power limit higher than 14 dBm EIRP," identifying as one such example power levels "up to 21 dBm EIRP."[64] Furthermore, the Commission asked whether "even higher PSD and EIRP limits [would] increase the risk of harmful interference to licensed incumbent services" and whether "the proposed geofencing system . . . [would] be sufficient to reduce this risk."[65] By using the phrase "even higher," the Commission signaled that it sought comment on power limits higher than those discussed earlier in the paragraph—i.e., higher than 1 dBm/MHz EIRP PSD and 21 dBm EIRP.

16. Apple, Broadcom et al. request that GVP devices be permitted to operate at up to 8 dBm/MHz EIRP PSD and 21 dBm EIRP across the entire 6 GHz band.[66] According to Apple, Broadcom et al., creating geofencing-capable devices "will require manufacturers to add expensive new hardware and software to a wide range of consumer and enterprise equipment," and such investment cannot be justified for the marginal benefit that would be provided by the proposed power limits.[67] Apple, Broadcom et al. stress that unless the GVP maximum permitted power is 21 dBm EIRP, consumers will not experience any additional benefit from a higher PSD when using channels wider than 80-megahertz because total power transmitted is proportional to the PSD and capping the maximum EIRP at 21 dBm would allow all channel bandwidths to operate with more than 14 dBm EIRP total power.[68] They explain that "increas[ing] power limits for *all* channel sizes available in the 6 GHz band . . . is important because wider channels are subject to more noise and therefore require additional power to maintain a sufficient signal-to-noise ratio.[69] Apple, Broadcom et al. similarly recommend permitting a maximum PSD of 8 dBm/MHz EIRP so that all channels, regardless of bandwidth, can operate at the maximum power level.[70] They further claim that "an increase in the PSD limit would not result in any higher risk of harmful interference because of the limitations imposed by the proposed geofencing system" (e.g., the proposal that "the size of an exclusion zone must increase in proportion to a GVP device's power level").[71]

17. Apple, Broadcom et al. point to several computer simulations they submitted prior to the issuance of the *6 GHz Second FNPRM* as evidence that GVP devices can operate at up to 21 dBm EIRP without creating a significant risk of harmful interference to licensed incumbents.[72] One computer simulation that modeled the interaction between outdoor VLP devices and the 97,888 6 GHz band fixed microwave links in the United States for 20-, 40-, 80-, and 160-megahertz bandwidth VLP signals[73] concluded that there was only a 0.00059% probability that a VLP device operating at 21 dBm EIRP

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[63] *6 GHz Second FNPRM*, 38 FCC Rcd at 10577, para. 107.

[64] *6 GHz Second FNPRM*, 38 FCC Rcd at 10577, para. 107.

[65] *Id.*

[66] Apple, Broadcom et al. Comments at 26.

[67] Apple, Broadcom et al. Comments at 26.

[68] *See id*. at 27-28. The comments contain a table showing the trade-offs between various PSD and maximum power levels for each channel bandwidth. *Id.*

[69] *Id*. at 28.

[70] *Id*. at 28-29. For example, Apple, Broadcom et al. note that unless the PSD level is increased above 1 dBm/MHz, a 20-megahertz channel could not transmit with more than 14 dBm EIRP, whereas that 20-megahertz channel could transmit with 21 dBm EIRP at an 8 dBm/MHz PSD level. *Id.* at 29 tbl.2.

[71] *Id*. at 29.

[72] *Id*. at 34-40.

[73] *Id*. at 35. This computer simulation was discussed in the *6 GHz Second Order*, 38 FCC Rcd at 10535-37, paras. 27-28.

would cause a microwave link to experience an interference-to-noise (I/N) ratio greater than -6 dB.[74] According to Apple, Broadcom et al., the computer simulation demonstrates that VLP devices operating at 21 dBm with no additional mitigation rules would not create a significant harmful interference risk.[75] Apple, Broadcom et al. argued that this minimal risk would be mitigated by the proposed geofencing rules, which "would prohibit transmissions in the very rare instances where the [computer simulations] found that [VLP] operations could exceed the -6 dB I/N metric."[76]

18. The Dynamic Spectrum Alliance (DSA) and Wi-Fi Alliance support the same power levels for GVP devices as Apple, Broadcom et al. DSA believes that the GVP power levels proposed by the Commission, 14 dBm EIRP and 1 dBm/MHz EIRP PSD, do not "provide[] a sufficient economic incentive for companies to make the necessary investments [to] develop[] and commercializ[e] such [devices]."[77] DSA points out that the proposed power levels would only benefit devices operating on 20-megahertz or 40-megahertz channels, but that most use cases are better suited to larger channel sizes.[78] DSA urges the Commission to instead adopt a geofenced VLP framework with a 21 dBm EIRP limit and 8 dBm/MHz EIRP PSD.[79] According to DSA, "[t]he higher EIRP limit . . . will provide greater reliability for [augmented reality/virtual reality] applications," and "[t]he increased EIRP PSD limits will enable narrow band applications, which may not be feasible under the [current] VLP limits."[80] The Wi-Fi Alliance ask that the Commission "create a new device class for higher power VLP devices capable of operating at up to 21 dBm EIRP and 8 dBm/MHz EIRP PSD.[81] According to the Wi-Fi Alliance, allowing VLP devices to operate at up to 21 dBm EIRP "will enable new applications that are not possible at the current VLP power levels and enable a more robust connectivity for existing applications."[82]

19. While Apple initially joined Apple, Broadcom et al. in requesting GVP power levels of up to 8 dBm/MHz EIRP PSD and 21 dBm maximum EIRP,[83] Apple later proposed a simplified geofencing version with only two power levels: 1 dBm/MHz EIRP PSD and 8 dBm/MHz EIRP PSD, both with a maximum 21 dBm EIRP, instead of permitting variable power up to the 8 dBm/MHz EIRP PSD and 21 dBm EIRP limits.[84] The geofencing systems would calculate two exclusion zones—one for each PSD level—and a GVP device would check its location to determine whether it may operate and, if so, its maximum power level.[85] This version would reduce the calculations needed by the geofencing systems because they would not need to support variable GVP power levels.

20. More recently, Apple and Meta contend that maximum authorized power levels of at least 11 dBm/MHz PSD and 24 dBm EIRP for GVP access points and 5 dBm/MHz PSD and 18 dBm EIRP for

[74] Apple, Broadcom et al. Comments at 35.

[75] *Id*.

[76] *Id*. at 40.

[77] Dynamic Spectrum Alliance Comments at 14.

[78] *Id*.

[79] *Id*.

[80] *Id*. at 14-15.

[81] Wi-Fi Alliance Reply at 12.

[82] Wi-Fi Alliance Comments at 16.

[83] Apple, Broadcom et al. Comments at 23.

[84] Letter from Paul Margie, Counsel, Apple Inc., to Marlene H. Dortch, Secretary, FCC, ET Docket No. 18-295, GN Docket No. 17-183, Attach. at 2 (filed Oct. 17, 2024).

[85] *Id*. at 4.

GVP client devices are "essential for adequate reliability and performance for GVP use cases."[86] They claim that "GVP devices are likely to predominately be wearable devices," such as smartwatches and augmented reality glasses, which have "significant latency and throughput requirements."[87] These wearable devices would face up to 96 dB of attenuation communicating across the user's body.[88] They also point to other use cases, such as multiple peer-to-peer links, which would also greatly benefit from higher power levels.[89] They claim that their analysis shows that these higher power levels are essential to meet the performance goals for these and other envisioned use cases.[90]

21. Federated Wireless supports the Commission's proposal to allow greater power for VLP devices operating under the control of a geofencing system, but instead of spending time and resources developing a new system for geofencing, Federated Wireless advocates relying on the currently authorized AFC systems.[91] Federated Wireless also encourages permitting GVP devices to operate at higher power than the proposed 1 dBm/MHz EIRP PSD and 14 dBm EIRP because AFC systems are "capable of offering the same level of protection to incumbents regardless of the unlicensed device transmit power."[92]

22. The Wi-Fi Alliance points out that the computer simulations upon which the Commission relied in permitting VLP operations "show virtually no impact on the microwave links even for VLP devices operating at 1 dBm/MHz EIRP PSD."[93] The Wi-Fi Alliance claims that VLP devices will be predominantly used indoors, that their signals will be attenuated by body loss when they are used outdoors, and that outdoor VLP transmitters will operate far below the likely height of any 6 GHz microwave facilities.[94] Therefore, the Wi-Fi Alliance claims that existing mitigation requirements are sufficient to protect microwave operations from VLP devices operating at up to 1 dBm/MHz EIRP PSD and 14 dBm EIRP.[95] The Wi-Fi Alliance contends that because the risk of harmful interference from VLP devices operating at this power level "is already extremely low," there is no benefit in imposing geofencing requirements.[96] The IEEE LAN/MAN Standards Committee (IEEE LMSC) also does not believe that the Commission should require geofencing if it increases the power level to 1 dBm/MHz EIRP PSD and 14 dBm EIRP because it effectively only would permit higher power for 20-megahertz and 40-megathertz channels and would not result in increased risk to incumbent services.[97] IEEE LMSC claims that the incremental improvement from this power increase does not justify mandating the

[86] Letter from Megan Anne Stull, Senior Manager, Government Affairs and Regulatory, Apple Inc., and Alan Norman, Public Policy Director, Meta Platforms, Inc., to Marlene H. Dortch, Secretary, FCC; ET Docket No. 18-295, GN Docket No. 17-183, at 1 (filed Aug. 8, 2025) (Apple and Meta Aug. 8, 2025 Ex Parte); *see also* Letter from Paul Margie, Counsel, Apple Inc., to Marlene H. Dortch, Secretary, FCC, ET Docket No. 18-295, GN Docket No. 17-183, at 2 (filed June 26, 2025) (GVP "client devices must operate at a minimum of 18 dBm EIRP and 5 dBm/MHz EIRP PSD to overcome body loss and deliver requisite levels of reliability and performance").

[87] Apple and Meta Aug. 8, 2025 Ex Parte at 1.

[88] *Id*.

[89] *Id*.

[90] *Id*. at 1-2.

[91] Federated Wireless Comments at 2-3.

[92] *Id*. at 3.

[93] Wi-Fi Alliance Comments at 11 (quoting *6 GHz Second Order*, 38 FCC Rcd at 10552, para. 50).

[94] *Id*. at 12.

[95] *Id*.

[96] Wi-Fi Alliance Comments at 15.

[97] *See* IEEE LAN/MAN Standards Committee Comments at 4 (filed by Paul Nikolich).

relatively complex geofencing mechanism and that developing this geofencing mechanism will potentially delay this VLP mode from deploying.[98]

23. Cisco and HP Enterprise support slightly higher VLP power levels to accommodate body loss, but caution that increasing VLP power needs to be done so as to ensure that unlicensed LPI devices continue to coexist among themselves and with VLP devices.[99] According to Cisco and HP Enterprise, the top request of enterprise customers is that Wi-Fi be more predictable and reliable.[100] Cisco and HP Enterprise explain that interference to enterprise Wi-Fi means less spectrum availability, which results in smaller channels with decreased capacity and increased latency.[101] They point out that "[g]eofencing does not consider coexistence with enterprise [Wi-Fi] networks" and that "[h]igher power VLP . . . could interfere with other VLP use[s]."[102] They claim that enterprise customers would like VLP to be coordinated by the infrastructure when in the presence of LPI access points.[103] Cisco and HP state that the actual affect that VLP and GVP devices will have on enterprise Wi-Fi networks is unknown, but that CableLabs is currently studying that issue.[104] Cisco and HP Enterprise recommend that the Commission "adopt reasonable limits on GVP/VLP while standards develop"—i.e., "slightly higher powered VLP to accommodate body loss"—that improve coexistence among the different types of Wi-Fi devices.[105]

24. AT&T urges caution with respect to liberalizing the 6 GHz unlicensed rules and expresses concern that the computer simulations on which VLP device rules are based remain unfiled and untested.[106] AT&T suggests that the Commission "gain some understanding of the impact of actual, commercially deployed VLP devices before liberalizing the rules by which they operate and, if it ultimately determines to do so, to act with caution in a manner that is reversible."[107] AT&T suggests that the power limits for GVP devices "should start conservatively, provide for future modification, and be capped with reference to [the] risks defined by geolocation parameters," with the power levels lower if the Commission adopts a geofencing framework that carries substantial risk to incumbent microwave receivers.[108] AT&T is concerned that the proposal of 1 dBm/MHz EIRP PSD limit "does not appear to be a conservative starting point" and, "[e]ven more dire, the *6 GHz Second FNPRM* seeks comment on increasing the [maximum] EIRP to 21 dBm."[109] AT&T complains that "the [GVP] proponents' response to the *6 GHz Second FNPRM* amounts to platitudes that geofencing . . . will self-evidently protect incumbents and the Commission need not worry because their prior studies . . . should nonetheless carry the day."[110] AT&T claims that "no geofencing advocate has advanced a proposal for geofencing that allows incumbents to rationally evaluate the potential for harmful interference."[111] AT&T demands that

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[98] *Id*.

[99] Cisco and HP Enterprise June 20, 2025 *Ex Parte* Presentation at 16.

[100] *Id*. at 3.

[101] *Id*. at 10.

[102] *Id*. at 16.

[103] *Id*.

[104] *Id*. at 12.

[105] *Id*. at 16.

[106] AT&T Comments at 5-6.

[107] *Id*. at 6.

[108] AT&T Comments at 12.

[109] *Id*. at 13.

[110] AT&T Reply at 4.

[111] *Id*.

before the Commission authorizes GVP operations, the record should contain proposed rules that cover such topics as location determination and accuracy, how geofencing boundaries will be implemented, additive interference, the geofencing model (geofencing system architecture), GVP device elevation, database and geofence reauthorization intervals, and an exclusion zone buffer to account for mobility.[112]

25. Evergy cautions that the Commission "should hold off on further expanding unlicensed operations in the 6 GHz band until enough real-world experience has occurred to gain the confidence of incumbents in the utility industry."[113] Evergy is concerned that unlicensed devices will raise the noise floor and result in harmful interference to incumbent licensed operations.[114] Evergy cautions that if harmful interference occurs, its "existing mission-critical systems may become unreliable and inoperable while its engineers engage in . . . [the] extremely difficult, if not impossible, task" of identifying the responsible unlicensed device(s).[115] Evergy describes the proposed 1 dBm/MHz EIRP PSD as "a dramatic increase in power that poses significant risk to incumbent licensees" and urges the Commission to reject this proposal as well as the request by GVP advocates for maximum power levels of 21 dBm EIRP and 8 dBm/MHz EIRP PSD.[116] Evergy asks that the Commission ensure that any geofencing solution protect microwave links commensurate with the protection provided by the AFC system.[117]

26. The American Petroleum Institute (API) does not support permitting VLP devices to operate at 1 dBm/MHz EIRP PSD until more field data on VLP devices and interference is collected, which it predicts would take two years or more.[118] Provided data is collected over the proper time frame and the results show VLP devices are operating without impacting incumbents, API claims that the proposed geofencing system allowing GVP devices to operate at up to 1 dBm/MHz EIRP PSD and 14 dBm EIRP appears to have merit.[119] The Utilities Technology Council and the Edison Electric Institute (UTC/EEI) joint comments advise the Commission to "refrain from further expanding unlicensed operations in the 6 GHz band" until it better understands the interference environment from currently authorized 6 GHz unlicensed devices.[120] The Association of Public-Safety Communications Officials, International (APCO), noting the rules for that VLP devices have only recently been implemented, advises the Commission to let "[r]eal-world operational experience and testing . . . guide any future decision-making rather than risk essential public safety communications networks with theoretical models and lab testing alone."[121]

27. The Electric Power Research Institute (EPRI) states that if VLP devices "[are] allowed to operate at 1 dBm/MHz [EIRP] PSD, then it is imperative that the method used to prevent operation in areas with elevated risk of harmful interference be infallible."[122] EPRI claims that its research shows that

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[112] *Id*. at 4-6.

[113] Evergy Reply at 4.

[114] *Id*.

[115] *Id*.

[116] *Id*. at 9. Evergy also asks the Commission to reject the request by the Wi-Fi Alliance to allow VLP devices to operate at 1 dBm/MHz EIRP PSD without geofencing. *Id.*

[117] *Id*. at 10.

[118] API Comments at 5.

[119] *Id*.

[120] UTC/EEI Reply at 5.

[121] APCO Reply at 2.

[122] EPRI Comments at 1. While this document is listed in the docket as being from Robert Chapman, Tim Godrey, and Jay Herman, the document clearly indicates that it represents the technical comments of the Electric Power Research Institute (EPRI). This document shall be referred to as the "EPRI Comments."

even at the -5 dBm/MHz EIRP PSD level at which VLP devices operate, a scheme to prevent VLP devices from operating co-channel in a microwave receiver's main beamwidth is necessary to prevent harmful interference and that exclusion zones could be an effective method to protect these sites provided the propagation models align with the findings from real-world testing.[123]

28. *Discussion*. We are adopting rules to permit GVP devices to operate in the U-NII-5 and U-NII-7 portions of the 6 GHz band at up to 11 dBm/MHz EIRP PSD and 24 dBm EIRP while under the control of a geofencing system. As discussed in more detail below, the geofencing system must comply with various requirements to prevent GVP operations at locations where they may cause a significant risk of harmful interference to licensed incumbent services that share the 6 GHz band. The geofencing system will use the same propagation models and protection criteria that are employed by AFC systems to calculate exclusion zones in which the GVP access points will not be permitted to operate co-channel with a microwave receiver.[124] The geofencing system will also prevent GVP access points from operating near certain radio astronomy observatories. The GVP access points will be required to have a geolocation capability to determine when they enter an exclusion zone and must adjust their operating frequency, if necessary, to meet this condition. GVP client devices, which will not be required to have a geolocation capability, will operate only under the control of a GVP access point at 6 dB less than the controlling access point's authorized power.

29. We adopt the 11 dBm/MHz EIRP PSD and 24 dBm EIRP power levels rather than the 1 dBm/MHz EIRP PSD and 14 dBm EIRP power levels proposed in the *6 GHz Second FNPRM* for several reasons. First, the geofencing systems will be equally effective in preventing a significant risk of harmful interference at the higher power levels because the size of the exclusion zones will increase to account for the higher power—i.e., the size of the exclusion zones scales with the power level. Second, we agree with commenters who opine that permitting higher power levels than those proposed in the *6 GHz Second FNPRM* provides a stronger incentive for manufacturers to invest in geofencing systems and GVP devices.[125] Moreover, we recognize that adopting the proposed GVP power levels, which are only an incremental power increase to the VLP power levels, may not convince industry to undertake the expenses associated with developing this new class of devices.[126] Lastly, we believe that 11 dBm/MHz EIRP PSD and 24 dBm EIRP are necessary for GVP access points to deliver the required reliability and performance for body worn applications, as Apple and Meta point out.[127] According to measurements conducted by the Wireless Research Center of North Carolina, which examined the attenuation between two body worn devices for six test subjects, body attenuation can range from 28 to 96 dB.[128] Considering the high level of signal attenuation that must be overcome between body-worn devices, we conclude that the higher power levels we are permitting are appropriate.

30. Commenters agree that permitting higher power levels will enable more versatile GVP devices to be developed and result in a wide variety of innovative products.[129] As Apple, Broadcom et al., point out, the higher PSD level will be particularly useful for applications that rely on narrow channels such as high bitrate audio and control signaling while the higher maximum power will benefit data-

[123] *Id*. at 2.

[124] Apple, Broadcom et al. Comments at 29.

[125] Apple, Broadcom et al. Comments at 26; Dynamic Spectrum Alliance Comments at 14; Wi-Fi Alliance Reply at 12.

[126] Apple, Broadcom et al. Comments at 26; Dynamic Spectrum Alliance Comments at 14; IEEE LAN/MAN Standards Committee Comments at 4.

[127] Apple and Meta Aug. 8, 2025 Ex Parte at 1.

[128] Apple, Broadcom et al. Comments, ET Docket No. 18-295, Attach. B at 9, Figure 15 (filed June 29, 2020).

[129] Apple, Broadcom et al. Comments at 30-31; Wi-Fi Alliance Comments at 9-10; IEEE LAN/MAN Standards Committee Comments at 3; DSA Comments at 14-15.

intensive tasks in applications such as artificial reality/virtual reality, automotive technologies, screen mirroring, hotspots, and indoor location and navigation.[130] Adopting the higher power levels requested by industry with a geofencing requirement provides more versatility to encourage innovative uses and incentivize investment without increasing the harmful interference risk to incumbent users. We also point out that even though we are permitting up to 11 dBm/MHz PSD and 24 dBm EIRP levels, we expect the majority of devices to operate below these maximum levels most of the time. For many reasons, including to increase battery life, portable devices generally operate at the minimum power level necessary to close the link. In addition, we note that Apple and Meta's filing shows that body attenuation is highly variable based on individual factors; the maximum power is only needed for the extreme cases when body attenuation is at its highest. Thus, the higher power levels we are allowing combined with a geofencing system that scales exclusion zones to the power level provides maximum flexibility for the development of versatile devices to provide new applications to the public while continuing to protect incumbent services from a significant risk of harmful interference.

31. We decline to adopt the two-power level model suggested by Apple.[131] We appreciate the desire to simplify geofencing system implementation, but believe this decision is best driven by geofencing system providers based on their intended customers and applications or through industry consensus within a standards process. The rules we adopt simply define maximum PSD and EIRP and permit geofencing system providers to determine whether to calculate a single exclusion zone based on the maximum power or to calculate multiple exclusion zones indexed for lower power levels. Thus, geofencing system providers can determine the proper tradeoff between the flexibility and complexity associated with calculating a single or multiple exclusion zones.

32. We also do not find it appropriate to limit the power available to GVP devices to protect enterprise LPI Wi-Fi devices, as suggested by Cisco and HP Enterprise. 6 GHz band unlicensed devices are expected to share the band with other unlicensed devices. The operators of enterprise Wi-Fi networks have no basis to expect that they can manage use of the 6 GHz band spectrum solely for their benefit. One of the Commission's goals for expanding unlicensed use in the 6 GHz bands is to encourage the development of innovative consumer devices. By increasing the power available to VLP devices that employ geofencing, we will enable exciting new applications, such as body-worn devices for augmented reality/virtual reality, as well as provide for higher data rates for existing uses, such as Wi-Fi hotspots. We do not believe that it would be in the public interest to forego these new applications to potentially prevent harmful interference from occurring to other unlicensed device users. The new applications and higher data rates will be widely available to all consumers and businesses. We believe this is preferrable to the alternative of restricting the capabilities of GVP devices by limiting their power in order to, in effect, permit enterprises to exclusively use the shared 6 GHz band spectrum within their facilities. Moreover, we note that our rules contain provisions designed to promote coexistence among all devices operating in the 6 GHz bands. For example, GVP devices will need to comply with the same contention-based protocol requirements already in place for LPI and VLP devices and the dynamic transmit power control requirement in place for VLP devices.[132]

33. We decline to delay adopting GVP rules in order to collect more data or conduct testing, as suggested by API, UTC/EEI, APCO, Evergy, and AT&T.[133] We also see no reason to adopt the incremental approach of initially adopting a lower GVP level and potentially increasing it after we gain

[130] Apple, Broadcom et al. Comments at 30.

[131] Letter from Paul Margie, Counsel, Apple Inc., to Marlene H. Dortch, Secretary, FCC, ET Docket No. 18-295, GN Docket No. 17-183, Attach. at 2 (filed Oct. 17, 2024).

[132] 47 CFR § 15.407(d)(6), (10).

[133] AT&T Comments at 6; Evergy Reply at 4; API Comments at 5; UTC/EEI Reply at 5; APCO Reply at 2.

more experience with GVP operations.[134] The Commission's rules for AFC-enabled standard-power devices were adopted in 2020,[135] and AFC systems have been approved for commercial operation since February 2024.[136] The Commission has not received any interference complaints related to 6 GHz standard-power devices operating under the control of AFC systems. Because GVP geofencing systems will employ the same propagation models and determine exclusion zones using the same I/N threshold as the AFC systems, we are confident that the geofencing systems will be equally effective at preventing a significant risk of harmful interference. Also, in the unlikely event that harmful interference occurs, we will require geofencing systems to adjust any or all exclusion zones. Thus, the rules contain an effective mitigation strategy should harmful interference occur.[137]

34. We are unpersuaded by Evergy's concerns regarding increasing the noise floor or causing harmful interference to microwave receivers.[138] The geofencing system will prevent operation of GVP access points and associated client devices at locations where they present a risk of causing harmful interference to microwave receivers. We note that Evergy has not presented any technical analysis indicating that such harmful interference will occur in practice or that GVP devices operating in conjunction with a geofencing system will raise the noise floor. Our experience with AFC systems and the fact that the exclusion zones can be adjusted, if necessary, indicate that harmful interference is unlikely to be an issue and that if any interference issues do arise, they can be addressed by the Commission. As to EPRI's contention that any method used to prevent VLP device operation in areas with elevated interference risk must be "infallible," we acknowledge that no spectrum management system is infallible.[139] However, based on past experience with using databases to effect spectrum management opportunities, such as with the AFC systems and the spectrum access systems (SAS) used to manage access to the 3550-3700 MHz band in the Citizens Broadband Radio Service, we believe that the geofencing systems that our rules are enabling will permit GVP operation without posing a significant risk of harmful interference.[140]

35. We disagree with AT&T that the lack of a specific proposal by GVP advocates prevented incumbents from rationally evaluating the potential for harmful interference.[141] The rules we are adopting closely mirror our proposal in the *6 GHz Second FNPRM* and require GVP devices to operate pursuant to a geofencing system that will be based on the same propagation models as used for the AFC systems. The *6 GHz Second FNPRM* sufficiently discussed the topics that AT&T claims must be included in a serious proposed set of GVP rules.[142]

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[134] AT&T Comments at 6.

[135] *6 GHz First Order*, 35 FCC Rcd at 3861-88, paras. 20-95.

[136] *OET Announces Approval of Seven 6 GHz Band Automated Frequency Coordination Systems for Commercial Operation and Seek Comment on C3Spectra's Proposed AFC System, Public Notice*, 39 FCC Rcd 1370 (OET 2024).

[137] *Infra* para. 160.

[138] Evergy Reply at 8-9.

[139] EPRI Comments at 1.

[140] 47 CFR pt. 96.

[141] AT&T Reply at 4-6.

[142] These topics included location determination and accuracy, *6 GHz Second FNPRM*, 38 FCC Rcd at 10595, para. 155; implementation of geofencing boundaries, *id.* at 10584-86, paras. 124-28; additive interference, *id.* at 10584, paras. 125-26; the geofencing model, *id.* at 10583, paras. 121-22; GVP device elevation, *id.* at 10596, para. 158; and database and geofence reauthorization intervals, *id.* at 10592, 10595-96, paras. 145, 156-57. Although AT&T could argue that the *6 GHz Second FNPRM* did not explicitly discuss expanding exclusion zone sizes to account for GVP devices that may be in motion, i.e., a "buffer for mobility," this concern is subsumed by the discussion for GVP devices to timely adjust operating frequencies when moving into exclusion zones. *See id.* at 10595, para. 156.

36. We are not increasing the general (i.e., non-geofenced) VLP PSD to 1 dBm/MHz EIRP, as suggested by the Wi-Fi Alliance and the IEEE LMSC.[143] The *6 GHz Second FNPRM* explicitly declined to seek comment on modifying the VLP rules for devices operating without a geofencing system except for some aspects of the out-of-band emission limits.[144] Thus, any consideration of higher power for non-geofenced VLP devices is beyond the scope of this proceeding.

37. Finally, AT&T questions the computer simulations on which the Commission relied when adopting the VLP device rules.[145] However, we are not relying on those computer simulation results in reaching our decision to permit GVP operations. Instead, we base our decision to permit GVP on the adoption of rules requiring the use of a geofencing system to prevent any significant risk of harmful interference. Therefore, the veracity of the simulations the Commission relied on when authorizing VLP devices is not relevant to our decision here permitting GVP operations.

B. GVP Client Device Power

38. The *6 GHz Second FNPRM* proposed to require client devices operating under the control of a GVP access point to transmit only on channels determined by that GVP access point.[146] Under this proposal, client devices would not be required to directly obtain or calculate exclusion zones.[147] The *6 GHz Second FNPRM* proposed that client devices operating under the control of a GVP access point be permitted to operate at the same power level as the GVP access point.[148]

39. AT&T expresses concern that the *6 GHz Second FNPRM* proposed to permit client devices connected to GVP access points to operate at the same power as the GVP access point, even though only the GVP access points will be subject to geolocation and geofencing requirements.[149] AT&T calls this a "significant and unexplained departure from the requirement" for standard-power and LPI operations that client devices operate at power levels at least 6 dB less than the associated access points.[150] AT&T suggests that if the Commission does not require GVP client devices to similarly operate at lower power levels, the exclusion zones should be extended by 365 meters, the range over which AT&T claims that two GVP devices could communicate.[151]

40. Apple, Broadcom et al. suggest that the Commission's rationale for adopting lower power limits for standard-power and LPI client devices does not apply to GVP devices.[152] Apple, Broadcom et al., note that the Commission mandated lower power for standard-power and LPI client devices "as a precaution against the theoretical scenario that a client device could operate in a location with a substantially different interference potential compared to its associated standard-power [access point]."[153] Apple, Broadcom et al. claim that scenario will not occur for GVP client devices because they "must operate in close proximity [to their access point] due to their lower power levels relative to standard power [access points]."[154] Apple, Broadcom et al. further explain that the power level for LPI client

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[143] Wi-Fi Alliance Comments at 13-15; IEEE LAN/MAN Standards Committee Comments at 4.

[144] *6 GHz Second FNPRM*, 38 FCC Rcd at 10576, para. 104.

[145] AT&T Comments at 5-6.

[146] *6 GHz Second FNPRM*, 38 FCC Rcd at 10582, para. 119.

[147] *Id*.

[148] *Id*.

[149] AT&T Comments at 13.

[150] *Id*.

[151] *Id*.

[152] Apple, Broadcom et al. Reply at 24.

[153] *Id*. at 24-25.

devices was specifically lowered to prevent outdoor use, an issue that is not relevant for GVP client devices, which would be allowed to operate outdoors.[155]

41. Apple supports the Commission's proposal to authorize the same power levels for GVP access points and client devices because the devices will rely on symmetrical bi-directional communication.[156] Apple suggests that if the Commission decides to adjust the size of the exclusion zones determined by the geofencing system to account for the potential separation distance between a GVP access point and client device, "expanding the exclusion zones by 75 meters would be a very conservative approach," as demonstrated by data presented by Apple and Meta.[157] The Apple and Meta data show the separation distance that can be achieved between GVP access points and client devices when operating a communication link at different Wi-Fi modulation and coding schemes (MCS) in urban and suburban areas.[158] These calculations were based on operation with 21 dBm EIRP, 4 dB of body loss, 0 dBi antenna gain, a transmit frequency of 6.5 GHz, and the use of the propagation models specified in the Commission's rules for AFC operation.[159] This data illustrates that as the MCS level increases the GVP access points and client devices must be closer together to successfully communicate.[160] Apple and Meta maintain that these calculations show that "a 75-meter buffer would more than account for the potential distance between a [GVP access point] and client [device] . . . because this would be larger than the maximum separation distance established using AFC modeling for devices operating at MCS 4."[161] Apple and Meta claim that "[GVP] devices are likely to overwhelmingly operate at MCS 4 and above" because "[o]peration at MCS 1 would not support the throughput requirements needed for this class of devices, which will enable [augmented reality], video, and other high-throughput applications."[162] They also maintain that "in the real world, [GVP] devices will rarely, if ever, be separated by 75 meters" because they "may not be fixed, must be workable at far lower power than standard Wi-Fi, and include a geolocation-capable [access point]."[163] Apple and Meta note that GVP devices "[t]ypically will be body-worn devices that operate with negligible separation distances."[164] Apple and Meta also claim that AT&T's suggested 365-meter buffer distance cannot be replicated and that AT&T relies on unrealistic

(Continued from previous page)

[154] *Id*. at 25.

[155] *Id*.

[156] Apple June 26, 2025 *Ex Parte* at 1.

[157] *Id*. at 1-2.

[158] Letter from Paul Margie, Counsel, Apple Inc., to Marlene H. Dortch, Secretary, FCC, ET Docket No. 18-295, GN Docket No. 17-183, Attach. at 3-4 (filed June 13, 2025).

[159] Apple and Meta June 13, 2025 *Ex Parte* at 1-2.

[160] An MCS is a combination of the modulation scheme used to encode digital data into a radio signal and the error control coding technique used to correct bit errors. In general, with a higher order MCS, the signal can carry a higher data rate but it is more susceptible to interference. Using a higher order MCS requires the signal to have a greater signal-to-noise ratio. Therefore, devices using a lower order MCS can communicate over a greater distance than those using a higher order MCS for a given power and signal-to-noise ratio. For example, two devices using an MCS 1 can be separated by a greater distance than if they are using MCS 4.

[161] *Id*. at 2.

[162] *Id*.

[163] *Id*.

[164] *Id*.

assumptions, such as using only the free-space propagation model.[165]

42. Recently, Apple and Meta have implicitly supported a 6 dB power differential between GVP access points and associated client devices by advocating that maximum authorized power levels of at least 11 dBm/MHz PSD and 24 dBm EIRP for GVP access points and 5 dBm/MHz PSD and 18 dBm EIRP for GVP client devices are essential for adequate reliability and performance for GVP use cases.[166]

43. *Discussion*. We are adopting GVP access point power levels that are higher than were proposed in the *6 GHz Second FNPRM*—up to 11 dBm/MHz EIRP PSD and 24 dBm EIRP instead of the proposed 1 dBm/MHz EIRP PSD and 14 dBm EIRP.[167] At these higher power levels, it is possible for client devices to operate at distances farther from the controlling GVP access point than anticipated under our proposal. Although many potential GVP applications, such as body-worn devices for augmented reality/virtual reality, will involve access points and client devices located on the same person, other applications, such as a GVP mobile hotspot, would likely involve client devices that are distant from the access point. Consequently, a client device operating at the same power as its controlling GVP access point could be located within an exclusion zone even when the GVP access point is safely outside of the exclusion zone. Therefore, consistent with existing 6 GHz client device rules,[168] we will require client devices under the control of a GVP access point to operate at power levels at least 6 dB less than the power level determined by the geofencing system for the associated GVP access point. Because we are implementing this power reduction requirement for GVP client devices, we decline to extend the exclusion zone boundaries, as AT&T suggests.

44. Apple, Broadcom et al. provide no rationale to support their claim that GVP client devices must operate in close proximity to GVP access points.[169] While Apple, Broadcom et al. are correct that one of the motivations for the 6 dB power differential between LPI access points and their associated client devices was to limit the client devices to indoor operation, client devices connected to standard-power access points are also restricted to 6 dB less power than their associated access point and such access points and client devices are not limited to indoor operation.[170] This illustrates that when adopting the rules for standard-power devices the Commission believed that it is necessary to impose a 6 dB power difference between access points and client devices to prevent the client devices from operating too close to microwave receivers even when the associated access point is operating under the control of an AFC system. We continue to hold to that reasoning and reach the same conclusion for GVP devices. In addition, Apple provides no basis for contending that GVP devices will rely on symmetrical bi-directional communication.[171] Other 6 GHz unlicensed devices such as standard-power and LPI devices function with a 6 dB power differential between access points and client devices and we see no basis for concluding that GVP devices cannot also be designed to account for this power difference.

45. We find that providing 6 dB lower power for GVP client devices is a superior approach for compensating for the separation distance between GVP access points and client devices than adding a 75-meter buffer to the exclusion zone boundaries, as suggested by Apple and Meta. The 75-meter buffer

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[165] *Id*. at 2-3. Apple and Meta note that the Commission has previously concluded that the free-space propagation model is appropriate only for distances of fewer than 30 meters. *Id.* (citing *6 GHz First Order*, 35 FCC Rcd at 3875, para. 64; *6 GHz Second Order*, 38 FCC Rcd at 10535-36, paras. 27, 29, 34).

[166] Apple and Meta August 8, 2025 Ex Parte at 1.

[167] *6 GHz Second FNPRM*, 38 FCC Rcd at 10577, para. 106.

[168] 47 CFR § 15.407(a)(7); *6 GHz First Order*, 35 FCC Rcd at 3862, 3890, paras. 22, 103; *see* 47 CFR § 15.407(a)(8).

[169] Apple, Broadcom et al. Reply at 25.

[170] 47 CFR § 15.407(a)(7); *6 GHz First Order,* 35 FCC Rcd at 3922-23, paras. 189-91.

[171] Apple June 26, 2025 *Ex Parte* at 1.

size is based on the assumption that at least MCS 4 will always be necessary for these devices. While this may be the case for the augmented-reality glasses and wristband electromyography technology that are the subject of Apple and Meta's presentation,[172] we are not limiting GVP devices to particular technologies or applications. GVP devices operating under the rules we are adopting are expected to operate at a range of MCS levels as needed for different applications and will be able to employ technologies other than Wi-Fi. Consequently, we cannot conclude that GVP access points and client devices will always be limited to a 75-meter separation distance. Applying the same 6 dB power level differential between access points and client devices as we have used for other types 6 GHz unlicensed devices is a more straightforward approach to protecting licensed operations that share the 6 GHz band, while also enabling GVP client devices to operate at the power levels that Apple and Meta state are necessary to ensure reliable communications.[173] This approach also maintains the coexistence scheme already in place to protect incumbents from a significant risk of harmful interference.

46. We do not believe that imposing a 6 dB power differential between GVP access points and associated client devices will hinder the usefulness of GVP devices. As noted above, Apple and Meta have advocated that GVP client devices should have a maximum permitted power level of at least 18 dBm and 5 dBm/MHz to support the envisioned use cases, such as body-worn devices for augmented reality applications and multiple peer-to-peer links.[174] While Apple, Broadcom et al. have indicated that they support 8 dBm/MHz EIRP PSD and 21 dBm EIRP power levels and also advocate for no power differential between GVP assess points and client devices, they have not indicated that limiting client devices to 3 dB below these power levels will hinder the implementation of particular use cases.[175] Therefore, we have no reason to conclude that the power limits we are establishing for client devices under the control of GVP access points will inhibit the usefulness of GVP devices.

47. Under the rules we are adopting, GVP client devices are limited to a maximum of 5 dBm/MHz EIRP PSD and 18 dBm EIRP. In addition, for GVP access points operating within an exclusion zone and pursuant to geofencing instructions limiting power below the maximum permitted, associated client devices will similarly be required to reduce power such that they are at least 6 dB less than the maximum power permitted for the GVP access point. For example, if a GVP access point is operating in an exclusion zone and limited by the geofencing system to 1 dBm/MHz EIRP PSD and 14 dBm EIRP, an associated client device will be limited to -5 dBm/MHz EIRP PSD and 8 dBm EIRP. However, if a GVP access point transmits at less than its maximum permitted power level, the maximum power for the client device is determined by subtracting 6 dB from the access points maximum permitted power, not by subtracting 6 dB from the access points transmit power. For example, if a GVP access point that is operating outside of any exclusion zone transmits at 5 dBm/MHz PSD and 18 dBm EIRP, an associated client device could transmit at this same power level because the maximum permitted power level of the access point is 11 dBm/MHz PSD and 24 dBm EIRP.

C. GVP Operations in U-NII-6 and U-NII-8

48. In the *6 GHz Second FNPRM,* the Commission proposed that geofencing systems protect BAS and CARS operations in the U-NII-6 and U-NII-8 bands.[176] The Commission noted that both the U-NII-6 and U-NII-8 bands are used by mobile broadcast auxiliary services, including outdoor electronic news gathering (ENG) trucks and low power short range devices, such as portable cameras and

[172] Apple and Meta June 13, 2025 *Ex Parte* Attach. at 2.

[173] Apple and Meta August 25, 2025 Ex Parte at 1.

[174] *Id*. at 1-2.

[175] Apple, Broadcom et al. Comments at 26-27, 32-33.

[176] *6 GHz Second FNPRM*, 38 FCC Rcd at 10586, para. 130.

microphones.[177] Low Power Auxiliary Stations, which are licensed in portions of the U-NII-8 band, operate on an itinerant basis and transmit over distances of approximately 100 meters for uses such as wireless microphones, cue and control communications, and TV camera synchronization signals.[178] ENG trucks transmit video programming, generally using telescoping directional antennas that are oriented toward a central receive site from remote sites, such as the location of news or sporting events, to a central receive site.[179] The Commission proposed that the geofencing systems protect the BAS and CARS operations using the same propagation models, interference protection criterion, and body loss assumptions as used to protect microwave receivers in the U-NII-5 and U-NII-7 bands.[180]

49. Due to the steerable nature of the central receive antennas, the Commission asked if exclusion zones surrounding central receive sites need to be circular to ensure protection in all directions, or could they be only part of a circle, i.e., less than 360 degrees.[181] The Commission noted that BAS and CARS operations are typically licensed for the entire band(s) in which they operate (i.e., U-NII-6, U-NII-8, or both), and asked whether GVP devices should avoid operation across the entire band that a BAS/CARS site receives within the exclusion zones.[182] The Commission sought comment on whether there are ways to reduce the size of the exclusion zones to protect BAS and CARS receive sites, limit the number of frequencies excluded within those zones, or limit receive site protection to only the specific times when they are in use.[183] More specifically, the Commission asked whether BAS and CARS users should be required to notify a geofencing system of their ENG operations, and for the geofencing systems to incorporate a push notification feature or similar functionality to provide information (e.g., actual operating locations and frequency usage, on a near real-time basis) to GVP devices so that the exclusion zones in the U-NII-6 and U-NII-8 bands can be tailored to actual usage rather than all possible usage areas.[184] The Commission noted that if we were to adopt a push notification or similar approach to protect BAS/CARS based on usage, there would be a need for one or more centralized systems to register BAS/CARS usage and provide the information to geofencing systems.[185]

50. The Commission proposed that low power short range BAS and CARS devices, such as portable cameras and microphones, and Low Power Auxiliary stations be protected from harmful interference by a combination of a required contention-based protocol and the low probability of a GVP device operating on the same channel in a nearby location.[186] The Commission explained that the sensing function associated with the contention-based protocol, along with the low probability for co-channel operation, is sufficient to ensure that GVP devices detect nearby mobile BAS operations and avoid transmitting co-channel to protect those operations from harmful interference.[187]

51. Apple, Broadcom et al. point to a computer simulation they submitted prior to the issuance of the *6 GHz Second FNPRM* as evidence that harmful interference will not occur to ENG

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[177] *Id.*

[178] 47 CFR pt. 74, subpt. H.

[179] These are referred to as "TV pickup stations" in the part 74 rules. 47 CFR § 74.601(a).

[180] *6 GHz Second FNPRM*, 38 FCC Rcd at 10586, para. 131.

[181] *6 GHz Second FNPRM*, 38 FCC Rcd at 10586, para. 130.

[182] *6 GHz Second FNPRM*, 38 FCC Rcd at 10586-87, para. 131.

[183] *6 GHz Second FNPRM*, 38 FCC Rcd at 10587, para. 133.

[184] *6 GHz Second FNPRM*, 38 FCC Rcd at 10587-88, para. 133.

[185] *6 GHz Second FNPRM*, 38 FCC Rcd at 10588-89, para. 136.

[186] *6 GHz Second FNPRM*, 38 FCC Rcd at 10589, para. 138.

