

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)	GN Docket No. 17-183
Between 3.7 and 24 GHz)	

THIRD REPORT AND ORDER

Adopted: December 11, 2024Released: December 13, 2024

By the Commission: Chairwoman Rosenworcel and Commissioner Starks issuing separate statements.

TABLE OF CONTENTS

Heading	Paragraph #
I. INTRODUCTION.....	1
II. BACKGROUND.....	3
III. DISCUSSION.....	12
A. Protecting Mobile Services.....	14
1. ENG Central Receive Sites	16
2. ENG Truck Receivers.....	29
3. Low-power Short Range Mobile Devices	50
4. Reservation of Spectrum for ENG	52
B. Protecting Fixed Services	53
C. Protecting the Fixed-Satellite Services	58
1. Fixed-Satellite Service Uplinks.....	58
2. Fixed-Satellite Service Downlinks.....	65
D. Protecting Passive Services.....	68
E. Technical Rules.....	74
F. Benefits and Cost	81
G. Table of Frequency Allocations.....	84
IV. PROCEDURAL MATTERS.....	85
V. ORDERING CLAUSES.....	90
APPENDIX A – FINAL RULES	
APPENDIX B – FINAL REGULATORY FLEXIBILITY ANALYSIS	

I. INTRODUCTION

1. In 2020, the Commission adopted rules making unlicensed device access to 1200 megahertz across the 6 GHz band (5.925-7.125 GHz) more flexible, resulting in increased unlicensed device usage. These rules unleashed a torrent of new devices taking advantage of the newer Wi-Fi 6 and 6E standards to provide users across the U.S. with a better Wi-Fi user experience. More recently, in 2023, the Commission expanded 6 GHz band unlicensed use to permit an additional class of unlicensed

access points—very low power (VLP) devices. VLP devices are intended to provide high data rate connections across short distances.

2. Today, we expand unlicensed VLP device operation to the entire 6 GHz band. This will provide additional spectrum for high-throughput, low latency operations for these versatile portable devices. Specifically, our actions today pave the way for these devices to use the latest standards and to take advantage of larger channels across the 6 GHz band. We expect that VLP devices will be instrumental in supporting cutting-edge applications, such as augmented and virtual reality and body-worn technologies, that will help businesses, enhance learning opportunities, advance healthcare opportunities, and bring new entertainment experiences. As we expand the spectrum available for VLP devices, we adopt the same power levels and other technical and operational requirements that apply to VLP devices in the U-NII-5 and U-NII-7 portions of the 6 GHz band, which are designed to prevent the licensed services that operate in the 6 GHz band from experiencing harmful interference. In this way, we facilitate more intensive use of our valuable spectrum resources, thereby enabling exciting new technologies to be deployed to American consumers, while ensuring that incumbent services are protected from harmful interference.

II. BACKGROUND

3. The 6 GHz band has allocations 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 These fixed microwave service licensees make significant use of the U-NII-5 and U-NII-7 bands, and also operate in relatively smaller numbers in 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

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 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 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, Figure 1.

⁴ As of September 19, 2024, the FCC databases indicate that there were 31,942 call signs for fixed microwave links in U-NII-5, 353 in U-NII-6, 16,241 in U-NII-7, and 5,110 in U-NII-8. The predominant usage in the U-NII-5 and U-NII-7 bands is common carrier, industrial/business pool, and public safety pool fixed point-to-point links. The U-NII-6 band is dominated by mobile industrial/business pool and public safety pool microwave and TV Pickup operations.

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

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)

4. 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

5. The Fixed Satellite Service (FSS) is allocated in the Earth-to-space direction in all four sub-bands, 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 3.7-4.2 GHz frequency band in the space-to-Earth direction to comprise the “conventional C band.”¹¹ Predominant FSS uses of these frequencies include content

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 at 8739, 8789-90, paras. 131-32 (2015).

¹⁰ 47 CFR § 2.106.

¹¹ 47 CFR § 25.103; *see Expanding Flexible Use of the 3.7 to 4.2 GHz Band*, Report and Order and Order of Proposed Modification, 35 FCC Rcd at 2343, 2406, paras. 147-48 (2020) (*C-Band Order*). In the *C-Band Order*, the Commission adopted rules to make 280 megahertz of mid-band spectrum available for flexible use (plus a 20 megahertz guard band) throughout the contiguous United States by transitioning existing 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). *C-Band Order*, 35 FCC Rcd at 2345, para. 4. Specifically, the *C-Band Order* established a December 5, 2025 deadline, by

(continued....)

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

6. In addition to these licensed incumbent services, an international footnote in the table of frequency allocations urges that we take “all practicable steps” to protect the radio astronomy service in the 6650-6675.2 MHz range from harmful interference.¹⁵ Finally, low-power unlicensed ultra-wideband (UWB) and wideband systems operate in the 6 GHz band under our part 15 rules.¹⁶ Like all other part 15 devices, UWB and wideband devices operate on a non-interference basis and must accept interference from and are not permitted to cause harmful interference to authorized stations.¹⁷

7. 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).¹⁸ The *6 GHz First Order* adopted rules for two categories of unlicensed operations—standard-power operations and low-power indoor (LPI) operations.¹⁹ 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.²⁰ Low-power indoor access points can operate across the entire 6

(Continued from previous page)

which incumbent space station operators were to complete transitioning their operations to the upper 200 megahertz of the band, but it also provided an opportunity for accelerated band clearing by allowing eligible space station operators to voluntarily commit to relocate on a two-phased accelerated schedule, with a Phase I deadline of December 5, 2021, and a Phase II deadline of December 5, 2023. *Id.* at 2408, 2414, paras. 155, 171; *see* 47 CFR § 27.1412(b)(1)–(2). All five eligible space station operators elected accelerated relocation, *Wireless Telecommunications Bureau Announces Accelerated Clearing in the 3.7–4.2 GHz Band*, GN Docket No. 18-122, Public Notice, 35 FCC Rcd at 5517 (WTB 2020), and completed both phases of the relocation process.

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

¹³ 47 CFR § 25.214(c)(5).

¹⁴ As shown in the Table of Frequency Allocations, international footnotes 5.458A and 5.458B apply to these bands and, as discussed *infra*, we are reinstating the text of these footnotes, which had been inadvertently removed, in section 2.106 of the rules. International footnote 5.458B provides 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. Currently no licensed FSS space-to-Earth stations in U-NII-7, and the 7.025-7.075 GHz allocation is limited to two grandfathered satellite systems with three grandfathered locations. 47 CFR § 2.106(d)(172).

¹⁵ 47 CFR § 2.106(c)(342).

¹⁶ 47 CFR § 15.250; *id.* pt. 15, subpt. F. Unlicensed UWB operations are permitted in many different frequency bands. *See id.* pt. 15, subpt. F. Wideband operations are mostly limited to the 6 GHz band. 47 CFR § 15.250 (limiting wideband operations to the 5.925-7.250 GHz band). For both the 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), 15.517(c), 15.519(c), 15.250(d)(1).

¹⁷ 47 CFR § 15.5(b).

¹⁸ *6 GHz First Order*.

¹⁹ *Id.* at 3860, paras. 17-18.

²⁰ 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. *Id.* § 15.407(a)(4); *6 GHz First Order*, 35 FCC Rcd at 3862, para.

(continued....)

GHz band, but at lower power levels than standard power operations, and must incorporate a contention-based protocol.²¹ Client devices operate under the control of either a standard-power or low-power indoor access point and communicate using power levels that depend on the type of access point to which they are connected.²²

8. 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*).²³ The VLP devices are authorized to operate anywhere, indoors and outdoors, without being under the control of an AFC system.²⁴ The VLP devices are limited to power levels that allow them to coexist with incumbent operations in the band: 14 dBm EIRP and a -5 dBm/MHz EIRP power spectral density.²⁵ VLP devices are also 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 must employ a contention-based protocol.²⁶ VLP devices are prohibited from operating as part of a fixed outdoor infrastructure, such as poles or buildings.²⁷ Also, VLP devices are required to prioritize operations above 6105 MHz prior to operating on frequencies between 5925 MHz and 6105 MHz to ensure that services below the U-NII-5 band are protected from potential harmful interference.²⁸ In the *6 GHz Second Order*, the Commission required emissions from VLP devices in the U-NII-5 and U-NII-7 bands to comply with the transmission emission mask adopted in the *6 GHz First Order*.²⁹ 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.³⁰ 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.³¹ 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.³² 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

(Continued from previous page)

22. 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.” *Id.* § 15.403.

²¹ *6 GHz First Order*, 35 FCC Rcd at 3860, 3889, paras. 18, 101.

²² *Id.* at 3860, para. 18.

²³ *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*).

²⁴ *See id.* at 10, 39, paras. 18, 67.

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

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

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

²⁸ 47 CFR § 15.407(d)(9); *6 GHz Second Order*, 38 FCC Rcd at 105572 para. 94.

²⁹ *6 GHz First Order*, 35 FCC Rcd at 3924-25, para. 196.

³⁰ *6 GHz First Order*, 35 Rcd at 3925, para. 196.

³¹ *Id.*

³² *Id.*

bands, must be suppressed by at least 40 dB.³³ We are adopting the same emission limits for VLP devices operating in the U-NII-6 and U-NII-8 bands. 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). Consistent with the rules adopted in the *6 GHz Second Order* for LPI and standard power devices, VLP devices will be prohibited from operating in low flying aircraft and unmanned aircraft systems.³⁴ For aircraft above 10,000 feet, VLP devices can operate across the 5.925-6.425 GHz band.³⁵ We will also continue to prohibit VLP devices from operating on oil platforms.³⁶ Similarly, in the *6 GHz Second Order*, VLP devices will continue to be permitted to operate on boats.³⁷

9. 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 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.³⁸ The *6 GHz Second FNPRM* also proposed to permit VLP operation at higher power levels while under the control of a geofencing system.³⁹ The geofencing system would utilize Commission databases to create exclusion zones to protect incumbent licensed services.⁴⁰ In addition, because the current 6 GHz unlicensed rules prohibit direct communication between client devices,⁴¹ the *6 GHz Second FNPRM* sought comment on allowing such communications between client devices to 6 GHz unlicensed low-power indoor access points.⁴² In this Third Report and Order, we only address the *6 GHz Second FNPRM* proposal to expand VLP operation to the U-NII-6 and U-NII-8 portions of the 6 GHz band while deferring the remaining issues to future Commission actions.⁴³

10. The Commission received comments from numerous parties in favor of allowing unlicensed VLP operations in the 6 GHz band, as well as from parties representing the interests of incumbent licensees raising concerns about potential harmful interference from the proposed unlicensed VLP operations in the U-NII-6 and U-NII-8 bands. In response to the *6 GHz Second FNPRM*, 6 GHz band unlicensed device proponents—including Apple, Broadcom, Google, Intel Corporation, Meta Platforms, Microsoft Corporation, Qualcomm,⁴⁴ the Wi-Fi Alliance,⁴⁵ the Wireless Broadband Alliance,⁴⁶

³³ *Id.*

³⁴ *6 GHz Second Order*, 38 FCC Rcd at 10573, para. 97.

³⁵ *Id.*; 47 CFR § 15.407(d)(1)(iv).

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

³⁷ *6 GHz Second Order*, 38 FCC Rcd at 10573, para. 96.

³⁸ *6 GHz Second FNPRM*, 38 FCC Rcd at 10576, 10600-01, paras. 104, 173. At the time the VLP rules were adopted, the record did not contain enough information on the harmful interference risk to incumbent services in the U-NII-6 and U-NII-8 bands from VLP operations to determine whether to allow VLP operations in those bands.

³⁹ *6 GHz Second FNPRM*, 38 FCC Rcd at 10576, para. 104.

⁴⁰ *Id.* at 10583-84, paras. 121, 123.

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

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

⁴³ To be clear, we are not here addressing the other issues raised in the *6 GHz Second FNPRM*, and they remain open for resolution in this proceeding. For the reasons discussed in this *Third Report and Order*, we believe that the benefits of expanding VLP operation to the entire 6 GHz band are clear enough at this time that such expansion should not be delayed pending resolution of other issues in this docket.

⁴⁴ Apple, Broadcom et al. Comments at 4 (a group of companies that includes Apple Inc., Broadcom Inc., Google LLC, Intel Corporation, Meta Platforms, Inc., Microsoft Corporation, and Qualcomm Inc.). This group of

(continued....)

the Japan Electronics and Information Technology Industries Association,⁴⁷ and the Consumer Technology Association (CTA)⁴⁸—support the Commission’s proposal for authorizing unlicensed VLP device operations across the 6 GHz band. They emphasize that such operations will support a host of immersive, real-time applications in areas such as healthcare, high accuracy location, advanced connectivity, innovative game experiences, and augmented reality/virtual-reality devices, among other uses. CTA points out that providing high-speed connections for some of the most advanced applications, including wearables and augmented and virtual reality (AR/VR), will help businesses, enhance learning opportunities, advance healthcare opportunities, and bring new entertainment experiences.⁴⁹ Several commenters also assert that technical rules can be established to protect incumbent spectrum users from harmful interference.⁵⁰ Apple, Broadcom, et al. submitted several technical studies to support their contention that VLP devices will not cause harmful interference to licensed incumbent users.⁵¹

11. Commenters representing incumbent users express various concerns about the potential for harmful interference to their operations from unlicensed VLP operations. Commenting parties include the National Public Safety Telecommunications Council on behalf of public safety microwave incumbents,⁵² Sirius XM Radio,⁵³ the National Association of Broadcasters (NAB)⁵⁴ on behalf of local radio and television stations and broadcast networks, and the National Academy of Sciences’ Committee on Radio Frequencies regarding radio astronomy observatories.⁵⁵ In its comment, Electric Power Research Institute (EPRI) states that incumbent microwave operators will incur significant costs in trying to locate VLP interference sources if the protection scheme is ineffective in providing adequate protection.⁵⁶ According to EPRI, “VLP sources being outdoor and portable or vehicular mobile[] will make locating the offending device extremely difficult if not impossible.”⁵⁷ MEMA also expressed

(Continued from previous page) _____

companies 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 shall 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 shall 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 also 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).

⁴⁵ Wi-Fi Alliance Comments at 2-6.

⁴⁶ Wireless Broadband Alliance Comments at 4.

⁴⁷ Japan Electronics and Information Technology Industries Association Comments at 1.

⁴⁸ Consumer Technology Association (CTA) Comments at 1-2.

⁴⁹ *Id.* at 1.

⁵⁰ Federated Wireless Comments at 2-3; IEEE 802 LAN/MAN Standards Committee (LMSC) Comments at 3.

⁵¹ Apple, Broadcom, et al. July 30, 2024 *Ex Parte*. Presentation at 3; Letter from Christopher Szymanski, Thomas Derham, Broadcom to Marlene H. Dortch, Secretary, FCC, ET Docket No.18-295 at 5 (filed Sept. 11, 2023) (2023 *VLP/ENG Study Ex Parte*); Apple, Broadcom, et al. July 31, 2024 *Ex Parte*; Apple, Broadcom, et al. June 28, 2024 *Ex Parte* at 4.

⁵² National Public Safety Telecommunications Council (NPSTC) Comments at 5-8.

⁵³ Sirius XM Radio Comments at 9-16.

⁵⁴ National Association of Broadcasters (NAB) Comments at 3-13.

⁵⁵ National Academy of Sciences’ Committee on Radio Frequencies Comments at 5-10 (CORF Comments).

⁵⁶ Electric Power Research Institute (EPRI) Comments at 3.

⁵⁷ *Id.*

interference concerns in its filing, pointing out that higher transmitting power in VLP devices could “increase the potential for interference with vehicle safety systems communications.”⁵⁸

III. DISCUSSION

12. We adopt rules to permit VLP devices to operate across the U-NII-6 and U-NII-8 portions of the 6 GHz band at the same power levels we adopted for VLP operations in the U-NII-5 and U-NII-7 bands: -5 dBm/MHz EIRP power spectral density (PSD) and 14 dBm EIRP. This will expand the spectrum available for VLP devices to 1200 megahertz, thereby permitting the use of up to seven 160-megahertz channels or three 320-megahertz channels. VLP devices will enable new innovative uses and will provide opportunities to enhance nascent applications, such as augmented reality/virtual reality, in-car connectivity, wearable on-body devices, healthcare monitoring, short-range mobile hotspots, high accuracy location and navigation, and automation.⁵⁹ The rules we are adopting are designed to support innovation to bring exciting new applications to market while protecting the important licensed services that operate in the U-NII-6 and U-NII-8 portions of the 6 GHz band from harmful interference. We conclude that VLP operation at the power levels we are permitting will have an insignificant potential for causing harmful interference to licensed users of the band.

13. In expanding VLP operations to the U-NII-6 and U-NII-8 portions of the 6 GHz band, we are adopting the same rules that the Commission previously adopted for VLP devices operating in the U-NII-5 and U-NII-7 bands. For example, VLP devices 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.⁶⁰

A. Protecting Mobile Services

14. The U-NII-6 and U-NII-8 bands are used for electronic newsgathering (ENG) and other video broadcasting-related applications by licensees operating under the part 74 broadcast auxiliary services, part 78 Cable Television Relay Service, and part 101 Local Television Transmission Service.⁶¹ 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.⁶² The *6 GHz Second FNPRM* specifically requested information on three categories of mobile 6 GHz band equipment: (i) outdoor ENG central receive sites; (ii) outdoor ENG truck receivers (transmissions from portable cameras and microphones to a receiver on a truck); and (iii) low-power short range mobile devices.⁶³ Commenters in response to the *6 GHz Second FNPRM* discussed the interference potential of VLP devices to outdoor ENG central receive sites and transmissions from portable cameras to outdoor ENG truck receivers.⁶⁴ No commenters provided feedback regarding other types of mobile 6 GHz equipment or use scenarios, such as low-power short range mobile devices. Because no commenters have raised concerns or suggested other use cases, we direct our examination of the potential for VLP devices to cause harmful interference

⁵⁸ MEMA Comments at 2.

⁵⁹ Apple, Broadcom et al. Comments at 4-5 (rec. June 29, 2020); Wi-Fi Alliance Comments at 4-8 (rec. June 29, 2020).

⁶⁰ See, e.g., 47 CFR §§ 15.407(a)(9), 15.407(d)(6), 15.407(d)(10).

⁶¹ 47 CFR pt. 74, subpt. F, pt. 78, pt. 101, subpt. J.

⁶² 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).

⁶³ *6 GHz Second FNPRM*, 38 FCC Rcd at 10601-04, paras. 175-82.

⁶⁴ See NAB Comments; NAB Reply 2-7; Apple, Broadcom et al. Comments at 7-19; Apple, Broadcom et al. Reply at 7-15; Apple, Broadcom, et al. July 31, 2024 *Ex Parte*; Apple, Broadcom, et al. June 28, 2024 *Ex Parte*.

to mobile applications to the three specific use cases discussed in the *6 GHz Second FNPRM*. As discussed in more detail below, we conclude that there is an insignificant risk that VLP device operation in the U-NII-6 and U-NII-8 bands will cause harmful interference to licensed mobile operations for these use cases.

15. Limiting our discussion to these three use cases closely mirrors the approach the Commission followed when adopting rules to permit unlicensed 6 GHz band low-power indoor devices to operate in the U-NII-6 and U-NII-8 bands. For low-power indoor devices, the Commission considered three distinct use cases as representative of mobile use of those portions of the 6 GHz band: (i) an ENG truck transmitting to a central receive site; (ii) portable cameras transmitting to an outdoor ENG truck receiver; and (iii) portable cameras transmitting to an indoor receive site.⁶⁵ These were the three use cases that were examined in an engineering study conducted by Alion (Alion Study) that was provided by NAB.⁶⁶ The first two of these use cases are identical to the cases in the *6 GHz Second FNPRM*, while the *6 GHz Second FNPRM* discusses a slightly broader third case. Given the Commission's past approach to considering the interference potential of 6 GHz unlicensed devices to mobile operations, we believe that discussing the three use cases raised in the *6 GHz Second FNPRM* adequately addresses mobile operations in the band.

1. ENG Central Receive Sites

16. The communications link between ENG trucks and a central receive site shares many of the characteristics of a fixed microwave link.⁶⁷ Specifically, the link uses directional antennas to send signals between two fixed locations that are mostly above the local clutter.⁶⁸ The *6 GHz Second FNPRM* proposed to permit VLP devices to operate in the U-NII-6 and U-NII-8 bands and sought comment on whether VLP devices could operate at up to -5 dBm/MHz EIRP PSD and 14 dBm EIRP in those bands while keeping the risk of harmful interference to ENG central receive sites to an insignificant level.⁶⁹ The *6 GHz Second FNPRM* also sought comment on whether the same type of analysis discussed in the *6 GHz Second Order* showing an insignificant harmful interference risk to fixed microwave receive sites would be appropriate with respect to ENG central receive sites, or whether there are inherent differences between BAS/CARS operations as compared to fixed point-to-point operations that must be considered when analyzing the harmful interference risk, e.g., differences in antenna beamwidth and gain, typical antenna heights or receive antenna locations.⁷⁰

17. NAB expresses concerns about potential interference to ENG central receive sites from VLP devices in the U-NII-6 and U-NII-8 bands.⁷¹ In making its comments, NAB considered a study filed by Apple, Broadcom, et al. on September 11, 2023, which found that VLP devices would not cause harmful interference to ENG central receive sites.⁷² NAB concedes that “in a Monte Carlo analysis that

⁶⁵ *6 GHz First Order*, 35 FCC Rcd at 3912-15, paras. 159-68.

