

FACT SHEET*
Modernizing the 5.9 GHz Band

First Report and Order, Further Notice of Proposed Rulemaking, and Order of Proposed Modification –
ET Docket No. 19-138

Background: In 1999, the Commission reserved 75 megahertz in the 5.9 GHz band (5.850-5.925 GHz) for Intelligent Transportation System (ITS) services and designated Dedicated Short-Range Communications (DSRC) as the technological standard for safety-related transportation and vehicular communications. Since that time, however, DSRC has barely been deployed, so this prime, mid-band spectrum has gone largely unused. Recently, cellular vehicle to everything (C-V2X), a newer radio technology standard incompatible with DSRC technology, has gained momentum both domestically and internationally as a means of providing safety-related transportation and vehicular communications.

Meanwhile, demand for access to mid-band spectrum for unlicensed applications has grown substantially. Unlicensed services such as Wi-Fi provide wireless connectivity for countless products used by American consumers, and Wireless Internet Service Providers use unlicensed spectrum to provide broadband connectivity in rural and underserved areas.

In December 2019, the Commission initiated a Notice of Proposed Rulemaking to take a fresh look at the 5.9 GHz band rules to ensure the spectrum supports its highest and best use.

What the First Report and Order Would Do:

- Adopt rules to repurpose 45 megahertz of spectrum in the 5.850-5.895 GHz band for unlicensed use and allow immediate access for unlicensed indoor operations across the 5.850-5.895 GHz band.
 - Requests to allow outdoor unlicensed operations in certain geographic locations would be considered through our existing regulatory processes.
- Require ITS licensees to cease use of the 5.850-5.895 GHz band one year following the effective date of the First Report and Order and operate only in the 5.895-5.925 GHz band.
- Require the transition of the ITS radio service standard from DSRC-based technology to C-V2X-based technology, subject to a transition period.

What the Further Notice of Proposed Rulemaking Would Do:

- Propose technical rules to allow outdoor unlicensed operations across the 5.850-5.895 GHz band once ITS operations have exited this portion of the band.
- Address transitioning all ITS operations in the revised ITS band at 5.895-5.925 GHz to C-V2X-based technology, including the appropriate timeline for the implementation and codification of C-V2X technical parameters for operation in the 5.895-5.925 GHz band.
- Seek comment on whether the Commission should allocate additional spectrum for ITS applications in the future.

What the Order of Proposed Modification would do:

- Propose modifying all ITS licenses in the 5.9 GHz band subject to the procedures for license modifications set forth in section 316 of the Communications Act.

* This document is being released as part of a “permit-but-disclose” proceeding. Any presentations or views on the subject expressed to the Commission or its staff, including by email, must be filed in ET Docket No. 19-138, which may be accessed via the Electronic Comment Filing System (<https://www.fcc.gov/ecfs>). Before filing, participants should familiarize themselves with the Commission’s *ex parte* rules, including the general prohibition on presentations (written and oral) on matters listed on the Sunshine Agenda, which is typically released a week prior to the Commission’s meeting. See 47 CFR § 1.1200 *et seq.*

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

In the Matter of
Use of the 5.850-5.925 GHz Band
ET Docket No. 19-138

FIRST REPORT AND ORDER, FURTHER NOTICE OF PROPOSED RULEMAKING, AND
ORDER OF PROPOSED MODIFICATION*

Adopted: []

Released: []

By the Commission:

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* This document has been circulated for tentative consideration by the Commission at its November 2020 open meeting. The issues referenced in this document and the Commission’s ultimate resolution of those issues remain under consideration and subject to change.

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I. INTRODUCTION

1. In this First Report and Order, we repurpose 45 megahertz of the 5.850-5.925 GHz band (the 5.9 GHz band) to allow for the expansion of unlicensed mid-band spectrum operations, while continuing to dedicate 30 megahertz of spectrum for vital intelligent transportation system (ITS) operations.¹ In addition, to promote the most efficient and effective use of this ITS spectrum, we are requiring the ITS service to use cellular vehicle to everything (C-V2X) based technology at the end of a transition period. By splitting the 5.9 GHz band between unlicensed and ITS uses, today’s decision puts the 5.9 GHz band in the best position to serve the needs of the American public.

2. Unlicensed devices using such technologies as Wi-Fi have become indispensable for providing low-cost wireless connectivity in countless products used by American consumers. To meet this demand, we take steps in this First Report and Order to promote unlicensed use of the 5.850-5.895 GHz portion of the 5.9 GHz band as soon as possible so that the American people can immediately begin receiving the benefits of unlicensed operations. Specifically, we adopt rules to repurpose for unlicensed operations the 5.850-5.895 GHz portion of the 5.9 GHz band (lower 45 megahertz), which, when added to the adjacent spectrum available for Unlicensed National Information Infrastructure (U-NII) devices below 5.850 GHz, will allow for increased high-throughput broadband unlicensed applications in spectrum that is a core component of today’s unlicensed ecosystem. On the effective date of this First Report and Order, we will allow immediate access for unlicensed indoor operations (at specified low power levels) across the 5.850-5.895 GHz portion of the 5.9 GHz band. We also will consider requests to allow for outdoor unlicensed operations, limited to specified geographic locations, through our existing regulatory process (Special Temporary Authority (STA) and/or waiver), which will be coordinated with National Telecommunications and Information Administration (NTIA) to ensure that federal incumbents are protected from harmful interference.

¹ ITS is a national program intended to improve the efficiency and safety of surface transportation systems. See Intermodal Surface Transportation Efficiency Act of 1991, Pub. L. No. 102-240, § 6051, 105 Stat. 1914 (1991). ITS applications rely on the integration of advanced vehicle safety communications technologies with highway infrastructure systems.

3. At the same time, we recognize that the 5.9 GHz band plays an important role in supporting ITS applications. Therefore, we retain 30 megahertz of spectrum in the 5.895-5.925 GHz portion of the 5.9 GHz band (upper 30 megahertz) for use by the ITS radio service—specifically C-V2X. In 1999, the Commission adopted a different standard for ITS services in the band. Dedicated Short-Range Communications, or DSRC, has barely been deployed, meaning this spectrum has been largely unused. In the intervening period, several automobile manufacturers and other stakeholders have turned their attention to C-V2X, in part because of its use of cellular-based protocols and support for advanced applications. We therefore modernize our rules to allow for deployment of C-V2X in the 5.895-5.925 GHz band.

4. In the Further Notice, we address the remaining issues before the Commission in this proceeding as we finalize the transition of the 5.9 GHz band under the modified band plan adopted in this First Report and Order. Specifically, we seek comment on: transitioning all ITS operations in the upper 30 megahertz to C-V2X-based technology, including the appropriate timeline for implementation; the adoption of C-V2X technical parameters for operation in the upper 30-megahertz portion; and the power and emission limits, and other issues, related to full-power outdoor unlicensed operations across the 5.850-5.895 GHz band portion of the 5.9 GHz band.

II. BACKGROUND

5. The demand for wireless broadband is growing at a phenomenal pace, as the American public and businesses increasingly rely on Internet connectivity. To meet this demand, the Commission continuously evaluates spectrum use and its rules in efforts to enable more efficient spectrum usage through a variety of methods, including authorizing unlicensed operations. In various proceedings over the past two decades, the Commission has established and expanded the spectrum available for U-NII devices throughout the mid-band spectrum located in the 5 GHz band.² As a result, for many years most of the spectrum between 5.150 GHz and the lower edge of the 5.9 GHz band³ has been available for unlicensed operations. This year, the Commission adopted rules to make the spectrum directly adjacent to the 5.9 GHz band, at 5.925 GHz-7.125 GHz (the 6 GHz band) available for unlicensed operations.⁴ Despite the Commission's commitment to increasing the availability of mid-band spectrum that can be

² Spectrum between 5 GHz and 6 GHz is part of the larger mid-band spectrum (a designation generally applied to spectrum between 2.5 GHz and 24 GHz). Mid-band spectrum has become highly desirable as a key component for future 5G buildout because of its balanced coverage and capacity characteristics. See, e.g., The FCC's 5G FAST Plan (Sept. 28, 2018), <https://www.fcc.gov/document/fccs-5g-fast-plan>.

³ See *Amendment of the Commission's Rules to Provide for Operation of Unlicensed NII Devices in the 5 GHz Frequency Range*, ET Docket No. 96-102, Report and Order, 12 FCC Rcd 1576 (1997) (*U-NII Report and Order*), Memorandum Opinion and Order, 13 FCC Rcd 14355 (1998) (establishing the 5.15-5.25 GHz (U-NII-1), the 5.25-5.35 GHz (U-NII-2A), and the 5.725-5.825 GHz (U-NII-3) bands); *Revision of Parts 2 and 15 of the Commission's Rules to Permit Unlicensed National Information Infrastructure (U-NII) devices in the 5 GHz Band*, ET Docket No. 03-122, Report and Order, 18 FCC Rcd 24484 (2003) (*U-NII-2C Report and Order*) (establishing the 5.47-5.725 GHz (U-NII-2C) band); *Revision of Part 15 of the Commission's Rules to Permit Unlicensed National Information Infrastructure (U-NII) Devices in the 5 GHz Band*, ET Docket No. 13-49, First Report and Order, 29 FCC Rcd 4127 (2014) (*U-NII 5 GHz Report and Order*) (adding 5.825-5.850 GHz to the 5.725-5.825 GHz (U-NII-3) band and deferring a decision on whether to allow unlicensed devices to use the 5.350-5.470 GHz U-NII-2B and 5.850-5.925 GHz U-NII-4 bands). In 2013, the Commission began to refer to the U-NII band segments by number to make it easier for the reader to follow U-NII discussions in the rulemaking docket and documents. See *Revision of Part 15 of the Commission's Rules to Permit Unlicensed National Information Infrastructure (U-NII) Devices in the 5 GHz Band*, ET Docket No. 13-49, Notice of Proposed Rulemaking, 28 FCC Rcd 1769, 1771, n.5 (2013) (*U-NII 5 GHz NPRM*).

⁴ See *Unlicensed Use of the 6 GHz Band*, ET Docket No. 18-295; *Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz*, GN Docket No. 17-183, Report and Order and Further Notice of Proposed Rulemaking, FCC 20-51, 35 FCC Rcd 3852 (2020) (*6 GHz Report and Order*) (unlicensed use of 5.925-7.125 GHz (U-NII-5 to -8)).

used for unlicensed operations, there continues to be steadily increasing demand for additional spectrum that can accommodate such operations.

6. Twenty years ago, the Commission reserved the entire 75 megahertz that makes up the 5.9 GHz band for ITS radio service and, in particular, Dedicated Short-Range Communications (DSRC) service.⁵ In doing so, the Commission noted the contemporaneous enactment of the Transportation Equity Act for the 21st Century, in which Congress directed the Commission to consider, in consultation with the Secretary of the Department of Transportation, spectrum needs for the operation of the ITS, including spectrum that could support operations using the DSRC vehicle-to-wayside wireless standard.⁶ At the time the Commission reserved the 5.9 GHz band for ITS, it was expected that the band would support widespread deployment of systems that would improve efficiency and promote safety within the nation's transportation infrastructure.⁷ In 2003, the Commission adopted licensing and service rules for DSRC operations that specified a single technological standard based on the expectation that, despite the Commission's general preference for leaving the selection of technologies to licensees, a single standard in this band was most likely to promote interoperability between vehicles and infrastructure, enable robust automotive safety communications, and accelerate the nationwide deployment of DSRC-based applications while reducing implementation costs.⁸

7. Since that time, the DSRC-based service has evolved slowly and has not been widely deployed within the consumer automobile market. Meanwhile, numerous technologies that operate outside the 5.9 GHz band have been or are being developed and deployed to improve transportation safety and efficiency, such as long-range and short-range radar systems in the 76-81 GHz band, safety and convenience features integrated into cellphone apps and connected to on-board displays through unlicensed spectrum protocols, optical cameras, sonar, and LiDAR (light detection and ranging).

8. Recently, C-V2X-based technology has gained momentum as a means of providing transportation and vehicle safety-related communications.⁹ As envisioned, C-V2X would be part of a connected vehicle ecosystem that provides direct communications between vehicles, between vehicles and infrastructure, between vehicles and other road users, and between vehicles and cellular

⁵ *Amendment of Parts 2 and 90 of the Commission's Rules to Allocate the 5.850-5.925 GHz Band to the Mobile Service for Dedicated Short Range Communications of Intelligent Transportation Services*, ET Docket No. 98-95, Report and Order, 14 FCC Rcd 18221 (1999) (*DSRC Report and Order*).

⁶ *DSRC Report and Order*, 14 FCC Rcd at 18222-23, paras. 2-3; Transportation Equity Act for the 21st Century, Pub. L.105-178, § 5206(f), 112 Stat. 107 (1998) (TEA). The TEA did not require that the Commission allocate the 5.9 GHz band for ITS, only that the Commission consider doing so.

⁷ *DSRC Report and Order*, 14 FCC Rcd at 18225, para. 9 (allocating the 5.9 GHz band for DSRC based on a finding that "DSRC applications are a key element in meeting the nation's transportation needs into the next century and in improving the safety of our nation's highways.").

⁸ *Amendment of the Commission's Rules Regarding Dedicated Short Range Communications Services in the 5.850-5.925 GHz Band (5.9 Band)*; *Amendment of Parts 2 and 90 of the Commission's Rules to Allocate the 5.850-5.925 GHz Band to the Mobile Service for Dedicated Short Range Communications of Intelligent Transportation Services*, ET Docket No. 98-95, Report and Order, 19 FCC Rcd 2458, 2466-68, paras. 13-16 (2003) (*DSRC Service Rules Order*). See also 47 CFR §§ 90.379 and 95.3159 (incorporating by reference the American Society for Testing and Materials (ASTM) E2213-03 DSRC standard (the ASTM-DSRC Standard)). In 2010, IEEE adopted a new standard, 802.11p, for wireless access in vehicular environments. See https://standards.ieee.org/standard/802_11p-2010.html.

⁹ On November 21, 2018, the 5G Automotive Association (5GAA), an association representing automotive, technology, and telecommunications companies, requested that the Commission waive the DSRC-specific rules to allow deployment of C-V2X in the 20-megahertz channel located at the upper edge of the 5.9 GHz band (i.e., the 5.905-5.925 GHz portion of the band). This waiver request is mooted by the current proceeding.

communications providers' mobile broadband networks.¹⁰ Proponents of C-V2X anticipate that it will serve as the foundation for vehicles to communicate with a wide range of other vehicles and infrastructure around them, providing non-line-of-sight awareness, providing their operators with notice of changing driving conditions with a high level of predictability for enhanced road safety, and engaging in automated driving.¹¹ Notably, C-V2X uses a different radio technology standard that is incompatible with DSRC-based operations.¹²

9. *5.9 GHz NPRM*. In December 2019, we initiated this rulemaking proceeding to take a “fresh look” at the optimal use of the valuable 75 megahertz that makes up the 5.9 GHz band, given (1) the exponentially growing demands for unlicensed applications' access to mid-band spectrum; (2) the relatively slow deployment of DSRC equipment; (3) the significant evolution of transportation and vehicular safety-related technologies outside the 5.9 GHz band; and (4) the rising interest in C-V2X as an alternative radio technology that could provide transportation and safety-related communications in the 5.9 GHz band. To that end, we proposed to create sub-bands within the 5.9 GHz band to allow unlicensed operations in the lower 45 megahertz of the band (5.850-5.895 GHz) and reserve the upper 30 megahertz of the band (5.895-5.925 GHz) for ITS.¹³ We reasoned that this 45/30 megahertz split for unlicensed devices and ITS applications would optimize the use of spectrum resources in the 5.9 GHz band. Under this proposal, the unlicensed portion of the band could be combined with spectrum in adjacent bands that support heavy unlicensed device use to provide cutting-edge high-throughput broadband applications on channels up to 160 megahertz wide, while the ITS portion of the band would remain dedicated to meet current and future ITS needs within the transportation and vehicular-safety related ecosystem.

10. The proposal specifically called for the uppermost 20 megahertz (5.905-5.925 GHz) to be dedicated to C-V2X and asked whether to designate the remaining 10 megahertz (5.895-5.905 GHz) for C-V2X or retain that 10 megahertz for DSRC.¹⁴

¹⁰ See *Use of the 5.850-5.925 GHz Band*, ET Docket No. 19-138, Notice of Proposed Rulemaking, 34 FCC Rcd 12603, 12605-606, para. 5 (2019) (*5.9 GHz NPRM*).

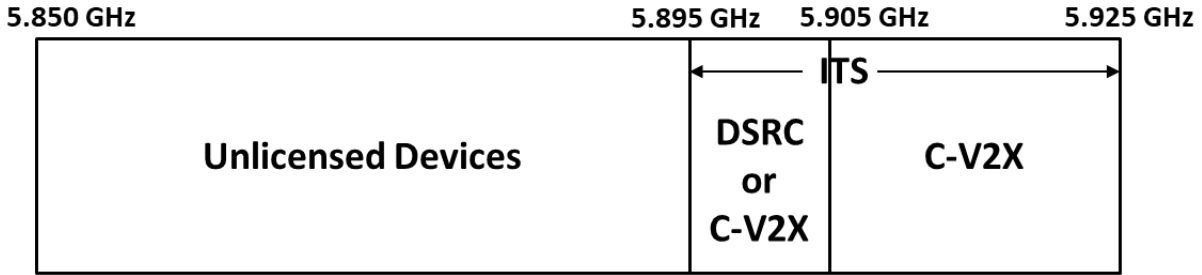
¹¹ See Qualcomm Connecting vehicles to everything with C-V2X at 2, <https://www.qualcomm.com/invention/5g/cellular-v2x>; Accelerating C-V2X commercialization at 15, <https://www.qualcomm.com/media/documents/files/accelerating-c-v2x-commercialization.pdf>; 5G NR based C-V2X, <https://www.qualcomm.com/media/documents/files/5g-nr-based-c-v2x-presentation.pdf> (last visited Oct. 27, 2020); 5G Americas March 2018 White Paper, Cellular V2X Communications Towards 5G, at 3, <https://www.5gamericas.org/white-papers/>. Some of these functions would be supported by the evolution to 5G New Radio-based C-V2X. *Id.*

¹² C-V2X standards development began in 2015 when 3GPP specified C-V2X features based on the 4G LTE-Pro system in 3GPP Release 14. While C-V2X is based on the 3GPP LTE family of standards, DSRC is based on the IEEE 802.11 family of standards.

¹³ See *5.9 GHz NPRM*, 34 FCC Rcd at 12608, para. 11.

¹⁴ See *5.9 GHz NPRM*, 34 FCC Rcd at 12613-16, paras. 24-31.

Proposed Band plan



11. Acknowledging that the proposals in the *5.9 GHz NPRM* could result in the need for DSRC incumbents to transition their operations out of some or all of the 5.9 GHz band, we sought comment on possible transition paths and the Commission's authority under section 316 of the Communications Act to modify or discontinue DSRC operations.¹⁵ In the *5.9 GHz NPRM* we also proposed technical rules that would govern the transportation and unlicensed uses in the 5.9 GHz band.¹⁶ We proposed that devices in the U-NII-4 band (5.850-5.895 GHz), or devices that operate across a single channel that spans the U-NII-3 (5.725-5.850 GHz) and U-NII-4 bands, protect ITS from harmful interference by meeting certain out-of-band emissions (OOBE) limits.¹⁷ We also proposed that U-NII-4 devices be permitted to operate at the same power levels as U-NII-3 devices.¹⁸

12. In addition to the primary non-Federal Mobile Service allocation for DSRC in the ITS radio service, the 5.9 GHz band is also allocated, in the U.S. Table of Frequency Allocations, for the Federal Radiolocation Service and the non-Federal Fixed Satellite Service (Earth-to-space) on a primary basis and the Amateur Service on a secondary basis for non-federal use.¹⁹ The 5.850-5.875 GHz segment of the 5.9 GHz band is designated internationally for industrial, scientific, and medical (ISM) applications.²⁰ In the *5.9 GHz NPRM*, we proposed rules that would ensure interference protections for federal operations in the Federal Radiolocation Service.²¹ We proposed that no additional provisions were needed to protect the non-Federal Fixed Satellite Service operations in the 5.9 GHz band from C-V2X devices, or to protect C-V2X devices from Amateur Services or ISM operation.²² We sought comment on the extent to which the transportation and vehicle-safety functions originally contemplated under the DSRC model are being, or are anticipated to be, provided in other bands or through other

¹⁵ See *5.9 GHz NPRM*, 34 FCC Rcd at 12616-18, paras. 32-36. See 47 U.S.C § 316 (modification by Commission of station licenses). On Dec. 19, 2019, the Commission temporarily froze the acceptance and processing of new and expanded use applications related to Part 90 services operating in certain portions (specifically, 5.850-5.895 GHz and 5.905-5.925 GHz) of the 5.850-5.925 GHz band (5.9 GHz band) and on the processing of applications to renew Part 90 licenses in the 5.9 GHz band).

¹⁶ See *5.9 GHz NPRM*, 34 FCC Rcd at 12618-20, paras. 37-45, 12622-24, paras. 53-58.

¹⁷ See *5.9 GHz NPRM*, 34 FCC Rcd at 12622-24, paras. 53-56.

¹⁸ See *5.9 GHz NPRM*, 34 FCC Rcd at 12622-23, para. 53, n.93.

¹⁹ See 47 CFR § 2.106, NG160.

²⁰ See 47 CFR § 2.106 Footnote 5.150.

²¹ See *5.9 GHz NPRM*, 34 FCC Rcd at 12620-21, 24, paras. 47-48, 57.