[187] *6 GHz Second FNPRM*, 38 FCC Rcd at 10590, para. 139.

receive sites from GVP operations at 21 dBm EIRP.[188] This simulation examined two ENG receive sites at Cowles Mountain, San Diego, CA, and the Old Post Office in Washington, DC.[189] The simulations analyzed mobile links from ENG trucks to BAS central receive sites for a total of six links per site.[190] The simulations purport to show that both sites had a close to zero percent probability of experiencing an I/N higher than -6 dB due to VLP devices operating at 21 dBm.[191] While Apple, Broadcom et al. claim the record shows there will be an insignificant risk of harmful interference when GVP operates at 21 dBm EIRP, they "support the Commission's belt-and-suspenders use of geofencing for this GVP device class."[192] They note that adopting a contention-based protocol requirement and the opportunity for broadcasters to report on ENG link locations will further diminish the risk of harmful interference to ENG incumbent licensees.[193]

52. NAB contends that the Commission's proposal to protect mobile operations using exclusion zones around registered ENG central receive sites is based on an incomplete view of how this spectrum is used.[194] It points out that "[w]hile transmission from a mobile ENG truck to a central receive site is a common way that licensed users of this spectrum operate," "[b]roadcasters make use of this spectrum in myriad ways when covering newsworthy events, including from camera-back transmitters to temporary receivers mounted on trucks that can operate nationwide."[195] NAB claims that the proposal for BAS users to provide operating locations and frequencies to a database administrator would "add[] significant burden and delay to the newsgathering process" and require "untold expense to implement a system to capture this information."[196] NAB also criticizes the computer simulation upon which Apple, Broadcom et . al. rely, claiming that the analysis showing absolutely no interference to ENG receivers is plainly unreasonable because many hypothetical VLP transmitter locations near an ENG receive antenna would present a signal exceeding a –6 dB I/N level.[197]

53. *Discussion*. We defer adoption of rules to permit GVP operation in the U-NII-6 and U-NII-8 bands because we do not believe that the record currently contains sufficient details to adopt geofencing that will efficiently manage spectrum while protecting mobile BAS and CARS operations. Because news events can occur anywhere with little notice, a geofencing system that is based on the actual location and directionality of the links between ENG truck transmitters and the central receive sites will require updated information on the locations of ENG truck transmitters. If the ENG operations are not tracked in a centralized database, the geofencing systems will have to protect the ENG receivers over a 360-degreee radius at all times. This large area will need to be protected across the entire U-NII-6 and U-NII-8 bands because BAS and CARS licenses typically permit transmissions across the entire bands. Because ENG news gathering is conducted by broadcasters throughout the nation, establishing exclusion zones at every ENG central receive site that covers the entire U-NII-6 and U-NII-8 bands will remove a tremendous amount of spectrum from use by GVP devices. Hence, to efficiently manage access to this spectrum we find that we should consider how geofencing systems can be designed to use information on

[188] Apple, Broadcom et al. Comments at 38.

[189] Apple, Broadcom et al. Comments Attach. A: *Frequency Sharing for Very Low Power ("VLP") Radio Networks in the 6 GHz Band*, RKF Engineering at 47-48, 51 (June 29, 2020).

[190] *Id*. at 50.

[191] Apple, Broadcom et al. Comments at 39-40.

[192] *Id*. at 40-41.

[193] Apple, Broadcom et al. Reply at 40.

[194] NAB Comments at 11.

[195] *Id.*

[196] *Id*.

[197] NAB Comments at 8-9.

actual ENG use to quickly update the exclusion zones governing GVP device use.

54. While Apple, Broadcom et al. support the use of geofencing systems for GVP devices operating in the U-NII-6 and U-NII-8 band and contend that NAB has not substantiated its claim that providing real-time information on BAS/CARS use would be a burden to newsgathering operations,[198] they have not provided any details on how geofencing systems would collect BAS/CARS usage information and manage GVP device spectrum use. For us to adopt rules for geofencing systems that use real-time information on BAS/CARS use, we would have to address many issues such as: How would the information on BAS/CARS use be collected? Who would collect this information? What specific information would be collected? How would the information be propagated to the various geofencing systems? How would updated exclusion zones based on this information be pushed to the GVP access points? How quickly would the GVP access points need to adjust their spectrum use as BAS/CARS spectrum use changes? Given the lack of record on how this process would work in practice, we do not believe that we have sufficient information to adopt rules for geofencing systems for the U-NII-6 and U-NII-8 bands. In adopting rules to permit GVP device operations in the U-NII-5 and U-NII-7 bands while deferring consideration of operations in the U-NII-6 and U-NII-8 bands, we are following the same path the Commission used to adopt rules for VLP devices. In the 2023 *6 GHz Second Order,* the Commission adopted rules to permit VLP device operation in U-NII-5 and U-NII-7.[199] In 2024, after obtaining a more robust record, the Commission expanded VLP operations to the U-NII-6 and U-NII-8 bands in the *6 GHz Third Order*.[200]

D. Geofencing System Architecture

55. In the *6 GHz Second FNPRM* the Commission proposed to provide manufacturers with flexibility to design appropriate geofencing systems for different equipment use cases rather than mandate a specific geofencing system architecture and provided three examples.[201] A first example architecture could have a centralized geofencing system calculate exclusion zones based on information obtained from Commission databases, e.g., the Universal Licensing System (ULS), as well the Commission's rules.[202] A GVP access point would contact the centralized geofencing system to download exclusion zones and then manage its spectrum use based on the downloaded information.[203] A second example architecture could have a GVP access point regularly send its location to a centralized geofencing system, which would then inform the access point as to the channels it may use.[204] This second example architecture would use the same methodology as the existing AFC systems that manage standard-power access point spectrum access with the added requirement to account for the inherent mobility associated with GVP access points.[205] A third example architecture could integrate the geofencing system within a GVP access point.[206] A GVP access point would obtain local licensing data by downloading information from an external source.[207] The GVP device would need to contain software necessary to use that data to

[198] Apple, Broadcom et al. Reply at 41-42.

[199] *6 GHz Second Order*, 38 FCC Rcd at 10532, para. 18.

[200] *6 GHz Third Order*, 39 FCC Rcd at 13908, para. 12.

[201] *6 GHz Second FNPRM*, 38 FCC Rcd at 10583, para. 121.

[202] *Id.* AFC systems are designed to provide lists of available channels and power levels to standard power access points and fixed client devices in the U-NII-5 and U-NII-7 bands at the single set of geographic coordinates where a device is registered. 47 CFR § 15.407(k)(4).

[203] *6 GHz Second FNPRM*, 38 FCC Rcd at 10583, para. 121.

[204] *Id.*

[205] *Id.*

[206] *Id.*

[207] *Id.*

independently determine exclusion zones and manage its spectrum use.[208] The first and second examples are categorized as "centralized" architectures because they rely on a central server to perform the calculations necessary to implement the geofenced exclusion zones, while the last is a "distributed architecture" in which the calculations are performed by each GVP access point. The Commission proposed to permit either a distributed or centralized architecture.[209] The Commission also sought comment on whether it should provide flexibility for the geofencing system implementations or specify a single approach.[210]

56. AT&T suggests that we require a geofencing architecture where the GVP device downloads keyhole-shaped geofenced exclusion zones from a central server because such a system would be simpler than the Commission's other two example architectures.[211] This suggested architecture is a specific example of the first example architecture which uses simplified exclusion zone boundaries rather than permitting more complex exclusion zones determined by propagation models consistent with the AFC systems as the Commission has proposed.[212] AT&T notes that the simplified approach of the first example architecture would "reduce[] the complexity and storage requirements of those [GVP] devices."[213] By contrast, AT&T claims that the Commission's second example architecture, in all practicality, would revert to the existing AFC system and result in overly complex exclusion zones.[214] AT&T also advises the Commission not to authorize a distributed architecture, i.e., the Commission's third example architecture.[215] According to AT&T, a distributed architecture would effectively require each device to be its own AFC system but without the controls in place for AFC systems, such as the standards-based interference calculation, AFC system public validation through trials, and a common interference reporting system.[216] AT&T claims that AFC system and device implementation variations would render device certification untenable.[217] AT&T argues that permitting these types of devices would "impose[] massive burdens on [fixed microwave] incumbents to continually monitor every VLP device application and conduct assessments to determine if a multiplicity of self-coordinating devices using proprietary mechanisms will actually protect [fixed microwave] incumbents.[218] Evergy advocates that the Commission require a centralized architecture to calculate exclusion zones to ensure licensed incumbents are protected in a consistent and predictable manner.[219] UTC/EEI also favor a centralized architecture, noting that a distributed framework would not be as effective and would pose a greater interference risk to incumbents.[220]

57. Apple, Broadcom et al. explain that the Commission's proposal to "allow[] both centralized and distributed geofencing systems affords device manufacturers sufficient flexibility to

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[208] *Id.*

[209] *6 GHz Second FNPRM*, 38 FCC Rcd at 10583, para. 121.

[210] *6 GHz Second FNPRM*, 38 FCC Rcd at 10583, para. 122.

[211] AT&T Comments at 7-8, 14-16.

[212] *6 GHz Second FNPRM*, 38 FCC Rcd at 10583, para. 121.

[213] AT&T Comments at 7-8.

[214] AT&T Comments at 8, 14-15.

[215] AT&T Comments at 15.

[216] AT&T Comments at 15.

[217] AT&T Comments at 15.

[218] AT&T Comments at 15-16.

[219] Evergy Reply at 10-11.

[220] UTC/EEI Comments at 10-11.

facilitate higher- power operations while still providing robust protections for incumbent operators."[221] According to Apple, Broadcom et al., "AT&T's opposition to the Commission's proposal fails to recognize that (1) the AFC rules prohibit mobile devices and (2) the Commission's geofencing proposal has several critical benefits compared to AFC—energy efficiency, consumer privacy, and flexibility."[222] Apple, Broadcom et al. claim that the fundamental difference between what the Commission proposes and AT&T's proposal is that the Commission's proposal facilitates mobile operations.[223] They note that the AFC rules prohibit mobile operations and that the Commission's proposal is "simple enough to facilitate mobile operations without imposing unnecessary device or AFC system complexity."[224] Apple, Broadcom et al. also claim that AT&T's proposal "would require frequent AFC system queries, which would drain consumers' batteries" and would compromise consumer privacy due to the need to constantly transmit the access point's location to third parties.[225] Apple, Broadcom et al. also claim that the Commission's proposal will support GVP technology adoption for a broad range of applications.[226] Apple, Broadcom et al. also disagree with AT&T's claim that consumer devices will not be capable of implementing a distributed architecture.[227] They explain that device manufacturers can choose which approach is best for its device; noting that the Commission's proposal allows more capable devices to use the distributed approach.[228]

58. Comsearch recommends that the Commission allow flexibility for the geofencing architecture, noting that the GVP device use case should determine which architecture is most feasible.[229] According to Comsearch, if a centralized approach, such as the current AFC systems, is used, the need for a mobile device to keep the centralized system informed of its location, direction, and velocity "would substantially complicate message exchange and spectrum availability calculations" compared to AFC systems.[230] However, Comsearch states that a centralized approach, such as an AFC system, would be more feasible for stationary GVP devices.[231]

59. Federated Wireless urges the Commission to "adapt the currently authorized AFC systems for the new [GVP] class" rather than certifying a novel system.[232] According to Federated Wireless, "[t]he information that AFC systems currently provide to [s]tandard [p]ower devices in the 6 GHz band is identical to what would be needed to allow higher-power [GVP] devices to access those frequencies."[233] In order to account for GVP device mobility, Federated Wireless suggests that information on channel availability and power levels could be calculated for a predefined area, with the device only needing to check-in with the AFC system again if it moves outside that area.[234] Federated

[221] Apple, Broadcom et al. Reply at 30.

[222] *Id*. at 31.

[223] *Id*. at 31.

[224] *Id*. at 31.

[225] *Id*. at 31-32.

[226] *Id*. at 32-33.

[227] *Id*. at 33-34.

[228] *Id*. at 33-34.

[229] Comsearch Comments at 2.

[230] *Id.*

[231] *Id*.

[232] Federated Wireless Comments at 3.

[233] Federated Wireless Reply at 2.

[234] Federated Wireless Reply at 3.

Wireless recommends that "AFC system operators work with [GVP] device manufacturers to specify how this interaction would work in practice and to address other challenges that are specific to [GVP] devices, including battery power consumption and privacy."[235] Federated Wireless also agrees with other commenters, such as Comsearch, that the Commission should accommodate any geofencing system architecture that allows GVP devices to operate without causing harmful interference to incumbents.[236] API claims that the geofencing calculation is best done by an AFC system rather than by a separate geofencing provider.[237]

60. *Discussion.* We will require geofencing systems to use a centralized architecture to control GVP access points. Although we sought comment on also permitting a distributed geofencing architecture, we find that it is appropriate to limit geofencing systems to a centralized architecture because of concerns that it would be difficult to test a distributed architecture geofencing system and that such a system would make it difficult to address any instance of harmful interference, should it occur. As AT&T notes, a distributed geofencing architecture would essentially permit each device to act as its own AFC system, but without any of the controls placed on AFC systems.[238] AFC systems are only authorized after extensive lab testing using industry developed test vectors and a public trial where interested parties have the opportunity to examine AFC system outputs for specific locations.[239] Because each GVP access point in a distributed geofencing system would need to calculate the exclusion zones, each GVP access point model would need to be tested to verify compliance with our exclusion zone rules. As AT&T states, the need to monitor every VLP device application and conduct sophisticated assessments on those devices would impose massive burdens on primary microwave incumbents to determine whether the VLP device adequately protects those systems.[240] Although AT&T raises concerns with testing the operation of distributed geofencing systems in its comments, no commenters provide any suggestions on how such systems may be tested. Given the importance that we place on preventing harmful interference from occurring to licensed incumbents and the need to verify through adequate testing the proper functioning of the geofencing systems, we will not permit use of a distributed geofencing architecture.

61. In the *6 GHz Second FNPRM*, the Commission proposed that each geofencing system operator for centralized systems establish and follow protocols to comply with Commission instructions regarding enforcement actions and to adjust exclusion zones, as necessary, to more accurately reflect the potential for harmful interference.[241] We are adopting these requirements for centralized geofencing systems.[242] These provisions enable the Commission to take action in the unlikely event that a GVP device causes harmful interference to a licensed incumbent. Under a centralized architecture, the Commission can simply issue necessary instructions to the approved geofencing systems to mitigate any harmful interference instances by either eliminating certain devices from operating as GVP devices or to adjust exclusion zones. However, it is not apparent, and commenters have not addressed, how these requirements can be satisfied for a distributed geofencing architecture where each GVP access point may not have regular contact with a database to receive such instructions in a timely manner. This is another reason we are not permitting a distributed geofencing architecture.

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[235] Federated Wireless Reply at 3.

[236] *Id*. at 3-4.

[237] API Comments at 5.

[238] AT&T Comments at 15.

[239] *OET Announces Commencement of Testing of the 6 GHz Band Automated Frequency Coordination Systems*, ET Docket 21-352, Public Notice, 38 FCC Rcd 7733, 7733, 7735-39, 7744-45, paras. 1, 6-18, 36 (OET 2023) https://www.fcc.gov/edocs/search-results?t=advanced&daNo=23-759.

[240] AT&T Comments at 15.

[241] *6 GHz Second FNPRM*, 38 FCC Rcd at 10627-28, Appx. B, § 15.407(o)(11).

[242] *Infra* para. 160.

62. While the Commission noted two examples of centralized geofencing architectures, we are providing flexibility for geofencing administrators to implement various centralized architectures. Our approach will permit geofencing systems to leverage existing AFC systems which could accelerate the time for GVP technology becoming commercially available.[243] However, we will not require that geofencing systems be based on the currently authorized AFC systems, as Federated Wireless and API suggest, because this may discourage innovation and limit the number of geofencing systems that are developed with no apparent benefit.[244] So long as a geofencing system uses a centralized architecture and meets our other requirements, we will not restrict administrators from implementing their preferred method. We believe that this flexible approach will lead to GVP devices that meet a wide variety of use cases. We believe that the first example architecture, where GVP access points determine whether they are in an exclusion zone by downloading information describing those zones from a centralized geofencing system, may be most likely to be deployed, but we will not require use of this specific architecture. Apple, Broadcom et al. argue that AT&T's opposition to the Commission's proposal to permit flexibility in the geofencing architecture fails to recognize the benefits that the proposal has compared to requiring an AFC system, such as energy efficiency, consumer privacy, and flexibility.[245] While we are not adopting the proposal to permit use of a distributed architecture, the flexibility that we are providing to permit use of any type of centralized architecture provides these benefits. Under the first example architecture, only infrequent communication is needed between the GVP access point and geofencing server because the GVP access point can download exclusion zones for a large area, thereby enhancing device battery life.[246] Because only infrequent communication will be required, use of the first example architecture will not substantially complicate message exchange and spectrum availability calculations as Comsearch implies.[247] The first example architecture will also protect consumer privacy because the device does not need to inform the database as it changes position.[248] The rules we are adopting provide the flexibility to use any type of centralized architecture, which should provide device manufacturers with the flexibility to work with geofencing system providers and design appropriate geofencing systems for different use cases.[249]

E. Protection of Fixed Microwave Systems

63. As proposed in the *6 GHz Second FNPRM*, we will protect fixed microwave services from a significant risk of harmful interference by requiring geofencing systems to determine location- and frequency-based exclusion zones for GVP access points around fixed microwave receivers based on the same criterion used by AFC systems to protect microwave receivers from standard-power access points and fixed client devices.[250] Specifically, the geofencing systems will calculate frequency-based exclusion zones using the same propagation models used by the AFC systems to avoid causing an I/N greater than the –6 dB interference protection criterion established for the AFC systems.[251] The – 6 dB criterion was established as an appropriate threshold to protect fixed microwave receivers. Individual GVP devices will use these exclusion zones to determine where they are prohibited from transmitting on particular

[243] Federated Wireless Comments at 3.

[244] Federated Wireless Comments at 3; API Comments at 5.

[245] Apple, Broadcom et al. Reply at 31.

[246] *Id*. at 31-32.

[247] *Id*. at 32.

[248] *Id*. at 32.

[249] *Id*. at 32-33.

[250] *6 GHz Second FNPRM*, 38 FCC Rcd at 10584, 10585, paras. 124, 127.

[251] *Id.*

frequencies to prevent harmful interference from occurring.[252]

64. *Interference protection criterion.* The *6 GHz Second FNPRM* proposed that geofencing systems calculate the GVP exclusion zones based on the same – 6 dB I/N interference protection criterion that the Commission adopted in the *6 GHz First Order* for AFC systems.[253] EPRI characterizes -6 dB as the appropriate interference protection metric,[254] while AT&T states that this metric "should be adjusted in view of additive impacts and the 'at sufferance' nature of Part 15 RLAN devices."[255]

65. The Commission adopted the – 6 dB I/N criterion for use by AFC systems based on an extensive technical record[256] and was supported by the Fixed Wireless Communications Coalition, the Utilities Technology Council et al., and other representatives of fixed microwave incumbents.[257] The – 6 dB I/N metric has also been extensively used in numerous computer simulations developed for analyzing the harmful interference risk posed by unlicensed devices in the 6 GHz band.[258] The – 6 dB I/N interference protection criterion used by AFC systems has been widely supported by 6 GHz unlicensed device proponents and microwave incumbents.[259] The –6 dB metric in conjunction with the propagation models required in our rules have proven sufficient in enabling adequate protection to fixed microwave receivers when standard power devices access spectrum under the supervision of an AFC system. The geofenced systems can similarly use this proven methodology to ensure microwave receivers are protected when unlicensed GVP devices access spectrum in a manner the geofenced system has determined will not present a significant risk of harmful interference. Therefore, we are adopting this same metric for geofencing systems to use when determining exclusion zones. Geofencing systems will be required to determine exclusion zone boundaries based on calculating locations where the I/N ratio exceeds – 6 dB using the propagation models specified in our rules.

66. While AT&T argues that additive interference undermines the technical justification for using the – 6 dB I/N metric, 6 GHz unlicensed devices only present a risk of interference if they are in the microwave antenna's main beam at a close enough distance.[260] The geofenced system that controls GVP access points' spectrum access will prevent those devices from operating at locations where they would present a significant risk of harmful interference. Furthermore, Monte Carlo analysis by Apple shows that the additive effects of LPI and VLP devices, operating without any frequency management mechanism such as a geofencing or AFC system, do not present a significant risk of harmful interference to microwave links.[261] Therefore, we do not agree with AT&T that additive effects undermine the technical reasoning for adopting the –6 dB metric. By adopting this metric, we ensure consistency

[252] *Id.*

[253] *6 GHz Second FNPRM*, 38 FCC Rcd at 10584, para. 124.

[254] EPRI Comments at 4.

[255] AT&T Reply at 7; *see* AT&T Comments at 11 n.20 (stating that "[t]he -6 dB criteria is the minimum that should be considered to protect primary [fixed microwave] incumbents" but that this metric should be adjusted to account for aggregate interference).

[256] *6 GHz First Order,* 35 FCC Rcd at 3878, para. 70.

[257] *See, e.g.*, Fixed Wireless Communications Coalition Comments at 27 (rec. Mar. 18, 2019); Utilities Technology Council et al. Comments at 3, 16 (rec. Mar. 18, 2019); Association of American Railroads Comments at 10 (rec. Mar. 19, 2019); Tucson Electric Power Comments at 26 (rec. Mar. 19, 2019); National Spectrum Managers Association Comments at 7 (rec. Mar. 18, 2019).

[258] CableLabs Dec. 20, 2019 *Ex Parte* at 9; Apple, Broadcom et al. Feb. 28, 2023 *Ex Parte* at 6, 14, 22; Apple Feb. 13, 2023 *Ex Parte* at 4, 6.

[259] *6 GHz First Order*, 35 FCC Rcd at 3878, para. 71.

[260] *6 GHz Second R&O*, 38 FCC Rcd at 10558, para. 61.

[261] Apple Feb. 13, 2023 *Ex Parte* at 17.

between the calculation methods used by AFC and geofencing systems which should enable geofencing administrators to easily develop and implement these systems. Moreover, use of this metric by AFC systems has been effective in preventing harmful interference from occurring to licensed incumbents from standard power device operations. In adopting the use of this metric by geofencing systems, we are not making a determination that any signal received with an I/N greater than – 6 dB would constitute "harmful interference" but are instead using this as a conservative means to ensure that microwave receivers are protected.[262]

67. *Propagation models.* The *6 GHz Second FNPRM* proposed that geofencing systems, to determine the VLP device exclusion zones, use the same propagation models that are used by AFC systems to provide channel and power information to standard power access points and fixed client devices.[263] Specifically, the Commission proposed to require geofencing systems to use the free space path-loss model at separation distances of up to 30 meters, the Wireless World Initiative New Radio phase II (WINNER II) model at separation distances greater than 30 meters and up to and including 1 kilometer, and the Irregular Terrain Model (ITM) combined with the appropriate clutter model at separation distances greater than 1 kilometer.[264] The Commission also proposed to require geofencing systems to use site-specific information, including buildings and terrain data, to determine the line-of-sight/non-line-of-sight path component in the WINNER II model, where such data are available.[265] For evaluating paths where such data are not available, the Commission proposed that geofencing systems use a probabilistic model combining the line-of-sight path and non-line-of-sight path into a single path-loss as set forth in the requirements for AFC systems.[266] The *6 GHz Second FNPRM* proposed that these propagation models be used to calculate the GVP exclusion zones.[267] These proposals were designed to ensure consistency among operating locations and parameters for various GVP systems, as well as consistency with the consensus methodology WinnForum published for AFC systems.[268]

68. EPRI agrees with the Commission that exclusion zones can be an effective method to protect microwave receivers, "provided that the propagation models that define the zones align with findings from real-world interference testing" and that the models account for line-of-sight paths between outdoor unlicensed devices and microwave receivers.[269] EPRI suggests using a purely geometric exclusion zone rather than relying on the Commission's proposed propagation models.[270] The geometric exclusion zone would be based on a 30-meter radius around the microwave receiver that extends into a keyhole shape with edges defined by the microwave receive antenna 3 dB bandwidth out to a distance of 10 kilometers.[271] EPRI states that such distance is necessary to eliminate a discontinuity between the

[262] *6 GHz First Order*, 35 FCC Rcd at 3878, para. 71. The Commission defines harmful interference as "[i]nterference which endangers the functioning of a radionavigation service or of other safety services or seriously degrades, obstructs, or repeatedly interrupts a radiocommunication service operating in accordance with ITU Radio Regulations." 47 CFR § 2.1(c); *see also id.* § 15.3(m).

[263] *6 GHz Second FNPRM*, 38 FCC Rcd at 10585, para. 127.

[264] *Id.*

[265] *Id.*; *see also* 47 CFR § 15.407(l)(1)(ii).

[266] *6 GHz Second FNPRM*, 38 FCC Rcd at 10585, para. 127; *see also* 47 CFR § 15.407(l)(1)(ii).

[267] *6 GHz Second FNPRM*, 38 FCC Rcd at 10585, para. 127.

[268] *6 GHz Second FNPRM*, 38 FCC Rcd at 10585, para. 127; 47 CFR § 15.407(l)(1); *Functional Requirements for the U.S. 6 GHz Band under the Control of an AFC System*, Document WINNF-TS-1014 Version V1.4.0, available at https://winnf.memberclicks.net/assets/work_products/Specifications/WINNF-TS-1014.pdf.

[269] EPRI Comments at 2.

[270] EPRI Comments at 4.

[271] EPRI Comments at 4, 8.

WINNER II and ITM propagation models used by the AFC systems, which EPRI claims implies that AFC systems under-protect FS systems.[272] If the Commission uses a propagation model approach to defining exclusion zones, EPRI advocates using free space path loss as a reliable conservative approach.[273] EPRI also questions whether the ITM clutter models used by the AFCs are relevant for GVP devices because they do not contain a specific category for roads and highways.[274] EPRI opines that automotive GVP devices are likely to be the first to market and that clutter may not be accurately modeled because the WINNER II model includes morphologies for "urban" and "suburban" areas but lacks guidance for roads and highways.[275]

69. AT&T similarly advocates for a simple keyhole exclusion zone that can be defined by a few discrete numbers such as latitude and longitude of the microwave receiver, direction of the main beam, radius of a circle around the receiver, and angle and distance defining a triangle with its apex at the microwave receiver and its base perpendicular to the main beam.[276] It points out that if the exclusion zone is more terrain-dependent, "it could only be defined with a string of high-precision latitude/longitude pairs," which is more complex and similar to the AFC systems that already exist.[277] AT&T suggests using free space path loss to determine the geofencing area and including a 1.9-kilometer buffer for mobility.[278] According to AT&T, the ITM propagation models "are extremely nuanced and susceptible to major variations even with minor changes in distance" and that the algorithms can be implemented in different ways leading to significantly different results.[279]

70. Apple, Broadcom et al. state that the AFC propagation models, which are based on the distance between a GVP device and a microwave receiver, "sufficiently protects incumbents and can be easily applied in the [GVP] context."[280] Further, they claim that using these models "ensures that the exclusion zones are effectively tailored to the actual operating conditions."[281] Apple, Broadcom et al. object to the suggestion that only free space path loss be used for calculating exclusion zones.[282] They point out that the Commission previously found the free space path loss model inappropriate "because it fails to account for obstruction and terrain variation."[283] According to Apple, Broadcom et al., while free space path loss can be appropriate for short paths to account for a higher line-of-sight potential, "it does not reflect real-world operating conditions for other locations."[284]

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[272] EPRI Comments at 4; Letter from EPRI to Marlene H. Dortch at 4 (Jan. 18, 2024) (on file in ET Docket No. 18-295) (*EPRI Letter*).

[273] ERPI Comments at 6-7; *see* UTC/EEI Reply at 7.

[274] EPRI Comments at 7-8. Specifically, EPRI points out that the National Land Clutter Database (NLCD) has no distinct classification for highways, streets, and roads. *Id.* at 7. In accordance with the WInnForum TS-1014 standard the AFC systems map the NLCD category for the location of the unlicensed device to the clutter types used in the clutter models. *Functional Requirements for the U.S. 6 GHz Band under the Control of an AFC System*, Document WINNF-TS-1014 Version V1.4.0 at 31.

[275] EPRI Comments at 7-8.

[276] AT&T Comments at 8.

[277] AT&T Comments at 8.

[278] AT&T Comments at 11-12.

[279] AT&T Comments at 12.

[280] Apple, Broadcom et al. Reply at 25.

[281] Apple, Broadcom et al. Reply at 25.

[282] Apple, Broadcom et al. Reply at 26.

[283] Apple, Broadcom et al. Reply at 26.

[284] *Id*.

71. We are adopting rules that base the exclusion zones on the same propagation models as used for AFC systems, which were adopted after carefully considering the record.[285] The Commission explained that the adopted approach, which uses a combination of propagation models to accommodate a variety of environments and distances, is the best way to balance unlicensed device access and incumbent protection.[286] Because GVP devices will operate on the same spectrum as standard power devices, their transmissions are subject to the same physical and temporal environment as those devices. Thus, we conclude that our experience with these propagation models, which account for the 6 GHz operating environment, since adopting the standard-power device rules provides strong support for concluding that they are similarly appropriate for managing GVP device spectrum access.[287] Since the first AFC systems were approved for commercial operation in February 2024,[288] we have not received any reports that harmful interference occurred to microwave receivers from standard-power access points.

72. When the Commission adopted the standard-power device rules, the record included contentions by microwave licensees that terrain and clutter losses should not be assumed using statistical models and that the appropriate propagation model should be free space path loss.[289] The Commission disagreed with the claims that a free space model must be used in cases where clutter and terrain data are not known.[290] While the Commission adopted the free space path loss model for short separation distances (up to 30 meters), it noted that this model drastically underpredicts path loss for longer distances because there is almost always interaction with the environment that reduces the signal level below free space.[291] As with standard power devices, using the free space path loss model to protect microwave receivers from GVP devices would overprotect such systems and unnecessarily restrict GVP devices resulting in less efficient spectrum use.[292]

73. By deciding to use the AFC propagation models, we reject the notion that geofencing exclusion zones should be defined using purely geometric models or simplified circle and triangle shapes, as suggested by EPRI and A&T. Instead, we will permit geofencing systems flexibility to specify exclusion zones using more complex boundaries, which we recognize can result in exclusion zones with complex shapes. Therefore, to simplify and reduce the data that needs to be conveyed to a GVP device, we will permit geofencing system administrators to simplify the exclusion zone boundaries, so long as they do not provide any less protection to microwave receivers. In other words, the exclusion zones can be simplified or smoothed to ease implementation, as long as the result protects microwave receivers to the same level or more than what the propagation models and the -6 dB I/N metric indicate. To accommodate GVP devices from different manufacturers and potentially multiple geofencing systems, and to ensure that exclusion zones are calculated and provided to GVP devices in a consistent manner, we expect that industry groups will create necessary standards, including an interface specification.[293]

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[285] *6 GHz First Order,* 35 FCC Rcd at 3874-75, paras. 63-64; Apple Oct. 17, 2024 *Ex Parte GVP Presentation* at 4.

[286] *6 GHz First Order,* 35 FCC Rcd at 3874, para. 63.

[287] *6 GHz First Order*, 35 FCC Rcd at 3861-88, paras. 20-95.

[288] *OET Announces Approval of Seven 6 GHz Band Automated Frequency Coordination Systems for Commercial Operation and Seeks Comment on C3Spectra's Proposed AFC System*, Public Notice, 39 FCC Rcd 1370 (OET 2024).

[289] *6 GHz First Order,* 35 FCC Rcd at 3874, para. 62.

[290] *6 GHz First Order,* 35 FCC Rcd at 3877, para. 67.

[291] *6 GHz First Order,* 35 FCC Rcd at 3874, para. 64.

[292] Apple, Broadcom et al. Reply at 26.

[293] The Wi-Fi Alliance oversaw standards development for AFC systems. For example, the Wi-Fi Alliance created a specification for the communications between standard-power devices and AFC systems. *AFC System to AFC*

(continued….)

74. We disagree with EPRI's concern that the ITM model under-protects microwave systems due to a discontinuity between the predicted propagation loss with the Winner II model at a distance of 1 kilometer.[294] EPRI provides no actual evidence that the ITM model is under-protecting the microwave receivers. In the *6 GHz First Order*, the Commission concluded that the ITM model was the appropriate propagation model for the AFC systems to use for distances greater than 1 kilometer, noting that it is supported by the record and has served reliably as a propagation model.[295] In addition, the ITM model has been used to determine spectrum availability in the spectrum access systems (SAS) used to manage access to the 3550-3700 MHz band in the Citizens Broadband Radio Service.[296] Given the lack of actual evidence that the ITM and Winner II models are not appropriate for use by the geofencing systems and our previous experience with these models for the AFC systems, we see no grounds to depart from the propagation models proposed in the *6 GHz Second FNPRM*.

75. Additionally, we disagree with EPRI's concerns that the clutter models used with the ITM model do not represent device use along roads. The clutter models specify clutter levels based on broad land use categories such as urban, suburban, and rural with the model for rural areas using different modeling based on barren areas, high crop yield fields, deciduous trees, coniferous trees, and village center.[297] Because roads are surrounded by buildings or trees that are reflective of these categories, we would expect the signals from devices transmitting on or along roadways to experience attenuation from clutter in the same manner as signals transmitted by devices located away from the roadway. For example, a signal transmitted from a GVP device located along a roadway in a suburban area would experience clutter effects from the buildings and trees in the surrounding environment that are reflective of a suburban environment. EPRI appears to be expecting a degree of precision from clutter models that is not realistic. The same considerations apply to EPRI's concerns regarding the WINNER II model's lack of guidance for use on roads.

76. *GVP Transmit Height.* The *6 GHz Second FNPRM* stated that the geofencing systems could use an antenna height above ground of 1.5 meters in the propagation models when creating the GVP exclusion zones.[298] AT&T points out that for unlicensed whitespace devices, the "geofencing parameters explicitly consider the elevation—antenna height—of the potentially interfering device."[299] AT&T also contends that an assumed antenna height of 1.5 meters is inappropriate because the microwave receiver main beam is highly directional and therefore is sensitive to changes in interferer elevation.[300] AT&T suggests that the "geofencing boundaries . . . should be determined using the worst-case antenna elevation based on terrain, topology, or LIDAR data."[301]

77. We expect that antenna height will not be a significant factor in calculating exclusion zones because most GVP device use will occur indoors. The computer simulations submitted by Apple,

(Continued from previous page)
Device Interface Specification, Wi-Fi Alliance, Version 1.0 (2021) available at https://www.wi-fi.org/file/afc-specification-and-test-plans.

[294] EPRI Comments at 4.

[295] *6 GHz First Order*, 35 FCC Rcd at 3876-77, para. 66.

[296] *Requirements for Commercial Operation in the U.S. 3550-3700 MHz Citizens Broadband Radio Service Band*, Wireless Innovation Forum, Document WINNF-TS-0112, at 11 (June 25, 2019), https://winnf.memberclicks.net/assets/CBRS/WINNF-TS-0112.pdf.

[297] *Functional Requirements for the U.S. 6 GHz Band under the Control of an AFC System*, Document WINNF-TS-1014 at 31, available at https://winnf.memberclicks.net/assets/work_products/Specifications/WINNF-TS-1014.pdf.

[298] *6 GHz Second FNPRM*, 38 FCC Rcd at 10585, para. 127.

[299] AT&T Comments at 10 (citing 47 CFR § 15.711(k)(5)).

[300] AT&T Comments at 10.

[301] AT&T Comments at 10.

Broadcom et al. that the Commission relied on when adopting the rule to permit VLP operation assumed that only 6% of the people using VLP devices would be outdoors.[302] The Commission concluded that this assumption was reasonable because it was based on Department of Transportation and Environmental Protection Agency statistics.[303] Because transmissions from indoor GVP devices will be subject to significant building attenuation, we believe that operation of indoor GVP devices at any elevation will not present a harmful interference risk. Hence, for 94% of GVP device use, the device elevation will not be a factor.

78. We also expect the vast majority of outdoor GVP device use will occur at ground level—that is, people will use the portable devices outdoors at ground level. For such use, we find that 1.5 meters above ground level is an appropriate approximate height.[304] We also note that the ITM model does account for terrain and hence does compensate for any difference in terrain height between the microwave receiver location and a GVP device being used at an elevation of 1.5 meters above the ground level.[305] While the WINNER II model does not account for the actual terrain, because this model is only used for distances less than one kilometer we do not expect that there will be significant variations in terrain for most cases.

79. There will be a small number of situations where GVP devices are used on building balconies and rooftops. In such cases, assuming a 1.5-meter device height above ground level would not be appropriate. However, we cannot endorse AT&T's proposed worst-case height solution based on terrain, topology, or LIDAR data as it would result in significantly overprotecting microwave receivers in most situations, such as when GVP devices are being used indoors, or at lower heights. Considering the ever-increasing demand for spectrum, we cannot justify eliminating more spectrum than is necessary from GVP use. Also, using such data, where available, would, in effect, assume all in-building GVP use is on the building rooftops instead of indoors or on lower elevation balconies, dramatically reducing the GVP operating area absent an increased harmful interference risk. We also note that LIDAR data is not available in all locations.

80. To compensate for the relatively fewer GVP devices that may be operating on building rooftops and balconies, we are requiring geofencing systems to assume a 10-meter height above ground level for GVP devices when calculating exclusion zones. We are using a 10-meter height for the GVP access points because this is the height assumed in *OET Bulletin No. 69*, which describes using the terrain-dependent Longley-Rice point-to-point propagation model for estimating received signal strength of television signals.[306] *OET Bulletin No. 69* was used by the Commission to make broadcast television signal coverage predictions when assigning channels during the transition from analog to digital television.[307] *OET Bulletin No. 69* provides an appropriate precedent for the assumed GVP device height

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[302] Apple, Broadcom et al. Feb. 28, 2023 *Ex Parte* at 9.

[303] *6 GHz Second Order*, 38 FCC Rcd at 10541, para. 35.

[304] The Commission previously found it reasonable for two computer simulations to assume that 90% of VLP devices would operate at a 1.5-meter height above ground level. *6 GHz Second Order*, 38 FCC Rcd at 10546, para. 41; *see also 6 GHz First Order,* 35 FCC Rcd at 3910, para. 153 (noting that an NAB study assumed indoor access points were at a height of 1.5 meters).

[305] *OET Bulletin No. 69, Longley-Rice Methodology for Evaluating TV Coverage and Interference*, at 1 (Feb. 6, 2004) (*OET Bulletin No. 69*), available at www.fcc.gov/Bureaus/Engineering_Technology/Documents/bulletins/oet69/oet69.pdf.

[306] *OET Bulletin No. 69* at 6.

[307] *Advanced Television Systems and Their Impact upon the Existing Television Broadcast Service*, MB Docket No. 87-268, Seventh Report and Order and Eighth Further Notice of Proposed Rule Making, 22 FCC Rcd 15581, 15588-89, paras. 17-18 (2007) (*Advanced Television Systems Seventh R&O*); *Advanced Television Systems and Their Impact upon the Existing Television Broadcast Service*, MB Docket No. 87-268, Seventh Further Notice of Proposed Rule Making, 21 FCC Rcd 12100, 12106, paras. 18-19 (2006).

for two reasons. First, GVP devices, like television sets, will be used where people live or work, which may be in buildings ranging in size from one-story houses to multi-story buildings. When choosing the height to use for *OET Bulletin No. 69*, the Commission chose a height that was appropriate to represent the wide variety of possible antenna locations.[308] This height is also appropriate to represent the wide variety of indoor GVP use. Second, the Longley-Rice propagation model is the basis of the ITM model,[309] which we are requiring geofencing systems to use for distances greater than one kilometer.[310] While using a 10-meter height will, in most cases, result in larger than necessary exclusion zones, we also note that some outdoor GVP use could occur at greater heights. In the latter case, however, such use will only present a harmful interference risk if it occurs on the same channel as being used by a microwave link and within a microwave receiver's main beam within a few kilometers from the microwave receiver location. We conclude that such cases are likely to be so rare as to present an insignificant risk of harmful interference occurring. Moreover, similar to VLP devices, GVP devices are designed to be inherently mobile, and any instances of potential interference are expected to be fleeting.[311]

81. *Body Loss.* The *6 GHz Second FNPRM*, similar to the Commission's conclusion for VLP devices in the *6 GHz Second Order*,[312] proposed to allow geofencing systems to assume 4 dB for body loss when calculating exclusion zones.[313] AT&T urges the Commission not to assume that all GVP devices will be body worn and subject to 4 dB of body loss, noting that "there is no rule that requires VLP devices to be body worn" and therefore "no basis for assuming [GVP] devices will, in fact, be body worn."[314] If the Commission adopts an assumption for body loss, AT&T suggests that the rules bar certification for GVP devices that are not explicitly designed to be body worn.[315] AT&T also asserts that because "VLP devices are likely to be deployed in pairs, . . . it is irrational to assume that both endpoints of the [communication] will be subject to body attenuation."[316] UTC/EEI point out that not all VLP devices will be oriented or used on the body where 4 dB of body loss can be assumed to occur.[317] EPRI states that if the GVP device is oriented such that there is no body shielding to the microwave receiver, a 0 dB body loss would be appropriate.[318] EPRI also suggests that "the first mass-market VLP devices will

[308] *Advanced Television Systems and Their Impact upon the Existing Television Broadcast Service,* Seventh Report and Order and Eighth Further Notice of Proposed Rulemaking, 22 FCC Rcd 15581, 15583, para. 2 (2007).

[309] Institute for Telecommunication Sciences, *Irregular Terrain Model (ITM) (Longley-Rice)*, https://its.ntia.gov/software/itm (last visited June 26, 2025).

[310] *See* discussion *supra* paras. 67, 71; *6 GHz First Order*, 35 FCC Rcd at 3874, para. 63.

[311] GVP devices are expected to behave similar to VLP devices in being inherently mobile and we similarly prevent GVP devices from being installed on fixed infrastructure. *See infra* para. 119. In the *6 GHz Second Order*, the Commission stated, "In addition, device mobility results in devices, even if remaining in a general location, constantly changing their orientation due to even subtle body movements. Such movements can result in widely varying VLP signal levels in any given direction. Thus, the maximum VLP signal level, which is likely to be less than the maximum our rules permit for a device in the worst-case location and operating co-channel to a microwave system, may only be oriented toward a microwave receiver for a short period of time, which also serves to keep the potential for causing harmful interference to a minimum." *6 GHz Second Order*, 38 FCC Rcd at 10556, para. 55.

[312] *6 GHz Second Order*, 38 FCC Rcd at 10545, para. 40.

[313] *6 GHz Second FNPRM*, 38 FCC Rcd at 10584, 10586, paras. 125, 131.

[314] AT&T Comments at 13.

[315] AT&T Comments at 13-14; AT&T Reply at 7; *see also* Evergy Reply at 11 ("To the extent that the Commission proposes to allow an assumption of 4 dB for body loss in the exclusion zone calculations, it should require that VLP devices operate on the body.").

[316] AT&T Comments at 14.

[317] UTC/EEI Reply at 8.

[318] EPRI Comments at 5.

be automotive" and that, "[b]ecause automotive bodies have glass in all directions[,] . . . more study is needed to determine what value of loss or gain is required to match real-world deployments."[319]

82. Apple, Broadcom et al. disagree with AT&T's suggestion that the Commission ignore body loss unless the rules require a device to be body worn, noting that "even if a device is not directly worn on the body, proximity effects can still be present."[320] Apple, Broadcom et al. note that the Commission previously concluded that "'such losses [still] occur due to absorption and reflections from a table or other surface the device is sitting on or, for in-vehicle use, from the vehicle's cabin.'"[321] Apple, Broadcom et al. also claim that "[GVP device] operations in cars will actually be *more protective* than on-body operations" because automotive bodies have close to 9 dB mean attenuation – far higher than our assumed body loss value.[322] API supports using 4 dB body loss for GVP devices.[323]

83. In the *6 GHz Second Order*, the Commission explained that a body loss value for analytic purposes must reflect not just the body loss itself, but also the wide range of values possible, the varying behavior of VLP device users, and the variety of uses for which VLP devices may be employed.[324] The Commission noted that a 4 dB body loss is appropriate because "body loss is used to represent attenuation from a range of objects near the VLP device such as a human body or the surface of table."[325] The Commission also found that a 4 dB body loss "appears to be a conservative assumption" because "the body loss measurements submitted by Apple, Broadcom et al. and Meta show a distribution with a mean higher than 4 dB and some measured attenuations were much greater than the 8 dB maximum of the truncated distributions used in the simulations."[326]

84. In the *6 GHz Third Order*, the Commission recognized that several related technical studies filed by Broadcom and Apple, Broadcom et al., referred to as the ENG Truck Receiver Studies, provided evidence to support its conclusion that harmful interference would not occur to electronic newsgathering (ENG) truck receivers from VLP device operations.[327] The ENG Truck Receiver Studies used a link budget methodology to calculate the signal-to-interference-plus-noise ratio (SINR) for an ENG camera transmitting at a fixed location 94 meters from an ENG truck receiver with antennas at various heights receiving interference from a single VLP device.[328] The ENG Truck Receiver Studies assumed 4 dB of body loss for the transmissions from the VLP device.[329] The Commission concluded in the *6 GHz Third Order* that using 4 dB for body loss in these link budget calculations is consistent with assumptions that it found were appropriate in the *6 GHz Second Order*.[330]

85. We find, consistent with the Commission's previous conclusions in the *6 GHz Second Order* and *6 GHz Third Order*, that it is appropriate for geofencing systems to assume a 4 dB body loss

[319] EPRI Comments at 5.

[320] Apple, Broadcom et al. Reply at 48.

[321] *Id*. (quoting *6 GHz Second Order*, 38 FCC Rcd at 10545, para. 40).

[322] *Id*. at 39 (citing LS telecom UK, *Final Report: In-car Mobile Signal Attenuation Measurements*, at 33, Fig. 13 (2017)).