⁶⁶ *Id.* at 3910, para. 152 (citing Alion Study, NAB Dec. 5, 2019 *Ex Parte*).

⁶⁷ *6 GHz Second Order*, 38 FCC Rcd at 10601, para. 175.

⁶⁸ *Id.*

⁶⁹ *Id.*

⁷⁰ *Id.*

⁷¹ NAB Comments at 8-10.

⁷² *Id.* at 3-4, 8-10 (citing Apple, Broadcom, and Meta Sept. 11, 2023 *Ex Parte*). The study consisted of a Monte Carlo simulation addressing the potential for VLP devices operating at -5 dBm/MHz to exceed -6 dB I/N for two specific ENG central receive sites. Apple, Broadcom, and Meta Sept. 11, 2023 *Ex Parte* at 2-3. The simulation used the same two ENG central receive sites and technical parameters that were used in a Monte Carlo Alion Study simulation previously submitted by NAB that examined the potential for 6 GHz band unlicensed access points to interfere with ENG receivers. Apple, Broadcom, and Meta Sept. 11, 2023 *Ex Parte* at 2.

relies on reasonable assumptions, some number, even a large number, of simulations might yield no degradation or interference to an ENG receiver,” but states that Apple, Broadcom, et al.’s claim of absolutely no interference to ENG receivers, ever, is “plainly and facially unreasonable.”⁷³ NAB states that “[m]any hypothetical VLP transmitters located near [an] ENG receive antenna would certainly present signals exceeding -6 dB above the receiver noise floor,” and argues as an example that the Washington, D.C. Old Post Office site considered in the Alion Study would have a received signal level 34 dB above the -6 dB I/N criterion from a VLP device located 500 meters away.⁷⁴ NAB disputes Apple, Broadcom, et al.’s claim that “‘ENG links typically are configured to operate with a significantly higher signal-to-noise ratio than needed to successfully operate,’” stating that this is “unfounded and inaccurate” because “ENG links are not ‘configured’ to operate in some excessive or overengineered manner . . . and often operate within a few dB of failure.”⁷⁵

18. On June 28, 2024, Apple, Broadcom, and Meta submitted an additional study performed by RKF Engineering on the potential for interference from VLP devices to ENG central receive sites in the 6 GHz band.⁷⁶ RKF performed a Monte Carlo analysis with 100,000 iterations over the contiguous United States to investigate the likelihood of harmful interference to ENG central receiver sites from VLP devices in the U-NII-6 and U-NII-8 bands.⁷⁷ A Monte Carlo simulation uses random sampling and statistical modeling to estimate mathematical functions and mimic the operations of complex systems.⁷⁸ The simulation examined all 567 ENG central receive sites listed in the FCC’s Universal Licensing System for the continental United States as a representative sample of all ENG central receive sites.⁷⁹ RKF states that “[t]he analysis demonstrates that the risk that VLP devices will cause exceedances of -6 dB I/N is extremely low,” and is in fact “lower than [in] other scenarios where the Commission has determined that sharing between 6 GHz [Radio Local Area Network (RLAN)] devices and incumbent licensees presented an ‘insignificant’ risk of harmful interference by the FCC’s definition.”⁸⁰ It states that 95% of ENG receive sites “had no exceedance over 100,000 simulation iterations,” and that “[t]he risk of harmful interference from VLP devices to [ENG receive sites] was exceedingly small with a 0.0001% average probability of an exceedance across all [ENG receive sites].”⁸¹

19. On November 7, 2024, Apple, Broadcom et al. submitted updated results for the June 28, 2024 study. NAB pointed out that it might be possible that the June 28, 2024 study had inverted the antenna pattern for the ENG central receive sites to have positive gain above the horizon instead of below the horizon.⁸² Apple, Broadcom et al. agreed with NAB that the antenna pattern used in the June 28, 2024 study was incorrect and submitted new simulation results with the antenna pattern correctly implemented.⁸³ The revised simulation indicates the probability of exceeding -6 dB I/N across all ENG

⁷³ NAB Comments at 8.

⁷⁴ *Id.* at 9.

⁷⁵ *Id.*

⁷⁶ Apple, Broadcom, and Meta June 28, 2024 *Ex Parte*; *Report on Frequency Sharing Between Very Low Power RLAN Devices and Broadcast Central Receive Stations in the 6 GHz Band* by RKF Engineering Solutions, LLC. (June 2024 Apple, Broadcom, and Meta Report).

⁷⁷ June 2024 Apple, Broadcom, and Meta Report at iii.

⁷⁸ Harrison RL, *Introduction To Monte Carlo Simulation*, AIP Conf Proc. 2010;1204:17–21. doi:10.1063/1.3295638.

⁷⁹ June 2024 Apple, Broadcom, and Meta Report at iii. Not all ENG central receive sites are listed in the Universal Licensing System.

⁸⁰ *Id.* at iv.

⁸¹ *Id.*

⁸² NAB Oct. 28, 2024 *Ex Parte* at 6-8; NAB Nov. 14, 2024 *Ex Parte* at 2.

⁸³ Apple, Broadcom et al. Nov. 7, 2024 *Ex Parte* at 3-5.

central receive sites was 0.0005%, which Apple, Broadcom et al. contend is below what the Commission found to be acceptable for low-power indoor operation in the U-NII-6 and U-NII-8 bands.⁸⁴ The revised simulation also indicates that the probability of exceeding -6 dB I/N for the ENG receive site with the highest probability of exceedance increased from 0.007% to 0.009%, which Apple, Broadcom et al. point out is much lower than the 0.04% exceedance probability for the worst-case link in the San Francisco study that the Commission relied on in the *6 GHz Second Order*.⁸⁵

20. We find that the June 28, 2024 computer simulations based on Monte Carlo analysis submitted by Apple, Broadcom, and Meta, as corrected by the Apple, Broadcom et al. November 7, 2024 filing, provides sufficient support for permitting VLP operation at up to -5 dBm/MHz EIRP power spectral density (PSD) and 14 dBm EIRP across the U-NII-6 and U-NII-8 portions of the 6 GHz band.⁸⁶ Relying on this computer simulation is consistent with a directive the Commission made in a 2023 Policy Statement to follow a data-driven approach to spectrum management rather than placing dispositive weight on worst-case examples that may be rare or never occur in practice.⁸⁷ Relying on Monte Carlo computer simulations is also consistent with the Commission's previous actions in adopting rules for unlicensed 6 GHz low-power indoor devices and for VLP devices in the U-NII-5 and U-NII-7 bands. For the low-power indoor device rules, the Commission characterized a Monte Carlo computer simulation submitted by CableLabs as "the best evidence in the record of the impact that unlicensed low-power indoor devices will have on incumbent operations," and for the VLP rules the Commission found that Monte Carlo computer simulations submitted by Apple, Broadcom et al. and by Apple provided sufficient support for permitting VLP operation in the U-NII-5 and U-NII-7 bands.⁸⁸

21. The Commission previously found that a well-designed computer simulation can simultaneously model many probabilistic factors that determine whether harmful interference may occur.⁸⁹ In the case of ENG central receive sites in the U-NII-6 and U-NII-8 bands, these factors include VLP device location variability in relation to the ENG receiver, height of the VLP device, whether the VLP device is operating co-channel to the ENG receiver, the VLP power level, and the radio propagation environment.⁹⁰ In examining the potential for harmful interference to occur to ENG central receive sites from VLP devices, the characteristics of the receivers and antennas must also be considered.⁹¹ ENG central receive sites use directional antennas typically located on tall towers or building rooftops,⁹² but unlike fixed microwave antennas their directivity may be variable to accommodate ENG signals from multiple directions. In addition, other factors that affect the potential for VLP devices to cause harmful interference include body loss, the use of transmit power control (TPC), and antenna polarization mismatch.⁹³

⁸⁴ *Id.* at 3-4 (citing *6 GHz First Order*, 35 FCC Rcd. at 3912, para. 160).

⁸⁵ *Id.* at 4 (citing *6 GHz Second Order*, 38 FCC Rcd. at 10552, para. 49).

⁸⁶ See Apple, Broadcom et al. Feb. 28, 2023 *Ex Parte*; Apple Feb. 13, 2023 *Ex Parte*.

⁸⁷ See *Principles for Promoting Efficient Use of Spectrum and Opportunities for New Services; Promoting Efficient Use of Spectrum through Improved Receiver Interference Immunity Performance*, ET Docket Nos. 23-122 and 22-137, Policy Statement, 38 FCC Rcd at 3682, 3692-94, paras. 36-47 (2023).

⁸⁸ *6 GHz First Order*, 35 FCC Rcd at 3896, para. 120; *6 GHz Second Order*, 38 FCC Rcd at 10534, para. 25.

⁸⁹ *6 GHz Second Order*, 38 FCC Rcd at 10535, para. 26.

⁹⁰ *Id.*

⁹¹ *Id.*

⁹² *Id.*

⁹³ *6 GHz First Order* 35 FCC Rcd at 3880, para.75; *6 GHz Second Order*, 38 FCC Rcd at 10545-46, 10550-51, paras. 40, 47.

22. Based on Apple, Broadcom, and Meta's June 28, 2024 study, as corrected by the Apple, Broadcom et al. November 7, 2024 filing, we conclude that there is an insignificant risk of harmful interference occurring to ENG central receiver sites from VLP devices operating in the U-NII-6 and U-NII-8 bands. This simulation provides a detailed description of all the assumptions used in performing a Monte Carlo analysis to determine the likelihood of harmful interference to ENG central receive sites from VLP devices operating in the U-NII-6 and U-NII-8 bands. With the exception of certain assumptions specific to ENG central receive sites described below, it uses the same assumptions as the San Francisco simulation that the Commission relied upon in the *6 GHz Second Order* when it adopted rules for VLP devices in the U-NII-5 and U-NII-7 bands.⁹⁴ It assumes a -5 dBm/MHz PSD VLP EIRP and a 14 dBm maximum EIRP, power reduction from TPC based on a Gaussian distribution with a 3 dB mean that is truncated at 0 dB and 6 dB, body loss based on a Gaussian distribution with a 4 dB mean that is truncated at 0 dB and 8 dB, and a VLP device height of 1.5 meters in 90% of cases with higher elevation (e.g., on balconies) in 10% of cases.⁹⁵ To determine the number of active VLP devices in each simulation iteration, the study used the same assumptions as for the San Francisco study regarding the percentage of people outdoors (6%), the percentage of people outdoors using VLP devices (25%), the percentage of VLP devices operating in unlicensed bands (90%), the percentage of those devices capable of using the 6 GHz band (50%), the percentage of the devices actually using the 6 GHz band (65%), and the percentage of devices actively transmitting at any instant (2%).⁹⁶ Multiplying these percentages by the total United States population results in 29,661 active VLP devices for each iteration.⁹⁷ The study also used the same propagation models previously specified by the Commission and used in prior studies, i.e., free space path loss at distances less than 30 meters, WINNER II LOS at distances between 30 meters and 50 meters, WINNER II Combined LOS/NLOS at distances between 50 meters and 1 kilometer, and ITM at distances greater than 1 kilometer.⁹⁸

23. Apple, Broadcom, and Meta's June 28, 2024 study used ENG receive site antenna information for the 567 receive sites listed in the Commission's ULS, specifically, the center frequency, bandwidth, location, antenna height above ground, and maximum antenna gain.⁹⁹ In analyzing the ULS data, RKF discovered that 99 of these sites had an apparently erroneous antenna height of exactly 6.1 meters listed when in fact the antenna height was much greater because it was mounted on a building or tall tower.¹⁰⁰ RKF believed that it was more appropriate to perform the analysis by excluding the sites with apparently erroneous antenna height information, but also provided results showing the effect of including these sites.¹⁰¹ Apple, Broadcom, and Meta's June 2024 study uses the same parameters and assumptions as NAB's Alion Study for ENG central receive sites, specifically, Vislink ProScan III antenna patterns (azimuth and elevation), a 4 dB receiver noise figure, and a 1 dB feeder loss.¹⁰²

⁹⁴ June 2024 Apple, Broadcom, and Meta Report at iii; *6 GHz Second Order*, 38 FCC Rcd at 10535-37, paras. 27-28.

⁹⁵ June 2024 Apple, Broadcom, and Meta Report at 12-15; *6 GHz Second Order*, 38 FCC Rcd at 10535-37, 10545-46, 10550-10551, paras. 27-28, 40, 47.

⁹⁶ June 2024 Apple, Broadcom, and Meta Report at 9; *6 GHz Second Order*, 38 FCC Rcd at 10541-42, para. 35; Apple, Broadcom et al. Feb. 28, 2023 *Ex Parte* at 9.

⁹⁷ June 2024 Apple, Broadcom, and Meta Report at 9. This compares with 1146 active devices in each iteration of the San Francisco simulation. *6 GHz Second Order*, 38 FCC Rcd at 10542, para. 35.

⁹⁸ June 2024 Apple, Broadcom, and Meta Report at 16; *6 GHz Second Order*, 38 FCC Rcd at 10535-36, para. 27.

⁹⁹ June 2024 Apple, Broadcom, and Meta Report at iii, 6-7.

¹⁰⁰ *Id.* at iv.

¹⁰¹ *Id.* at iv, 19-20.

¹⁰² *Id.* at 6-7.

24. Apple, Broadcom, and Meta's June 28, 2024 study, as corrected by the Apple, Broadcom et al. November 7, 2024 filing, shows that the average probability of exceeding the -6 dB I/N interference protection criterion in a given iteration is only 0.0005% per central receive site.¹⁰³ Further, the study showed the worst-case probability for a single receive site to exceed this metric is only 0.009%.¹⁰⁴ Based on the results of this study, which uses assumptions and parameters that are consistent with those the Commission previously accepted, we find that the risk of harmful interference to ENG central receive sites is insignificant. We note that these results showing an extremely low harmful interference likelihood are consistent with those of the September 11, 2023 study submitted by Apple, Broadcom, et al., which analyzed the potential for interference from VLP devices at two ENG central receive sites.¹⁰⁵ We recognize the limitations of Apple, Broadcom, and Meta's latest analysis in that not every ENG central receive site is listed in the ULS, but we believe that the sample size is large enough to represent the harmful interference potential of VLP devices in the U-NII-6 and U-NII-8 bands. Regardless of whether the analysis includes or excludes the 99 receive sites listed in the ULS that have apparently incorrect height information, our conclusion is the same in that the likelihood that the -6 dB I/N ratio will be exceeded at ENG central receive sites is very low and presents only an insignificant harmful interference risk.¹⁰⁶

25. NAB takes issue with several aspects of Apple, Broadcom, and Meta's June 28, 2024 study. NAB faults the study for placing VLP devices at locations throughout the entire contiguous United States, which it notes includes locations more than 30 kilometers from ENG central receive sites. NAB claims that interference would not be possible at such distances.¹⁰⁷ NAB also claims that the study does not include enough active VLP devices in each iteration. It points out that by using only approximately 30,000 VLP devices across the contiguous United States, it only evaluates potential interference from an average of one device in every 100 square miles.¹⁰⁸ We disagree with NAB regarding the merit of its criticism. Apple, Broadcom, and Meta's June 28, 2024 study, as corrected by the Apple, Broadcom et al. November 7, 2024 filing, provides I/N statistics at ENG central receive sites resulting from VLP operations. We believe that the methodology employed, which randomly placed the active VLP devices based on population density, was appropriate for evaluating the potential interference environment to generate these I/N statistics. The study used appropriate assumptions to determine that 30,000 VLP devices will be transmitting at a time. As noted, active VLP devices were placed based on population density, and because the study accounts for receivers in densely populated areas, the number of active VLP devices near ENG central receive sites evaluated during each iteration is likely to be far higher than NAB's calculated average. We agree with Apple, Broadcom et al. that the inclusion of VLP devices in the simulation that are distant from ENG central receive sites does not change the properly modeled density of VLP devices close to the ENG central receive sites, which is based on user density.¹⁰⁹ Thus, NAB's argument does not reflect the nature of how VLP devices were actually placed for evaluation. Relatedly, we also note that the fact that many VLP devices will not be located within 30 kilometers of an

¹⁰³ *Id.* at 20; Apple, Broadcom et al. Nov. 7, 2024 *Ex Parte* at 3. In choosing to use the -6 dB I/N interference protection criterion, the Commission noted in the *6 GHz First Order* that the metric was supported by several microwave incumbents and that it was not making a determination that any signal received with an I/N greater than -6 dB would constitute harmful interference. See *6 GHz First Order*, 35 FCC Rcd at 3878, para. 71.

¹⁰⁴ June 2024 Apple, Broadcom, and Meta Report at 20; Apple, Broadcom et al. Nov. 7, 2024 *Ex Parte* at 4.

¹⁰⁵ Apple, Broadcom, and Meta Sept. 11, 2023 *Ex Parte* at 3.

¹⁰⁶ June 2024 Apple, Broadcom, and Meta Report at 19-20.

¹⁰⁷ NAB Oct. 28, 2024 *Ex Parte* at 6; NAB Nov. 14, 2024 *Ex Parte* at 2.

¹⁰⁸ *Id.* at 7.

¹⁰⁹ Apple, Broadcom et al. Nov. 7, 2024 *Ex Parte* at 2.

ENG central receiver site reflects the reality that the majority of VLP devices active at any given time will not be operating near these locations.¹¹⁰

26. We disagree with NAB's contention that a VLP device operating at 500 meters from the Old Post Office Building in Washington D.C. would produce a received signal level that exceeds the -6 dB I/N threshold by 34 dB at an ENG receiver located there.¹¹¹ We reiterate that exceeding a -6 dB I/N does not constitute harmful interference, rather, if the probability of exceeding this level is extremely low, then the probability of actual harmful interference is insignificant.¹¹² NAB does not describe how it calculated its result, but based on the magnitude we believe that NAB used a methodology inconsistent with previous Commission orders, resulting in an unrealistically high I/N ratio. Its result appears to be consistent with the use of free-space propagation modeling, whereas the Commission previously rejected free-space propagation modeling at distances greater than 30 meters,¹¹³ stating that free space propagation has limited applicability beyond that distance because it ignores environmental clutter and over long distances can result in extremely conservative calculations that under predict the amount of actual path loss.¹¹⁴ The Commission found that the WINNER II model is more appropriate for distances between 30 meters and 1 kilometer because it accounts for obstructions from urban and suburban clutter, which the free space model does not.¹¹⁵ Also, NAB's stated value of -104 dBm/10 MHz for ENG receiver sensitivity appears to be too low.¹¹⁶ We calculate that this level would be the thermal noise floor of a receiver with a 10 megahertz bandwidth, meaning it does not include the receiver noise figure.¹¹⁷ The Alion Study specifies that a receiver noise figure of 4 dB along with a line loss of 1 dB should be included in calculating potential interference to ENG receivers.¹¹⁸ Additionally, NAB failed to include other mitigating factors that the Commission previously found were appropriate, specifically, 3 dB for TPC, 4 dB for body loss, 3 dB for antenna polarization mismatch, and 5 dB for antenna pattern mismatch.¹¹⁹ Taking all these factors into account, we calculate that the received signal strength in NAB's example would be -129 dBm, compared to a receiver noise floor of -100 dBm (including noise figure), significantly less than the -6 dB I/N metric.¹²⁰

¹¹⁰ *Id.* 2 (“[T]he fact that the vast majority of VLP devices will not operate in locations where they could cause harmful interference is a key finding of the study”).

¹¹¹ NAB Comments at 9.

¹¹² *6 GHz First Order*, 35 FCC Rcd at 3878, para. 71.

¹¹³ 47 CFR § 15.407(l)(1)(i).

¹¹⁴ *6 GHz First Order*, 35 FCC Rcd at 3875, para. 64.

¹¹⁵ 47 CFR § 15.407(l)(1)(ii); *6 GHz First Order*, 35 FCC Rcd at 3875, para. 65.

¹¹⁶ *See* NAB Comments at 9.

¹¹⁷ The thermal noise floor of a receiver (in watts) is calculated by the equation $P = kTB$, where P is the noise power, k is Boltzmann's constant, T is the temperature in kelvin, and B is the bandwidth in hertz. For a bandwidth of 10 megahertz and temperature of 293 kelvin (20 degrees Celsius), the noise floor is -103.9 dBm.

¹¹⁸ Alion Study, NAB Dec. 5, 2019 *Ex Parte* at 3.

¹¹⁹ *6 GHz First Order*, 35 FCC Rcd at 3880, para. 75; *6 GHz Second Order*, 38 FCC Rcd at 10545-46, 10550-10551, 10562-63, paras. 40, 47, 71.

¹²⁰ Assuming a VLP device operates with a PSD of -5 dBm/MHz EIRP, its power within a 10 MHz bandwidth would be 10 dB (10 times) greater, or 5 dBm. Using the WINNER II model the Commission previously specified must be used at distances from more than 30 meters up to and including 1 kilometer, the path loss (combined LOS/NLOS) at 500 meters would be 143 dB, which is approximately 40 dB greater than free space path loss. Assuming a 25 dB antenna gain as NAB indicated and a feeder loss of 1 dB, the power at the receiver would be 5 dBm – 143 dB + 25 dB – 1 dB = -114 dBm. The receiver noise floor would be the -104 thermal noise floor plus a 4 dB noise figure, or -100 dBm, so the I/N ratio would be -14 dB. Including additional mitigating factors that NAB did not include, specifically, 3 dB for TPC, 4 dB for body loss, 3 dB for antenna polarization mismatch, and 5 dB for

(continued....)