²² See *5.9 GHz NPRM*, 34 FCC Rcd at 12621-22, paras. 49-51. Under the Commission's rules, stations of a secondary service must not cause harmful interference to, and cannot claim protection from harmful interference from, stations of primary services to which frequencies are already assigned or may be assigned at a later date. 47 CFR § 2.104(d)(3)(i), (ii).

means.²³ Finally, we laid the groundwork for evaluating and calculating the costs and benefits of designating a significant portion of this band for unlicensed operations.²⁴

III. REPORT AND ORDER

13. In this First Report and Order, we conclude that the most efficient use of the 75 megahertz of mid-band spectrum in the 5.9 GHz band will be achieved by allowing unlicensed use in the lower 45 megahertz of the band (5.850-5.895 GHz) and designating the upper 30 megahertz of the band (5.895-5.925 GHz) for ITS service applications. We also take steps in this First Report and Order to authorize unlicensed service in the 5.850-5.895 GHz portion of the 5.9 GHz band as soon as possible so that the American people can begin receiving the benefits of unlicensed operations without any unnecessary delay. Specifically, as of the effective date of this First Report and Order, we will allow immediate access for unlicensed indoor operations across the entire 5.850-5.895 GHz portion of the 5.9 GHz band, under specified power and other technical limitations designed to protect ITS service from harmful interference. We also will consider requests for full power outdoor operations, limited to specified geographic locations, through our existing regulatory process for individualized and temporary access to spectrum (e.g., STA and/or waiver), which will be coordinated with NTIA to ensure that federal incumbents are protected from harmful interference. We further conclude that, to promote the most efficient and effective use of the spectrum that will continue to be designated for ITS, only a single technology is appropriate, and we will require use of C-V2X technology. Pending resolution of the transition of ITS operations to C-V2X, ITS licensees will be able to continue their DSRC-based operations or, alternatively, request to begin C-V2X-based operations through our existing regulatory processes (e.g., STA, experimental licensing, and/or waiver), as appropriate.

A. Dividing the 5.9 GHz Band for Unlicensed Operations and for ITS

14. In the *5.9 GHz NPRM*, we proposed two sub-bands within the 75 megahertz in the 5.9 GHz band – allowing 45 megahertz for unlicensed operations and 30 megahertz for ITS – believing that this would optimize the use of the 5.9 GHz spectrum resources to fully and effectively serve the American people.²⁵ Since the Commission first designated the 5.9 GHz band for ITS in 1999, transportation and vehicular safety-related technologies have evolved significantly, as have demands for access to mid-band spectrum, particularly for unlicensed operations. Based on our evaluation of these changed circumstances, we have determined that the optimal use of this band has changed as well, and that the public interest would be better served by reconfiguring the 5.9 GHz band in accordance with our proposal to designate 45 megahertz (at 5.850-5.895 GHz) as a lower sub-band for new unlicensed use, and 30 megahertz (at 5.895-5.925 GHz) as an upper sub-band for ITS applications. Repurposing this valuable 75-megahertz portion of spectrum in this manner will ensure the quickest path towards its most efficient and effective use.

1. Unlicensed Operations in the Lower 45 Megahertz of the 5.9 GHz Band

15. Demand for spectrum to support unlicensed use has intensified in recent years.²⁶ Wi-Fi access points (and their associated connected devices) provide high data rate local area network connections for smart phones, tablets, computers, television, and other devices inside and outside the home to interconnect with and access the Internet. Wi-Fi has become a staple in American life, and many households rely on Wi-Fi to connect to the Internet. It also enables data-offloading from commercial

²³ See *5.9 GHz NPRM*, 34 FCC Rcd at 12624-25, paras. 59-62.

²⁴ See *5.9 GHz NPRM*, 34 FCC Rcd at 12625-27, paras. 63-67.

²⁵ *5.9 GHz NPRM*, 34 FCC Rcd at 12608-16, paras. 11-31.

²⁶ *5.9 GHz NPRM*, 34 FCC Rcd at 12609, para. 14.

wireless networks to relieve congestion when consumer demand is high.²⁷ Industry studies project that the U.S. will need between 788 megahertz and 1.6 gigahertz of new mid-band spectrum by 2025 to accommodate the growing demand for Wi-Fi.²⁸ We continue to seek ways to meet the growing demand for spectrum to support unlicensed use²⁹ and earlier this year authorized additional U-NII bands in the 6 GHz band.³⁰

16. Mobile operators routinely use unlicensed spectrum for network offloading and mobile carriers have widely implemented Wi-Fi calling.³¹ The ongoing pandemic in the U.S has further increased reliance on Wi-Fi as more households are turning to distance learning, teleworking, and social networking. Since the pandemic began, the nation's reliance on in-home connectivity has increased dramatically and this dependence and reliance on unlicensed spectrum during these uncertain times is expected to continue.³² For example, AT&T reported a 76% over-the-average increase in Wi-Fi calling minutes than its previous month.³³ Similarly, Comcast's Xfinity Mobile has seen a 49% increase in its Wi-Fi offloading from its mobile devices.³⁴ Verizon has reported week-over-week increases during peak hour usage with a 75% increase for gaming, 34% increase for VPN, 20% increase in web traffic, and 12% increase in video streaming.³⁵ The vitality and the importance of unlicensed is more critical than ever before.

17. The latest Wi-Fi standards, IEEE 802.11ax (marketed as "Wi-Fi 6") and 802.11ac can deliver gigabit speeds, superior performance in crowded environments, and better device battery life than earlier versions of Wi-Fi. In particular, new unlicensed devices are expected to provision maximum speeds that are two-and-a-half-times faster than predecessor technology, and incorporate features such as multi-user, multiple input and multiple output (MU-MIMO) and orthogonal frequency division multiple access (OFDMA) to optimize data transmission.³⁶ The latest standards provide flexibility—permitting

²⁷ *5.9 GHz NPRM*, 34 FCC Rcd at 12609, paras. 13-14. Offloading reduces the amount of data flowing through a carrier's network, which reduces the potential for network congestion by freeing bandwidth (especially in indoor environments) resulting in increased performance for all users. As large amounts of data transmission are expected from new connected consumer and commercial devices operating on 5G networks, the demand for offloading is expected to rise significantly.

²⁸ *5.9 GHz NPRM*, 34 FCC Rcd at 12609, para. 14. See Steve Methley & William Webb, Quotient Assocs. Ltd., *Wi-Fi Spectrum Needs Study* at 26, 28 (Feb. 2017), Rolf de Vegt et al., Qualcomm Techs., Inc., *A Quantification of 5 GHz Unlicensed Band Spectrum Needs* at 5 (2017).

²⁹ *5.9 GHz NPRM*, 34 FCC Rcd at 12609, para. 14.

³⁰ *Unlicensed Use of the 6 GHz Band, et al.*, ET Docket No. 18-295 and GN Docket No. 17-183, Report and Order and Further Notice of Proposed Rulemaking, 35 FCC Rcd 3852 (2020) (*6 GHz Report and Order*).

³¹ T-Mobile Comments at 4.

³² Comcast Reply at 3.

³³ See Monica Allevan, *AT&T: Wi-Fi Calling Up 76%*, FierceWireless (Mar. 30, 2020), <https://www.fiercewireless.com/wireless/at-t-wi-fi-calling-up-76>.

³⁴ See Comcast, *COVID-19 Network Update* (last updated Apr. 15, 2020), <https://corporate.comcast.com/covid-19/network>.

³⁵ Kiki Intarasuwan, *How Coronavirus Affects Internet Usage and What you can Do to Make your Wi-Fi Faster* (Mar. 18, 2020) <https://www.nbcnewyork.com/news/local/how-coronavirus-affects-internet-usage-and-what-you-can-do-to-make-your-wi-fi-faster/2332117/>

³⁶ See, e.g., Jacob Kastrenakes, *Wi-Fi 6: is it really that much faster?* (Feb. 21, 2019), <https://www.theverge.com/2019/2/21/18232026/wi-fi-6-speed-explained-router-wifi-how-does-work>.

operation using a variety of bandwidths in the 5 GHz and 6 GHz bands—but require wide-bandwidth 160-megahertz channels to deliver the most capacity and advanced features.³⁷

18. As we discussed in the *5.9 GHz NPRM*, the U-NII bands that span much of the 5 GHz band play a crucial role in accommodating the needs of businesses and consumers for fixed and mobile broadband communications and represent a core component of today’s unlicensed device ecosystem.³⁸ When specifically proposing to authorize unlicensed operations in the lower 45 megahertz of the 5.9 GHz band, we explained that this particular spectrum is especially well-positioned to deliver immediate and significant benefits for unlicensed devices and can help the Commission meet the continued demand for spectrum access.³⁹ We noted that this particular 45 megahertz of spectrum could be combined with the adjacent U-NII-3 band (5.725-5.850 GHz) to provide a large contiguous block of unlicensed spectrum that could accommodate a variety of options—including two 80-megahertz Wi-Fi channels, four 40-megahertz Wi-Fi channels, or a single contiguous 160-megahertz Wi-Fi channel. We further noted that, because the 5.850-5.895 GHz sub-band is adjacent to the U-NII-3 band that supports unlicensed operations, equipment manufacturers should be able to readily and cost-effectively manufacture devices to expand operations into this sub-band.⁴⁰ We sought comment on our proposal to authorize unlicensed operations in this particular spectrum in the 5.9 GHz band.⁴¹

19. The Wi-Fi Alliance, Wireless Internet Service Providers Association (WISPA), NCTA – The Internet & Television Association (NCTA), NTCA – The Rural Broadband Association (NTCA), Broadcom/Facebook, Cisco Systems, Inc. (Cisco), Comcast Corporation (Comcast), and others support our proposal for making this 45 megahertz available for unlicensed operations.⁴² Comcast states that the Commission’s proposal would produce a contiguous 160-megahertz unlicensed channel that can be used on a widespread basis, supporting next-generation Wi-Fi, advancing 5G, and addressing the strain on today’s overburdened Wi-Fi frequencies.⁴³ Broadcom and Facebook state that the additional 45 megahertz of the U-NII-4 band combined with the existing, adjacent U-NII-3 band will allow next-generation Wi-Fi, which operates on wider channels allowing gigabit connectivity with lower latency, improved coverage, and power efficiency to be deployed in the band.⁴⁴ Proponents of ITS, however, oppose separating the band into segments and expanding unlicensed use to the lower 45 megahertz. 5G Automotive Association (5GAA), the Alliance for Automotive Innovation, the American Public Transportation Association (APTA), Car 2 Car Communication Consortium (Car 2 Car), Toyota Motor North America, Inc. (Toyota), and several other commenters generally contend that all 75 megahertz is needed for ITS.⁴⁵ The U.S. Department of Transportation (U.S. DOT) also contends that the full 75

³⁷ See, IEEE Standards Association, *IEEE P802.11ax = IEEE Draft Standard for Information Technology – Telecommunications and Information Exchange Between Systems Local and Metropolitan Area Networks – Specific Requirements Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications Amendment Enhancements for High Efficiency WLAN*, https://standards.ieee.org/project/802_11ax.html (last visited Oct. 27, 2020).

³⁸ *5.9 GHz NPRM*, 34 FCC Rcd at 12609, paras. 13-14.

³⁹ *5.9 GHz NPRM*, 34 FCC Rcd at 12610, para. 16.

⁴⁰ *5.9 GHz NPRM*, 34 FCC Rcd at 12610, para. 16.

⁴¹ *5.9 GHz NPRM*, 34 FCC Rcd at 12610-11, para. 17.

⁴² See, e.g., Wi-Fi Alliance Comments at 2-4, WISPA Comments at 1-2, NCTA Comments at 1-3, NTCA Reply Comments at 1, Broadcom/Facebook Comments at 1, Cisco Comments at 14-16, Comcast Comments at 7-10.

⁴³ Comcast Comments at 6-7.

⁴⁴ Broadcom/Facebook Comments at 1-2.

⁴⁵ 5GAA Comments at 36 (contending that the public interest is not best served by making the lower 45 megahertz of the 5.9 GHz band available for unlicensed services given the recent history of the Commission’s unlicensed efforts; proposing that some portions of the 5.9 GHz band be available for C-V2X technology, and other for DSRC

(continued....)

megahertz of the 5.9 GHz band should be retained for safety and other transportation purposes.⁴⁶ In addition, some commenters have suggested that we postpone consideration of our proposal for several more years to see if ITS providers can substantially implement operations in the 5.9 GHz band.⁴⁷

20. We adopt our proposal to make the 45 megahertz at 5.850-5.895 GHz available for unlicensed operations. We believe that this approach will provide the American public with the most efficient use of spectrum, based on current and future needs. The combination of the U-NII-3 band with this new U-NII-4 band is greater than the sum of its parts. Whereas the upper portion of the U-NII-3 band can only support at most one 80-megahertz channel and the U-NII-4 band (in isolation) could only support a single 40-megahertz channel, together they can enable a single 160-megahertz channel for U-NII operations. Not only is this the widest, highest throughput channel permitted today by industry-developed standards for U-NII devices, it is also the only 160-megahertz wide channel currently available below 6 GHz not required to use dynamic frequency selection (DFS)⁴⁸ technology. Thus, the entirety of the U.S. would have continuous access to this wide channel.

21. Commenters who support making this 45 megahertz of spectrum available for unlicensed operations agree that the 5.850-5.895 GHz sub-band is especially well-positioned to deliver immediate and potentially significant benefits. They assert that this spectrum will allow the Commission to take proactive action to ensure that limited spectrum resources provide maximum benefits to American consumers who continue to demand additional spectrum access.⁴⁹ They also agree that providing 45 megahertz of 5.9 GHz spectrum that can be combined with the adjacent U-NII-3 band (5.725-5.850 GHz) will provide a large contiguous block of spectrum that provides flexibility to deliver a wide variety of applications—including one 160-megahertz Wi-Fi channel, two 80-megahertz Wi-Fi channels, four 40-megahertz Wi-Fi channels, or eight 20-megahertz Wi-Fi channels.⁵⁰

22. We expect the benefits arising from this reallocation of the lower band will be available to American consumers shortly after the rules in this proceeding become effective. Comcast submits that, because of its proximity to the U-NII-3 band, only software or firmware upgrades to much of the Wi-Fi equipment already deployed and operating are needed to allow consumers to access the 5.9 GHz spectrum, a benefit that would not be possible in any other band.⁵¹ NCTA agrees that, since the 5.9 GHz

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technology); Alliance for Automotive Innovation Reply Comments at 29 (recommending that for the first 5 years after adoption the Commission should reserve the upper 20 megahertz of the 5.9 GHz band for Long Term Evolution Cellular-Vehicle to Everything (LTE C-V2X), reserve the lower 20 megahertz of the 5.9 GHz band for DSRC, and make the middle 30 megahertz of the 5.9 GHz band available on a priority basis for Next-Gen DSRC and Advanced (5G) C-V2X applications as they are developed and deployed); APTA Comments at 2 (contending that the 5.9 GHz spectrum is essential for current and future safety critical communications system deployments in all types of vehicles, including those serving the needs of public transportation); Car 2 Car Comments at 1 (preserve the 75-megahertz spectrum band for transportation safety); Toyota Reply Comments at 5 (urges maintaining the entire 75 megahertz of spectrum in the 5.9 GHz band for ITS, contending that a wide and diverse group of stakeholders with a strong and enduring commitment to transportation safety are united in wanting all 75 megahertz of spectrum for ITS).

⁴⁶ U.S. DOT Reply Comments at 3 (filed under NTIA).

⁴⁷ See, e.g., Applied Information Comment (recommending that ITS have another seven years).

⁴⁸ Dynamic Frequency Selection is a mechanism that dynamically detects signals from other systems and avoids co-channel operation with these systems, notably radar systems. 47 CFR §15.403.

⁴⁹ See, e.g., NCTA Comments at 9-11; Wireless Internet Service Providers Association (WISPA) Comments at 2.

⁵⁰ See, e.g., Comcast Comments at 8-9; WISPA Reply Comments at 7; Joint Reply Comments of Broadcom and Facebook at 3; Wi-Fi Alliance Comments at 4.

⁵¹ See Comcast Corporation Comments at 8. Firmware is software that is embedded in a piece of hardware. See Lifewire, *What is Firmware?* A definition of firmware and how firmware works, by Tim Fisher (Feb. 28, 2020), <https://lifewire.com/whar-is-firmware-2625881>.

band is adjacent to the U-NII-3 band, existing Wi-Fi access points will be able to use the band immediately, with only software or firmware changes, saving years of delay compared to any other band and lowering costs across the board.⁵² NCTA contends that since many existing 5 GHz-capable devices can take advantage of 5.9 GHz spectrum with software or firmware changes, the congestion-easing capacity attendant with adding new unlicensed spectrum in the 5.9 GHz band will benefit consumers very quickly.⁵³ Under the Commission's equipment authorization rules and policies, a change to an approved device to add a new frequency band subject to new technical requirements is permitted as a Class II permissive change for a device not approved as a Software Defined Radio, as long as such changes are performed by software and do not require any hardware changes.⁵⁴ We anticipate that many Wi-Fi access points currently operating using U-NII-3 spectrum, in addition to being capable of software upgrades, will be able to meet the requirements we adopt for indoor-only devices.

23. Additionally, proponents of unlicensed operations generally agree that equipment manufacturers will be able to readily and cost-effectively manufacture new devices capable of expanding operations in the U-NII-3 band to include this sub-band. The rules adopted today will, in combination with those rules governing the adjacent U-NII-3 band, enable the first contiguous 160-megahertz channel for U-NII devices below 6 GHz that will not require use of DFS interference mitigation technologies, the equipment approval process will be straightforward and not entail additional complex tests to verify DFS operation. The Wi-Fi Alliance states that the DFS requirement impedes spectrum use in some cases because it cannot be accommodated by some applications, requires additional certification and approval, extending time-to-market, and adds to device design complexity and costs.⁵⁵ Comcast states that equipment developed without DFS for the 5.9 GHz band will be available sooner than equipment subject to DFS test procedures.⁵⁶ In the 5.9 GHz band, eliminating the need to incorporate DFS technologies means that the equipment approval process will be straightforward and not entail additional complex tests to verify DFS operation. The readily available 160-megahertz channel will enable new applications that will help maintain the United States' role as an innovator and global spectrum policy leader.

24. Additionally, it appears that many wireless Internet service providers (WISPs) currently have the capability to use the 45 megahertz of the 5.9 GHz spectrum and believe that there is sufficient customer demand to warrant its use.⁵⁷ While we are not allowing outdoor unlicensed use today as a general rule, we are proposing rules for outdoor use in the Further Notice below. However, we will allow some outdoor operations in certain specified locations in the band through the STA process (i.e., on a non-interference basis), where such operations would not cause harmful interference to any incumbent operations.

⁵² NCTA Comments at 10.

⁵³ *Id.* at 29.

⁵⁴ 47 CFR § 2.1043; Federal Communications Commission Office of Engineering and Technology Laboratory Division Permissive Change Policy at 5, Sec. V.A., B., and 7, Sec. V. G. (178919 D01 Permissive Change Policy v06) (Oct. 16, 2015), <https://apps.fcc.gov/oetcf/kdb/forms/FTSSearchResultPage.cfm?switch=P&id=33013>. In such a case, the filing for equipment authorization must include a complete test report demonstrating compliance with the new rules and may also require a change in equipment class associated with the new rules. *Id.*

⁵⁵ Wi-Fi Alliance Comments at 4.

⁵⁶ Comcast Comments at 9.

⁵⁷ We note that in late March, the FCC's Wireless Telecommunications Bureau (WTB) began granting temporary access to 5.9 GHz spectrum (via Special Temporary Authority (STA)) for certain WISPs that serve largely rural and suburban communities. The STAs allow WISPs to use the lower 45 megahertz of the band to help serve their customers. To date, the FCC has granted STAs to more than 100 WISPs, and many of those providers have reported that the spectrum is helping to address the increased demand for broadband associated with the COVID-19 pandemic. See FCC, *5.9 GHz Band Boosts Consumer Internet Access During Covid-19 Pandemic*, (May 4, 2020), <https://www.fcc.gov/document/59-ghz-band-boosts-consumer-internet-access-during-covid-19-pandemic>.

25. We conclude that authorizing 45 megahertz of spectrum for unlicensed operations, while providing 30 megahertz for ITS, best serves the public interest.

2. Safety-Related Intelligent Transportation Systems in the Upper 30 Megahertz (5.895-5.925 GHz) of the 5.9 GHz Band

26. As stated in the *5.9 GHz NPRM*, we recognize the importance of promoting vehicular-safety and other benefits of ITS; we also see a continuing role for the 5.9 GHz band, as part of a larger ecosystem enabling ITS services, in providing these benefits to the American public.⁵⁸ Certain ITS-related functions are well-suited for the 5.9 GHz band—including non-line-of-site applications and certain vehicle-to-infrastructure applications—and could improve transportation and vehicular-safety related applications in the coming years.⁵⁹ Therefore, based on our consideration of the record, we adopt our proposal and will continue to make the upper 30-megahertz portion (5.895-5.925 GHz) of the 5.9 GHz band available for ITS.

27. Our decision will ensure continued availability of spectrum sufficient for DSRC licensees to continue existing operations and deploy those same services at scale. We conclude, as supported by many of the commenters, that reserving the entire 5.9 GHz band for possible additional services by DSRC (or C-V2X) is not the most efficient or effective use of that band, nor is it in the best public interest to do so. WISPA rightly points out that DSRC use of the band has not come to fruition, and changes are essential to maximize the use of this valuable spectrum for the public's greatest well-being, particularly Americans in rural areas that lack adequate broadband access.⁶⁰ To that end, we note that many of WISPA's members have been able to make temporary use of unused spectrum in the 5.9 GHz band to deliver broadband Internet access service to rural and underserved areas during the current COVID-19 pandemic.⁶¹

28. Several factors guide our determination of how much spectrum to retain for ITS: (1) the failure of the 5.9 GHz band to become used ubiquitously for the broad range of ITS applications that were originally anticipated; (2) the strong public interest benefits that will accrue by allowing unlicensed use in 45 megahertz of the 5.9 GHz band; and (3) the need for dedicated 5.9 GHz spectrum to support core automotive safety applications. We find that reserving 30 megahertz of spectrum for ITS will support the provision of core safety-related functions and provide continuing spectrum access for existing DSRC licensees authorized in the band.

a. 30 megahertz for ITS

29. When the Commission first set aside the 5.9 GHz band in 1999,⁶² an extensive set of DSRC applications was identified for the band—things such as “traffic light control, traffic monitoring, travelers' alerts, automatic toll collection, traffic congestion detection, emergency vehicle signal preemption of traffic lights, and electronic inspection of moving trucks through data transmissions with

⁵⁸ *5.9 GHz NPRM*, 34 FCC Rcd at 12611, paras. 18-19.

⁵⁹ *5.9 GHz NPRM*, 34 FCC Rcd at 12611, para. 19.

⁶⁰ WISPA Reply Comments at 2.

⁶¹ See FCC, *5.9 GHz Band Boosts Consumer Internet Access During Covid-19 Pandemic* (May 4, 2020), <https://www.fcc.gov/document/59-ghz-band-boosts-consumer-internet-access-during-covid-19-pandemic>.