[323] API Comments at 6.

[324] *6 GHz Second FNPRM*, 38 FCC Rcd at 10545, para. 40.

[325] *6 GHz Second FNPRM*, 38 FCC Rcd at 10545, para. 40.

[326] *6 GHz Second FNPRM*, 38 FCC Rcd at 10545-46, para. 40.

[327] *6 GHz Third Order*, 39 FCC Rcd at 13923, para. 43.

[328] *6 GHz Third Order*, 39 FCC Rcd at 13917, para. 31.

[329] Apple, Broadcom et al. Comments at 16.

[330] *6 GHz Third Order*, 39 FCC Rcd at 13923, para. 43.

value when calculating the exclusion zones to protect microwave receivers. Several commenters object to an assumption of 4 dB of body loss because not all GVP devices will be body worn.[331] While we agree with commenters that not all GVP devices will be body worn, we reiterate our statement from the *6 GHz Second Order* that the term "body loss" refers not only to the attenuation when a GVP device is used on or near a human body, but also to the attenuation from other nearby objects, such as a table that the device is sitting on or a vehicle's passenger cabin. Apple, Broadcom et al. concur that "body loss" can occur "even if a device is not directly worn on the body" because "proximity effects can still be present."[332] Although some commenters appear to claim that the 4 dB body loss assumption should not apply in certain scenarios,[333] we note that they did not submit any technical data to support those claims. Thus, based on the record before us, we will permit geofencing systems to account for up to 4 dB body loss consistent with our previous conclusion as to the appropriate body loss to assume for interference related VLP device calculations.

86. The body-loss measurements that Apple, Broadcom et al. previously submitted on the record illustrate that 4 dB is a conservative body-loss value. According to these measurements, a smartphone transmitting in six different locations on six different people, the measured body loss was greater than 4 dB 90% of the time and could be as high as 30 dB.[334] These measurements indicate that excluding body loss from the exclusion zone calculation will result in larger exclusion zones than are necessary to protect the microwave links the vast majority of the time. Therefore, assuming no body loss, as several commenters suggest, would conflict with the Commission's goal to promote efficient spectrum use.

87. We do not agree with EPRI that more study is needed regarding VLP use in automobiles before we adopt a body loss value for the geofencing systems.[335] As noted, body loss also refers to loss from nearby objects. Notably, Apple, Broadcom, et al. cited a technical study finding that, on average, vehicles cause 9 dB of signal attenuation to devices operating in the 2 GHz band.[336] While the 6 GHz band was not explicitly tested, this study demonstrates that devices operating in-vehicle at 6 GHz would experience some level of attenuation. Therefore, because signals transmitted by a GVP device within an automobile will be subject to some amount of attenuation from the vehicle cabin, we believe it is appropriate to assume that at least 4 dB of attenuation will be present for this use case.

88. *Aggregate interference*. The *6 GHz Second FNPRM* proposed that geofencing systems not be required to consider aggregate interference effects from multiple GVP devices, noting that these devices will operate at a significantly lower power level than standard-power access points and fixed client devices for which the Commission previously determined that an aggregate interference limit is not necessary.[337] Apple, Broadcom et al. agree that the risk of aggregate interference from GVP is even lower than for standard-power devices because "GVP devices will operate at a considerably lower power level compared to standard power [access points]" and the required contention-based protocol will "greatly decrease[] the likelihood of simultaneous transmission that could lead to aggregate interference."[338] EPRI

[331] *E.g.*, AT&T Comments at 13-14; UTC/EEI Reply at 8; EPRI Comments at 5; *see* Evergy Reply at 11.

[332] Apple, Broadcom et al. Reply at 48.

[333] *See* AT&T Comments at 14; EPRI Comments at 5.

[334] Apple, Broadcom et al. Comments, ET Docket No. 18-295, Attach. B at Figure 26 (rec. June 29, 2020).

[335] EPRI Comments at 5.

[336] Apple, Broadcom, et al. Reply at 39, n.146; *see also* Apple, Broadcom et al. Comments, ET Docket No. 18-95, at E-6 (Feb. 15, 2019) ("[A]n average of 10 dB of [vehicle penetration loss] is a conservative value.").

[337] *6 GHz Second FNPRM*, 38 FCC Rcd at 10584, para. 125 (citing *6 GHz First Order,* 35 FCC Rcd at 3879, para. 72).

[338] Apple, Broadcom et al. Reply at 28.

claims that its real-world testing confirms that additive interference effects are real and that geofencing systems must acknowledge additive interference.[339] According to EPRI, locations where line-of-sight paths occur between unlicensed devices and microwave receivers are not rare corner cases and that when multiple devices operate at such locations the aggregate interference effects significantly increases the potential for harmful interference.[340] AT&T suggests that the Commission follow the practice adopted in the United Kingdom and the European Union "where an additional 4 dB margin was included to adjust for aggregate effects."[341] AT&T also cites an instance where the Commission assumed a 4 dB margin to account for aggregate interference when setting a power flux density interference limit into satellite earth station receivers.[342] AT&T notes that the Commission's previous finding regarding aggregate interference pre-dates the two technical studies filed by EPRI and FirstEnergy and the technical study filed by Southern Company.[343]

89. The two studies conducted by EPRI and FirstEnergy, which AT&T references, purport to show measured reduction in microwave link fade margin from aggregate effects of multiple access points.[344] However, these two studies show inconsistencies that cast doubt on the results. For example, the first study shows that, in some instances, the reduction in link fade margin actually decreases when multiple access points are transmitting compared to when just one access point is transmitting but increases in other instances.[345] We speculate that the inconsistencies in the two EPRI and FirstEnergy studies are related to the methodology employed for measuring the impact from unlicensed device operation on microwave links. EPRI and FirstEnergy regularly measured a baseline fade margin with no unlicensed devices transmitting by reducing the microwave transmitter power level until bit errors occurred.[346] One or more unlicensed devices were then turned on and the microwave link power level was reduced until errors occurred.[347] The difference in the microwave link power level at which errors occurred between these two cases was the "reduction in fade margin," which EPRI and FirstEnergy claims is due to unlicensed device operation.[348] But this methodology is flawed because the fading level experienced on a microwave link constantly changes, which means that the baseline fade margin does not remain constant during the testing. To account for variation in link fading, EPRI and FirstEnergy either used the baseline fade margin before the unlicensed devices were turned on, or interpolated or calculated the average of the baseline fade margin measurements made before and after the measurements with the

[339] EPRI Comments at 2.

[340] EPRI Reply at 2.

[341] AT&T Comments at 11 n.20 (citing Statement*: Improving Spectrum Access for Wifi –Spectrum Use in the 5 and 6 GHz Bands*, UK Ofcom (Jan. 17, 2020), available at: https://www.ofcom.org.uk/consultations-and-statements/category-2/improvingspectrum-access-for-wi-fi; *Sharing and compatibility studies related to Wireless Access Systems including Radio Local Area Networks (WAS/RLAN) in the frequency band 5925-6425 MHz*, Electronic Communications Committee, European Conference of Postal and Telecommunications Administrations, ECC Report 302 at 31, Table 17 (May 29, 2019) available at: https://docdb.cept.org/download/cc03c766-35f8/ECC%20Report%20302.pdf).

[342] AT&T Comments at 11 n.20 (citing *Expanding Flexible Use of the 3.7 to 4.2 GHz Band*, Report and Order and Order of Proposed Modification, 35 FCC Rcd 2343, 2475-76, para. 363 (2020)).

[343] AT&T Comments at 11 n.20.

[344] EPRI, FirstEnergy 6 GHz Additive Interference Study – Public, Oct. 12, 2022 *Ex Parte* at 6-1, 6-2; EPRI FirstEnergy 6 GHz Additive Interference Study – Phase 2 Winter, May 9, 2023 *Ex Parte* at vii.

[345] EPRI, FirstEnergy 6 GHz Additive Interference Study – Public, Oct. 12, 2022 *Ex Parte* at Figures 4-6, 4-9, 4-10.

[346] EPRI, FirstEnergy 6 GHz Additive Interference Study – Public, Oct. 12, 2022 *Ex Parte* at 2-16.

[347] EPRI, FirstEnergy 6 GHz Additive Interference Study – Public, Oct. 12, 2022 *Ex Parte* at 2-16.

[348] EPRI, FirstEnergy 6 GHz Additive Interference Study – Public, Oct. 12, 2022 *Ex Parte* at 2-17.

unlicensed devices.[349] As the fade margin measurement plot in the second EPRI and FirstEnergy test report shows, the baseline fade margin over the three-day testing period varied between 25 and 29 dB and the difference between two successive baseline fade margin measurements was as much as 2 dB.[350] Based on the data in these test reports, it is difficult to conclude whether the fade margin reduction was due to variation in the baseline fade margin over time[351] or was caused by the additive effect from multiple unlicensed devices simultaneously transmitting. We also note that when using multiple simultaneously transmitting unlicensed devices, EPRI and FirstEnergy set them to use "iperf-tenstreams" which generates "10 concurrent streams of maximum rate TCP."[352] This produced continuous extremely high-rate transmissions instead of the bursty discontinuous transmissions typical of Wi-Fi. Hence, we would not expect this type of testing to accurately model the effects of typical unlicensed devices. The technical study by Southern Company, which AT&T also references, is also lacking because it merely speculates that aggregate interference could occur from multiple access points in a specific building rather than actually measuring whether such aggregate interference actually occurs.[353] Therefore, we do not find these technical studies persuasive and conclude that there is no need to adjust the exclusion zones based on the potential for aggregate interference from multiple GVP devices.

90. AT&T points out that the Commission assumed a 4 dB factor for aggregate interference when setting a power flux density (PFD) limit for out-of-band emissions from base and mobile stations in the 3.7-3.98 GHz band into satellite earth station antennas in the adjacent 4-4.2 GHz band.[354] The 3.7-3.98 GHz band has been auctioned to wireless mobile broadband carriers.[355] Spectrum use by wireless carriers typically differs from spectrum use by unlicensed devices. Wireless carriers set up their networks to provide ubiquitous coverage with higher power levels than are permitted for unlicensed devices. Base stations employed by wireless carriers transmit continuously, unlike the bursty transmissions of unlicensed Wi-Fi devices. Given the differences in how the licensed 3.7-3.98 GHz band is being used compared to the likely characteristics of GVP devices, we do not believe that our prior decision assuming a 4 dB margin for aggregate interference in the 3.7-3.98 GHz band is relevant to 6 GHz GVP devices.

91. AT&T refers to a statement from the United Kingdom spectrum regulator on 5 and 6 GHz band Wi-Fi use and a report on a simulation study conducted by the Electronic Communications Committee of the European Conference on Postal and Telecommunications Administrations to support a claim that the United Kingdom and the European Union use a 4 dB margin for aggregate effects.[356] We note that neither of these documents mentions a 4 dB margin to compensate for the aggregate interference effects.

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[349] EPRI, FirstEnergy 6 GHz Additive Interference Study – Public, Oct. 12, 2022 *Ex Parte* at 4-7; EPRI FirstEnergy 6 GHz Additive Interference Study – Phase 2 Winter, May 9, 2023 *Ex Parte* at 2-11.

[350] EPRI FirstEnergy 6 GHz Additive Interference Study – Phase 2 Winter, May 9, 2023 *Ex Parte* at Figure 3-1, at 3-2.

[351] In microwave point-to-point links, fading can change rapidly, with fading occurring over a few seconds due to rapidly changing atmospheric conditions. For example, a 40 dB fade can last about 4 seconds. *See* George Kizer, *Digital Microwave Communications* 339 (2013).

[352] EPRI, FirstEnergy 6 GHz Additive Interference Study – Public, Oct. 12, 2022 *Ex Parte* at 2-11.

[353] Southern Company Services March 21, 2021 *Ex Parte* Letter attachment: "Test Report on the Effects of 6 GHz Unlicensed RLAN units on Fortson to Columbus Microwave Link" at 52 (stating that most rooms "have a similar view of the site and the impact would be additive if more than one overlapped Columbus frequency").

[354] *Expanding Flexible Use of the 3.7 to 4.2 GHz Band*, Report and Order and Order of Proposed Modification, 35 FCC Rcd 2343, 2475-76, para. 363 (2020).

[355] *FCC Announces Winning Bidders in C-Band Auction*, Press Release (Feb. 24, 2021), available at https://docs.fcc.gov/public/attachments/DOC-370267A1.pdf.

[356] AT&T Comments at 11 n.20.

92. *Adjacent channel protection.* The *6 GHz Second FNPRM* proposed that GVP exclusion zones only account for co-channel operation and not consider adjacent channel operations.[357] This is a departure from the rules for standard-power devices, which require AFC systems to account for the potential of standard-power devices causing harmful interference to microwave links operating on an adjacent channel.[358] The *6 GHz Second FNPRM* explained that this was appropriate due to the significantly lower operating power of GVP devices compared to standard-power devices.[359] AT&T argues that there is "no basis to exclude adjacent channel protection if the keyhole calculations indicate that adjacent channel geofencing is warranted."[360] Apple, Broadcom et al. agree with the *6 GHz Second FNPRM* proposal, noting that the Commission already concluded in the *6 GHz First Order* that the adjacent channel interference risk to microwave receivers from standard-power devices is low.[361] They argue that because "[GVP] devices will operate at significantly lower power levels than standard-power devices, . . . the already low risk [is] insignificant."[362]

93. We will not require that geofencing systems account for potential adjacent channel interference effects when determining exclusion zones because we do not believe that such adjacent channel operations will present a significant harmful interference risk to microwave receivers. The rules we are adopting for GVP devices require emissions to be suppressed by 20 dB at 1 megahertz outside the channel edge, by 28 dB at one channel bandwidth from the channel center, and by 40 dB at one- and one-half times the channel bandwidth away from channel center.[363] This means that energy from a GVP device will be limited to -9 dBm/MHz at one megahertz outside the channel edge with even lower power at greater spectral distance.[364] Given the low energy level that GVP devices will emit into adjacent channels, we conclude that they are unlikely to present an interference risk to microwave receivers on adjacent channels. Thus, we cannot justify imposing such additional complexity on geofencing systems. We recognize that this is a departure from our rules for standard-power devices. However, we conclude that the lower GVP signal levels compared to standard-power devices (i.e., standard-power client devices operate at a maximum 17 dBm/MHz) justifies our approach.

94. *Exclusion zone update interval.* The *6 GHz Second FNPRM* proposed to require geofencing systems to obtain the most recent public access file data from the Commission's ULS database at least once per day and to recalculate the exclusion zones, as necessary, to account for any new or updated information.[365] The *6 GHz Second FNPRM* explained that a once-per-day interval is appropriate because ULS, which contains the data required to determine exclusion zones to protect fixed microwave receivers, is generally updated on a daily basis.[366] Therefore, a daily update interval would

[357] *6 GHz Second FNPRM*, 38 FCC Rcd at 10591, para. 144.

[358] 47 CFR § 15.407(l); *6 GHz First Order,* 35 FCC Rcd at 3881, para. 77.

[359] *6 GHz Second FNPRM*, 38 FCC Rcd at 10591, para. 144.

[360] AT&T Comments at 12.

[361] Apple, Broadcom et al. Reply at 38.

[362] Apple, Broadcom et al. Reply at 38.

[363] 47 CFR § 15.407(b)(7).

[364] The 11 dBm/MHz EIRP PSD limit reduced by 20 dB is -9 dBm/MHz EIRP PSD.

[365] *6 GHz Second FNPRM*, 38 FCC Rcd at 10592, 10596, paras. 145, 160. The *6 GHz Second FNPRM* also proposed to require geofencing systems to obtain updated data from the COALS database that contains information on BAS/CARS central receive sites. Because there are no BAS/CARS licensees in the U-NII-5 and U-NII-7 bands where GVP devices will operate, there is no need to require geofencing systems to obtain updated data from COALS.

[366] *6 GHz Second FNPRM*, 38 FCC Rcd at 10592, para. 145.

ensure that newly registered microwave receive sites are promptly protected.[367] Furthermore, the *6 GHz Second FNPRM* proposed to require GVP access points to obtain updated exclusion zones from the geofencing systems at least once per day.[368]

95. There were no comments opposing the daily ULS update interval for geofencing systems. AT&T agrees that a daily ULS database update is reasonable.[369] We will require geofencing systems to update their data from the ULS database at least once per day and to update the exclusion zones daily based on the updated data.

96. AT&T asks the Commission to require GVP access points to obtain updated exclusion zones from the geofencing system every hour.[370] AT&T notes that this one-hour reauthentication interval would be consistent with the rules for unlicensed whitespace devices and contends that the Commission provided no rationale for not proposing the same rule for GVP access points.[371] However, this fails to acknowledge that GVP devices will have different operational characteristics than white space devices. White space devices are required to update hourly because there are wireless microphones in the band that can be registered at any time.[372] In the 6 GHz band, newly registered microwave receivers are added to the ULS database once a day. Consequently, it is unnecessary for the geofencing systems to update the exclusion zones or for the GVP access points to download the updated exclusion zones more than once a day. Therefore, we will require a GVP access point to obtain updated exclusion zones from the geofencing system at least once per day. If the GVP access point fails to obtain the updated information on any given day, the GVP access point may continue to operate until 11:59 p.m. of the following day at which time it must cease operations until it can obtain updated frequency-specific information for its location.

97. Microwave links may begin operation prior to obtaining a license so long as certain criteria are met, such as completing successful frequency coordination and filing an application that appears in the ULS database as pending.[373] In addition, temporary fixed microwave links 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.[374] The *6 GHz Second FNPRM* sought comment on requiring geofencing systems to follow the same criteria for protecting fixed and temporary fixed sites as AFC systems use for standard power access points and fixed client devices.[375] No comments from the record directly address this issue. Accordingly, for the reasons set forth in the *6 GHz First Report and Order*,[376] we will require that the geofencing systems protect pending facilities and temporary fixed stations that are registered in ULS.

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[367] *6 GHz Second FNPRM*, 38 FCC Rcd at 10592, 10596, paras. 145, 160.

[368] *6 GHz Second FNPRM*, 38 FCC Rcd at 10596, para. 160.

[369] AT&T Reply at 6.

[370] AT&T Comments at 9; *see* AT&T Reply at 6.

[371] AT&T Reply at 6; AT&T Comments at 9.

[372] *Amendment of Part 74 of the Commission's Rules for Low Power Auxiliary Stations in the Repurposed 600 MHz Band and the 600 MHz Duplex Gap, Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions, Unlicensed White Space Device Operations in the Television Bands, Unlicensed Operation in the TV Broadcast Bands*, ET Docket No. 14-165, GN Docket No. 12-268, ET Docket Nos. 20-36 and 04-186, Second Order on Reconsideration, Further Notice of Proposed Rulemaking, and Order, 37 FCC Rcd at 1393, para. 22 (2022) (*2022 White Spaces Order and FNPRM*).

[373] 47 CFR § 101.31(b).

[374] 47 CFR § 101.31(a)(2).

[375] *6 GHz Second FNPRM*, 38 FCC Rcd at 10584, para. 124; *6 GHz First Order,* 35 FCC Rcd at 3865, para. 32.

[376] *6 GHz First Order,* 35 FCC Rcd at 3865, para. 32.

Because the geofencing systems must have knowledge of the location of temporary fixed links in order to protect them from harmful interference, we will require operators of temporary fixed stations register the details of their operations (transmitter and receiver location, antenna height, antenna azimuth, antenna make, and model, etc.) in the ULS database if they desire to be protected from potentially receiving harmful interference from GVP devices in the U-NII-5 and U-NII-7 bands.

98. *Exclusion or Inclusion Zones*. Under the requirements we are adopting, geofencing systems will determine exclusion zones around microwave receiver and radio astronomy observatories where GVP access points are required to avoid operating on particular frequencies. The *6 GHz Second FNPRM* proposed that as an alternative to defining exclusion zones, the geofencing systems may also determine areas where particular frequencies are available throughout the entire area based on the same criteria used to calculate exclusion zones.[377] Allowing geofencing systems to specify "inclusion zones" instead of exclusion zones could provide increased flexibility for implementing geofencing. No commenters addressed this alternative. Because using either exclusion zones or inclusion zones will provide equivalent protection to microwave receivers and radio astronomy observatories, we will permit geofencing systems to use either an exclusion-zone or an inclusion-zone approach. We expect that industry groups will create necessary standards, including addressing the most efficient method for implementing incumbent protection.

F. Protection of FSS

99. The entire 6 GHz band is allocated for the FSS in the Earth-to-space direction, except for the 7.075-7.125 GHz portion of the band.[378] Additionally, portions of the U-NII-7 and U-NII-8 bands are allocated for FSS space-to-Earth (downlink) operations.[379] However, there are no licensed downlink earth stations in the U-NII-7 band. Sirius XM and Globalstar, the only satellite licensees who filed comments in response to the *6 GHz Second FNPRM*, limited those comments to their U-NII-8 band operations.[380] Because we are permitting GVP devices to operate only in the U-NII-5 and U-NII-7 bands at this time, Sirius XM's and Globalstar's concerns regarding their operations in the U-NII-8 band are not relevant to GVP operation.

100. In the *6 GHz First Order*, the Commission concluded that because the satellites receiving in the U-NII-5 and U-NII-7 bands are limited to geostationary orbits, approximately 35,800 kilometers above the equator, the Commission found that standard power unlicensed devices would be unlikely to cause harmful interference to the space station receivers.[381] The only restriction that the Commission adopted to protect the satellite receivers, which the Commission characterized as a "precautionary measure," was to require that outdoor standard-power access points limit their maximum EIRP above a 30-degree elevation angle to 21 dBm.[382] In the *6 GHz Second Order*, the Commission determined that no restrictions on VLP devices are necessary to protect FSS Earth-to-space operations.[383] This conclusion was based on the fact that VLP devices, operating at up to 14 dBm EIRP, transmit at significantly lower

[377] *6 GHz Second FNPRM*, 38 FCC Rcd at 10581, para. 115.

[378] 47 CFR § 2.106. The space-to-Earth allocation is limited to non-geostationary Mobile-Satellite Service feeder links, and earth stations receiving in this band are limited to locations within 300 meters of coordinates in Brewster, WA, Clifton, TX, and Finca Pascual, PR. *Id.* § 2.106(d)(172). Globalstar also operates earth station receive sites at Wasilla, AK and Sebring, FL. Globalstar Comments at 3-4. These last two locations are authorized to operate on a coprimary basis for feeder downlinks for FSS, except for 7.025-7.055 GHz band, where they are authorized only on an unprotected basis. *Id*. § 2.106(b)(458).

[379] 47 CFR § 25.214(c)(5).

[380] Sirius XM Comments (filed Mar. 27, 2024); Globalstar Reply (filed Mar. 27, 2024).

[381] *6 GHz First Order,* 35 FCC Rcd at 3886, para. 91.

[382] *6 GHz First Order,* 35 FCC Rcd at 3886, para. 92; *accord* 47 CFR § 15.407(a)(4).

[383] *6 GHz Second Order*, 38 FCC Rcd at 10567, para. 82.

power than the 21 dBm allowed for standard power access points above 30 degrees elevation.[384]

101. We conclude that GVP operations will not cause harmful interference to FSS satellite receivers. FSS satellites in geostationary orbits are unlikely to receive harmful interference from GVP devices because of the relatively low transmit powers of the GVP devices and the large distance to the satellites. This conclusion is supported by a study conducted by RKF Engineering (2018 RKF Study), which found that the interference level at the satellites would be less than -20 dB I/N from 6 GHz unlicensed devices that included outdoor access points operating at up 36 dBm.[385] While Sirius XM criticized a number of the assumptions used in the 2018 RKF Study, as the Commission explained in the *6 GHz Third Order*, Sirius XM's contentions do not provide a reason to reconsider our conclusion about the likelihood of interference occurring to FSS uplinks.[386] We also note that no one has produced any technical studies illustrating that GVP devices operating at the power levels we are adopting will present a harmful interference risk to geostationary satellite receivers.

102. We do not believe it is necessary to adopt a restriction on GVP EIRP for higher elevation angles as we did for standard power access points. Because we are prohibiting GVP devices from use on fixed infrastructure, these will be portable, battery-powered devices. Such devices will generally operate at the lowest power necessary to maximize their operating time. While these devices may operate at the maximum power we are permitting in certain situations, such as to overcome large body losses or to compensate for longer than typical distances, we expect such situations to be rare. This differs from access points, which typically operate at a constant power level. Therefore, we see no reason to adopt the precautionary restriction on power transmitted above 30 degrees elevation that we applied to standard power access points.

G. Protection of Passive Services

103. *Radio astronomy.* Several radio astronomy observatories located in remote areas observe methanol spectral lines in the 6.65-6.6752 GHz portion of the U-NII-7 band.[387] The table of frequency allocations urges that we take "all practicable steps" to protect the radio astronomy service in the 6.650-6.675.2 GHz range from harmful interference.[388] In the *6 GHz Second FNPRM*, the Commission proposed to require that geofencing systems implement the same exclusion zone rules for protecting radio astronomy sites in the 6.650-6.6752 GHz band as standard power access points and fixed client devices, which are based on the distance to the radio horizon.[389] The locations of the protected radio astronomy sites and the protection criteria for these sites are specified in the standard power access point and fixed client device rules.[390]

104. The National Academy of Sciences' Committee on Radio Frequencies (CORF) points to

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[384] *6 GHz Second Order*, 38 FCC Rcd at 10567, para. 82.

[385] Apple, Broadcom et al. Reply at 18 (citing Frequency Sharing for Radio Local Area Networks in the 6 GHz Band, prepared by RKF Engineering Services, LLC, Attachment to *Ex Parte* Filing of Apple Inc. et al., GN Docket No. 17-183, filed Jan. 26, 2018 ("2018 RKF Study")); 2018 RKF Study at 21, 42-43.

[386] *6 GHz Third Order*, 39 FCC Rcd at 13931-32, para. 62.

[387] *6 GHz First Order*, 35 FCC Rcd at 3884, para. 87.

[388] 47 CFR § 2.106(c)(342) & tbl.17 ("In making assignments to stations of other services to which the bands in table 17 to paragraph (c)(342) of this section are allocated . . ., all practicable steps must be taken to protect the radio astronomy service from harmful interference."); *see also id.* § 2.106(b)(458)(i) (international footnote 5.458A) ("In making assignments in the band 6700-7075 MHz to space stations of the fixed-satellite service, administrations are urged to take all practicable steps to protect spectral line observations of the radio astronomy service in the band 6650-6675.2 MHz from harmful interference from unwanted emissions.").

[389] *6 GHz Second FNPRM*, 38 FCC Rcd at 10590, para. 141 (citing 47 CFR § 15.407(m)).

[390] 47 CFR § 15.407(m).

its previous arguments that VLP devices should avoid channels that overlap the 6.7 GHz radio astronomy band.[391] In the *6 GHz Second Order*, the Commission considered and rejected CORF's request to prohibit VLP devices from using certain frequencies or channels to protect radio astronomy operations, stating that VLP devices' interference potential in the U-NII-7 band is even lower than for LPI devices that were already permitted to operate at higher power levels than those adopted for VLP devices.[392] However, GVP devices will operate at higher power than VLP, which increases their potential for causing harmful interference to radio astronomy operations. Therefore, we will prohibit GVP access points from operating inside of exclusion zones in the 6.65-6.6752 GHz portion of the U-NII-7 band used by radio astronomy. We conclude that the geofencing system will prevent higher power GVP devices from operating co-frequency inside exclusion zones around radio observatory sites where they could cause harmful interference.

105. *Earth-Exploration Satellite Service (EESS).* Remote sensing using the EESS, which CORF states is critical to weather prediction and studying climate change and the Earth in general, operates in the 6.425-7.250 GHz band, which includes the U-NII-6, U-NII-7, and U-NII-8 bands.[393] In the *6 GHz Second FNPRM*, the Commission sought comment on the harmful interference risk from GVP devices on oil platforms to EESS monitoring operations.[394] We also sought comment on appropriate restrictions for VLP device use on boats to protect EESS operations, and if so, should those restrictions be limited to boats in the oceans, given that EESS is used for sensing over the ocean.[395] CORF suggests that EESS (passive) observations in the U-NII-6, U-NII-7, and U-NII-8 bands can be protected by programming GVP devices to avoid these bands while in oceanic zones and coastal waters.[396] We agree with CORF and conclude that geofencing will prevent GVP devices in the U-NII-7 band from operating co-frequency with EESS observations within ocean exclusion zones. However, CORF has not indicated what boundary should be used to designate ocean exclusion zones. To balance EESS protection requirements with providing flexibility to maximize locations in which GVP devices can operate, we will use the United States territorial sea border to define the boundary of the ocean exclusion zones, which is 12 nautical miles (nm) from the baseline of each coastal State. This will allow GVP devices to operate near the coastlines while ensuring that EESS sensing ocean temperatures avoid receiving harmful interference over ocean areas.

106. We will also exclude GVP access points from oil platforms to mirror the rules for VLP devices, standard-power access points, and low power indoor access points.[397] We note that Apple, Broadcom et al. and API support not permitting GVP access on oil platforms.[398] The Wi-Fi Alliance suggests removing all restrictions on unlicensed operation on oil platforms, claiming the 2023 World Radio Conference (WRC-23) resolved to migrate all EESS ocean sensor measurements to other frequency bands.[399] We note, however, that the WRC-23 resolution cited by the Wi-Fi Alliance only resolved to study other frequency bands for EESS and does not indicate that EESS would stop using the 6 GHz

[391] CORF Comments at 10.

[392] *6 GHz Second Order*, 38 FCC Rcd at 10567-68, para. 84.

[393] CORF Comments at 10. The table of frequency allocations indicates that "[i]n the band 6425-7075 MHz, passive microwave sensor measurements are carried out over the oceans." 47 CFR § 2.106(b)(458) (stating that "Administrations should bear in mind the needs of the Earth exploration-satellite (passive) . . . service[] in their future planning of the bands 6425-7075 MHz and 7075-7250 MHz").

[394] *6 GHz Second FNPRM*, 38 FCC Rcd at 10600, para. 170.

[395] *Id.*

[396] CORF Comments at 12.

[397] 47 CFR § 15.407(d)(1)(i).

[398] Apple, Broadcom et al. Reply at 49; API Comments at 7.

[399] Wi-Fi Alliance Reply at 7.

band.[400] Therefore, we have no grounds to change our policy regarding 6 GHz unlicensed devices on oil platforms.

107. CORF also indicates that EESS sensing operations may be extended to large inland bodies of water, such as the Great Lakes, and requests that the Commission not allow VLP devices on boats in these bodies of water.[401] It suggests geofencing could also be used to prevent GVP operations in these inland lakes.[402] We find these concerns about potential future EESS use to be speculative and decline to prohibit GVP devices from operating on boats in the Great Lakes or in other large inland bodies of water at this time.

H. GVP Device Requirements

108. *Geolocation capability.* Consistent with the requirements for standard power access points, in the *6 GHz Second FNPRM,* the Commission proposed to require that GVP access points include a geolocation capability to determine their geographic coordinates.[403] Additionally, the Commission proposed that the geolocation capability include the ability to determine location uncertainty in meters, with a 95% confidence level, and that the applicant for certification of a GVP access point demonstrate the accuracy of the geo-location method used and the location uncertainty.[404] The Commission further proposed to require a GVP access point, using its geographic coordinates, to take this location uncertainty into account when determining whether it is within an exclusion zone.[405] AT&T contends that geofencing proponents should describe how devices will determine not only their location, but also the accuracy associated with that location determination.[406] Furthermore, AT&T claims that the location accuracy determination must be specific to the area in which the location measurement is being taken.[407] Alternatively, AT&T suggests that geofencing proponents explain how the Commission's rules will ensure that any flexibility granted to equipment manufacturers to develop individualized systems for determining a device's location will meet those requirements.[408]

109. We see no reason why geofencing proponents should have to describe how GVP access points will determine their location and the accuracy associated with that location determination, as suggested by AT&T, because device manufacturers will be required to provide this information as part of the equipment certification process. Our rules will require GVP device manufacturers to provide an attestation describing the geolocation method used, the method's accuracy, and the location uncertainty accuracy as part of the FCC certification process. Therefore, the GVP manufacturers will be required to demonstrate the accuracy of the geolocation method used and the location uncertainty estimate. Device manufacturers of standard-power access points have successfully demonstrated their devices' compliance with our previous geolocation requirements.

110. Consistent with our previous actions for standard-power access points and white space devices, we will require GVP access points to include a geolocation capability to determine their

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[400] *World Radio Conference 2023 Final Acts*, International Telecommunications Union at 565-566 (2023) available https://www.itu.int/dms_pub/itu-r/opb/act/R-ACT-WRC.16-2024-PDF-E.pdf.

[401] CORF Comments at 13.

[402] *Id.*

[403] *6 GHz Second FNPRM*, 38 FCC Rcd at 10595, para. 155 (citing 47 CFR § 15.407(k)(9)(i); *6 GHz First Order*, 35 FCC Rcd at 3868, para. 40).

[404] *6 GHz Second FNPRM*, 38 FCC Rcd at 10595, para. 155.

[405] *6 GHz Second FNPRM*, 38 FCC Rcd at 10595, para. 155.

[406] AT&T Reply at 5.

[407] *Id*.

[408] *Id*.

geographic coordinates. Unlike for standard-power access points, we will not provide the option for the GVP access points to use an external geolocation source.[409] This is because we expect that most GVP access points will be devices, such as mobile phones, that have a built-in geolocation capability. We also note that no commenters have indicated that we should provide the option for GVP access points to use an external geolocation source. We are requiring GVP access points to determine their location uncertainty in meters with a 95% confidence level, as is the case for standard-power access points.[410] Furthermore, we are requiring that the GVP access point use its determined coordinates and location uncertainty when comparing the device's specific location to frequency-specific information (i.e., exclusion zones) obtained from the geofencing system. This means that when the access point estimates that the geolocation coordinates are less accurate, the GVP access point will have to operate at a greater distance from the boundary of the exclusion zone. Taking into account the uncertainty estimate when determining whether the GVP access point is outside of an exclusion zone recognizes the fact that no geolocation technique is absolutely accurate and thereby provides a greater level of protection to the microwave receivers. These geolocation requirements serve as part of the multi-faceted methodology in protecting fixed microwave receivers by ensuring GVP devices operate appropriately based on their location respective to exclusion zones.

111. *Geofence re-check interval.* In the *6 GHz Second FNPRM*, the Commission proposed to require GVP access points to have the capability to timely adjust their operating frequencies when moving into, out of, or between exclusion zones.[411] The Commission proposed flexible requirements for the device re-check or update interval to enable device designers to optimize efficiency while still ensuring that the devices do not operate on channels where the – 6dB I/N metric is not met.[412] The Commission proposed that the time interval for a geofenced device to re-check its location and adjust its frequency usage must decrease proportionally based on an increase in the mobile device's speed.[413] This would require a GVP access point to regularly re-check its location and speed to properly identify its position with respect to any exclusion zones that may exist within its vicinity.[414] As an additional safeguard, the Commission proposed to require a GVP access point to determine its location and speed at least once every minute.[415] The Commission sought comment on the efficacy of its proposals and on any alternatives that may better provide GVP device designers sufficient flexibility without degrading the protection granted to incumbents.[416]

112. Apple, Broadcom et al. recommend the Commission permit manufacturers to comply with a location re-check interval in a manner that does not result in unnecessary, frequent checks that drain the device's battery and impact the user experience.[417] To that end, they advocate that the Commission not require GVP access points to determine their location and speed at least once per minute as this would unnecessarily undermine device performance.[418] Instead, they recommend the Commission adopt a flexible and technology-neutral approach that does not require a specific time interval or a

[409] 47 CFR § 15.407(k)(9).

[410] *6 GHz First Order*, 35 FCC Rcd at 3868, para. 42 & n.100.

[411] *6 GHz Second FNPRM*, 38 FCC Rcd at 10595, para. 156.

[412] *6 GHz Second FNPRM*, 38 FCC Rcd at 10595, para. 156.

[413] *Id*.

[414] *Id*.

[415] *Id*.

[416] *Id*. at 10595-96, para. 157.

[417] Apple, Broadcom, et al. Comments at 45-47.

[418] Apple, Broadcom, et al. Comments at 46.

particular technology solution.[419] Additionally, they urge the Commission to permit manufacturers to demonstrate that their approach effectively complies with the exclusion zone rules when submitting a new device for certification.[420]

113. AT&T suggests that the rules for unlicensed whitespace devices could provide a model for how to protect fixed microwave incumbents and points to white space provisions for a 60-second reauthorization interval, a 1.9 km buffer, and a 100-meter reauthorization requirement.[421] Regarding an appropriate re-check interval, AT&T suggests that a GVP access point be required to re-check its location every 60 seconds.[422] AT&T also suggests that a GVP access point be required to re-check its location upon a location change (i.e., if the device moves a certain distance), or due to a device's proximity to the nearest exclusion zone.[423]

114. We will not require a specific methodology for the re-check interval at which the GVP access point must re-check its location and determine whether it is complying with the geofencing information. Instead, we will require that the GVP access point re-check its location at an interval that ensures that the device adjusts its operating frequencies within one second of when any portion of the device's location uncertainty area crosses into an exclusion zone, so as to ensure that no harmful interference occurs to incumbents. Rather than being prescriptive, we will permit device manufacturers to choose any re-check interval methodology that ensures that a GVP access point complies with this requirement. This requirement will provide flexibility for device manufacturers and promote innovative solutions without compromising incumbent protection. We disagree with AT&T that we should follow an approach based on the white space device requirements.[424] The white space device rules addressed mobility using rigid assumptions, such as a 60 second recheck interval and a 1.9 km buffer, which was based on a mobile device traveling at 70 mph and re-checking every 60 seconds.[425] These rigid assumptions deviate from the flexible approach the Commission is taking with GVP devices. This flexible approach recognizes that some geolocation solutions are able to provide additional information beyond a device's current position, such as its velocity and acceleration. The flexible approach will ensure that GVP devices re-check less frequently if they are stationary or moving at slow speeds, thus conserving power. Similarly, GVP devices traveling faster or near the boundary of an exclusion zone will be required to re-check their location more frequently. In this way, the flexible approach will provide superior protection to licensees while enhancing GVP device operations. This flexible approach is intended to facilitate the benefits of these devices for the public while still protecting licensees. Given the benefits of this flexible approach, we see no need to follow the more rigid approach the Commission used for mobile white space devices. We also note that no mobile white space devices have ever been certified and therefore we have no real-world experience with the efficacy of those more rigid restrictions in protecting other users. Furthermore, AT&T does not present any specific concerns that the proposed re-check interval, or any alternatives presented on the record, will contribute to an increased harmful interference risk.

115. *Transmit Power Control.* In the *6 GHz Second FNPRM*, the Commission proposed to require GVP devices operating within the U-NII-5 through U-NII-8 bands to employ a transmit power control (TPC) mechanism that has the capability to operate at least 6 dB below the maximum EIRP

[419] Apple, Broadcom, et al. Comments at 46-47.

[420] Apple, Broadcom, et al. Comments at 46-47.

[421] AT&T Comments at 8-9 (citing 47 CFR § 15.711(d)(1), (d)(2), (k)(8)).

[422] AT&T Comments at 9.

[423] AT&T Comments at 9.

[424] AT&T Reply at 10.

[425] *Unlicensed White Space Device Operations in the Television Bands*, Report and Order and Further Notice of Proposed Rulemaking, 35 FCC Rcd 12603, 12625-26, para. 58 (2020).

permitted for the bands (e.g., 14 dBm or 21 dBm).[426] The Commission proactively determined that it did not expect that a TPC requirement for GVP devices would present an undue burden on device manufacturers because GVP devices were expected to be battery-powered devices and were likely to implement TPC in order to conserve battery power.[427] As a result, the Commission reasoned that "[b]ecause many VLP devices will be capable of both geofenced and non-geofenced operation, these devices will by necessity incorporate the ability to implement at least a 6 dB power reduction."[428] The Commission sought comment on a variety of issues related to the relative power levels necessary for GVP devices to mitigate any potential for harmful interference.[429] More specifically, the Commission asked whether there was a need to specify any additional TPC requirements for GVP devices given that they would be permitted to operate with higher power than VLP devices.[430] The Commission noted that there is a European requirement that TPC shall provide, on average, a mitigation factor of at least 3 dB on the maximum permitted output power of the systems; or, if transmit power control is not in use, then the maximum permitted mean EIRP and the corresponding mean EIRP density limit shall be reduced by 3 dB.[431]

116. In response, API recommends that the Commission require TPC on all VLP devices, not just those operating at higher powers.[432] It suggests a more expansive TPC power reduction with a 12 dB range, applied in steps no greater than 3 dB, with the output power reduced to as low as 2 dBm EIRP / -11 dBm/MHz EIRP PSD.[433] It claims that this would help to minimize interference to incumbents and other unlicensed 6 GHz users.[434] Apple Broadcom et al. note that the Commission has already determined that "a 6 dB [TPC] range is sufficient to protect incumbents," and that API has provided "no new evidence demonstrating that this conclusion was incorrect."[435] They claim that requiring a 12 dB TPC range would negatively impact consumers and would dissuade manufacturers from investing in both VLP and GVP devices because it would increase transceiver complexity and cost.[436]

117. We will require GVP access points to meet the same TPC requirements as stipulated in our rules for VLP devices.[437] GVP access points will be required to employ a TPC mechanism with the capability to operate at least 6 dB below the maximum 11 dBm/MHz EIRP PSD. The record lacks technical justification to adopt a different TPC requirement than what is already in place for VLP devices. TPC would help minimize the risk of interference to incumbents as it provides GVP devices with the ability to adjust power levels and subsequently operate at power levels that do not increase the risk of harmful interference. We believe that requiring GVP devices to comply with the same rule in place for VLP devices is sufficient to ensure that devices have the capability to dynamically adjust power to

[426] *6 GHz Second FNPRM*, 38 FCC Rcd at 10578, para. 108.

[427] *6 GHz Second FNPRM*, 38 FCC Rcd at 10578, para. 108.

[428] *6 GHz Second FNPRM*, 38 FCC Rcd at 10578, paras. 1-8.

[429] *6 GHz Second FNPRM*, 38 FCC Rcd at 10578, para. 108.

[430] *6 GHz Second FNPRM*, 38 FCC Rcd at 10578, para. 108.

[431] *6 GHz Second FNPRM*, 38 FCC Rcd at 10578, para. 108; *see* ECC Decision (04)08, On the harmonized use of the 5 GHz frequency bands for Wireless Access Systems including Radio Local Area Networks (WAS/RLAN), amended 1 July 2022, available at https://docdb.cept.org/download/4053.

[432] API Comments at 6.

[433] *Id*.

[434] API Comments at 6.

[435] Apple, Broadcom et al. Reply at 46-47.

[436] *Id*. at 47.

[437] 47 CFR § 15.407(d)(10).

operate both efficiently and in a manner that continues to minimize the harmful interference risk to incumbents.

118. *Contention-Based Protocol.* To add to the protections afforded to licensed incumbents, the *6 GHz Second FNPRM* proposed to require that GVP devices implement a contention-based protocol.[438] While no comments directly support requiring GVP devices to implement a contention-based protocol and no comments oppose such a requirement, several commenters highlight the efficacy of contention-based protocols in mitigating the risk of harmful interference.[439] GVP devices will be operating co-channel with both LPI and VLP unlicensed devices. Requiring use of a contention-based protocol will help promote efficient spectrum sharing between the different types of unlicensed devices. Furthermore, GVP devices will likely also be capable of operating as VLP devices, which are required to employ a contention-based protocol. Consistent with our rules for VLP unlicensed devices, we will require GVP devices to implement a contention-based protocol that will act to avoid channels on which incumbent systems are transmitting and to promote efficient spectrum usage in channels where other unlicensed users are transmitting.

119. *Fixed Infrastructure.* In the *6 GHz Second FNPRM*, the Commission proposed to prohibit GVP devices from operating as part of a fixed outdoor infrastructure as an additional measure to reduce the likelihood of harmful interference to licensed incumbent users.[440] We note that no commenters oppose the adoption of this prohibition. API, the only commenter to address this issue, agrees that GVP devices attached to fixed outdoor infrastructure should be prohibited.[441] Consistent with the requirements we adopted for VLP devices in the *6 GHz Second Order*, we will prohibit GVP devices from operating as part of a fixed outdoor infrastructure.[442] Thus, GVP devices will be prohibited from attaching to outdoor infrastructure, such as poles or buildings, which will help ensure that the GVP devices are used only for mobile applications.[443] Device mobility prevents GVP devices from remaining in potentially problematic locations for significant periods of time. In addition, as the *6GHz Second Order* explained with regard to VLP devices, by prohibiting GVP use as part of fixed outdoor infrastructure, we are ensuring that the GVP devices will be subject to body and/or clutter loss and that most of the GVP devices will operate at 1.5 meters above ground.[444]

120. *Integrated Antenna*. In the *6 GHz Second FNPRM,* the Commission proposed to require that GVP access points employ a permanently attached integrated antenna.[445] An identical provision requiring use of an integrated antenna currently applies to LPI access points and subordinate devices.[446] No commenters addressed the proposed integrated antenna requirement. As proposed, we will require GVP access points to use a permanently attached integrated antenna. Because this requirement will prevent users from replacing GVP antennas with high gain directional antennas, it will help ensure that

[438] *6 GHz Second FNPRM*, 38 FCC Rcd at 10590, para. 139.