27. In sum, Apple, Broadcom, and Meta’s latest study performed in the same manner and using the same assumptions as previous studies (with the exception of those specific to ENG receivers) that the Commission found acceptable for permitting VLP devices in the U-NII-5 and U-NII-7 bands shows that the likelihood of VLP devices in the U-NII-6 and U-NII-8 bands exceeding -6 dB I/N at an ENG central receive site is extremely low.¹²¹ In addition, our calculations show that even in what NAB indicates would be a worst-case scenario, a VLP device would likely not exceed -6 dB I/N. Thus, we conclude that the risk of harmful interference from VLP devices to ENG central receive sites in the U-NII-6 and U-NII-8 bands is insignificant. Because this interference risk is so low in the absence of any of the additional factors or mitigation measures suggested by Apple, Broadcom, et al. that could further reduce the likelihood of harmful interference (i.e., that links have a significantly higher signal-to-noise ratio than needed to successfully operate, the locations of ENG trucks can be moved to get a better line of sight to a fixed receive site, and ENG power levels can be increased), we do not address NAB’s arguments on the validity of the Apple, Broadcom, et al.’s statements.¹²²

28. NAB’s points regarding interference matters in other bands and outside the record of this proceeding do not add support to its claims of potential interference described here, and we have adequately addressed those for purposes of this rulemaking. Specifically, NAB claims that it has repeatedly demonstrated that broadcasters have lost access to licensed spectrum in the 2.4 GHz band “due to ruinous interference from unlicensed devices” that “has continued unabated for nearly 25 years.”¹²³ The Commission has previously concluded that the record in this proceeding “contains no substantial evidence of harmful interference to broadcast operations in the 2.4 GHz band” and noted the absence of interference complaints regarding the 2.4 GHz band.¹²⁴ No commenter to this proceeding offers new information regarding such interference claims, and we decline to revisit them on our own motion. NAB also contends that even when interference occurs among licensed users, such as alleged interference to private land mobile systems in spectrum bands shared with broadcast television stations, the Commission has not consistently investigated or resolved these conflicts.¹²⁵ NAB claims that rather than take action to resolve these longstanding interference problems, the Commission has demurred. According to NAB, this past FCC inaction raises concerns that if the risk of interference is not addressed now it will go unaddressed in the future.¹²⁶ The Commission takes seriously its responsibility to prevent harmful interference from occurring. We have concluded that permitting VLP devices to operate in the U-NII-6 and U-NII-8 bands will present an insignificant harmful interference risk to licensed mobile operations. Therefore, we have adequately addressed NAB’s interference concerns and NAB’s allegations concerning the Commission’s inaction regarding interference in other bands do not provide grounds to alter our course. Nonetheless, the Commission also remains committed to resolving harmful incidents in the unlikely possibility that they occur.

(Continued from previous page) _____

antenna discrimination results in an additional 15 dB reduction in the calculated receive level to -129 dBm, or a -29 dB I/N ratio.

¹²¹ Apple, Broadcom, et al.’s June 2024 study uses the parameters from NAB’s Alion Study for fixed ENG receivers, specifically, it used Vislink ProScan III antenna patterns (azimuth and elevation), a 4 dB receiver noise figure, and a 1 dB feeder loss. June 2024 Apple, Broadcom, and Meta Report at 6-7.

¹²² Apple, Broadcom, and Meta Sept. 11, 2023 *Ex Parte* at 5-6; NAB Comments at 9-10.

¹²³ NAB Oct. 30, 2024 *Ex Parte* at 12.

¹²⁴ 6 GHz Second Order, 38 FCC Rcd at 10615, 10616-17, paras. 208, 211-12.

¹²⁵ NAB Oct. 30, 2024 *Ex Parte* at 12-13.

¹²⁶ *Id.* at 13.

2. ENG Truck Receivers

29. Electronic newsgathering (ENG) trucks are generally situated near a news or sporting event and receive signals from hand-held cameras or other portable news gathering equipment.¹²⁷ According to the Alion Study previously submitted by NAB, the ENG truck receive antenna may be omni-directional or sectoral with adjustable height from 5 to 50 feet and the signals may use various bandwidths between 3 and 20 megahertz.¹²⁸ The *6 GHz Second FNPRM* proposed to permit VLP devices to operate in the U-NII-6 and U-NII-8 bands and sought comment on whether the devices can operate at up to -5 dBm/MHz EIRP PSD and 14 dBm EIRP while minimizing the risk of harmful interference to ENG truck receivers.¹²⁹ The *6 GHz Second FNPRM* asked what is the appropriate metric for evaluating the harmful interference risk to an ENG truck receiver; if signal-to-interference-plus-noise ratio (SINR) is used as a metric what value or range of values should be used; and is there a connection between reliance on an I/N metric for evaluating ENG trucks connecting to a central receive site and evaluating the risk to a truck receiver based on SINR?¹³⁰ The *6 GHz Second FNPRM* also requested information on the typical bandwidth and coding rates used by ENG truck receivers and how close a random VLP device can come to a ENG truck receiver under normal operating conditions.¹³¹

30. According to Apple, Broadcom et al., a SINR of 1 dB is necessary for the link between a camera and a portable ENG truck receiver to operate without harmful interference.¹³² As described in their comments,¹³³ the parties base this claim on empirical SINR measurements that Broadcom previously submitted showing the level necessary to maintain an error-free video signal for different signal bandwidths, coding rates, and unlicensed device activity factors.¹³⁴ These measurements show that there would be no audio or video defects with an SINR of at least 1 dB for an unlicensed device activity factor of 2% and a video signal of 10 megahertz bandwidth.¹³⁵ Apple, Broadcom et al. note that the *6 GHz First Order* relied on these Broadcom measurements in authorizing low-power indoor operations in the U-NII-6 and U-NII-8 bands.¹³⁶ Apple, Broadcom et al. claim that while the Commission, in the *6 GHz First Order*, discussed studies that apply a 10 dB SINR threshold for interference, it did not adopt this 10 dB SINR as an interference threshold.¹³⁷ Instead, they note that the Commission observed that the Broadcom measurements found ““that for a 10% activity factor the [ENG] link required a signal-to-interference-plus-noise of between 2 and 9 dB.””¹³⁸ Apple, Broadcom et al. point out that the Commission has more recently determined that a more realistic 2% activity factor should be assumed for VLP devices.¹³⁹ Therefore, they claim that Broadcom’s measurements demonstrate that with a VLP duty

¹²⁷ *6 GHz Second FNPRM*, 38 FCC Rcd at 10602, para. 177.

¹²⁸ Alion Study, NAB Dec. 5, 2019 *Ex Parte* at 5.

¹²⁹ *6 GHz Second FNPRM*, 38 FCC Rcd at 10603, para. 179.

¹³⁰ *Id.*

¹³¹ *Id.*

¹³² Apple, Broadcom et al. Comments at 20-21.

¹³³ *Id.*

¹³⁴ Broadcom Feb. 28, 2020 *Ex Parte* at 2.

¹³⁵ See Apple, Broadcom et al. Comments at 21. The bit error rate would be less than 1×10^{-8} , which, according to Broadcom, would result in no audio or video defects. Broadcom Feb. 28, 2020 *Ex Parte* at 1-2.

¹³⁶ Apple, Broadcom et al. Comments at 21 (citing *6 GHz First Order*, 35 FCC Rcd at 3914, para. 164).

¹³⁷ Apple, Broadcom et al. Comments at 21.

¹³⁸ *Id.* (quoting *6 GHz First Order*, 35 FCC Rcd at 3914, para. 164).

¹³⁹ *Id.* (citing *6 GHz Second Order*, 38 FCC Rcd at 10541-42, para. 35).

cycle of 2%, the portable equipment to ENG truck receiver link only requires an SINR of 1 dB.¹⁴⁰ Apple, Broadcom et al. also suggest that assuming broadcasters would use a 10 megahertz bandwidth signal rather than an 8 megahertz bandwidth signal is more realistic as this would be more robust and support higher throughput.¹⁴¹ But, even with an 8 megahertz bandwidth, they state that the ENG Truck Receiver Studies show harmful interference is extremely unlikely because only a 7 dB SINR would be needed for a 2% activity factor and a SINR below 10 dB is only possible in a small area very close to the truck receiver and only when the truck receiver is not elevated.¹⁴²

31. Apple, Broadcom et al. claim that the record demonstrates that VLP devices will not pose a significant interference risk to the link between mobile transmitters and ENG truck receivers.¹⁴³ To support this claim, they refer to a set of related technical studies submitted by Broadcom and Apple, Broadcom et al. (collectively, “ENG Truck Receiver Studies”).¹⁴⁴ The ENG Truck Receiver Studies use a link budget methodology to calculate the SINR for an ENG camera transmitting at a fixed location 94 meters from an ENG truck receiver receiving interference from a single VLP device. The ENG Truck Receiver Studies present plots of the variation of SINR with VLP device location within a 94-meter radius of the ENG truck receiver for truck antenna heights of 1.5, 2.5, 5, 10, and 15 meters.¹⁴⁵ The ENG Truck Receiver Studies assume that a portable ENG camera transmits with either 20 dBm or 23 dBm of power from a fixed location 94 meters away from the ENG truck receiver and that the ENG truck receiver uses a 10 megahertz bandwidth, has a 4 dB noise figure, and uses the ITU-R F.1336-4 antenna pattern used in the Alion Study.¹⁴⁶ The ENG Truck Receiver Studies use a free space propagation model, assume that the VLP device transmits at -5 dBm/MHz, 4 dB of body loss, a power reduction of 3 dB from transmit power control, an attenuation of 5 dB from the mismatch between the VLP device’s antenna pattern and the ENG receiver, and a 3 dB loss from polarization mismatch between the VLP device antenna and truck receiver.¹⁴⁷ Apple, Broadcom et al. claim that the ENG Truck Receiver Studies show that a SINR below 1 dB only occurs when the VLP device is operating within a few meters of the ENG truck receiver and the ENG truck receiver antenna is located at the same height as the VLP device.¹⁴⁸ Apple, Broadcom et al. view such a scenario as unlikely because the receive antenna would likely be

¹⁴⁰ *Id.* at 22.

¹⁴¹ *Id.*

¹⁴² *Id.* at 22-23.

¹⁴³ *Id.* at 15; Apple, Broadcom et al. Sept. 5, 2024 *Ex Parte* at 1-2.

¹⁴⁴ Apple, Broadcom et al. Comments at 15 (referring to Broadcom, Sept. 11, 2023 *Ex Parte* and Broadcom, Sept. 27, 2023 *Ex Parte*). The Apple, Broadcom et al. Comments repeat the results from the two studies previously filed by Broadcom for ENG truck receiver antenna heights of 1.5, 5, 10, and 15 meters and provide results for an antenna height of 2.5 meters. Apple, Broadcom et al. Comments at 15-19. The results for a 1.5 meter height, which is referred to as “0 m Elevation v. VLP Transmitter” in the Apple, Broadcom et al. Comments, were first presented in a September 11, 2023 filing by Broadcom, Broadcom, Sept. 11, 2023 *Ex Parte* at 3, and the results for 5, 10, and 15 meter receiver heights were first presented in a September 27, 2023 filing by Broadcom, Broadcom, Sept. 27, 2023 *Ex Parte* at 2-3. More recently, Apple, Broadcom, et al. presented higher resolution plots of the SINR from these previous studies for ENG truck antenna heights of 2.5 and 5 meters as well as presented results for these two antenna heights at ENG camera transmitter power levels of 20 dBm and 23 dBm. Apple, Broadcom, et al. Sept. 5, 2024 *Ex Parte*, Presentation at 15-22. In our discussion, we will use data from the September 5, 2024 filing for the 2.5 and 5 meter height ENG truck receive antennas. Hereinafter, all these filings will be referred to collectively as the “ENG Truck Receiver Studies.”

¹⁴⁵ Apple, Broadcom et al. Comments at 17-19.

¹⁴⁶ *Id.* at 11, 16; Apple, Broadcom, et al. Sept. 5, 2024 *Ex Parte*, Presentation at 4, 6-13; Alion Study, NAB Dec. 5, 2019 *Ex Parte* at 6.

¹⁴⁷ Apple, Broadcom et al. Comments at 16.

¹⁴⁸ *Id.* at 15-19.

located on top of the truck or on a telescoping mast, and the VLP device would operate so close to the truck receiver that it could easily be observed and controlled.¹⁴⁹ They claim that “in every realistic scenario” the SINR will be above 8 dB.¹⁵⁰ They also point out that for antenna heights above 2.5 meters, the SINR is greater than 10 dB at all locations.¹⁵¹ According to Apple, Broadcom et al., the results of the ENG Truck Receiver Studies are conservative because 94 meters is an unusually long distance for ENG transmissions, the ENG receiver would be elevated on a mast especially where the ENG transmitter is located so far from the receiver, and ENG transmitters commonly use an antenna with 3 dB of gain to transmit at 23 dBm instead of 20 dBm.¹⁵² Apple, Broadcom et al. contend that if the ENG receiver is elevated to 5 meters, the SINR would be at least 15 dB for all locations at least one meter from the truck.¹⁵³

32. Apple, Broadcom et al. also suggest that the Commission adopt a requirement that VLP devices operating in the U-NII-6 and U-NII-8 bands be required to employ a contention-based protocol as is required for the U-NII-5 and U-NII-7 bands.¹⁵⁴ They point out that the Commission previously acknowledged that the contention-based protocol will protect incumbents by “avoid[ing] co-frequency interference with other services sharing the band.”¹⁵⁵ According to Information Technology Industry Council, a VLP device that is near an ENG truck receiver will also be close enough to an ENG camera transmitter for the contention-based protocol to detect the signal and select an alternative channel.¹⁵⁶

33. NAB criticizes Broadcom for assuming both the VLP devices and ENG truck receiver are located at fixed locations with the ENG transmitter always 94 meters away from the truck receiver.¹⁵⁷ According to NAB the purpose of using a radio link for ENG is to allow the camera transmitter to move in real time and a Monte Carlo simulation should consider a variety of possible scenarios.¹⁵⁸ NAB also faults the ENG Truck Receiver Studies for assuming static line-of-sight conditions, claiming that the probability that the signals from both the ENG camera and the VLP device will be simultaneously faded is situation-dependent and that fades can be greater than 10 dB.¹⁵⁹ NAB characterizes the 5 dB VLP/ENG antenna mismatch and 3 dB body loss used by Broadcom as “unexplained and unjustified” and claims that Apple, Broadcom et al.’s measurements allow for less body loss 20 percent of the time.¹⁶⁰ NAB claims that it was improper for Broadcom to include body loss, antenna mismatch, and polarization loss

¹⁴⁹ *Id.* at 19.

¹⁵⁰ Apple, Broadcom, et al. Sept. 5, 2024 *Ex Parte* at 2. This is apparently referring to an ENG truck receiver antenna height of 2.5 meters. Apple, Broadcom, et al. Sept. 5, 2024 *Ex Parte* at 1-2; Apple, Broadcom, et al. Sept. 5, 2024 *Ex Parte*, Presentation at 7.

¹⁵¹ Apple, Broadcom et al. Comments at 19.

¹⁵² Apple, Broadcom, et al. Sept. 5, 2024 *Ex Parte* at 2.

¹⁵³ *Id.*

¹⁵⁴ Apple, Broadcom et al. Comments at 20.

¹⁵⁵ *Id.* (quoting *6 GHz First Order*, 35 FCC Rcd at 3889, para. 102).

¹⁵⁶ Information Technology Industry Council Comments at 2.

¹⁵⁷ NAB Comments at 7. NAB’s Comments also criticize the ENG Truck Receiver Studies for only using a single ENG antenna height, but this apparently is the result of NAB examining only one of Broadcom’s two filings — i.e., the September 11, 2023 filing that presented results for ENG truck antenna and VLP devices with identical heights. NAB Comments at n.10, 5.

¹⁵⁸ NAB Comments at 7.

¹⁵⁹ *Id.*; NAB Oct. 28, 2024 *Ex Parte* at 9.

¹⁶⁰ NAB Comments at 7; NAB Oct. 28, 2024 *Ex Parte* at 10.

for the link between the VLP device and ENG truck receiver but not include these losses for the link between the ENG camera and ENG truck receiver.¹⁶¹

34. NAB also criticizes Broadcom's use of SINR instead of a -6 dB I/N as has been used by the Commission.¹⁶² NAB explains that SINR may be appropriate for static conditions where the signal paths are well characterized and the systems well engineered, but both ENG and VLP operations are variable in time and location, which indicates the appropriate protection criteria is one that preserves the incumbent's noise floor.¹⁶³ Regarding use of a 1 dB SINR threshold as an interference threshold, NAB states that Apple, Broadcom et al. neither provide the assumed ENG link parameters (modulation type, error correction code, bandwidth, etc.), nor describe the bandwidth of the Wi-Fi interference.¹⁶⁴ NAB believes that the 1 dB SINR threshold employed by Apple, Broadcom et al. is not realistic based on bench measurements and decades of ENG field experience by broadcasters.¹⁶⁵ NAB points to bench and field tests conducted by the Department of Defense and its contractors for the 2 GHz band that demonstrate a SINR threshold of 11.3 dB is needed to avoid harmful interference from a co-channel interferer with a 3.2 megahertz bandwidth.¹⁶⁶ NAB suggest that because 6 GHz and 2 GHz ENG systems use identical modulation, coding, and bandwidth, this result is applicable to the 6 GHz band and that wider bandwidth Wi-Fi signals would have more interference potential.¹⁶⁷ NAB also claims that these measurements indicate the duty cycle of the interfering signal has little effect because once a link is broken it requires a significant interference-free interval to reestablish.¹⁶⁸

35. According to NAB, for Apple, Broadcom et al.'s claim that VLP devices will not pose a significant harmful interference risk to be viable, "the following confluence of circumstances must hold as well: an atypically low height of the ENG receiving antenna; 4 dB of continuous body loss; antenna pattern and polarization mismatches of 5 dB and 3 dB; operation with continuous transmit power reduction; and static free-space conditions for both the ENG transmitter and VLP devices."¹⁶⁹ NAB contends that for all of these conditions to be simultaneously true, a series of providential conditions would have to occur.¹⁷⁰ NAB also points out that Broadcom's claims that VLP devices causing interference are likely to leave the area quickly ignore the fact that newsworthy events frequently transpire in proximity to crowds, meaning that ENG receivers can easily receive harmful interference from nearby VLP devices.¹⁷¹ Because VLP devices are not required to operate through an access point, there would not be any way to shut down operations if interference were to occur during breaking news

¹⁶¹ NAB Oct. 30, 2024 *Ex Parte* at 10.

¹⁶² *Id.*

¹⁶³ *Id.* at 7-8.

¹⁶⁴ NAB Reply at 7.

¹⁶⁵ *Id.*

¹⁶⁶ *Id.* at 8 (citing Army Spectrum Management Office CIO/G-6. "Electromagnetic Compatibility Evaluation of TRR Equipment to ENG Equipment (Aug. 30, 2016)).

¹⁶⁷ *Id.* at 8.

¹⁶⁸ *Id.*

¹⁶⁹ *Id.* at 5-6.

¹⁷⁰ *Id.* at 6. NAB contends that "for all of these assumptions to be simultaneously true, a series of providential conditions would have to occur: radiation from the VLP device would have to be continuously blocked by the body of the user; the VLP device antenna would have to be tilted at an idiosyncratic angle to minimize coupling between the VLP and ENG antennas; the device would always have to operate at reduced transmit power; and the device would have to be held motionless while in use." *Id.*

¹⁷¹ NAB Comments at 4 (referring to the Broadcom Sept. 11, 2023 *Ex Parte*).

event.¹⁷² NAB also explains that assertions that news gathering operations are opportunistic with respect to channel selection are incorrect and irrelevant because television stations in most markets have defined channel plans and VLP device operation is also opportunistic.¹⁷³ The Society of Broadcast Engineers (SBE) states that the studies proffered by VLP supporters are flawed as demonstrated by NAB, in that they do not account for the full range of mobile BAS operations and rest on mere assumptions.¹⁷⁴ SBE also points to comments of the Electric Power Research Institute (EPRI) which claim that real-world testing has shown results differing from those predicted by Monte Carlo simulations provided by VLP proponents and call for the models and inputs of the studies to be made public.¹⁷⁵

36. NAB claims that an ENG truck receiver with an antenna height of 15 meters would receive a signal from a VLP device located 100 meters distant that exceeds the -6 dB I/N criterion established by the Commission by more than 34 dB.¹⁷⁶ For this ENG truck receiver and VLP device, NAB calculates that the desired-to-undesired (D/U) ratio would be 12 dB under static conditions for a signal from a camera transmitter located 4 meters from the truck receiver.¹⁷⁷ According to NAB, this would leave the ENG receiver only 0.7 dB from failure under static conditions based on measurements showing a D/U ratio of 11.3 dB is required to achieve zero uncorrected errors.¹⁷⁸ NAB claims that this 0.7 dB margin for a typical link configuration is unacceptably low because some configurations will fall short of the median value and the link will not close.¹⁷⁹ NAB notes that in addition both transmitters are likely to be in motion, resulting in statistical fading due to multipath effects, which increase the likelihood of harmful interference.¹⁸⁰

37. Apple, Broadcom et al. respond to NAB that there is no record support for NAB's claim that an 11.3 dB D/U ratio is required for error-free ENG operation, noting that NAB's citation is to an NAB conference related to the 2 GHz band.¹⁸¹ Apple, Broadcom et al. fault NAB for failing to address the Broadcom measurement data that directly contradicts this claim and that the Commission relied on in the *6 GHz First Order*.¹⁸² Apple, Broadcom et al. claim that the ENG Truck Receiver Studies employ a more conservative methodology than a Monte Carlo approach because they used an ENG transmitter 94 meters from the receiver while a Monte Carlo approach would have included a large number of shorter distances.¹⁸³ Apple, Broadcom et al. note that NAB raised the same objection regarding fading about a 2020 ENG study by Broadcom that it raises about the ENG Truck Receiver Studies and that the Commission rejected this contention in the *6 GHz First Order*.¹⁸⁴ Apple, Broadcom et al. also note that the assumption of 5 dB from the mismatch between the VLP device's antenna pattern and the ENG

¹⁷² *Id.* at 5.