⁶² *Amendment of Parts 2 and 90 of the Commission's Rules to Allocate the 5.850-5.925 GHz Band to the Mobile Service for Dedicated Short Range Communications of Intelligent Transportation Services*, ET Docket No. 98-95, Report and Order, 14 FCC Rcd 18221 (1999) (*DSRC Report and Order*). ITS is a national program intended to improve the efficiency and safety of surface transportation systems. See Intermodal Surface Transportation Efficiency Act of 1991, Pub. L. No. 102-240, § 6051, 105 Stat. 1914 (1991). ITS applications rely on the integration of advanced vehicle safety communications technologies with highway infrastructure systems.

roadside inspection facilities.”⁶³ In its 2003 Order, the Commission adopted service rules for the band⁶⁴ and recognized that DSRC deployment would involve both vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communications, and it established a licensing regime consisting of vehicle-mounted and portable on-board units (OBUs) licensed under Part 95 of the rules and fixed roadside units (RSUs) licensed under Part 90 of the rules.⁶⁵ In the record supporting that decision, numerous parties described an environment where both public safety and private users would share the band, with protocols to ensure that public safety activities (defined expansively) would have priority over private transmissions.⁶⁶

30. In the 20 years since the Commission designated the 5.9 GHz band for DSRC use, certain vehicle-to-vehicle, vehicle-to-infrastructure, and vehicle-to-everything basic safety and related applications have been standardized. The technical standards for these basic vehicle-to-vehicle and vehicle-to-infrastructure applications (e.g., Basic Safety Message, Personal Safety Message, and related applications) were developed and standardized several years ago—indeed, the DSRC 1.0 standard was released in 2006.⁶⁷

⁶³ Press Release, FCC, FCC Allocations Spectrum in 5.9 GHz Range for Intelligent Transportation Systems Use; Action Will Improve the Efficiency of the Nation’s Transportation Infrastructure (Oct 21, 1999) <https://docs.fcc.gov/public/attachments/DOC-177370A1.doc>. In defining DSRC, the rule stated that it would “perform operations related to the improvement of traffic flow, traffic safety and other intelligent transportation service applications in a variety of public and commercial environments.” *DSRC Report and Order* at Appx. A, 47 C.F.R. § 90.7.

⁶⁴ *Amendment of the Commission’s Rules Regarding Dedicated Short Range Communications Services in the 5.850-5.925 GHz Band (5.9 Band); Amendment of Parts 2 and 90 of the Commission’s Rules to Allocate the 5.850-5.925 GHz Band to the Mobile Service for Dedicated Short Range Communications of Intelligent Transportation Services*, ET Docket No. 98-95, Report and Order, 19 FCC Rcd 2458 (2003) (*DSRC Service Rules Order*). See also 47 CFR §§ 90.379 and 95.3159 (incorporating by reference the American Society for Testing and Materials (ASTM) E2213-03 DSRC standard (the ASTM-DSRC Standard)). In 2010, IEEE adopted a new standard, 802.11p, for wireless access in vehicular environments. See https://standards.ieee.org/standard/802_11p-2010.html. Our rules continue to reference the ASTM-DSRC Standard.

⁶⁵ A roadside unit (RSU) is a transceiver that is mounted along a road or pedestrian passageway. An RSU may also be mounted on a vehicle or hand-carried, but it may operate only when the vehicle or hand-carried unit is stationary. An RSU broadcasts data to OBUs or exchanges data with OBUs in its communications zone. An OBU is a transceiver that is normally mounted in or on a vehicle, or in some instances may be a portable unit. RSUs operate under Part 90 of the Rules; while on-board units (OBUs) mounted in vehicles and portable units are licensed by rule under Part 95 of the Rules. Portable RSUs may be operated upon grant of the geographic-area license. Licensees must register appropriate data (e.g., channels, location, power, etc.) for each fixed site RSU with the Commission prior to its operation. While no individual license is required to operate an OBU, such units may only transmit data associated with a valid Part 90 license.

⁶⁶ See, e.g., ITS America Comments, ET Docket No. 98-95, at 2 (“DSRC-based ITS services will provide the traveling public access via a wireless link to a wide variety of public safety and non-public safety services and information. Through an installed transceiver unit in a vehicle, for example, a driver could pay tolls, pay for parking, receive traffic and road condition updates and hear public safety warning messages.”); MARK IV Industries LTD Reply, ET Docket No. 98-95, at 1 (“We propose that the scope of such Public Safety uses be expansive and inclusive so that all of the public functions related to electronic toll collection, traffic monitoring, commercial vehicle and airport facility access operations, in addition to many others, are included.”); Technical Affairs Committee of the Association of International Automobile Manufacturers Reply, ET Docket No 98-95, at 1.

⁶⁷ A DSRC Fact Sheet was released by U.S. DOT in September 2009, based on the December 2006 Version 1.0 of the DSRC standard. It states: “The basic safety message contains vehicle safety-related information that is periodically broadcast to surrounding vehicles.” See <https://www.standards.its.dot.gov/Factsheets/Factsheet/71>. The latest version of the DSRC message standard was published in 2016. See <https://www.standards.its.dot.gov/StdsSummary/StandardsGroup?stdgroup=407>.

31. But actual DSRC-based ITS service has not been widely deployed. There are 118 active DSRC licenses in the Commission's database.⁶⁸ According to the American Association of State Highway and Transportation Officials (AASHTO), these include 38 state or local licensees that are involved with 57 operational projects, and include 6,182 DSRC roadside units (RSUs) and 15,506 vehicles equipped with DSRC on-board units (OBUs), and an additional 1,916 roadside units and 3,371 additional on-board units being planned.⁶⁹ However, the operations are limited to particular geographic areas, and most of the vehicles that have on-board units are limited to certain fleet units (e.g., buses and police cars) and are being tested for specific traffic safety and related applications in those particular areas.⁷⁰ In short, deployments for the most part have been limited to government-funded demonstration projects⁷¹ that have been designed to test DSRC use to address particular traffic and safety concerns.⁷² Considering that there are approximately 274 million registered vehicles in the United States⁷³ operating across approximately 4.2 million miles of paved and unpaved roadways,⁷⁴ there has not been any widescale deployment of DSRC. Indeed, there currently is no deployment within the commercial consumer automobile market. In short, DSRC-based ITS has not lived up to the original promise of achieving the ITS goals identified when the spectrum was allocated—leaving valuable mid-band spectrum underused.

32. Meanwhile, numerous technologies that operate outside the 5.9 GHz band have been or are being developed and deployed on a wide scale throughout the vehicular marketplace, including the commercial consumer automobile market, to improve transportation safety and efficiency. Additionally,

⁶⁸ ULS inquiry of October 26, 2020. An authorization to operate in the DSRC service may be obtained by any territory, possession, state, city, county, town, or similar governmental entity; and any public safety or industrial/business entity meeting the pertinent eligibility requirements. Prior to operation, applicants are issued a non-exclusive, geographic area license: governmental entities are authorized based on that entity's legal jurisdictional area of operations; and non-governmental entities are licensed based on each applicant's area of operation (i.e., by county, state, multi-state, or nationwide).

⁶⁹ American Association of State Highway and Transportation Officials (AASHTO) Comments at 7 (stating that 34 states and 4 localities have roadside unit licenses). *See also* Central Ohio Transit Authority Comments at 10; and Intelligent Transportation Society of America Comments at 19-20.

⁷⁰ *See, e.g.*, ITS America Oct. 6, 2020 *Ex Parte*, Attachment (slide deck) (discussing deployment of V2X in New York City, Michigan, Tampa, and Texas).

⁷¹ According to U.S. DOT, it has provided more than \$1 billion in funding. NCTA Comments at 12 (citing U.S. DOT February 20, 2020 slide deck); *Preserving the 5.9 GHz Safety Band for Transportation*, at slide 2 (Feb. 20, 2020), <https://www.transportation.gov/research-and-technology/preserving59ghz-safety-band-transportation-0>. State and county DOT agencies have also issued grants according to the American Association of State Highway and Transportation Officials (AASHTO). *See* AASHTO Comments, July 7, 2016, at 9-16 to 5.9 GHz *Public Notice*, ET Docket No. 13-49, 31 FCC Rcd 6130 (2016).

⁷² For example, AASHTO states that the California DOT (CalTrans) and the University of California, with funding from the US DOT and a number of states, deployed DSRC units at 10 intersections in Palo Alto, CA to test and evaluate Multi-Modal Intelligent Traffic Signal System (MMITSS) software, which balances priorities between transit, emergency vehicles, and freight traffic; Utah DOT and Utah Transit Authority have begun deployment of DSRC units along a corridor in the Salt Lake City area running MMITSS software to provide signal priority to transit buses, with the goal of improving schedule reliability; and Pennsylvania DOT and Carnegie Mellon University have installed DSRC at 35 intersections in the neighborhoods of Pittsburgh to broadcast Signal Phase and Timing data as the first step of a 25-year plan to install DSRC in signals and vehicles throughout the area. *See* AASHTO Comments, ET Docket No. 13-49, at 9-16 (July 7, 2016).

⁷³ *See* Statista.com, Number of motor vehicles registered in the United States from 1990 to 2018, <https://www.statista.com/statistics/183505/number-of-vehicles-in-the-united-states-since-1990/> (last visited Oct. 27, 2020).

⁷⁴ *See* Bureau of Transportation Statistics, Public Road and Street Mileage in the United States by Type of Surface, <https://www.bts.gov/content/public-road-and-street-mileage-united-states-type-surfacea> (last visited Oct. 27, 2020).

safety and convenience features are increasingly being integrated into cellphone apps and connect to on-board displays through unlicensed spectrum protocols. For example, the Waze driving app uses real-time data sourced by other drivers to deliver, among other things, updated accident and construction zone warnings. The app is now being integrated into vehicle display systems.⁷⁵ A Valeo system being deployed on 2020 General Motors truck models allows drivers to “see through” objects in tow by integrating images wirelessly transmitted from a camera mounted on the back of a trailer into the in-cabin display.⁷⁶ Optical cameras, sonar, and LiDAR (light detection and ranging) are commonly found in many of today’s vehicles. These new technologies have materially and significantly advanced overall automotive safety, generally surpassing many functions that were originally envisioned to be performed by DSRC (e.g., lane-keeping alerts, lane merge, etc.).⁷⁷ The Commission has also made more spectrum available for vehicular radars.⁷⁸ Long-range radar systems in the 76-81 GHz band are especially useful for automatic emergency braking systems and adaptive cruise control systems.⁷⁹

33. Proponents of the Commission’s proposal contend that 30 megahertz of spectrum is the appropriate amount of spectrum for ITS safety-related services in the band. Open Technology Institute/Public Knowledge argue that real-time V2X safety communication requires no more than 30 megahertz of spectrum.⁸⁰ NCTA asserts that 30 megahertz of spectrum for V2X technologies is sufficient to continue to offer the kinds of safety-of-life services in the band now being provided, albeit currently at a very small scale in certain geographic areas.⁸¹ NCTA argues that exclusive-use spectrum rights should be limited to safety-of-life V2X functions that cannot be achieved through other technologies.⁸² NCTA notes that many automotive safety functions originally contemplated for V2X in the 5.9 GHz band 20 years ago—such as alerting drivers to vehicles or other objects, lane-merging alerts, and emergency braking—are already being met by other technologies like radar, lidar, cameras, and sensors.⁸³ NCTA contends that only crash-avoidance information such as Basic Safety Messages (which includes the “core” message functionality) should be preserved for ITS in the band, and that V2X technology, whether DSRC-based or C-V2X-based, requires less than 30 megahertz; thus 30 megahertz should be sufficient

⁷⁵ Zac Estrada, Ford connects Waze through its infotainment system, *The Verge* (Jan. 10, 2018), <https://www.theverge.com/2018/1/10/16874976/ford-waze-infotainment-ces-2018>.

⁷⁶ Brian Dorr, Invisible Tow-Behind: GMC Launches ‘Transparent Trailer View,’ *Gear Junkie* (Feb. 12, 2019), <https://gearjunkie.com/gmc-transparent-trailer-view>. Valeo, World premiere at CES 2019 of Valeo XtraVue Trailer, the invisible trailer system (Jan. 8, 2019), <https://www.valeo.com/en/world-premiere-at-ces-2019-of-valeo-xtravue-trailer-the-invisible-trailer-system/>.

⁷⁷ See, e.g., *DSRC Service Rules Order*, 19 FCC Rcd at 2519-2520, Appx. C (listing many DSRC-based advanced vehicle safety systems—including road departure, lane merge, work zone warning, vehicle stopped or slowing, vehicle-to-vehicle collision avoidance—that appear to be available today using non-DSRC technologies).

⁷⁸ See *Amendment of Parts 1, 2, 15, 90 and 95 of the Commission’s Rules to Permit Radar Services in the 76-81 GHz Band*, ET Docket No. 15-26, Report and Order, 32 FCC Rcd 8822 (2017).

⁷⁹ Paul Pickering, The Radar Technology Behind Autonomous Vehicles, *ECN* (Dec. 7, 2017), <https://www.ecnmag.com/article/2017/12/radar-technology-behind-autonomous-vehicles>. See also Continental AG, Continental’s Next Generation Radar Technology Enables New Safety Features (Aug. 19, 2019), <https://www.continental.com/en-us/press-press-releases/next-gen-short-range-radar-181454> (announcing a new 77 GHz short-range radar that offers improved performance over a prior 24 GHz model and describing radar sensors as “a fundamental tool for advanced driver assistance systems” that “enable more advanced features for the vehicle of the future”).

⁸⁰ OTI and PK Comments at 20.

⁸¹ NCTA Reply at 17-27.

⁸² NCTA Reply at 19-20.

⁸³ NCTA Reply at 19-20.

for existing connected vehicle applications.⁸⁴ Broadcom, Facebook, the Dynamic Spectrum Alliance, the Institute for Policy Innovation, and others similarly support the Commission's proposal.⁸⁵

34. Although ITS proponent 5GAA indicates that its "greatly preferred" option is for the Commission to continue to allocate the entire 5.9 GHz band for ITS, 5GAA also indicates that it would support, as an alternative, an allocation of the upper 30 megahertz for C-V2X Direct operations.⁸⁶ Under either option, so-called "Basic C-V2X Direct services" could be deployed in the upper 30 megahertz.⁸⁷ Qualcomm supports 5GAA's second option in the event the Commission designates the lower 45 megahertz for unlicensed operations.⁸⁸ 5GAA states that C-V2X Direct would enable (1) V2X communications which are used to communicate basic safety information between nearby vehicles to prevent collisions and improve traffic flow; (2) V2I communications (e.g., traffic signals, variable message signs, etc.), which are used to communicate safety and traffic information, prevent accidents associated with roadway conditions, and improve traffic efficiency, and (3) vehicle-to-pedestrian communications to communicate safety information between vehicles and other road users (e.g., pedestrians, bicyclists, scooter riders, etc.) to prevent accidents.⁸⁹ Qualcomm asserts that if 30 megahertz of spectrum is made available for C-V2X-based ITS, it will be effectively used by automakers, technology providers, and service providers.⁹⁰

35. We agree with these commenters that 30 megahertz is sufficient for ITS services in the 5.9 GHz band. *First*, we find 30 megahertz sufficient for the provision of core vehicle safety-related ITS functions currently being offered by DSRC licenses pursuant to established standards and contemplated when the Commission originally provided for ITS services in the band. These include vehicle-to-vehicle basic safety applications, including Basic Safety Messages,⁹¹ Personal Safety Message applications,⁹² as well as vehicle-to-infrastructure applications.⁹³ Notably, the existing DSRC band plan designated only 20

⁸⁴ NCTA Reply at 20-23.

⁸⁵ *See, e.g.*, Broadcom, Inc. and Facebook, Inc. Comments at 1, Dynamic Spectrum Alliance Comments at 1-4, Institute for Policy Innovation at 1-3, WISPA Comments at 1; Tech Freedom Comments at 7; Free State Foundation Comments at 3.

⁸⁶ 5GAA Oct. 1, 2020 *Ex Parte* at 2. 5GAA's alternative proposal is contingent upon our imposing specific safeguards on unlicensed use of the lower portion for unlicensed use, including limiting such use to indoor operations, to protect ITS operations in the upper 30 megahertz, and identifying 40 megahertz of dedicated mid-band spectrum elsewhere for advanced C-V2X operations. *Id.*

⁸⁷ 5GAA Oct. 1, 2020 *Ex Parte* at 2.

⁸⁸ Qualcomm Oct. 16, 2020 *Ex Parte* at 1-3.

⁸⁹ 5GAA Oct. 1, 2020 *Ex Parte* at 2, n.1.

⁹⁰ Qualcomm Oct. 16, 2020 *Ex Parte* at 1.

⁹¹ Basic Safety Message (BSM) functions are designed to provide speed, direction, turning angle, path history, and acceleration/deceleration from the connected vehicle to nearby connected vehicles to support crash warning applications. Example applications include intersection movement assist, left-turn assist, forward collision warning, and lane change warning. *See, e.g.*, Panasonic Oct. 6, 2020 *Ex Parte*, Attachment ("Spectrum Requirements for Intelligent Transportation Systems") at 6 (referencing Car 2 Car study).

⁹² Personal Safety Message (PSM) functions are designed to provide warning messages between connected vehicles and connected Vulnerable Road Users (VRUs), such as pedestrians, bicyclists, and roadside workers. *See* IEEE 1609 Working Group Comments at 6-7.

⁹³ V2I functions include a collection of messages providing information to the driver of the connected vehicle and to that vehicle from smart road infrastructure. These include three components: (a) signal, phase and timing (SPAT) information, which is sent by red lights to provide the next green phase; (b) map data, which describes road lane topology, intersections, and to some extent traffic maneuvers, such as traffic changes through construction zones; and (c) in-vehicle information, which carries information such as speed limits. *See* Car 2 Car Communications Consortium Comments at 3.

megahertz for two safety channels (Channel 172 exclusively for vehicle-to-vehicle safety communications for accident avoidance and mitigation, and safety of life and property applications; and Channel 184 exclusively for high-power, longer-distance communications to be used for public safety applications involving safety of life and property, including road intersection collision mitigation). And Car 2 Car's filings reflect that 30 megahertz, even if channelized with no overlap, can accommodate various core safety-related functions, including vehicle-to-vehicle and vehicle-to-infrastructure functions such as Basic Safety Message and Personal Safety Message functions, with more spectrum potentially available for platooning and other services.⁹⁴

36. *Second*, the record demonstrates that 30 megahertz is more than sufficient to preserve DSRC licensees' ability to expand their existing safety-related services to millions more vehicles. As U.S. DOT and others have recognized, the benefits of V2X services in the 5.9 GHz band require a "critical mass of communicating vehicles" in the American fleet to achieve many of the safety-related benefits.⁹⁵ ITS (both DSRC and C-V2X) are designed to reuse spectrum geographically, so we are confident that 30 megahertz is sufficient to deploy ITS-based services at scale. In other words, despite the limited deployment of DSRC to date for the testing of targeted safety applications, we expect reserving 30 megahertz for ITS is still sufficient to enable the widespread deployment of ITS services to the American automotive public.

37. *Third*, we find that 30 megahertz will be sufficient for the safety applications of the next-generation of ITS—C-V2X. 5GAA has delineated multiple accident avoidance and other safety use cases, including V2V, V2I, and vehicle-to-pedestrian applications, that can be supported over 30 megahertz of spectrum.⁹⁶ We also agree with Qualcomm that, with this 30 megahertz of spectrum made available for C-V2X-based ITS, automakers, technology providers, and service providers will effectively use the spectrum for vehicle safety-related applications.⁹⁷ With this 30 megahertz, incumbent licensees will be able to provide the same types of ITS services that, up until this point have been developed and deployed on a limited basis, going forward on a widescale basis, including for use in millions of commercially available vehicles (e.g., automobiles, trucks) to bring the benefits of these ITS safety-related services more broadly to the American public.

38. *Fourth*, prudent management of radio spectrum demands that we take into account the maturation and increasing prevalence of other technologies for the provision of messages to provide core safety in the ITS system. For example, the Commission has dedicated spectrum in the 76-81 GHz band for vehicular radars, which is actively used today in providing enhanced safety features,⁹⁸ and which does not rely on use of the 5.9 GHz band. Commercial cellular services and frequently updated databases can provide important roadway-related information—indeed, Wi-Fi operations in the 5.9 GHz band could take the place of many of the non-safety-related applications contemplated for ITS. If spectrum is to be put to its highest and best use, ITS services in the 5.9 GHz band should not duplicate information that is already readily available, nor should excess 5.9 GHz band spectrum continue to be reserved for applications that can or have already been provided using other spectrum bands or alternative technology. Instead, dedicated ITS spectrum must be reserved for safety-related ITS services that cannot be readily

⁹⁴ Car 2 Car Comments at 2, Table 1.

⁹⁵ NCTA Comments at 12 (quoting DOT).

⁹⁶ 5GAA Comments at 6-7.

⁹⁷ Qualcomm Oct. 16, 2020 *Ex Parte* at 1.

⁹⁸ Short-range radar safety services in the 76-81 GHz band include obstacle avoidance, collision warning, lane departure warning, lane change aids, blind spot detection, parking aids, airbag arming, autonomous braking, and pedestrian detection. Long-range radar safety services in the 76-81 GHz band include collision avoidance and adaptive cruise control. *Amendment of Part 1, 2, 15, 90 and 95 of the Commission's Rules to Permit Radar Services in the 76-81 GHz Band*, ET Docket No. 15-26, Report and Order, 32 FCC Rcd 8822, 8823-24, para. 3, n.8 (2017) (76-81 GHz R&O).

achieved through other means. While ITS proponents contend that future advanced ITS functions that may be developed may offer potential enhancements to technologies developed and widely deployed in vehicles today using spectrum outside of the 5.9 GHz band (radars, Lidar, etc.), there are likely to be other technological developments, including automated driving capabilities, that are being more rapidly deployed, and more importantly achieve the kind of critical fleet penetration, to provide the same or similar vehicular safety benefits. As U.S. DOT and others have acknowledged, V2X in the 5.9 GHz band is not a requirement for deployment of automated driving systems.⁹⁹

39. *Fifth*, we are not persuaded that more than 30 megahertz is needed for potential new applications that extend beyond the types of safety-related services currently being offered by DSRC licensees pursuant to the Commission's rules. The 75 megahertz in the 5.9 GHz band has been underused for many years, and DSRC service has not been widely deployed. Potential future advanced applications, however, are still under development and have not been deployed and widescale commercial deployment would at best still be years away (if it occurred at all).