[439] DSA Comments at 7-8; IEEE LAN/MAN Standards Committee Comments at 3; Apple, Broadcom et al. Reply at 28.

[440] *6 GHz Second FNPRM*, 38 FCC Rcd at 10596, para. 159.

[441] API Comments at 6-7.

[442] *6 GHz Second Order*, 38 FCC Rcd at 10555, para. 55.

[443] *6 GHz Second Order*, 38 FCC Rcd at 10555, para. 55.

[444] *6 GHz Second Order*, 38 FCC Rcd at 10555, para. 55.

[445] *6 GHz Second FNPRM*, 38 FCC Rcd at 10625, Appx. B: 47 CFR § 15.407(a)(10).

[446] 47 CFR § 15.407(a)(10).

GVP use complies with the power limits that are specified in terms of radiated power (i.e., EIRP).[447]

121. In the *6 GHz Second Order*, the Commission defined a VLP device as "a device that operates in the 5.925-6.425 GHz and 6.525-6.875 GHz bands and has an integrated antenna."[448] However, the Commission inadvertently did not add VLP devices to the rule provision requiring a permanently attached integrated antenna for low power indoor and subordinate devices. For consistency, we now add VLP devices to this rule provision.[449] We find that notice and comment are unnecessary as simply extending the application of this requirement from LPI and subordinate devices to VLP devices for the sake of consistency with the existing rule definition is insignificant in nature and the impact would be inconsequential to the industry and to the public.[450]

I. GVP Client-to-Client Communications

122. In the *6 GHz Second FNPRM*, the Commission proposed to permit direct client-to-client communications between GVP client devices when they are both under the control of the same GVP access point and the geofencing system determines that they are operating outside of any geofencing restrictions; i.e., there are channels available for GVP use that are not subject to geofencing requirements in the location where these devices are being used.[451] Apple, Broadcom et al. "support the concept of direct client communications between client devices when operating under geofencing requirements."[452] The Ultra Wide Band Alliance (UWBA) also supports client-to-client communications, emphasizing that clients can use reduced transmit power to reach another client directly and that overall traffic will be reduced by reducing clients communicating through an access point.[453] UTC/EEI raise concerns that "client-to-client operations will exponentially increase the interference threat to licensed microwave systems, and the Commission should refrain from authorizing [client-to-client] for low power indoor ("LPI") and VLP operations."[454] They suggest that the record does not provide sufficient evidence that geofencing will be able to control VLP client-to-client communications.[455]

~~123.~~ We adopt our proposal to allow direct communication between two client devices under control of a GVP access point subject to the client devices being required to operate on the frequency in either the U-NII-5 or U-NII-7 band that they are using to communicate with the GVP access point. All GVP access points will still be subject to the applicable geofencing requirements, including location and geofencing recheck intervals and switching channels or ceasing communications should they enter an exclusion zone and are currently using a channel that is prohibited within that area. If a GVP access point switches frequencies, the client devices will also be required to switch frequencies to continue operating in a client-to-client mode. We note that UTC/EEI's concerns do not address direct communication between client devices under the control of GVP access points but instead are directed at LPI and VLP operations. The GVP access point and the client devices under its control will operate only on a

[447] The Commission explained when adopting the integrated antenna requirement for LPI access points that it would prevent use of high gain directional antennas. *6 GHz First Order*, 35 FCC Rcd at 3891, para. 107.

[448] 47 CFR § 15.403; *6 GHz Second FNPRM*, 38 FCC Rcd at 10621, Appx. A: 47 CFR § 15.403.

[449] We note that because the definition of a VLP device includes the requirement that it have an integrated antenna, this is not a substantial change to the rules.

[450] *See* 5 U.S.C § 553(b)(B); *see also Mack Trucks, Inc. v. EPA*, 682 F.3d 87, 94 (D.C. Cir. 2012) (stating that notice and comment are "unnecessary" when "the administrative rule is a routine determination, insignificant in nature and impact, and inconsequential to the industry and to the public" (internal quotation marks omitted)).

[451] *6 GHz Second FNPRM*, 38 FCC Rcd at 10594, para. 151.

[452] Apple, Broadcom et al. C2C Comments at 4.

[453] UWBA Comments at 4.

[454] UTC/EEI Reply Comments at 1.

[455] UTC/EEI Reply Comments at 9.

frequency consistent with the exclusion zones obtained from the geofencing system. Because each client device will be limited to 6 dB less power than what is permitted for the controlling GVP access point, they will operate close enough to the access point to keep them from operating within any exclusion zone, thus ensuring they do not operate in locations and on channels that could potentially increase the risk of harmful interference to microwave receivers. Because each client device in this scenario would be limited to using the maximum power permitted for GVP client devices for the intra-client communications, there would be no increase in the potential for causing harmful interference to microwave receivers compared to the client devices each individually communicating with the controlling GVP access point. As Wi-Fi Alliance and UWBA point out, direct client-to-client communication will allow reduced overall traffic through an access point thus promoting a more efficient use of spectrum.[456]

124. In the *6 GHz Second FNPRM*, the Commission also proposed to permit GVP devices that are operating under the control of the same low power indoor access point to directly communicate with each other.[457] In addition, the Commission sought comment on permitting direct communication between clients of low power indoor access points.[458] We are deferring any decision on client-to-client communications for devices operating under the control of low power indoor access points.

125. We note that the rules we are adopting permit GVP access points to directly communicate with each other. This communication can be conducted at the power levels permitted for GVP access points — i.e. at a maximum 11 dBm/MHz EIRP PSD and 24 dBm EIRP in accordance with the exclusion zones provided by a geofencing system. Therefore, devices that would typically operate as client devices, such as body-worn augmented reality glasses, smart wristwatches, or laptop computers, can operate at the higher access point power level if they meet the requirements of GVP access points, such as having a geolocation capability and operating on frequencies and at power levels only in accordance with the exclusion zones provided by a geofencing system. These devices will not be able to operate at the higher GVP access point power level unless they have first obtained exclusion zone information. This may require them to initially operate at lower power levels as a GVP client device or VLP device to communicate with an access point to obtain the exclusion zones before they can operate at the higher GVP access point power level. We note that nothing in our rules prohibits a GVP access point from relaying exclusion zone information obtained from a geofencing system to another GVP access point. Consequently, a GVP access point could operate as a client device to another GVP access point, use this connection to register with and obtain exclusion zone information from a geofencing system, and then switch to operation as a GVP access point and increase its transmit power level accordingly.

J. Approval of Geofencing Systems

126. We delegate to the Commission's Office of Engineering and Technology (OET) the authority to administer the geofencing systems and geofencing system operator functions in accordance with the rules we are adopting to govern 6 GHz band geofencing systems. We also delegate OET authority to develop specific methods that will be used to designate geofencing system operators; to designate geofencing system operators; to develop procedures that these geofencing system operators will use to ensure compliance with the requirements for geofencing system operations; to make determinations regarding the continued acceptability of individual geofencing system operators; and to perform other functions as needed to administer the geofencing systems. We amend part 0 of our rules to delegate to OET authority to oversee the geofencing systems.[459]

127. OET's review process to designate geofencing system operators should ensure adequate testing to verify that the geofencing systems are calculating appropriate exclusion zones in conformance

[456] WFA Comments at 19-20; UWBA Comments at 4.

[457] *6 GHz Second FNPRM*, 38 FCC Rcd at 10593, para 150.

[458] *6 GHz Second FNPRM*, 38 FCC Rcd at 10608, para 192.

[459] 47 CFR § 0.241(k) in the Final Rules Appendix.

with our geofencing system rules. When the Commission adopted rules for AFC systems, it directed OET to follow a multi-step testing and review process to approve AFC operators and to ensure that AFC system operators administered their systems with minimal chance of harmful interference occurring to licensed incumbents.[460] In doing so, the Commission and OET gained substantial experience in determining the specific steps necessary to ensure efficient administration of unlicensed device access to spectrum using automated coordination mechanisms. Given this history of review, certification, and testing, we are confident that OET has sufficient expertise overseeing spectrum access management system development. As such, we do not believe it is necessary to require or specifically spell out overly prescriptive review, testing, and administration procedures here. Instead, we delegate authority to OET to develop a review and testing process for geofencing systems.

128. During AFC system development, industry groups took an active role in developing the AFC systems and the AFC test process. Specifically, the WInnForum developed a functional requirements document that specified many operational requirements for the AFC systems, and the Wi-Fi Alliance developed an interface standard for the communications between the standard-power access points and AFC systems.[461] The Wi-Fi Alliance developed a plan for AFC system lab testing, and the WInnForum and the Wi-Fi Alliance jointly developed test vectors for lab testing.[462] The test plan and test vectors were used as one step in the AFC system test process before approval for commercial operations.[463] The development of the geofencing systems may be distinct from that of the AFC systems, and we anticipate the development and approval of a diverse set of solutions.[464] We encourage industry groups, including, but not limited to WInnForum and the Wi-Fi Alliance, to develop geofencing system specifications as well as test processes and test vectors that can be used to verify the proper geofencing system functioning. We note that the WInnForum has indicated its willingness to support geofencing system development and a desire "to work with the Commission as well as all stakeholders in the development of specifications, recommendations and reports that will be required to develop and ultimately certify VLP geofencing systems."[465] FWCC indicates that its members "stand ready to work with other stakeholders through the WInnForum to develop and test appropriate geofencing systems."[466] We welcome industry group efforts, such as those from the WInnForum and Wi-Fi Alliance, to develop geofencing systems to enable GVP device deployment and encourage microwave incumbents to participate in such efforts.

129. We will permit OET to designate multiple geofencing systems as implied in the *6 GHz*

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[460] *6 GHz First Order*, 35 FCC Rcd at 3870-71, para. 49.

[461] Wireless Innovation Forum, *Functional Requirements for the U.S. 6 GHz Band under the Control of an AFC System*, Document WINNF-TS-1014, Version V1.5.0, available at https://winnf.memberclicks.net/assets/work_products/Specifications/WINNF-TS-1014.pdf; Wi-Fi Alliance, *AFC System to AFC Device Interface Specification*, Version 1.0 (2021).

[462] Wi-Fi Alliance, *AFC System (SUT) Compliance Test Plan Version 1.5*, available at https://www.wi-fi.org/discover-wi-fi/6-ghz-afc-resources; Wi-Fi Alliance, *AFC System (SUT) Compliance Test Vectors v1.2*, available at https://www.wi-fi.org/discover-wi-fi/6-ghz-afc-resources.

[463] *OET Announces Commencement of Testing of the 6 GHz Band Automated Frequency Coordination Systems*, ET Docket 21-352, Public Notice, 38 FCC Rcd 7733, 7735-37, paras. 7-9 (OET 2023), https://www.fcc.gov/edocs/search-results?t=advanced&daNo=23-759.

[464] Letter from Paul Margie, Counsel to Apple, Inc. to Marlene H. Dortch, Secretary, FCC, ET Docket No. 18-295, at 2 (filed January 23, 2026).

[465] WInnForum Comments at 3.

[466] FWCC Reply at 7. FWCC does caution that "the Commission should not make further changes to the [6 GHz] band's rules until it can ensure the protection of licensed incumbents and after the industry develops additional experience with the recent rule changes." *Id*.

Second FNPRM.[467] While the *6 GHz Second FNPRM* did not explicitly address whether there should be multiple or a single geofencing system operator, the Commission clearly contemplated the potential designation of multiple geofencing system operators by proposing several rules that presumed there would be multiple geofencing system operators. For example, the Commission proposed that "[f]or centralized geofencing systems, geofencing system *operators* must provide continuous service."[468] It also proposed requirements "for geofencing system *operators*"[469] and for "*[e]ach* geofencing system and operator thereof."[470] In seeking comment on these proposed rules, the Commission implicitly expressed that it intended to consider permitting multiple geofencing system operators rather than only a single operator. No commenters addressed whether the Commission should designate multiple geofencing operators. Designating multiple geofencing system operators is consistent with our actions for 6 GHz AFC systems, television white spaces, and CBRS.[471] Designating multiple geofencing systems will prevent one party from obtaining a monopoly, which should provide an incentive for geofencing system operators to provide reliable service and to keep costs low.

130. In the *6 GHz Second FNPRM*, the Commission proposed that geofencing systems may charge fees for providing service and that the Commission may, upon request, review the fees and require changes to the fees if it finds them to be unreasonable.[472] No commenters addressed this fee issue. We appreciate that different financial models are likely to be employed by geofencing systems. For example, a device manufacturer may operate a geofencing system to provide service to GVP access points it manufactures without charging any fees to the access point user. Other geofencing systems may employ a subscription model requiring the device user to pay for services. We will not prohibit geofencing systems from charging fees for their services. As has been the case for AFC systems, we expect that there will be multiple geofencing systems approved for commercial operations and that competition from these different systems will keep any fees charged to reasonable levels. However, as a safeguard, we will adopt our proposal that we may, upon request, review the fees charged and require changes if they are unreasonable.

131. In the *6 GHz Second FNPRM*, the Commission proposed that centralized geofencing systems must provide continuous service to all GVP devices for which they are designated to provide service, and that if a geofencing system ceases operation, the operator must provide at least 30-days' notice to the Commission and make arrangements for those devices to continue to receive exclusion zone update information.[473] No commenters addressed this proposal. This requirement addresses a concern that if a geofencing system stops operating, GVP devices may be stranded with no means to obtain updated geofencing exclusion zones. To ensure that consumers who use GVP devices are protected from such an occurrence, we are adopting this requirement. However, upon review, we believe the term "designated" is potentially unclear as it implies that some entity has designated that the geofencing system is to provide service to particular GVP devices. Instead, we shall replace "are designated" with "have agreed" in the rule to avoid any confusion.

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[467] *6 GHz Second FNPRM*, 38 FCC Rcd at 10592-93, 10627, para. 147, Appx. B, § 15.407(o)(7)(i) (emphasis added))

[468] *6 GHz Second FNPRM*, 38 FCC Rcd at 10592-93, 10627, para. 147, Appx. B, § 15.407(o)(7)(i); *id.* at 10592, para. 146 (proposing requirements "for geofencing system operators" (emphasis added)).

[469] *Id.* at 10592, para. 146 (emphasis added).

[470] *Id.* at 10627, Appx. B, § 15.407(o)(11) (emphasis added).

[471] 47 CFR §§ 15.407(k)(12), 15.715, 96.63; *6 GHz First Order,* 35 FCC Rcd at 3871, para. 51.

[472] *6 GHz Second FNPRM*, 38 FCC Rcd at 10593, para. 147.

[473] *6 GHz Second FNPRM*, 38 FCC Rcd at 10592-93, para. 147.

K. Technical Rules

132. *Emission mask.* In the *6 GHz Second FNPRM*, the Commission proposed to require GVP devices within the U-NII-5 through U-NII-8 bands to comply with the transmission emission mask adopted for standard-power and LPI devices in the *6 GHz First Order* and for VLP devices in the *6 GHz Second Order*.[474] The Commission reasoned that because GVP devices would likely operate in the same bands and on the same channels as VLP, LPI, and standard-power 6 GHz devices and need to protect the same incumbent operations, utilizing the same emission mask for GVP devices is appropriate.[475] The Commission stated that using the same mask would ensure that licensed incumbents are fully protected from unlicensed adjacent channel operations.[476] The Commission believed that specifying the same emissions requirements would reduce costs by permitting devices throughout the VLP ecosystem to use the same filters and benefit from economies of scale.[477] No commenters addressed the proposed transmission GVP emission mask. For the reasons discussed in *6 GHz Second FNPRM,* we adopt the proposed transmission emission mask.

133. This emission mask requires GVP devices to suppress their power spectral density by 20 dB at one megahertz outside of an unlicensed device's channel edge, 28 dB at one channel bandwidth from an unlicensed device's channel center, and 40 dB at one and one-half times the channel bandwidth away from an unlicensed device's channel center.[478] At frequencies between one megahertz outside an unlicensed device's channel edge and one channel bandwidth from the center of the channel, the limits are linearly interpolated between the 20 dB and 28 dB suppression levels.[479] At frequencies between one and one and one-half times an unlicensed device's channel bandwidth from the center of the channel, the limits are linearly interpolated between the 28 dB and 40 dB.[480] Emissions removed from the channel center by more than one and one-half times the channel bandwidth, but within the U-NII-5 and U-NII-8 bands, are to be suppressed by at least 40 dB.[481]

134. *Emission Limits outside of U-NII-5 and U-NII-8.* As proposed in the *6 GHz Second FNPRM*, we are adopting emission limits for GVP devices outside of the 6 GHz band that are identical to the emission limits adopted in the *6 GHz First Order* for standard-power and low power indoor devices and in the *6 GHz Second Order* for VLP devices.[482] Specifically, we are adopting a -27 dBm/MHz EIRP limit at frequencies below the bottom of the U-NII-5 band (5.925 GHz) and above the upper edge of the U-NII-8 band (7.125 GHz), but will not apply this limit between the sub-bands, i.e., between the U-NII-5 and U-NII-6, the U-NII-6 and U-NII-7, and the U-NII-7 and U-NII-8 bands.[483] Those emissions are already subject to an emission mask discussed above. We note that these limits are designed to protect

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[474] *6 GHz Second FNPRM*, 38 FCC Rcd at 10578, para. 109 (citing *6 GHz Second Order*, 38 FCC Rcd at 10568, para. 86; *6 GHz First Order,* 35 FCC Rcd at 3924-25, para. 196).

[475] *6 GHz Second FNPRM*, 38 FCC Rcd at 10579, para. 109.

[476] *6 GHz Second FNPRM*, 38 FCC Rcd at 10579, para. 109.

[477] *Id*.

[478] *6 GHz First Order,* 35 FCC Rcd at 3925, para. 196.

[479] *Id*.

[480] *Id*.

[481] *Id*.

[482] *See 6 GHz Second FNPRM*, 38 FCC Rcd at 10579, para. 110; *see also* 47 CFR § 15.407(b)(6); *6 GHz First Order,* 35 FCC Rcd at 3925, para. 197; *6 GHz Second Order*, 38 FCC Rcd at 10568-69, para. 87.

[483] *See 6 GHz Second FNPRM*, 38 FCC Rcd at 10579, para. 110. Emissions between the sub-bands are subject to the emission mask discussed above. *See supra* para. 132.

cellular vehicle-to-everything (C-V2X) operations below and federal operations above the 6 GHz band.[484] While the Commission previously determined that the -27 dBm/MHz limit was sufficient to ensure C-V2X operations were protected from harmful interference from U-NII devices operating in other bands,[485] in the *6 GHz Second FNPRM*, the Commission sought comment on whether any adjustments are needed to our VLP device rules to adequately protect C-V2X operation in vehicles.[486] We are deferring consideration of adjusting the in-vehicle VLP device OOBE issue raised in the *6 GHz Second FNPRM* at this time, as potential adjustments to those limits are outside of the scope of this instant Report and Order, which is directed to authorizing GVP devices, and are more appropriately considered in a future proceeding.

135. Prior to adoption of the *6 GHz Second FNPRM,* NTIA filed comments directed at VLP operations that included a Department of Transportation study (*DoT Exhibit*) addressing C-V2X protection requirements in the 5.895-5.925 GHz Intelligent Transportation Systems (ITS) band in which C-V2X technology is used.[487] ITS operators in this band transmit basic safety messages for crash-avoidance and require low-latency, harmful-interference-free operation.[488] According to the *DoT Exhibit*, testing showed that if 6 GHz devices that comply with the -27 dBm/MHz OOBE limit were to operate inside of a motor vehicle, the operational range of C-V2X receivers operating in the same vehicle would decrease by more than 50%.[489] The *DoT Exhibit* claims that implementing both parts of a two-part compromise submitted by several VLP proponents, which would require VLP devices to prioritize operations to frequencies above 6.105 GHz and limit VLP OOBE below 5.925 GHz to -37 dBm/MHz, is necessary to protect C-V2X receivers.[490]

136. We note that no commenter opposed adopting a GVP out-of-band emission (OOBE) limit below the U-NII-5 band and above the U-NII-8 band. The Wi-Fi Alliance contends that given the adequate protection afforded to C-V2X operations by the OOBE limit in place for other U-NII devices, there is no reason to subject GVP devices to more restrictive OOBE limits than for VLP devices.[491] Qualcomm Incorporated (Qualcomm) claims that the Commission should adopt a more stringent OOBE level for VLP devices and that this level of protection should be extended to GVP devices.[492] It contends that at the transmit power level of 21 dBm for GVP devices, Qualcomm's 6 GHz chipsets support an OOBE level of -38 dBm/MHz at the 5.925 GHz edge, which is already well below -37 dBm/MHz and would not require any transmit power reduction for unlicensed operations in the 320, 160, 80, 40, or 20 megahertz-wide Wi-Fi channels closest to the 5.925 GHz band edge.[493] Thus, Qualcomm claims that

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[484] *6 GHz Second FNPRM*, 38 FCC Rcd at 10579, para. 110.

[485] *6 GHz First Order*, 35 FCC Rcd at 3925-26, paras. 197-98 (recognizing that -27 dBm/MHz is the appropriate out-of-band emission limit and that using a root-mean-square (RMS) measurement is sufficient to protect incumbent services from unlicensed 6 GHz devices); *6 GHz Second Order*, 38 FCC Rcd at 10670, para. 90; *see Use of the 5.850-5.925 GHz Band*, ET Docket No. 19-138, First Report and Order, Further Notice of Proposed Rulemaking, and Order of Proposed Modification, 35 FCC Rcd 13440, 13474-76, paras. 80-83 (2020); *see also 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, 4158-60, paras. 114-20 (2014).

[486] *6 GHz Second FNPRM*, 38 FCC Rcd at 10605-06, paras. 185-86.

[487] *6 GHz Second FNPRM*, 38 FCC Rcd at 10605, para. 185 (citing Letter from Charles Cooper, Associate Administrator, Office of Spectrum Management, NTIA, to Marlene H. Dortch, Secretary, FCC, ET Docket No. 18-295, at 5-7 (filed Oct. 10, 2023) (*DOT Exhibit*)).

[488] *6 GHz Second FNPRM*, 38 FCC Rcd at 10605, para. 185.

[489] *DOT Exhibit* at 2.

[490] *Id*. at 3 (citing Broadcom, Cisco, Facebook, Intel, Qualcomm Mar. 1, 2021 *Ex Parte* at 1).

[491] Wi-Fi Alliance Comments at 19.

[492] Qualcomm Reply at 1-2.

"there is no technical obstacle to 6 GHz VLP unlicensed devices complying with a -37 dBm/MHz OOBE level that is needed to protect C-V2X operation in the 5.9 GHz band from harmful interference."[494] It requests that the Commission maintain the 6.105 GHz prioritization rule, which can be relaxed to 6.0 GHz, and at the same time adopt a more stringent OOBE limit at the bottom edge of the U-NII-5 band.[495]

137. The 5G Automotive Association (5GAA) asserts that the Commission's -27 dBm/MHz VLP, and by extension the proposed GVP, OOBE limit is insufficient.[496] According to 5GAA, DOT testing shows that when one or more VLP devices are in close proximity (i.e., inside a vehicle), their respective OOBE reduces the range at which C-V2X devices can effectively communicate by more than 50%, particularly in non-line-of-sight scenarios.[497] It claims that the U-NII interference from adjacent channels could reduce the ideal 300-meter range for safety applications to as little as 25 meters, thus diminishing driver response time and impacting critical safety alerts.[498] Therefore, 5GAA proposes an OOBE no less restrictive than -37 dBm/MHz.[499] 5GAA also challenges the Commission's conclusion that more stringent protection is not required as C-V2X devices are already designed to coexist with one another.[500] It explains that this misconstrues the system in place that coordinates with other C-V2X devices, which is not true for VLP devices because they operate outside the C-V2X system.[501] Additionally, it claims that VLP devices can operate with higher duty cycles over a several-second period in which critical C-V2X messages need to be successfully transmitted.[502] The Alliance for Automotive Innovation claims that in addition to prioritizing VLP operation frequencies above 6105 MHz, the Commission should adopt the -37 dBm/MHz OOBE limit for VLP devices.[503] It contends that this limit has been agreed to by stakeholders in the unlicensed and C-V2X industries.[504] It also claims that ongoing DOT testing is being done to assess the interference risks presented by mobile VLP devices in the lower U-NII-5 band.[505] 5GAA has filed several slides that it claims are from a presentation given by DOT about U-NII-5 band test results.[506]

138. The Association of State Highway and Transportation Officials (ASHTO) et al. echoes the overall sentiment of the automotive industry and opines that while a prioritization rule helps to

(Continued from previous page)

[493] Qualcomm Reply at 1; *see also* Letter from John Kuzin, Senior Vice President, Qualcomm, Inc., to Marlene H. Dortch, Secretary, FCC, ET Docket No. 18-295, GN Docket No. 17-183, at 1-2 (filed July 25, 2025).

[494] Qualcomm Reply at 1.

[495] Qualcomm Reply at 1-2; Letter from John Kuzin, Senior Vice President, Qualcomm, Inc., to Marlene H. Dortch, Secretary, FCC, ET Docket No. 18-295, GN Docket No. 17-183, at 3 (filed July 25, 2025).

[496] 5GAA Comments at 1-2; *see also* Letter from Suzanne M. Tetreault, Counsel, 5G Automotive Association, to Marlene H. Dortch, Secretary, FCC, ET Docket No. 18-295, GN Docket No. 17-183, Slides at 2 (filed July 30, 2025) ("interference caused by out-of-band emissions (OOBE) from VLP and potential new Geofenced Variable Power (GVP) devices in the 6 GHz band risk diminishing C-V2X's effectiveness.")

[497] 5GAA Comments at 4.

[498] 5GAA Comments at 5.

[499] 5GAA Comments at 3-6.

[500] 5GAA Comments at 7.

[501] 5GAA Comments at 7.

[502] *Id.* at 7.

[503] Alliance for Automotive Innovation Comments at 4.

[504] Alliance for Automotive Innovation Comments at 5.

[505] Alliance for Automotive Innovation Comments at 8.

[506] Letter from Suzanne M. Tetreault, Counsel, 5G Automotive Association, to Marlene H. Dortch, Secretary, FCC, ET Docket No. 18-295, GN Docket No. 17-183, at 1, slides at 6-7 (filed July 30, 2025).

mitigate the potential for harmful interference, the Commission has acknowledged that many VLP devices will still operate on the lowermost channels.[507] While ASHTO et al. make no specific request regarding GVP devices, they do however request that the Commission adopt a -37 dBm/MHz OOBE limit for VLP devices, which will provide C-V2X safety operations much-needed protection.[508] They claim that this OOBE limit can be achieved without lowering in-band VLP transmit power and that VLP devices comply with an European Union -45 dBm/MHz OOBE limit without impacting their transmit power.[509]

139. We decline to adopt a general GVP OOBE limit lower than what we originally proposed in the *6 GHz Second FNPRM*—e.g., -37 dBm/MHz. In particular, we cannot rely on the testing scenario in the *DOT Exhibit* filed by NTIA and DOT on October 10, 2023, as a basis for a real-world interference analysis. The *DOT Exhibit* analysis included operations from devices in the U-NII-4 band and is intended to extrapolate its findings to the U-NII-5 band. In its analysis, DOT selected operational parameters from channel 171 (5855 MHz) and applied them in a manner intended to represent a channel whose OOBE it claimed could potentially interfere with CV2X channel 183 (5915 MHz).[510] However, this analysis is not persuasive because U-NII-4 devices have different operational parameters than U-NII-5 GVP devices. Operational parameters for U-NII-4 devices include a maximum of 36 dBm EIRP for 40 MHz channels and when spanning the bands of U-NII-3 and U-NII-4 or utilizing concatenated channels to create an 80 MHz channel this power limit is not raised.[511] In addition, devices operating in the U-NII-4 band are only permitted to operate indoors only and must not be housed in a weatherized enclosure.[512] Therefore, a device configured in the manner in which it was configured in the *DOT Exhibit* could not exist under the Commission's current rules. Likewise, there are operational differences for GVP devices that do not apply to U-NII-4 Channel 171. For instance, the power limit we are adopting for U-NII-5 GVP devices is lower than those permitted for U-NII-4 devices.[513] In fact, the maximum EIRP limit that we adopt today for GVP devices is 12 dB lower than those permitted for a U-NII-4 access point.[514] In addition, devices authorized to operate under U-NII-5 rules must suppress emission by as much as 40 dB outside of its intended operating channel,[515] as opposed to a U-NII-4 device where no such in-band channel emission mask is required by the Commission's rules. Here we note that the use cases and the resultant rules of the UNII-4 and UNII-5 bands were derived for different purposes. Each rule set is uniquely defined and not intended for substitution or cross-application.

140. The *DOT Exhibit* also used a 70% duty cycle for the unlicensed devices.[516] However, with the current proposed uses of unlicensed devices in the 6 GHz band, GVP devices will utilize wide channels up to 320 MHz, as opposed to the 80 MHz channel the *DOT Exhibit* intended to model. Assuming that the 80 MHz wide channel selection was appropriate, we note that wider channels (i.e. channels exceeding 20 MHz) and channels with more advanced modulations schemes tend to transfer

[507] ASHTO et al. Comments at 2.

[508] ASHTO et al. Comments at 2.

[509] ASHTO et al. Comments at 1-4.

[510] *DOT Exhibit* at 5-7.

[511] 47 CFR § 15.407(a)(3)(ii).

[512] 47 CFR § 15.403. This rule defines "Indoor Access Point," in relevant part, as "an access point that operates in the 5.850-5.895 GHz or the 5.925-7.125 GHz band, is supplied power from a wired connection, has an integrated antenna, is not battery powered, and does not have a weatherized enclosure." *Id.*

[513] 47 CFR § 15.407(a)(7) and (b)(8)(iii) in the Final Rules Appendix.

[514] *Id.*

[515] 47 CFR § 15.407(b)(7).

[516] *DOT Exhibit* at 5.

larger amounts of data faster. Thus, the resultant duty cycle is typically lower than for narrower channels or for legacy technology with less advanced modulation schemes. Because the commenters advocating for a lower OOBE limit rely on the *DOT Exhibit* as evidence for their arguments, their arguments are not persuasive.[517] We cannot express an opinion about the more recent DOT testing that 5GAA references because the two slides they provide summarizing the testing do not provide adequate technical details for us to reach any conclusion.[518] We also note that the Wi-Fi channel plan starts at 5.945 GHz, which provides a 20 megahertz-wide guard band to the edge of the U-NII-5 band, thereby providing additional protection to C-V2X operations.[519] In addition, the requirement to prioritize operations above 6.105 GHz, noted below, will minimize the number of devices operating near the lower portion of the 6 GHz band closest to C-V2X operations. Thus, based on the record, we remain unconvinced that a more stringent OOBE limit for GVP U-NII-5 devices is necessary to protect ITS services in the adjacent band. As such, we are extending the -27 dBm/ MHz OOBE limit currently applied for VLP, standard-power, and low power indoor devices to GVP devices.

141. *Prioritization of operations over 6.105 GHz.* To provide protection from harmful interference to C-V2X operations below 5.925 GHz, in the *6 GHz Second FNPRM*, the Commission proposed to impose a channel prioritization requirement on GVP devices.[520] The Commission reasoned that because GVP devices could be mobile and potentially used near C-V2X receivers, it proposed to require GVP devices to prioritize spectrum above 6.105 GHz.[521] This prioritization requirement was part of a compromise proposal between the auto industry, chip manufacturers, and technology aggregators,[522] whereby it was claimed that prioritizing channels above 6.105 GHz will reduce the likelihood of VLP devices operating adjacent to the ITS band when VLP devices are used in vehicles.[523] The Commission adopted this prioritization suggestion for VLP devices in the *6 GHz Second Order* to protect ITS operations below the U-NII-5 band from harmful interference.[524]

142. Several commenters generally support adopting this prioritization requirement for GVP devices, while no commenters opposed imposing this requirement.[525] Qualcomm initially supported the prioritization of operations over 6.105 GHz but in a more recent filing has proposed lowering this threshold.[526] Qualcomm now contends that lowering the prioritization threshold from 6.105 GHz to 6.0 GHz is feasible, would continue to protect CV2X reception, and would provide additional channels to be used when a GVP device first select an operating channel in accordance with the prioritization rule.[527]

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[517] 5GAA Comments at 3-6; 5GAA Comments at 1-2; Alliance for Automotive Innovation Comments at 4; ASHTO et al. Comments at 2; *see also* 5GAA July, 28 2025 *Ex Parte* at 2.

[518] Letter from Suzanne M. Tetreault, Counsel, 5G Automotive Association, to Marlene H. Dortch, Secretary, FCC, ET Docket No. 18-295, GN Docket No. 17-183, at 1, slides at 6-7 (filed July 30, 2025).

[519] A general overview of the Wi-Fi 6E Channelization available at https://www.litepoint.com/blog/wi-fi-6e-standard-and-channels/.

[520] *6 GHz Second FNPRM*, 38 FCC Rcd at 10579, paras. 110-11.

[521] *6 GHz Second FNPRM*, 38 FCC Rcd at 10579, para. 110.

[522] Broadcom, Cisco, Facebook, Intel, Qualcomm Mar. 1, 2021 *Ex Parte* at 1.

[523] Broadcom, Cisco, Facebook, Intel, Qualcomm Mar. 1, 2021 *Ex Parte* at 1.

[524] *6 GHz Second Order*, 38 FCC Rcd at 10572, para. 94.

[525] Alliance of Automotive Innovation Comments at 5-7; ASHTO Comments at 1-2; 5GAA Comments at 1; *see also* Qualcomm Inc. Reply at 1-2.

[526] Letter from John Kuzin, Senior Vice President, Qualcomm, Inc., to Marlene H. Dortch, Secretary, FCC, ET Docket No. 18-295, GN Docket No. 17-183, at 3 (filed July 25, 2025).

[527] *Id.*

143. We find that the Commission's original analysis supporting such prioritization for VLP devices applies equally to GVP devices for the same underlying reasons. Prioritizing channels for operations above 6.105 GHz provides an additional layer of protection for both in-vehicle and out-of-vehicle devices by helping to reduce congestion in the lower portion of the band. This approach also enhances protection for adjacent band devices by statistically increasing the average spectral separation from the CV2X channels, thereby reducing the likelihood of harmful interference. At the same time, it avoids the unnecessary exclusion of valuable 6 GHz spectrum from potential use. The combination of existing out-of-band emission (OOBE) limits, channel mask requirements, and the prioritization of operations above 6.105 GHz constitutes a comprehensive framework of technical restrictions. Collectively, these measures are expected to provide sufficient protection and mitigate the potential for harmful interference into CV2X receivers operating in adjacent bands. As previously noted, these restrictions were adopted for VLP devices out of an abundance of caution to ensure that safety of life services below the U-NII-5 band are protected from harmful interference.[528] Therefore, we are requiring GVP devices to prioritize operations on frequencies above 6.105 GHz prior to operating on frequencies between 5.925 GHz and 6.105 GHz.

144. We set 6.105 GHz as the breakpoint for prioritization rather than use 6.0 GHz, as Qualcomm suggests. No commenters other than Qualcomm suggest using 6.0 GHz for this purpose and Qualcomm has provided no technical data supporting its position. Given the lack of justification for adopting a different prioritization scheme for GVP devices than for VLP devices, we see no reason to adopt a different rule for GVP devices.

145. *GVP Device Registration*. In the *6 GHz First Order*, the Commission defined specific information that standard-power access points are required to provide when registering with an AFC system.[529] These parameters include geographic coordinates (latitude and longitude referenced to North American Datum 1983 (NAD 83)), antenna height above ground level, FCC identifier (FCC ID), and unique manufacturer's serial number.[530] The AFC system requires an access point's latitude and longitude coordinates and antenna height above ground to determine which frequencies are available at the access point's location.[531] The AFC system also uses the FCC ID and the access point's serial number to verify that the device is authorized for 6 GHz band operations and, if necessary, to address any interference concerns.[532] Consistent with the requirements set forth for standard-power devices operating under the control of an AFC system, we will impose similar requirements for GVP devices to register with a geofencing system when requesting exclusion zones.[533] To register, a GVP access point will be required to provide the geofencing system with the access point's FCC ID and either its unique manufacturer's serial number or its model name/number or other information sufficient to uniquely identify the device manufacturer and model.[534] Although the access point's FCC ID, serial number, model name/number, or other information uniquely identifying the device manufacturer and model are not required to calculate exclusion zones, geofencing systems will use the information for two purposes.[535] First, the information will be used to authenticate the access point to ensure that no

[528] *6 GHz Second Order*, 38 FCC Rcd at 10571-72, paras. 93-94.

[529] *6 GHz First Order*, 35 FCC Rcd at 3867, 3883, 3954, paras. 38, 83, Appx. A, § 15.407(k)(8)(ii).

[530] *Id.*

[531] *6 GHz First Order*, 35 FCC Rcd at 3867, para. 38.

[532] *6 GHz First Order*, 35 FCC Rcd at 3883, para. 83.

[533] The Commission requires standard-power access points to report their FCC ID and serial number to the AFC system during registration. 47 CFR § 15.407(k)(8)(ii).

[534] *6 GHz First Order*, 35 FCC Rcd at 3883, para. 83; Letter from Paul Margie, Counsel to Apple, Inc. to Marlene H. Dortch, Secretary, FCC, ET Docket No. 18-295, at 1 (filed January 23, 2026).

[535] *6 GHz First Order*, 35 FCC Rcd at 3883, para. 83.

unauthorized devices are operating in the band.[536] Geofencing systems will verify the device's FCC ID by accessing the Commission's Equipment Authorization System (EAS) database.[537] Second, the information will be used for interference mitigation and enforcement purposes to investigate the source if harmful interference were to occur.[538] During the registration process, GVP access points are required to provide sufficient information necessary for geofencing systems to assign exclusion zones for initial operation.

146. Consistent with the requirements for AFC systems, we will require geofencing systems to store registered information in a secure database until a GVP access point ceases operation, which we will define as a VLP access point not contacting the geofencing system to verify exclusion zone information for more than three months. In addition, since GVP access points will be in motion, they may need to download additional exclusion zone information, and they are required to contact the geofencing system daily to obtain any updated exclusion zones. As a result, new information will get updated in the geofencing systems' databases on at least a daily basis, which alleviates the need to store registered information for longer than three months. To ensure users' privacy, the geofencing system will use the registered data only to protect incumbents and for potential interference mitigation.

147. In previous filings, several parties voiced privacy concerns related to device registration in the AFC system, stating that registration requirements would compromise user privacy.[539] We will require that GVP access points provide geofencing systems with only the information necessary to receive its geofenced area of operation. A GVP access point will obtain exclusion zones for the area in which it is located from the geofencing system that will enable it to determine the frequencies on which it may operate and the power level it may transmit at. The exclusion zones may be downloaded for areas with varying levels of geographic granularity, including but not limited to: polygons with specified vertices, a circle of specified radius centered at a point, or a broader region up to and including entire states. Consequently, the GVP access point will not need to provide its specific latitude and longitude to download the exclusion zones and will not need to continuously provide its coordinates to the geofencing system as it moves. We believe this approach will provide greater flexibility in implementing the geofencing system without raising any potential privacy concerns.

148. *Security Issues.* In the *6 GHz Second FNPRM*, the Commission proposed to require that GVP access points and geofencing systems incorporate adequate security measures.[540] While we received no comments in response to these security proposals, previous security requirements adopted for AFC standard power access points received strong support.[541] Reliable and secure communication between any GVP devices and associated geofencing systems are essential for successful GVP operations and incumbents' protection. Consistent with our previous actions and the proposal in the *6 GHz Second FNPRM*, we will require that GVP access points and geofencing systems employ protocols and procedures to ensure that all communications and interactions between the access points and the geofencing system are accurate and secure and that unauthorized parties cannot access or alter the

[536] *6 GHz First Order*, 35 FCC Rcd at 3883, para. 83.

[537] *6 GHz First Order*, 35 FCC Rcd at 3883, para. 83.

[538] *6 GHz First Order*, 35 FCC Rcd at 3883, para. 83.

[539] Qualcomm Comments at 3,11 (filed Feb. 15, 2019)(arguing that the rules for the AFC need to be simple and flexible and should not require unlicensed system registration);; Hewlett Packard Enterprise Reply at 28 (filed Mar. 18, 2019) (arguing that the Commission should not require device registration or identifiers); Apple Comments at 14 (filed Feb. 15, 2019) (declaring that creating a log of uniquely-identified 6 GHz devices would be fundamentally inconsistent with users' privacy expectations).

[540] *6 GHz Second FNPRM*, 38 FCC Rcd at 10596-97, para. 161.

[541] *6 GHz First Order*, 35 FCC Rcd at 3881, para. 78.

exclusion zones sent to an access point.[542] These security measures must (1) prevent GVP access points from accessing geofencing systems not approved by the Commission, (2) ensure that unauthorized parties cannot modify devices to operate in a manner inconsistent with the rules and licensed incumbent protection criteria, and (3) ensure that communications between VLP access points and geofencing systems are secure to prevent corruption or unauthorized interception of data.[543] Additionally, geofencing systems must incorporate security measures to protect against unauthorized data input or alteration of stored data (e.g., database information and the list of excluded/ available frequencies) and to protect the communication link between the geofencing system and Commission databases.[544] We will also require that geofencing systems and/or associated GVP access points establish communications authentication procedures for communications between GVP access points and GVP client devices.[545] We do not mandate specific security models. Instead, we will require GVP device manufacturers and geofencing system operators to demonstrate that their systems contain the necessary communication and information security features during the device certification and geofencing system approval processes.[546]

149. *International Borders*. In the *6 GHz Second FNPRM*, the Commission proposed that GVP operations would have to comply with international agreements with Canada and Mexico.[547] No commenters addressed this proposal. As is the case for AFC systems, we will require the geofencing systems to implement the terms of international agreements with Canada and Mexico by protecting microwave operations in Canada and Mexico near the United States border.[548]

150. *Restrictions on GVP device use on airplanes.* In the *6 GHz Second FNPRM* the Commission sought comment on permitting GVP devices to be more generally used onboard commercial and general aviation aircraft.[549] Additionally, the Commission sought comment on whether it should permit GVP devices to operate across all flight phases, whether GVP devices could be permitted to operate only when above 10,000 feet, and whether to permit GVP devices to operate on aircraft at all.[550] Apple, Broadcom et al. note that while the Commission banned standard-power access points from operating on any moving vehicle including aircraft, "the Commission's geofencing proposal . . . is explicitly designed to be simple enough to facilitate mobile operations without imposing unnecessary device or . . . system complexity."[551] Furthermore, they claim that "[p]ortability is the key feature for the [GVP] device class."[552]

151. We will prohibit GVP device use on board any aircraft. While we recognize that unlicensed GVP proponents want to expand the opportunity for unlicensed connectivity on aircraft, we

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[542] *6 GHz Second FNPRM*, 38 FCC Rcd at 10596-97, para. 161.

[543] *6 GHz Second FNPRM*, 38 FCC Rcd at 10596-97, para. 161.

[544] *6 GHz Second FNPRM*, 38 FCC Rcd at 10597, para. 161.

[545] *6 GHz Second FNPRM*, 38 FCC Rcd at 10597, para. 161.

[546] *See 6 GHz Second FNPRM*, 38 FCC Rcd at 10597, para. 163 (proposing that "[a]pplicants seeking [GVP] device certifications would have to show in their applications how their device will comply with any geofencing requirements adopted in this proceeding," which includes these security requirements); *id.* at 10580, para. 112 ("We also propose procedures for testing and approving geofencing systems to ensure that they would operate as intended . . . .").

[547] *6 GHz Second FNPRM*, 38 FCC Rcd at 10584, para. 123.

[548] 47 CFR § 15.407(k)(14); *6 GHz First Order,* 35 FCC Rcd at 3866, para. 33.

[549] *6 GHz Second FNPRM*, 38 FCC Rcd at 10599, para. 168.

[550] *Id*.

[551] Apple, Broadcom et al. Reply at 31.