¹⁷³ *Id.* at 8.

¹⁷⁴ Society of Broadcast Engineers Reply 5 (citing NAB Comments at Section II).

¹⁷⁵ *Id.* at 5 (citing Electric Power Research Institute Comments at 3).

¹⁷⁶ NAB Comments at 5-6.

¹⁷⁷ *Id.* at 6.

¹⁷⁸ *Id.* (citing Russell, R. and Weller, R., "ENG and DoD: Update on 2 GHz Sharing," Proc. NAB BEIT Conference (2023)).

¹⁷⁹ NAB Reply at 6-7.

¹⁸⁰ NAB Comments at 6; NAB Reply at 7; NAB Oct. 28, 2024 *Ex Parte* at 8 ("Multipath fading occurs even over very short distances and cannot be ignored!").

¹⁸¹ Apple, Broadcom et al. Reply at 9.

¹⁸² *Id.* at 9-10.

¹⁸³ *Id.* at 10.

¹⁸⁴ *Id.* at 10-11 (citing *6 GHz First Order*, 35 FCC Rcd at 3914, para. 164).

receiver and 4 dB for body loss that NAB criticizes are consistent with assumptions upon which the Commission has previously relied.¹⁸⁵

38. *Discussion.* We conclude that VLP devices can operate without creating a significant risk of harmful interference to communication links between portable ENG transmitters and ENG truck receivers. We base this conclusion on many factors, including the large power differential between portable ENG transmitters and VLP devices, the requirement that VLP devices employ a contention-based protocol, and the low probability that a VLP device will overlap the ENG signal in frequency because of the large amount of spectrum available for VLP operations. The results of the ENG Truck Receiver Studies provide additional support for our conclusion.

39. The consequences of the large power differential between ENG portable transmitters and VLP devices is illustrated by examining in detail the example provided by NAB of an ENG truck receiver with a 15 foot high antenna receiving signals from a VLP device located 100 meters away and an ENG portable camera transmitter located 4 meters away.¹⁸⁶ This situation represents one of the worst potential interference cases because the VLP device is in the main beam of the ENG truck receiver antenna while the ENG portable camera transmitter is far below the antenna's main beam. According to the antenna pattern for an ENG truck receiver used in a Alion Study previously submitted by NAB, the antenna gain toward the VLP device would be 10.1 dB while the gain would be only -8.9 dB toward the ENG portable camera signal, assuming both transmitters are at a 1.5 meter height.¹⁸⁷ This 19 dB difference in antenna gain is greater than the difference in propagation loss of 17.1 dB between the two locations using a free space path loss model, which illustrates that moving the VLP device closer to the truck receiver would not result in the VLP device's interference potential being appreciably worse.¹⁸⁸

40. In providing this example, NAB has considered only the antenna gain and propagation loss in calculating the received power from these two transmitters.¹⁸⁹ In the *6 GHz First Order*, when the Commission examined a set of link budget examples provided by AT&T, it treated statistical quantities such as polarization loss and antenna discrimination using median or average values.¹⁹⁰ As was done in the *6 GHz First Order*, we believe that for a static link budget analysis it is appropriate to treat such statistical quantities using median values when calculating signal levels for NAB's example case.¹⁹¹ Using mean values for these parameters, we evaluate the received signal power from the VLP device—operating at -5 dBm/MHz EIRP PSD and 14 dBm EIRP—at the ENG truck receiver to be -88.8 dBm.¹⁹² For the ENG camera transmitter, NAB used 20 dBm as the transmit power.¹⁹³ As Apple, Broadcom et al. point out, ENG camera transmitters commonly use antennas with 3 dB of gain which would increase the transmit EIRP to 23 dBm.¹⁹⁴ This results in -57.6 dBm received signal power at the ENG truck

¹⁸⁵ *Id.* at 11-12 (citing *6 GHz First Order*, 35 FCC Rcd at 3898, para. 125; *6 GHz Second Order*, 38 FCC Rcd at 10544-45, para. 39).

¹⁸⁶ NAB Comments at 5-6.

¹⁸⁷ Alion Study, NAB Dec. 5, 2019 *Ex Parte* at 8.

¹⁸⁸ The free space path loss from the VLP device to the ENG truck receiver would be 88.8 dB while the path loss from the ENG camera transmitter would be 71.7 dB.

¹⁸⁹ NAB Comments at 5-6, n.16, n.18.

¹⁹⁰ *6 GHz First Order*, 35 FCC Rcd at 3898-3901, paras. 127-29.

¹⁹¹ *Id.* at 3900-01, para. 129, tbl. 5; *6 GHz Second Order*, 38 FCC Rcd at 10544-45, 10549-51, paras. 39, 46-47.

¹⁹² Received Power = (VLP Tx power in 10 megahertz) – (Path Loss) – (ENG Antenna Gain) – (Body Loss) – (Polarization Mismatch) – (VLP device antenna pattern) – (Transmit Power Control) = 5 dBm – 88.8 dB + 10.1 dB – 4 dB – 3 dB – 5 dB – 3 dB = -88.8 dBm.

¹⁹³ NAB Comments at n.18.

¹⁹⁴ Apple, Broadcom et. al. Sept. 5, 2024 *Ex Parte* at 2.

receiver.¹⁹⁵ The resulting D/U ratio is 31.2 dB, which greatly exceeds the 11.3 dB D/U ratio that NAB states is necessary to avoid harmful interference.¹⁹⁶ Even if the ENG portable camera transmits with only 20 dBm of power, the resulting 28.2 dB D/U ratio would greatly exceed the 11.3 dB D/U ratio.¹⁹⁷ Regarding NAB's concern that fading is likely to occur from the motion of the devices thereby increasing the interference likelihood, given that both the ENG transmitter and VLP device are likely to be stationary or possibly moving slowly and that the distances between transmitters and the receiver are less than 100 meters, we expect that any fading that occurs would be mild and less than 10 dB in magnitude.¹⁹⁸ These large D/U ratios indicate that even with that level of fading the D/U ratio would remain above 11.3 dB. This illustrates that VLP devices operating at the power level that we are permitting under our rules are unlikely to cause harmful interference to this type of ENG operation. In addition, for this particular example, the signal from the VLP device is likely to experience more clutter loss than the signal from the ENG transmitter due to the greater distance, which suggests that the D/U ratio would be even greater.

41. The fact that we are requiring the VLP devices to employ a contention-based protocol also lessens the risk that harmful interference will occur to ENG operations.¹⁹⁹ For the scenarios discussed in both NAB's examples and the ENG Truck Receiver Studies, the portable ENG transmitter is likely to be within a relatively close distance to the truck receivers—i.e., 100 meters or less. VLP devices that present a harmful interference risk are also likely to be within such a distance of the ENG truck receiver. Consequently, the VLP devices and portable ENG transmitters will operate in close proximity to each other. In such situations, the VLP device should be able to detect when a portable ENG transmitter is operating nearby on the same channel. Because the portable ENG transmitter operates continuously when sending a video signal, we would expect that the contention-based protocol used by the VLP device will cause it to vacate the channel used by the portable ENG transmitter and thereby further lessen the potential for harmful interference to occur.

42. Because there is 1200 megahertz of 6 GHz band spectrum available for VLP device operation under the rules adopted in this Order, it is unlikely that a VLP device will transmit co-channel with a portable ENG camera transmitter. This provides additional protection against harmful interference occurring. For a VLP device using a 20 megahertz bandwidth, there is a 1.7% chance of channel overlap with an ENG transmitter operating in a 10 megahertz bandwidth.²⁰⁰ For VLP devices using a 160 megahertz bandwidth, the likelihood of channel overlap would be 11.8%.²⁰¹

¹⁹⁵ Received Power = (VLP Tx power in 10 megahertz) – (Path Loss) – (ENG Antenna Gain) = 23 dBm – 71.7 dB – 8.9 dB = -57.6 dBm.

¹⁹⁶ NAB Comments at 6; NAB Nov. 14, 2024 *Ex Parte*.

¹⁹⁷ Amplifiers are available to increase the power level for these cameras to 30 dBm, which would provide an even higher D/U ratio. DBS Barrel Booster Amplifier Specification, DOMO Broadcast Systems, <https://www.dombroadcast.com/wp-content/uploads/2022/12/DBS-Barrel-Booster-V2.pdf> (providing 30 dBm output power for a 20 dBm input power); HEVC 4K UHD Camera Transmitter HCAM Datasheet, Vislink Technologies, https://www.vislink.com/wp-content/uploads/2022/11/Vislink-HCAM-Datasheet-11_01_22.pdf (provides up to 100 mW (20 dBm) of transmit power without the barrel booster option).

¹⁹⁸ NAB Comment at 6. No information submitted on the record addresses the extent of fading that may occur other than NAB's unsupported contention that such fading may be greater than 10 dB. *Id.* at 7.

¹⁹⁹ 47 CFR § 15.407(d)(6); *6 GHz First Order* at 3889, para. 101; *6 GHz Second Order*, 38 FCC Rcd at 10561, para. 67.

²⁰⁰ Because 17.5 of the 59 20-megahertz channels in the Wi-Fi 6 GHz band channel plan overlap the U-NII-6 and U-NII-8 bands, there is a 29.6% likelihood of a VLP device operating in these bands. If a VLP device operates in these bands, there would be a 5.7% chance the 10 megahertz bandwidth signal would overlap the VLP signal (20/350). This results in a 1.7% of overlap (5.7% \times 29.6%) = 1.7%.

43. We are basing our conclusion that there is an insignificant risk of harmful interference occurring to ENG truck receivers from VLP operations on the factors discussed above: the power differential between VLP devices and portable ENG transmitters, the use of a contention-based protocol by VLP devices, and the large amount of spectrum available for VLP operations in the 6 GHz band. In addition to these factors, we also recognize that the ENG Truck Receiver Studies provide additional evidence to support this conclusion. Despite NAB and SBE's contentions, we believe that the assumptions used in the ENG Truck Receiver Studies are appropriate. The 4 dB for body loss, 3 dB power reduction from transmit power control, 5 dB attenuation from the mismatch between the VLP device's antenna pattern and the ENG truck receiver, and 3 dB loss from polarization mismatch between the VLP device antenna and the ENG truck receiver are consistent with the assumptions that the Commission concluded were appropriate in the *6 GHz First Order* and/or the *6 GHz Second Order*.²⁰² We also believe that Broadcom was correct not to include these losses for the ENG camera to ENG truck receiver link. As shown in the pictures submitted by NAB, the portable ENG cameras use an external antenna that is not body worn and is located on the back of the camera that is at least half a foot from the operator's body. Because this antenna is located several wavelengths away from body, body loss is expected to be insignificant.²⁰³ As the vertical orientation of the antenna does not change as the camera operator moves, there is unlikely to be polarization loss. Antenna pattern mismatch is not a significant factor for large external antennas that have omni-directional patterns such as the camera antennas. The ENG Truck Receiver Studies assume a receiver bandwidth, noise figure, and antenna pattern that were taken from the Alion Study previously submitted by NAB, which included an interference analysis for an ENG portable camera transmitting to an ENG truck receiver.²⁰⁴ In addition, contrary to NAB's contention, Broadcom does indicate the ENG camera's modulation, coding rates, and signal bandwidths used in its SINR measurement study.²⁰⁵ While Broadcom does not specify the unlicensed device signal bandwidth when conducting these measurements, we presume that the unlicensed device's signal fully overlaps the 8- or 10-megahertz ENG signals examined based on the 20-megahertz minimum Wi-Fi bandwidth.

44. In examining the ENG Truck Receiver Studies, we appreciate that a 94-meter distance

(Continued from previous page) _____

²⁰¹ In the Wi-Fi 6 GHz band channel plan, one of the seven available 160-megahertz channels overlaps U-NII-6, one partially overlaps U-NII-8 by 30 megahertz, and one is totally contained in U-NII-8. This results in a probability of overlap between the VLP and 10-megahertz wide ENG signal of: $(1/7)[(100/350)+(160/350)+(30/350)] = 0.118$.

²⁰² *6 GHz First Order*, 35 FCC Rcd at 3900-01, para. 129, tbl. 5; *6 GHz Second Order*, 38 FCC Rcd at 10544-45, 10549-51, paras. 39, 46-47. The *6 GHz First Order* did not consider body loss and transmit power control as these would be inappropriate for devices that cannot be battery powered, but the *6 GHz Second Order* did find these factors appropriate for a VLP device analysis. 47 CFR § 15.403 (Indoor Access Point definition); *6 GHz Second Order*, 38 FCC Rcd at 10544-46, 10549-51, paras. 39-40, 46-47. For antenna pattern mismatch (i.e. antenna discrimination), in the *6 GHz First Order* the Commission found 5 dB was appropriate for a link budget analysis, but explicitly using this factor was unnecessary for the Monte Carlo analysis discussed in the *6 GHz Second Order* because one of the simulations used an antenna pattern developed by the European Conference of Postal and Telecommunications Administrators (CEPT) SE45 working group and the other used an antenna pattern for client devices from the ECC 302 report rather than a fixed value. *6 GHz First Order*, 35 FCC Rcd at 3900-01, para. 129; *6 GHz Second Order*, 38 FCC Rcd at 10535-36, 10548-49, paras. 27, 45. Use of an antenna pattern is possible in a Monte Carlo simulation but cannot be done in a link budget analysis such as the ENG Truck Receiver Studies. A 3 dB attenuation for polarization mismatch was used in the link budget analysis the Commission conducted in the *6 GHz First Order* while one of the computer simulations examined in the *6 GHz Second R&O* used a probability distribution for polarization mismatch. *6 GHz First Order*, 35 FCC Rcd at 3900-01, para. 129; *6 GHz Second Order*, 38 FCC Rcd at 10538-39, paras. 29-30; Apple Feb. 13, 2023 *Ex Parte* at 11.

²⁰³ NAB Oct. 21, 2024 *Ex Parte* at 5.

²⁰⁴ Broadcom Sept. 11, 2023 *Ex Parte* at 2; Alion Study, NAB Dec. 5, 2019 *Ex Parte* at 5, 7-8.

²⁰⁵ Broadcom Feb. 28, 2020 *Ex Parte* at 1; NAB Reply at 7.

between the ENG portable camera transmitter and ENG truck receiver is at the outer range of what is likely to occur in practice.²⁰⁶ Given this large distance between the ENG portable camera transmitter and the ENG truck receiver, we would expect that the ENG truck receiver would use an elevated antenna—at least 5 meters in height—in order to increase the available margin by elevating the signal path over any obstacles.²⁰⁷ At such a height, the ENG Truck Receiver Studies indicate that the SINR would be greater than 11 dB for VLP devices located anywhere within 94 meters of the ENG truck receiver when the camera is transmitting at 20 dBm and greater than 14 dB if the camera transmits at 23 dBm.²⁰⁸ When the ENG truck is being used to relay video signals to a central receive site, it would likely use a 15-meter antenna height to rise above any ground clutter and to achieve a line-of-sight link to the ENG central receive site, which would result in a SINR of over 23 dB.²⁰⁹ Even if a 2.5-meter antenna height were used, as would be the case for a receiver on the roof of the truck, the area where a VLP device would result in a SINR that is lower than 10 dB is small and the SINR remains above 8 dB everywhere for an ENG camera transmitting at 20 dBm.²¹⁰

45. We cannot endorse use of an SINR of 1 dB as an indication of whether there is an insignificant risk of harmful interference occurring when examining the results of the ENG Truck Receiver Studies, as suggested by Apple, Broadcom et al. According to the SINR measurements submitted by Broadcom, a 1 dB SINR is needed to ensure error-free video signals when a Wi-Fi device with a 2% activity factor when an 10 megahertz bandwidth video signal is used.²¹¹ While this appears to be a valid result for a static channel, we agree with NAB that fading may affect the signals received from the ENG transmitter and VLP device. No information submitted on the record addresses the extent of fading that may occur other than NAB's unsupported contention that such fading may be greater than 10 dB.²¹² Given that the portable ENG camera transmitter and body worn VLP devices are likely to be stationary or moving slowly and that the distances between transmitters and the receiver are less than 100 meters, we expect that any fading that occurs would be mild and less than 10 dB in magnitude. Even with this level of fading the ENG Truck Receiver Studies support our conclusion that there is an insignificant risk that harmful interference will occur to the ENG truck receivers. The ENG Truck Receiver Studies indicate that for an ENG truck receiver antenna elevation of at least 5 meters, the SINR remains above 11 dB when the ENG transmitter is transmitting at 20 dBm and the SINR is above 14 dB when the ENG transmitter is transmitting at 23 dBm.²¹³ We note that an 11 dB SINR is only slightly lower than the 11.3 dB SINR at which NAB claims bench and field tests demonstrate to be the median threshold for no harmful interference.²¹⁴ The SINR increases to at least 23 dB when the ENG truck receiver antenna is raised to 15 meters as would often occur for relaying a video signal to an ENG central receive site.²¹⁵ While the ENG Truck Receiver Studies indicate the SINR can be as low as 8 dB if the ENG truck receiver height is only 2.5 meters, we note that NAB states that with robust modulation and coding the

²⁰⁶ Apple, Broadcom et al. Sept. 5, 2024 *Ex Parte* at 2 (“is an unusually long distance for ENG transmissions.”).

²⁰⁷ We agree with Apple, Broadcom et al. that use of an antenna on top of the truck would be an unusual situation with the ENG transmitter located so far from the truck receiver. Apple, Broadcom et al. Sept. 5, 2024 *Ex Parte* at 2.

²⁰⁸ Apple, Broadcom et al. Comments at 18; Apple, Broadcom, et al. Sept. 5, 2024 *Ex Parte*, Presentation at 9, 13.

²⁰⁹ Apple, Broadcom et al. Comments at 19; NAB Comments at 5 (referring to 15 meters as “a common height”).

²¹⁰ Apple, Broadcom et al. Comments at 17; Apple, Broadcom, et al. Sept. 5, 2024 *Ex Parte*, Presentation at 7.

²¹¹ Broadcom Feb. 28, 2020 *Ex Parte* at 2.

²¹² NAB Comment at 7.

²¹³ Apple, Broadcom, et al. Sept. 5, 2024 *Ex Parte*, Presentation at 6-7.

²¹⁴ NAB Reply at 8. Because NAB's claims are based on an Army Spectrum Management Office document which is not part of the record, we cannot judge the accuracy of this claim.

²¹⁵ Apple, Broadcom et al. Comments at 19.

required SINR can be reduced to 7.3 dB.²¹⁶ In addition, Apple, Broadcom, et. al. show that the SINR will exceed 8 dB in every scenario examined and that SINRs of less than 11 dB are quite rare, providing an additional basis for our conclusion that the risk of harmful interference to mobile receivers is insignificant.²¹⁷

46. We do not believe that the ENG Truck Receiver Studies' examination of the SINR produced by VLP devices instead of I/N is improper, as NAB suggests. In the *6 GHz First Order*, the Commission agreed with the technical study findings provided by CableLabs and Apple, Broadcom et al. that examined the potential for interference from 6 GHz low-power indoor devices to ENG truck receivers, which used SINR as a measure of interference potential.²¹⁸ It also adopted a -6 dB I/N ratio for use by the automated frequency coordination (AFC) systems that manage spectrum access by 6 GHz standard power access points.²¹⁹ The Commission made the decision to use I/N for this purpose based on implementation simplicity and because it was used by most commenters in their analyses.²²⁰ In making this decision, the Commission clearly stated that it was not "making a determination that any signal received with an I/N greater than -6 dB would constitute harmful interference."²²¹ The Commission did not prohibit (or imply that it was prohibiting) the use of other signal quality measurements besides I/N as an indication as to whether harmful interference may occur. In examining a study that uses SINR, we are not implying that any SINR below a particular level constitutes harmful interference.

47. We agree with NAB that a Monte Carlo simulation that considers a wide variety of situations would have been more informative than the approach employed by the ENG Truck Receiver Studies. We acknowledge the limitations of the ENG Truck Receiver Studies in only considering one location for the ENG camera transmitter rather than examining more scenarios as could have been done in a Monte Carlo simulation. Despite this limitation, we conclude the ENG Truck Receiver Studies provide additional support for concluding that there is an insignificant harmful interference risk to ENG receivers from VLP devices.