40. *Sixth*, the Commission has used a variety of techniques to achieve greater spectrum efficiency in other bands. For example, we have reduced the amount of spectrum being used (such as by requiring more spectrally efficient technologies) or increased the number of possible users through advanced sharing techniques. Here, we find the more appropriate action is to divide the band into two separate spectrum segments. This is the quickest, most efficient way to realize our goals, rather than subjecting the band to additional testing to determine appropriate sharing techniques

41. *Seventh*, preserving 30 megahertz for ITS use in the 5.9 GHz will comport with the use many other countries have designated for this band and allow global harmonization. We start by noting that many countries are providing for ITS use in the 5.9 GHz band, with variances in the upper and lower channel bounds, available bandwidth, technology, and nature of services being developed. Notably, it appears that no other countries have reserved 75 megahertz for safety-of-life ITS uses.¹⁰⁰ For example, Open Technology Institute and Public Knowledge describe Japan's use of a single 10-megahertz channel to provide V2X safety-related benefits.¹⁰¹ And China has only allocated 20 megahertz for such ITS use.¹⁰² Although some countries have allocated more to ITS,¹⁰³ we find that, based on the worldwide experience, each jurisdiction appears to have made an individual policy choice that it has found to be most appropriate for its particular circumstances. To the extent that there is a broad allocation of spectrum in the 5.9 GHz band to support ITS technologies (even if there is no overall consensus on which technology or applications will ultimately be deployed in specific portion(s) of the band),¹⁰⁴ there are potential harmonization benefits in retaining some dedicated spectrum for ITS in this frequency range—especially in the upper 20 megahertz, which R Street identifies as “the only spectrum in common use across all countries.”¹⁰⁵ Our plan to introduce C-V2X in the band, in conjunction with other

⁹⁹ U.S. DOT March 9, 2020 Comments at 2; AASHTO Comments at 19 (typical “autonomous” vehicles do not require any vehicle-to-vehicle communications, and current autonomous vehicle testing to not use direct V2V communication between and among vehicles operating on the public road).

¹⁰⁰ NCTA Reply at 27-32.

¹⁰¹ OTI and PK Comments at 20. *See also* Motor & Equipment Manufacturers Association Reply Comments at 7 (stating that, out of 80 megahertz, 10 megahertz is “dedicated exclusively for transportation safety communications.”)

¹⁰² *See* R Street Institute Comments at 6.

¹⁰³ ITS allocations (not limited to safety-of-life) in this camp include Europe (50 megahertz, 5.875–5.925 GHz); Singapore (50 megahertz, 5.875–5.925 GHz); Australia (70 megahertz, 5.855–5.925 GHz); and Korea (70 megahertz, 5.855–5.925 GHz). *See* R Street Institute Comments at 6; Autotalks Comments at 6-7.

¹⁰⁴ The International Telecommunication Union Radiocommunication Sector (ITU-R) recommends designating the 5.9 GHz band for ITS. *See* Car2Car Comments at 4.

¹⁰⁵ *See e.g.*, R Street Institute Comments at 7.

administrations' support for such use within the 5.9 GHz band, should facilitate economies of scale in the production and deployment of equipment and, ultimately, provision of the core safety functions originally contemplated for the band.

42. We disagree with ITS proponents who insist that the entire band be preserved for future ITS developments that could make use of the entire 75 megahertz in the 5.9 GHz band. Although it is possible that ITS might ultimately make use of the entire 75 megahertz if it continued to be set aside for ITS, such a decision would not optimize use of this valuable spectrum—and the credibility of such arguments is lacking given that these same arguments have been advanced by ITS proponents for years and years with no discernible change in the marketplace. We agree with 5GAA and Qualcomm that 30 megahertz is sufficient for providing basic safety and related services, consistent with those originally contemplated when the Commission authorized DSRC-based ITS service in the 5.9 GHz band, and sufficient to advance new services should operators use spectrum efficiently. We find that the public interest is best served by dividing the 5.9 GHz band to address the needs of both ITS and unlicensed users.

43. We disagree with the position of Car 2 Car and other commenters that argue that more than 30 megahertz should be reserved to accommodate future advanced ITS safety-related services that are under development.¹⁰⁶ Car 2 Car Communication Consortium, referencing its own spectrum study, acknowledges that 30 megahertz is more than sufficient to support the initial phases of ITS that are related to “awareness driving,” including several vehicle-to-vehicle applications (including Basic Safety Message and Personal Safety Message) and vehicle-to-infrastructure applications.¹⁰⁷ But Car 2 Car goes on to claim that limiting the spectrum to this amount may risk sufficient support for platooning¹⁰⁸ or protection of unconnected “vulnerable road users” (e.g., pedestrians, bicyclists, roadside and roadside workers who cannot send/receive Personal Safety Messages to/from connected vehicles),¹⁰⁹ and would not support later phases of ITS currently under study associated with “sensing driving” and “cooperative awareness driving” (including Collective Perception Messages¹¹⁰ and Maneuver Coordination Messages¹¹¹), which could require more spectrum and could help enable future autonomous driving

¹⁰⁶ See Car 2 Car Communication Consortium Comments at 1-8, 18-19. See also Panasonic Oct. 6, 2020 *Ex Parte*, Attachment (“Spectrum Requirements for Intelligent Transportation Systems”) at 2-4 (referencing Car 2 Car study); Volkswagen Comments at 9 (30 megahertz is needed for vehicle-to-vehicle and vehicle-to-infrastructure safety applications today).

¹⁰⁷ See Car 2 Car Communication Consortium Comments at 1-8, 18-19.

¹⁰⁸ Platooning functions relate to a type of cooperative automated driving for connected vehicles, generally trucks, that travel together in a coordinated manner. See Continental Reply at 16.

¹⁰⁹ Vulnerable road users (VRUs) include pedestrians, bicyclists, motorcyclists, scooter users, and roadside workers. See, e.g., Car 2 Car Communications Consortium Comments at 2.

¹¹⁰ Collective Perception Message (CPM) functions, which are under development at this time, are anticipated to involve smart roadside infrastructure and connected vehicles detecting and providing information to other connected vehicles about all traffic participants in the vicinity, including non-connected vulnerable road users and vehicles. Example applications include accident avoidance with vulnerable roadside users, overtaking warnings with collective perception, extended intersection collision warning with collective perception, cooperative awareness of objects on the street, wrong-way vehicle warnings in cases of non-V2X equipped wrong-way vehicles.

¹¹¹ Maneuver Coordination Message (MCM) functions, which are under development, are anticipated to facilitate negotiations between connected vehicles for non-ordinary highway situations. Example applications may include: cooperative lane change: opening gaps for vehicles to safely change lanes; cooperative overtaking (opening gaps for vehicles to safely overtake), maneuver coordination for automated driving (exchange of intended driving paths); cooperative merging; improved cooperative driving applications (e.g., improved intersection movement assist and improved left turn assist).

services.¹¹²

44. We disagree with Car 2 Car's premise that 70 megahertz of spectrum may be needed to accommodate all of the various message types (e.g., urban, suburban, and highway use cases), including possible future applications.¹¹³ Continental, the IEEE 1609 Working Group, and others similarly contend that 30 megahertz would not be sufficient for potential future, but not yet developed or deployed, advanced services (including cooperative awareness driving, maneuver coordination, and platooning).¹¹⁴ 5GAA agrees that 30 megahertz would not be sufficient for "advanced" applications that are currently under development, which would need an additional 40 megahertz of spectrum,¹¹⁵ and the Alliance for Automotive Innovation asserts that providing only 30 megahertz for vehicle-to-everything (V2X) applications would undercut the technology's possible benefits by eliminating spectrum needed for anticipated technological innovations.¹¹⁶ U.S. DOT contends that all 75 megahertz should be preserved for ITS¹¹⁷ noting that limiting ITS to 30 megahertz would reduce the utility of V2X and that safety innovations under development, including cooperative automated driving systems, may be lost.¹¹⁸ U.S. DOT and others also contend that the 5.9 GHz band is ideally suited for V2X because of the band's non-line-of-sight communication capabilities, asserting for instance that this can promote advanced driver assistance systems by enabling sensor data that is already being employed by individual vehicles using other spectrum (e.g., radar, LiDAR, cameras) to be shared cooperatively (at low latency) to improve vehicular safety among more users.¹¹⁹ Some ITS proponents contend that limiting the amount of available spectrum to 30 megahertz may eliminate or significantly delay development and deployment of certain ITS capabilities.¹²⁰ In addition, the Commission received comments from other interested parties, including automakers and related entities,¹²¹ transportation-related associations and state departments of transportation,¹²² public safety entities,¹²³ and others¹²⁴ advocating for retention of the entire 5.9 GHz

¹¹² See Car2Car Communication Consortium Comments at 1-8, 18-19.

¹¹³ Car2Car Comments at 2. Car2Car provides a chart that purports to show the spectrum requirements, in megahertz, for six message types (basic safety message, infrastructure to vehicle, personal safety message, collective perception message, platooning control message and maneuver coordination message) for urban, suburban and highway driving use cases.

¹¹⁴ Continental Reply Comments at 15-17; Continental June 5, 2020 *Ex Parte* (slide presentation); Continental Oct. 7, 2020 *Ex Parte* at 1-2; see also Continental Comments at 4-7; IEEE 1609 Working Group Comments at 5-10 (75 megahertz is needed for the wide range of safety-related ITS applications, including Basic Safety Message, vulnerable road users, and connected and automated vehicles that are under development, citing Car 2 Car spectrum study); U.S Technical Advisory Group Comments at 5-10 (same).

¹¹⁵ 5GAA Comments at 22-31 (30 megahertz would support "C-V2X Direct" operations but not "advanced" C-V2X); see also Panasonic Oct. 6, 2020 *Ex Parte*, Attachment ("Spectrum Requirements for Intelligent Transportation Systems") at 2-4 (referencing 5GAA analysis).

¹¹⁶ Alliance for Automotive Innovation Reply Comments at 22-24.

¹¹⁷ See generally U.S. DOT March 9, 2020 Comments.

¹¹⁸ U.S. DOT March 9, 2020 Comments at 1-3; see also *id.* at 14-19.

¹¹⁹ See, e.g., U.S. DOT March 9, 2020 Comments at 29-32; IEEE 1609 Working Group Comments at 8; Panasonic Comments at 14.

¹²⁰ See, e.g., Car 2 Car Comments at 4; Continental June 5, 2020 *Ex Parte* at 1, 4.

¹²¹ See, e.g., GM Comments at 8-9 (potential safety benefits related to protecting vulnerable road users, cooperative driving, platooning, and advanced driving with sensors will be lost or limited); Honda Comments at 10; Jaguar Land Rover Comments at 3; Nissan Comments at 1; Volkswagen Comments at 4-5; Volvo Comments at 2; BMW Comments at 3; Fiat-Chrysler Comments at 3; Ford Reply at 6-7; Toyota Reply at 5-9; Autotalks Comments at 2; European Automobile Manufacturers Association Comments at 1-2; Bosch Comments at 4.

band for ITS to ensure that there is sufficient spectrum for both current and future safety-related applications.

45. NCTA, WISPA, and others dispute that any additional spectrum should be made available for these potential, future ITS applications. NCTA notes that Car 2 Car's own study indicates that 30 megahertz is sufficient for Basic Safety Messages (which requires no more than 10 megahertz) and various vehicle-to-infrastructure applications, including signal phase and timing, road/lane topology maneuver, in-vehicle information and other similar messages, as well as the Personal Safety Message (which require only 20 megahertz).¹²⁵ NCTA further notes that even after 20 years there are no commercially marketed vehicles that includes DSRC radios to even provide ITS basic safety services.¹²⁶ NCTA contends that the Commission should not consider the potential spectrum needs of future versions of ITS technologies, that these other potential future V2X applications are "speculative developments" which may or may not develop.¹²⁷ NCTA states that this would invite repeat of the same error made in 1999 which resulted in underuse of valuable mid-band while awaiting research and development.¹²⁸ WISPA contends that commenters seeking to continue to reserve the existing ITS spectrum reservation without modification, fail to make the case that the entire band must be withheld from other uses. It further argues that to continue to wait for benefits that have proven elusive for more than two decades,¹²⁹ are based on speculation about "future potential" or the "potential evolution" ITS applications needs and a desire to "future proof" possible future uses.¹³⁰ In addition, Open Technology Institute/Public Knowledge argue that leaving the entire 5.9 GHz allocated for auto-related communications (whether under the DSRC or C-V2X standards) would impose high costs on consumers with little return on the horizon and, hence, a stalled 5.9 GHz band would only remain a roadblock to the realization of consumer and public benefits.¹³¹

46. Given the significant advances that have been made in automotive connectivity using a variety of means in different spectrum bands outside of 5.9 GHz, an ever-greater portion of the overall valuable spectrum resource is being used to support automotive-related functions, including those related to safety. Viewed from this perspective, we are not persuaded by arguments that the entire 5.9 GHz band is needed for ITS in order to ensure that possible future developments can be accommodated, even if it is possible that such future developments could potentially provide some additional safety benefits. Even if

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¹²² See, e.g., ITS America Comments at 3; American Trucking Association Comments at 2; American Highway Users Alliance Comments at 3; American Public Transportation Association Comments at 2; Automotive Safety Council Comments at 1-2; AASHTO Comments at 3; California DOT Comments at 3; City of New York Comments at 5-6; Colorado DOT Comments at 1-2; Georgia DOT Comments at 15; Michigan DOT Comments at 1-3; Pennsylvania DOT Comments at 1; Texas DOT Comments at 2-4.

¹²³ See, e.g., National Public Safety Telecommunications Council Comments at 1; National Sheriff's Association Comments at 1.

¹²⁴ See, e.g., Consumer Reports Comments at 1; LG Electronics Comments at 1; Qualcomm Comments at 9-16; Bosch Comments at 5; NXP Semiconductors Comments at 1; AT&T Comments at 1; T-Mobile Comments at 1; League of American Bicyclists Comments.

¹²⁵ NCTA Reply at 24 (citing Car 2 Car Position Paper on Road Safety and Road Efficiency Spectrum Needs in the 5.9 GHz for C-ITS and Cooperative Automated Driving (Feb. 28, 2020)).

¹²⁶ NCTA Reply at 26.

¹²⁷ NCTA Reply at 24-27.

¹²⁸ NCTA Reply at 26-27.

¹²⁹ WISPA Reply Comments at 2-3.

¹³⁰ WISPA Reply at 11.

¹³¹ *Id.* at 6-7.

each of the message types identified may be needed to deliver specific applications, basic safety messages and collective perception messages would not be delivered simultaneously, and each type of message will have varying requirements for frequency and duration. Thus, we believe that the ITS messaging system must work to prioritize and deliver messages more efficiently in the 30 megahertz that will be available for ITS, such as by adjusting message timing to provide multiple types of messages on a single channel to provide the same level of safety to vehicles as can be done on the existing spectrum.

47. Finally, we disagree with ITS proponents that assert that our decision will undercut U.S. leadership in innovation based on other countries around the world that have made more spectrum available for ITS in the 5.9 GHz band.¹³² As noted, the actual amount of spectrum varies by country. And we are not aware of any widespread deployments that use the full 75 megahertz that that proponents say is needed to maintain U.S. leadership—indeed, it appears that the United States is not the only country where the long-time promises of ITS have failed to bear fruit. As such, we conclude that targeting the upper 30 megahertz for ITS use (and transitioning that spectrum to C-V2X over time) will enable America to lead in this wireless sector, as it has in others.

b. Transitioning ITS out of the 5.850-5.895 GHz Portion of the 5.9 GHz Band.

48. We adopt a timeline for existing ITS operations to cease use of the lower 45-megahertz (i.e. 5.850-5.895 GHz) band segment. In the *5.9 GHz NPRM*, we recognized that a limited number of DSRC systems have been authorized and constructed within the larger 75 megahertz-wide 5.9 GHz band and sought comment on the transition of these operations to the spectrum that would be retained for ITS.¹³³ In particular, we asked whether we should adopt a six-month period in which existing DSRC operations, licensed under Part 90 of our rules, and all on-board units operating pursuant to our Part 95 rules would have to re-channelize or discontinue service, as well as whether a shorter or longer period would be appropriate.¹³⁴ We also proposed to modify existing ITS licenses to allow operation in only the 5.895-5.925 GHz portion of the band, to the extent that licensees wanted to operate a C-V2X system, or in the 5.895-5.905 GHz portion of the band, to the extent that licensees wanted to continue their DSRC operations.¹³⁵

49. We adopt our proposal to require existing ITS licensees to cease use of the 5.850-5.895 GHz portion of the 5.9 GHz band and will provide ITS licensees up to one year from the effective date of this First Report and Order to cease operating in this portion of the band. Some commenters support requiring the ITS operations in the lower 45 megahertz to transition out of this spectrum within six months of our decision,¹³⁶ while others state that six months is not sufficient.¹³⁷ Taking the record into account, we believe providing ITS licensees one year from the effective date of this First Report and Order provides a sufficient and reasonable amount of time for them to take the necessary steps to transition from the lower 45 megahertz of spectrum and to engage in the same types of operations in the upper 30 megahertz that they were conducting in the band. Thus, our action today will accommodate the needs of these incumbent licensees and provide sufficient time to consolidate their operations to the upper

¹³² See, e.g., 5GAA Comments at 34-35 (many other countries have allocated amounts similar to 75 megahertz for ITS); Car 2 Car Comments at 4-5 (other countries are allocating spectrum for cooperative automated driving); Autotalks Comments at 6-7 (many other countries allocate more than 30 megahertz for ITS); Alliance for Automotive Innovation Reply Comments at 25-27; Continental Reply Comments at 17-19; ITS America Reply Comments at 35.

¹³³ *5.9 GHz NPRM*, 34 FCC Rcd at 12616-18, paras. 32-36.

¹³⁴ *5.9 GHz NPRM*, 34 FCC Rcd at 12618, para. 36.

¹³⁵ *5.9 GHz NPRM*, 34 FCC Rcd at 12617, para. 34.

¹³⁶ See NCTA Comments at 44; T-Mobile Comments at 2, n.5.

¹³⁷ OmniAir Consortium Comments at 11.

portion of the band, while enabling unlicensed system operators to begin taking advantage of the U-NII-4 band with indoor-only deployments as soon as possible.

50. The Commission first suggested a six-month transition period nearly a year ago,¹³⁸ providing licensees as well as manufacturers with notice that the Commission was contemplating adopting rules that would require them to vacate the lower portion of the band. Based on the record before us, we believe that allowing one year from the effective date of this First Report and Order is more than adequate for ITS licensees and equipment manufacturers to take the steps needed to complete the transition to the modified ITS band. We do not believe this transition period presents an undue burden to the ITS licensees as, to date, there have only been limited ITS deployments with relatively few installed transmitters. Because the majority of the installed base is being used in trials for roadside units at known locations, it should be simple to identify and modify that equipment. All ITS equipment authorized in the U.S. has the ability to operate over the upper 70 megahertz of the 5.9 GHz band. Hence, moving operations to the upper 30 megahertz should be possible within the proposed one-year period time frame through firmware upgrades. Furthermore, we do not expect our decision to delay introduction of on-board units as, under normal vehicle development cycles, we would expect at least two years before such equipment could be deployed in vehicles in large numbers.¹³⁹ Manufacturers should have ample time to integrate new on-board units that comply with our rules into future model year vehicles.

51. Accordingly, we use our authority under section 316 of the Communications Act to modify all existing ITS licenses to permit operation only in the 5.895-5.925 GHz portion of the 5.9 GHz band; effectively removing any authority to operate in the lower 45 megahertz and to implement the one-year transition period.¹⁴⁰ In addition, because licensees are required to register their RSUs on specific bands, and not all RSUs are currently registered for the upper 30 megahertz, we are modifying all licenses to change the channels for which RSUs are authorized to the 5.895-5.925 GHz.¹⁴¹ We find that such modifications are consistent with our statutory authority, supported by judicial and Commission precedent, and will serve the public interest.

52. Section 316 of the Communications Act vests the Commission with broad authority to modify licenses “if in the judgment of the Commission such action will promote the public interest, convenience, and necessity.”¹⁴² We find that modifying existing ITS authorizations to clear use of the lower 45 megahertz of spectrum in the 5.850-5.895 GHz portion of the 5.9 GHz band (and confine their operations to the upper 30 megahertz of spectrum in the 5.895-5.925 GHz portion of the band) is within the Commission’s statutory authority, consistent with prior Commission practice, and will promote the public interest, convenience, and necessity. We accordingly will modify all 5.850-5.895 GHz authorizations to carry out the clearing of this portion of the band. Specifically, the Commission will modify all active ITS licenses as follows: Authorize the full 30 megahertz of spectrum in the 5.895-5.925 GHz segment of the 5.9 GHz band on every existing license, including on individually registered RSUs, to the extent not already authorized; create a notification requirement consistent with the transition deadline of one year from the effective date of this First Report and Order, which will require licensees to certify that they have ceased operating in the 5.850-5.895 GHz portion of the band; any licensee that does

¹³⁸ 5.9 GHz NPRM, 34 FCC Rcd at 12618, para. 36.

¹³⁹ See National Highway Traffic Safety Administration (NHTSA), Department of Transportation (DOT), Federal Motor Vehicle Safety Standards; V2V Communications Notice of Proposed Rulemaking (NPRM). 82 FR 3854, which states new V2X requirements, if adopted, would phase-in two model years after the final rule is adopted to accommodate vehicle manufacturers’ product cycles.

¹⁴⁰ As per 47 U.S.C. § 316, we provide for a 30-day protest period before these modifications can become final.

¹⁴¹ These license modifications are subject to the protest period provided by section 316, as clarified in the ordering clauses.

¹⁴² *Id.* See also *California Metro Mobile Commc’ns, Inc. v. FCC*, 365 F.3d 38, 45 (D.C. Cir. 2004) (“Section 316 grants the Commission broad power to modify licenses.”).

not transition to the upper 30 megahertz of spectrum in the 5.895-5.925 GHz segment of the 5.9 GHz band, as evidenced by failure to file the required notification advising the Commission of its transition, will have their license terminated automatically without specific Commission action; and at a reasonable time after the transition deadline, the Commission will automatically remove all frequencies in the 5.850-5.895 GHz portion of the band that remain on any ITS license, including on individually registered RSUs. We believe the notification requirement will ensure clearing of lower 45 megahertz of spectrum. We direct the Wireless Telecommunications Bureau to establish the procedural requirements of the notification process via Public Notice.

53. We revise our rules to prohibit new ITS applications for the 5.850-5.895 GHz portion of the band, as well as modify section 95.3163 to reflect that licensed by rule on-board units are similarly limited to operate only in the 5.895-5.925 GHz band as of the end of the one year sunset period.¹⁴³ While some existing ITS licenses have expiration dates that stretch to 2030,¹⁴⁴ and implementations are in varied states of system maturity,¹⁴⁵ we are not terminating any license or any licensee's renewal expectancy, and we believe that this transition plan treats each license in a consistent manner.