[552] Apple, Broadcom et al. Reply at 31.

note that the Commission already authorized VLP devices to operate on aircraft above 10,000 feet in the U-NII-5 band.[553] We find there are logistical issues that would prevent GVP devices from adequately operating while in compliance with the geofencing requirements. For example, GVP devices in aircraft would likely be unable to check their location and verify they are not operating in an exclusion zone. While most fixed links are directed to the horizon and below and would not be impacted by GVP operations in aircraft at high altitudes, we recognize there are some links that are configured to point above the horizon to establish links to sites at higher elevation. In these scenarios, a GVP device operating on an aircraft that is unable to update its location could transmit while in the main beam of a microwave link. Therefore, we will prohibit the use of GVP devices on aircraft.

152. In the *6 GHz Second FNPRM,* the Commission noted that VLP devices mounted on a unmanned aircraft system (UAS) could pose more than an insignificant harmful interference risk, given the potential for a UAS to fly almost anywhere and have a clear line-of-sight to a microwave receiver.[554] The Commission also recognized that an exclusion zone for UAS usage would be much larger than for general usage because a UAS flies at a higher altitude than the 1.5 meters that the Commission proposed that geofencing systems would assume in calculating exclusion zones.[555] Nonetheless, the Commission sought comment on whether there are operational limitations or guidelines that it could adopt to permit VLP devices to operate mounted on a UAS.[556] API, the only commenter to address GVP UAS use, recommends prohibiting GVP use on UAS regardless of their operating altitude.[557] We will not permit GVP use on UAS. Because UAS may fly at altitudes exceeding the 10-meter height that we are mandating geofencing systems assume in calculating exclusion zones, we believe such use will present a harmful interference risk.

153. *Mandatory firmware updates.* AT&T contends that the Commission should mandate that "all new unlicensed devices be required to accept mandatory firmware updates that alter operating parameters."[558] AT&T points to a statement by the R St. Institute that "'once spectrum is designated for unlicensed use, it cannot be reallocated as the most productive use of particular bands changes.'"[559] AT&T claims that its proposal is consistent with NTIA Commerce Spectrum Management Advisory Committee's (CSMAC) views, which recommended that "'[a]ccess to new unlicensed bands should generally be conditioned in ways that reserve the flexibility to reallocate a band in the future or to change its operating rules.'"[560] APCO International states that the Commission should, wherever possible, require unlicensed devices and systems to have capability to modify system parameters through over-the-air firmware updates.[561]

154. In reply, Apple, Broadcom et. al. maintain that mandatory firmware updates are "unnecessary, would impose substantial costs on manufacturers, and could undermine the cybersecurity of consumer devices."[562] They contend that "a change to a device's firmware could require a

[553] *6 GHz Second Order*, 38 FCC Rcd at 10573, para. 97.

[554] *6 GHz Second FNPRM*, 38 FCC Rcd at 10600, para. 169.

[555] *Id*.

[556] *Id*.

[557] API Comments at 8.

[558] AT&T Comments at 6-7; AT&T Reply at 2-3.

[559] AT&T Comments at 6 (quoting R St. Institute Comments at 3).

[560] AT&T Comments at 7 (quoting Commerce Spectrum Management Advisory Committee, Unlicensed Uses Subcommittee Report (dated Jan. 11, 2010)).

[561] APCO Reply at 3.

[562] Apple, Broadcom et. al. Reply at 45.

manufacturer to seek recertification," which "is a lengthy process and therefore should not be approached lightly."[563] They state that "rather than maximizing spectrum efficiency, . . . a mandate that every unlicensed device must permit over-the-air . . . firmware updates that can change the device's core radio functions would create a serious security risk."[564] Apple, Broadcom et. al. claim that such a change would "require[] manufacturers to build in a pathway that a threat actor could exploit to remotely increase unlicensed devices' power levels or frequency ranges across the country."[565]

155. In the *6 GHz Third Order*, the Commission declined to impose a mandatory firmware update for VLP devices because of its conclusion that there is an insignificant risk that harmful interference would occur due to VLP device operations.[566] The Commission noted that the vast majority of devices have the inherent capability for firmware updates as manufacturers regularly make changes and upgrades to correct bugs, enable more efficient operation, or add capabilities.[567] We believe that this same rationale applies to GVP devices. As the Commission noted in the *6 GHz Third Order*, such a mandate could be complex and was not raised in the *6 GHz Second FNPRM*, and therefore, we do not have a record to explore such a mandate. Given our conclusion that there is an insignificant risk that harmful interference will occur due to the operation of GVP devices in the U-NII-5 and U-NII-7 bands, we do not believe that such a mandate is necessary. A firmware mandate is even less necessary for GVP devices than for VLP devices because GVP devices will be under the supervision of geofencing systems. The geofencing systems will be able to adjust the operating frequencies and exclusion zone calculations if required by future rule changes or to respond in the event of a harmful interference incident. Additionally, manufacturers typically design devices to support firmware updates, even in the absence of a mandate. These updates are commonly used to correct software issues, improve performance, or modify device behavior. Given these factors, we do not see a compelling reason to impose a firmware or software update mandate. No evidence has been presented to justify such a requirement, and imposing one would amount to an unnecessary regulatory burden. Therefore, we decline to mandate automatic over-the-air firmware updates for GVP devices.

156. *Enforcement instructions.* The National Public Safety Telecommunications Council (NPSTC) states that "it is imperative that 6 GHz licensees have a viable mechanism to report and expeditiously resolve any . . . harmful interference to critical microwave links."[568] It notes that several AFC systems have committed to establish a "'centralized means to receive and address complaints regarding purported harmful interference from AFC-authorized unlicensed operations.'"[569] NTPSC contends that even if these recommended procedures are used, they would only apply to AFC-controlled 6

[563] *Id*.

[564] *Id*. (internal quotation marks omitted).

[565] *Id*.

[566] *6 GHz Third Order*, 39 FCC Rcd at 13936-37, para.78-79.

[567] *6 GHz Third Order*, 39 FCC Rcd at 13937, para. 79.

[568] National Public Safety Telecommunications Council (NPSTC) Comments at 5.

[569] NTPSTC Comments at 5-6 (quoting *OET Announces Approval of Seven 6 GHz Band Automated Frequency Coordination Systems for Commercial Operation and Seek Comment on C3Spectra's Proposed AFC System,* Public Notice, 39 FCC Rcd 1370, 1379, para. 18 (OET 2024)). NPSTC claims that the microwave incumbents were not part of the effort to develop an interference complaint and resolution process, but they remain hopeful that AFC operators will adhere to the procedures established and endorse the microwave incumbent's perspective in the multi-stakeholder group report. NTPSTC Comments at 6 (citing Letter from Richard Bernhardt, Don Root, Edgar Figueroa, and Brett Kilbourne, Chairs of the 6 GHz Multi-Stakeholder Group to Marlene H. Dortch, Secretary, Federal Communications Commission, ET Docket No. 18-295 (filed July 11, 2022), attaching "Best Practices and Recommended Procedures for Interference Detection, Reporting, and Resolution to Protect Fixed Microwave Service Receivers in the 6 GHz Band.").

GHz devices and are concerned that this is not a comprehensive approach.[570] If harmful interference does occur, NPSTC is unclear how the interference source will be determined, i.e., whether it is from a standard-power, low power indoor, VLP, or a GVP device.[571] It claims that licensed stakeholders in the 6 GHz band need a viable means to report and expeditiously resolve harmful interference regardless of the 6 GHz unlicensed device involved.[572]

157. NPSTC indicates that past enforcement cases show that the Commission's established procedures for resolving interference issues are not as expeditious as it would prefer.[573] As an example, it refers to an ongoing interference case involving an unlicensed device interfering with a commercial wireless system that took almost a year to address.[574] NPSTC recommends that "the Commission put in place a more expeditious and effective process to resolve any harmful interference."[575]

158. In reply, Apple, Broadcom et al. view the Commission's current enforcement and reporting mechanisms as proven to be sufficient as evidenced by the operation of millions of unlicensed consumer devices in the 6 GHz band, beginning in 2020, without any evidence of harmful interference to licensed users.[576] They state that "unlicensed devices have also operated in other bands with sensitive users, such as the 5 GHz band, without the need for special enforcement rules."[577] They believe that the Commission has enforcement requirements in place and that "any additional enforcement requirements would be superfluous to the Commission's current enforcement authority."[578]

159. We find that in a general sense, and as it applies to 6 GHz devices, the Commission has a long history of performing interference analyses and using such analyses in carefully crafting part 15 rules to protect incumbent systems. These analyses have demonstrated that the likelihood of a 6 GHz unlicensed device causing harmful interference is insignificant, based on the technical rules that the Commission has adopted.[579] As 6 GHz devices are unlicensed, we note that section 15.5(b) of the Commission's rules provides that "[o]peration of an intentional, unintentional, or incidental radiator is subject to the condition[] that no harmful interference is caused."[580] In the unlikely event that harmful interference does occur due to 6 GHz device operations, section 15.5(c) of the Commission's rules provides that "[t]he operator of a radio frequency device shall be required to cease operating the device upon notification by a Commission representative that the device is causing harmful interference," even if the device was properly certified and configured, and that "[o]peration shall not resume until the

[570] NPSTC Comments at 6.

[571] NPSTC Comments at 6.

[572] NPSTC Comments at 6.

[573] NPSTC Comments at 7.

[574] *Id.* at 7 (citing Citation and Order, File No. EB-FIELDNER-22-00033924. Released May 19, 2023).

[575] NPSTC Comments at 8.

[576] Apple, Broadcom et al. Reply at 45.

[577] Apple, Broadcom et al. Reply at 45.

[578] Apple, Broadcom et al. Reply at 45 (citing *6 GHz Second Order*, 38 FCC Rcd at 10557, para. 58 & n.280).

[579] *6 GHz Second Order,* 38 FCC Rcd at 10557, para. 58.

[580] 47 CFR. § 15.5(b); *see also* 47 CFR § 15.3(m) (defining "harmful interference" as "[a]ny emission, radiation or induction that endangers the functioning of a radio navigation service or of other safety services or seriously degrades, obstructs or repeatedly interrupts a radiocommunications service operating in accordance with this chapter"); *6 GHz Second Order*, 38 FCC Rcd at 10557, para. 58; *6 GHz First Order*, 35 FCC Rcd at 3909, para. 149 ("[O]nce interference to a protected service crosses the relevant threshold specified in section 15.3(m) for harmful interference, it is immediately actionable for enforcement purposes.").

condition causing the harmful interference has been corrected."[581] We recognize the Enforcement Bureau's efforts and reiterate that the Commission does not promise a zero chance of interference.[582] As Apple, Broadcom et al. point out, unlicensed devices have operated in many bands without the requirement to include additional enforcement protections. As it pertains to low power indoor and VLP devices, we believe that the rules that we have adopted are sufficient to adequately protect incumbent users from harmful interference.

160. Because these enforcement and compliance mechanisms are applicable to GVP devices, we are adopting provisions to enable harmful interference that occurs from the operation of GVP devices to be mitigated. In the *6 GHz Second FNPRM,* the Commission recognized a need for geofenced systems to seamlessly coordinate enforcement requests and database updates.[583] In that respect, it proposed several enforcement-related rules concerning data updates and enforcement instructions.[584] We are adopting these proposals. That is, the following rules that are consistent with the rules for AFC systems will apply to geofencing systems. We require geofencing systems to ensure that their databases contain the information required by our rules, including frequency-specific exclusion zones and GVP access point's authorization parameters. We also require the geofenced systems to respond in a timely manner to verify, correct, or remove, as appropriate, data in the event that the Commission or a party presents a claim of inaccuracies in the geofencing system. In addition, we require geofencing systems to establish and follow protocols to comply with enforcement instructions from the Commission, including discontinuing GVP access point operations on specified frequencies in designated geographic areas and predetermined exclusion zones. We also require geofencing systems to comply with instructions from the Commission to adjust exclusion zones, if necessary, to more accurately reflect the harmful interference potential.

161. As for NPSTC's request that the Commission put in place a more expeditious and effective process to resolve any harmful interference, this appears to be directed at the Commission's enforcement procedures in general rather than specifically at 6 GHz unlicensed GVP operations.[585] The example case that NPSTC refers to as "interference from an unlicensed device to a licensed commercial wireless system"[586] does not involve someone operating an unlicensed part 15 device in accordance with the Commission's rules that causes interference to a licensed receiver. Instead, it involves someone operating a device in violation of the Commission's rules which causes harmful interference to a licensed

[581] 47 CFR. § 15.5(c).

[582] *See* 47 CFR §§ 0.311, 0.111(a)(4) (stating that a function of the Enforcement Bureau is to "[r]esolve complaints regarding radiofrequency interference and complaints regarding radiofrequency equipment and devices"). Part of the Commission's Enforcement Bureau web page discusses the investigation and resolution of harmful interference, including highlighting the ability of the Enforcement Bureau's field agents to "us[e] their radio frequency expertise and specialized instruments and equipment, including direction-finding equipment, to identify the source of radio frequency interference." https://www.fcc.gov/enforcement/areas/interference-resolution. In adopting the *6 GHz First Order*, the Commission noted that "Enforcement Bureau field agents use fixed, vehicular-mounted, and portable commercial and specialized spectrum monitoring equipment to conduct investigations and carry out interference resolution and enforcement activities." *6 GHz First Order*, 35 FCC Rcd at 3909, para. 149 n.397. The Commission also stated that "[t]he Enforcement Bureau works with entities at the federal, state, county, and local levels of government to resolve interference." *Id.* To further the Enforcement Bureau's efforts to resolve any occurrences of harmful interference, the Commission established an online, user-friendly "Radio Frequency Service Interference Complaint Portal" for the submission of radio interference complaints by, among others, public safety, commercial, and federal entities. https://fccprod.servicenowservices.com/psix-esix.

[583] *6 GHz Second Order*, 38 FCC Rcd at 10592, para. 146.

[584] *Id.*

[585] NPSTC Comments at 8.

[586] NPSTC Comments at 7.

radio receiver.[587] While the operator of the interfering radio equipment in that case did not have a license to transmit in the frequency band at issue and in that sense was "unlicensed," that operator was not operating an unlicensed part 15 device in compliance with our rules such as would be the case for GVP devices.[588] To the extent that NPSTC's concerns are that our enforcement rules and procedures are not sufficiently expeditious, this involves addressing issues more far reaching than the scope of this proceeding.

162. *Definitions of GVP Access Points and Client Devices*. In the *6 GHz Second FNPRM*, the Commission proposed to define a GVP access point as an access point that operates in the 5.925–7.125 GHz band, has an integrated antenna, and uses a geofencing system to determine channel availability at its location.[589] The *6 GHz Second FNPRM* explained that this definition adequately describes the types of VLP devices that could operate under a geofencing system, and the proposed requirement for an integrated antenna, which is consistent with the current rules for indoor access points and subordinate devices, will help ensure that GVP devices cannot be easily modified to increase their EIRP.[590] No commenters addressed this proposed definition. No commenters addressed this proposed definition. This definition is a straightforward description of a GVP access point. Other than adjusting the frequency range to account for the fact that we are not permitting GVP devices to operate in the U-NII-6 or U-NII-8 bands, we see no reason to modify this definition, which we shall incorporate into our rules.

163. The *6 GHz Second FNPRM* did not propose a definition of GVP client devices, and no commenters have suggested such a definition. However, the *6 GHz Second FNPRM* noted that client devices that operate under the control of a GVP access point may also be capable of operating under the control of LPI access points and standard power access points, in which case the client devices must adjust their power levels depending on which type of access point they are connected to.[591] Our rules currently define a client device as "[a] U-NII device whose transmissions are generally under the control of an access point and is not capable of initiating a network."[592] This definition currently applies to client devices that operate under the control of either standard-power or LPI access points. This definition, by its current wording, will also apply to client devices that operate under the control of a GVP access point. Therefore, we see no need to adopt an additional definition that explicitly defines a GVP client device. All client devices will be restricted to transmitting at power levels no more than 6 dB less than the level at which the controlling access point is authorized to operate, whether that access point is a standard-power, low power indoor, or GVP access point.

L. Benefits and Costs

164. In the *6 GHz Second FNPRM*, the Commission sought comment on the benefits and costs of its proposals for implementing GVP devices in the 6 GHz band.[593] The Commission did not receive any comments that included economic benefit or cost estimates for GVP devices.

165. Benefit estimates from rules we previously adopted in this proceeding have been

[587] *Luis Martinez, York, Pennsylvania*, File No.: EB-FIELDNER-22-00033924, Citation and Order, 38 FCC Rcd 4747 (EB 2023).

[588] The device caused interference to T-Mobile operations in the 2500 MHz band (i.e. 2400-2690 MHz). *Id*. at 4748, para. 4. The Commission's rules do not permit the operation unlicensed part 15 devices in the 2500 MHz band at power levels that could cause this type of harmful interference.

[589] *See 6 GHz Second FNPRM*, 38 FCC Rcd at 10582, para. 118.

[590] *Id*.

[591] *6 GHz Second FNPRM*, 38 FCC Rcd at 10582, para. 119.

[592] 47 CFR § 15.403.

[593] *6 GHz Second FNPRM*, 38 FCC Rcd at 10582, 10583, 10584, 10585, 10588, 10589, 10590, 10591, 10593, paras. 117, 122, 126, 128, 134, 135, 137, 140, 143, 148.

substantial. One report estimates that opening the 6 GHz band to unlicensed use has produced $870 billion in economic value in 2023 and 2024 together, and that this total benefit will increase to $1.2 trillion by 2027.[594] In the *6GHz Second Order*, the Commission conservatively estimated benefits from permitting VLP devices to operate in the U-NII-5 and U-NII-7 bands to be $2 billion.[595] In the *6 GHz Third Order*, the Commission conservatively estimated benefits from opening the U-NII-6 and U-NII-8 bands to VLP devices would be $820 million.[596]

166. Consistent with previous experience in this proceeding, we anticipate that the rules permitting GVP devices to operate in the U-NII-5 and U-NII-7 portions of the 6 GHz band will yield substantial benefits. The higher power GVP devices will enable increased data rates and greater range for current VLP applications. While geofencing will limit GVP operating areas, even a 5% improvement in economic value derived from these devices relative to our estimated benefits for VLP in the U-NII-5 and U-NII-7 portions of the 6 GHz band would result in $100 million in additional benefits over a five-year period, or on average, annual benefits of $20 million.[597] We believe this estimate to be conservative because higher data rates and range will not only enhance existing VLP applications, but also create opportunities for new applications, including augmented reality/virtual reality, short-range hotspots, automation processes, and indoor location and navigation. The expanded opportunities presented by these new GVP applications have the potential to yield benefits comparable to the benefits from existing VLP devices already operating within areas that may be subject to geofencing. Thus, GVP use may yield benefits much higher than $100 million over a longer time horizon.

167. We anticipate that the rules we are promulgating will impose no additional costs on the public. While manufacturers and users may incur costs in setting up the new GVP ecosystem, these costs will be voluntarily incurred and thus will not result in a private cost without a countervailing private benefit. This would include any costs for switching to new devices or developing and maintaining the geofencing systems. 6 GHz band users will be protected from harmful interference by the geofencing system, so there will be no costs imposed on other 6 GHz band users. We therefore conclude that permitting GVP devices to operate in the 6 GHz band will yield substantial economic benefits to the American public.

IV. THIRD FURTHER NOTICE OF PROPOSED RULEMAKING

A. Use of Building Entry Loss by AFC Systems

168. In this Third Further Notice of Proposed Rulemaking, we propose to allow AFC systems to take into account building entry loss (BEL) when determining frequency and power-level availability for access points that are authorized to operate in both standard power and LPI modes — i.e., composite indoor/standard-power access points. [598] In a Public Notice approving conditional operation for the first seven AFC systems, OET recognized that BEL could be an input to any predictive propagation model to

[594] Telecom Advisory Services, LLC, Assessing the Economic Value of Wi-Fi in the United States at 7, 95 (Sept. 2024), https://wififorward.org/wp-content/uploads/2024/09/Assessing-the-Economic-Value-of-Wi-Fi.pdf.

[595] *6 GHz Second Order,* 38 FCC Rcd at 10575-76, para. 102.

[596] *6 GHz Third Order*, 39 FCC Rcd at 13937, para. 82.

[597] Discounting the average benefit using a discount rate of 7% yields a discounted net present benefit of approximately $82 million.

[598] The term "composite" refers to device certified under more than one equipment class. In this case, the access point is both an "indoor access point" and a "standard power access point," as defined in 47 CFR § 15.403, and hence is a "composite indoor/standard power access point." We note that while the term "indoor access point" is used in our part 15 rules, these devices are often referred to as a "low power indoor" or "LPI" access points in Commission documents to be more descriptive because they operate with significantly lower power than standard power access points. For consistency with our rules, we will refer to them as "indoor access points" in this section of the Further Notice.

determine permitted power levels for 6 GHz standard-power devices.[599] However, OET took no position on whether to permit AFC systems to account for BEL in their calculations.[600] OET stated that it may consider waiver requests by AFC operators to use BEL in their calculations as long as the waiver request provides full support for how standard power devices will be constrained to indoor locations, how interference protection to incumbent spectrum users will be provided, and any arrangements by the AFC operators to ensure that indoor versus outdoor location data is being properly transmitted, interpreted, and acted on appropriately.[601] In response, the Wi-Fi Alliance,[602] Broadcom Inc.,[603] Sony,[604] Comsearch,[605] C3Spectra,[606] Federated Wireless, Qualcomm,[607] and AXON Networks[608] filed waiver requests to input BEL into their AFC system propagation models when assessing frequency availability and power constraints for composite indoor/standard-power access points. In the waiver requests, the companies explained that their respective AFC systems were capable of distinguishing between indoor composite indoor/standard-power access points and stand-alone standard power access points based on the FCC identification number and certified equipment class information.[609]

169. On March 21, 2023, OET issued a Public Notice soliciting comments on the Wi-Fi Alliance Waiver Request.[610] The Commission received comments from numerous parties in favor of allowing AFC systems to adjust their calculations to incorporate BEL,[611] as well as from parties

[599] *OET Announces Conditional Approval for 6 GHz Band Automated Frequency Coordination Systems,* Public Notice, DA 22-1146, 37 FCC Rcd 13071, 13089, para. 40 (OET 2022) (*AFC Approval Public Notice*).

[600] *Id*.

[601] *Id*.

[602] *Request by Wi-Fi Alliance for Waiver of Section 15.407(l)(2) of the Commission's Rules*, ET Docket No. 23-107 (filed Feb. 17, 2023) (*Wi-Fi Alliance Waiver Request*). Wi-Fi Alliance refers to access points that operate in both standard-power and LPI modes as "composite *Indoor Only With AFC With Restriction* devices." *Id.* at 2 (emphasis in original).

[603] *Broadcom Waiver Request*, ET Docket No. 23-107 (filed Mar. 22, 2023) (*Broadcom Waiver Request*).

[604] *Sony Waiver Request*, ET Docket No. 23-107 (filed Jan. 23, 2024) (*Sony Waiver Request*).

[605] *Request by Comsearch for Waiver of Section 15.407(l)(1) of the Commission's Rules*, ET Docket No. 21-352 (filed Jan. 27, 2025) (*Comsearch Waiver Request*).

[606] *Request for Waiver of Section 15.407(l)(1) to Incorporate Building Entry Loss (BEL) into C3Spectra's AFC System*, ET Docket No. 21-352 (filed Feb. 9, 2025) (*C3Spectra Waiver Request*).

[607] *Qualcomm and Federated Wireless Waiver Request*, ET Docket No. 21-352 (filed Apr. 7, 2023) (*Qualcomm and Federated Wireless Waiver Request*).

[608] *AXON Networks Inc. Request for Waiver of Section 15.407 (l)(1) to Account for Building Entry Loss*, ET Docket No. 21-352 (filed July 24, 2025) (*AXON Networks Waiver Request*).

[609] Wi-Fi Alliance Waiver Request at 3-4; Broadcom Waiver Request at 2-4; Sony Waiver Request at 2-3; Comsearch Waiver Request at 3-5; C3Spectra Waiver Request at 1; Qualcomm and Federated Wireless Waiver Request at 3-4; AXON Networks Waiver Request at 1-2.

[610] *Office of Engineering and Technology Seeks Comment on Wi-Fi Alliance Request for Waiver of Section 15.407(l)(2) of the Commission's Part 15 Rules for AFC System Operation in the 6 GHz Band*, ET Docket No. 23-107, Public Notice, 38 FCC Rcd 2059 (OET 2023).

[611] NCTA - The Internet & Television Association; Hewlett Packard Enterprise (HPE); Dynamic Spectrum Alliance (DSA); Broadcom Inc.; Federated Wireless, Inc.; Cisco Systems, Inc.; Public Interest Spectrum Coalition; Wi-Fi Alliance (WFA); Joint filing of Broadcom Inc., Cisco Systems, Inc., Hewlett Packard Enterprise, Federated Wireless Inc., and Qualcomm Incorporated; Joint filing of Broadcom Inc., Cisco Systems, Inc., Google LLC, Hewlett Packard Enterprise, Intel Corporation, Microsoft Corporation, and Qualcomm Incorporated.

representing microwave licensees' interests raising concerns about potential harmful interference.[612] Broadcom pointed out that including BEL in AFC system calculations ensures indoor-only access points "are not needlessly constrained to much lower power or channel availability than is necessary" to keep the signal received from the access point from exceeding the conservative -6 dB I/N interference protection criterion for standard power operations.[613] NCTA—The Internet and Television Association (NCTA) explained that "composite devices designed for indoor-only use will allow consumers and businesses to experience the benefits of enhanced 6 GHz coverage, throughput, and speed."[614] Dynamic Spectrum Alliance (DSA) emphasized that indoor-only composite devices can help satisfy the growing demand for affordable and enhanced broadband access by allowing efficient 6 GHz band unlicensed use.[615]

170. Several commenters representing incumbent users sought additional information on how AFC systems can ensure that composite devices would only operate indoors and protect fixed microwave incumbents from harmful interference.[616] Commenters, including AT&T, UTC, Southern, APCO, and NWCC, also raised harmful interference concerns. For example, UTC claimed that taking BEL into consideration poses a risk because there is a "mountain of evidence that LPI devices are certain to cause interference."[617] AT&T also raised concerns regarding potential interference caused by communication between standard-power client devices operating outdoors and composite indoor/standard-power access points operating indoors.[618] APCO expressed interference concerns in its filing, questioning how public safety communications will be protected from harmful interference.[619]

171. On December 5, 2024, OET granted waiver relief to the Wi-Fi Alliance, Broadcom, Sony, Federated Wireless, and Qualcomm to include BEL into their respective AFC systems' predictive propagation models.[620] Waiver relief was also granted to Comsearch and C3Spectra on May 20, 2025.[621] To ensure that harmful interference to authorized operations and other spectrum users would not occur, OET required that the AFC systems be capable of identifying composite indoor/standard-power access points based on the FCC identification number and certified Equipment Class information provided by a standard-power access point spectrum inquiry request.[622] In addition, OET only permitted the AFC systems to incorporate building entry loss up to and including 6 dB in their predictive propagation model calculations limited to a spectrum inquiry request initiated from a composite indoor/standard-power

[612] *See generally* AT&T Comments; UTC Comments; Southern Company Services, Inc. Comments; APCO Comments; NWCC Reply.

[613] Broadcom Comments at 4.

[614] NCTA Comments at 3.

[615] DSA Comments at 3.

[616] AT&T Comments at 3-5; UTC Comments at 3; Southern Company Comments at 4-6; APCO Comments at 3-4; NWCC Reply at 4; FWCC Nov. 12, 2024 *Ex Parte* at 1-2.

[617] UTC Comments at 6.

[618] AT&T Comments at 5-8. FWCC makes a similar argument regarding client devices operating outdoors. FWCC Nov. 12, 2024 *Ex Parte* at 2-3.

[619] APCO Comments at 3.

[620] *Wi-Fi Alliance Request for Waiver of Section 15.407(l)(2) of the Commission's Rules for AFC System Operation in the 6 GHz Band*, ET Docket No. 23-107, Public Notice, 39 FCC Rcd 13216, 13216, 13224, paras. 1, 20 (OET 2024) (*BEL Waiver Order*).

[621] *Comsearch and C3Spectra Request for Waiver of Section 15.407(l)(1) of the Commission's Rules for AFC System Operation in the 6 GHz Band*, ET Docket Nos. 23-107 and 21-352, Order, DA 25-362 (OET May 20, 2025).

[622] *BEL Waiver Order*, 39 FCC Rcd at 13224, para. 19.

access point.[623]

172. We propose to update our rules consistent with the waivers OET granted to permit the AFC operators to take BEL into consideration in their calculations. We propose to adopt rules that will require AFC systems to be capable of identifying composite indoor/standard-power access points based on the FCC ID provided by the access point during registration and certified equipment class information obtained from the Commission's Equipment Authorization System in order to be eligible to apply BEL in their propagation calculations. Only upon confirmation that a device is certified as an composite indoor/standard-power access point can the AFC system assume no more than 6 dB of BEL when it provides frequency and power-level information to that device. Allowing the AFC systems to consider BEL when determining frequency availability will increase the composite indoor/standard-power access point operating power when appropriate, thereby increasing their utility to consumers. The greater operating power will enable the access points to provide increased indoor coverage and/or provide higher data rates. This will expand the use of the 6 GHz band, thereby furthering the Commission's goal to encourage more efficient spectrum use. We seek comment on our proposal. Are there any other factors that need to be taken into consideration to permit the AFC systems to apply BEL in their calculations?

173. We seek comment on whether 6 dB is the correct amount of BEL attenuation to permit the AFC systems to use in their calculation for composite indoor/standard-power access points or whether the 6 dB accommodation we made in the waiver grants can be increased. What is the harmful interference risk, if any, to licensed incumbents associated with increasing the amount of BEL an AFC can use when it provides frequency and power-level information to a composite indoor/standard-power access point? What are the advantages and disadvantages of allowing a higher BEL attenuation? What tangible risks, if any, would there be for harmful interference occurring if the AFC systems use a BEL greater than 6 dB in their calculations? Should we require AFC operators to use a particular methodology to determine the appropriate amount of BEL for a given composite indoor/standard-power access point and, if so, what should that methodology be? Alternatively, should AFC operators have discretion to determine the amount of BEL to apply up to 6 dB? If AFC operators should have such discretion, what factors should they be required to take into consideration when determining the amount of BEL to apply?

B. Low Power Indoor Access Points on Cruise Ships

174. In the *6 GHz First Order*, the Commission prohibited low power indoor (LPI) access point operation on boats.[624] The Commission noted that according to the National Academy of Science's Committee on Radio Frequency, the 6.425-7.075 GHz and 7.075-7.250 GHz bands are used for remote sensing by the Earth Exploration Satellite Service, including over oceans.[625] The Commission explained that it was prohibiting LPI access point use on boats because of the lack of building attenuation when the access points are used indoors and to protect Earth Exploration Satellite Service operations over the oceans.[626]

175. Cisco Systems (Cisco) requests that the Commission modify its prohibition on shipborne LPI access points by creating an exception for cruise ships.[627] According to Cisco, "there is insufficient spectrum available in large congested indoor common areas of cruise ships, such as restaurants, casinos,

[623] *Id*.

[624] *6 GHz First Order*, 35 FCC Rcd at 3929, 3931, paras. 207, 212,

[625] *6 GHz First Order*, 35 FCC Rcd at 3931, para. 212 (citing The National Academy of Sciences Committee on Radio Frequencies Comments, ET Docket No. 18-295, at 8-9 (rec. Feb. 14, 2019)).

[626] *6 GHz First Order*, 35 FCC Rcd at 3931, para. 212. The Commission also prohibited the operation of standard-power access points on ships. *Id*.

[627] Cisco Comments, ET Docket No. 18-295, at 3 (rec. April 11, 2025) (Cisco Comments); Cisco June 25, 2025 *Ex Parte*; Cisco June 17, 2025 *Ex Parte*.

theaters, and promenades[,] [which] can impact Wi-Fi performance."[628] Cisco explains that the inability to access the 6 GHz band limits the available non-overlapping Wi-Fi channels leading to increased co-channel and adjacent channel interference and that access to the entire 6 GHz band would increase the likelihood of achieving gigabit speeds in the dense environment.[629] Cisco also points out that "signals within cruise ships experience high building entry loss ('BEL') due to the vessels' thick metal walls and thermally efficient glass windows."[630] Cisco claims that "[c]ruise ships are also likely have far higher BEL than traditional land-based hotels, which do not have walls made of metal."[631]

176. We propose to amend our rules to permit LPI access points to operate on cruise ships. As Cisco has pointed out, transmissions made from within cruise ships are likely to experience significant attenuation from the thick metal walls of the cruise ship, thereby reducing the risk of harmful interference to Earth Exploration Satellite Service operations. In addition, there are a limited number of cruise ships.[632] We appreciate the need for additional spectrum for unlicensed device operation on board cruise ships considering that many of these ships have thousands of passengers contained within a relatively small footprint.[633] We seek comment on this proposal. What impact will the operation of LPI access points on cruise ships have on Earth Exploration Satellite Service measurements made over the oceans?

177. We propose limiting this exception to our rules to cruise ships for two reasons. First, smaller boats may have less substantial construction with reduced BEL that could present a greater interference risk to Earth Exploration Satellite Service operations. Second, completely removing the prohibition on LPI use on boats would greatly increase the amount of LPI use over the oceans, which would increase the potential risk to the Earth Exploration Satellite Service. For purposes of this rule exception, we propose to adopt the definition of cruise ships in 33 CFR § 101.105:

> Cruise Ship means any vessel over 100 gross register tons, carrying more than 12 passengers for hire which makes voyages lasting more than 24 hours, of which any part is on the high seas. Passengers from cruise ships are embarked or disembarked in the U.S. or its territories. Cruise ships do not include ferries that hold Coast Guard Certificates of Inspection endorsed for "Lakes, Bays, and Sounds", that transit international waters for only short periods of time on frequent schedules.[634]

178. We seek comment on limiting the exception to the prohibition on use of LPI access points on boats to cruise ships as defined in 33 CFR § 101.105. Should our rules reflect a more or less restrictive definition of cruise ships? Would specifying a larger number of passengers in the cruise ship definition be appropriate because only larger cruise ships will have a need for increased Wi-Fi spectrum? Would it be appropriate to permit LPI access points to be used on other types of boats?

C. Updating the Existing 6 GHz Band Unlicensed Rules

179. In the five years since the Commission adopted rules for standard power and low power indoor devices, the 6 GHz band has become an essential part of the unlicensed device ecosystem. More than 5000 different Wi-Fi device models that support the 6 GHz band were released between 2021 and

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[628] Cisco Comments at 5.

[629] *Id*. at 5-6.

[630] *Id*. at 8.

[631] *Id*.

[632] According to the Cruise Lines International Association, there are 306 cruise ships in the fleets of member cruise lines. Cruise Lines International Association, *CLIA Main Site*, https://cruising.org/CLIA-cruise-lines (last visited May 30, 2025).

[633] "Cruise ships can carry as many as 10,000 passengers and crew . . . ." Cisco Comments at 2.

[634] 33 CFR § 101.105. Cisco proposed that we use this definition of cruise ships. Cisco Comments at 10.

2024.[635] Now that 6 GHz band unlicensed devices have become widely deployed, we believe that it is appropriate to consider whether any adjustments are needed to the 6 GHz band unlicensed rules to encourage further innovation. We seek comment broadly on any changes that could be made to the 6 GHz band unlicensed rules to reflect technological and business developments since the rules were first adopted in 2020.[636] These rule modifications could involve any of the categories of 6 GHz band unlicensed devices: standard power access points, indoor access points, geofenced variable power access point, or client device as well as the AFC and geofencing systems.[637]

D. Benefits and Costs

180. We seek comment on whether the proposed rules discussed above would generate benefits that outweigh the associated costs. We tentatively conclude that the proposed rules will yield modest benefits, including a one-time cost savings of $4,800 from streamlining the AFC waiver application process and a recurring annual benefit of $35.6 million. We seek comment on these preliminary assessments and request that commenters provide applicable estimates with supporting data and statistics.

181. *Benefits*. We anticipate that these proposed rule changes–permitting AFC systems to account for BEL and authorizing LPI access point operation aboard cruise ships—would result in modest economic benefits of approximately $4,800 in one-time cost savings and $35.6 million in annual benefit to society as a whole. Eight AFC operators have filed waiver requests to incorporate BEL into their AFC system propagation models,[638] and seven of those operators have been granted waiver relief.[639] Because OET has authority to grant such waivers on an individual basis, updating our rules to align with the relief already granted would not materially alter current BEL adjustment practices. The primary impact of the proposed rule change would be creating regulatory certainty and reducing the time and resources that AFC operators and the Commission are required to devote to the waiver application and review process. To date, the Commission has conditionally approved fifteen AFC systems.[640] Excluding the seven AFC

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[635] Clas Hetting, *Massive Market Adoption: 5000+ Wi-Fi Devices Now Support 6 GHz, 1200+ Support Wi-Fi 7, Intel Says*, WiFi Now (April 22, 2025), https://wifinowglobal.com/news-and-blog/massive-market-adoption-5000-wi-fi-devices-now-support-6-ghz-1230-support-wi-fi-7-intel-says/.

[636] We are focusing this inquiry on updates to the 6 GHz unlicensed rules that reflect developments since their adoption. Our goal is to identify opportunities to enhance flexibility for unlicensed devices and promote more efficient use of the band. Unless supported by compelling, real-world evidence, this inquiry should not be interpreted as an opportunity to revisit prior decisions. We will not consider changes that diminish flexibility or impose new restrictions on unlicensed operations without strong, evidence-based justification.

[637] Letter from Bill Davenport, Chief Director for Connectivity and Technology Policy, Cisco Systems Inc., to Marlene H. Dortch, Secretary, FCC, ET Docket No. 18-295, at 1-2 (filed January 16, 2026) (suggesting the Commission seek comment on updating the 6 GHz band unlicensed rules); Letter from Brett Kilbourne, Senior Vice President Policy and General Counsel, Utilities Technology Council, to Marlene H. Dortch, Secretary, FCC, ET Docket No. 18-295, at 2 (filed January 22, 2026) (suggesting the Commission invite comment on modifying the requirements for AFC and geofencing systems regarding propagation models and additive interference).

[638] The eight operators are the Wi-Fi Alliance, Broadcom Inc., Sony, Comsearch, C3Spectra, Federated Wireless, Qualcomm, and AXON Networks.

[639] The waiver was granted to the Wi-Fi Alliance, Broadcom, Sony, Federated Wireless, Qualcomm, Comsearch, and C3Spectra.

[640] *OET Announces Conditional Approval for 6 GHz Band Automated Frequency Coordination System*, ET Docket No. 21-352, Public Notice, 37 FCC Rcd 13071, 13071, para. 1 (OET 2022) (conditionally approving thirteen entities to operate automated frequency coordination (AFC) systems to manage access to 6 GHz band spectrum by standard-power unlicensed devices: Broadcom, Google, Comsearch, Sony Group, Kyrio, Key Bridge Wireless, Nokia Innovations, Federated Wireless, Wireless Broadband Alliance, Wi-Fi Alliance, Qualcomm, Plume Design, and RED Technologies); *OET Announces Conditional Approval Of C3spectra's 6 GHz Band Automated Frequency Coordination System And Seeks Comment On Axon Networks' Proposed AFC System*, ET Docket No. 21-352,

(continued….)

operators already granted the waivers, we estimate that up to eight additional AFC operators could benefit from the time savings associated with eliminating the need for individual waiver requests. Further, we assume that operators will rely on outside counsel to file waiver requests at the hourly rate of an attorney at $300/hour.[641] We assume that each waiver requires two hours of work by an attorney and calculate the potential cost savings from reduced waiver burdens as follows: 1 attorney × $300/hour × 2 hours × 8 operators = $4,800. This estimate is conservative, as it does not account for potential cost savings resulting from reduced internal communications, including those that may require engineering input or consultation between operators and outside counsel. Based on this analysis, we believe that our proposals to streamline the waiver process will result in a one-time cost savings of approximately $4,800.

182. On the other hand, we find that permitting LPI operation on cruise ships would result in higher economic benefits by enabling cruise ship passengers to remain connected throughout their voyages in a more cost-efficient manner. We estimate that the proposed rules would contribute approximately $35.6 million in annual benefits. In 2025, approximately 19 million U.S. residents are expected to take cruise vacations,[642] with an average trip duration of approximately 7.1 days.[643] These cruise ship vacations account for approximately 0.11% of the aggregate annual American man-hours as calculated as follows: (19 million cruise ship passengers × 7.1 days)/(342 million U.S. population × 365 days) = 0.11%.[644] Based on the economic analysis cited in prior Commission orders,[645] authorizing LPI operation in 6 GHz is expected to contribute approximately $32.4 billion to the U.S. economy in 2025.[646] Assuming that cruise ship passenger-time represents 0.11% of total U.S. consumers time, we estimate the annual benefit attributable to LPI operation on board cruise ships as follows: $32.4 billion × 0.11% = $35,623,500, which we round to $35.6 million. Taken together, we expect that the proposed rules would result in a one-time benefit of approximately $4,800 from streamlining the consideration of BEL in AFC system applications and an annual benefits of approximately $35.6 million from permitting LPI device operation on board cruise ships.

183. *Costs*. For the proposed rule permitting AFC systems to account for BEL, we anticipate that the rule will impose no additional costs on the public. While AFC operators may incur costs to reconfigure their systems to incorporate BEL into their propagation models and adjust coordination

(Continued from previous page)
Public Notice, 39 FCC Rcd 7040, 7040, para. 1 (OET 2024); O*ET Announces Approval Of Axon Networks' 6 GHz Band Automated Frequency Coordination System For Commercial Operation*, ET Docket No. 21-352, Public Notice, DA 25-559, at 1, para. 1 (OET June 27, 2025).

[641] Our estimated rate for attorneys ($300/hour) is based on the Commission's estimates of labor costs as represented in a 2024 Paperwork Reduction Act (PRA) analysis. International Section 214 Process and Tariff Requirements – 47 CFR Sections 63.10-63.25, 1.40001, 1.40003, OMB Control No. 3060-0686 Paperwork Reduction Act (PRA) Supporting Statement at 10 (Mar. 2024), https://www.reginfo.gov/public/do/PRAViewDocument?ref_nbr=202404-3060-002.

[642] AAA, Record 19 million Americans Projected to Cruise This Year (Jan. 27, 2025), https://newsroom.aaa.com/2025/01/aaa-record-19-million-americans-projected-to-cruise-this-year/.

[643] CLIN, State of the Cruise Industry Report 2025 at 26 (2025), https://cruising.org/sites/default/files/2025-05/State%20of%20the%20Cruise%20Industry%20Report%202025.pdf.

[644] U.S. Census Bureau, U.S. and World Population Clock, https://www.census.gov/popclock/ (last visited July 30, 2025) (estimating the U.S. population to be approximately 342 million).

[645] *See 6 GHz First Order*, 35 FCC Rcd at 3937, para. 229 & n.601; *see also 6 GHz Second Order*, 38 FCC Rcd at 10575, para. 102 & n.42.

[646] Telecom Advisory Services, LLC, Assessing the Economic Value of Unlicensed Use in the 5.9 GHz & 6 GHz Bands at 56, tbl. 4-15 (Apr. 2020), http://wififorward.org/wp-content/uploads/2020/04/5.9-6.0-FINAL-for-distribution.pdf (estimating LPI benefits in 6 GHz band in 2025 include $6.138 billion from return to speed, $1.338 billion from consumer surplus, $10.362 billion from broader deployment of IoT, and $14.547 billion from savings in enterprise traffic, totaling $32.385 billion).

procedures accordingly, such costs would be incurred voluntarily only when operators determine that the expected benefits outweigh the associated cost. Therefore, we do not separately account for these costs, as we anticipate this proposal to be cost-neutral from a regulatory perspective. Moreover, we expect that allowing AFC systems to account for BEL will not result in harmful interference to existing licensed operations. As such, we anticipate no additional costs would be imposed on incumbent licensed users.

184. For the proposed use of LPI devices on board cruise ships, we similarly anticipate no cost to the public. While the proposed rule may stimulate consumer demand for LPI devices to be used on board cruise ships, any associated consumer expenditures are expected to be captured by device manufacturers as producer surplus. Therefore, these expenditures represent a transfer within the economy rather than a net cost, and are not included in our cost estimates. We recognize that cruise ship operators may incur costs to install LPI access points indoors for use by passengers and crew. However, such installations are entirely voluntary, and operators are expected to proceed only when the expected benefits (e.g., premiums they can charge for the use) exceed the associated costs. Accordingly, we consider this proposal to be cost-neutral from a regulatory standpoint. Based on this expectation, we do not separately quantify the costs associated with voluntary adoption of LPI access points on board cruise ships. Meanwhile, we anticipate that permitting LPI access points to operate on board cruise ships will not result in harmful interference to Earth Exploration Satellite Service operations. The expectation is based on the limited number of such ships and the substantial attenuation of indoor signals caused by the thick metal walls and internal structures of the vessels. Therefore, we tentatively conclude that the proposed rules will not incur any substantial costs.