48. We disagree with SBE that the evidence to support VLP operations is flawed because the various studies submitted for the record do not account for the full range of mobile operations.²²² As explained above, we are limiting our discussion to three use cases—ENG central receive sites, ENG truck receivers, and low-power short range devices—consistent with the *6 GHz Second FNPRM* and the approach followed for low-power devices in the *6 GHz First Order*.²²³ As neither SBE nor any other commenters have suggested other use cases beyond these three cases, we believe the approach we are following is reasonable. We also disagree with SBE that the technical studies from Apple, Broadcom et al. are flawed because EPRI claims real-world test have shown differing results from previous Monte Carlo simulations.²²⁴ The measurement studies that EPRI cites all claim that interference is occurring from unlicensed devices at particular fixed locations because the I/N ratio is greater than -6 dB.²²⁵ Because Monte Carlo simulations are designed to examine the likelihood of interference occurring in

²¹⁶ *Id.* at 17; NAB Reply at 8. Because NAB's claims are based on an Army Spectrum Management Office document which is not part of the record, we cannot judge the accuracy of these claim.

²¹⁷ Apple, Broadcom, et al. Sept. 5, 2024 *Ex Parte*, Presentation at 6-13, 15-22, 24.

²¹⁸ *6 GHz First Order*, 35 FCC Rcd at 3914, para. 166.

²¹⁹ *Id.* at 3878, paras. 70-71.

²²⁰ *Id.* at 3878, para. 70.

²²¹ *Id.* at 3878, para. 71 (internal quotation marks omitted).

²²² SBE Reply at 5.

²²³ *See supra* paras. 14-1514-15.

²²⁴ SBE Reply at 5 (citing Electric Power Research Institute Comments at 3).

²²⁵ Electric Power Research Institute Comments at 1, 3.

general and the simulations have indicate that it is not impossible for an I/N over -6 dB to occur, the fact that there may exist locations where the I/N exceeds -6 dB does mean that the results differ from the Monte Carlo simulations. In addition, the Commission has not indicated that the occurrence of an I/N of greater the -6 dB indicates that harmful interference is occurring.²²⁶ We also reject EPRI's suggestion that the models and inputs of the Monte Carlo simulations be made publicly available for the same reasons the Commission rejected a similar request in the *6 GHz Second Order*.²²⁷ We believe that Apple, Broadcom et al. and Broadcom have provided sufficient information for knowledgeable engineers to understand the algorithms and models used in the technical studies they have submitted and find it noteworthy that no opponent of VLP expansion to U-NII-6 and U-NII-8 have conducted their own similar technical studies.

49. In reaching our conclusion that VLP devices will not present a significant risk of causing harmful interference to ENG truck receivers, we are not relying on the opportunistic nature of ENG operations or on the assumption that VLP devices causing interference are likely to leave the areas quickly. Mobile ENG operations by broadcasters are conducted on a primary basis and licensees have the right to operate on any channel permitted by their license and are not expected to need to adjust their operating frequency to avoid VLP devices. We also do not find that NAB's concern that there would be no way to shut down VLP devices that cause interference during a breaking news event provides justification for prohibiting VLP devices in the U-NII-6 and U-NII-8 bands because the record supports our conclusion that the risk of such harmful interference occurring would be insignificant.²²⁸ Because of the difference in power levels between the ENG operations and VLP devices, the use of a contention-based protocol by VLP devices, and the large amount of spectrum available for VLP operations, we expect there to be an insignificant risk that harmful interference will occur to ENG truck receivers. This conclusion is further supported by the ENG Truck Receiver Studies.

3. Low-power Short Range Mobile Devices

50. No commenters provided technical studies or described specific use cases for low-power short range mobile devices. Low-power short range mobile devices include portable cameras and microphones as well as Low-power Auxiliary Stations, which 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.²²⁹ While we refer to these devices as low-power short range mobile devices, they operate at significantly higher power than VLP devices—portable ENG cameras typically operate at 20 dBm and Low-power Auxiliary Stations may operate at up to 30 dBm.²³⁰ The *6 GHz Second FNPRM* suggested that these low-power short range mobile devices be protected by a combination of a required contention-based protocol and the low probability of a VLP device operating on the same channel in a nearby location.²³¹ We conclude that these measures will adequately protect low-power short range mobile devices from harmful interference from VLP devices.

51. The *6 GHz First Order* discussed a simulation submitted by Apple, Broadcom et al. that simulated ENG equipment operating indoors within the U.S. House of Representatives chamber, a scenario which had been explored in the Alion Study submitted by NAB.²³² To confirm that the energy

²²⁶ *6 GHz First Order*, 35 FCC Rcd at 3878, para. 71.

²²⁷ Electric Power Research Institute Comments at 3; *6 GHz Second Order*, 38 FCC Rcd at 10552-54, paras. 51-52.

²²⁸ NAB Comments at 5.

²²⁹ *6 GHz Second FNPRM*, 38 FCC Rcd at 10601, para. 174.

²³⁰ NAB Comments at 6 n.18 (using a ENG camera power of 20 dBm); Apple, Broadcom, et al. Sept. 5, 2024 *Ex Parte*, Presentation at 4; 47 CFR § 74.861(d)(1).

²³¹ *6 GHz Second FNPRM*, 38 FCC Rcd at 10603, para. 180.

²³² *6 GHz First Order*, 35 FCC Rcd at 3915, para. 168 (discussing Apple, Broadcom et al. Feb. 28, 2020, *Ex Parte* at 11); Alion Study, NAB Dec. 5, 2019 *Ex Parte* at 15-20.

sensing employed by the contention-based protocol in the 802.11 specification could be used to mitigate interference to indoor ENG receivers, the simulation calculated the received power level from ENG transmitters at 20 unlicensed access point locations operating within the U.S. House of Representatives chamber.²³³ The results of this simulation demonstrate that, even at the lowest ENG transmit power level, all unlicensed access points would detect the ENG signal at greater than the -62 dBm threshold used in the 802.11 specification and therefore not transmit co-channel with the ENG transmitters.²³⁴ While this simulation was limited to low-power ENG cameras and associated receivers, it should equally apply to other low-power short range mobile devices that operate with similar power levels and at similar distances. This simulation illustrates that unlicensed VLP devices using such a contention-based protocol have the capability to sense the energy from nearby low-power mobile devices and avoid using the same channel. In addition, for the same reasons as discussed above regarding ENG truck receivers, the 1200 megahertz of 6 GHz band spectrum available for VLP device operation makes it unlikely that even absent a contention-based protocol, these devices would transmit co-channel with low-power short range mobile devices.²³⁵

4. Reservation of Spectrum for ENG

52. We note that NAB requests that the Commission “adopt a 55 MHz carve-out at the top of the U-NII-8 band at which no VLP operations are permitted, at least until there is significant experience to determine such a carve-out is unnecessary.”²³⁶ NAB has made similar requests previously in this proceeding,²³⁷ and in both instances the Commission chose not to adopt NAB’s suggestion.²³⁸ In this case, NAB repeats prior concerns without providing any new information that addresses any changes in operational parameters. As we have thoroughly addressed interference considerations related to VLP operations in the U-NII-6 and U-NII-8 bands herein and found that such operations will have an insignificant potential for causing harmful interference to ENG operations, we decline to adopt NAB’s suggestion.

B. Protecting Fixed Services

53. The operational and technical characteristics of the limited number of fixed microwave links in the U-NII-6 and U-NII-8 bands are consistent with those in the U-NII-5 and U-NII-7 bands. Because we are adopting identical technical rules for VLP operation in the U-NII-6 and U-NII-8 bands as apply in U-NII-5 and U-NII-7 bands, the Commission’s conclusion in the *6 GHz Second Order* that VLP operations will not present a significant risk of harmful interference to fixed microwave links applies equally to the U-NII-6 and U-NII-7 bands.²³⁹

54. Apple, Broadcom et al. and the IEEE 802 LAN/MAN Standards Committee support this contention, suggesting that the previously conducted studies demonstrate that there will be no harmful interference to incumbent fixed microwave services in the U-NII-6 and U-NII-8 bands.²⁴⁰ AT&T raises concerns that the simulation studies the Commission previously relied upon remain unfiled and untested

²³³ Apple, Broadcom et al. Feb. 28, 2020, *Ex Parte* at 11-13.

²³⁴ *Id.* at 13.

²³⁵ *See supra* para. 42.

²³⁶ NAB Comments at 13; *accord id.* at 3; NAB Reply at 1-2, 11; NAB Oct. 30, 2024 *Ex Parte* at 2; NAB Nov. 14, 2024 *Ex Parte* at 3; *see* EIBASS Reply at 1; SBE Reply at 3; SBE Nov. 8, 2024 *Ex Parte* at 1-3.

²³⁷ NAB Apr. 10, 2020 *Ex Parte* at 2; NAB Reply, ET Docket No. 18-295, Public Notice DA 22-253, 6-8 (filed June 9, 2022).

²³⁸ *6 GHz First Order*, 35 FCC Rcd at 3912, para. 158; *6 GHz Second Order*, 38 FCC Rcd at 10616-17, para. 212.

²³⁹ *6 GHz Second Order*, 38 FCC Rcd at 10534, para. 24.

²⁴⁰ Apple, Broadcom et al. Comments at 2; IEEE 802 LAN/MAN Standards Committee (Paul Nikolich) Comments at 3.

and contends it is poor public policy to rely on studies that have not been filed for public review.²⁴¹ The Fixed Wireless Communications Coalition (FWCC) states that the record was insufficient to act on the proposals prior to the *6 GHz Second FNPRM* and remains insufficient to support Commission action because the comments “were either non-substantive or rehashed information previously submitted [in] the record.”²⁴² Several microwave licensees and their representatives urge the Commission to gain real-world experience or require testing with VLP devices before further liberalizing the rules.²⁴³ The American Petroleum Institute (API) raises several specific concerns regarding the technical studies that the Commission relied upon in its decision to permit VLP in the U-NII-5 and U-NII-7 bands.²⁴⁴ API claims that for the Houston area microwave link simulation (Houston Simulation) submitted by Apple, using an antenna based on the Commission’s rules instead of the 44 dBi gain antenna with the ITU-R F.1245 pattern relied upon by Apple, would have resulted in more predicted interference.²⁴⁵ API also criticizes the Houston Simulation’s use of 1.3 dB cable loss (i.e., feeder loss) for microwave systems, claiming that most modern microwave systems utilize receivers with the radio directly connected to the antenna that may have less than 0.5 of coupling loss.²⁴⁶ Regarding the Commission’s discussion of a link budget analysis submitted by Nokia, API suggest that the Commission should not have included a 2 dB feeder loss and that what API refers to as “antenna polarization mismatch” should have been 1.5 dB instead of 5 dB.²⁴⁷

55. In responding to AT&T’s previous request that the code for the simulation studies be publicly disclosed, the Commission in the *6 GHz Second Order* explained that both Apple, Broadcom et al. and Apple provided sufficient information regarding their simulations.²⁴⁸ We see no reason to reconsider this finding or the Commission’s reliance on these simulations in concluding that VLP devices will not result in a significant risk of harmful interference to fixed microwave receivers. We also do not agree with FWCC’s general contention about the sufficiency of the record to support our expansion of VLP operations to the U-NII-6 and U-NII-8 bands. Given that the VLP operations we are now authorizing in the U-NII-6 and U-NII-8 bands are identical to what we currently permit in the adjacent much larger U-NII-5 and U-NII-7 bands, we see no reason to pause our rulemaking for some unspecified time to gain experience with VLP devices as suggested by some of the microwave licensees.

56. Regarding API’s concerns, the *6 GHz Second Order* explained that the Houston Simulation’s use of the ITU-R F.1245 antenna pattern with a 44 dBi gain was appropriate because it represents an “average” antenna, which would provide a reasonable estimate of microwave link interference performance.²⁴⁹ The goal of a Monte Carlo simulation is to obtain overall statistics on the potential for harmful interference to occur to all microwave links. Hence, we disagree with API’s contention that a pattern based strictly on what is permitted by our rules would be more appropriate, as

²⁴¹ AT&T Comment at 5-6.

²⁴² FWCC Reply at 2.

²⁴³ AT&T Comments at 6; Everygy Reply at 3 (asking “the Commission to require systematic testing . . . under the existing rules before further expanding unlicensed operations”); Utilities Technology Council and Edison Electric Institute Comments at 5 (arguing that “[t]he Commission should refrain from further expanding unlicensed operations in the 6 GHz band . . . until such time that it has a better understanding of the interference environment that is created by the unlicensed operations it has already authorized”); APCO Reply at 2 (“Real-world operational experience and testing should guide any future decision making . . .”).

²⁴⁴ American Petroleum institute Comments at 2-4.

²⁴⁵ *Id.* at 2-3.

²⁴⁶ *Id.* at 3.

²⁴⁷ *Id.* at 3-4.

²⁴⁸ *6 GHz Second Order*, 38 FCC Rcd at 10553-54, para. 52.

²⁴⁹ *Id.* at 10547, para. 43.

this would likely result in a worst-case overprediction of harmful interference occurring rather than overall interference statistics. Regarding the Houston Simulation's 1.3 dB feeder loss, AT&T previously raised the same concern that some microwave radios are mounted directly to the antenna and have no feeder loss.²⁵⁰ The *6 GHz Second Order* explained that using 1.3 dB feeder loss was a reasonable approach as the simulation is designed to model the interference potential in general rather than explore the interference risk for a particular microwave receiver.²⁵¹

57. We also do not agree with API's concerns regarding the Nokia link budget analysis. Contrary to API's contention, the 5 dB loss the Commission applied was for "RLAN/FS antenna pattern mismatch between unlicensed devices and microwave receivers" rather than for a polarization mismatch.²⁵² This 5 dB value was used by the Commission in link budget analyses in the *6 GHz First Order* for analyzing potential interference from low-power indoor devices to microwave receivers and is based on the antenna patterns of typical indoor enterprise and consumer access points.²⁵³ In those analyses, the Commission applied a separate attenuation for polarization loss.²⁵⁴ The Commission also used a 2 dB feeder loss for the link budget analysis in the *6 GHz First Order*.²⁵⁵ The *6 GHz Second Order* explained that because the Nokia analysis is a link budget that assumes the same type of microwave antennas and that the VLP devices likely have similar antenna patterns to the low-power indoor devices, these assumptions are appropriate for examining the Nokia analysis.²⁵⁶ We also note that even after the Commission applied these adjustments for antenna pattern mismatch and feeder loss, Nokia's suggested VLP power would be -11 dBm/MHz EIRP, which is significantly lower than the -5 dBm/MHz EIRP limit the Commission adopted for VLP devices.²⁵⁷ As the Commission explained, a Monte Carlo analysis rather than a static link budget analysis is a more realistic indication of the potential for VLP devices to cause harmful interference.²⁵⁸ Hence, even if the Commission had not applied the 7 dB of adjustment to the Nokia analysis, it would not have changed its conclusion regarding the risk of harmful interference occurring to microwave receivers from VLP devices.

C. Protecting the Fixed-Satellite Services

1. Fixed-Satellite Service Uplinks

58. In the *6 GHz First Order*, the Commission authorized standard power devices in the U-NII-5 and U-NII-7 portions of the 6 GHz band and low-power indoor unlicensed devices across the entire 6 GHz band.²⁵⁹ To protect FSS uplinks that operate in all except the upper fifty megahertz of the 6 GHz band, the Commission required outdoor standard power access points to limit their maximum EIRP above a 30 degree elevation angle to 21 dBm.²⁶⁰ However, the Commission determined no restrictions were necessary for low power indoor devices because of these device's relatively low EIRP as well as

²⁵⁰ AT&T Aug. 29, 2023 *Ex Parte* at 11.

²⁵¹ *6 GHz Second Order*, 38 FCC Rcd at 10551, para. 48.

²⁵² *Id.* at 10563, para. 73.

²⁵³ *6 GHz First Order*, 35 FCC Rcd at 3898, 3900, paras. 125, 129, tbl. 5.

²⁵⁴ *Id.* at 3900, para. 129, tbl. 5.

²⁵⁵ *Id.* at 3901, para. 129, tbl. 5.

²⁵⁶ *6 GHz Second Order*, 38 FCC Rcd at 10563, n.328.

²⁵⁷ *Id.* at 10563, para. 73.

²⁵⁸ *Id.* at 10563-64, paras. 73, 75.

²⁵⁹ *6 GHz First Order*, 35 FCC Rcd at 3860, paras. 17-18.

²⁶⁰ *Id.* at 3886, para. 92; accord 47 CFR § 15.407(a)(4).

building attenuation due to the indoor operation.²⁶¹ Similarly, in the *6 GHz Second Order*, the Commission determined that VLP devices operating in the U-NII-5 and U-NII-7 bands did not require any restrictions because VLP devices are limited to no more than 14 dBm.²⁶² In the *6 GHz Second FNPRM*, the Commission proposed expanding VLP access to the entire 6 GHz band but made no specific proposal regarding protecting FSS Earth-to-space operations.²⁶³

59. Sirius XM urges the Commission to prohibit outdoor VLP devices in the upper U-NII-8 band, as they may disrupt Satellite Digital Audio Radio Service (SDARS) operations.²⁶⁴ While SDARS is not a part of the FSS, its ground stations use a portion of the U-NII-8 band to transmit digital audio signals to Sirius XM's geostationary satellite constellation.²⁶⁵ Sirius XM points out that the only analysis provided by unlicensed proponents of interference to FSS receivers was a 2018 study conducted by RKF Engineering (2018 RKF Study) that addressed FSS, but not SDARS.²⁶⁶ According to Sirius XM, SDARS is different than FSS because it must deliver a reliable signal to consumer-grade antennas rather than the large high-gain antennas used by C-band FSS operations.²⁶⁷ Sirius XM previously criticized the assumptions used by the 2018 RKF Study and further calls into question a number of its assumptions. Specifically, Sirius points out that the 2018 RKF Study assumed a 2% outdoor use factor while more recent simulations have assumed a 6% outdoor use factor, that the Study used an estimate of 6 GHz band unlicensed devices that is far lower than more recent estimates of connected devices from Cisco, and that device activity factors have been trending higher due to increased video streaming.²⁶⁸ Sirius points out that the interference levels from VLP devices would be 40 times higher than low-power indoor devices due to the lack of building attenuation.²⁶⁹ Sirius XM also cautions that once interference occurs to SDARS, there would not be a practical enforcement mechanism to resolve it.²⁷⁰ Sirius contends that the risk of harm to the valuable SDARS service outweighs the benefit of satisfying an undemonstrated need for more spectrum for outdoor VLP device use.²⁷¹ Sirius XM renews its previous proposal that the Commission prescribe a maximum aggregate increase in the uplink noise floor and prohibit the manufacture, importation, and sale of additional unlicensed devices if a -23 dB I/N is exceeded.²⁷² It also suggests that VLP devices be required to prioritize other parts of the 6 GHz spectrum outside of the SDARS uplink band.²⁷³

60. Apple, Broadcom et al. respond that Sirius XM presents no detailed analysis of the interference risk to its system, nor any concrete interference protection requirements.²⁷⁴ Apple, Broadcom

²⁶¹ *Id.* at 3916, para. 171.

²⁶² *6 GHz Second Order*, 38 FCC Rcd at 10567, para. 82.

²⁶³ *Id.* at 10600-01, 10604, paras. 173, 183-84.

²⁶⁴ Sirius XM Comments at 4.

²⁶⁵ Sirius XM Comments at 2-3.

²⁶⁶ *Id.* at 9-10; Sirius XM Reply at 7-8.

²⁶⁷ Sirius XM Comments at 9-10 (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. 25, 2018 ("2018 RKF Report")).

²⁶⁸ *Id.* at 10-11 (citing Sirius XM Radio June 22 2018 *Ex Parte*, Docket No. 17-183).

²⁶⁹ Sirius XM Reply at 6; Sirius XM Oct. 9, 2024 *Ex Parte* at 1-2.

²⁷⁰ Sirius XM Comments at 13-18.

²⁷¹ *Id.* at 18.

²⁷² *Id.* at 22-23; Sirius XM Oct. 9, 2024 *Ex Parte* at 2.

²⁷³ Sirius XM Reply at 15; Sirius XM Oct. 9, 2024 *Ex Parte* at 2.