54. Licensees, once the existing licensing freeze is modified, may register new roadside units only to operate within the modified ITS band of 5.895-5.925 GHz. Licensees may, at any time on their own motion, modify their roadside unit location registrations that show frequency usage in the lower 45 megahertz to reflect only the 5.895-5.925 frequencies in the modified ITS band. By no later than the transition date, licensees would be required to cease all operations in the 5.850-5.895 GHz band as any ITS operation in the band on or after that date would violate the Commission's rules.¹⁴⁶

55. Existing ITS licensees that currently operate on channels in the 5.850-5.895 GHz portion of the 5.9 GHz band may move any of their DSRC-based operations to channels in the 5.895-5.925 GHz portion of the band at any time before they are required to cease operations in the 5.850-5.895 GHz portion. Furthermore, we anticipate that some ITS licensees may wish to operate C-V2X-based ITS in the 5.895-5.925 GHz ITS band, and we will allow them to do so at any time through existing regulatory processes, under certain circumstances, and in such a way that would not interfere with existing DSRC-based operations. This could enable a smoother and more rapid development and deployment of C-V2X-based ITS operations in the future.

B. Unlicensed Operations in the 5.850-5.895 GHz Band

56. As discussed above, we are designating 45 megahertz in the 5.850-5.895 GHz portion of the 5.9 GHz band for unlicensed operations. This 45-megahertz band will expand the unlicensed ecosystem by providing additional spectrum adjacent to the upper edge of the U-NII-3 band for unlicensed devices.¹⁴⁷

57. Below, we set out the technical and operational rules for unlicensed operations in the 5.850-5.895 GHz band as well as rules for protecting incumbents in the band. After review of the

¹⁴³ We note that vehicle owners do not necessarily have control over on-board unit operations. The rule change here is procedural in nature and the Commission does not intend to seek enforcement action on vehicle owners with on-board DSRC units that continue to operate throughout the 5.9 GHz band. As these units operate at low power levels, we do not believe they pose a significant risk of harmful interference.

¹⁴⁴ See note 75, *supra*.

¹⁴⁵ The Commission's Universal Licensing System shows that 52 DSRC licensees have been granted registrations for RSU sites.

¹⁴⁶ This includes portable RSUs not subject to registration requirements.

¹⁴⁷ In this band, ultra-wideband devices have been permitted to operate, but at very low power levels (see 47 CFR Part 15, Subpart F), and unlicensed in general has been authorized to operate, but also at low power levels (i.e., the limits in 47 CFR § 15.209).

pertinent technical and legal issues before us and an examination of the record, we adopt a staged approach to effectuate the band-repurposing actions taken herein. The approach we take is designed to optimize use of the 5.850-5.895 GHz band by unlicensed operations as soon as possible in this portion of the 5.9 GHz band with full consideration of the need to protect incumbent operations in this band. Specifically, at this time we will permit only indoor unlicensed operations to operate across the entire 5.850-5.895 GHz portion of the band. We limit unlicensed use to indoor operations in recognition of the potential that ITS licensees may currently be operating in portions of the 5.850-5.895 GHz band in particular geographic areas, as well as the need to protect federal incumbents operating in particular geographic zones in the 5.850-5.895 GHz band. We decline to allow full-power unlicensed outdoor operations at this time. Instead, such use across the band will be allowed at a later time, after ITS operations have ceased to operate in the 5.850-5.895 GHz band and after we have adopted rules that will ensure protection of federal operations from these outdoor operations. We nonetheless will allow some outdoor operations in certain specified locations in the band through the STA process (i.e., on a non-interference basis), where such operations would not cause harmful interference to any incumbent operations.

1. Technical and Operational Rules for Unlicensed Operations

58. In the *5.9 GHz NPRM*, we proposed to place the U-NII-4 unlicensed device rules in Part 15, subpart E along with the existing U-NII rules and subject to all of the general Part 15 operational principles. We also proposed that U-NII-4 devices be subject to similar technical and operational rules as apply to the U-NII-3 band. Proponents of ITS services suggest that U-NII-4 operations should be restricted to indoor-only use to protect adjacent-band ITS operations from harmful interference.¹⁴⁸ 5GAA, Cisco, and Qualcomm submit that restricting U-NII-4 operations to indoor-only use would also allow for relaxation of the OOB limits on frequencies outside of the 5.850-5.895 GHz band, which would allow for more flexible use of the band and enable robust wideband operations indoors.¹⁴⁹ Proponents of unlicensed operations suggest that the Commission should consider separate rules for indoor and outdoor U-NII-4 band operations, rather than adopting indoor-only use restrictions or applying more stringent OOB limits across all unlicensed operations in the U-NII-4 band.¹⁵⁰

a. Indoor Unlicensed Operations to Protect Federal Incumbents and ITS Operations while ITS Remains in the 5.850-5.895 GHz Band

59. We conclude that in order to protect incumbent 5.9 GHz band services from potential interference by unlicensed operations— including Federal incumbents and ITS operations while those remain in the 5.850-5.925 GHz portion of the band – we will permit only indoor unlicensed operations to operate across the band at this time.

(i) Protection of Federal Incumbents

60. The 5.650-5.925 GHz band is allocated on a primary basis for the Federal Radiolocation Service and is used by the Department of Defense (DoD) for fixed and mobile radar operations.¹⁵¹ Unlicensed U-NII-3 devices currently share spectrum with DoD radar operations in the 5.725-5.850 GHz band without implementing any special frequency avoidance techniques. Unlicensed devices generally

¹⁴⁸ See, e.g., 5GAA Comments at 42, n.123; Car 2 Car Comments at 18; Cisco Comments at 15-16; Ford Reply Comments at 8; IEEE 1609 WG Comments at 15; OmniAir Comments at 10; Qualcomm Comments at 18-19; Toyota Reply Comments at 14; and U.S. TAG Comments at 11.

¹⁴⁹ See 5GAA Comments at 42, n.123; Cisco Comments at 15-16; Qualcomm Comments at 18-19.

¹⁵⁰ See, e.g., Broadcom/Facebook Comments at 6; Comcast Reply Comments at 12; Dynamic Spectrum Alliance Comments at 5; NCTA Comments at 49-50; New America's Open Technology Institute with the American Library Association, Benton Foundation, Next Century Cities, and Public Knowledge Reply Comments at 22-24; Wi-Fi Alliance Comments at 7-8; and WISPA Comments at 6-7.

¹⁵¹ See 47 CFR § 2.106.

operate without incident in the U-NII-3 band. There have been some isolated instances of harmful interference, however, which the Commission worked with the National Telecommunications and Information Administration (NTIA) and DoD to resolve.¹⁵² Notably, at the time the Commission adopted rules for the U-NII-3 band, it was unaware of these DoD radars.¹⁵³ In the *5.9 GHz NPRM*, we proposed to adopt the same technical rules (e.g., radiated power, power spectral density, etc.) for U-NII-4 devices as apply to U-NII-3 devices. The Commission also sought comment on whether there are any mitigation measures, such as technical or operational conditions or constraints that could be imposed on U-NII-4 devices, to protect DoD radars in the band.¹⁵⁴ And the Commission committed to continue working with NTIA and DoD to consider whether there are policies or procedures that could minimize the potential for harmful interference to DoD radars from U-NII-4 devices.

61. Comcast submits that the Commission should adopt its proposal for U-NII-4 devices to adhere to the same technical rules as U-NII-3 devices with respect to federal DoD radar operations.¹⁵⁵ WISPA agrees with the Commission's judgment that no other mitigation measures are required to protect DoD radar operations in the 5.9 GHz band.¹⁵⁶ NCTA states that the Commission should adopt its proposal to authorize U-NII-4 devices without requiring any special frequency avoidance techniques or similar constraints since U-NII-3 devices have shared spectrum with co-channel federal incumbents for years without any specialized frequency avoidance techniques, and in general sharing has been successful.¹⁵⁷

62. NTIA conducted analyses to assess the potential of U-NII-4 devices to cause harmful interference to DoD radar operations. That analysis concludes that a 33 dBm/20 MHz equivalent isotropically radiated power (EIRP) limit for indoor U-NII-4 devices is unlikely to cause harmful interference to federal radar operations in the 5.9 GHz band.¹⁵⁸ We support NTIA's recommended power limit as we believe it properly balances federal radar protection levels with ensuring that U-NII-4 devices can operate with enough power to provide reliable connections to the American public. As NTIA expresses the power level as a density of 20 dBm/MHz, we are adopting rules consistent with that recommendation.

63. While we agree with NTIA's power density limit recommendation for U-NII-4 indoor devices, it is worth noting that there are a number of NTIA's assumptions that differ from our assumptions in the *6 GHz Report and Order* analysis. For example, one distinction is with respect to the probability that a Wi-Fi channel is operating in the U-NII-4 band. In general, this probability depends on

¹⁵² We are aware of harmful interference that occurred to an Air Force radar tracking system that has become operational at Cape Canaveral. See Advisory Notice 5 GHz Interference to Patrick Air Force Base and Cape Canaveral Air Force Station Tracking Radars, FCC Enforcement Bureau Office of the Field Director (rel. Jul. 27, 2016).

¹⁵³ U-NII Report and Order, 12 FCC Rcd at 1596-97 para. 46, 1610, para. 82 (establishing the 5.725-5.825 GHz (U-NII-3) band); U-NII 5 GHz Report and Order, 29 FCC Rcd at 4151, para. 88 (adding 5.825-5.850 GHz to the 5.725-5.825 GHz (U-NII-3) band); 47 CFR § 15.407(a)(3). In its comments in the initial proceeding that established the U-NII-3 band, NTIA did not mention radar tracking system operations at Cape Canaveral. See NTIA Reply Comments, Docket No. 96-102, filed Aug. 16, 1996, Appendix D at D-5. See also NTIA Comments in the U-NII-3 expansion proceeding, Docket No. 13-49, filed June 10, 2013.

¹⁵⁴ See *5.9 GHz NPRM*, 34 FCC Rcd at 12624, para. 57.

¹⁵⁵ Comcast Corporation Comments at 10, n.28.

¹⁵⁶ WISPA Comments at 7.

¹⁵⁷ NCTA Comments at 46.

¹⁵⁸ NTIA Technical Report 21-551 Compatibility of Federal Systems Operating in the 5850-5915 MHz Band with Intelligent Transportation Systems and Unlicensed National Information Infrastructure Devices, Edward Drocella, Yang Weng, Michael Ghorbanzadeh, Edison Juleau, Nickolas LaSorte, at 17.

channel bandwidth, the total number of available channels across the unlicensed bands with the corresponding bandwidth, as well as the channel bandwidth use distribution (20, 40, 80 or 160 megahertz). However, NTIA's analysis incorporates a channel-scaling parameter that broadly reflects the number of effective users in the U-NII-4 band and thus considers this probability using a single parameter. This and other varying assumptions can lead to some differences in the final numerical results. Nevertheless, we agree with NTIA's recommendation that 33dBm/20 MHz EIRP limit will not cause harmful interference to DoD radar operations.

64. For the U-NII-4 band, indoor access point EIRP will be limited to 33 dBm/20 MHz and 36 dBm/40 MHz. When combined with U-NII-3 band spectrum, indoor access point EIRP can scale to 36 dBm for 80 and 160 megahertz channels. Under this framework, operators relying on indoor U-NII-4 devices will be able to operate at the highest power levels we permit for U-NII devices (i.e., 36 dBm EIRP) using the wider channels to maximize throughput and utility of the band. At the same time, the limit on power density across all possible U-NII device bandwidths will ensure that DoD radars are protected from harmful interference. In addition to the power limit on *indoor* U-NII-4 devices, NTIA recommends further reducing the potential for harmful interference by adopting rules ensuring that indoor devices are not deployed outdoors and that expedient and effective corrective measures be put in place to eliminate interference should it occur.¹⁵⁹ For example, NTIA points out that we could limit devices to indoor use by requiring U-NII-4 access points to get their power through a wired connection (not battery-powered), have an integrated antenna, and not have a weatherized enclosure.¹⁶⁰ NTIA contends that should harmful interference occur, U-NII-4 service providers should have the capability to remotely block the interfering device(s) from using certain channels and/or to reduce the operating power of the devices. NTIA recommends that such measures be taken if U-NII-4 devices are causing harmful interference to DoD radars, noting that one of the primary operating conditions under Part 15 is that the operator must correct harmful interference *even if it requires ceasing operation*.¹⁶¹ NTIA further recommends that service providers and operators be expected to respond promptly to such FCC directives upon receipt.¹⁶²

65. We believe the basic measures recommended by NTIA can be taken to protect primary federal radiolocation operations in the band without imposing undue burdens on equipment manufacturers, service providers or users. Specifically, consistent with the rules the Commission adopted for 6 GHz low-power indoor access points¹⁶³ and consistent with NTIA's recommendations, we will require U-NII-4 devices to incorporate design measures to ensure indoor devices are not deployed outdoors. Since building attenuation is a key factor in minimizing the potential for harmful interference from indoor access points to incumbents' receivers, we are adopting reasonable and practical measures that will restrict access points at this time to indoor operations. Specifically, we adopt three equipment-related hardware requirements that are designed to keep these low-power access points indoors. *First*, as suggested by NTIA, we will require that the access point devices cannot be weather resistant.¹⁶⁴ *Second*, we will require that the access points have integrated antennas or otherwise prohibit the capability of connecting other antennas to the devices, which will prevent substituting higher gain directional antennas

¹⁵⁹ See letter from Charles Cooper, Associate Administrator, Office of Spectrum Management, NTIA, to Mr. Ronald Repasi, Chief, Office of Engineering and Technology, FCC, dated Sept. 8, 2020 (*NTIA Sept. 8, 2020 Letter*) at 4. See also *Unlicensed Use of the 6 GHz Band*, Report and Order and Further Notice of Proposed Rulemaking, 35 FCC Rcd 3852 (2020), <https://docs.fcc.gov/public/attachments/FCC-20-51A1.pdf>.

¹⁶⁰ See, e.g., 47 CFR §§ 15.257, 15.403, and 15.517.

¹⁶¹ See 47 CFR § 15.5.

¹⁶² See *NTIA Sept. 8, 2020 Letter* at 4.

¹⁶³ *6 GHz Report and Order*, 35 FCC Rcd at 3891, para. 107 (requiring that access points not be weather resistant, have integrated antennas and prohibit the capability of connecting other antennas to the devices, and prohibit operation on battery power).

¹⁶⁴ NTIA Letter at 4.

and make the devices less capable or suitable for outdoor use. *Third*, we will prohibit these access points from operating on battery power (except for back-up power in case of a power outage). Furthermore, we will require that the access points be marketed “for indoor use only” and include a label attached to the equipment stating that “FCC regulations restrict operation to indoor use only.” We will also require that this statement be placed in the device’s user manual. This statement, along with existing Commission requirements for Part 15 equipment,¹⁶⁵ will inform consumers of the appropriate use.¹⁶⁶ We find that these requirements will make outdoor operations impractical and unsuitable.

66. U-NII-4 operations providers have committed, as an industry best practice, to remotely block device(s) from using certain channels and/or to reduce the operating power of the device(s) upon notification by the Commission of harmful interference to DoD radars.¹⁶⁷ By limiting their power density and implementing the control of the access point operation, we agree with NTIA that U-NII-4 devices can operate at locations across the United States (except at the locations specified in Appendix A, Table A-1, U-NII-4 Exclusion Zones) so that the American public will enjoy the widest deployment of devices possible. Furthermore, once DSRC devices are cleared from the U-NII-4 band, we can permit the outdoor operations with a provision to protect federal radiolocation operations. In the Further Notice below, we explore options for enabling outdoor U-NII-4 device operation, including reasonable interference avoidance and mitigation techniques to protect federal radar operations.

(ii) Protecting ITS Operations During the Transition Period

67. DSRC devices are allowed to continue to operate in the lower 45 megahertz of the 5.9 GHz band for one year after the effective date of the First Report and Order. Accordingly, U-NII devices in the lower 45 megahertz of the 5.9 GHz band will be temporarily operating on a co-channel basis with ITS operations in the few geographic areas in which DSRC-based ITS operations remain in the band in the near term.

68. These co-channel operations require us to develop rules that minimize the impact of unlicensed device operation on ITS operations. As a first step, we must evaluate the probability of harmful interference that may occur under current DSRC system deployment densities. Once determined, that probability provides a basis for analyzing the potential that unlicensed operations might have on co-channel DSRC operations. Our analysis is based on an approach similar to that which we used when introducing unlicensed devices into the 6 GHz band, where low power indoor unlicensed Wi-Fi devices share spectrum with the licensed Fixed and Mobile Services.¹⁶⁸ That band provides a blueprint for similar analysis in the 5.9 GHz band as the initial sharing regime is similar; new unlicensed devices will be sharing spectrum, albeit on a temporary basis, with incumbent DSRC roadside units (RSUs) and on-board units (OBUs).

69. According to the American Association of State Highway and Transportation Officials there are 6,182 DSRC RSUs deployed throughout the U.S. and 15,506 vehicles equipped with DSRC

¹⁶⁵ For example, 47 CFR § 15.19(a)(3) requires devices to bear the general conditions associated with Part 15 operation and 47 CFR § 15.21 requires the user manual to caution users that equipment modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment. See also,

¹⁶⁶ When reviewing approved U-NII-3 equipment permissive change requests, we may, on a case-by-case basis, exempt such devices from the labeling requirement.

¹⁶⁷ See Letter from Danielle J. Piñeres, Vice President & Associate General Counsel, NCTA, to Marlene H. Dortch, Secretary, FCC, ET Docket No. 19-138, at 2 (filed Oct. 9, 2020) (NCTA Oct. 9, 2020 *Ex Parte*).

¹⁶⁸ See 35 FCC Rcd at 3888, Subsection B. Although the approach for the link analysis is similar, the overall situation in the 5.9 GHz band is different in that 1) ITS will only be operating co-channel with unlicensed operations in the lower 45 megahertz of the 5.9 GHz band on a temporary basis; and 2) the density of 5.9 GHz-band incumbent ITS operations across the U.S is significantly less than that of incumbent operations in the 6 GHz band.

OBUs.¹⁶⁹ For context, there are approximately 274 million registered vehicles in the United States¹⁷⁰ operating across approximately 4.2 million miles of paved and unpaved roadways.¹⁷¹ Thus, the vast majority of vehicles are not equipped with DSRC OBUs, just as vast stretches of roadways do not have any DSRC RSU installations. The relative number of OBU-equipped vehicles or roadway miles with installed RSUs are unlikely to change in any significant way before ITS operations move out of the lower 45 megahertz.

70. In the vehicle-to-vehicle (V2V) communications scenario, interference from an unlicensed device can only occur if there are at least two vehicles with overlapping coverage areas and there is at least one unlicensed device transmitting within that coverage area on the same channel. According to Department of Transportation report FHWA-JPO-17-483, the maximum “PER-Free range” (the range within which the ITS Packet Error Rate (PER) is below 20%) is 600 meters in an unobstructed environment.¹⁷² We estimate that in a typical scenario, at any instant of time there can be as many as 200 vehicles in the PER-Free range.¹⁷³ Therefore, the probability that two or more randomly selected vehicles are equipped with an OBU and are within the PER-Free communication range is 0.00006326.¹⁷⁴ To simplify the calculation, and look at the worst case situation, we further assume that the probability of an unlicensed device transmitting within the coverage area on the same channel is one.¹⁷⁵ Thus, the probability of interference is essentially a function of the probability of two or more OBUs operating in the PER-Free range, which is 0.00006326.¹⁷⁶

¹⁶⁹ American Association of State Highway and Transportation Officials (AASHTO) Comments at 7.

¹⁷⁰ See Statista.com, Number of motor vehicles registered in the United States from 1990 to 2018, <https://www.statista.com/statistics/183505/number-of-vehicles-in-the-united-states-since-1990/> (last visited Oct. 27, 2020).

¹⁷¹ See bts.gov, Public Road and Street Mileage in the United States by Type of Surface, <https://www.bts.gov/content/public-road-and-street-mileage-united-states-type-surfacea> (last visited Oct. 27, 2020).

¹⁷² See Department of Transportation report FHWA-JPO-17-483, at 48-52, Table 7, <https://rosap.ntl.bts.gov/view/dot/31627> (last visited Oct. 27, 2020).

¹⁷³ In a four-lane roadway with a vehicle every 12 meters there will be 200 vehicles in a 600-meter stretch. See <https://www.drivingtestsuccess.com/blog/safe-separation-distance> (last visited Oct. 27, 2020). This is also consistent with the typical scenario as defined in the Department of Transportation report FHWA-JPO-17-483 (See the report at 207, and 41). Furthermore, the maximum number of devices the DSRC system can handle is about 200 vehicles.

¹⁷⁴ The probability that a randomly selected registered vehicle in the United States is equipped with an OBU is 15,506/274,000,000 or 0.000057. The probability that at least two randomly selected vehicles out of 200 registered vehicles are equipped with an OBU in a PER-Free range is 0.00006326.

$$p_n(k_1 \leq k \leq k_2) = \sum_{k=k_1}^{k_2} \binom{n}{k} p^k (1-p)^{n-k}$$

See Bernoulli Trials (Papoulis, A. (1984) *Probability, Random Variables, And Stochastic Processes*, McGraw-Hill, at 42-46).

¹⁷⁵ Because the actual probability of this situation occurring is less than one, real-world results will result in probabilities less than that calculated here.

¹⁷⁶ We recognize that the probability of two or more OBUs operating in the PER-Free range may be marginally higher in certain cities/localities with a higher probability of vehicles being equipped with an OBU. However, so long as the total number of OBUs remains unchanged in the United States, any marginal increase in probability in one or more area(s) will correspondingly reduce the probability in the remaining areas of the United States. Therefore, uniform distribution of vehicles equipped with an OBU is representative and appropriate when considering a nationwide license.

71. Similarly, in the vehicle to infrastructure (V2I) communications situation, interference from an unlicensed device can only occur if there is at least one vehicle and at least one unlicensed device transmitting within an RSU's coverage area on the same channel. Because the OBU transmits at lower power, its operating range sets the limit over which analysis should be conducted. Thus, for the V2I scenario, our analysis assumes the same PER-Free range and the same number of vehicles as for the V2V link. The probability of a randomly selected vehicle equipped with an OBU and within the PER-Free range of an RSU is 0.0000061.¹⁷⁷ As in the V2V scenario, the worst case would occur when the probability of an unlicensed device transmitting within an RSU's coverage area and on the same channel is one.¹⁷⁸ Thus, the probability of interference is a function of the probability that a randomly selected vehicle within the PER-Free range of an RSU is equipped with an OBU, 0.0000061.