V. PROCEDURAL MATTERS

185. *Regulatory Flexibility Act*. The Regulatory Flexibility Act of 1980, as amended (RFA),[647] requires that an agency prepare a regulatory flexibility analysis for notice and comment rulemakings, unless the agency certifies that "the rule will not, if promulgated, have a significant economic impact on a substantial number of small entities."[648] Accordingly, the Commission has prepared a Final Regulatory Flexibility Analysis (FRFA) concerning the possible impact of the rule changes contained in this *Fourth Report and Order* on small entities. The FRFA is set forth in Appendix C.

186. The Commission has also prepared an Initial Regulatory Flexibility Analysis (IRFA) concerning the potential impact of rule and policy change proposals on small entities in the *Third Further Notice of Proposed Rulemaking*. The IRFA is set forth in Appendix D. The Commission invites the general public, in particular small businesses, to comment on the IRFA. Comments must be filed by the deadlines for comments on the *Third Further Notice of Proposed Rulemaking* indicated on the first page of this document and must have a separate and distinct heading designating them as responses to the IRFA.

187. *Paperwork Reduction Act.* This *Fourth Report and Order* does not contain new or modified information collections subject to the Paperwork Reduction Act of 1995 (PRA), 44 U.S.C. §§ 3501-3521. In addition, therefore, it does not contain any new or modified information collection burden "for small business concerns with fewer than 25 employees," pursuant to the Small Business Paperwork Relief Act of 2002, 44 U.S.C. § 3506(c)(4).

188. This *Third Further Notice of Proposed Rulemaking* does not contain proposed information collections subject to the Paperwork Reduction Act of 1995 (PRA), 44 U.S.C. §§ 3501-3521. In addition, therefore, it does not contain any new or modified information collection burden for small business concerns with fewer than 25 employees, pursuant to the Small Business Paperwork Relief Act of

[647] 5 U.S.C. §§ 601-612. The RFA has been amended by the Small Business Regulatory Enforcement Fairness Act (SBREFA), Pub. L. No. 104-121, 110 Stat. 847 (1996).

[648] *Id.* § 605(b).

2002, 44 U.S.C. § 3506(c)(4).

189. *Congressional Review Act.* The Commission has determined, and the Administrator of the Office of Information and Regulatory Affairs, Office of Management and Budget, concurs, that this rule is "major" under the Congressional Review Act, 5 U.S.C. § 804(2). The Commission will send a copy of this *Fourth Report and Order* to Congress and the Government Accountability Office pursuant to 5 U.S.C. § 801(a)(1)(A).

190. *Providing Accountability Through Transparency Act*. Consistent with the Providing Accountability Through Transparency Act, Public Law 118-9, a summary of the *Third Further Notice of Proposed Rulemaking* will be available on https://www.fcc.gov/proposed-rulemakings.

191. *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).

- Electronic Filers: Comments may be filed electronically using the Internet by accessing the ECFS: https://www.fcc.gov/ecfs/.
- Paper Filers: Parties who choose to file by paper must file an original and one copy of each filing.
    - Filings can be sent by hand or messenger delivery, by commercial courier, or by the U.S. Postal Service. **All filings must be addressed to the Secretary, Federal Communications Commission.**
    - Hand-delivered or messenger-delivered paper filings for the Commission's Secretary are accepted between 8:00 a.m. and 4:00 p.m. by the FCC's mailing contractor at 9050 Junction Drive, Annapolis Junction, MD 20701. 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 courier deliveries (any deliveries not by the U.S. Postal Service) must be sent to 9050 Junction Drive, Annapolis Junction, MD 20701.
    - Filings sent by U.S. Postal Service First-Class Mail, Priority Mail, and Priority Mail Express must be sent to 45 L Street NE, Washington, DC 20554.

192. *Ex Parte Rules*. This proceeding shall be treated as a "permit-but-disclose" proceeding in accordance with the Commission's *ex parte* rules.[649] 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

[649] 47 CFR § 1.1200 *et seq.*

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 this proceeding should familiarize themselves with the Commission's *ex parte* rules.

193. *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.

194. *Additional Information*. For additional information on this proceeding, contact Nicholas Oros of the Office of Engineering and Technology, Policy and Rules Division, at 202-418-0636 or Nicholas.Oros@fcc.gov.

VI. ORDERING CLAUSES

195. Accordingly, IT IS ORDERED that, pursuant to sections 2, 4(i), 302, and 303 of the Communications Act of 1934, as amended, 47 U.S.C. §§ 152, 154(i), 302a, 303, this *Fourth Report and Order and Third Further Notice of Proposed Rulemaking* IS HEREBY ADOPTED.[650]

196. IT IS FURTHER ORDERED that this *Fourth Report and Order and Third Further Notice of Proposed Rulemaking* SHALL BE EFFECTIVE 60 days after publication in the Federal Register.

197. IT IS FURTHER ORDERED that the Office of the Secretary SHALL SEND a copy of this *Fourth Report and Order and Third Further Notice of Proposed Rulemaking,* including the Final and Initial Regulatory Flexibility Analyses, to the Chief Counsel for Advocacy of the Small Business Administration.

198. IT IS FURTHER ORDERED that the Office of Managing Director, Performance Program Management, SHALL SEND a copy of this *Fourth Report and Order* in a report to be sent to Congress and the Government Accountability Office pursuant to the Congressional Review Act, 5 U.S.C. § 801(a)(1)(A).

FEDERAL COMMUNICATIONS COMMISSION

Marlene H. Dortch
Secretary

[650] Pursuant to Executive Order 14215, 90 Fed. Reg. 10447 (Feb. 20, 2025), this regulatory action has been determined to be economically significant under Executive Order 12866, 58 Fed. Reg. 68708 (Dec. 28, 1993).

APPENDIX A

Final Rules

Parts 0 and 15 of Title 47 of the Code of Federal Regulations are amended as follows:

PART 0 – COMMISSION ORGANIZATION

1. The authority citation for part 0 continues to read as follows:

AUTHORITY: 47 U.S.C. 151, 154(i), 154(j), 155, 225, 409, and 1754, unless otherwise noted.

2. Amend § 0.241 by revising paragraph (k) to read as follows:

§ 0.241 Authority delegated.

* * * * *

(k) The Chief of the Office of Engineering and Technology is delegated authority to administer the Automated Frequency Coordination (AFC) systems, AFC system operator functions, geofencing systems, and geofencing system operator functions set forth in subpart E of part 15 of this chapter. The Chief is delegated authority to develop specific methods that will be used to designate AFC system and geofencing system operators; to designate AFC system and geofencing system operators; to develop procedures that these AFC system and geofencing system operators will use to ensure compliance with the requirements for AFC system and geofencing system operations; to make determinations regarding the continued acceptability of individual AFC system and geofencing system operators; and to perform other functions as needed to administer the AFC and geofencing systems.

* * * * *

PART 15 – RADIO FREQUENCY DEVICES

1. 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.

2. Amend § 15.403 by adding the definitions of "Geofenced variable power access point," "Geofencing," and "Geofencing system" in alphabetical order, to read as follows:

§ 15.403 Definitions.

* * * * *

Geofenced variable power access point. For the purpose of this subpart, an access point that operates in the 5.925–6.425 GHz and 6.525 -6.875 GHz bands, has an integrated antenna, and uses a geofencing system to determine channel availability at its location.

Geofencing. For the purposes of this subpart, a method of establishing exclusion zones within which geofenced variable power access points and associated devices are not permitted to operate on frequencies specified by the geofencing system; and inclusions zones within which such devices are permitted to operate on frequencies specified by the geofencing system.

Geofencing system. A system that automatically determines frequency specific zones where geofenced variable power access points are either permitted to operate or not permitted to operate in the 5.925-6.425 GHz and 6.525-6.875 GHz bands.

* * * * *

3. Amend § 15.407 by:

a. Redesignating paragraphs (a)(7) and (8) as paragraphs (a)(8)(i) and (ii);

b. Adding paragraphs (a)(7) and (a)(8)(iii);

c. Revising paragraphs (a)(10), (d)(1)(i), (d)(1)(iv), (d)(3), and (d)(5);

d. Redesignating paragraph (d)(7) as paragraph (d)(5)(iii);

e. Adding and reserving paragraph (d)(7);

f. Revising paragraphs (d)(8) through (10);

g. Revising paragraph (k)(3);

h. Redesignating and revising paragraph (l) as paragraph (n);

i. Adding paragraph (l);

j. Redesignating and revising paragraph (m) as paragraph (o); and

h. Redesignating and revising paragraph (n) as paragraph (p) to read as follows:

§ 15.407 General technical requirements.

(a) * * *

(7) For a geofenced variable power access point operating in the 5.925–6.425 GHz or 6.525–6.875 GHz band, the maximum power spectral density must not exceed 11 dBm e.i.r.p. in any 1-megahertz band. In addition, the maximum e.i.r.p. over the frequency band of operation must not exceed 24 dBm.

(8) Client device operation:

(i) For client devices, except for fixed client devices as defined in this subpart, operating under the control of a standard power access point in 5.925–6.425 GHz and 6.525–6.875 GHz bands, the maximum power spectral density must not exceed 17 dBm e.i.r.p. in any 1-megahertz band, the maximum e.i.r.p. over the frequency band of operation must not exceed 30 dBm, and the device must limit its power to no more than 6 dB below its associated standard power access point's authorized transmit power.

(ii) For client devices operating under the control of an indoor access point in the 5.925–7.125 GHz bands, the maximum power spectral density must not exceed −1 dBm e.i.r.p. in any 1-megahertz band, and the maximum e.i.r.p. over the frequency band of operation must not exceed 24 dBm.

(iii) For client devices operating under the control of a geofenced variable power access point in the 5.925–6.425 GHz and 6.525–6.875 GHz bands, the maximum power spectral density must not exceed 5 dBm e.i.r.p. in any 1-megahertz band, the maximum e.i.r.p. over the frequency band of operation must not exceed 18 dBm, and the device must limit its power to no more than 6 dB below its associated geofenced variable power access point's authorized transmit power.

* * * * *

(10) Access points operating under the provisions of paragraphs (a)(5), (6), (7) and (9) of this section must employ a permanently attached integrated antenna.

* * * * *

(d) * * *

(1) * * *

(i) ***Oil platforms.*** Standard power access points, fixed client devices, geofenced variable power access points, very low power devices, and low-power indoor access points in the 5.925-7.125 GHz band are prohibited from operating on oil platforms.

* * * * *

(iv) ***Aircraft.*** Standard power access points, fixed client devices, geofenced variable power access points, very low power devices, and low-power indoor access points in the 5.925-7.125 GHz band are prohibited from operating on aircraft, except that very low power devices and low-power indoor access points are permitted to operate in the 5.925-6.425 GHz bands in large aircraft while flying above 10,000 feet.

* * * * *

(3) Transmitters operating under the provisions of paragraphs (a)(5), (6), and (8)(ii) of this section are limited to indoor locations.

* * * * *

(5) Client Devices:

(i) In the 5.925–7.125 GHz band, client devices must operate under the control of a standard power access point, indoor access point, subordinate device, or geofenced variable power access point; Subordinate devices must operate under the control of an indoor access point.

(ii) Access points and subordinate devices may connect to other access points or subordinate devices.

(iii) Fixed client devices may only connect to a standard power access point.

(iv) In all cases, an exception exists such that a client device may transmit brief messages to an access point when attempting to join its network after detecting a signal that confirms that an access point is operating on a particular channel.

(v) Client-to-client communications: Client devices are prohibited from connecting directly to another client device, except that client devices under the control of the same geofenced variable power access point may communicate directly with each other using the same frequency they are using to communicate with the geofenced variable power access point.

* * * * *

(7) [Reserved]

(8) Very low power devices, geofenced variable power access points, and clients operating under the control of a geofenced variable power access point may not be installed on fixed outdoor infrastructure. Such devices may not be mounted on outdoor structures, such as buildings or poles.

(9) Geofenced variable power access points and very low power devices must prioritize operations on frequencies above 6.105 GHz prior to operating on frequencies between 5.925 GHz and 6.105 GHz.

(10) Transmit power control (TPC). Geofenced variable power access points and very low power devices operating in the 5.925-7.125 GHz band shall employ a TPC mechanism with the capability to operate at least 6 dB below the device's maximum e.i.r.p. PSD value.

(k) * * *

(3) An AFC system must 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 standard power access points and fixed client devices. Based on the criteria specified in paragraph (n) of this section, an AFC system must establish location and frequency-based exclusion zones (both co-channel and adjacent channel) around fixed microwave receivers operating in the 5.925-6.425 GHz and 6.525-6.875 GHz bands. Individual standard power access points and fixed client devices must not operate co-channel to fixed microwave system frequencies within co-channel exclusion zones, or on adjacent channel frequencies within adjacent channel exclusion zones.

* * * * *

(7)

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(iii) Providing standard power access points and fixed client devices with the permissible frequencies and the maximum permissible power in each frequency range at their locations using propagation models and interference protection criteria defined in paragraph (n) of this section.

* * * * *

(l) ***Geofencing System.***

(1) A geofencing system must 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 specific zones for geofenced variable power access points and provide that information to those devices. These zones must be determined for specified frequencies based on the propagation models and protection criteria specified in paragraph (n) of this section.

(i) The zones can be determined as exclusion zones specifying frequencies on which and locations where geofenced variable power devices are not permitted to operate or inclusion zones specifying frequencies on which and locations where geofenced variable power devices are permitted to operate.

(ii) The geofencing system must assume that geofenced variable power devices are at a height of 10 meters when determining exclusion zones.

(iii) The geofencing system must access the Commission's licensing databases and update the frequency-specific zones at least once per day to ensure that they are based on the most recent information in the Commission's databases.

(2) Geofencing systems must establish exclusion or inclusion zones to prevent geofenced variable power access point operations between 6.525-6.875 GHz on the oceans beyond the United States territorial sea as defined in 33 CFR 2.22(a)(1).

(3) The geofencing system must ensure that all communications and interactions between the geofencing system and the geofenced variable power access point and/or all communications between the geofencing system and Commission databases are accurate and secure and that unauthorized parties cannot access or alter the database or any information it provides to geofenced variable power access points. Additionally, the geofencing system must incorporate security measures to protect against unauthorized data input or alteration of stored data.

(4) A geofencing system must verify the validity of the FCC identifier (FCC ID) of any geofenced variable power access point seeking access to its services prior to authorizing the access point to begin operation. A list of geofenced variable power access points with valid FCC IDs and the FCC IDs of those devices must be obtained from the Commission's Equipment Authorization System.

(5) A geofencing system must implement the terms of international agreements with Mexico and Canada.

(6) With regard to enforcement instruction *and* data accuracy, each geofencing system must:

(i) Ensure that a regularly updated geofencing system database that contains the information described in this section, including frequency-specific exclusion or inclusion zones and geofenced variable power access points authorization parameters, is maintained.

(ii) Respond in a timely manner to verify, correct, or remove, as appropriate, data in the event that the Commission or a party presents a claim of inaccuracies in the geofencing system.

(iii) Establish and follow protocols to comply with enforcement instructions from the

Commission, including discontinuing geofenced variable power access point operations on specified frequencies in designated geographic areas and predetermined exclusion zones.

(iv) Comply with instructions from the Commission to adjust frequency-specific exclusion or inclusion zones to more accurately reflect the potential for harmful interference.

(7) A geofencing system operator must provide continuous service to all geofenced variable power access points for which it has agreed to provide service. If a geofencing system ceases operation, the operator must provide at least 30 days' notice to the Commission and a description of any arrangements made for those devices to continue to receive location and frequency-specific update information.

(8) A geofencing system operator may charge fees for providing service. The Commission may, upon request, review the fees and can require changes to those fees if the Commission finds them to be unreasonable.

(m) ***Geofenced variable power access point requirements.***

(1) A geofenced variable power access point must register with and be authorized by a geofencing system prior to the geofenced variable power access point's initial service transmission. At registration the geofenced variable power access point must provide its FCC identifier (FCC ID) and either its unique manufacturer's serial number or its model name/number or other information sufficient to uniquely identify the device manufacturer and model.

(2) Geofenced variable power access point device geo-location capability:

(i) A geofenced variable power access point must include an internal geo-location capability to automatically determine the geofenced variable power access point's geographic coordinates and location uncertainty (in meters), with a 95% confidence level. The geofenced variable power access point must use such coordinates and location uncertainty when comparing the device's specific location to frequency-specific information for its location obtained from the geofencing system.

(ii) Geofenced variable power access point equipment authorization applicants must provide an attestation describing the geo-location method used, that method's accuracy, and the location uncertainty accuracy.

(3) A geofenced variable power access point must access a geofencing system to obtain frequency-specific information (i.e., exclusion zones or inclusion zones) for the area in which it is operating or intends to operate (e.g., within a specific point radius or within specific boundaries) prior to transmitting. If the geofenced variable power access point moves beyond those boundaries, it must obtain additional frequency-specific information for the new area and adjust its operating frequency, if necessary, prior to operating in this new area. If the geofenced variable power access point does not obtain frequency specific information for the area in which it is currently located, it may not transmit. The geofenced variable power access point must obtain updated frequency-specific information from the geofencing system at least once per day. If the geofenced variable power access point fails to obtain the updated frequency specific information on any given day, the geofenced variable power access point may continue to operate until 11:59 p.m. of the following day at which time it must cease operations until it can obtain updated frequency-specific information for its location.

(4) A geofenced variable power access point must determine its location and avoid transmitting on frequencies that are not available in accordance with the frequency-specific information for its location obtained from the geofencing system. The geofenced variable power access point may not permit a client device operating under its control to transmit on frequencies that are not available to the geofenced variable power access point. The geofenced variable power access point must determine its location frequently enough to ensure that it can adjust its operating frequency, including ceasing operation, within one second after any portion of the access point's

location uncertainty region crosses into an area in which its current operating frequency is prohibited.

(5) A geofenced variable power access point must incorporate adequate security measures to prevent it from accessing geofencing systems not approved by the FCC, to ensure that unauthorized parties cannot modify the device to operate in a manner inconsistent with the rules and protection criteria set forth in this section, and to ensure that communications between the geofenced variable power access point and geofencing systems and between the geofenced variable power access point and a client device operating under its control are secure to prevent corruption or unauthorized interception of data.

(n) ***Incumbent protection by AFC and geofencing systems: Fixed microwave services.***

(1) Propagation Models: Propagation models to determine the appropriate separation distance between a standard power access point, a fixed client device, or geofenced variable power access point and an incumbent fixed microwave service receiver. For a separation distance:

(i) Up to 30 meters, the AFC system and geofencing system must use the free space path-loss model.

(ii) More than 30 meters and up to and including one kilometer, the AFC system and geofencing system must use the Wireless World Initiative New Radio phase II (WINNER II) model. The AFC system or geofencing system must use site-specific information, including buildings and terrain data, for determining the line-of-sight/non-line-of-sight path component in the WINNER II model, where such data is available. For evaluating paths where such data is not available, the AFC system and geofencing system must use a probabilistic model combining the line-of-sight path and non-line-of-sight path into a single path-loss as follows:

$$\text{Path-loss (L)} = \Sigma_i P(i) * L_i = P_{LOS} * L_{LOS} + P_{NLOS} * L_{NLOS},$$

where P_{LOS} is the probability of line-of-sight, L_{LOS} is the line-of-sight path loss, P_{NLOS} is the probability of non-line-of sight, L_{NLOS} is the non-line-of-sight path loss, and L is the combined path loss. The WINNER II path loss models include a formula to determine P_{LOS} as a function of antenna heights and distance. P_{NLOS} is equal to $(1-P_{LOS})$. In all cases, the AFC system and geofencing system will use the correct WINNER II parameters to match the morphology of the path between a standard power access point or geofenced variable power access point and a fixed microwave receiver (*i.e.,* Urban, Suburban, or Rural).

(iii) More than one kilometer, the AFC system and geofencing system must use Irregular Terrain Model (ITM) combined with the appropriate clutter model. To account for the effects of clutter, such as buildings and foliage, the AFC system and geofencing system must combine the ITM with the ITU-R P.2108-0 (06/2017) clutter model for urban and suburban environments and the ITU-R P.452-16 (07/2015) clutter model for rural environments. The AFC system and geofencing system should use the most appropriate clutter category for the local morphology when using ITU-R P.452-16. However, if detailed local information is not available, the "Village Centre" clutter category should be used. The AFC system and geofencing system must use 1 arc-second digital elevation terrain data and, for locations where such data is not available, the most granular available digital elevation terrain data.

(2) Interference Protection Criteria:

(i) The AFC system and geofencing system must use −6 dB I/N as the interference protection criteria in determining the size of the co-channel zone where I (interference) is the co-channel signal from the standard power access point, geofenced variable power access point, or fixed client

device at the fixed microwave service receiver, and N (noise) is background noise level at the fixed microwave service receiver.

(ii) The AFC system must use −6 dB I/N as the interference protection criteria in determining the size of the adjacent channel zone, where I (interference) is the signal from the standard power access point or fixed client device's out of channel emissions at the fixed microwave service receiver and N (noise) is background noise level at the fixed microwave service receiver. The adjacent channel zone must be calculated based on the emissions requirements of paragraph (b)(7) of this section.

(3) Geofencing systems may include up to 4 dB additional loss to account for losses due to scattering and absorption from a nearby body or object.

(o) ***Incumbent protection by AFC and geofencing systems: Radio Astronomy Services.*** The AFC system and geofencing system must enforce a zone to the following radio observatories that observe between 6650-6675.2 MHz: Arecibo Observatory, the Green Bank Observatory, the Very Large Array (VLA), the 10 Stations of the Very Long Baseline Array (VLBA), the Owens Valley Radio Observatory, and the Allen Telescope Array. The zone sizes are based on the radio line-of-sight and determined using 4/3 earth curvature and the following formula:

dkm_los = 4.12 * (sqrt(Htx) + sqrt(Hrx)),

where Htx is the height of the unlicensed standard power access point or fixed client device and Hrx is the height of the radio astronomy antenna in meters above ground level. Htx is 10 meters for an unlicensed geofenced variable power access point. Coordinate locations of the radio observatories are listed in § 2.106(c)(131), (c)(385) of this chapter.

(p) ***Incumbent protection of Fixed-Satellite Services.*** Standard power access points and fixed client devices located outdoors must limit their maximum e.i.r.p. at any elevation angle above 30 degrees as measured from the horizon to 21 dBm (125 mW) to protect fixed satellite services.

APPENDIX B

Proposed Rules

For the reasons discussed in the document, the Federal Communications Commission proposes to amend 47 CFR part 15 as follows:

PART 15 – RADIO FREQUENCY DEVICES

1. 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.

2. Amend § 15.407 by revising paragraphs (d)(1)(iii) and (d)(4) and adding paragraphs (k)(17) and (l)(1)(iv) to read as follows:

§ 15.407 General technical requirements.

* * * * *

(d) * * *

(1) * * *

* * * * *

(iii) ***Boats.*** Operation of standard power access points, fixed client devices, and indoor access points in the 5.925-7.125 GHz band is prohibited on boats, except that indoor access points are permitted to operate on cruise ships as defined in 33 CFR 101.105.

* * * * *

(4) In the 5.925-7.125 GHz band, indoor access points and subordinate devices must bear the following statement in a conspicuous location on the device and in the user's manual: FCC regulations restrict operation of this device to indoor use only. The operation of this device is prohibited on oil platforms, cars, trains, boats, and aircraft, except that operation of this device is permitted in large aircraft while flying above 10,000 feet and on cruise ships as defined in 33 CFR 101.105.

(k) * * *

* * * * *

(17) An AFC system must be capable of identifying composite indoor/standard-power access points based on the FCC ID provided by the access point during registration and certified equipment class information obtained from the Commission’s Equipment Authorization System.

(l) * * *

(1) * * *

* * * * *

(iv) An AFC system may incorporate building entry loss up to and including 6 dB in its propagation model calculations in response to a spectrum inquiry request initiated from a composite low-power indoor/standard-power access point.

* * * * *

APPENDIX C

Final Regulatory Flexibility Analysis

1. As required by the Regulatory Flexibility Act of 1980, as amended (RFA),[1] the Federal Communications Commission (Commission) incorporated an Initial Regulatory Flexibility Analysis (IRFA) in the *Unlicensed Use of the 6 GHz Band, et al., Second Report and Order, Second Further Notice of Proposed Rulemaking, and Memorandum Opinion and Order on Remand*, released in November 2023.[2] The Commission sought written public comment on the proposals in the *Second Further Notice of Proposed Rulemaking*, including comment on the IFRA. No comments were filed addressing the IRFA. This Final Regulatory Flexibility Analysis (FRFA) conforms to the RFA and it (or summaries thereof) will be published in the Federal Register.[3]

A. Need for, and Objectives of, the Rules

2. The Commission previously adopted rules to permit several types of unlicensed devices to operate in the 6 GHz band (5.925-7.125 GHz). Standard-power devices operate at fixed locations under the control of automated frequency coordination (AFC) systems which protect incumbent licensed services in the 6 GHz band from receiving harmful interference. Low power indoor (LPI) devices are restricted to indoor operation and operate at lower power to protect licensed incumbent users. Very low power (VLP) unlicensed devices, which operate at even lower power levels than LPI devices, can be used anywhere without the need for an AFC system.

3. In the *Fourth Report and Order* the Commission adopts rules for an additional type of 6 GHz band unlicensed device, geofenced variable power (GVP) devices. GVP devices operate at significantly higher power than VLP devices but will be restricted from operating in exclusion zones on certain frequencies to protect incumbent licensed services from harmful interference. GVP devices will be required to download frequency-specific exclusion zones for the area in which they are operating from a geofencing system. The geofencing system will determine the exclusion zones based on information in the Commission's licensing database using propagation models and interference protection criteria specified by the Commission. Because GVP devices will not operate in exclusion zones on particular frequencies, they will not present a significant risk of causing harmful interference to licensed services which share the 6 GHz band. GVP device operations are limited to the U-NII-5 (5.925-6.425 GHz) and U-NII-7 (6.525-6.875 GHz) portions of the 6 GHz band and they can transmit at up to 11 dBm/MHz EIRP power spectral density (PSD) and 24 dBm EIRP. GVP devices will provide the capability for increased data rates and greater range than VLP devices thereby enabling exciting new applications such as augmented reality/virtual reality, short-range hotspots, automation processes, and indoor location and navigation.

B. Summary of Significant Issues Raised by Public Comments in Response to the IRFA

4. No comments were filed addressing the impact of the proposed rules on small entities.

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[1] 5 U.S.C. §§ 601 *et seq*., as amended by the Small Business Regulatory Enforcement and Fairness Act (SBREFA), Pub. L. No. 104-121, 110 Stat. 847 (1996).

[2] *Unlicensed Use of the 6 GHz Band; Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz*, Second Report and Order, Second Further Notice of Proposed Rulemaking, and Memorandum Opinion and Order on Remand, ET Docket No. 18-295, GN Docket No. 17-183, 38 FCC Rcd 10523, Appendix D (2023) (*6 GHz Second FNPRM*).

[3] 5 U.S.C. § 604.

C. Response to Comments by the Chief Counsel for Advocacy of the Small Business Administration

5. Pursuant to the Small Business Jobs Act of 2010, which amended the RFA,[4] the Commission is required to respond to any comments filed by the Chief Counsel for the Small Business Administration (SBA) Office of Advocacy, and provide a detailed statement of any change made to the proposed rules as a result of those comments.[5] The Chief Counsel did not file any comments in response to the proposed rules in this proceeding.

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

6. 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 rules adopted herein.[6] The RFA generally defines the term "small entity" as having the same meaning as under the Small Business Act.[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 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]

7. Our actions, over time, may affect small entities that are not easily categorized at present. We therefore describe three broad groups of small entities that could be directly affected by our actions.[10] 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 34.75 million businesses.[12] Next, "small organizations" are not-for-profit enterprises that are independently owned and operated and not dominant their field.[13] While we do not have data regarding the number of non-profits that meet that criteria, over 99 percent of nonprofits have fewer than 500 employees.[14] Finally, "small governmental jurisdictions" are defined as cities, counties, towns, townships, villages, school districts, or special districts with populations of less than fifty thousand.[15] Based on the 2022 U.S. Census

[4] Small Business Jobs Act of 2010, Pub. L. No. 111-240, 124 Stat. 2504 (2010).

[5] 5 U.S.C. § 604 (a)(3).

[6] *Id.* § 604 (a)(4).

[7] *Id.* § 601(6).

[8] *Id*. § 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."

[9] 15 U.S.C. § 632.

[10] 5 U.S.C. § 601(3)-(6).

[11] *See* SBA, Office of Advocacy, *Frequently Asked Questions About Small Business* (July 23, 2024), https://advocacy.sba.gov/wp-content/uploads/2024/12/Frequently-Asked-Questions-About-Small-Business_2024-508.pdf.

[12] *Id*.

[13] 5 U.S.C. § 601(4).

[14] *See* SBA, Office of Advocacy, *Small Business Facts, Spotlight on Nonprofits* (July 2019), https://advocacy.sba.gov/2019/07/25/small-business-facts-spotlight-on-nonprofits/.

[15] 5 U.S.C. § 601(5).

of Governments data, we estimate that at least 48,724 out of 90,835 local government jurisdictions have a population of less than 50,000.[16]

8. The actions taken in the *Fourth Report and Order* will apply to small entities in the industries identified in the chart below by their six-digit North American Industry Classification System (NAICS)[17] codes and corresponding SBA size standard. [18]

Regulated Industry (NAICS Classification)	NAICS Code	SBA Size Standard	Total Firms[19]	Small Firms[20]	% Small Firms in Industry
Wireless Telecommunications Carriers (except Satellite)[21]	517112	1,500 employees	2,893	2,837	98.06
Satellite Telecommunications[22]	517410	$47 million	275	242	88.00
Radio Stations[23]	516110	$47 million	2,963	1,879	63.42

9. Based on currently available U.S. Census data regarding the estimated number of small firms in each identified industry, we conclude that the adopted rules will impact a substantial number of small entities. Where available, we provide additional information regarding the number of potentially affected entities in the above identified industries, and information for other affected entities, as follows.

2024 Universal Service Monitoring Report Telecommunications Service Provider Data [24] **(Data as of December 2023)**	**SBA Size Standard (1500 Employees)**		
Affected Entity	**Total # FCC Form 499A Filers**	**Small Firms**	**% Small Entities**

[16] *See* U.S. Census Bureau, 2022 Census of Governments –Organization, https://www.census.gov/data/tables/2022/econ/gus/2022-governments.html, tables 1-11.

[17] The North American Industry Classification System (NAICS) is the standard used by Federal statistical agencies in classifying business establishments for the purpose of collecting, analyzing, and publishing statistical data related to the U.S. business economy. *See* www.census.gov/NAICS for further details regarding the NAICS codes identified in this chart.

[18] The size standards in this chart are set forth in 13 CFR 121.201 by six digit NAICS code.

[19] *See* U.S. Census Bureau, *2017 Economic Census of the United States*, *Employment Size of Firms for the U.S.: 2017,* Table ID: EC1700SIZEEMPFIRM, *and 2017 Economic Census of the United States*, *Selected Sectors: Sales, Value of Shipments, or Revenue Size of Firms for the U.S.: 2017,* Table ID: EC1700SIZEREVFIRM.

[20] *Id.*

[21] Affected Entities in this industry include Fixed Microwave Services and Public Safety Radio Licensees.

[22] Affected Entities in this industry include Fixed Satellite Small Transmit/Receive Earth Stations.

[23] Affected Entities in this industry include Auxiliary, Special Broadcast and Other Program Distribution Services.

[24] Federal-State Joint Board on Universal Service, Universal Service Monitoring Report at 26, Table 1.12 (2024), https://docs.fcc.gov/public/attachments/DOC-408848A1.pdf.

2024 Universal Service Monitoring Report Telecommunications Service Provider Data [24] (Data as of December 2023)	SBA Size Standard (1500 Employees)		
Affected Entity	**Total # FCC Form 499A Filers**	**Small Firms**	**% Small Entities**
Wireless Telecommunications Carriers (except Satellite)[25]	585	498	85.13

E. Description of Economic Impact and Projected Reporting, Recordkeeping and Other Compliance Requirements for Small Entities

10. The RFA directs agencies to provide a description of the projected reporting, recordkeeping and other compliance requirements of the rule, including an estimate of the classes of small entities which will be subject to the requirement and the type of professional skills necessary for preparation of the report or record.[26]

11. The adopted rules will permit GVP devices to operate across the U-NII-5 (5.925-6.425 GHz) and U-NII-7 (6.525-6.875 GHz) sub-bands of the 6 GHz band at a power level no greater than 11 dBm/MHz EIRP PSD and 24 dBm EIRP. The GVP devices will be required to avoid operation on particular frequencies within exclusion zones that are obtained from a geofencing system to avoid causing harmful interference to fixed microwave receivers and radio astronomy receive sites. Consistent with existing 6 GHz unlicensed client device rules, client devices under the control of a GVP access point must operate at power levels at least 6 dB less than the power level determined by the geofencing system for the associated GVP access point. Geofencing systems will be required to use a centralized architecture to control GVP access points and determine the location and frequency-based exclusion zones for GVP access points around fixed microwave receivers based on the same criteria used to protect microwave receivers from standard-power access points and fixed client devices. Geofencing systems must assume a 10 meter height above ground level for GVP devices when calculating exclusion zones. Geofencing systems must obtain updated information on microwave receivers from the Commission's licensing database and update the frequency-based exclusion zones daily. GVP access points must obtain updated frequency-based exclusion zones from the geofencing system daily. GVP access points must also meet the same transmit power control (TPC) requirements as stipulated in our rules for VLP devices. GVP devices will be prohibited from use on aircraft or attaching to outdoor infrastructure, and must use a permanently attached integrated antenna.

12. The rules will require applicants for certification of GVP devices to show in their application for device certification how their devices will comply with all technical requirements in the rules. This new requirement will not increase the cost of applying for device certification due to its similarities to our existing part 15 rules regarding standard-power devices operating in conjunction with Automated Frequency Coordination (AFC) systems to protect the same incumbent licensed services. .

13. Operators of geofencing systems will be required to undergo a review process to be developed by the Commission's Office of Engineering and Technology (OET) which will involve adequate testing to verify that the geofencing systems are calculating appropriate exclusion zones. Because OET has not yet developed this review process, we are unable to estimate the cost the geofencing operator will incur during the process. In essence, the geofencing systems for the 6 GHz band build upon the principles established in other automated spectrum sharing frameworks, such as AFC systems in the 6

[25] Affected Entities in this industry include all reporting wireless carriers and service providers.

[26] 5 U.S.C. § 604(a)(5).

GHz band and spectrum access systems (SAS) used to manage access to the 3550-3700 MHz band in the Citizens Broadband Radio Service.[27] These frameworks emphasize dynamic spectrum access, leveraging automated coordination systems to enable efficient spectrum use while protecting incumbent licensees.

14. No comments were received regarding cost estimates for GVP devices operated by small entities, however the Commission estimates the economic value to wireless device users in the 6 GHz band will vastly exceed their cost.[28] By opening access to the 6 GHz band, the adopted rules will foster extensive growth in the market for GVP devices and open up exciting new applications such as augmented reality/virtual reality, short-range hotspots, automation processes, and indoor location and navigation. The adopted rules will permit unlicensed small entities to operate GVP devices in the 6 GHz band without the additional complications or costs incurred to obtain a license.

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

15. The RFA requires an agency to provide, "a description of the steps the agency has taken to minimize the significant economic impact on small entities…including a statement of the factual, policy, and legal reasons for selecting the alternative adopted in the final rule and why each one of the other significant alternatives to the rule considered by the agency which affect the impact on small entities was rejected."[29]

16. The rules adopted by the Commission in the *Fourth Report and Order* should benefit small entities by giving them more options for gaining access to valuable spectrum while creating little to no risk of harmful interference to licensed incumbents sharing the 6 GHz band. The adopted rules reflect the Commission's efforts to balance the benefits provided to GVP device users with protecting incumbent operators in the 6 GHz band from harmful interference. Additionally, the Commission considered alternative proposals and weighed their benefits against their potential costs to small businesses and other entities. For example, in considering the types of architectures that the geofencing systems could utilize, the Commission considered proposals to permit the geofencing systems to use either a centralized architecture, where the GVP device must download the exclusion zones from a server, or a decentralized architecture, where the GVP device can calculate the exclusion zones. The Commission chose to require use of a centralized architecture because it would permit the Commission to adjust the size of the exclusion zones if needed to address any interference issues that may arise. The Commission believed this decision was appropriate even though it limited the flexibility in deploying GVP devices, because it would help protect licensed microwave receivers.

17. The Commission also adopted the 11 dBm/MHz EIRP PSD and 24 dBm EIRP power levels rather than the 1 dBm/MHz EIRP PSD and 14 dBm EIRP power levels proposed in the *6 GHz Second FNPRM*, agreeing with commenters that permitting higher power levels provides a stronger incentive for manufacturers to invest in geofencing systems and GVP devices. We declined to adopt other alternatives proposed by commenters, such as establishing additional power levels or limiting power to protect low power indoor Wi-Fi devices because these proposals may discourage the development of innovative consumer devices. The Commission also declined to adopt geofencing exclusion zones that use geometric models or simplified circle and triangle shapes as suggested by commenters, and instead, will allow small and other operators flexibility to specify exclusion zones using more complex boundaries

[27] *Requirements for Commercial Operation in the U.S. 3550-3700 MHz Citizens Broadband Radio Service Band*, Wireless Innovation Forum, Document WINNF-TS-0112, at 11 (June 25, 2019), https://winnf.memberclicks.net/assets/CBRS/WINNF-TS-0112.pdf.

[28] Specifically, our minimal estimate of the discounted aggregate economic benefit of approximately $82 million over a five-year period will exceed the estimated one-time aggregate implementation cost of approximately $32 million.

[29] *Id*. § 604(a)(6).

so long as they do not provide any less protection to microwave receivers. Commenters also suggested specific methodology for the GVP access point to re-check its location at a specific time interval. Instead, the Commission will allow for more flexibility and will permit small and other device manufacturers to choose any re-check interval methodology that ensures a GVP access point complies with interference requirements.

18. Many of the entities holding licenses for use of the 6 GHz band qualify as small entities. The adopted rules for unlicensed operation in this band are designed to prevent the unlicensed GVP 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 permitting GVP unlicensed devices to operate in the 6 GHz band.

19. The Commission believes that this rulemaking, by permitting GVP devices to operate in the 6 GHz band, will 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 economic benefit for small businesses.

G. Report to Congress

20. The Commission will send a copy of the *Fourth Report and Order*, including this Final Regulatory Flexibility Analysis, in a report to Congress pursuant to the Congressional Review Act.[30] In addition, the Commission will send a copy of the *Fourth Report and Order*, including this Final Regulatory Flexibility Analysis, to the Chief Counsel for Advocacy of the SBA and will publish a copy of the *Fourth Report and Order*, and this Final Regulatory Flexibility Analysis (or summaries thereof) in the Federal Register.[31]

[30] *Id.* § 801(a)(1)(A).

[31] *Id.* § 604(b).

APPENDIX D

Initial Regulatory Flexibility Analysis

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

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

2. The Commission has previously adopted rules to permit two types of unlicensed access points to operate in the 6 GHz band (5.925-7.125 GHz): standard-power access points and low power indoor (LPI) access points.[4] Standard-power access points operate at fixed locations under the control of automated frequency coordination (AFC) systems which protect incumbent licensed services in the 6 GHz band from receiving harmful interference. Standard-power access points provide their location to an AFC system and the AFC system uses propagation models specified in the Commission rules to determine the frequencies and power levels that the standard-power access point can operate at to prevent microwave receivers that share the 6 GHz band from receiving harmful interference.[5] LPI access points operate independently of AFC systems, are restricted to indoor operation, and operate at lower power than standard-power devices to protect the microwave receivers from receiving harmful interference.[6] Unlicensed client devices operate under the control of either a standard-power or low power indoor access point.[7]

3. In the *Third Further Notice of Proposed Rulemaking* the Commission proposes to permit AFC systems to take into account building entry loss (BEL) when determining frequency and power-level availability for access points that are authorized to operate in both LPI and standard power modes — i.e., composite indoor/standard-power access points. The proposed rules will require AFC systems to be capable of distinguishing between indoor composite indoor /standard power access points and standard power access points based on the access point's FCC identification number and certified equipment class information to be eligible to apply BEL in the propagation calculations. Only upon confirmation that a device is certified as an indoor composite indoor/standard-power access point can the AFC system assume up to 6 dB of BEL when it provides channel and power level information to that device. Allowing the AFC systems to consider BEL when determining channel availability will increase the composite indoor/standard-power access point operating power when appropriate, thereby increasing their

[1] 5 U.S.C. §§ 601 *et seq*., as amended by the Small Business Regulatory Enforcement and Fairness Act (SBREFA), Pub. L. No. 104-121, 110 Stat. 847 (1996).

[2] *Id.* § 603(a).

[3] *Id*.

[4] *Unlicensed Use of the 6 GHz Band*, ET Docket No. 18-295, Report and Order and Further Notice of Proposed Rulemaking, 35 FCC Rcd 3852, 3860, paras. 17-18 (2020) (*6 GHz First Order*).

[5] 47 CFR §§ 15.407(l).

[6] *6 GHz First Order*, 35 FCC Rcd 3888-89, paras. 98-103.

[7] 47 CFR §§ 15.403, 15.407(a)(7), 15.407(a)(8).

utility to consumers. While the Commission in the *Third Further Notice of Proposed Rulemaking* proposed to permit AFC systems to assume up to 6 dB of BEL for composite indoor/standard-power access points, it also seeks comment on permitting the AFC systems to assume a larger amount of BEL.

4. The Commission's rules currently prohibit the operation of LPI access points on boats. The Commission adopted this prohibition because of the lack of building attenuation when the access points are used on boats and to protect earth exploration satellite service operations over the oceans. In the *Third Further Notice of Proposed Rulemaking* the Commission proposes to relax the prohibition on shipborne operation of LPI access points by permitting their operation on cruise ships. The Commission is making this proposal due to the limited number of cruise ships and the fact that transmissions within cruise ships are likely to experience significant attenuation from the thick metal walls of the ship thereby reducing the risk of harmful interference to earth exploration satellite service operations.

B. Legal Basis

5. The proposed action is authorized pursuant to sections 2, 4(i), 302, and 303 of the Communications Act of 1934, as amended, 47 U.S.C. §§ 152, 154(i), 302a, 303.

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

6. 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 rules adopted herein.[8] The RFA generally defines the term "small entity" as having the same meaning as under the Small Business Act.[9] In addition, the term "small business" has the same meaning as the term "small business concern" under the Small Business Act."[10] A "small 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.[11]

7. Our actions, over time, may affect small entities that are not easily categorized at present. We therefore describe three broad groups of small entities that could be directly affected by our actions.[12] In general, a small business is an independent business having fewer than 500 employees.[13] These types of small businesses represent 99.9% of all businesses in the United States, which translates to 34.75 million businesses.[14] Next, "small organizations" are not-for-profit enterprises that are independently owned and operated and not dominant their field.[15] While we do not have data regarding the number of non-profits that meet that criteria, over 99 percent of nonprofits have fewer than 500 employees.[16] Finally,

[8] *Id.* § 604 (a)(4).

[9] *Id.* § 601(6).

[10] *Id*. § 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."

[11] 15 U.S.C. § 632.

[12] 5 U.S.C. § 601(3)-(6).

[13] *See* SBA, Office of Advocacy, *Frequently Asked Questions About Small Business* (July 23, 2024), https://advocacy.sba.gov/wp-content/uploads/2024/12/Frequently-Asked-Questions-About-Small-Business_2024-508.pdf.

[14] *Id*.

[15] 5 U.S.C. § 601(4).

[16] *See* SBA, Office of Advocacy, *Small Business Facts, Spotlight on Nonprofits* (July 2019), https://advocacy.sba.gov/2019/07/25/small-business-facts-spotlight-on-nonprofits/.