²⁷⁴ Apple, Broadcom et al. Reply at 16.

et al. contend that Sirius XM's satellites are no different from other 6 GHz FSS operations in that they receive aggregate interference over a large footprint and receive interference from numerous existing terrestrial licensees and that the record demonstrates these other devices contribute orders of magnitude more energy than unlicensed devices will.²⁷⁵ According to Apple, Broadcom et al., high power 6 GHz licensees will continue to be the dominant interferers to Sirius XM's uplinks, not VLP devices.²⁷⁶ They point to the 2018 RKF Study on the potential for interference from standard-power devices operating at 4 Watts (36 dBm) and claim that interference from VLP devices would be even fainter than the -20 dB I/N predicted.²⁷⁷

61. *Discussion.* We believe that our previous conclusion that FSS uplinks in the U-NII-5 and U-NII-7 bands will not have a significant risk of experiencing harmful interference from VLP devices applies equally to FSS uplinks in the U-NII-6 and U-NII-8 bands, including to Sirius XM's SDARS system. This conclusion is based on the fact that VLP devices, which can operate with up to 14 dBm EIRP, will transmit with significantly less power than the 21 dBm power permitted above 30 degrees elevation for standard power access points.²⁷⁸ Sirius XM's SDARS operations in the U-NII-8 band have the same characteristics as 6 GHz FSS systems. As with 6 GHz band FSS systems, its satellites operate in geostationary orbits and have receive beams that cover the entire United States.²⁷⁹ Its satellites potentially receive interference from other licensed users that share the 6 GHz band just as 6 GHz FSS uplinks. As to Sirius XM's observation that the power received from outdoor VLP devices can be significantly higher than the power from low-power indoor devices due to the lack of building attenuation, the power from outdoor VLP devices would be significantly less than that of standard power access points, which our rules permit to operate outdoors and which the Commission previously found are unlikely to cause harmful interference to FSS receivers.²⁸⁰

62. We note that Sirius XM has not produced any technical analysis regarding the Commission's proposal to permit U-NII-8 VLP operations. Instead, Sirius XM refers back to its previous critique of the 2018 RKF Study, which was available to the Commission prior to adopting the rules for 6 GHz band standard power and low-power indoor devices. The only new points regarding the 2018 RKF Study that Sirius XM now raises are that more recent technical studies regarding VLP devices filed by unlicensed proponents assume a 6% outdoor use factor instead of 2%, that Cisco recent estimates of connected devices are higher than the 2018 RKF Study, and that unlicensed device activity factors will continue to increase due to video downloads. We note that the 6% and 2% outdoor use factors to which Sirius refers have different meanings in the 2018 RKF Study than in the more recent VLP simulation Sirius references. The 2018 RKF Study assumed that 2% of the "RLANs" are outdoors while the Apple, Broadcom, et al. simulation of VLP use in San Francisco assumed 6% of the people were outdoors with 25% of those people using VLP devices and only 2% of those devices active at any given time.²⁸¹ The two simulations also had different foci: The 2018 RKF Study simulated radio local area networks, including Wi-Fi access points, both indoor and outdoor across the entire United States while the Apple, Broadcom, et al. simulation only considered outdoor VLP use in San Francisco.²⁸² Given the different meanings of these outdoor use factors, we cannot directly compare whether the two simulations in fact

²⁷⁵ *Id.* at 17.

²⁷⁶ *Id.* at 18.

²⁷⁷ *Id.* at 18.

²⁷⁸ *6 GHz Second Order*, 38 FCC Rcd at 10567, para. 82.

²⁷⁹ "Many C-band Satellites have receive beams that encompass the entire contiguous United States." Intelsat and SES Americom Comments at 3 (Feb. 15, 2019).

²⁸⁰ Sirius XM Reply at 6; *6 GHz First Order*, 35 FCC Rcd at 3886-87, paras. 91-92.

²⁸¹ 2018 RKF Report at 14; Apple, Broadcom et al. Feb. 28, 2023 *Ex Parte* at 8.

²⁸² 2018 RKF Report at 12; Apple, Broadcom et al. Feb. 28, 2023 *Ex Parte* at 5-8.

represent a different level of outdoor device use. Because of the different scope of these two simulations, we believe it was appropriate to use different methodologies for modeling the number of outdoor devices. The Cisco connected device data Sirius XM points to is for all Internet-connected devices in general and not for 6 GHz VLP devices in particular. As for the contention regarding increasing device activity factor because of growing video activity on the Internet, the Commission stated in the *6 GHz Second Order*, which was adopted in 2023, that assuming a 2% activity factor for VLP devices is reasonable for analytical purposes and we see no reason to reconsider this conclusion.²⁸³ Given the limited new technical information that has been presented, we are not convinced that we should reconsider our conclusion as to the likelihood of interference occurring to FSS uplinks.

63. Sirius's concern about the lack of any practical enforcement mechanism if harmful interference were to occur also does not give us reason to limit VLP access to the U-NII-8 band. We are concluding, based on the currently available technical evidence, that there is an insignificant risk that harmful interference will occur to 6 GHz FSS systems and SDARS systems and thus there is no basis to prevent the introduction of an exciting new service to the public. As the demand for spectrum continues to grow, we believe that it is in the public interest to continue to find ways to more intensively use the valuable spectrum resource, so long as we also conclude that the evidence presented in the record shows the likelihood for harmful interference to remain insignificant.

64. Because we have concluded that the likelihood of harmful interference occurring to Sirius XM's system from VLP devices is insignificant, we see no reason to adopt an aggregate interference threshold as Sirius XM suggests. We also do not find it appropriate to require VLP devices to prioritize operations in portions of the 6 GHz band outside of the SDARS uplink spectrum because the record does not support that Sirius XM will experience a harmful interference problem from VLP device operations.

2. Fixed-Satellite Service Downlinks

65. Portions of the U-NII-7 and U-NII-8 bands are allocated for FSS space-to-Earth (downlink) operations.²⁸⁴ However, no such earth stations are currently licensed in the U-NII-7 band. The U-NII-8 space-to-Earth allocation is limited to use by non-geostationary Mobile-Satellite Service feeder links.²⁸⁵ Globalstar operates earth station receive sites in the U-NII-8 band at Clifton TX, Naalehu, HI, Wasilla, AK, Reno NV, Sebring, FL, and Barrio of Las Palmas, Cabo Rojo, PR.²⁸⁶

66. In the *6 GHz Second FNPRM*, the Commission sought comment on whether any restrictions on VLP devices are necessary to protect space-to-Earth stations.²⁸⁷ The Commission recognized that VLP devices operate at significantly lower power spectral density levels than the geofenced VLP devices it also proposed to permit in the *6 GHz Second FNPRM*; therefore, it sought comment on how this difference impacts the analysis of potential harmful interference.²⁸⁸ Globalstar, the only stakeholder in the U-NII-8 band for FSS downlink transmission, expresses concern that a new class of higher-power, geofenced VLP devices could cause harmful interference and suggests that the geofencing system protect their earth stations.²⁸⁹ However, Globalstar does not address VLP operations

²⁸³ Sirius XM at 11; Comments at *6 GHz Second Order*, 38 FCC Rcd at 10541-42, para. 35.

²⁸⁴ 47 CFR § 25.214(c)(5).

²⁸⁵ As shown in the Table of Frequency Allocations, international footnotes 5.458A and 5.458B apply to this band and, as discussed *infra*, we are reinstating the text of these footnotes, which had been inadvertently removed, in section 2.106 of the rules. International footnote 5.458B provides 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.

²⁸⁶ Globalstar Comments at 3-4.

²⁸⁷ *6 GHz Second FNPRM*, 38 FCC Rcd at 10604, para. 184.

²⁸⁸ *Id.*

²⁸⁹ Globalstar Comments at 4-5.

of the type previously authorized in the U-NII-5 and U-NII-7 bands.²⁹⁰

67. In the *6 GHz First Order*, we concluded that the low probability of harmful interference to FSS space-to-Earth stations from low-power indoor devices in the U-NII-8 band was due to the indoor restriction and a transmit EIRP below 30 dBm.²⁹¹ While a majority of VLP use cases are expected to be indoors, there will undoubtedly be scenarios in which VLP operations occur outdoors.²⁹² In these cases, VLP transmissions will still be attenuated by transmit power control (TPC) and body loss. Additionally, at 1.5 meters at which most VLP devices will be operated there will be significant clutter loss. These losses will bring the effective EIRP below that of a low-power access points effective EIRP.²⁹³ We also note that Globalstar has raised no interference concerns regarding VLP operation in U-NII-8 at the current VLP power levels. Therefore, we conclude that no restrictions on VLP devices are necessary to protect FSS space-to-Earth operations.

D. Protecting Passive Services

68. CORF expresses concerns about potential interference from VLP devices to the radio astronomy service and to the Earth Exploration Satellite Service (EESS) in the U-NII-6, U-NII-7, and U-NII-8 bands.²⁹⁴ 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.²⁹⁵ Remote sensing using the EESS, which CORF states is critical to weather prediction and the study of climate change and of the Earth in general, operates in the 6.425-7.250 GHz band, which includes all of the U-NII-6, U-NII-7, and U-NII-8 bands.²⁹⁶ CORF argues that the methodology the Commission used in the *6 GHz Second Order* to calculate VLP power limits in the U-NII-7 band by extrapolating the low-power indoor power limits was not appropriate in that the Commission failed to properly take into account differences between the two types of devices, including power levels and building entry loss.²⁹⁷ CORF requests that certain frequencies around the 6.65-6.6752 GHz band be made unavailable to VLP devices in areas close to radio astronomy sites, but suggests that these frequencies could be made available in areas where the spectrum is congested but are sufficiently removed from radio astronomy sites to avoid causing interference.²⁹⁸

69. With regard to the EESS in the U-NII-6, U-NII-7, and U-NII-8 bands, CORF argues that a 14 dBm EIRP VLP device would exceed the ITU-R RS.2017 -166 dBW interference threshold in a 200 MHz bandwidth.²⁹⁹ It states that a single 14 dBm EIRP VLP device within a receiver's antenna beam and

²⁹⁰ See Globalstar Comments.

²⁹¹ *6 GHz First Order*, 35 FCC Rcd at 3916-17, para. 171; see also *6 GHz Second FNPRM*, 38 FCC Rcd at 10604, para. 183.

²⁹² *6 GHz Second Order*, 38 FCC Rcd at 10541-42, para. 35.

²⁹³ An LPI access point's effective EIRP is the max 30 dBm attenuated to 9.5 dBm by 20.5 building entry loss. 47 CFR 15.407(a)(5); *6 GHz First Order*, 35 FCC Rcd at 3894, n.297. In an outdoor scenario, in most cases, a VLP device operating at a max EIRP of 14 dBm will experience attenuation on average of 4 dB body loss and 3 dB of power reduction due to TPC, thus rendering it with an effective EIRP of 7 dBm. See *supra* paras: 2525, 4343; *6 GHz Second Order*, 38 FCC Rcd at 10544-46, 10549-51, paras. 39-40, 46-47.

²⁹⁴ CORF Comments at 5, 10.

²⁹⁵ *6 GHz First Order*, 35 FCC Rcd at 3884, para. 87.

²⁹⁶ CORF Comments at 10.

²⁹⁷ *Id.* at 7.

²⁹⁸ *Id.* at 7-9.

²⁹⁹ *Id.* at 11; International Telecommunications Union Recommendation ITU-R RS.2017-0, *Performance and interference criteria for satellite passive remote sensing*, https://www.itu.int/dms_pubrec/itu-r/rec/rs/R-REC-RS.2017-0-201208-I!!PDF-E.pdf, Table 2, at 5.

passband could result in a signal that exceeds the ITU-R RS.2017 threshold by as much as 33 dB.³⁰⁰ CORF further states that VLP devices in the U-NII-5 band would have a negligible effect on sensing operations in the bands where the EESS operates.³⁰¹ As a result, CORF states that geofencing could be used with devices programmed to avoid the U-NII-6, U-NII-7, and U-NII-8 bands in oceanic zones, including in coastal waters, and non-geofenced usage could be restricted to the U-NII-5 band only.³⁰²

70. *Discussion.* We decline to restrict the frequencies that may be used by VLP devices in the U-NII-7 band to protect radio astronomy operations. That request is outside the scope of this Order, which addresses VLP operations in only the U-NII-6 and U-NII-8 bands. However, we note that in the *6 GHz Second Order* the Commission already considered and rejected CORF's request to prohibit use of certain frequencies by VLP devices to protect radio astronomy operations, stating that the interference potential for VLP devices in the U-NII-7 band is even lower than for low-power indoor devices that were already permitted to operate at higher power levels than those adopted for VLP devices.³⁰³ We continue to believe that VLP devices in the U-NII-7 band are unlikely to interfere with radio astronomy operations, noting that CORF's analysis, in which it questioned the validity of extrapolating the low power indoor device power limit to determine the appropriate VLP device power limit, suggests a greater value for building entry loss (30 dB) than the Commission previously found to be appropriate (20.5 dB).³⁰⁴ Additionally, CORF failed to consider mitigating factors that reduce the potential for interference, including, 3 dB for the use of TPC, 4 dB for body loss, and 2% (17 dB) activity factor correction.³⁰⁵

71. We find that we can permit VLP devices to operate in the U-NII-6 and U-NII-8 bands while protecting the EESS. In the *6 GHz Second Order*, the Commission permitted VLP devices to operate in the U-NII-7 band where the EESS also operates, subject to a prohibition on their use on oil platforms to protect ocean temperature sensing activities.³⁰⁶ The power levels we are permitting for VLP devices in the U-NII-6 and U-NII-8 bands are the same as those we permit for VLP devices in the U-NII-7 band, and as discussed below, we are maintaining the prohibition on operation on oil platforms. Consequently, EESS operations in the U-NII-6 and U-NII-8 bands will be protected to the same extent that they are in the U-NII-7 band.

72. CORF's analysis of potential interference in the U-NII-6 and U-NII-8 bands overstates VLP device interference potential to the EESS.³⁰⁷ In particular, CORF's analysis fails to consider certain mitigating factors that the Commission previously found to be appropriate. When using the Commission's previously assumed factors of 5 dB for antenna pattern mismatch, 3 dB for antenna polarization loss, 20.5 dB for building entry loss, 3 dB for the use of TPC, and 4 dB for body loss, we calculate a 4.2 dB protection margin.³⁰⁸ It should be noted that this calculation does not take into account clutter loss that can exist. Furthermore, given that EESS observation times are in the order of

³⁰⁰ CORF Comments at 11-12.

³⁰¹ *Id.* at 12.

³⁰² *Id.* at 12.

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

³⁰⁴ *Id.* at 10559-60 at 37, para. 64. This extrapolation requires an assumption for building entry loss. A higher building entry loss as CORF suggests would result in a lower calculated VLP device power level.

³⁰⁵ *Id.* at 10541-42, 10545-46, 10550-51, paras. 35, 40, 47.

³⁰⁶ *Id.* at 10573, para. 96. The Commission found it was not necessary to prohibit operation of VLP devices on boats to protect the EESS. *Id.*

³⁰⁷ CORF Comments at 11-12.

³⁰⁸ *6 GHz First Order*, 35 FCC Rcd at 3880, para. 75; *6 GHz Second Order*, 38 FCC Rcd at 10545-46, 10550-51, 10559-60, 10562-63, paras. 40, 47, 64, 71. CORF acknowledges that building entry loss and beam directionality (antenna mismatch) are appropriate in a VLP analysis. CORF Comments at 12.

milliseconds while Wi-Fi transmissions are generally in the order of microseconds, we believe that using the average power instead of peak power is appropriate. With a conservative 2% activity factor assumption (a 17 dB reduction), the protection margin evaluates to 21.2 dB.³⁰⁹

73. Given the limited footprint of EESS satellites, the significant protection margin that exists, and that large numbers of VLP devices generally are not transmitting simultaneously on boats in an area, we believe that continuing to allow VLP devices to operate on boats in the ocean will not result in any significant risk to EESS operations.³¹⁰ For these same reasons, we do not see a need to impose restrictions on VLP devices over large lakes and rivers, as CORF suggests.³¹¹ We will continue to prohibit 6 GHz devices, including VLP devices, from operating on oil platforms because oil platform locations tends to be concentrated in areas where the passive and active sensing of EESS operations are conducted.³¹²

E. Technical Rules

74. In the *6 GHz Second Order*, the Commission adopted rules that permitted VLP devices to operate in the U-NII-5 and U-NII-7 bands at power levels up to -5 dBm/MHz EIRP PSD and 14 dBm EIRP.³¹³ The Commission determined that the risk of harmful interference to incumbent services in those bands was insignificant for VLP devices operating at that power level.³¹⁴ As a natural outgrowth of that determination, in the *6 GHz Second FNPRM*, the Commission proposed to permit VLP devices to operate in the U-NII-6 and U-NII-8 bands without geofencing.³¹⁵ In this Third Report and Order, we are adopting this proposal.

75. Many of the proponents arguing to expand VLP operations to the U-NII-6 and U-NII-8 bands without geofencing suggest no changes to the technical rules governing VLP U-NII-5 and U-NII-7 operations.³¹⁶ Several commenters, as discussed in more detail below, suggest modification to the rules that will apply to VLP operation throughout the 6 GHz band. To the extent that we did not seek comment on those rule changes in the *6 GHz Second FNPRM*, we are not able to consider applying them to U-NII-5 and U-NII-7 VLP operations. In addition, we believe that having uniform rules that apply to all VLP operations will be of great benefit because it will make product development easier and lead to economies of scale that will reduce cost. For this reason, we are adopting identical technical rules for VLP operations in the U-NII-6 and U-NII-8 bands as currently apply to such operations in the U-NII-5 and U-NII-7 bands.

76. However, the *6 GHz Second FNPRM* did seek comment on making several changes to the VLP rules. The Commission sought comment on any adjustment needed to the VLP device rules to adequately protect C-V2X operations in vehicles.³¹⁷ The Commission also sought comment on relaxing the restrictions regarding VLP use on aircraft and on oil platforms and on providing additional flexibility

³⁰⁹ *6 GHz Second Order*, 38 FCC Rcd at 10541-42, para. 35.

³¹⁰ Contrary to CORF's comments, the rules adopted in the *6 GHz Second Order* do not prohibit the operation of VLP devices on boats. *Id.* at 10573, para. 96; *see also* CORF Comments at 13.

³¹¹ CORF Comments at 13.

³¹² *6 GHz Second Order*, 38 FCC Rcd at 10573, para. 96.

³¹³ *Id.* at 10532, para. 18.

³¹⁴ *Id.* at 10552, 10555, paras. 50,54.

³¹⁵ *Id.* at 10600-01, para. 173.

³¹⁶ Apple, Broadcom et al. Comments at 5-22; Apple, Broadcom et al. Reply at 4-15; Wireless Broadband Alliance Comments at 2; Dynamic Spectrum Alliance Comments at 6-8; Computer & Communications Industry Association Comments at 1.

³¹⁷ *6 GHz Second FNPRM*, 38 FCC Rcd at 10605-06, para. 186.

for in-vehicle use.³¹⁸ We defer action on all of these *6 GHz Second FNPRM* proposals.³¹⁹

77. *VLP Power Levels.* The Wi-Fi Alliance and the IEEE 802 LAN/MAN Standards Committee support increasing the permitted power for VLP devices to 1 dBm/MHz with a total EIRP of 14 dBm without use of a geofencing system.³²⁰ IEEE 802 LAN/MAN Standards Committee states this would contribute to global harmonization of VLP devices and claims that this increased power spectral density for 20 and 40 megahertz wide channels would not cause any risk to incumbent services as these channel sizes may not be widely used.³²¹ The Commission determined the power levels for VLP devices in the *6 GHz Second Order* based on an extensive record examining the potential for these devices to cause harmful interference to microwave receivers. No commenters submitted additional technical analysis examining interference to microwave receivers, and the simulation submitted by Apple, Broadcom, et al. of interference to ENG central receive sites assumed a VLP power of -5 dBm/MHz.³²² Therefore, the record does not support adjusting the power for VLP device operations.

78. *Firmware Download.* AT&T suggests that all new unlicensed devices be required to accept mandatory firmware updates that alter their operating parameters, which will allow unlicensed performance to be changed in the future, enhancing efficiency and improving spectrum management.³²³ AT&T claims this would be consistent with NTIA's Commerce Spectrum Management Advisory Committee's recommendation that rules for unlicensed devices be designed to avoid creating obstacles to future reallocation of the band.³²⁴ APCO also supports requiring, wherever possible, that unlicensed devices be capable of modification through over-the-air firmware updates as the harm resulting from interference from unlicensed devices is potentially irreversible.³²⁵ Sirius XM also advocates that new unlicensed devices be capable of changing operating parameters through over-the-air firmware updates to address interference to its satellite radio system from unlicensed devices that are in the hands of consumers.³²⁶ Utilities Technology Council recommends that the Commission require all new unlicensed devices to accept mandatory firmware updates that alter their operating parameters to allow devices to be changed in the future for enhanced efficiency and improved spectrum management.³²⁷

79. While AT&T and others assert that requiring unlicensed devices to be capable of firmware updates could have many benefits, such as permitting devices to adjust their operations to account for changing priorities in spectrum demand and evolving technology capabilities or to address interference issues, such a mandate could be complex and was not raised in the *6 GHz Second FNPRM*. Accordingly, 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 VLP devices in the U-NII-6 and U-NII-8 bands we do not believe such a mandate is necessary. Therefore, we will not impose a

³¹⁸ *Id.* at 10599-10600, paras. 168-72.

³¹⁹ To be clear, we are not addressing these other issues raised in the *6 GHz Second FNPRM* here, and they remain open for resolution in this proceeding. For the reasons discussed in this *Third Report and Order*, we believe that the benefits of expanding VLP operation to the entire 6 GHz band are clear enough at this time that such expansion should not be delayed pending resolution of other issues in this docket.

³²⁰ Wi-Fi Alliance Comments at n.38; IEEE 802 LAN/MAN Standards Committee (Paul Nikolich) Comments at 3-4.

³²¹ IEEE 802 LAN/MAN Standards Committee (Paul Nikolich) Comments at 4.

³²² Apple, Broadcom et al. June 28, 2024 *Ex Parte* at 8.

³²³ AT&T Comments at 6-7.

³²⁴ *Id.* at 7.

³²⁵ APCO Reply at 3.

³²⁶ Sirius XM Oct. 9, 2024 *Ex Parte* at 2; Sirius XM Nov. 5, 2024 *Ex Parte* at 5-6.