72. As with our 6 GHz band analysis, we consider other important factors such as building entry loss, probability of frequency overlap, unlicensed device antenna discrimination, path loss, clutter loss, activity factor, and polarization loss. In considering these factors, we treat all of the statistical quantities using a median or average value, as is commonly done in link budget analyses.¹⁷⁹ Because we are limiting the unlicensed devices to in-building use until one year after the effective date of this First Report and Order, the co-channel analysis includes building entry loss and uses a median value of 20.5 dB, consistent with the 70/30 building entry loss (a mix of 70% traditional and 30% thermally efficient building types) that the Commission recognized in the *6 GHz Report and Order*.¹⁸⁰ The probability of frequency overlap depends on the number of unlicensed device channels available; the higher the number of available channels, the lower the probability that a given channel, in the vicinity of an ITS RSU or OBU, overlaps the respective ITS channel in the lower 45 megahertz of 5.9 GHz band. We again make a simplifying assumption and consider the worst case where an unlicensed device uses the combined U-NII-3 and U-NII-4 band to transmit over a 160-megahertz channel, resulting in an assumption of 100% overlap probability of an unlicensed device and an ITS device.¹⁸¹

73. In the *6 GHz Report and Order*, the Commission determined that typical indoor enterprise and consumer access point antenna EIRP patterns exhibit less gain toward the horizon and that a 5 dB antenna discrimination correction is required to account for this real-world behavior.¹⁸² In our analysis, we assume the worst-case, direct line-of-sight propagation condition. We note, however, the free-space-path-loss model has a limited range of applicability because it ignores environmental clutter, which over long distances can result in extremely conservative calculations that under-predict the amount of actual path loss. This is particularly true for urban and suburban environments, as well as vehicular communication environments, where clutter loss can be quite substantial depending on the separation distance. We also assume a polarization loss factor of 3 dB that accounts for losses due to the relative

¹⁷⁷ The probability that an RSU exists in a PER-Free range and at least one car is equipped with OBU is equal to product of the probability that RSU exists in a PER-Free range and the conditional probability that one or more vehicles out of 200 registered vehicles is equipped with an OBU. The probability that an RSU exists in a PER-Free range is given by the number of RSUs times the probability of PER-Free ranges in the U.S. roadways, $6,182 * (600 / (4.2e6 * 1609.3)) = 0.0005487$. The conditional probability that one or more vehicles out of 200 registered vehicles is equipped with an OBU follows the above combinatorial analysis with respect to V2V.

¹⁷⁸ Because the actual probability of this situation occurring is less than one, real-world results will result in probabilities less than that calculated here.

¹⁷⁹ See 35 FCC Rcd at 3898, para. 127.

¹⁸⁰ See 35 FCC Rcd at 3933, para. 218.

¹⁸¹ Because devices will use a mix of 20-megahertz, 40-megahertz, 80-megahertz and 160-megahertz channels, the actual overlap probability is less than one and the potential for harmful interference occurring will be less than the probability calculated here.

¹⁸² See 35 FCC Rcd at 3898, para. 125.

orientation of transmit and receive antennas.¹⁸³

74. In the *6 GHz Report and Order* the Commission recognized that inference from Wi-Fi devices is dominated by the single closest Wi-Fi device to the victim.¹⁸⁴ Consistent with that approach, we assume a single Wi-Fi interferer for our co-channel interference analysis. Assuming the maximum separation distance between two OBUs transmitting with a maximum power of 20 dBm EIRP is 600 meters, the received power is -83.38 dBm/10MHz under free space path loss conditions. Since the access point can be located anywhere between the two OBUs, the expected position is midway between the two (i.e., 300 meters from each OBU). Assuming a maximum 20 dBm/MHz access point transmit power over the 160-megahertz channel,¹⁸⁵ the received interference power at the OBUs is approximately -96 dBm/10MHz, over 12 dB below OBU received power.

75. We recognize that not all access points may be located at the midpoint between OBUs. To provide even greater assurance of interference-free operation, we require that the indoor devices, both access points and their associated client devices, employ a contention-based protocol.¹⁸⁶ A contention-based protocol allows multiple users to share spectrum by providing a reasonable opportunity for the different users to transmit¹⁸⁷ and it can also lower the unlicensed device's EIRP. This is particularly pertinent with respect to Wi-Fi devices where the expected activity factor is low.¹⁸⁸ Given that the probability of interference potential in the PER-Free range is 0.00006326, the inclusion of a contention-based protocol, a low load factor on the ITS network,¹⁸⁹ a 12 dB margin below the OBU received power and a low activity factor, we conclude that the 20 dBm/MHz we are adopting to protect federal operations will similarly protect DSRC V2V operations from co-channel harmful interference while they are still operating in the lower 45 megahertz.

76. We reach a similar conclusion with respect to V2I links. Because the OBU to RSU link limits the operating distance, we assume the same PER-Free range and the same number of vehicles as for the V2V link analysis. As the probability of interference for the V2I link (0.0000061) is an order of magnitude lower than the V2V link (0.00006326) and following the same logic, we conclude that the 20 dBm/MHz we are adopting to protect federal operations will similarly protect DSRC V2I operations from co-channel harmful interference while they are still operating in the lower 45 megahertz.

77. *Client Devices.* Consistent with the rules for the 6 GHz band as well as the U-NII-1 band, we are adopting rules that limit client devices to power levels 6 dB below the power limits for access points.¹⁹⁰ We find this appropriate to reduce the potential of harmful interference to co-channel operation within the band—both with DSRC operations (until such time as they move out of the band)

¹⁸³ See 35 FCC Rcd at 3880, para. 75.

¹⁸⁴ See 35 FCC Rcd at 3879, para. 71.

¹⁸⁵ Our rules limit the maximum EIRP to 36 dBm for all channels. Thus, the EIRP power density is given by $36 \text{ dBm} - 10 * \log_{10}(160) = 14 \text{ dBm/MHz}$.

¹⁸⁶ Notably, DSRC implements a contention-based protocol that allows 204 vehicles to share the spectrum while transmitting BSMs at 10 Hz. See Department of Transportation report FHWA-JPO-17-483, at 41.

¹⁸⁷ See 35 FCC Rcd at 3889, para. 101.

¹⁸⁸ CableLabs claims that “empirical 5 GHz Wi-Fi activity data from 500,000 APs measured over ten days reveals that the 99th percentile peak Wi-Fi activity level is in fact 7%, and the weighted average activity factor is 0.4%.” See NCTA Reply Comments, Attachment A, at 17.

¹⁸⁹ As noted above the probability of two or more vehicles being in the PER-Free range is 0.00006326. Even assuming two vehicles are in the PER-Free range, for a network that can handle 204 vehicles this is a very low network load.

¹⁹⁰ See 35 FCC Rcd at 3922, para. 189 and 47 CFR § 15.407(a)(1)(iv) limiting U-NII-1 client devices to 250 mW or 6 dB below the 1 W permitted for access points.

and with DoD radar operations that will remain in the band. In general, a client device operates under the control of an access point but, depending on the separation distance from the access point, the client device may have a slightly different propagation path and hence, a slightly different interference potential to a victim receiver. To ensure that client devices remain in close proximity to the indoor access points and thus keep the potential for causing harmful interference low, we are requiring client devices to operate only under the control of an access point and limiting their PSD and maximum transmit power to 6 dB below the power permitted for the access points. The requirement that client devices operate only under the control of an access point is similar to the requirement the Commission adopted for 6 GHz U-NII devices to protect co-channel incumbent operations.¹⁹¹ In essence, this limitation prevents outdoor client-to-client communications that could cause harmful interference to federal radiolocation stations and to co-channel ITS operations pending their move to the 5.895-5.925 GHz band. We explore in the Further Notice whether we can remove the prohibition on client-to-client communications after ITS systems move out of the U-NII-4 band and only federal radiolocation sites will need to be protected.

(iii) Out-of-Band Emission Limits

78. In the *5.9 GHz NPRM*, we proposed to limit the OOB limit from U-NII-4 devices, or devices that operate across a single channel that spans the U-NII-3 and U-NII-4 bands, to -27 dBm/MHz at or above 5.925 GHz, which is the same limit required for U-NII-3 devices at this frequency; we sought comment generally on the OOB limits we should apply at the upper end of the U-NII-4 band.¹⁹² We further proposed that U-NII-4 devices, or devices that operate across a single channel that spans the U-NII-3 and U-NII-4 bands, meet the same OOB limits as U-NII-3 devices at the lower edge of the combined U-NII-3 and U-NII-4 band, i.e., at 5.725 GHz, while not imposing an OOB limit for U-NII-4 devices at the U-NII-3/U-NII-4 band edge (i.e., at 5.850 GHz).¹⁹³ These proposals were intended to support separate U-NII-3 and U-NII-4 bands to provide flexibility for designing U-NII-3 equipment under the less stringent OOB rules at the upper edge of the band, and provide flexibility for devices to operate across the U-NII-3 and U-NII-4 bands using the widest bandwidths permitted under the IEEE 802.11 standard.¹⁹⁴

79. Proponents of ITS operations contend that the proposed unlicensed device OOB limit at 5.925 GHz is not restrictive enough to protect ITS operations in the 5.895-5.925 GHz band from harmful interference. ITS proponents suggest that U-NII-4 devices, or devices that operate across a single channel that spans the U-NII-3 and U-NII-4 bands, meet OOB limits that are much more restrictive than the existing U-NII-3 OOB limits: General Motors suggests that U-NII-4 unlicensed devices limit their OOB to -17 dBm/MHz in the first 10 megahertz beyond the band edge (5.895-5.905 GHz) and -27 dBm/MHz at or above 5.905 GHz; Toyota suggests that the OOB be limited to -27 dBm/MHz at or above 5.895 GHz; Car 2 Car Communication Consortium, IEEE 1609 Working Group, US Technical Advisory Group, and Volkswagen separately suggest that U-NII-4 OOB be limited to -40 dBm/MHz at 10 megahertz above the band edge, the same as the out-of-channel limit for ITS devices; and Ford

¹⁹¹ 47 CFR 15.407(d)(5).

¹⁹² See *5.9 GHz NPRM*, 34 FCC Rcd at 12623, para. 54. Under the Commission's current rules, emissions from transmitters operating in the U-NII-3 band are limited to a level of -27 dBm/MHz at 75 megahertz or more above or below the band edge increasing linearly to 10 dBm/MHz at 25 megahertz above or below the band edge, and from 25 megahertz above or below the band edge increasing linearly to a level of 15.6 dBm/MHz at 5 megahertz above or below the band edge, and from 5 megahertz above or below the band edge increasing linearly to a level of 27 dBm/MHz at the band edge. 47 CFR § 15.407(b)(4)(i). These specifications result in OOB limits of -5 dBm/MHz at 5.895 GHz, decreasing linearly to -27 dBm/MHz at 5.925 GHz.

¹⁹³ *5.9 GHz NPRM*, 34 FCC Rcd at 12623, para. 55.

¹⁹⁴ *Id.* at 12263-64, para. 56.

suggests that OOB be limited to -108 dBm/MHz, measured at the C-V2X device.¹⁹⁵ However, ITS proponents offer that the OOB limits can be relaxed as long as U-NII-4 devices are restricted to indoor-only use. 5GAA and Cisco Systems, Inc. (Cisco) separately state that if U-NII-4 band operations are restricted to indoor-only use, then the OOB limits could be relaxed to 0 dBm/MHz at 5.895 GHz, decreasing linearly to -17 dBm/MHz at or above 5.905 GHz.¹⁹⁶ Qualcomm asserts that 5GAA's suggested approach would protect C-V2X Direct operations in the upper 30 megahertz of the 5.9 GHz band while enabling robust wideband unlicensed operations indoors, where almost all unlicensed Wi-Fi operations occur today. Qualcomm states that restricting U-NII-4 operations to indoor use would allow the Commission to adopt a more relaxed mask for U-NII-4 operations than what is needed outdoors to protect C-V2X Direct because the indoor unlicensed signals would be attenuated by building entry loss.¹⁹⁷

80. Proponents of unlicensed operations oppose the proposed -27 dBm/MHz OOB limit at the upper end of the U-NII-4 band. They contend that this limit would necessitate low transmit power levels for all devices operating in the U-NII-4 band, thereby significantly reducing or even eliminating the possibility of unlicensed deployments in the band, especially with wider-bandwidth operation, which is intended to be a primary benefit of the proposed designation.¹⁹⁸ Instead, unlicensed proponents suggest more relaxed OOB limits for unlicensed operations in the U-NII-4 band than proposed in the 5.9 GHz NPRM. WISPA submits that indoor unlicensed operations could have a -5 dBm/MHz OOB limit at or above 5.895 GHz.¹⁹⁹ Broadcom, CableLabs, Facebook, and NCTA together suggest that the OOB for indoor unlicensed operations be limited to 7 dBm/MHz at 5.895 GHz, decreasing linearly to -9 dBm/MHz at 5.925 GHz, measured using the root mean square method.²⁰⁰ The Wi-Fi Alliance suggests 15 dBm/MHz OOB limits for indoor unlicensed devices at 5.895 GHz, decreasing linearly to -7 dBm/MHz at 5.925 GHz.²⁰¹ The Wi-Fi Alliance contends that after building attenuation and signal path losses are accounted for, these OOB limits would mirror the existing U-NII-3 OOB limits at and above 5.895 GHz, which would allow U-NII-4 devices to provide protection to ITS services in the adjacent spectrum even with OOB levels 20 dB higher than those currently required for U-NII-3 devices.²⁰² Wi-Fi Alliance also supports applying the existing U-NII-3 OOB limits at the lower edge of the U-NII-3 band for U-NII-4 devices, or devices that operate across a single channel that spans the U-NII-3 and U-NII-4 bands, i.e., at 5.725 GHz, while not imposing any OOB limit for U-NII-4 devices at the U-NII-3/U-NII-4 band edge (i.e., at 5.850 GHz).²⁰³

81. The Commission previously affirmed that the U-NII-3 OOB limits protect DSRC operations, and those limits have proven to be effective for the protection of incumbent operations in the

¹⁹⁵ GM Comments at 11; Toyota Comments at 18; Car 2 Car Comments at 18; IEEE 1609 Working Group Comments at 15, US Technical Advisory Group Comments at 11; Volkswagen Comments at 9; and Ford Comments at 10.

¹⁹⁶ 5GAA Comments at 44; Cisco Comments at 15-16.

¹⁹⁷ Qualcomm Comments at 19.

¹⁹⁸ See, e.g., Broadcom, Inc. and Facebook, Inc. Comments at 5-6; Dynamic Spectrum Alliance Comments at 4; Wi-Fi Alliance Comments at 6-7.

¹⁹⁹ WISPA Comments at 6.

²⁰⁰ Letter from Chris Szymanski, Broadcom; Rob Alderfer, CableLabs; Alan Norman, Facebook; and Danielle Piñeres, NCTA, to Marlene H. Dortch, Secretary, FCC, ET Docket No. 19-138 (filed July 31, 2020) (Compromise Proposal Letter) at 4.

²⁰¹ Wi-Fi Alliance Comments at 8.

²⁰² Wi-Fi Alliance Reply Comments at 7-8.

²⁰³ Wi-Fi Alliance Comments at 2-3.

5.9 GHz band.²⁰⁴ Thus, we will impose the same level of protection from U-NII-4 devices. However, in doing so, we will take advantage of building attenuation, as well as other factors, to provide flexibility and maximum utility to American consumers. This flexibility can be provided by adopting Wi-Fi Alliance's proposed indoor unlicensed device OOB limits of 15 dBm/MHz at 5.895 GHz, decreasing linearly to -7 dBm/MHz at 5.925 GHz. The record supports these protection levels, which are the same as the current OOB limits after accounting for building attenuation. We further expect the separation distance between indoor U-NII-4 devices and ITS operations would further improve the OOB limits compared to the existing U-NII-3 OOB limits. We are not persuaded that the more restrictive OOB limits suggested by ITS proponents are needed to protect DSRC operations since those limits are more restrictive than the U-NII-3 OOB limits, which the Commission previously affirmed would protect DSRC operations.²⁰⁵ We are also not persuaded that the more relaxed OOB limits suggested by unlicensed proponents would adequately protect ITS operations from harmful interference since those limits are less restrictive than the existing U-NII-3 OOB limits. No commenter disagreed with our proposals to apply the existing U-NII-3 OOB limits at the lower edge of the U-NII-3 band for U-NII-4 devices, or devices that operate across a single channel that spans the U-NII-3 and U-NII-4 bands, i.e., at 5.725 GHz, while not imposing any OOB limits for U-NII-4 devices at the U-NII-3/U-NII-4 band edge, i.e., at 5.850 GHz. These limits will protect adjacent-band ITS operations from harmful interference due to unlicensed operations in the U-NII-4 band while also supporting separate U-NII-3 and U-NII-4 bands. These limits will provide flexibility to design U-NII-3 equipment under the less stringent OOB rules at the upper edge of the band as well as for devices to operate across the U-NII-3 and U-NII-4 bands using the widest channel bandwidths permitted under the IEEE 802.11 standard. We therefore adopt those limits too.

82. *Measurement procedures.* Finally, we address the measurement procedures for 5.9 GHz unlicensed devices. Broadcom, CableLabs, Facebook, and NCTA state that their proposed OOB values should be measured using a root mean square (RMS) measurement. These parties contend that an RMS average measurement is the most appropriate method to ensure protection for adjacent operations, as the Commission found in the 6 GHz proceeding. They similarly claim that, since 5GAA agreed that RMS measurement was the appropriate approach at the top of the 5.9 GHz band, it is likewise appropriate for the bottom of the 5.9 GHz band.²⁰⁶ WISPA submits that using an RMS (i.e., average) measurement for ensuring OOB from unlicensed operations at the 5.925 GHz band edge should not cause harmful interference to federal users or incumbent licensees. WISPA argues that peak-hold measurements, which result in signal levels that are generally between 10 and 20 dB higher than the RMS method, are less demonstrative of the actual potential for causing harmful interference. WISPA contends that although federal radiolocation systems operate in the 5.850-5.925 GHz band, those operations are in-band and protected by the geographic prohibition on operation near them. WISPA further contends that the RMS measurement is more appropriate for determining potential interference both to ITS systems and to Part

²⁰⁴ See *Revision of Part 15 of the Commission's Rules to Permit Unlicensed National Information Infrastructure (U-NII) Devices in the 5 GHz Band*, First Report and Order, 29 FCC Rcd 4127 (2014) (*UNII 5 GHz Report and Order*) (adding 5.825-5.850 GHz to the 5.725-5.825 GHz (U-NII-3) band and deferring a decision on whether to allow unlicensed devices to use the 5.350-5.470 GHz U-NII-2B and 5.850-5.925 GHz U-NII-4 bands), *recon. denied*; *Revision of Part 15 of the Commission's Rules to Permit Unlicensed National Information Infrastructure (U-NII) Devices in the 5 GHz Band*, Memorandum Opinion and Order, 31 FCC Rcd 2317, 2324, para. 23 (2016).

²⁰⁵ *Revision of Part 15 of the Commission's Rules to Permit Unlicensed National Information Infrastructure (U-NII) Devices in the 5 GHz Band*, Memorandum Opinion and Order, 31 FCC Rcd 2317, 2324, para. 23 (2016).

²⁰⁶ Letter from Chris Szymanski, Broadcom; Rob Alderfer, CableLabs; Alan Norman, Facebook; and Danielle Piñeres, NCTA, to Marlene H. Dortch, Secretary, FCC, ET Docket No. 19-138, at 4-5, n.16 (filed July 31, 2020) (*Compromise Proposal Letter*) (citing the *6 GHz Report and Order*, 35 FCC Rcd at 3926, para. 198, that decided the -27 dBm/MHz OOB limit adopted to protect adjacent ITS services at the top of the 5.9 GHz band should be verified using an RMS detector or other appropriate techniques for measuring average power).

101 fixed systems operating above 5.925 GHz.²⁰⁷ NCTA suggests that OOB limits should be verified using an RMS detector or other appropriate techniques for measuring average power, as the Commission recognized in the *6 GHz Report and Order*, because 5 GHz U-NII-band measurement guidance specifying peak power was instituted to mitigate a known interference issue with federal radars that is not present in the 5.9 GHz band.²⁰⁸

83. An RMS detector may be used to conduct 5.9 GHz unlicensed device OOB measurements. This decision is consistent with the decision in the *6 GHz Report and Order* that the OOB limit adopted to protect adjacent ITS services at the top of the 5.9 GHz band should be verified using an RMS detector or other appropriate techniques for measuring average power.²⁰⁹ We will provide guidance to the test labs and telecommunications certification bodies which conduct equipment approval measurements and equipment approval oversight. Because RMS measurements represent the continuous power being generated from a device, as opposed to peak power, which may only be reached occasionally and for short periods of time, we believe an RMS measurement is more appropriate for ensuring that U-NII devices' potential for causing harmful interference to adjacent-band operations is significantly minimized. We note the Commission has provided a measurement guidance in the past for similar devices in the 5 GHz band where a peak measurement is specified.²¹⁰ However, that procedure was instituted to mitigate potential interference with terminal Doppler weather radars which are not present in the 5.9 GHz band. We will update our Knowledge Database guidance consistent with this decision.

b. Outdoor Unlicensed Operations

84. Pending our resolution of the issues on which we seek comment in the Further Notice, we will consider requests for outdoor operations in the 5.850-5.895 GHz band in certain specified locations and on a non-interference basis, upon a proper showing submitted through the STA or waiver process.

(i) Exclusion Zones for Outdoor Unlicensed Operation

85. In the *5.9 GHz NPRM*, we sought comment on whether there are any mitigation measures, such as technical or operational conditions or constraints that the Commission should consider for U-NII-4 operations to protect federal radars in the 5.9 GHz band.²¹¹ Comcast submits that the Commission should adopt its proposal to adopt the same technical rules as U-NII-3 with respect to U-NII-4 devices and federal DoD radar operations.²¹² WISPA agrees with the Commission's suggestion that no other mitigation measures are required to protect DoD radar operations in the 5.9 GHz band from U-NII-4 devices.²¹³ NCTA states that the Commission should adopt its proposal to authorize U-NII-4 devices without requiring any special frequency avoidance techniques or similar constraints since U-NII-3 devices have shared spectrum with co-channel federal incumbents for years without any specialized frequency avoidance techniques, and in general sharing has been successful.²¹⁴

86. NTIA has reviewed the federal radar operations authorized in the 5.9 GHz band and determined that the number of radar sites needing protection can be reduced to from 59 to 30 sites. NTIA's analysis concluded that exclusion zones are needed to protect federal radiolocation systems only from U-NII-4 *outdoor* point-to-point (P2P) and point-to-multipoint (P2MP) devices. The exclusion zones

²⁰⁷ See letter from WISPA to Marlene H. Dortch, Secretary, FCC, at 2 (Aug. 27, 2020).