"small governmental jurisdictions" are defined as cities, counties, towns, townships, villages, school districts, or special districts with populations of less than fifty thousand.[17] Based on the 2022 U.S. Census of Governments data, we estimate that at least 48,724 out of 90,835 local government jurisdictions have a population of less than 50,000.[18]

8. The actions taken in the *Third Further Notice of Proposed Rulemaking* will apply to small entities in the industries identified in the chart below by their six-digit North American Industry Classification System[19] codes and corresponding SBA size standard.[20]

Regulated Industry (NAICS Classification)	NAICS Code	SBA Size Standard	Total Firms[21]	Small Firms[22]	% Small Firms in Industry
Wireless Telecommunications Carriers (except Satellite)[23]	517112	1,500 employees	2,893	2,837	98.06
Satellite Telecommunications[24]	517410	$47 million	275	242	88.00

9. Based on currently available U.S. Census data regarding the estimated number of small firms in each identified industry, we conclude that the proposed rules may impact a substantial number of small entities. Where available, we provide additional information regarding the number of potentially affected entities in the above identified industries, and information for other affected entities, as follows.

2024 Universal Service Monitoring Report Telecommunications Service Provider Data [25] (Data as of December 2023)	SBA Size Standard (1500 Employees)		
Affected Entity	Total # FCC Form 499A Filers	Small Firms	% Small Entities

[17] 5 U.S.C. § 601(5).

[18] *See* U.S. Census Bureau, 2022 Census of Governments –Organization, https://www.census.gov/data/tables/2022/econ/gus/2022-governments.html, tables 1-11.

[19] The North American Industry Classification System (NAICS) is the standard used by Federal statistical agencies in classifying business establishments for the purpose of collecting, analyzing, and publishing statistical data related to the U.S. business economy. *See* www.census.gov/NAICS for further details regarding the NAICS codes identified in this chart.

[20] The size standards in this chart are set forth in 13 CFR 121.201 by six digit NAICS code.

[21] *See* U.S. Census Bureau, *2017 Economic Census of the United States*, *Employment Size of Firms for the U.S.: 2017,* Table ID: EC1700SIZEEMPFIRM, *and 2017 Economic Census of the United States*, *Selected Sectors: Sales, Value of Shipments, or Revenue Size of Firms for the U.S.: 2017,* Table ID: EC1700SIZEREVFIRM.

[22] *Id.*

[23] Affected Entities in this industry include Fixed Microwave Services and Public Safety Radio Licensees.

[24] Affected Entities in this industry include Fixed Satellite Small Transmit/Receive Earth Stations.

[25] Federal-State Joint Board on Universal Service, Universal Service Monitoring Report at 26, Table 1.12 (2024), https://docs.fcc.gov/public/attachments/DOC-408848A1.pdf.

2024 Universal Service Monitoring Report Telecommunications Service Provider Data [25] (Data as of December 2023)	SBA Size Standard (1500 Employees)		
Affected Entity	**Total # FCC Form 499A Filers**	**Small Firms**	**% Small Entities**
Wireless Telecommunications Carriers (except Satellite)[26]	585	498	85.13

D. Description of Economic Impact and Projected Reporting, Recordkeeping, and Other Compliance Requirements for Small Entities

10. The RFA directs agencies to describe the economic impact of proposed rules on small entities, as well as projected reporting, recordkeeping and other compliance requirements, including an estimate of the classes of small entities which will be subject to the requirements and the type of professional skills necessary for preparation of the report or record. [27]

11. The proposed rule will permit AFC systems to assume up to an additional 6 dB of BEL attenuation when determining the available frequencies and power levels for composite indoor/standard-power access points. Only AFC systems that are capable of distinguishing between indoor composite indoor/standard power access points and standard power access points based on the FCC identification number and certified equipment class information will be eligible to apply BEL in their propagation calculations. The proposed rules will not require AFC systems to apply BEL in their propagation calculations. Therefore, the AFC system operators will not be required to add the capability to distinguish between indoor composite indoor/standard power access points and standard power access points to their AFC systems and will not have any mandatory compliance cost from the proposed rule. Because this rule only applies to AFC systems' propagation calculations, users of standard-power, LPI, or composite indoor/standard-power access points will have no compliance cost from the proposed rules.

12. Due to the fact that the AFC systems will only be permitted to apply BEL for calculations involving access points that are composite indoor/standard-power access points, they will only use BEL in calculations for access points that are located indoors. Signals transmitted by access points located indoors will experience significant attenuation as they pass through the structure. Therefore, permitting the AFC systems to use BEL in their calculations will not result in a significant increase in the risk that harmful interference will occur to microwave receivers that operate in the 6 GHz band. Finally, microwave licensees, including those that are considered small businesses, should experience no impact from the proposed rule.

13. We do not believe that the proposed rule permitting LPI access point operation on cruise ships will impose any reporting, recordkeeping, or other compliance cost on small entities. This rule will apply to all LPI access point operators, including small business entities. Due to the fact that indoor access points are unlicensed devices under the Commission's Part 15 rules, there is no need for device users to obtain a license, report their operations, or incur other compliance cost.

E. Discussion of Significant Alternatives Considered That Minimize the Significant Economic Impact on Small Entities

14. The RFA directs agencies to provide a description of any significant alternatives to the proposed rules that would accomplish the stated objectives of applicable statutes, and minimize any

[26] Affected Entities in this industry include all reporting wireless carriers and service providers.

[27] 5 U.S.C. § 603(b)(4).

significant economic impact on small entities.[28] The discussion is required to include alternatives such as: "(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 and reporting requirements under the rule for such 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 such small entities."[29]

15. As discussed above, we do not believe that the proposed rule to permit AFC systems to assume up to an additional 6 dB of BEL attenuation for composite indoor/standard-power access points will have a significant economic impact on small entities. For that reason, we do not believe that there is a need to consider alternatives to minimize the economic impact on small entities. Adoption of the proposed rule will enable composite indoor/standard-power access points to potentially operate at locations where they would currently be prohibited from operating or may permit them to transmit with greater power than currently permitted. This proposed rule will increase the coverage area or data rates of the composite indoor/standard-power access points. Small entities that use these composite indoor/standard-power access points will be able to take advantage of the enhanced capabilities of these devices. Because the user is not required to obtain a license to use a 6 GHz unlicensed device, they are ideal for use by small entities.

16. Ultimately, due to the discussion above, we do not believe that the proposed rule permitting LPI access point use on cruise ships will impose a compliance cost on small entities and therefore there will not be any significant economic impact on small entities.

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

17. None.

[28] *Id.* § 603(c).

[29] *Id.* § 603(c)(1)-(4).

APPENDIX E

Regulatory Impact Analysis
6 GHz Fourth Report and Order

I. EXECUTIVE SUMMARY

A. Summary

1. In the *6 GHz Fourth Report and Order*, the Federal Communications Commission (FCC) expands the Very Low Power (VLP) rules to allow geofenced variable power (GVP) devices to operate in the U-NII-5 and U-NII-7 portions of the 6 GHz band. These GVP devices can operate at significantly higher power than VLP devices, but they will be restricted from operating in exclusion zones on certain frequencies to protect incumbent licensed services from harmful interference. Exclusion zones will be calculated consistent with the protection methodology being used by the AFC systems that control spectrum access by standard-power devices to avoid causing harmful interference to incumbent licensed users. GVP devices will provide capability for increased data rates and greater range thereby enabling new applications such as augmented reality/virtual reality, short-range hotspots, automation processes, and indoor location and navigation. This economically significant regulatory action is submitted to the Office of Information and Regulatory Affairs (OIRA) for interagency review. This regulatory impact analysis (RIA) presents an assessment of the regulatory compliance costs and benefits associated with this action and is consistent with Executive Order 12866. Comparing the GVP rules with other alternative policy options, we conclude that the adoption of these proposed rules will result in significant benefits that outweigh the associated costs. This rule is considered a deregulatory action under Executive Order 14192.

B. Table of Benefits and Costs

2. *Summary of Benefits and Costs*. Based on our analysis, the present value of benefits over five years discounted using a 3% and 7% discount rate would be, respectively, $91.6 million and $82 million. This would be accompanied by a one-time cost of approximately $4.1 million to the U.S. government as well as $28.3 million in private costs. Because all costs incurred to achieve the benefits are voluntary, we find that private entities would only incur these costs if they expect that their private benefits will exceed such costs in the foreseeable future. As a result, we believe the overall benefits of the regulatory action easily outweigh the total costs, with no negative impact on the public or the existing licensed users that would be subject to the geofencing requirements.

	One-time	Recurring (per year)	Present Value over 5 Years (3% discount)	Present Value over 5 Years (7% discount)
Benefit		$20,000,000	$91,600,000	$82,000,000
Costs				
Private	$28,300,000		$28,300,000	$28,300,000
Government	$4,100,000		$4,100,000	$4,100,000

II. NEED FOR REGULATORY ACTION

3. Wireless telecommunications devices function by transmitting signals over the electromagnetic spectrum, a finite public resource managed by the FCC. To promote efficient use of the spectrum and to minimize harmful interference, the FCC allocates spectrum into various bands. It designates some bands for licensed use—such as commercial broadcast radio or mobile telephony, and others for unlicensed use under technical standards to prevent harmful interference. Unlicensed devices operate under standards and rules that limit power levels and emissions to prevent interference, and that

have enabled ubiquitous technologies, such as Wi-Fi, Bluetooth, and other short-range wireless systems. These unlicensed uses have facilitated seamless connectivity and innovation across sectors and have become essential to modern life. However, rapidly increasing demand for unlicensed spectrum access has outpaced the capacity of existing allocations.

4. By adopting the rules in the *6 GHz Fourth Report and Order* that permit GVP device access points to operate at a higher power level (up to 11 dBm/MHz EIRP power spectral density (PSD) and 24 dBm EIRP) outside of exclusion zones in the U-NII-5 (5.925-6.425 GHz) and U-NII-7 (6.525-6.875 GHz) portions of the 6 GHz band (5.925-7.125 GHz), the Commission addresses a regulatory constraint that has adversely restricted the development and deployment of advanced unlicensed use cases.[1] These include short-range, high-throughput wireless applications such as hotspots, wearable technology, and augmented reality (AR) and virtual reality (VR) connectivity. Current rules do not adequately accommodate these emerging applications and have resulted in a market inefficiency where available spectrum is underutilized relative to its economic potential.

5. The adoption of the proposed rules corrects this regulatory failure by enabling more intensive use of the 6 GHz band while safeguarding incumbent licensed operations through geofencing constraints. In doing so, the Commission furthers its statutory obligation and longstanding policy objective to ensure that spectrum is put to its highest and best use. By allowing GVP devices to operate under specific technical standards that balance innovation with interference protection, the Report and Order advances spectrum efficiency and responds to technological evolution and consumer demand.

III. BACKGROUND ON 6 GHZ

6. The *6 GHz Fourth Report and Order* expands unlicensed use in the 6 GHz band.[2] This modifies the current ways unlicensed use is allowed in the 6 GHz band. In terms of licensed use, the 6 GHz band is allocated for the Fixed Service, Mobile Service, and Fixed Satellite Service (FSS) across four sub-bands.[3] These four sub-bands—which we refer to as U-NII-5, U-NII-6, U-NII-7, and U-NII-8, respectively—are delineated based on the prevalence and characteristics of the incumbent licensed services that operate in each sub-band. The Fixed Satellite Service operates in all four sub-bands except for the 7.075-7.125 GHz portion of the U-NII-8 band. Fixed Microwave is a predominant licensed service in U-NII-5, U-NII-7 and U-NII-8 bands. The Broadcast Auxiliary Service (BAS) and Cable Television Relay Service (CARS) operate in the U-NII-6 band on a mobile basis, and in the U-NII-8 band on both a fixed and mobile basis.

7. In 2020, the Commission adopted a Report and Order and Further Notice of Proposed Rulemaking (*6 GHz First Order*) that made unlicensed operations available in the 6 GHz band (5.925-7.125 GHz).[4] Specifically, the *6 GHz First Order* adopted rules for two categories of unlicensed

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[1] *Unlicensed Use of the 6 GHz Band; Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz*, Fourth Report and Order, and Third Further Notice of Proposed Rulemaking, and Memorandum Opinion and Order on Remand, ET Docket No. 18-295, GN Docket No. 17-183 (2025) (*6 GHz Fourth Report and Order)*.

[2] The following discussion in this section heavily references passages in the *6 GHz Fourth Report and Order. 6 GHz Fourth Report and Order*, Section II (2025).

[3] *Unlicensed Use of the 6 GHz Band; Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz*, Notice of Proposed Rulemaking, 33 FCC Rcd at 10496, 10499-501, paras. 8-13 (2018) (*Notice*); *Unlicensed Use of the 6 GHz Band; Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz*, Report and Order and Further Notice of Proposed Rulemaking, 35 FCC Rcd at 3852, 3855, para. 7 (2020) (*6 GHz First Order*), *rev'd in part, aff'd in part, and remanded*, *AT&T Servs. Inc., v. FCC*, 21 F.4th 841, 853-54 (D.C. Cir. 2020) (affirming *6 GHz Order* and reversing and remanding to address issue of whether to "reserve a sliver of the 6 GHz band for licensed mobile operation").

[4] *6 GHz First Order*.

operations—standard-power operations and low-power indoor (LPI) operations.[5] On November 1, 2023, the Commission released a Second Report and Order that allowed unlicensed very low power (VLP) devices to operate in the U-NII-5 and U-NII-7 portions of the 6 GHz band (*6 GHz Second Order*).[6] VLP devices are authorized to operate anywhere, indoors and outdoors, without being under the control of an AFC system.[7] In the Second Further Notice of Proposed Rulemaking (*6 GHz Second FNPRM*), which was adopted concurrently with the *6 GHz Second Order*, the Commission proposed to expand VLP operation to the U-NII-6 (6.425-6.525 GHz) and U-NII-8 (6.875-7.125 GHz) portions of the 6 GHz band, with no requirement that the devices be kept indoors or be under the control of an AFC system.[8] On December 11, 2024, the Commission released a Third Report and Order (*6 GHz Third Order*) that, adopting the same technical and operational requirements previously established for VLP devices in the U-NII-5 and U-NII-7 bands, authorized VLP operation in the U-NII-6 and U-NII-8 bands.[9]

IV. REGULATORY ACTION

8. The *6 GHz Fourth Report and Order* adopts rules permitting GVP devices to operate in the U-NII-5 and U-NII-7 portions of the 6 GHz band with up to 11 dBm/MHz EIRP PSD and 24 dBm EIRP.[10] Geofencing systems provide the GVP devices with exclusion zones in which the GVP devices are prohibited from operating on particular frequencies. The geofencing system calculates these exclusion zones to avoid causing harmful interference to licensed fixed microwave links and radio astronomy observatories. Using geofencing will enable GVP devices to operate at significantly higher power levels than the -5 dBm/MHz EIRP PSD and 14 dBm EIRP at which non-geofenced VLP devices are currently permitted to operate. The adopted rules are summarized as follows:

A. Power limits for GVP Access Points

9. The rules will permit GVP devices to operate at up to 11 dBm/MHz EIRP PSD and 24 dBm EIRP maximum power while under the control of a geofencing system, which prevents GVP operation at locations where they may cause harmful interference to licensed incumbent services that share the 6 GHz band. The geofencing system will use the same propagation models and protection criteria that are employed by AFC systems to calculate exclusion zones within which the GVP access points will not be permitted to operate co-channel with a microwave receiver. The GVP access points will be required to have a geolocation capability to determine when they enter an exclusion zone and must adjust their operating frequency, if necessary, to meet this condition. GVP client devices, which will not be required to have a geolocation capability, will operate only under the control of a GVP access point at 6 dB less than the controlling access point's authorized power.

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[5] *Id*. at 3860, paras. 17-18.

[6] *Unlicensed Use of the 6 GHz Band; Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz*, Second Report and Order, Second Further Notice of Proposed Rulemaking, and Memorandum Opinion and Order on Remand, ET Docket No. 18-295, GN Docket No. 17-183, 38 FCC Rcd 10523, 10532, para. 18 (2023) (*6 GHz Second Order* or *6 GHz Second FNPRM*).

[7] *See 6 GHz Second Order,* 38 FCC Rcd at 10532, 10561, paras. 18, 67.

[8] *6 GHz Second FNPRM*, 38 FCC Rcd at 10576, 10600-01, paras. 104, 173.

[9] *Unlicensed Use of the 6 GHz Band; Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz*, Third Report and Order, ET Docket No. 18-295, GN Docket No. 17-183, 39 FCC Rcd 13901, 13908, paras. 12-13 (2024) (*6 GHz Third Order*).

[10] The following discussion in this section heavily references passages in the *6 GHz Fourth Report and Order. 6 GHz Fourth Report and Order*, Section III (2025).

B. GVP Client Device Power

10. The rules set GVP access point power levels of 11 dBm/MHz PSD EIRP and 24 dBm maximum EIRP. Consistent with existing 6 GHz client device rules,[11] client devices under the control of a GVP access point will be required to operate at power levels at least 6 dB less than the power level determined by the geofencing system for the associated GVP access point. The rules limit GVP client devices to a maximum of 5 dBm/MHz PSD EIRP and 18 dBm EIRP. In addition, for GVP access points that are required to operate with reduced power in accordance with the exclusion zones, associated client devices will similarly be required to reduce power such that they are at least 6 dB less than the power permitted for the GVP access point by the geofencing system. Consistent with the *6 GHz Second FNPRM*, GVP access point are defined as an access point that operates in the 5.925–6.425 GHz and 6.525-6.875 GHz bands, has an integrated antenna, and uses a geofencing system to determine channel availability at its location.[12] All client devices will be restricted to transmitting at power levels no more than 6 dB less than the level at which the controlling access point is authorized to operate; whether that access point is a standard-power, low power indoor, or GVP access point.

C. Geofencing System Architecture

11. Geofencing systems will be required to use a centralized architecture to control GVP access points.[13] The geofencing system operator will be required to establish and follow protocols to comply with Commission instructions regarding enforcement actions and to adjust exclusion zones, as necessary.

D. Protection of Fixed Microwave Systems

12. When calculating the GVP exclusion zones to protect microwave receivers, the geofencing systems will be required: (1) to use the same -6 dB I/N interference protection criterion that the Commission adopted in the *6 GHz First Order* for AFC systems; (2) to use the free space path-loss model at separation distances up to 30 meters, the Wireless World Initiative New Radio phase II (WINNER II) model at separation distances greater than 30 meters and up to and including 1 kilometer, and the Irregular Terrain Model (ITM) combined with the appropriate clutter model at separation distances greater than 1 kilometer; (3) to assume a 10 meter height above ground level for GVP devices; (4) to assume a 4 dB body loss value; and (5) to update their data from the Commission's Universal Licensing System (ULS) database at least once per day and to update the exclusion zones daily based on the updated data.

E. Protection of Passive Services

13. GVP access points will be prohibited from operating inside of exclusion zones around certain radio astronomy observatories in the 6.65-6.6752 GHz portion of the U-NII-7 band.

F. Earth-Exploration Satellite Service (EESS)

14. To protect EESS passive sensors that are used over the oceans, GVP access points will be prohibited from operating in ocean exclusion zones. The United States territorial sea border will be used to define the boundary of the ocean exclusion zones, which is 12 nautical miles (nm) from the baseline boarder of each coastal State. GVP access points are also prohibited from use on oil platforms to mirror the rules for VLP devices, standard-power access points, and low power indoor access points.

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[11] 47 CFR § 15.407(a)(7), (a)(8); *6 GHz First Order*, 35 FCC Rcd at 3862, 3890, paras. 22, 103.

[12] *6 GHz Second FNPRM*, 38 FCC Rcd at 10582, para. 118.

[13] In a centralized architecture the GVP access points contact the geofencing system over the internet to receive the exclusion zones. This is in contrast to a distributed architecture where the GVP access points calculate the exclusion zones.

G. GVP Device Requirements

15. GVP access points will be required: (1) to include a geolocation capability to determine their geographic coordinates with a determined location uncertainty in meters with a 95% confidence level; (2) to re-check their locations at an interval that ensures the device adjusts its operating frequencies, within one second, after any portion of the device's location uncertainty area crosses into an exclusion zone so as to ensure no harmful interference occurs; (3) to employ a transmit power control (TPC) mechanism that has the capability to operate at least 6 dB below the maximum EIRP permitted for the bands (e.g., 14 dBm or 21 dBm); (4) to implement a contention-based protocol which will act to avoid channels on which incumbent systems are actively transmitting; (5) to not attach to outdoor infrastructure, such as poles or buildings, which will help ensure that the GVP devices are used only for mobile applications; and (6) to use a permanently attached integrated antenna.

H. GVP Client-to-Client Communications

16. Direct communication between two client devices under control of a GVP access point will be allowed, subject to the client devices being required to operate on the frequency in either the U-NII-5 and U-NII-7 band that they are using to communicate with the GVP access point. As previously indicated, if a GVP access point switches frequencies, the client devices will also be required to switch frequencies to continue operating in a client-to-client mode.

I. Approval of Geofencing Systems

17. Authority to administer the geofencing systems and geofencing system operator functions in accordance with the rules Commission is adopting to govern 6 GHz band geofencing systems is delegated to the Commission's Office of Engineering and Technology (OET). OET is further authorized to develop a review process for designating geofencing operators and to designate geofencing system operators based on the outcome of this process. This review process will involve adequate testing to verify that the geofencing systems are calculating appropriate exclusion zones in conformance with the geofencing system rules. OET will be permitted to designate multiple geofencing systems. Geofencing systems will not be prohibited from charging fees for their services. Centralized geofencing systems must provide continuous service to all VLP devices for which they have agreements to provide service, and that if a geofencing system ceases operation, the operator must provide at least 30-day notice to the Commission and make arrangements for those devices to continue to receive exclusion zone update information.

J. Technical Rules

18. The Commission adopts the following technical rules for GVP devices:

19. *Emission Mask*. GVP devices must suppress their power spectral density by 20 dB at one megahertz outside of an unlicensed device's channel edge, 28 dB at one channel bandwidth from an unlicensed device's channel center, and 40 dB at one and one-half times the channel bandwidth away from an unlicensed device's channel center. At frequencies between one megahertz outside an unlicensed device's channel edge and one channel bandwidth from the center of the channel, the limits are linearly interpolated between the 20 dB and 28 dB suppression levels. At frequencies between one and one and one-half times an unlicensed device's channel bandwidth from the center of the channel, the limits are linearly interpolated between the 28 dB and 40 dB. Emissions removed from the channel center by more than one and one-half times the channel bandwidth, but within the U-NII-5 and U-NII-8 bands, are to be suppressed by at least 40 dB.

20. *Emission Limits Outside of U-NII-5 and U-NII-8*. The Commission is adopting a -27 dBm/MHz EIRP out-of-band emission limit at frequencies below the bottom of the U-NII-5 band (5.925 GHz) and above the upper edge of the U-NII-8 band (7.125 GHz), but will not apply this limit

between the sub-bands, i.e., between the U-NII-5 and U-NII-6, the U-NII-6 and U-NII-7, and the U-NII-7 and U-NII-8 bands.[14]

21. *Prioritization of Operations Over 6.105 GHz.* GVP devices will be required to prioritize operations on frequencies above 6.105 GHz prior to operating on frequencies between 5.925 GHz and 6.105 GHz.

22. *GVP Device Registration*. To register, a GVP access point will be required to provide the geofencing system with the access point's FCC ID and either its unique manufacturer's serial number or its model name/number or other information sufficient to uniquely identify the device manufacturer and model. The geofencing system uses the FCC ID and the access point's serial number to verify that the device is authorized for 6 GHz band operations and, if necessary, to address any interference concerns.

23. *Security Issues.* GVP access points and geofencing systems will be required to employ protocols and procedures to ensure that all communications and interactions between the access points and the geofencing system are accurate and secure and that unauthorized parties cannot access or alter the exclusion zones sent to an access point. These security measures must also: 1) prevent GVP access points from accessing geofencing systems not approved by the Commission, 2) ensure that unauthorized parties cannot modify devices to operate in a manner inconsistent with the rules and licensed incumbent protection criteria, and 3) ensure that communications between GVP access points and geofencing systems are secure to prevent corruption or unauthorized interception of data. Additionally, geofencing systems must incorporate security measures to protect against unauthorized data input or alteration of stored data and to protect the communication link between the geofencing system and Commission databases.

24. *International Borders.* The geofencing systems will be required to implement the terms of international agreements with Canada and Mexico.

25. *Restrictions on GVP Device Use on Airplanes.* GVP device use is prohibited on board any aircraft.

26. *Enforcement Instructions*. Geofencing systems will be required to ensure that their databases contain the information required by our rules, including frequency-specific exclusion zones and GVP access point's authorization parameters. In addition, the geofenced systems will be required to respond in a timely manner to verify, correct, or remove, as appropriate, data in the event that the Commission or a party presents a claim of inaccuracies in the geofencing system. In addition, geofencing systems will be required to establish and follow protocols to comply with enforcement instructions from the Commission, including discontinuing GVP access point operations on specified frequencies in designated geographic areas and predetermined exclusion zones. Finally, geofencing systems will be required to comply with instructions from the Commission to adjust exclusion zones, if necessary, to more accurately reflect the harmful interference potential.

V. BENEFITS

27. To assess the potential benefits of the rules, we evaluate their anticipated effect on the development and growth of AR/VR applications using the 6 GHz band, specifically in terms of incremental producer surplus and associated spillover effects on overall U.S. GDP. Our analysis is limited to hardware, software, and content sold within the United States, and the estimated producer surplus reflects only the incremental profits accruing to U.S.-based producers.

28. In the *6 GHz Second Order*, we noted that one industry report estimated the overall economic value of allowing VLP devices to operate in the 6 GHz band to be approximately $39 billion

[14] Emissions between the sub-bands are subject to the emission mask discussed above.

over a five-year period.[15] This estimated benefit includes a total of $13.74 billion from the increase in producer surplus derived from AR/VR sales by U.S. firms and $25.78 billion of increased GDP as the spillover value of AR/VR to the economy in the United States between 2021 and 2025.[16] Because the Commission, in the *6 GHz Second Order,* only allowed VLP devices to operate with -5 dBm/MHz EIRP PSD and 14 dBm EIRP across the U-NII-5 and U-NII-7 portions of the 6 GHz band, we conservatively estimated the overall benefits of the rules adopted in the *6 GHz Second Order* to be 5% of the $39 billion, which is approximately $2 billion over a five-year period. As the Report and Order increases the power level of VLP devices from -5 dBm/MHz EIRP power spectral density (PSD) and 14 dBm EIRP to 11 dBm/MHz EIRP power spectral density (PSD) and 24 dBm EIRP with restrictions of geofencing in the U-NII-5 and U-NII-7 portions of the 6 GHz band, we anticipate that connectivity for some of the existing VLP devices will improve, and more VLP devices would be allowed to operate in these bands.

29. We estimate that, even if the incremental benefit of the Report and Order were only 5% of the $2 billion from allowing VLP devices to operate at a lower power limit in the same band as adopted in the *6 GHz Second Order*, it would result in a $100 million benefit over the five-year period, or $20 million annually. This estimate is highly conservative, as it focuses solely on the impact of the spectrum policy change on AR/VR development and its associated spillover effects, while largely omitting potential additional benefits from enhanced signal strength for other GVP devices, including hotspots and wearable devices. Additionally, we note that our estimate is only 0.25% (= 5% × 5%) of the estimated $39 billion value of allowing VLP devices to operate in the 6 GHz that we refer to above, and so we view this as a benefits floor. We anticipate that the actual benefits could be many times higher than this estimate.

30. These benefits are not discounted as we limit the analysis to a five-year period consistent with the assessments in *6 GHz First Order and 6 GHz Second Order* based on the original Telcom Advisory Services analysis.[17] Given the rapid pace of technological change, we lack sufficient confidence to project benefits beyond five years and therefore consider it reasonable to present undiscounted benefits over the five-year horizon. For reference, assuming the $20 million annual benefit accrued perpetually, we estimate that the net present value of the benefits over a five year period would be approximately $91.6 million and $82 million, using, respectively, the 3% and 7% discount rates.[18]

31. Our analysis of the benefits is inherently constrained by the uncertainty surrounding emerging technological opportunities. The increased power limit for VLP devices has the potential to enable a broad range of applications, many of which we cannot anticipate. These future use cases, which would operate under the newly adopted higher power limits with geofencing requirements, are expected

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[15] *6 GHz Second Order*, 38 FCC Rcd at 10575, para. 102 & n.423 (citing Telecom Advisory Services, LLC, Assessing the Economic Value of Unlicensed Use in the 5.9 GHz & 6 GHz Bands at 49-56 (Apr. 2020), http://wififorward.org/wp-content/uploads/2020/04/5.9-6.0-FINAL-for-distribution.pdf).

[16] The study estimated the ratio used to determine the impact on Wi-Fi equipment sales from the allocation of 45 MHz in 5.9 GHz band ranging between 24.58% of sales in 2021 and 28.87% in 2025. It then applied these same ratios as the effect attributable to the spectrum policy change to the 6 GHz band. *See* Telecom Advisory Services, LLC, Assessing the Economic Value of Unlicensed Use in the 5.9 GHz & 6 GHz Bands at 53-55 (Apr. 2020), http://wififorward.org/wp-content/uploads/2020/04/5.9-6.0-FINAL-for-distribution.pdf.

[17] The Telecom Advisory Services Report only calculated benefits between 2020 and 2025. The Telecom Advisory Services, LLC, Assessing the Economic Value of Unlicensed Use in the 5.9 GHz & 6 GHz Bands at 4-8 (Apr. 2020), http://wififorward.org/wp-content/uploads/2020/04/5.9-6.0-FINAL-for-distribution.pdf.

[18] Assuming the rules result in $20 million annual benefit in the next five years, the net present value is approximately $92 million ($= \frac{\$20,000,000}{(1+3\%)^1} + \frac{\$20,000,000}{(1+3\%)^2} + \frac{\$20,000,000}{(1+3\%)^3} + \frac{\$20,000,000}{(1+3\%)^4} + \frac{\$20,000,000}{(1+3\%)^5} = \$91,594,144 \sim \$92$ million) under a 3% discount rate, and $82 million under a 7% discount rate ($= \frac{\$20,000,000}{(1+7\%)^1} + \frac{\$20,000,000}{(1+7\%)^2} + \frac{\$20,000,000}{(1+7\%)^3} + \frac{\$20,000,000}{(1+7\%)^4} + \frac{\$20,000,000}{(1+7\%)^5} = \$82,003,949 \sim \$82$ million).

to differ significantly from historical use patterns. As a result, we lack sufficient detail to conduct a comprehensive benefits analysis and instead reference the general analysis of the 2020 Telecom Advisory Services Report, which glosses over unknowable details of future use cases.[19] While our estimate of benefits may inherit inaccuracies from the underlying assumptions of this report upon which we rely, we mitigate this uncertainty by conservatively assuming that only a small fraction of the projected benefits will be realized. Accordingly, we believe our estimates are likely to understate the true potential benefits.

VI. COSTS

32. We anticipate that all costs associated with the rules we are adopting would be optional. While manufacturers and users may incur costs to transition to and operate in the new GVP ecosystem, they would do so voluntarily, such that our updated rules would not result in private costs without countervailing private benefits. This would include any costs for switching to new devices or developing and maintaining the geofencing systems. We anticipate that manufacturers and users will pursue new use cases only where the expected benefits exceed associated costs. Accordingly, we find that the Commission's action is likely to generate net benefits for the industry. Below, we quantify the estimated private costs of implementing geofencing systems and developing new devices, as well as separately, costs to the Federal Government.

33. GVP devices must work in tandem with a geofencing system to avoid causing harmful interference to licensed fixed microwave links and radio astronomy observatories. The geofencing systems will calculate exclusion zones in which the GVP devices will not be permitted to operate co-frequency with microwave links or in a portion of the U-NII-7 band used by radio astronomy. Each GVP access point will be required to have a geolocation capability to determine its location and avoid operating on prohibited frequencies within the exclusion zones. Therefore, 6 GHz band users will be protected from harmful interference by the geofencing system, so there will be no costs imposed on other 6 GHz band users.

34. *Geofencing System Providers*. The main costs that geofencing system providers would incur involve the development of geofencing standards and implementing these standards in the geofencing systems. We anticipate that most geofencing system providers are currently offering the AFC services given the large overlap of information and technologies used in both geofencing and AFC systems. We anticipate the geofencing standards development process to be similar to that of the AFC standards development in which about thirty engineers from various interested parties collaborated over several months in a working group.[20] We estimate that it may take up to six months to develop such standards. Assuming an average computer network architect's monthly compensation is $22,648,[21] we estimate that standards development would incur an aggregate one-time fixed cost from 30 engineers × 6 months × $22,648 = $4,076,640, which we round to $4.1 million.

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[19] Telecom Advisory Services, LLC, Assessing the Economic Value of Unlicensed Use in the 5.9 GHz & 6 GHz Bands (Apr. 2020), http://wififorward.org/wp-content/uploads/2020/04/5.9-6.0-FINAL-for-distribution.pdf.

[20] Wireless Innovation Forum, *Functional Requirements for the U.S. 6 GHz Band under the Control of an AFC System* at 7 (Oct. 6, 2023), https://winnf.memberclicks.net/assets/work_products/Specifications/WINNF-TS-1014-V1.0.0%206GHz%20Functional%20Requirements.pdf.

[21] The Bureau of Labor Statistics (BLS) estimates the average computer network architect's annual income is $135,890. BLS, *Occupational Employment and Wage Statistics, Industry: Cross-industry, Private, Federal, State, and Local Government Period: May 2024*, https://data.bls.gov/oes/#/industry/000000 (last visited July 23, 2025) (navigating to "Computer Network Architects (15-1241)"). We assume a 100% markup of the wage for the overhead (including benefit) costs and estimate the average total compensation of a computer network architect to be $135,890 × 200% = $271,780. Compensation for 1 months of work would therefore be (1/12) × $271,780 = $22,648. U.S. Department of Health and Human Services, Guidelines for Regulatory Impact Analysis 2016 at 30, https://aspe.hhs.gov/sites/default/files/migrated_legacy_files//171981/HHS_RIAGuidance.pdf.

35. Because geofencing systems perform many of the same tasks as AFC systems, AFC system operators will be able to rely on the existing AFC software for a lot of functionality while an entity that tries to create a geofencing system from scratch will have a much higher cost. Given the substantial overlap of the geo-information and technology that geofencing and AFC systems share, we anticipate that the geofencing system developers are likely to be a subset of existing AFC system providers. There were 13 AFC system operators that applied and obtained conditional approvals for testing their AFC systems,[22] nine of which were approved for commercial operations.[23] We estimate that it requires three computer network architects, working around four months, to design, implement, and test the new geofencing system. Accounting for potential market entrants, we conservatively double the applicant count and assume that all 26 applicants eventually obtain the approval to commercially operate their geofencing systems. We estimate a total cost to create the geofencing systems as follows: 3 computer network architects × 4 months × $22,648 × 26 operators = $7,066,176, which we round to $7.1 million. Therefore, the total private cost incurred to develop geofencing standards and systems is approximately $4.1 million + $7.1 million = $11.2 million as a one-time cost.

36. Based on our experience with payment structures in the Citizens Broadband Radio Service (CBRS), we anticipate that users of G-VLP may incur payments to geofencing providers. Although the specific compensation arrangements are confidential private information,[24] such payments would constitute transfers between the geofencing system operator and the G-VLP users. Accordingly, while these costs are not easily quantifiable, they do not affect overall societal costs. The *6 GHz Second FNPRM* proposed that the Commission may, upon request, review the fees and require changes to the fees if it finds them to be unreasonable.[25] As has been the case for AFC systems, we expect that there will be multiple geofencing systems approved for commercial operations and that competition from these different systems will keep any fees charged to reasonable levels. However, as a safeguard we will adopt our proposal that we may, upon request, review the fees charged and require changes if they are unreasonable.

37. *Device Manufacturers.* Adoption of G-VLP is anticipated to spur innovation in device designs and expand market demand for G-VLP access point and client devices. Given the inherent

[22] *OET Announces Conditional Approval for 6 GHz Band Automated Frequency Coordination System*, ET Docket No. 21-352, Public Notice, DA 22-1146, at 1 (OET Nov. 2, 2022) (conditionally approves thirteen entities to operate automated frequency coordination (AFC) systems to manage access to 6 GHz band spectrum by standard-power unlicensed devices: Broadcom, Google, Comsearch, Sony Group, Kyrio, Key Bridge Wireless, Nokia Innovations, Federated Wireless, Wireless Broadband Alliance, Wi-Fi Alliance (WFA), Qualcomm, Plume Design, and RED Technologies).

[23] *See OET Announces Approval of Seven 6 GHz Band Automated Frequency Coordination Systems for Commercial Operation and Seeks Comment on C3 Spectra's Proposed AFC System*, ET Docket No. 21-352, Public Notice, DA 24-166, at 1 (OET Feb. 23, 2024) (approves seven applications to operate automated frequency coordination (AFC) systems submitted by Qualcomm Incorporated (Qualcomm), Federated Wireless, Inc. (Federated Wireless), Sony Group Corporation (Sony), Comsearch, a CommScope Company (Comsearch), the Wi-Fi Alliance Services Corporation (Wi-Fi Alliance),[23] the Wireless Broadband Alliance, Inc. (Wireless Broadband Alliance), and Broadcom Inc (Broadcom)); *see also OET Announces Approval of C3Spectra's 6 GHz Band Automated Frequency Coordination System for Commercial Operation*, ET Docket No. 21-352, Public Notice, DA 25-47, at 1 (OET Jan. 15, 2025) (approves C3spectra's application to operate automated frequency coordination (AFC) system); *OET Announces Approval of AXON Networks' 6 GHz Band Automated Frequency Coordination System for Commercial Operation*, ET Docket No. 21-352, Public Notice, DA 25-559, at 1 (OET June 27, 2025) (approves AXON Networks' application to operate automated frequency coordination (AFC) system).

[24] One AFC provider in CBRS and 6 GHz, Federate Wireless had CBRS rates on their website in May 2025 but has recently changed their URL and removed these rates from their current website. Federated Wireless, CBRS for WISPs, https://web.archive.org/web/20250518215913/https://www.federatedwireless.com/wispa/ (last visited May 18, 2025).

[25] *6 GHz Second FNPRM*, 38 FCC Rcd at 10593, para. 147.

uncertainty associated with innovation in emerging technologies, we are unable to quantify with precision the research and development costs associated with new device models or the material costs of newly introduced devices. Nonetheless, we anticipate that existing device software will require updates to enable operation in the geofenced 6 GHz band. We expect such software modification to be limited in scope, as they would be similar to those currently utilized for AFC operations in the 6 GHz band. Accordingly, we estimate that a single software developer working over a two-month period would be sufficient to develop, test and implement the necessary software updates for each manufacturer. Given that there are 93 VLP devices authorized as of July 2025,[26] we use the number of approved VLP devices as the proxy for the number of device manufacturers. This figure is conservatively high as it implies that each device is manufactured by a distinct firm, whereas many firms, such as Apple, produce multiple types of VLP devices. We estimate that each manufacturer would incur a one-time cost of approximately $48,190,[27] representing the two-month compensation for a software developer. Thus the total manufacturers' cost of software updating would be approximately 93 manufacturers × $48,190 per manufacturer = $4,481,670, which we round to $4.5 million.

38. Additionally, existing VLP devices seeking to operate at higher power limits under the geofencing requirement will need to obtain re-certification through the FCC's permissive change process, which involves validation through independent lab testing. There are currently 93 VLP devices authorized to operate in the 6 GHz band.[28] We estimate that a team of three FCC-recognized accredited testing laboratory engineers could complete the required testing within one month, and that a separate team of three in-house engineers working for a manufacturer could prepare the necessary application materials and accompanying reports in an additional month. Assuming a monthly compensation of $22,648 per engineer,[29] the total costs of re-authorization is calculated as follows: 2 teams × 3 engineers × 93 devices × $22,648 per engineer per month × 1 month = $12,637,584, which we round to $12.6 million. We do not account for the cost of equipment authorization for any newly developed devices, as such costs would be incurred irrespective of any changes to the applicable spectrum rules. Thus, the total cost incurred by manufacturers to update their software and re-certify existing devices in order to operate under the G-VLP provisions is approximately $4.5 million + $12.6 million = $17.1 million as a one-time cost.

39. *Estimated Costs to Federal Government*. We anticipate that implementation of the proposed rules could result in modest costs to the Commission in three areas: (1) support for the development of geofencing standards; (2) review and approval of each geofencing system; and (3) review of VLP device re-certification requests. Each of these activities is expected to require some level of technical expertise. Accordingly, we estimate the relevant labor cost based on the annual wage of a GS-12, Step 5 employee in the Washington-DC-Baltimore locality, which is $114,923.[30] After adjusting to

[26] FCC, staff query of the equipment authorization database.

[27] The Bureau of Labor Statistics (BLS) estimates the average software developer's annual income is $144,570. BLS, Occupational Employment and Wage Statistics, Industry: Cross-industry, Private, Federal, State, and Local Government Period: May 2024, https://data.bls.gov/oes/#/industry/000000, Data extracted on July 23, 2025. Accounting for benefits, we therefore estimate the average total compensation of a software developer to be $144,570 × 200% = $289,140. Compensation for 2 months of work would therefore be (2/12) × $289,140 = $48,190.

[28] *Supra* note 37.

[29] OPM, *Salary Table 2025-DCB* (Jan. 2025), https://www.opm.gov/policy-data-oversight/pay-leave/salaries-wages/salary-tables/pdf/2025/DCB.pdf.

[30] OPM, *Salary Table 2025-DCB* (Jan. 2025), https://www.opm.gov/policy-data-oversight/pay-leave/salaries-wages/salary-tables/pdf/2025/DCB.pdf.

account for overhead and fringe benefits, we estimate the full annual compensation for such an employee to be approximately $229,846.[31]

40. For the development of geofencing standards, we assume that no more than three FCC staff members would be engaged over a six-month period in collaboration with industry stakeholders. Based on the estimated $229,846 annual compensation, we calculate the associated cost as follows: $229,846 × 3 staff × 6 months / 12 months = $344,769, which we round to $300,000.

41. For the review and approval of geofencing systems, we again assume a team of 3 FCC staff members would be assigned to evaluate submitted applications and accompanying test results. Given that properly prepared applications are expected to be relatively straightforward to assess, we estimate that each review can be completed within a two-month period. We further assume that the number of geofencing system providers will be comparable to the number of AFC systems providers in the 6 GHz band. At present, 13 operators are conditionally approved to operate AFC systems in the 6 GHz band,[32] with nine having obtained approval for commercial operations.[33] To be conservative, we double the AFC operators to account for potential new entrants and assume that 26 geofencing system applications will be submitted for FCC approval. Accordingly, we estimate the total geofencing system review and approval costs to be $229,846 × 3 staff × 26 geofencing providers × 2 months / 12 months = $2,987,998, which we round to $3 million to avoid the appearance of false precision.

42. For the review and approval of VLP devices to operate as GVP devices through recertification requests, we again assume a team of 3 FCC staff members to be responsible for the process. Because test results from FCC-recognized accredited testing labs are required for recertification, the FCC would randomly select these requests for an in-depth review in practice. Even if we conservatively assume that all applications go through the FCC in-depth review, and each review takes three days, we calculate the FCC review and approval costs for device recertification as follows: $229,846 × 93 VLP devices recertification requests × 3 staff × 3 days / (52 weeks × 5 work days) = $739,927, which we round to $700,000.

43. Taken together, we expect that the government would incur a total cost of $4 million (= $300,000 for standards development + $3,000,000 for geofencing approval + $700,000 for VLP

[31] By adding a 100% overhead (including benefit) mark-up, we estimate the total compensation to be $114,923 × (200%) = $229,846. U.S. Department of Health and Human Services, Guidelines for Regulatory Impact Analysis 2016 at 30, https://aspe.hhs.gov/sites/default/files/migrated_legacy_files//171981/HHS_RIAGuidance.pdf.

[32] *OET Announces Conditional Approval for 6 GHz Band Automated Frequency Coordination System*, ET Docket No. 21-352, Public Notice, DA 22-1146, at 1 (OET Nov. 2, 2022) (conditionally approves thirteen entities to operate automated frequency coordination (AFC) systems to manage access to 6 GHz band spectrum by standard-power unlicensed devices: Broadcom, Google, Comsearch, Sony Group, Kyrio, Key Bridge Wireless, Nokia Innovations, Federated Wireless, Wireless Broadband Alliance, Wi-Fi Alliance (WFA), Qualcomm, Plume Design, and RED Technologies).