³²⁷ Utilities Technology Council Nov. 28, 2024 *Ex Parte* at 2.

firmware update mandate on VLP devices. However, we note that the vast majority of today's devices have capability for firmware updates as manufacturers routinely make changes and upgrades to correct bugs, enable more efficient operation, or add capabilities. Thus, even absent a Commission mandate, we expect that most, if not all, VLP devices will have the ability to receive firmware updates, including updates to change a device's ability to transmit on certain frequencies, if such an update is necessary.³²⁸

80. *Transmit Power Control (TPC)*. The VLP rules require that VLP devices employ a TPC mechanism that has the capability to operate at least 6 dB below the maximum -5 dBm/MHz EIRP PSD.³²⁹ The Ultra Wide Band Alliance suggests that the Commission expand the TPC requirement beyond the 6 dB level.³³⁰ The Ultra Wide Band Alliance notes there are many benefits to using only the power required for a given link, such as reducing the area that could be impacted, increasing device density, and increasing the overall capacity of the band.³³¹ While the Ultra Wide Band Alliance encourages the Commission to consider technical requirements for use of TPC that will "encourage innovation in intelligent TPC as part of link adaptation schemes," it does not provide any concrete proposal on what specific TPC rules the Commission should require.³³² Without a specific proposal, we are unable to evaluate the merits of their request or the impact it would have on VLP operations.

F. Benefits and Cost

81. In the *6 GHz Second FNPRM*, the Commission sought comment on whether allowing VLP devices in the U-NII-6 and U-NII-8 bands will yield comparable benefits to those that stem from allowing VLP devices in the U-NII-5 and U-NII-7 bands in the *6 GHz Second Order*.³³³ The Commission tentatively concluded that at a minimum the benefits would be in proportion to the amount of spectrum in the U-NII-6 and U-NII-8 bands relative to the amount of spectrum in the U-NII-5 and U-NII-7 bands.³³⁴ No commenter objected to this methodology so we will estimate benefits on that basis.

82. The *6 GHz Second Order* found a lower bound of the benefit of opening the U-NII-5 and U-NII-7 bands to unlicensed use to be \$2 billion.³³⁵ We expect unlicensed uses in the U-NII-6 and U-NII-8 bands to be similar, but with less megahertz of spectrum involved compared to the U-NII-5 and U-NII-7 bands. To approximate a new lower bound of benefits, we therefore multiply the ratio of the sum of megahertz of spectrum in the U-NII-6 and U-NII-8 bands to the sum of megahertz of spectrum in the U-NII-5 and U-NII-7 MHz bands by \$2 billion, resulting in \$820 million of expected benefits.³³⁶ This lower bound also does not include any benefits that may come from creating a large contiguous band of spectrum for unlicensed use, which may allow greater speed and decreased latency. In any case, these benefits will be well in excess of the costs that we estimate.

³²⁸ Sirius XM Nov. 27, 2024 *Ex Parte* at 1.

³²⁹ 47 CFR § 15.407(d)(10).

³³⁰ Ultra Wide Band (UWB) Alliance Comments at 6.

³³¹ *Id.* at 7. The Ultra Wide Band Alliance states that the ability to set power below the currently mandated 8 dBm EIRP would benefit all users. *Id.* at 7-8. We are uncertain what 8 dBm mandate they are referring to.

³³² *Id.* at 7.

³³³ *6 GHz Second FNPRM*, 38 FCC Rcd at 10600-01, para. 173.

³³⁴ *Id.* at 10601, para. 173.

³³⁵ *6 GHz Second Order*, 38 FCC Rcd at 10575-6, para. 102.

³³⁶ The U-NII-5 band contains 500 megahertz of spectrum, the U-NII-6 band contains 100 megahertz, the U-NII-7 band contains 350 megahertz, and the U-NII-8 band contains 250 megahertz. The ratio of the sum of megahertz of spectrum in the U-NII-6 and U-NII-8 bands to the sum of megahertz of spectrum in the U-NII-5 and U-NII-7 bands is therefore $(100 \text{ MHz} + 250 \text{ MHz}) / (500 \text{ MHz} + 350 \text{ MHz}) = 0.41$. The estimated benefits of unlicensed use in the U-NII-6 and U-NII-8 bands is therefore $0.41 \times \$2 \text{ billion} = \820 million .

83. Because any changes to the design of VLP devices will be voluntary for device manufacturers, the rules that we promulgate do not have net cost implications for the existing unlicensed device ecosystem. Manufacturers will change designs only if the additional revenue from taking advantage of the U-NII-6 and U-NII-8 bands outweighs the costs of redesign. And because the harmful interference risk to incumbent operators is insignificant and we are not imposing any specific requirements on any incumbent operator, there are also no cost implications on them. Thus, by promulgating these rules to enable VLP devices to operate in the U-NII-6 and U-NII-8 portions of the 6 GHz band, significant economic benefits will be bestowed on the American public.

G. Table of Frequency Allocations

84. Finally, we take this opportunity to reinstate the text of international footnotes 5.458A and 5.458B in the Table of Frequency Allocations (Table), section 2.106 of our rules.³³⁷ This text was inadvertently removed when we implemented formatting changes to accommodate the Office of the Federal Register's publication guidelines, even though the underlying citations to these footnotes continued to be printed in the graphical portion of the Table under both the International Table and the United States Table columns.³³⁸ Because this change is editorial and does not alter the substance of these pre-existing footnotes, we find good cause to conclude that notice and comment are not necessary for its adoption.

IV. PROCEDURAL MATTERS

85. *Regulatory Flexibility Act.* The Regulatory Flexibility Act of 1980, as amended (RFA),³³⁹ requires that an agency prepare a regulatory flexibility analysis for notice-and-comment rulemaking, unless the agency certifies that “the rule will not, if promulgated, have a significant economic impact on a substantial number of small entities.”³⁴⁰ Accordingly, we have prepared a Final Regulatory Flexibility Analysis (FRFA) concerning the possible impact of the rule and policy changes contained in this *Third Report and Order* on small entities. The FRFA is set forth in Appendix B.

86. *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.

87. *Paperwork Reduction Act.* This document does not contain new or modified information collection requirements subject to the Paperwork Reduction Act of 1995, Public Law 104-13. 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, Public Law 107-198, 44 U.S.C. § 3506(c)(4).

88. *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 *Third Report and Order* to Congress and the Government Accountability Office pursuant to 5 U.S.C. § 801(a)(1)(A).

89. *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.

³³⁷ 47 C.F.R. § 2.106(b)(458)(i) and (ii).

³³⁸ 47 C.F.R. § 2.106(a) at p. 44, 6700-7075 GHz block (International Table) and 6700-6875 GHz, 6875-7025 GHz, and 7025-7075 GHz blocks (United States Table).

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

³⁴⁰ 5 U.S.C. § 605(b).

V. ORDERING CLAUSES

90. Accordingly, IT IS ORDERED, 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 *Third Report and Order* is hereby ADOPTED.

91. IT IS FURTHER ORDERED that the amendments of the Commission's rules as set forth in Appendix A ARE ADOPTED, effective 60 days from the date of publication in the Federal Register.

92. IT IS FURTHER ORDERED that the Office of the Secretary, SHALL SEND a copy of this *Third Report and Order*, including the Final Regulatory Flexibility Analysis, to the Chief Counsel for Advocacy of the Small Business Administration.

93. IT IS FURTHER ORDERED that the Office of Managing Director, Performance Program Management, SHALL SEND a copy of this *Third 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

APPENDIX A

Final Rules

For the reasons discussed in the preamble, the Federal Communications Commission amends 47 CFR parts 2 and 15 as follows:

PART 2 – FREQUENCY ALLOCATIONS AND RADIO TREATY MATTERS; GENERAL RULES AND REGULATIONS

1. The authority citation for part 2 continues to read as follows:

AUTHORITY: 47 U.S.C. 154, 302a, 303, and 336, unless otherwise noted.

2. Amend § 2.106(b)(458) by adding paragraphs (i) and (ii) to read as follows:

§ 2.106 Table of Frequency Allocations.

* * * * *

(b) * * *

(458) * * *

(i) 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.

(ii) 5.458B The space-to-Earth allocation to the fixed-satellite service in the band 6700-7075 MHz is limited to feeder links for non-geostationary satellite systems of the mobile-satellite service and is subject to coordination under No. 9.11A. The use of the band 6700-7075 MHz (space-to-Earth) by feeder links for non-geostationary satellite systems in the mobile-satellite service is not subject to No. 22.2.

* * * * *

PART 15 – RADIO FREQUENCY DEVICES

3. 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.

4. Amend § 15.403 by revising the definition of “Very low power device” to read as follows:

§ 15.403 Definitions.

* * * * *

Very low power device. For the purpose of this subpart, a device that operates in the 5.925-7.125 GHz band and has an integrated antenna. These devices do not need to operate under the control of an access point.

* * * * *

5. Amend §15.407 by revising paragraphs (a)(9) and (d)(10) to read as follows:

§ 15.407 General technical requirements.

(a) * * *

- (9) For very low power devices operating in the 5.925-7.125 GHz band, the maximum power spectral density must not exceed -5 dBm e.i.r.p in any 1-megahertz band and the maximum e.i.r.p must not exceed 14 dBm.

* * * * *

(d) * * *

- (10) Very low power devices operating in the 5.925-7.125 GHz band shall employ a transmit power control (TPC) mechanism. A very low power device is required to have the capability to operate at least 6 dB below the maximum EIRP PSD value of -5 dBm/ MHz.

APPENDIX B**Final Regulatory Flexibility Analysis**

1. As required by the Regulatory Flexibility Act of 1980, as amended (RFA),¹ an Initial Regulatory Flexibility Analysis (IRFA) was incorporated in the *Unlicensed Use of the 6 GHz Band*, 2nd *Further Notice of Proposed Rulemaking (Notice)* released in November 2023.² The Commission sought written public comment on the proposals in the *Notice*, including comment on the IRFA.³ No comments were filed addressing the IRFA. This present Final Regulatory Flexibility Analysis (FRFA) conforms to the RFA.⁴

A. Need for, and Objectives of, the Third Report and Order

2. In the *Third Report and Order*, the Commission is expanding unlicensed very low power (VLP) device operation to the entire 6 GHz band (5925-7125 MHz). This pivotal move will provide greater flexibility to small and other entities that provide or use VLP devices by making additional spectrum available for these versatile portable devices, thereby empowering groundbreaking applications such as augmented and virtual reality. Currently VLP devices are restricted to the U-NII-5 (5925-6425 MHz) and U-NII-7 (6525-6874 MHz) portions of the 6 GHz band. Opening up the U-NII-6 (6425-6525 MHz) and U-NII-8 (6875-7125 MHz) portions of the band for VLP devices will create benefits in proportion to the amount of spectrum in U-NII-6 and U-NII-8 bands comparative to the amount of spectrum in the U-NII-5 and U-NII-7 bands. In addition, the adopted rules will maintain the same power levels and operational requirements as currently apply to VLP devices in the U-NII-5 and U-NII-7 bands. The innovations provided by VLP devices through expanded use of the 6 GHz band will significantly benefit small and other businesses, enhance occasions for learning, advance healthcare opportunities, and create new entertainment experiences, thus paving the way for more intensive use of valuable spectrum resources and the deployment of transformative new technologies for American consumers.

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

3. There were no comments filed that specifically addressed the proposed rules and policies presented in the IRFA.

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

4. Pursuant to the Small Business Jobs Act of 2010, which amended the RFA, the Commission is required to respond to any comments filed by the Chief Counsel for Advocacy of the Small Business Administration (SBA), and to provide a detailed statement of any change made to the proposed rules as a result of those comments.⁵

5. The Chief Counsel did not file any comments in response to the proposed rule(s) in this proceeding.

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

² *Unlicensed Use of the 6 GHz Band*, ET Docket No. 18-295, 2nd Notice of Proposed Rulemaking, FCC 23-86, (rel. Nov. 1, 2023) (*Notice*).

³ *See generally Notice*.

⁴ 5 U.S.C. § 604.

⁵ *Id.* § 604 (a)(3).

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 rules adopted herein.⁶ The RFA generally defines the term “small entity” as having the same meaning as the terms “small business,” “small organization,” and “small governmental jurisdiction.”⁷ In addition, the term “small business” has the same meaning as the term “small business concern” under the Small Business Act.⁸ A “small 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. *Small Businesses, Small Organizations, Small Governmental Jurisdictions.* Our actions, over time, may affect small entities that are not easily categorized at present. We therefore describe, at the outset, three broad groups of small entities that could be directly affected herein.¹⁰ First, while there are industry specific size standards for small businesses that are used in the regulatory flexibility analysis, according to data from the Small Business Administration’s (SBA) Office of Advocacy, in general a small business is an independent business having fewer than 500 employees.¹¹ These types of small businesses represent 99.9% of all businesses in the United States, which translates to 33.2 million businesses.¹²

8. Next, the type of small entity described as a “small organization” is generally “any not-for-profit enterprise which is independently owned and operated and is not dominant in its field.”¹³ The Internal Revenue Service (IRS) uses a revenue benchmark of \$50,000 or less to delineate its annual electronic filing requirements for small exempt organizations.¹⁴ Nationwide, for tax year 2022, there were approximately 530,109 small exempt organizations in the U.S. reporting revenues of \$50,000 or less according to the registration and tax data for exempt organizations available from the IRS.¹⁵

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, “What’s New With Small Business?,” <https://advocacy.sba.gov/wp-content/uploads/2023/03/Whats-New-Infographic-March-2023-508c.pdf> (Mar. 2023).

¹² *Id.*

¹³ 5 U.S.C. § 601(4).

¹⁴ The IRS benchmark is similar to the population of less than 50,000 benchmark in 5 U.S.C § 601(5) that is used to define a small governmental jurisdiction. Therefore, the IRS benchmark has been used to estimate the number of small organizations in this small entity description. See Annual Electronic Filing Requirement for Small Exempt Organizations – Form 990-N (e-Postcard), “Who must file,” <https://www.irs.gov/charities-non-profits/annual-electronic-filing-requirement-for-small-exempt-organizations-form-990-n-e-postcard>. We note that the IRS data does not provide information on whether a small exempt organization is independently owned and operated or dominant in its field.

¹⁵ See Exempt Organizations Business Master File Extract (EO BMF), “CSV Files by Region,” <https://www.irs.gov/charities-non-profits/exempt-organizations-business-master-file-extract-eo-bmf>. The IRS Exempt Organization Business Master File (EO BMF) Extract provides information on all registered tax-exempt/non-profit organizations. The data utilized for purposes of this description was extracted from the IRS EO

(continued....)

9. Finally, the small entity described as a “small governmental jurisdiction” is defined generally as “governments of cities, counties, towns, townships, villages, school districts, or special districts, with a population of less than fifty thousand.”¹⁶ U.S. Census Bureau data from the 2022 Census of Governments¹⁷ indicate there were 90,837 local governmental jurisdictions consisting of general purpose governments and special purpose governments in the United States.¹⁸ Of this number, there were 36,845 general purpose governments (county,¹⁹ municipal, and town or township²⁰) with populations of less than 50,000 and 11,879 special purpose governments (independent school districts²¹) with enrollment populations of less than 50,000.²² Accordingly, based on the 2022 U.S. Census of Governments data, we estimate that at least 48,724 entities fall into the category of “small governmental jurisdictions.”²³

10. *Fixed Microwave Services.* Fixed microwave services include common carrier,²⁴ private-operational fixed,²⁵ and broadcast auxiliary radio services.²⁶ They also include the Upper Microwave

(Continued from previous page)

BMF data for businesses for the tax year 2022 with revenue less than or equal to \$50,000 for Region 1-Northeast Area (71,897), Region 2-Mid-Atlantic and Great Lakes Areas (197,296), and Region 3-Gulf Coast and Pacific Coast Areas (260,447) that includes the continental U.S., Alaska, and Hawaii. This data includes information for Puerto Rico (469).

¹⁶ 5 U.S.C. § 601(5).

¹⁷ 13 U.S.C. § 161. The Census of Governments survey is conducted every five (5) years compiling data for years ending with “2” and “7”. See also Census of Governments, <https://www.census.gov/programs-surveys/economic-census/year/2022/about.html>.

¹⁸ See U.S. Census Bureau, 2022 Census of Governments – Organization Table 2. Local Governments by Type and State: 2022 [CG2200ORG02], <https://www.census.gov/data/tables/2022/econ/gus/2022-governments.html>. Local governmental jurisdictions are made up of general purpose governments (county, municipal and town or township) and special purpose governments (special districts and independent school districts). See also tbl.2. CG2200ORG02 Table Notes_Local Governments by Type and State_2022.

¹⁹ See *id.* at tbl.5. County Governments by Population-Size Group and State: 2022 [CG2200ORG05], <https://www.census.gov/data/tables/2022/econ/gus/2022-governments.html>. There were 2,097 county governments with populations less than 50,000. This category does not include subcounty (municipal and township) governments.

²⁰ See *id.* at tbl.6. Subcounty General-Purpose Governments by Population-Size Group and State: 2022 [CG2200ORG06], <https://www.census.gov/data/tables/2022/econ/gus/2022-governments.html>. There were 18,693 municipal and 16,055 town and township governments with populations less than 50,000.

²¹ See *id.* at tbl.10. Elementary and Secondary School Systems by Enrollment-Size Group and State: 2022 [CG2200ORG10], <https://www.census.gov/data/tables/2022/econ/gus/2022-governments.html>. There were 11,879 independent school districts with enrollment populations less than 50,000. See also tbl.4. Special-Purpose Local Governments by State Census Years 1942 to 2022 [CG2200ORG04], CG2200ORG04 Table Notes_Special Purpose Local Governments by State_Census Years 1942 to 2022.

²² While the special purpose governments category also includes local special district governments, the 2022 Census of Governments data does not provide data aggregated based on population size for the special purpose governments category. Therefore, only data from independent school districts is included in the special purpose governments category.

²³ This total is derived from the sum of the number of general purpose governments (county, municipal and town or township) with populations of less than 50,000 (36,845) and the number of special purpose governments - independent school districts with enrollment populations of less than 50,000 (11,879), from the 2022 Census of Governments - Organizations tbls. 5, 6 & 10.

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

²⁵ See *id.* Subparts C and H.

²⁶ Auxiliary Microwave Service is governed by Part 74 of Title 47 of the Commission’s Rules. See 47 CFR Part 74. Available to licensees of broadcast stations and to broadcast and cable network entities, broadcast auxiliary

(continued....)

Flexible Use Service (UMFUS),²⁷ Millimeter Wave Service (70/80/90 GHz),²⁸ Local Multipoint Distribution Service (LMDS),²⁹ the Digital Electronic Message Service (DEMS),³⁰ 24 GHz Service,³¹ Multiple Address Systems (MAS),³² and Multichannel Video Distribution and Data Service (MVDDS),³³ where in some bands licensees can choose between common carrier and non-common carrier status.³⁴ Wireless Telecommunications Carriers (*except Satellite*)³⁵ is the closest industry with a SBA small business size standard applicable to these services. The SBA small size standard for this industry classifies a business as small if it has 1,500 or fewer employees.³⁶ U.S. Census Bureau data for 2017 show that there were 2,893 firms that operated in this industry for the entire year.³⁷ Of this number, 2,837 firms employed fewer than 250 employees.³⁸ Thus under the SBA size standard, the Commission estimates that a majority of fixed microwave service licensees can be considered small.

11. The Commission's small business size standards with respect to fixed microwave services involve eligibility for bidding credits and installment payments in the auction of licenses for the various frequency bands included in fixed microwave services. When bidding credits are adopted for the auction of licenses in fixed microwave services frequency bands, such credits may be available to several types of small businesses based average gross revenues (small, very small and entrepreneur) pursuant to the competitive bidding rules adopted in conjunction with the requirements for the auction and/or as identified in Part 101 of the Commission's rules for the specific fixed microwave services frequency bands.³⁹

12. In frequency bands where licenses were subject to auction, the Commission notes that as a general matter, the number of winning bidders that qualify as small businesses at the close of an auction does not necessarily represent the number of small businesses currently in service. Further, the Commission does not generally track subsequent business size unless, in the context of assignments or transfers, unjust enrichment issues are implicated. Additionally, since the Commission does not collect data on the number of employees for licensees providing these services, at this time we are not able to

(Continued from previous page) —————

microwave stations are used for relaying broadcast television signals from the studio to the transmitter, or between two points such as a main studio and an auxiliary studio. The service also includes mobile TV pickups, which relay signals from a remote location back to the studio.

²⁷ See 47 CFR Part 30.

²⁸ See 47 CFR Part 101, Subpart Q.

²⁹ See *id.* Subpart L.

³⁰ See *id.* Subpart G.

³¹ See *id.*

³² See *id.* Subpart O.

³³ See *id.* Subpart P.

³⁴ See 47 CFR §§ 101.533, 101.1017.

³⁵ See U.S. Census Bureau, *2017 NAICS Definition*, "517312 Wireless Telecommunications Carriers (*except Satellite*)," <https://www.census.gov/naics/?input=517312&year=2017&details=517312>.

³⁶ See 13 CFR § 121.201, NAICS Code 517312 (as of 10/1/22, NAICS Code 517112).

³⁷ See U.S. Census Bureau, *2017 Economic Census of the United States, Employment Size of Firms for the U.S.: 2017*, Table ID: EC1700SIZEEMPFIEM, NAICS Code 517312, <https://data.census.gov/cedsci/table?y=2017&n=517312&tid=ECNSIZE2017.EC1700SIZEEMPFIEM&hidePrevie w=false>. At this time, the 2022 Economic Census data is not available.