²⁰⁸ See NCTA Reply Comments at 60, n.236; see also *6 GHz Report and Order*, 35 FCC Rcd at 3926, para. 198

²⁰⁹ *6 GHz Report and Order*, 35 FCC Rcd at 3926, para. 198.

²¹⁰ See KDB Publication No. 789033.

²¹¹ 47 U.S.C. § 902(b)(2)(A).

²¹² Comcast Corporation Comments at 10, n.28.

²¹³ WISPA Comments at 7.

²¹⁴ NCTA Comments at 46.

recommended by NTIA are set forth in Table 2 of its Sept. 8, 2020 letter. To enforce the exclusion zones, NTIA recommends that interference mitigation techniques such as geo-fencing be employed to protect federal radiolocation operations. NTIA emphasizes that it is important that outdoor U-NII devices are not permitted to operate inside of these exclusion zones to ensure that federal radiolocation systems are protected from harmful interference.²¹⁵ NTIA also requests that the new rules make clear that it may authorize additional exclusion zones or modify the existing exclusion zones listed in Table 2 as necessary to ensure federal radiolocation stations are protected.²¹⁶

87. We agree that some mitigation measures are needed to ensure that outdoor U-NII point-to-point and point-to-multipoint operations, whether operated on a temporary basis pursuant to an STA or waiver request or permanently following resolution of the issues discussed in the Further Notice, do not cause harmful interference to federal radiolocation systems. We also agree that exclusion zones may be the best method for ensuring such protection. We will add these geographic areas where outdoor U-NII-4 device operation will be precluded to Section 15.407 of the rules. Additionally, given that DoD may deploy radars in areas other than the 30 sites listed in Section 15.407((a)(3)(viii)), we delegate authority to the Office of Engineering and Technology to update this list. In the Further Notice, we seek comment on the best way to implement these exclusion zones that provide the protection needed while imposing the least burden on U-NII-4 system operators.

(ii) Permitting Limited Outdoor Unlicensed Deployment Through the STA Process

88. Although we are not permitting outdoor unlicensed operations across the 5.850-5.895 GHz portion of the 5.9 GHz band at this time, we nonetheless will allow limited outdoor operations through either the STA or other existing regulatory process. Outdoor unlicensed operations are limited to specified locations outside of the U-NII-4 device exclusion zones in the Appendix A. The Commission will coordinate requests for outdoor unlicensed operations with NTIA, until such time as ITS operations will have ceased operating in the 5.850-5.895 GHz portion of the 5.9 GHz band and we develop a mechanism to ensure protection of federal operations.

2. Protection of Other Incumbents in the 5.850-5.895 GHz Band

89. The 5.9 GHz band also contains allocations for the non-federal Fixed Satellite Service (FSS) (Earth-to-space) on a primary basis and the Amateur Service on a secondary basis for non-federal use.²¹⁷ Since certain of these services operate in the 5.850-5.895 GHz portion of the 5.9 GHz band, in the Further Notice we propose provisions to ensure that these services are protected from harmful interference from unlicensed devices in the 5.850-5.895 GHz band.

a. Amateur Operations

90. In the *5.9 GHz NPRM*, we tentatively concluded that our proposal to apply the existing U-NII-3 power rules to the 5.850-5.895 GHz band would protect co-channel secondary Amateur Service operations from harmful interference and sought comment on this approach. Proponents of Amateur Services contend that authorizing unlicensed operations in the 5.9 GHz band will cause harmful interference to co-channel Amateur Service operations.²¹⁸ However, they do not include any specific

²¹⁵ See National Telecommunication and Information Administration Technical Report TR 20-544 *Lessons Learned from the Development and Deployment of 5 GHz Unlicensed National Information Infrastructure (U-NII) Dynamic Frequency Selection (DFS) Devices*, <https://www.ntia.doc.gov/report/2019/lessons-learned-development-and-deployment-5-ghz-unlicensed-national-information>. Section 8 describes interference to a federal radar from a U-NII device.

²¹⁶ See *NTIA Sept. 8, 2020 Letter* at 3-4.

²¹⁷ 47 CFR § 2.106.

²¹⁸ See, e.g., Amateur Radio Emergency Data Network Comments at 3; Amateur Television Network Comments at 1.

technical analysis for their particular position. These commenters suggest that the Commission should abandon its proposal to authorize unlicensed operations in the U-NII-4 band to avoid harmful interference to amateur operations.²¹⁹

91. We believe that U-NII devices operating in the U-NII-4 band will not cause harmful interference to amateur operations because of the relatively low power with which U-NII devices will operate as compared to amateur stations, which are permitted to operate with as much as 1.5 kW (62 dBm) peak envelope power.²²⁰ Furthermore, as noted above, the Amateur Service is an allocated service that is entitled to interference protection within the 5 GHz spectrum, whereas U-NII devices operate under our Part 15 rules on the conditions of not causing harmful interference and accepting any interference from an authorized radio station.²²¹

92. Commenters also oppose reallocating the lower 45 megahertz of the 5.9 GHz band from the Amateur Service to Part 15 unlicensed operations.²²² As an initial matter, Part 15 unlicensed devices do not operate pursuant to an allocation.²²³ Thus, in the *5.9 GHz NPRM*, the Commission did not propose to reallocate the lower 45 megahertz of the 5.9 GHz band from the Amateur Service to Part 15 unlicensed operations; it proposed to authorize unlicensed operations under Part 15 in the lower 45 megahertz of the 5.9 GHz band.²²⁴ Therefore, we dismiss such concerns as beyond the scope of this proceeding.

C. ITS in the 5.895-5.925 GHz Band

93. To promote the most effective and efficient use of the upper 30 megahertz of spectrum in the 5.9 GHz band that we dedicate for ITS, we determine that the service should be based on use of one technology, and we further conclude that C-V2X technology provides the best means of achieving our goals for ITS in the coming years. In this First Report and Order, we provide sufficient technical flexibility to enable ITS licensees currently using DSRC-based technology to operate in this 30-megahertz ITS band until the time by which ITS services must operate using C-V2X technology. Because we believe that many (of not most) of the few active ITS licensees will want to transition to C-V2X technology as soon as possible to speed development and deployment of ITS services, we also will permit, under certain circumstances through existing regulatory processes, the development and deployment of C-V2X technology during the transition period in such a way that it would not interfere with existing DSRC-based operations. Finally, in the Further Notice below, we seek comment on the date by which all ITS operations in this band must use C-V2X-based technology, as well as on the final technical rules for C-V2X use of the 30 megahertz of spectrum that promotes the most effective ITS operations and applications using this spectrum.

1. ITS Operations using C-V2X Technology

94. In the *5.9 GHz NPRM*, we proposed to authorize C-V2X operations in the upper 20 megahertz of the revised ITS band (5.905-5.925 GHz),²²⁵ and we sought comment on whether the remaining 10 megahertz of the band (5.895-5.905 GHz) should be dedicated for C-V2X as well or instead be reserved for DSRC operations.²²⁶ In proposing the use of C-V2X, we sought to authorize use of technology that would be most capable of rapid development and deployment while transportation and

²¹⁹ *Id.* at 2; San Bernardino Microwave Society at 6.

²²⁰ 47 CFR § 97.313(b).

²²¹ 47 CFR §§ 2.106, 15.5(b)-(c).

²²² *See, e.g.*, Amateur Television Network Comments at 1.

²²³ 47 CFR § 2.105(e), n.1.

²²⁴ *See 5.9 GHz NPRM*, 34 FCC Rcd at 12608, para. 11; 12622-23, para. 53.

²²⁵ *5.9 GHz NPRM*, 34 FCC Rcd at 12613-15, paras. 24-27.

²²⁶ *5.9 GHz NPRM*, 34 FCC Rcd at 12615-16, paras. 28-31.

vehicular safety-related applications now and making continuous improvements into the future. We explained that C-V2X should be able to achieve network effects necessary to maximize transportation and vehicular safety-related benefits; facilitate rapid development and deployment; enable improvements, learning, and upgrades; and be robust and secure.²²⁷ At the same time, we recognized that some commenters might support continued use of the DSRC-based technology in the ITS band.²²⁸ We further noted that DSRC and C-V2X were technically incompatible.²²⁹ We underscored our goal of promoting the most spectrally efficient use of the ITS band, and invited comment on how best to ensure that we optimize the band for delivery of ITS.²³⁰

95. In the years since the Commission first adopted DSRC technology for ITS operation in the 5.9 GHz band, communications applications that rely on cellular-based technologies have become increasingly ubiquitous. C-V2X reflects the efforts of a diverse group of communications and transportation industry stakeholders to integrate this technology into ITS use. Based on the information in the record, we find the public interest will be served by adopting C-V2X as the ITS delivery technology in the entire 30 megahertz of the ITS band, which in turn requires phasing-out the existing DSRC technology.

96. The Commission received numerous comments from automobile manufacturers and significant elements of the automotive and technology industries that support the use of C-V2X technology.²³¹ None of these commenters support limiting C-V2X technology to only the 20-megahertz portion of the ITS band as proposed in the *5.9 GHz NPRM* and, to the extent the Commission provides only 30 megahertz for ITS, support use of the entire 30 for C-V2X.²³² Some of these commenters suggest that we go further and set aside the entire 75 megahertz for ITS using C-V2X technology.²³³ Supporters of C-V2X technology cite benefits over DSRC, such as better performance and linkage to 5G technology, which enables applications to continue evolving and provides for faster implementation.²³⁴ We additionally note that several entities with ongoing interest in DSRC operations also generally support retaining as much ITS spectrum as possible and, among these, some expressed a willingness to consider the use of C-V2X technology as a means toward that end.²³⁵

97. As discussed in the *5.9 GHz NPRM*, we seek to provide the most spectrally efficient means of ensuring the availability of ITS.²³⁶ Given that DSRC and C-V2X are technically incompatible with each other, we believe that allowing use of only a single delivery technology for ITS is important for the sake of efficient use of the 30 megahertz of spectrum as well as maximizing the safety benefits ITS can deliver to the American public. As in 2003 when the Commission specified a single technological standard, and as the Commission reiterated in the *5.9 GHz NPRM*, we continue to believe that a single standard for ITS in this band is most likely to promote interoperability between vehicles and infrastructure in the United States, enable robust automotive safety communications, and accelerate the

²²⁷ *5.9 GHz NPRM*, 34 FCC Rcd at 12613, para. 24.

²²⁸ *5.9 GHz NPRM*, 34 FCC Rcd at 12616, para. 31.

²²⁹ *5.9 GHz NPRM*, 34 FCC Rcd at 12615, para. 28.

²³⁰ *5.9 GHz NPRM*, 34 FCC Rcd at 12615, para. 28.

²³¹ See, e.g., 5GAA Comments, Nokia Reply Comments at 1-2; Ford Comments at 6.

²³² See, e.g., 5GAA Comments at 8.

²³³ See, e.g., 5GAAComments at 5-6; Fiat Chrysler Comments at 4; and Harman Comments.

²³⁴ 5GAA Comments at 9-16; Nokia Reply Comments at 3-5; Ford Comments at 6.

²³⁵ See, e.g., American Highway Users Alliance Comments at 2-3.

²³⁶ *5.9 GHz NPRM*, 34 FCC Rcd at 12615, para. 28.

nationwide deployment of ITS applications while reducing implementation costs.²³⁷ Safety-related applications, such as collision-avoidance functions, must be “heard” by vehicles using ITS, and having a single technological standard will ensure that all such equipped vehicles will have compatible technology;²³⁸ specifying only one technology as the standard will remove any technological compatibility risk and lead to a more safe, secure, and trustworthy vehicular safety ecosystem. Accordingly, although some commenters request that we take a “technology neutral” approach,²³⁹ we decline to do so here. Given that we are limiting the 5.9 GHz ITS spectrum to 30 megahertz, we believe we must ensure that it can be used most efficiently, and that requires use of only one technology.²⁴⁰ We also believe it important at this time to remove any uncertainty as to the technology that will be used in this revised ITS band so that automobile manufacturers, the automotive and technology industries, and those implementing ITS services can focus on building out the ITS infrastructure and equipping vehicles rather than continuing to divide resources across two competing standards in the coming years.²⁴¹

98. We consider a variety of issues when making spectrum decisions that will affect the implementation of essential public safety and transportation services. Such decisions have the potential to impact a broad group of stakeholders, including state and local governments, equipment (automotive and communications) manufacturers, and communications service providers. After careful consideration of the technology-related issues, including the advantages and disadvantages of both DSRC and C-V2X, in the record before us, we conclude the public interest will best be served by adopting C-V2X as the ITS delivery technology and phasing out the existing DSRC technology. We consider issues related to implementing this decision, such as timing, the authorization process, and technical rule requirements, in the Further Notice of Proposed Rulemaking that follows this First Report and Order.

99. *Spurring investment and fast deployment in the band.* We observe that DSRC has not enjoyed widespread deployment as the ITS technology mandated in the U.S.²⁴² At the same time,

²³⁷ See *Amendment of the Commission’s Rules Regarding Dedicated Short Range Communications Services in the 5.850-5.925 GHz Band (5.9 Band); Amendment of Parts 2 and 90 of the Commission’s Rules to Allocate the 5.850-5.925 GHz Band to the Mobile Service for Dedicated Short Range Communications of Intelligent Transportation Services*, ET Docket No. 98-95, Report and Order, 19 FCC Rcd 2458, 2466-68, paras. 13-16 (2003); *5.9 GHz NPRM*, 34 FCC Rcd at 12604, para. 3.

²³⁸ Preliminary Technical Assessment by Department of Transportation submitted in ET Docket 19-138 titled “Concerns with Draft FCC NPRM: Use of 5.850-5.925 GHz Band,” at 1.

²³⁹ See, e.g., U.S. DOT Reply Comments at 44-45 (supporting a technology neutral approach while additional testing is conducted examining the performance of C-V2X and DSRC). We note that some administrations like Europe have adopted a more technology neutral approach. Autotalks Comments at 6-7 (In Europe, 30 megahertz is allocated for V2X, arranged as three channels of 10 megahertz each (5875-5905 MHz); a channel is allocated per service, and not per technology). This model is unproven, however, as EU regulations are still being revised and are not currently finalized. Car2Car Communications Consortium (Commission Decision 2008/671/EC9 and Commission Implementing Decision (EU) 2019/1345) is currently being revised).

²⁴⁰ See, e.g., Cisco Comments at 13-14 (one strong ecosystem is better than two weakened ecosystems).

²⁴¹ See, e.g., Cisco Comments at 13-14 (providing a clear technology path will provide much-needed certainty to the market).

²⁴² According to AASHTO, there are 6,182 DSRC RSUs deployed throughout the U.S. and 15,506 vehicles equipped with DSRC OBUs. AASHTO Comments at 7. For context, there are approximately 274 million registered vehicles in the United States operating over approximately 4.2 million miles of paved and unpaved roadways. See Statista.com, [Number of motor vehicles registered in the United States from 1990 to 2018](https://www.statista.com/statistics/183505/number-of-vehicles-in-the-united-states-since-1990/), <https://www.statista.com/statistics/183505/number-of-vehicles-in-the-united-states-since-1990/> (last visited Oct. 27, 2020) and bts.gov, [Public Road and Street Mileage in the United States by Type of Surface](https://www.bts.gov/content/public-road-and-street-mileage-united-states-type-surfacea), <https://www.bts.gov/content/public-road-and-street-mileage-united-states-type-surfacea> (last visited Oct. 27, 2020).

momentum both domestically and globally, appears to be shifting toward the use of C-V2X for ITS.²⁴³ International deployment and uses of DSRC remain in flux, and as 5GAA notes, many automakers and developers are moving toward C-V2X.²⁴⁴ China has adopted C-V2X in lieu of DSRC, and the European Union is exploring whether to implement policies to create a path for C-V2X Direct deployment in Europe.²⁴⁵ By designating C-V2X for ITS delivery, the U.S. is positioning itself as a global leader to be at the forefront of continued C-V2X technology development as it becomes more globally harmonized.

100. We base our decision on the record before us and the spectrum realities that exist today. The record presents multiple factors that shape our view. Advocates for C-V2X claim several benefits that establish that C-V2X is the better choice at this time. 5GAA claims that C-V2X Direct technology outperforms DSRC on reliability, range and resilience to interference, which in turn will help improve non-line-of-site capabilities to promote safety benefits.²⁴⁶ Further, 5GAA asserts that during times of peak congestion, C-V2X functionality can offload less time-critical V2V, V2I, and V2P (vehicle-to-pedestrian) communications to the cellular network, thus supporting safety-critical communications.²⁴⁷ 5GAA and Qualcomm contend that C-V2X is better for achieving network effects insofar as cost efficiencies support deployment on a more accelerated basis.²⁴⁸ 5GAA further states that new vehicles now generally are equipped with C-V2X network mode chipsets,²⁴⁹ and it and Qualcomm assert that C-V2X technology can leverage cellular networks and thereby reduce the infrastructure costs associated with deploying V2X.²⁵⁰ 5GAA and Cisco also note that because C-V2X operates on both 20 and 10 megahertz channels it could support throughput throughout the 30 megahertz of spectrum that would be available.²⁵¹

101. Advocates for DSRC, in turn, assert that it may have certain advantages over C-V2X.²⁵² For example, State DOT agencies, assert that DSRC is preferred over C-V2X as they are concerned about potential negative impacts on current DSRC installations and operations and the resources that would be required to redesign the ITS system.²⁵³ In addition, NXP states that recent test results that do not demonstrate clear advantages of C-V2X over DSRC and believes that taking the band away from

²⁴³ See, e.g., 5GAA Comments at 18-21 (noting that Ford intends to deploy C-V2X in all of its new vehicle models sold in America (pending favorable regulatory action) and that several other automobile manufacturers, including Audi, Daimler North America Corp., BMW of North America, and Jaguar Land Rover are have trialed C-V2X).

²⁴⁴ 5GAA Comments at 18-21; 5GAA Reply at 70-10; see also, e.g., Ford Comments at 6; Land Rover Comments at 1;

²⁴⁵ Autotalks Comments 6-7; 5GAA Comments at 21. According to 5GAA, Chinese regulators allocated spectrum for C-V2X in 2018 and major automakers will deploy C-V2X-enabled vehicles in China next year; the European Union rejected DSRC as the preferred ITS technology in 2019 and is now exploring an approach that would create a path for C-V2X deployment in Europe. 5GAA Comments at 21. Global automotive manufacturers are already making deployment plans based on adoption of C-V2X, according to 5GAA. *Id.*

²⁴⁶ 5GAA Comments at 10-11.

²⁴⁷ 5GAA Comments at 12-13.

²⁴⁸ 5GAA Comments at 15; Qualcomm Comments at 5-6.

²⁴⁹ 5GAA Comments at 15.

²⁵⁰ 5GAA Comments at 15; Qualcomm Comments at 5-6 (C-V2X Direct enables cellular communications directly, without connecting to any cellular network and without requiring any network service subscription).

²⁵¹ 5GAA Comments at 26; Cisco Comments at 13-14.

²⁵² See, e.g., NXP April 27, 2020 *Ex Parte* at Comments at 2; DSRC Auto Safety Coalition Comments at 8-13..

²⁵³ See, e.g., City of Fremont Comments; Macomb County Department of Roads Comments; TennSmart Comments.

DSRC would be against the principle of technology neutrality.²⁵⁴ Several also express concern that C-V2X is a new vehicular technology that is untested and unproven compared to DSRC, which is a mature system ready for mass deployment.²⁵⁵ NXP observes that worldwide roll-out of DSRC technology accelerated in 2019; noting that in Europe, all versions of the new Volkswagen Golf model 8 are equipped with DSRC technology and that road operators such as are rolling out DSRC across several countries.²⁵⁶ Further, NXP opines that because C-V2X is based on classic 4G LTE, it is “old technology.”²⁵⁷

102. We conclude that choosing C-V2X as the sole ITS connected vehicle technology in the U.S. is the best for promoting more robust ITS deployment in the 5.9 GHz band in the coming years. While each technology has the capability of providing safety-related ITS services, we are persuaded that C-V2X, through its ability to achieve greater network effects and leverage cellular networks to reduce infrastructure costs, promises a more efficient and effective use of the spectrum. We do not anticipate any appreciable delay in deployment of this newer technology as many companies are already producing C-V2X devices (including dual-mode devices) and readying their availability for use,²⁵⁸ and many states are already deploying C-V2X or dual-mode equipment. We are also not convinced that the limited examples of recent DSRC deployments in other countries outweigh the U.S. automotive industry’s focus on deploying C-V2X technology, or that those limited deployments portend a significant growth in DSRC deployments here in the U.S. We are confident that our action today will expedite and expand the deployment of ITS safety benefits while ensuring efficient use of the spectrum.

103. We reject claims by Institute for Policy Innovations (IPI) that ITS is an idea whose time has passed and that vehicle connectivity is not critical to potential automotive safety benefits. By reducing the ITS band can be focused on deploying critical vehicular safety applications and take its position as part of a larger framework of technology solutions currently available to make road travel safer for the American people. We also reject the requests by various local entities, state departments of transportation, and others, arguing that the Commission should continue to conduct testing in coordination with the U.S. DOT, both with C-V2X and DSRC technology, to fully understand the operational impacts of these services to each other. We are choosing a single technology for the entire ITS band that we determine is best suited for ITS in the coming years. Further delay will not serve the American public. Rather, it is best to move forward with a revised 5.9 GHz band plan which supports C-V2X technology so that these vehicle related safety applications can be fully deployed quickly. Automotive stakeholders have had ample time to evaluate the various technologies and make their case as to the better approach. Based on the record before us, we believe that opting to permit a single technology—C-V2X—in the revised band plan best serves the American public.