[33] *See OET Announces Approval of Seven 6 GHz Band Automated Frequency Coordination Systems for Commercial Operation and Seeks Comment on C3 Spectra's Proposed AFC System*, ET Docket No. 21-352, Public Notice, DA 24-166, at 1 (OET Feb. 23, 2024) (approves seven applications to operate automated frequency coordination (AFC) systems submitted by Qualcomm Incorporated (Qualcomm), Federated Wireless, Inc. (Federated Wireless), Sony Group Corporation (Sony), Comsearch, a CommScope Company (Comsearch), the Wi-Fi Alliance Services Corporation (Wi-Fi Alliance),[33] the Wireless Broadband Alliance, Inc. (Wireless Broadband Alliance), and Broadcom Inc (Broadcom)); *see also OET Announces Approval of C3Spectra's 6 GHz Band Automated Frequency Coordination System for Commercial Operation*, ET Docket No. 21-352, Public Notice, DA 25-47, at 1 (OET Jan. 15, 2025) (approves C3spectra's application to operate automated frequency coordination (AFC) system); *OET Announces Approval of AXON Networks' 6 GHz Band Automated Frequency Coordination System for Commercial Operation*, ET Docket No. 21-352, Public Notice, DA 25-559, at 1 (OET June 27, 2025) (approves AXON Networks' application to operate automated frequency coordination (AFC) system).

recertification = $4,000,000, or $4 million). Given that we assume most of the associated costs are incurred within the first year of our rules taking into effect, this estimate is likely overstated as applications may arrive over the next five years and we do not discount our numerical cost estimates.

VII. ALTERNATE POLICIES

A. Alternative A – No Action

44. Under this alternative, the Commission would decline to adopt the proposed rules in the *6 GHz Second FNPRM* and take no further regulatory action to expand VLP operations in the 6 GHz band. As a result, VLP devices would remain limited to the existing technical parameters established in the *6 GHz Second Order*, namely, up to the -5 dBm/MHz EIRP PSD and 14 dBm EIRP across all bands in 6 GHz. Maintaining the status quo would constrain the development and deployment of unlicensed portable applications that require greater power levels or broader propagation characteristics—such as augmented and virtual reality systems, short-ranged outdoor connectivity. These use cases, which are projected to generate additional producer surplus and GDP, would remain technically infeasible or commercially unviable under the current rules.

45. In addition, failure to act would leave the 6 GHz band underutilized relative to its potential economic and technological value. Demand for unlicensed spectrum access has continued to grow rapidly as more devices and applications rely on high-throughput, low-latency wireless connections. Without further action, the Commission would forgo an opportunity to promote more efficient use of spectrum, stimulate innovation, and generate substantial net benefits to the economy.

B. Alternative B – Low Power Limit with Geofencing throughout the 6 GHz Band

46. In the *6 GHz Second FNPRM*, the Commission proposed to allow VLP devices to operate in the U-NII-5 through U-NII-8 bands (i.e., a total of 1200 MHz of spectrum) at a PSD level at up to 1 dBm/MHz EIRP PSD and 14 dBm EIRP—provided they operate under the control of a geofencing system that prevents devices from operating in close proximity to co-channel licensed incumbent services in these bands.[34]

47. Under this alternative, the Commission would raise the power spectral density limit from up to -5 dBm/MHz EIRP PSD and 14 dBm EIRP to up to 1 dBm/MHz EIRP PSD and 14 dBm EIRP instead of the rules the order is adopting (up to 11 dBm/MHz EIRP PSD and 24 dBm EIRP maximum power), while still applying geofencing restrictions to VLP. Under this proposed alternative, consumers might not experience benefit when using wider channels, which is anticipated under Alternative C as adopted. Meanwhile, both Alternatives B and C would be equally effective in preventing harmful interference as geofencing systems dynamically adjust the size of the exclusion zones in accordance with the proposed power levels.

48. Under both this alternative and the rules that we adopt, GVP devices would be required to incorporate a capability to ensure that they avoid transmitting on certain channels within certain geographic areas, i.e., this is analogous to erecting a fence to prevent VLP devices from operating on certain channels within certain geographic areas, hence the descriptive term “geofencing system.” While a geofencing system is not identical to an AFC system that several parties requested be required for VLP device operation, it will provide similar protection to licensed incumbent operations.[35]

49. Apple, Broadcom and others contend that creating geofencing capable devices will require manufacturers to add new expensive hardware and software to a wide range of consumer and enterprise equipment and that such investment cannot be justified for the marginal benefit that would be

[34] *6 GHz Second FNPRM*, 38 FCC Rcd at 10576, para. 104.

[35] *6 GHz Second FNPRM*, 38 FCC Rcd at 10577, para. 106.

provided by the proposed power limits.[36] These parties stress that, unless the GVP maximum permitted power is raised to 21 dBm, consumers will not experience any benefit when using channels wider than 40-megahertz because total power transmitted is proportional to the PSD and capping maximum EIRP at 14 dBm would limit all channel bandwidths, 20-megahertz or larger to that maximum power whereas capping maximum power at 21 dBm would allow all channel bandwidths, 40-megarherz or wider to operate with more than 14 dBm total power.[37] These parties similarly recommend increasing the PSD to 8 dBm/MHz EIRP so that all channels regardless of bandwidth can operate at the maximum power level.[38] They explain that increasing the power level for all channel sizes is important because wider bandwidth channels are subject to more noise and therefore require additional power to maintain a sufficient signal-to-noise ratio.[39]

50. Similarly, the Dynamic Spectrum Alliance (DSA) argues that the GVP power levels proposed by the Commission, 14 dBm EIRP and 1 dBm/MHz EIRP PSD, does not provide a sufficient economic incentive for manufacturers to make the investments necessary to develop and commercialize such devices.[40] DSA points out that the proposed power levels would only benefit devices operating on 20-megahertz or 40-megahertz channels, but that most use cases are better suited to larger channel sizes.[41]

51. Although this alternative offers a conservative path forward, it may have limited practical values with the relatively low power spectral density limit and constrain the further development and deployment of VLP devices in the 6 GHz bands. Accordingly, we believe this alternative will generate negligible net benefits to the economy as a whole.

C. Alternative C (adopted rules)– High Power Limit with Geofencing in Selected Sub-bands of 6 GHz Band

52. Under this alternative, the Commission would increase the power limit of VLP devices to 11 dBm/MHz EIRP PSD and 24 dBm EIRP under the control of a geofencing system while restricting the application to U-NII-5 and U-NII-7 bands only. Similar to alternative B, incorporating geofencing capabilities will protect licensed incumbent operations by ensuring transmissions occur only outside of defined exclusion zones surrounding critical microwave and FSS transmission equipment.

53. Apple points out that the GVP exclusion zone calculations can account for any power level because the geofenced areas around the microwave receivers will grow commensurate with the power level of the GVP device.[42] However, Apple contends that sufficient GVP client device power levels are essential for reliable GVP device operation to meet consumer expectations.[43] Apple claims that, to overcome body loss, client devices must operate with at least 5 dBm/MHz EIRP PSD and 18 dBm EIRP to deliver the required reliability and performance.[44] It states that operation below this power level

[36] Apple, Broadcom et al. Comments at 26.

[37] *Id*. at 27-28. The comments contain a table showing the trade-offs between various PSD and maximum power levels for each channel bandwidth.

[38] *Id*. at 28-29. Apple, Broadcom et al. note that unless the PSD level is increased above 1 dBm/MHz, a 20-megahertz channel could not transmit with more than 14 dBm EIRP whereas that 20-megahertz channel could transmit with 21 dBm EIRP at an 8 dBm/MHz PSD level.

[39] *Id*. at 28.

[40] Dynamic Spectrum Alliance Comments at 14.

[41] *Id*.

[42] Letter from Paul Margie, Counsel, Apple Inc., to Marlene H. Dortch, Secretary, FCC, ET Docket Nos. 18-295, 17-183, at 2 (filed June 26, 2025).

[43] *Id*.

[44] *Id*.

would result in frequent dropped connections.[45] Apple and Meta contend that maximum authorized power levels of at least 11 dBm/MHz PSD and 24 dBm EIRP for GVP access points and 5 dBm/MHz PSD and 18 dBm EIRP for GVP client devices are essential for adequate reliability and performance for GVP use cases.[46]

54. The Report and Order adopts the 11 dBm/MHz EIRP PSD and 24 dBm EIRP power levels rather than the 1 dBm/MHz EIRP PSD and 14 dBm EIRP power levels proposed in the *6 GHz Second FNPRM* for several reasons. First, the geofencing systems will be equally effective in preventing harmful interference at the higher power level because the size of the exclusion zones will increase to account for the higher power — *i.e.*, the size of the exclusion zones scales with the power level.

55. Second, the Report and Order finds that permitting higher power levels provides a stronger incentive for manufacturers to invest in geofencing systems and GVP devices. Moreover, other countries currently permit VLP devices to operate at 1 dBm/MHz without the need for a geofencing system and that such an incremental power increase to our existing VLP rules as proposed in the *6 GHz Second FNPRM* may not convince industry to undertake expenses associated with developing this new class of devices.[47]

56. Lastly, Apple and Meta point out that 11 dBm/MHz EIRP PSD and 24 dBm EIRP are necessary for GVP access points to deliver the required reliability and performance for body worn applications.[48] As noted by commenters, permitting higher power levels will enable more versatile GVP devices to be developed and result in a wide variety of innovative products.[49] Adopting the higher power levels requested by industry with a geofencing requirement provides more versatility to encourage innovative uses and incentivize investment without increasing the harmful interference risk to incumbent users. We find that the higher PSD level that the Report and Order adopts relative to other alternatives will be particularly useful for applications that rely on narrow channels such as high bitrate audio and control signaling while the higher maximum power will benefit data-intensive tasks in applications such as artificial reality/virtual reality, automotive technologies, screen mirroring, hotspots, and indoor location and navigation. Our analysis finds that this alternative generates the highest net benefits after accounting for associated costs.

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[45] *Id*.

[46] Letter from Megan Anne Stull, Senior Manager, Government and Regulatory Affairs, Apple Inc.; and Alan Norman, Public Policy Director, Meta Platforms, Inc.; to Marlene H. Dortch, Secretary, FCC; ET Docket Nos. 18-295, 17-183, at 1 (filed August 8, 2025).

[47] Apple, Broadcom et al. Comments at 26; Dynamic Spectrum Alliance Comments at 14; IEEE LAN/MAN Standards Committee Comments at 4; *6GHz harmonization decision: more spectrum available for better and faster Wi-Fi* (June 17, 2021), https://digital-strategy.ec.europa.eu/en/library/6ghz-harmonisation-decision-more-spectrum-available-better-and-faster-wi-fi (The specific rules can be found in the downloadable Annex); Australian Government, *Radiocommunications (Low Interference Potential Devices) Class Licence 2015* (May 19, 2023), https://www.legislation.gov.au/F2015L01438/latest/text (technical rules for VLP devices classified as 63AB class of transmitter); Ofcom, *Improving spectrum access for Wi-Fi Spectrum use in the 5 GHz and 6 GHz bands* (July 24, 2020), https://www.ofcom.org.uk/siteassets/resources/documents/consultations/category-2-6-weeks/189812-improving-spectrum-access-for-wi-fi----spectrum-use-in-the-5-and-6-ghz-bands/associated-documents/6ghz-statement.pdf?v=325088 (This statement outlines the newly adopted technical rules for, among other devices, VLP devices operating at an EIRP of 14 dBm).

[48] Letter from Megan Anne Stull, Senior Manager, Government and Regulatory Affairs, Apple Inc.; and Alan Norman, Public Policy Director, Meta Platforms, Inc.; to Marlene H. Dortch, Secretary, FCC; ET Docket Nos. 18-295, 17-183, at 1-2 (filed August 8, 2025).

[49] Apple, Broadcom et al. Comments at 30.

VIII. JUSTIFICATION DETERMINATION

A. Benefits Exceed Costs

57. Consistent with previous experience in this proceeding, we anticipate that the rules permitting GVP devices to operate in the U-NII-5 and U-NII-7 portions of the 6 GHz band will yield substantial benefits. The higher power GVP devices will enable increased data rates and greater range for current VLP applications. While geofencing will limit GVP operating areas, even a 5% improvement in economic value derived from these devices relative to our estimated benefits for VLP in the U-NII-5 and U-NII-7 portions of the 6 GHz band would result in $100 million in additional benefits over a five-year period, or $20 million annually. We believe this estimate to be conservative because higher data rates and range will not only enhance existing VLP applications but also create opportunities for new applications, including augmented reality/virtual reality, short-range hotspots, automation processes, and indoor location and navigation. Assuming these annual benefits persist indefinitely, the present value of the benefit stream discounted at a 7% rate is approximately $286 million.

58. Because all costs incurred to achieve the benefits are optional, we find that private entities would only incur these costs if they expect that they will be able to recoup such costs in the foreseeable future. As noted above, while manufacturers and users may incur costs to transition to and operate in the new GVP ecosystem, they would do so voluntarily, such that our updated rules would not result in private costs without countervailing private benefits. 6 GHz band users will be protected from harmful interference by the geofencing system, so there will be no costs imposed on other 6 GHz band users. We estimate that the overall implementation cost to the government is approximately $1.9 million. We therefore conclude that permitting GVP devices to operate in the 6 GHz band will yield substantial economic benefits to the American public that outweigh the associated implementation costs.

B. Highest Net-Benefit Alternative

59. Based on the record and economic analysis, we find that Alternative C—the higher power limit with geofencing—offers the greatest net benefit among the three alternatives considered. By authorizing GVP operations at up to 11 dBm/MHz EIRP PSD and the maximum 24 dBM EIRP, Alternative C enables a wider range of high-throughput, low-latency applications that are not technically feasible under the lower power limits in Alternative B or the status quo in Alternative A. At the same time, the geofencing requirement provides a targeted and cost-effective means of mitigating interference to licensed incumbent operations.

60. Although Alternative B offers lower interference risk, it also yields significantly reduced economic benefits with the limited use cases under a much lower power limit. Alternative A, which maintains current rules, forgoes substantial potential gains altogether. Even under conservative assumptions—such as capturing only 5% of a $2 billion in benefits—Alternative C would generate benefits exceeding $100 million over a five-year period, far outweighing anticipated implementation costs. Accordingly, we conclude that Alternative C best advances the Commission's goals of promoting innovation, maximizing spectrum efficiency, and delivering the highest measurable net benefits to the public among the alternative options.

IX. SMALL ENTITY IMPACTS

61. The rules adopted by the Commission in the Report and Order should benefit small entities by giving them more options for gaining access to valuable spectrum while creating little to no risk of harmful interference to licensed incumbents sharing the 6 GHz band.[50]

62. The adopted rules reflect the Commission's efforts to balance the benefits provided to GVP device users with protecting incumbent operators in the 6 GHz band from harmful interference.

[50] This discussion of small entity impacts heavily excerpts from *6 GHz Fourth Report and Order*, Appx. C (2025).

Additionally, the Commission considered alternative proposals and weighed their benefits against their potential costs to small businesses and other entities.

63. Many of the entities holding licenses for use of the 6 GHz band qualify as small entities. The Regulatory Flexibility Act of 1980, as amended (RFA),[51] generally defines the term "small entity" as having the same meaning as under the Small Business Act.[52] In addition, the term "small business" has the same meaning as the term "small business concern" under the Small Business Act."[53] A "small 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.[54]

64. Our actions, over time, may affect small entities that are not easily categorized at present. We therefore describe three broad groups of small entities that could be directly affected by our actions.[55] In general, a small business is an independent business having fewer than 500 employees.[56] Next, "small organizations" are not-for-profit enterprises that are independently owned and operated and not dominant their field.[57] Finally, "small governmental jurisdictions" are defined as cities, counties, towns, townships, villages, school districts, or special districts with populations of less than fifty thousand.[58]

65. The actions taken in the *Fourth Report and Order* will apply to small entities in three six-digit industries of the North American Industry Classification System (NAICS),[59] and are identified by the corresponding SBA size standard.[60] Industries Wireless Telecommunications Carriers (except Satellite) (NAICS Code: 517122), Satellite Telecommunications (NAICS Code: 517410), and Radio Stations (NAICS Code: 516110) have 2,837 small firms, 242 small firms, and 1,879 small firms, respectively. We further note that the 2025 Universal Service Monitoring Report Telecommunications

[51] 5 U.S.C. §§ 601 *et seq*., as amended by the Small Business Regulatory Enforcement and Fairness Act (SBREFA), Pub. L. No. 104-121, 110 Stat. 847 (1996).

[52] *Id.* § 601(6).

[53] *Id*. § 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."

[54] 15 U.S.C. § 632.

[55] 5 U.S.C. § 601(3)-(6).

[56] *See* SBA, Office of Advocacy, *Frequently Asked Questions About Small Business* (July 23, 2024), https://advocacy.sba.gov/wp-content/uploads/2024/12/Frequently-Asked-Questions-About-Small-Business_2024-508.pdf.

[57] 5 U.S.C. § 601(4).

[58] 5 U.S.C. § 601(5).

[59] The North American Industry Classification System (NAICS) is the standard used by Federal statistical agencies in classifying business establishments for the purpose of collecting, analyzing, and publishing statistical data related to the U.S. business economy. *See* www.census.gov/NAICS for further details regarding the NAICS codes identified in this chart.

[60] The size standards are set forth in 13 CFR 121.201 by six-digit NAICS code. The size standard is 1,500 employees for Wireless Telecommunications Carriers (except Satellite). The size standard is $47 million in annual receipts for Satellite Telecommunications and Radio Stations.

Service Provider Data reports 498 small entities in Wireless Telecommunications Carriers (except Satellite).[61]

66. The adopted rules for unlicensed operation in this band are designed to prevent the unlicensed GVP 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 permitting GVP unlicensed devices to operate in the 6 GHz band. Users of devices operating under our part 15 rules do not need to obtain a Commission license. Therefore, we expect that small entities would make use of 6 GHz GVP devices under the adopted rules and this would provide small entities with access to valuable spectrum without the expense and inconvenience of having to obtain a license. The Commission believes that this rulemaking, by permitting GVP devices to operate in the 6 GHz band, will 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 economic benefit for small businesses.

X. IMPACTS ON DISADVANTAGED POPULATIONS

67. Disparate impacts on disadvantaged populations such as the poor or the disabled are unlikely to occur. Benefits from expanded unlicensed spectrum will be broad-based as they will not be specific to a particular license holder. Thus, no particular population will be likely to enjoy less benefits than others. Moreover, costs are limited to those entities developing and managing new geofencing system and support devices and not private individuals. Some device users may incur additional fees to use the geofencing systems, but there is no reason to believe this will affect any subpopulations disproportionately. Thus, disadvantaged populations are unlikely to incur disproportionate costs.

[61] Affected Entities in this industry include all reporting wireless carriers and service providers. The size standard is 1,500 employees. Federal-State Joint Board on Universal Service, Universal Service Monitoring Report at 26, Table 1.12 (2024), https://docs.fcc.gov/public/attachments/DOC-408848A1.pdf.

APPENDIX F

Regulatory Impact Analysis
6 GHz Third Further Notice of Proposed Rulemaking

I. EXECUTIVE SUMMARY

A. Summary

1. In the *6 GHz Third Further Notice of Proposed Rulemaking*, we propose allowing AFC systems to account for building entry loss (BEL) when determining frequency and power availability for composite indoor/standard-power access points. Consistent with prior OET waivers, AFC systems must identify these devices using FCC ID and certified equipment class information from the Commission's Equipment Authorization System before applying BEL in propagation calculations. Once confirmed, AFC systems may assume up to 6 dB BEL when providing frequency and power-level data. This change will enable higher operating power for eligible devices, improving their utility to consumers. We also propose amending our rules to allow LPI access points on cruise ships. Transmissions from inside cruise ships face significant attenuation from thick metal walls, reducing interference risk to Earth Exploration Satellite Service operations. Given the limited number of ships and thousands of passengers in confined spaces, additional spectrum for onboard unlicensed devices is proposed.

B. Table of Benefits and Costs

2. *Summary of Benefits and Costs*. We tentatively conclude that the proposed rules will yield a one-time cost savings of $4,800 from streamlining the AFC waiver application process and a recurring annual benefit of $35.6 million. The estimated present value of the benefits over a five year period is respectively, $163 million and $146 million using discount rates of 3% and 7%. We anticipate minimal costs to the public as a result of the proposed rules. We seek comment on these preliminary assessments and request that commenters provide applicable estimates with supporting data and statistics.

	One-time	Recurring (per year)	Present Value over 5 Years (3% discount)	Present Value over 5 Years (7% discount)
Benefit	$4,800	$35,600,000	$163,000,000	$146,000,000

II. NEED FOR REGULATORY ACTION

3. Regulatory action is necessary to provide clarity and consistency in how AFC systems account for building entry loss (BEL). While waiver relief has enabled some operators to incorporate BEL, relying on individual waivers creates uncertainty and inefficiencies. Updating the rules will standardize this practice, ensure accurate identification of composite indoor/standard-power access points, and allow appropriate power adjustments without compromising interference protection. These changes will improve indoor coverage, support higher data rates, and promote more efficient use of the 6 GHz band, advancing the Commission's goal of expanding unlicensed spectrum access.

4. Furthermore, regulatory action is needed to address the growing demand for reliable high-speed connectivity in the dense environments of cruise ships. Current restrictions on LPI access points aboard vessels limit available spectrum, causing congestion and degraded Wi-Fi performance in large indoor areas. Allowing LPI operation on cruise ships would alleviate these issues while posing minimal interference risk to Earth Exploration Satellite Service operations, as signals are significantly attenuated by the ships' thick metal walls and glass structures. Combined with the limited number of cruise ships, this targeted exception would enhance passenger connectivity without compromising incumbent services.

III. BACKGROUND ON 6 GHZ

5. The *6 GHz Fourth Report and Order* expands unlicensed use in the 6 GHz band.[1] This modifies the current ways unlicensed use is allowed in the 6 GHz band. In terms of licensed use, the 6 GHz band is allocated for the Fixed Service, Mobile Service, and Fixed Satellite Service (FSS) across four sub-bands.[2] These four sub-bands—which we refer to as U-NII-5, U-NII-6, U-NII-7, and U-NII-8, respectively—are delineated based on the prevalence and characteristics of the incumbent licensed services that operate in each sub-band. The Fixed Satellite Service operates in all four sub-bands except for the 7.075-7.125 GHz portion of the U-NII-8 band. Fixed Microwave is a predominant licensed service in U-NII-5, U-NII-7 and U-NII-8 bands. The Broadcast Auxiliary Service (BAS) and Cable Television Relay Service (CARS) operate in the U-NII-6 band on a mobile basis, and in the U-NII-8 band on both a fixed and mobile basis.

6. In 2020, the Commission adopted a Report and Order and Further Notice of Proposed Rulemaking (*6 GHz First Order*) that made unlicensed operations available in the 6 GHz band (5.925-7.125 GHz).[3] Specifically, the *6 GHz First Order* adopted rules for two categories of unlicensed operations—standard-power operations and low-power indoor (LPI) operations.[4] On November 1, 2023, the Commission released a Second Report and Order that allowed unlicensed very low power (VLP) devices to operate in the U-NII-5 and U-NII-7 portions of the 6 GHz band (*6 GHz Second Order*).[5] VLP devices are authorized to operate anywhere, indoors and outdoors, without being under the control of an AFC system.[6] In the Second Further Notice of Proposed Rulemaking (*6 GHz Second FNPRM*), which was adopted concurrently with the *6 GHz Second Order*, the Commission proposed to expand VLP operation to the U-NII-6 (6.425-6.525 GHz) and U-NII-8 (6.875-7.125 GHz) portions of the 6 GHz band, with no requirement that the devices be kept indoors or be under the control of an AFC system.[7] On December 11, 2024, the Commission released a Third Report and Order (*6 GHz Third Order*) that, adopting the same technical and operational requirements previously established for VLP devices in the U-NII-5 and U-NII-7 bands, authorized VLP operation in the U-NII-6 and U-NII-8 bands.[8]

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[1] The following discussion in this section heavily references passages in the *6 GHz Fourth Report and Order*. *6 GHz Fourth Report and Order*, Section II (2025).

[2] *Unlicensed Use of the 6 GHz Band; Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz*, Notice of Proposed Rulemaking, 33 FCC Rcd at 10496, 10499-501, paras. 8-13 (2018) (*Notice*); *Unlicensed Use of the 6 GHz Band; Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz*, Report and Order and Further Notice of Proposed Rulemaking, 35 FCC Rcd at 3852, 3855, para. 7 (2020) (*6 GHz First Order*), *rev'd in part, aff'd in part, and remanded*, *AT&T Servs. Inc., v. FCC*, 21 F.4th 841, 853-54 (D.C. Cir. 2020) (affirming *6 GHz Order* and reversing and remanding to address issue of whether to "reserve a sliver of the 6 GHz band for licensed mobile operation").

[3] *6 GHz First Order*.

[4] *Id*. at 3860, paras. 17-18.

[5] *Unlicensed Use of the 6 GHz Band; Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz*, Second Report and Order, Second Further Notice of Proposed Rulemaking, and Memorandum Opinion and Order on Remand, ET Docket No. 18-295, GN Docket No. 17-183, 38 FCC Rcd 10523, 10532, para. 18 (2023) (*6 GHz Second Order* or *6 GHz Second FNPRM*).

[6] *See 6 GHz Second Order,* 38 FCC Rcd at 10532, 10561, paras. 18, 67.

[7] *6 GHz Second FNPRM*, 38 FCC Rcd at 10576, 10600-01, paras. 104, 173.

[8] *Unlicensed Use of the 6 GHz Band; Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz*, Third Report and Order, ET Docket No. 18-295, GN Docket No. 17-183, 39 FCC Rcd 13901, 13908, paras. 12-13 (2024) (*6 GHz Third Order*).

IV. REGULATORY ACTION

7. This *6 GHz Third Further Notice of Proposed Rulemaking* proposes the following regulatory actions.

A. Allow AFC Systems to Account for Building Entry Loss (BEL)

8. The Commission proposes updating its rules to permit Automated Frequency Coordination (AFC) systems to incorporate BEL when determining frequency and power levels for composite indoor/standard-power access points. AFC systems would be required to verify device certification and apply up to 6 dB of BEL in propagation calculations, enabling higher indoor operating power and improving coverage and data rates.

B. Permit Low Power Indoor (LPI) Access Points on Cruise Ships

9. The Commission proposes amending its rules to allow LPI access points to operate aboard cruise ships. This change addresses Wi-Fi congestion in large indoor areas on ships and leverages the significant signal attenuation caused by thick metal walls, which minimizes interference risk to Earth Exploration Satellite Service operations. The exception would apply only to cruise ships as defined in federal regulations.

V. BENEFITS

10. We anticipate that these proposed rule changes–permitting AFC systems to account for BEL and authorizing LPI access point operation aboard cruise ships—would result in economic benefits of approximately $4,800 in one-time cost savings and $35.6 million in annual benefit to society as a whole. Eight AFC operators have filed waiver requests to incorporate BEL into their AFC system propagation models,[9] and seven of those operators have been granted waiver relief.[10] Because OET has authority to grant such waivers on an individual basis, updating our rules to align with the relief already granted would not materially alter current BEL adjustment practices. The primary impact of the proposed rule change would be creating regulatory certainty and reducing the time and resources that AFC operators and the Commission are required to devote to the waiver application and review process. To date, the Commission has conditionally approved fifteen AFC systems.[11] Excluding the seven AFC operators already granted the waivers, we estimate that up to eight additional AFC operators could benefit from the time savings associated with eliminating the need for individual waiver requests. Further, we assume that operators will rely on outside counsel to file waiver requests at the hourly rate of an attorney at $300/hour.[12] We assume that each waiver requires two hours of work by an attorney and calculate the

[9] The eight operators are the Wi-Fi Alliance, Broadcom Inc., Sony, Comsearch, C3Spectra, Federated Wireless, Qualcomm, and AXON Networks.

[10] The waiver was granted to the Wi-Fi Alliance, Broadcom, Sony, Federated Wireless, Qualcomm, Comsearch, and C3Spectra.

[11] *OET Announces Conditional Approval for 6 GHz Band Automated Frequency Coordination System*, ET Docket No. 21-352, Public Notice, 37 FCC Rcd 13071, 13071, para. 1 (OET 2022) (conditionally approving thirteen entities to operate automated frequency coordination (AFC) systems to manage access to 6 GHz band spectrum by standard-power unlicensed devices: Broadcom, Google, Comsearch, Sony Group, Kyrio, Key Bridge Wireless, Nokia Innovations, Federated Wireless, Wireless Broadband Alliance, Wi-Fi Alliance, Qualcomm, Plume Design, and RED Technologies); *OET Announces Conditional Approval Of C3spectra's 6 GHz Band Automated Frequency Coordination System And Seeks Comment On Axon Networks' Proposed AFC System*, ET Docket No. 21-352, Public Notice, 39 FCC Rcd 7040, 7040, para. 1 (OET 2024); O*ET Announces Approval Of Axon Networks' 6 GHz Band Automated Frequency Coordination System For Commercial Operation*, ET Docket No. 21-352, Public Notice, DA 25-559, at 1, para. 1 (OET June 27, 2025).

[12] Our estimated rate for attorneys ($300/hour) is based on the Commission's estimates of labor costs as represented in a 2024 Paperwork Reduction Act (PRA) analysis. International Section 214 Process and Tariff Requirements – 47 CFR Sections 63.10-63.25, 1.40001, 1.40003, OMB Control No. 3060-0686 Paperwork Reduction Act (PRA) (continued….)

potential cost savings from reduced waiver burdens as follows: 1 attorney × $300/hour × 2 hours × 8 operators = $4,800. This estimate is conservative, as it does not account for potential cost savings resulting from reduced internal communications, including those that may require engineering input or consultation between operators and outside counsel. Based on this analysis, we believe that our proposals to streamline the waiver process will result in a one-time cost savings of approximately $4,800.

11. On the other hand, we find that permitting LPI operation on cruise ships would result in higher economic benefits by enabling cruise ship passengers to remain connected throughout their voyages in a more cost-efficient manner. We estimate that the proposed rules would contribute approximately $35.6 million in annual benefits. In 2025, approximately 19 million U.S. residents are expected to take cruise vacations,[13] with an average trip duration of approximately 7.1 days.[14] These cruise ship vacations account for approximately 0.11% of the aggregate annual American man-hours as calculated as follows: (19 million cruise ship passengers × 7.1 days)/(342 million U.S. population × 365 days) = 0.11%.[15] Based on the economic analysis cited in prior Commission orders,[16] authorizing LPI operation in 6 GHz is expected to contribute approximately $32.4 billion to the U.S. economy in 2025.[17] Assuming that cruise ship passenger-time represents 0.11% of total U.S. consumers time, we estimate the annual benefit attributable to LPI operation on board cruise ships as follows: $32.4 billion × 0.11% = $35,623,500, which we round to $35.6 million. Taken together, we expect that the proposed rules would result in a one-time benefit of approximately $4,800 from streamlining the consideration of BEL in AFC system applications and an annual benefits of approximately $35.6 million from permitting LPI device operation on board cruise ships. The estimated present value of the total benefits over a five year period is $163 million and $146 million using a 3% and 7% discount rate respectively.[18]

VI. COSTS

12. For the proposed rule permitting AFC systems to account for BEL, we anticipate that the rule will impose no additional costs on the public. While AFC operators may incur costs to reconfigure their systems to incorporate BEL into their propagation models and adjust coordination procedures accordingly, such costs would be incurred voluntarily only when operators determine that the expected

(Continued from previous page)
Supporting Statement at 10 (Mar. 2024), https://www.reginfo.gov/public/do/PRAViewDocument?ref_nbr=202404-3060-002.

[13] AAA, Record 19 million Americans Projected to Cruise This Year (Jan. 27, 2025), https://newsroom.aaa.com/2025/01/aaa-record-19-million-americans-projected-to-cruise-this-year/.

[14] CLIN, State of the Cruise Industry Report 2025 at 26 (2025), https://cruising.org/sites/default/files/2025-05/State%20of%20the%20Cruise%20Industry%20Report%202025.pdf.

[15] U.S. Census Bureau, U.S. and World Population Clock, https://www.census.gov/popclock/ (last visited July 30, 2025) (estimating the U.S. population to be approximately 342 million).

[16] *See 6 GHz First Order*, 35 FCC Rcd at 3937, para. 229 & n.601; *see also 6 GHz Second Order*, 38 FCC Rcd at 10575, para. 102 & n.42.

[17] Telecom Advisory Services, LLC, Assessing the Economic Value of Unlicensed Use in the 5.9 GHz & 6 GHz Bands at 56, tbl. 4-15 (Apr. 2020), http://wififorward.org/wp-content/uploads/2020/04/5.9-6.0-FINAL-for-distribution.pdf (estimating LPI benefits in 6 GHz band in 2025 include $6.138 billion from return to speed, $1.338 billion from consumer surplus, $10.362 billion from broader deployment of IoT, and $14.547 billion from savings in enterprise traffic, totaling $32.385 billion).

[18] Assuming the proposed rules result in $4,800 one-time cost saving in the first year, and $35.6 million annual benefit in the next five years, the net present value is approximately $163 million (= $\frac{\$4,800}{(1+3\%)^1} + \frac{\$35,600,000}{(1+3\%)^1} + \frac{\$35,600,000}{(1+3\%)^2} + \frac{\$35,600,000}{(1+3\%)^3} + \frac{\$35,600,000}{(1+3\%)^4} + \frac{\$35,600,000}{(1+3\%)^5}$ = $163,037,576 ~ $163 million) under a 3% discount rate, and $146 million under a 7% discount rate (= $\frac{\$4,800}{(1+7\%)^1} + \frac{\$35,600,000}{(1+7\%)^1} + \frac{\$35,600,000}{(1+7\%)^2} + \frac{\$35,600,000}{(1+7\%)^3} + \frac{\$35,600,000}{(1+7\%)^4} + \frac{\$35,600,000}{(1+7\%)^5}$ = $145,967,029 ~ $146 million).

benefits outweigh the associated cost. Therefore, we do not separately account for these costs, as we anticipate this proposal to be cost-neutral from a regulatory perspective. Moreover, we expect that allowing AFC systems to account for BEL will not result in harmful interference to existing licensed operations. As such, we anticipate no additional costs would be imposed on incumbent licensed users.

13. For the proposed use of LPI devices on board cruise ships, we similarly anticipate no cost to the public. While the proposed rule may stimulate consumer demand for LPI devices to be used on board cruise ships, any associated consumer expenditures are expected to be captured by device manufacturers as producer surplus. Therefore, these expenditures represent a transfer within the economy rather than a net cost, and are not included in our cost estimates. We recognize that cruise ship operators may incur costs to install LPI access points indoors for use by passengers and crew. However, such installations are entirely voluntary, and operators are expected to proceed only when the expected benefits (e.g., premiums they can charge for the use) exceed the associated costs. Accordingly, we consider this proposal to be cost-neutral from a regulatory standpoint. Based on this expectation, we do not separately quantify the costs associated with voluntary adoption of LPI access points on board cruise ships. Meanwhile, we anticipate that permitting LPI access points to operate on board cruise ships will not result in harmful interference to Earth Exploration Satellite Service operations. The expectation is based on the limited number of such ships and the substantial attenuation of indoor signals caused by the thick metal walls and internal structures of the vessels. Therefore, we tentatively conclude that the proposed rules will not incur any substantial costs.

VII. ALTERNATE POLICIES

14. An alternative is to take no regulatory action, leaving current rules unchanged. This approach would forgo all potential benefits, including improved spectrum efficiency, enhanced device performance, and consumer connectivity gains that could result from the proposed changes.

VIII. JUSTIFICATION DETERMINATION

15. The estimated benefits of the proposed rules far exceed any potential costs. Permitting AFC systems to account for building entry loss will streamline waiver processes, saving approximately $4,800 in one-time costs, while authorizing LPI access points on cruise ships is projected to generate $35.6 million in annual benefits. Over five years, the present value of these benefits ranges from $146 million to $163 million. In contrast, the anticipated costs are negligible, as system adjustments and cruise ship installations are voluntary and expected only when benefits outweigh expenses to individual stakeholders. This clear disparity demonstrates that the proposed rules deliver substantial net benefits to consumers and industry without imposing significant regulatory burdens.

IX. SMALL ENTITY IMPACTS

16. The rules proposed by the Commission in the 6 GHz Further Notice of Proposed Rulemaking should benefit small entities by giving them more options for gaining access to valuable spectrum while creating little to no risk of harmful interference to licensed incumbents sharing the 6 GHz band.[19]

17. The proposed rules reflect the Commission's efforts to balance the benefits provided to unlicensed device users with protecting incumbent operators in the 6 GHz band from harmful interference.

18. Many of the entities holding licenses for use of the 6 GHz band qualify as small entities. The Regulatory Flexibility Act of 1980, as amended (RFA),[20] generally defines the term "small entity" as

[19] This discussion of small entity impacts heavily excerpts from *6 GHz Fourth Report and Order*, Appx. C (2025).

[20] 5 U.S.C. §§ 601 *et seq*., as amended by the Small Business Regulatory Enforcement and Fairness Act (SBREFA), Pub. L. No. 104-121, 110 Stat. 847 (1996).

having the same meaning as under the Small Business Act.[21] In addition, the term "small business" has the same meaning as the term "small business concern" under the Small Business Act."[22] A "small 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.[23]

19. Our actions, over time, may affect small entities that are not easily categorized at present. We therefore describe three broad groups of small entities that could be directly affected by our actions.[24] In general, a small business is an independent business having fewer than 500 employees.[25] Next, "small organizations" are not-for-profit enterprises that are independently owned and operated and not dominant their field.[26] Finally, "small governmental jurisdictions" are defined as cities, counties, towns, townships, villages, school districts, or special districts with populations of less than fifty thousand.[27]

20. The actions proposed in the *6 GHz Third Further Notice of Proposed Rulemaking* will apply to small entities in three six-digit industries of the North American Industry Classification System (NAICS),[28] and are identified by the corresponding SBA size standard.[29] Industries Wireless Telecommunications Carriers (except Satellite) (NAICS Code: 517122), Satellite Telecommunications (NAICS Code: 517410), and Radio Stations (NAICS Code: 516110) have 2,837 small firms, 242 small firms, and 1,879 small firms, respectively. We further note that the 2025 Universal Service Monitoring Report Telecommunications Service Provider Data reports 498 small entities in Wireless Telecommunications Carriers (except Satellite).[30]

21. The proposed rules allowing AFC systems to account for building entry loss (BEL) and to allow LPI access points on cruise ships 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. Users of devices operating under our part 15 rules do not need to obtain a Commission license. Therefore, we expect that small entities would make use of unlicensed devices under the

[21] *Id.* § 601(6).

[22] *Id.* § 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."

[23] 15 U.S.C. § 632.

[24] 5 U.S.C. § 601(3)-(6).

[25] *See* SBA, Office of Advocacy, *Frequently Asked Questions About Small Business* (July 23, 2024), https://advocacy.sba.gov/wp-content/uploads/2024/12/Frequently-Asked-Questions-About-Small-Business_2024-508.pdf.

[26] 5 U.S.C. § 601(4).

[27] 5 U.S.C. § 601(5).

[28] The North American Industry Classification System (NAICS) is the standard used by Federal statistical agencies in classifying business establishments for the purpose of collecting, analyzing, and publishing statistical data related to the U.S. business economy. *See* www.census.gov/NAICS for further details regarding the NAICS codes identified in this chart.

[29] The size standards are set forth in 13 CFR 121.201 by six-digit NAICS code. The size standard is 1,500 employees for Wireless Telecommunications Carriers (except Satellite). The size standard is $47 million in annual receipts for Satellite Telecommunications and Radio Stations.

[30] Affected Entities in this industry include all reporting wireless carriers and service providers. The size standard is 1,500 employees. Federal-State Joint Board on Universal Service, Universal Service Monitoring Report at 26, Table 1.12 (2024), https://docs.fcc.gov/public/attachments/DOC-408848A1.pdf.

proposed rules and this would provide small entities with access to valuable spectrum without the expense and inconvenience of having to obtain a license. The Commission believes that this rulemaking will 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 economic benefit for small businesses.

X. IMPACTS ON DISADVANTAGED POPULATIONS

22. Disparate impacts on disadvantaged populations such as the poor or the disabled are unlikely to occur. Benefits from expanded unlicensed spectrum will be broad-based as they will not be specific to a particular license holder. Thus, no particular population will be likely to enjoy less benefits than others. Moreover, costs are limited to those entities developing and managing new geofencing system and support devices and not private individuals. AFC system providers may incur small adjustment fees to account for BEL, but there is no reason to believe this will affect any subpopulations disproportionately. Thus, disadvantaged populations are unlikely to incur disproportionate costs.

STATEMENT OF
CHAIRMAN BRENDAN CARR

Re: *Unlicensed Use of the 6 GHz Band; Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz*, Fourth Report and Order and Third Further Notice of Proposed Rulemaking, ET Docket No. 18-295, and GN Docket No. 17-183 (January 29, 2026).

Earlier this month, I made the annual pilgrimage to the Consumer Electronics Show in Las Vegas. And as is tradition, I eventually found a chance to duck out and stroll the bustling floor, where I admired the whiz-bang gadgets on display—robots, concept cars, paper-thin TVs, you name it. Witnessing ingenuity in action never gets old.

But perhaps one of the most consequential innovations at CES was not as exotic: the next generation of Wi-Fi. You see, at this year's show, America's tech industry debuted Wi-Fi 8 routers and chips for launch as soon as this year. This next generation of Wi-Fi will offer blazing fast speeds and massive bandwidth with more efficient power, higher throughput, and better client-to-client communications.

That is a big deal. After all, we have seen so much innovation take place across our spectrum bands—both licensed and unlicensed. And at CES, you could see unlicensed bands powering everything from AI-enabled wearables to consumer drones (American-made drones, of course).

Now, you might not have seen the FCC's own dedicated teams of engineers at CES. But they deserve a shoutout here because they are the ones who worked tirelessly to bring more unlicensed spectrum to the marketplace and to allow innovators to supercharge existing unlicensed bands.

In 2020, under the first Trump Administration, Chairman Ajit Pai recognized that we faced an acute shortage of unlicensed spectrum as American companies were busy building a new generation of consumer devices. So, the FCC went big and opened up 1,200 megahertz in the 6 GHz band for unlicensed use. Consumers across America now benefit from a better Wi□Fi experience.

Today, we build on that foundation and offer more flexibility to support future innovations in the 6 GHz band. We create a new class of devices known as geofenced variable power devices (a name that just rolls right off the tongue). These devices can operate at higher power and—unlike previous device categories—can be used both indoors and outdoors. With these devices, we are finally filling an important gap left open by our previous decisions. To make it possible, we will use geofencing to protect incumbent users from interference.

With higher power and outdoor mobility, expect more compelling AR/VR, short□range hotspots, automation, and navigation. And importantly, we keep the 6 GHz band moving forward as a platform for America's wireless leadership and technological dynamism. Our consumers, our economy, and our innovators will be better off for it.

President Trump has been clear that the Administration is working successfully to unleash America's technological leadership. And today's FCC decision marks another win in this broader effort.

For their work on this item, I would like to thank Andrew Hendrickson, Nicholas Oros, Michael Ha, Bahman Badipour, Aole Wilkinsel, Aniqa Tahsin, and Matthew Miller at the Office of Engineering and Technology and Keith McCrickard from the Office of General Counsel and Aleks Yankelevich, Cher Li, and Patrick Sun from the Office of Economics & Analytics.

STATEMENT OF
COMMISSIONER OLIVIA TRUSTY

Re: *Unlicensed Use of the 6 GHz Band; Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz*, Fourth Report and Order and Third Further Notice of Proposed Rulemaking, ET Docket No. 18-295, and GN Docket No. 17-183 (January 29, 2026).

United States leadership in spectrum innovation requires a balanced spectrum policy that recognizes the importance of both licensed and unlicensed operations. I'm pleased to support today's Fourth Report and Order because it will enhance the value of the 6 GHz band and reinforce U.S. leadership in next generation technologies.

Unlicensed innovation is rapidly expanding into applications that demand low latency, high throughput, and reliable indoor connectivity. Among other things, these applications could include Augmented Reality glasses supporting remote collaboration; immersive training tools for first responders and industrial workers; or wearable devices that monitor health, fitness, and environmental conditions in real time. By authorizing geofenced variable power, or GVP, devices, the Commission enables these technologies to scale and meet growing consumer demand, while maintaining appropriate protections for incumbent users. Importantly, while the 6 GHz band offers significant promise for wearable and other emerging use cases, this item appropriately takes a technology-neutral approach that leaves room for future innovations we cannot yet predict.

The Further Notice of Proposed Rulemaking builds on this progress by proposing additional opportunities for unlicensed use in the 6 GHz band. Specifically, it seeks comment on allowing certain devices to operate at higher power under defined conditions, which could improve indoor coverage and deliver greater benefits to American consumers. The FNPRM also explores expanding connectivity at sea by proposing rule changes to permit low-power indoor access points on cruise ships. Together, these proposals move us closer to our shared goal of universal connectivity, ensuring that advanced wireless capabilities are available wherever Americans live, work, or travel.

I thank the staff of the Office of Engineering and Technology for their work on this item.