³⁸ *Id.* The available U.S. Census Bureau data does not provide a more precise estimate of the number of firms that meet the SBA size standard.

³⁹ See 47 CFR §§ 101.538(a)(1)-(3), 101.1112(b)-(d), 101.1319(a)(1)-(2), and 101.1429(a)(1)-(3).

estimate the number of licensees with active licenses that would qualify as small under the SBA's small business size standard.

13. *Public Safety Radio Licensees.* As a general matter, Public Safety Radio Pool licensees include police, fire, local government, forestry conservation, highway maintenance, and emergency medical services.⁴⁰ Because of the vast array of public safety licensees, the Commission has not developed a small business size standard specifically applicable to public safety licensees. Wireless Telecommunications Carriers (*except* Satellite)⁴¹ is the closest industry with a SBA small business size standard applicable to these services. The SBA small business size standard for this industry classifies a business as small if it has 1,500 or fewer employees.⁴² U.S. Census Bureau data for 2017 show that there were 2,893 firms that operated in this industry for the entire year.⁴³ Of this number, 2,837 firms employed fewer than 250 employees.⁴⁴ Thus under the SBA size standard, the Commission estimates that a majority of licensees in this industry can be considered small.

14. With respect to local governments, in particular, since many governmental entities comprise the licensees for these services, we include under public safety services the number of government entities affected. According to Commission records as of December 2021, there were approximately 127,019 active licenses within these services.⁴⁵ Included in this number were 3,577 active licenses in the Public Safety 4.9 GHz band.⁴⁶ Since the Commission does not collect data on the number of employees for licensees providing these services, at this time we are therefore not able to estimate the

⁴⁰ See subparts A and B of Part 90 of the Commission's Rules, 47 CFR §§ 90.1-90.22. Police licensees serve state, county, and municipal enforcement through telephony (voice), telegraphy (code), and teletype and facsimile (printed material). Fire licensees are comprised of private volunteer or professional fire companies, as well as units under governmental control. Public Safety Radio Pool licensees also include state, county, or municipal entities that use radio for official purposes. State departments of conservation and private forest organizations comprise forestry service licensees that set up communications networks among fire lookout towers and ground crews. State and local governments are highway maintenance licensees that provide emergency and routine communications to aid other public safety services to keep main roads safe for vehicular traffic. Emergency medical licensees use these channels for emergency medical service communications related to the delivery of emergency medical treatment. Additional licensees include medical services, rescue organizations, veterinarians, persons with disabilities, disaster relief organizations, school buses, beach patrols, establishments in isolated areas, communications standby facilities, and emergency repair of public communications facilities.

⁴¹ See U.S. Census Bureau, *2017 NAICS Definition*, "517312 Wireless Telecommunications Carriers (*except* Satellite)," <https://www.census.gov/naics/?input=517312&year=2017&details=517312>.

⁴² See 13 CFR § 121.201, NAICS Code 517312 (as of 10/1/22, NAICS Code 517112).

⁴³ See U.S. Census Bureau, *2017 Economic Census of the United States, Employment Size of Firms for the U.S.: 2017*, Table ID: EC1700SIZEEMPFIEM, NAICS Code 517312, <https://data.census.gov/cedsci/table?y=2017&n=517312&tid=ECNSIZE2017.EC1700SIZEEMPFIEM&hidePreview=false>. At this time, the 2022 Economic Census data is not available.

⁴⁴ *Id.* The available U.S. Census Bureau data does not provide a more precise estimate of the number of firms that meet the SBA size standard.

⁴⁵ Based on a FCC Universal Licensing System search on December 13, 2021. <https://wireless2.fcc.gov/UlsApp/UlsSearch/searchAdvanced.jsp>. Search parameters: Service Group = All, "Match only the following radio service(s)", Radio Service = GE, GF, GP, PA, PW, YE, YF, YP, YW; Authorization Type = All; Status = Active. We note that the number of active licenses does not equate to the number of licensees. A licensee can have one or more licenses.

⁴⁶ Based on a FCC Universal Licensing System search on December 13, 2021. <https://wireless2.fcc.gov/UlsApp/UlsSearch/searchAdvanced.jsp>. Search parameters: Service Group = All, "Match only the following radio service(s)", Radio Service = PA; Authorization Type = All; Status = Active. We note that the number of active licenses does not equate to the number of licensees. A licensee can have one or more licenses.

number of licensees with active licenses that would qualify as small under the SBA's small business size standard.

15. *Satellite Telecommunications.* This industry comprises firms "primarily engaged in providing telecommunications services to other establishments in the telecommunications and broadcasting industries by forwarding and receiving communications signals via a system of satellites or reselling satellite telecommunications."⁴⁷ Satellite telecommunications service providers include satellite and earth station operators. The SBA small business size standard for this industry classifies a business with \$44 million or less in annual receipts as small.⁴⁸ U.S. Census Bureau data for 2017 show that 275 firms in this industry operated for the entire year.⁴⁹ Of this number, 242 firms had revenue of less than \$25 million.⁵⁰ Additionally, based on Commission data in the 2022 Universal Service Monitoring Report, as of December 31, 2021, there were 65 providers that reported they were engaged in the provision of satellite telecommunications services.⁵¹ Of these providers, the Commission estimates that approximately 42 providers have 1,500 or fewer employees.⁵² Consequently, using the SBA's small business size standard, a little more than half of these providers can be considered small entities.

16. *Auxiliary, Special Broadcast and Other Program Distribution Services.* This service involves a variety of transmitters, generally used to relay broadcast programming to the public (through translator and booster stations) or within the program distribution chain (from a remote news gathering unit back to the station). Neither the SBA nor the Commission have developed a small business size standard applicable to broadcast auxiliary licensees. The closest applicable industries with a SBA small business size standard fall within two industries - Radio Stations⁵³ and Television Broadcasting.⁵⁴ The SBA small business size standard for Radio Stations classifies firms having \$47 million or less in annual receipts as small.⁵⁵ U.S. Census Bureau data for 2017 show that 2,963 firms operated in this industry during that year.⁵⁶ Of that number, 1,879 firms operated with revenue of less than \$25 million per year.⁵⁷

⁴⁷ See U.S. Census Bureau, *2017 NAICS Definition, "517410 Satellite Telecommunications,"* <https://www.census.gov/naics/?input=517410&year=2017&details=517410>.

⁴⁸ See 13 CFR § 121.201, NAICS Code 517410.

⁴⁹ See U.S. Census Bureau, *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, NAICS Code 517410, <https://data.census.gov/cedsci/table?y=2017&n=517410&tid=ECNSIZE2017.EC1700SIZEREVFIRM&hidePreview=false>. At this time, the 2022 Economic Census data is not available.

⁵⁰ *Id.* The available U.S. Census Bureau data does not provide a more precise estimate of the number of firms that meet the SBA size standard. We also note that according to the U.S. Census Bureau glossary, the terms receipts and revenues are used interchangeably, see https://www.census.gov/glossary/#term_ReceiptsRevenueServices.

⁵¹ Federal-State Joint Board on Universal Service, Universal Service Monitoring Report at 26, Table 1.12 (2022), <https://docs.fcc.gov/public/attachments/DOC-391070A1.pdf>.

⁵² *Id.*

⁵³ See U.S. Census Bureau, *2017 NAICS Definition, "515112 Radio Stations,"* <https://www.census.gov/naics/?input=515112&year=2017&details=515112>.

⁵⁴ See U.S. Census Bureau, *2017 NAICS Definition, "515120 Television Broadcasting,"* <https://www.census.gov/naics/?input=515120&year=2017&details=515120>.

⁵⁵ See 13 CFR § 121.201, NAICS Code 515112 (as of 10/1/22 NAICS Code 516110).

⁵⁶ See U.S. Census Bureau, *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, NAICS Code 515112, <https://data.census.gov/cedsci/table?y=2017&n=515112&tid=ECNSIZE2017.EC1700SIZEREVFIRM&hidePreview=false>. At this time, the 2022 Economic Census data is not available. We note that the US Census Bureau withheld publication of the number of firms that operated for the entire year.

For Television Broadcasting, the SBA small business size standard also classifies firms having \$47 million or less in annual receipts as small.⁵⁸ U.S. Census Bureau data for 2017 show that 744 firms in this industry operated for the entire year.⁵⁹ Of that number, 657 firms had revenue of less than \$25 million per year.⁶⁰ Accordingly, based on the U.S. Census Bureau data for Radio Stations and Television Broadcasting, the Commission estimates that the majority of Auxiliary, Special Broadcast and Other Program Distribution Services firms are small under the SBA size standard.

17. *Fixed Satellite Small Transmit/Receive Earth Stations.* Neither the SBA nor the Commission have developed a small business size standard specifically applicable to Fixed Satellite Small Transmit/Receive Earth Stations. Satellite Telecommunications⁶¹ is the closest industry with an SBA small business size standard. The SBA size standard for this industry classifies a business as small if it has \$44 million or less in annual receipts.⁶² For this industry, U.S. Census Bureau data for 2017 show that there was a total of 275 firms that operated for the entire year.⁶³ Of this total, 242 firms had revenue of less than \$25 million.⁶⁴ Additionally, based on Commission data in the 2022 Universal Service Monitoring Report, as of December 31, 2021, there were 65 providers that reported they were engaged in the provision of satellite telecommunications services.⁶⁵ Of these providers, the Commission estimates that approximately 42 providers have 1,500 or fewer employees.⁶⁶ Consequently, using the SBA's small business size standard, a little more than half of these providers can be considered small entities.

(Continued from previous page)

⁵⁷ *Id.* The available U.S. Census Bureau data does not provide a more precise estimate of the number of firms that meet the SBA size standard. We note that the U.S. Census Bureau withheld publication of the number of firms that operated with sales/value of shipments/revenue in the individual categories for less than \$100,000, and \$100,000 to \$249,999 to avoid disclosing data for individual companies (see Cell Notes for the sales/value of shipments/revenue in these categories). Therefore, the number of firms with revenue that meet the SBA size standard would be higher than noted herein. We also note that according to the U.S. Census Bureau glossary, the terms receipts and revenues are used interchangeably, see https://www.census.gov/glossary/#term_ReceiptsRevenueServices.

⁵⁸ See 13 CFR § 121.201, NAICS Code 515120 (as of 10/1/22 NAICS Code 516120).

⁵⁹ See U.S. Census Bureau, *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, NAICS Code 515120, <https://data.census.gov/cedsci/table?y=2017&n=515120&tid=ECNSIZE2017.EC1700SIZEREVFIRM&hidePreview=false>. At this time, the 2022 Economic Census data is not available.

⁶⁰ *Id.* The available U.S. Census Bureau data does not provide a more precise estimate of the number of firms that meet the SBA size standard. We also note that according to the U.S. Census Bureau glossary, the terms receipts and revenues are used interchangeably, see https://www.census.gov/glossary/#term_ReceiptsRevenueServices.

⁶¹ See U.S. Census Bureau, *2017 NAICS Definition, "517410 Satellite Telecommunications,"* <https://www.census.gov/naics/?input=517410&year=2017&details=517410>.

⁶² See 13 CFR § 121.201, NAICS Code 517410.

⁶³ See U.S. Census Bureau, *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, NAICS Code 517410, <https://data.census.gov/cedsci/table?y=2017&n=517410&tid=ECNSIZE2017.EC1700SIZEREVFIRM&hidePreview=false>. At this time, the 2022 Economic Census data is not available.

⁶⁴ *Id.* The available U.S. Census Bureau data does not provide a more precise estimate of the number of firms that meet the SBA size standard. We also note that according to the U.S. Census Bureau glossary, the terms receipts and revenues are used interchangeably, see https://www.census.gov/glossary/#term_ReceiptsRevenueServices.

⁶⁵ Federal-State Joint Board on Universal Service, Universal Service Monitoring Report at 26, Table 1.12 (2022), <https://docs.fcc.gov/public/attachments/DOC-391070A1.pdf>.

⁶⁶ *Id.*

E. Description of Projected Reporting, Recordkeeping, and Other Compliance Requirements for Small Entities

18. The rules adopted in the *Third Report & Order* will impose new or modified reporting, recordkeeping or other compliance requirements on small and other entities. Specifically, manufacturers of VLP devices will be required to obtain certification of their devices from the Commission to ensure they comply with the Commission's technical rules. Further, we will require applicants for certification of VLP devices to show in their application for device certification how their devices will comply with all technical requirements set in the *Third Report and Order*. This certification requirement is the same as currently applies to VLP devices that operate in the U-NII-5 and U-NII-7 portions of the 6 GHz band. This requirement will not increase the cost of applying for certification.

19. At this time, the Commission is not in a position to determine whether these new rules will require small entities to hire attorneys, engineers, consultants, or other professionals. However, the adopted rules will provide opportunities for small entities to grow their businesses by allowing VLP devices to operate across the U-NII-6 and U-NII-8 portions of the 6 GHz band under the same technical rules under which they are currently permitted to operate in the U-NII-5 and U-NII-7 portions of the band. In addition, any changes to the design of VLP devices by device manufacturers is voluntary. Therefore, there is no net cost implied for existing unlicensed device ecosystem nor cost implications on incumbent operators since the promulgating rules does not mention any specific requirements. It is optional for manufacturers to change designs only if the additional revenue from taking advantage of the new accessible bands outweighs the cost of the redesign.

20. The Commission currently estimates the economic value to service providers operating in the 6 GHz band will vastly exceed their cost. By opening the same access to the U-NII-6 and U-NII-8 portions of the 6 GHz band, the adopted rules will foster extensive growth in the market for VLP devices. For example, one report estimated that VLP devices would produce over \$39 billion in economic value over five years.⁶⁷ Lastly, the adopted rules will permit unlicensed small entities to operate VLP devices across the entire 6 GHz band without the additional complications or costs incurred to obtain a license.

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

21. 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."⁶⁸

22. The rules adopted by the Commission in the *Third Report and Order* should benefit small entities by giving them more options for gaining access to valuable spectrum while creating little to no harmful interference to licensed incumbents sharing the 6 GHz band. Through comments provided during the rulemaking proceeding, the Commission considered various proposals from small and other entities. The adopted rules reflect the Commission's efforts to balance the desire of unlicensed VLP device operators, some of which are small entities, to utilize additional 6 GHz band spectrum with as much power as possible to maximize the benefits provided to their customers while protecting small entities and other incumbent operators in the 6 GHz band from harmful interference that could potentially create a significant economic impact to their businesses. Additionally, the Commission considered alternative proposals and weighed their benefits against their potential costs to small businesses and other entities. For example, the Commission considered comments by licensees who conduct electronic

⁶⁷ 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>.

⁶⁸ 5 U.S.C. § 604(a)(6).

newsgathering (ENG) that a portion of the 6 GHz band be reserved for such mobile operations. The Commission also considered a proposal that all new unlicensed VLP devices be required to accept mandatory firmware updates that alter their operating parameters which will allow unlicensed performance to be changed in the future, enhancing efficiency and improving spectrum management. However, the Commission concluded that adopting either of these proposals would be both unnecessary and burdensome, as the risk of harmful interference from VLP devices operating at that same power level of U-NII-5 and U-NII-7 VLP devices is insignificant and would create an unnecessary cost to small and other VLP device operators.

23. Many of the entities holding licenses for use of the 6 GHz band qualify as small entities. The adopted rules will permit VLP devices to operate across the U-NII-6 and U-NII-8 sub-bands of the 6 GHz band at a power level no greater than -5 dBm/MHz EIRP power spectral density and 14 dBm EIRP. The adopted rules for unlicensed operation in this band are designed to prevent the unlicensed VLP devices from causing harmful interference to the licensed services operating in the band such as electronic newsgathering and other video broadcasting related applications, satellite operators, and fixed microwave links which also operate in portions of the U-NII-6 and U-NII-8 sub-bands. 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 unlicensed VLP devices to operate in the 6 GHz band.

24. 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 VLP devices under the adopted rules and that this would also provide small entities with access to valuable spectrum without the expense and inconvenience of having to obtain a license. The Commission believes that the rules adopted in the *Third Report and Order*, which permit VLP devices to operate in the entire 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

25. The Commission will send a copy of the *Third Report and Order*, including this FRFA, in a report to Congress pursuant to the Congressional Review Act.⁶⁹ In addition, the Commission will send a copy of the *Third Report and Order*, including this FRFA, to the Chief Counsel for Advocacy of the SBA. A copy of the *Third Report and Order*, and FRFA (or summaries thereof) will also be published in the Federal Register.⁷⁰

⁶⁹ *Id.* § 801(a)(1)(A).

⁷⁰ *Id.* § 604(b).

**STATEMENT OF
CHAIRWOMAN JESSICA ROSENWORCEL**

Re: 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 (December 11, 2024)

This week the Armed Services Committee in both the Senate and House of Representatives released a compromise version of the 2025 National Defense Authorization Act. It is one of the highest priority bills we will see before the end of this Congress. This legislation has something in it that is also a high priority for the Federal Communications Commission—and that’s authorizing auction authority for spectrum licenses we have on hand in order to raise revenues to fully fund the removal of insecure equipment in our communications networks. This is good news for national security. It is also good news because it will mean more licensed spectrum off our shelves and put to use connecting millions of Americans.

But powerful innovation in wireless does not only come from licensed spectrum. Unlicensed spectrum matters, too. In fact, our lives run on unlicensed spectrum. We use it for everything from connecting at work and home with Wi-Fi to supply chain management in warehouses and delivery trucks, from maximizing our workouts with fitness trackers and earbuds to making our homes smarter and more efficient.

I like to think of unlicensed spectrum as an invisible force in our economy. Wi-Fi alone will foster \$769 billion in economic growth in 2024. That number is projected to rise 21 percent in 2025 and as high as 67 percent by 2027 when the latest version of Wi-Fi will be available in millions of devices.

This was all made possible more than three decades ago when creative engineers at this agency challenged the status quo by suggesting that spectrum that was not licensed could be put to use for all. So the FCC opened a handful of underused frequencies—airwaves that were widely viewed as “garbage bands”—to anyone who followed some basic technical rules. Unlicensed spectrum was born.

What followed was revolutionary. We made it possible to access airwaves without licenses, to innovate without permission, and to develop low-power wireless technologies that have changed the way we live and work.

The challenge now is to keep this good stuff growing. So a few years ago, when the global pandemic put our Wi-Fi routers centerstage, the FCC determined it was vital to identify additional spectrum to carry our unlicensed wireless activity and set aside a large swath of airwaves in the 6 GHz band. This was the right thing to do. Because as fiber, cable, and commercial wireless move to gigabit speeds, we need to ensure our Wi-Fi connections have the wider channels and additional bandwidth they need to keep pace.

Today we take the effort to support unlicensed activity in the 6 GHz band even further. We are opening up 350 megahertz of the 6 GHz band to small mobile devices operating at very low power. When you combine that with the 850 megahertz of the 6 GHz band that we made available for low-power use just a year ago, we are expanding access to 1,200 megahertz to help jumpstart the next generation of unlicensed wireless devices.

This 1,200 megahertz means unlicensed bandwidth with a mix of high capacity and low latency that is absolutely prime for immersive, real-time applications. These are the airwaves where we can develop wearable technologies and expand access to augmented and virtual reality in ways that will provide new opportunities in education, healthcare, and entertainment. This is the unlicensed spectrum where the future happens—and with the 6 GHz band the United States is leading the way.

Thank you to the staff responsible for this effort, including Ira Keltz, Dana Shaffer, Krista Senell, Jamie Coleman, Jamison Prime, Michael Ha, Nicholas Oros, Bahman Badipour, Martin Doczkat, Hugh Van Tuyl, Aniqah Tahsin, Damian Ariza, Joe Prebble, David Duarte, and Siobahn Philemon from the

Office of Engineering and Technology; Jeff Neumann from the Media Bureau; Patrick Sun, Aleks Yankelevich, and Pramesh Jobanputra from the Office of Economics and Analytics; Keith McCrickard, Doug Klein, Anjali Singh, and Dave Konczal from the Office of General Counsel; Dante Ibarra from the Office of International Affairs; Roger Noel, Paul Powell, Blaise Scinto, John Schauble, and Chris Andes from the Wireless Telecommunications Bureau; Whitney Lohmeyer, Sankar Persaud, Franco Hinojosa, Scott Mackoul, and Stephen Duall from the Space Bureau; and Mike Gussow and Joycelyn James from the Office of Communications Business Opportunities.

**STATEMENT OF
COMMISSIONER GEOFFREY STARKS**

Re: *Unlicensed Use of the 6 GHz Band, Expanding Flexible Use in Mid-Band Spectrum Between 4.7 and 24 GHz*, ET Docket No. 18-295, and GN Docket No. 17-183, Third Report and Order

Today's order isn't just an important step forward in its own right, it's a continuation of the Commission's steadfast commitment to ensuring the 6 GHz band reaches its full potential. This has been a long time coming. As I said when we adopted our 2020 order, the 6 GHz band holds the unique potential to serve as "a lynchpin for a more innovative, and more inclusive, wireless future." By extending very low power (VLP) device operations to the U-NII- 6 and 8 bands, we're providing the spectrum the IoT ecosystem needs to thrive and safeguarding the United States' position as the leader in unlicensed communications.

I want to thank to OET staff for their diligent work on this item. It's a culmination of years of progress buttressing Wi-Fi innovation in the 6 GHz band.