2. Transitioning to C-V2X Operations in the ITS Band

104. In proposing to authorize C-V2X operations in most or all of the 30 megahertz of spectrum in the new ITS band (5.895-5.925 GHz), we sought comment on possible transition paths for ITS licensees using DSRC-based technology in some or all of the existing 5.9 GHz band.²⁵⁹ We sought up-to-date information on actual DSRC operations (e.g. information on the on-board units and roadside units deployed), noting that DSRC deployment had been limited and that many DSRC operations appeared to be demonstration or pilot projects.²⁶⁰ We inquired generally about possible transition paths to

²⁵⁴ NXP Reply Comments at 2.

²⁵⁵ Comments of City of New York at 1-2; *see* Intelligent Transportation Society of Michigan Comments at 2-3.

²⁵⁶ NXP Comments Attachment at 3-4.

²⁵⁷ NXP Comments Attachment at 4.

²⁵⁸ *See, e.g.*, Panasonic Comments; Bosch Comments at 3.

²⁵⁹ 5.9 GHz NPRM, 34 FCC Rcd at 12616-17, para. 32.

²⁶⁰ 5.9 GHz NPRM, 34 FCC Rcd at 12617-18, paras. 33, 35.

C-V2X-based solutions.²⁶¹ To facilitate the transition of existing ITS licensees, we proposed to modify existing licenses to allow operation of C-V2X and invited comment on how this would affect current licensees with operational sites.²⁶² We also inquired about any legal considerations relating to the transition.²⁶³ These included how long to allow existing licensees to continue DSRC-based operations (e.g., roadside infrastructure or on-board units), where we sought comment on whether six months would be sufficient for migrating to C-V2X-based operations.²⁶⁴ We also asked that commenters address any other considerations or approaches that the Commission should take to effectuate an appropriate transition of DSRC operations to C-V2X.²⁶⁵ With regard to the technical rules for operating C-V2X in the 30 megahertz of ITS spectrum, we proposed to adopt rules that largely follow the approach taken when the rules for DSRC were adopted.²⁶⁶

105. Several ITS licensees and proponents provided various types of information about the state of DSRC operations. We note that the Commission's database currently lists 124 active DSRC licenses on channels in the 5.850-5.925 GHz band: 91 licensees are considered "public safety eligible" with the remaining 33 qualified under the Industrial/Business Pool requirements. While 52 licensees have been granted registrations for fixed site RSUs we do not know the extent of portable/mobile RSU and/or OBU-OBU communications. We have no direct data on how many OBUs are operating under a given DSRC license because there is no requirement to obtain a Commission license to operate an OBU.

106. We received very limited response with respect to our inquiry about the considerations and best methods for transitioning current DSRC-based ITS licensees to C-V2X. While some unlicensed proponents commented that migrating to C-V2X in the upper 30 megahertz should be required to be completed in six months,²⁶⁷ we received no substantive comments on how the transition to C-V2X could be implemented, or the actual timeline. Most ITS proponents focused their comments on seeking to retain use of the entire 75 megahertz of spectrum in the 5.9 GHz band, not on transition matters. Accordingly, we do not have enough of a record on which to make an informed decision how best to proceed with regard to these transition matters. In the Further Notice, we seek comment on these issues to develop a more complete record with respect to the date by which all ITS operations will be required to use C-V2X-based technology in the upper 30 megahertz of the 5.9 GHz band. Now that we have decided on the band plan for the 5.9 GHz band and our approach for ITS operations, we expect to develop a sufficiently complete record that can more fully inform our decisions.

107. As proposed in the *5.9 GHz NPRM*, we will modify existing ITS licenses to allow operation only in the 5.895-5.925 GHz band.²⁶⁸ We will require licensees to transition out of the 5.850-5.895 GHz segment of the band within one year of the effective date of this First Report and Order and designate C-V2X technology as the ITS delivery system allowed for under our rules once the transition to the revised ITS band is complete. Our decision here begins the transition of DSRC-based ITS in the 5.9 GHz band to the 5.895-5.925 GHz portion of the band while we develop a more complete record to determine the appropriate date and procedures by which all ITS operations must transition to C-V2X technology. Furthermore, we anticipate that some DSRC licensees may wish to operate C-V2X-based ITS in the 5.895-5.925 GHz ITS band, and we will allow them to do so at any time through the STA,

²⁶¹ *5.9 GHz NPRM*, 34 FCC Rcd at 12617, para. 33.

²⁶² *5.9 GHz NPRM*, 34 FCC Rcd at 12617, para. 34.

²⁶³ *Id.*

²⁶⁴ *5.9 GHz NPRM*, 34 FCC Rcd at 12618, para. 36.

²⁶⁵ *5.9 GHz NPRM*, 34 FCC Rcd at 12617, para. 33, 12618, para. 36.

²⁶⁶ *5.9 GHz NPRM*, 34 FCC Rcd at 12618, para. 37.

²⁶⁷ NCTA Comments at 44; T-Mobile Comments at 2, n.5.

²⁶⁸ *See 5.9 GHz NPRM*, para. 34.

experimental licensing or other existing regulatory processes,²⁶⁹ on a non-interference basis upon proper showing. This flexible, case-by-case approach will enable a smoother and more rapid development and deployment of C-V2X-based ITS operations in the near term.

3. Protecting Federal Operations

108. In the *5.9 GHz NPRM*, we proposed to retain for licensees using C-V2X technology the existing coordination rules that currently apply to DSRC RSUs, including compliance with existing DSRC rules to protect the 5.9 GHz band primary Federal Radiolocation Service.²⁷⁰ We noted that DSRC RSUs are not protected from harmful interference caused by incumbent federal operations.²⁷¹ The existing DSRC rules that protect the 5.9 GHz federal radars require that RSU installations within 75 kilometers of 59 specified federal radar locations must be coordinated with NTIA.²⁷² As we also observed, requiring C-V2X equipment to coordinate installations within the 75-kilometer coordination zones represents “the most straightforward approach for enabling compatibility with federal operations.”²⁷³ We sought comment on this proposal.

109. NTIA, the only commenting party, agrees with the Commission that requiring ITS RSUs to coordinate installations within a coordination zone is the best approach to facilitate sharing with federal systems.²⁷⁴ Based upon its analysis, NTIA believes the coordination zones set forth in Section 90.371(b) of the Commission’s rules for DSRC RSUs can equally apply to C-V2X RSUs. However, to optimize unencumbered non-federal operations, NTIA examined current federal radar usage and determined that the number of protection zones can be reduced from 59 to 30, and rather than applying a single protection distance to all federal stations, most of the coordination zones could be tailored to the operating parameters of each station and generally reduced from the current 75 kilometers.²⁷⁵ The remaining 30 coordination zones are shown in Table 1 of NTIA’s Sept. 8, 2020 letter to the Chief of the FCC’s Office of Engineering and Technology. Since under existing rules, NTIA may authorize additional federal radiolocation services,²⁷⁶ NTIA requests that the rules be clarified to specifically recognize its authority to amend, modify, or revoke such assignments²⁷⁷ that could affect the coordination zones. Accordingly, NTIA requests that Section 90.371(b) be revised as follows: “...Operation of RSU stations within...kilometers of the locations listed in the table below, to which NTIA may amend, modify, or revoke locations and associated parameters, must be coordinated through the National Telecommunications and Information Administration.”²⁷⁸

110. NTIA also performed an analysis assessing the potential impact of C-V2X OBUs on federal operations. The NTIA analysis, based upon the Commission’s proposed rules for C-V2X OBUs, indicates that coordinating these devices would not be necessary to protect federal operations.

²⁶⁹ We note that currently there are 18 existing experimental licenses authorizing the operation of C-V2X. FCC Universal Licensing System, September 23, 2020.

²⁷⁰ See *5.9 GHz NPRM*, 34 FCC Rcd at 12620, paras. 46-47.

²⁷¹ See *5.9 GHz NPRM*, 34 FCC Rcd at 12620, para. 47 (citing 47 C.F.R. § 90.371(b)).

²⁷² See 47 CFR 90.371(b).

²⁷³ See *5.9 GHz NPRM*, 34 FCC Rcd at 12620, para. 47.

²⁷⁴ See *NTIA Sept. 8, 2020 Letter* at 3.

²⁷⁵ The protection requirements contained herein are premised upon the power and out-of-band emission levels contemplated by the Commission. Any deviation from those parameters may result in a change to these requirements.

²⁷⁶ See 47 CFR 90.371(c).

²⁷⁷ 47 U.S.C. 902(b)(2)(A).

²⁷⁸ See *NTIA Sept. 8, 2020 Letter* at 3.

111. We agree that sharing between ITS and Government operations is permitted if proper coordination is performed, and thus we adopt the NTIA recommendation. We find that this coordination requirement will enable ITS deployment across the U.S. We will replace the current table in Section 90.371 with NTIA's revised table.

D. Statutory Considerations

112. Here we set forth in greater detail the Commission's authority to transition ITS licensees to the upper 30 megahertz of the band, as well as its authority to ultimately transition ITS licenses from DSRC-based to C-V2X-based technology.²⁷⁹ As explained below, both actions are well within the Commission's broad authority to regulate spectrum in the "public interest" under Title III of the Act. In this regard, we focus only on DSRC licensees, because under the Commission's existing licensing rules the only ITS service permitted under those rules is DSRC service.²⁸⁰

113. *Relocating DSRC to the upper 30 megahertz.* We find that relocating DSRC operations to the upper 30 megahertz of the band is within the Commission's authority under section 316 of the Communications Act.²⁸¹ Section 316 gives the Commission authority to modify, by rulemaking or adjudication, any license "either for a limited time or for the duration of the term thereof, if in the judgment of the Commission such action will promote the public interest, convenience, and necessity."²⁸² But courts have held that the Commission's authority to "modify" licenses under section 316 does not confer on the Commission the ability to effect a "fundamental change" to those licenses.²⁸³ This means that the Commission can permissibly exercise its authority under section 316 if (1) it finds that doing so serves the "public interest" and (2) the modification is not so sweeping as to amount to a "fundamental change" to the licenses being modified. We address each of these questions in turn.

114. As explained more fully above, this modification is manifestly in the public interest.²⁸⁴ The modification will make room for valuable new unlicensed uses in the lower 45 megahertz of the band, while providing existing DSRC licensees sufficient spectrum to provide substantially the same vehicular safety services they now provide. This modification is therefore consistent with the long line of Commission actions changing or reducing frequencies where it has found that doing so is in the public interest.²⁸⁵

115. That leaves only the question whether relocating ITS operations to the upper 30 megahertz constitutes a "fundamental change" to the licenses of incumbent DSRC operations. Several commenters argue that it would, because DSRC requires the entire 75 megahertz to provide a mix of

²⁷⁹ We sought comment on these statutory considerations in the *5.9 GHz NPRM*. See *5.9 GHz NPRM*, 34 FCC Rcd at 12617, para. 34.

²⁸⁰ 47 CFR § 90.379; see also NCTA Comments at 11 (noting that "[t]he current rules for the 5.9 GHz band block not only Wi-Fi, but also any other technology that does not 'comply with' the ASTM E2213-03 DSRC Standard").

²⁸¹ 47 U.S.C. § 316.

²⁸² 47 U.S.C. § 316(a)(1); see also *California Metro Mobile Communications Inc. v. FCC*, 365 F.3d 38, 45 (D.C. Cir. 2004) ("Section 316 grants the Commission broad power to modify licenses.").

²⁸³ See, e.g., *MCI Telecommunications Corp. v. AT&T*, 512 U.S. 218, 228 (1994) (holding that statutory "authority to 'modify' does not contemplate fundamental changes"); *Cnty Television, Inc. v. FCC*, 216 F.3d 1133, 1140-41 (D.C. Cir. 2000) (applying that reasoning to section 316 and suggesting that impairing the ability of a licensee to provide the same services as those enabled by the original license might be considered a fundamental change), *cert. denied*, 531 U.S. 1071 (2001).

²⁸⁴ See Section III.A.2, *supra*.

²⁸⁵ *Expanding Flexible Use of the 3.7 to 4.2 GHz Band*, Report and Order and Proposed Modification, 35 FCC Rcd 2343, para. 126 (2020) (*3.7 GHz Report and Order*) (finding that "[t]he Commission has long relied on section 316 to change or reduce the frequencies used by a licensed service where it has found that doing so would serve the public interest" and describing examples of such Commission action).

current safety-related uses plus future uses that are under development.²⁸⁶ We disagree. Although effectively revoking a license or substantially disrupting a licensee’s ability to provide service may amount to a fundamental change, courts have repeatedly found that if a licensee can continue to provide substantially the same service, a modification to that license is not a fundamental change.²⁸⁷ As explained above, our review of the extensive record in this proceeding supports our conclusion that relocating DSRC licensees to the upper 30 megahertz of the band will not meaningfully interfere with same types of safety-related services that they are currently offering through limited deployment. Indeed, this 30 megahertz will accommodate not only the limited number of vehicles currently equipped with DSRC as currently allowed for under the Commission’s rules (e.g., certain fleet vehicles, which are mostly involved in pilot projects), but also additional commercial vehicles (e.g., fleet vehicles, trucks, cars) that might incorporate DSRC-based equipment and that could become available for American consumers on a wider basis across the country in the future—notwithstanding current trends by many manufacturers for introduction of the newer C-V2X technology.

116. What is more, the transition path in this order is designed to accommodate a transition that minimizes any potential disruption to DSRC operations. *First*, it is technically feasible. As described above, we find that it is technologically possible for ITS to operate on 30 megahertz in the upper part of the band, as we designate the lower 45 megahertz of the 5.9 GHz band for unlicensed use. Reconfiguring DSRC-based devices by updating firmware and/or software should allow current ITS licensees using DSRC to operate in the three adjacent channels in the revised band plan. *Second*, to minimize any disruption, we provide a reasonable time for any transition activities. We will not require existing licensees to vacate use of channels in the lower 45-megahertz portion of the 5.9 GHz band immediately; instead, we will give incumbent licensees a reasonable amount of time of one year to develop and implement a transition path out of that portion of the 5.9 GHz band, as we discuss earlier in this First Report and Order, thereby ensuring that the incumbents will be able to transition their services to the upper portion of the band. *Finally*, we find that these accommodations are particularly reasonable in light of the minimal current deployment of DSRC.

117. At bottom, the argument that the Commission’s action amounts to a “fundamental change” rests on the assertion that it will upend the *future* plans of DSRC licensees to provide certain advanced ITS services, which some commenters argue require the use of the full 75 megahertz currently allocated to DSRC licensees.²⁸⁸ But as we explain at length above, our review of the record—including the history, current deployment of basic safety-related DSRC-based ITS services, and status of future plans for these advanced services—leaves us unconvinced that relocation to the upper 30 megahertz will

²⁸⁶ See Alliance for Automotive Innovation Comments at 2, 33-36 (the FCC lacks authority to adopt and implement the proposed band plan; fundamentally changing the incumbents’ 5.9 GHz licenses as the Commission proposed in the 5.9 GHz NPRM would violate Sections 316 and 312 of the Communications Act). See also, e.g., AASHTO Comments at 3-4, 11, 15; National School Transportation Assoc. Comments at 2-3; OmniAir Comments at 1; TennSMART Comments at 1; Toyota Comments at 7-8; US TAG Comments at 4, 12; DSRC Auto Safety Coalition Comments at i-ii; Car 2 Car Comments at 2.

²⁸⁷ See, e.g., *Cnty Television*, 216 F.3d at 1136, 1140-41 (finding that the Commission’s actions will not effect a “fundamental change” where affected licensees could “begin and end the transition period broadcasting television programming to the public under very similar terms” and could “provide essentially the same services, with some flexibility to provide ancillary services as well, under their licenses during the transition”).

²⁸⁸ See, e.g., AT&T Comments at 4 (allocating 30 megahertz to the ITS would allow both technologies to support the Basic Safety Message, although it would preclude their use for advanced ITS applications (*i.e.*, not the basic safety-of-life/property applications contemplated when the service was authorized) and the evolution of C-V2X to 5G); AASHTO Comments at 15 (the Commission proposal represents a fundamental change to the terms of the DSRC licenses because it would leave insufficient bandwidth for the effective development of the planned safety applications).

upend any concrete business plans of DSRC licensees.²⁸⁹ As the D.C. Circuit explained in detail in *Teledesic*, in managing spectrum “[t]he Commission correctly conceives of its role in prophetic and managerial terms”—it must “predict the effect and growth rate of technological newcomers on the spectrum, while striking a balance between protecting valuable existing uses and making room for . . . new technologies.”²⁹⁰ In making this determination, we conclude that the potential deployment of future advanced DSRC-based ITS services that may or may not develop years into the future are too uncertain and remote to warrant the further reservation of spectrum for their deployment. After 20 years, with no widescale deployment of even the basic vehicle safety applications that have been available for years, the Commission cannot reasonably justify the protection of such possible future deployment of advanced ITS service at the expense of proven and market-ready technologies that stand ready to make use of the lower 45 megahertz. *Transition to C-V2X*. The Commission likewise has the authority under Title III to transition operations in the upper 30 megahertz from DSRC to C-V2X. As we explain above, we find that transitioning to C-V2X is in the public interest.²⁹¹ We note that the exercise of our authority under Title III to transition operations to a new technology is consistent with past Commission actions modifying technical operational rules and mandating the use of newer technologies to maximize spectral efficiency.²⁹²

118. The Alliance for Automotive Innovation and ITS America claim that if the Commission adopts a band plan that provides no spectrum for ITS licenses using DSRC technology, then the licenses effectively will be revoked and thus the Commission would exceed its section 312 authority.²⁹³ However, our decisions today do not represent a termination of DSRC licenses. Licensees will continue to be able to provide the same vehicular safety services on the upper 30 megahertz of the band that they provide under the current ITS band designation, and the ultimate transition from DSRC to C-V2X will similarly not result in any change in or reduction of vehicular-safety services. Licenses that operate under the new technical rules will maintain the same renewal expectancy they have today.²⁹⁴ Furthermore, we are providing flexibility for ITS licensees to choose to migrate to C-V2X technologies in the upper 30

²⁸⁹ As noted above, the focus of our section 316 inquiry is the effect of our proposal on DSRC service authorized under our existing licensing rules—not the prospects for a proposed new C-V2X set of services not currently authorized under the rules.

²⁹⁰ *Teledesic*, 275 F.3d at 84.

²⁹¹ As we discuss above, *see supra* at Section C.1, as part of our analysis of the most spectrally efficient use of the band, we find it in the public interest to adopt a single ITS standard to remove any technological compatibility issues and ensure a safer vehicular safety ecosystem. We are seeking comment on the details of this transition in the Further Notice of Proposed Rulemaking.

²⁹² *See, e.g., Committee for Effective Cellular Rules v. FCC*, 53 F.3d 1309, 1319-20 (D.C. Cir. 1995) (upholding technical rule modifications that effectively increased service areas of incumbent licenses); *Replacement of Part 90 by Part 88*, Report and Order and Further Notice of Proposed Rule Making, 10 FCC Rcd 10076 (1995) (establishing a narrowband channel plan for incumbent PLMRS licensees, along with new equipment type acceptance requirements, to transition existing and new PLMRS services to more spectrally efficient technologies). *See also Expanding Flexible Use of the 3.7 to 4.2 GHz Band*, Report and Order and Proposed Modification, 35 FCC Rcd, 2343 (2020) (determining that incumbent satellite licensees could be relocated to smaller portion of C-band without restricting ability of incumbents to provide comparable service, in part because of availability of compression technologies).

²⁹³ Alliance for Automotive Innovation Comments at 36; ITS America Comments at 15. *See also* General Motors Comments at 13 (cutting 60% of the ITS spectrum may violate Section 312). Section 312 of the Communications Act sets out the Commission’s authority to revoke a license. *See* 47 U.S.C. § 312.

²⁹⁴ We note here the particularities of ITS licensing. RSUs are individually, geographically licensed, while OBUs are licensed by rule. To the extent that we do shorten the terms of, terminate or modify the renewal expectancy of RSU licenses, the Commission’s broad regulatory authority covers the comparable modification of the related license-by-rule service through the rulemaking process. Here, the fate of the OBUs, as the licensed by rule dimension of the ITS, would be tied to that of the RSUs, as the individually licensed dimension.

megahertz sooner than required by our rules if the C-V2X operations would not interfere with any existing ITS licensee that continues to use DSRC-based technology before it ultimately transitions to C-V2X.

119. *Other statutory considerations.* Cisco Systems argues that the Commission must explain how its repurposing of the 5.9 GHz band will be consistent with the directives of the Transportation Equity Act for the 21st Century (TEA),²⁹⁵ and how the revised rules will continue to foster the objectives identified by the U.S. DOT in its implementation of the TEA.²⁹⁶ In the TEA, Congress directed the Commission to consider, in consultation with the Secretary of the U.S. DOT, spectrum needs for the operation of the ITS, including spectrum for the dedicated short-range vehicle-to-wayside wireless standard. However, the TEA did not require that the Commission designate the 5.9 GHz band – or any band – for ITS, only that the Commission *consider* doing so.²⁹⁷ The TEA directed the Commission to complete a rulemaking on ITS spectrum by January 1, 2000, which it did.²⁹⁸ That was all that Congress required for the Commission to achieve its statutory duties. Any other action we take on the spectrum we designated for ITS is done pursuant to our general authority to act in the public interest, convenience and necessity, which, as the D.C. Circuit has explained, is the sort of spectrum management issue for which the Commission’s authority is at its zenith.²⁹⁹

120. ITS America claims that based on concerns expressed by the U.S. DOT and other transportation safety experts, adopting our proposal to reduce the amount of ITS spectrum in the 5.9 GHz band would not satisfy the requirements of Section 1 of the Communications Act as it relates to the Commission’s responsibility to manage spectrum to ensure safety-of-life and property through the use of wire and radio communications.³⁰⁰ We disagree. The record shows significant support for ensuring safety of life and property through the use of ITS in the upper 30 megahertz of the band, allowing us to repurpose the lower 45 megahertz of the band for unlicensed operations. Furthermore, we disagree with ITS America’s suggestion that Section 1 of the Communications Act binds the Commission so that it may only modify 5.9 GHz band licenses consistent with U.S. DOT’s recommendations.³⁰¹ ITS America appears to fundamentally misunderstand the role Congress afforded the Commission to oversee non-federal use of spectrum (including state and local governmental spectrum use), whether for public safety or commercial purposes.³⁰²

E. Benefits and Costs: Economic Analysis

121. We have reviewed the benefits of repurposing the lower 45 megahertz of the 5.9 GHz band for unlicensed use and the direct costs associated with transitioning existing ITS licensees to the upper 30 megahertz of the band. The evidence leads to the conclusion that the benefits, in terms of new economic activity, are well above the costs. We expect to realize substantial benefits by expanding Wi-Fi capacity. Even using our most conservative approach to calculate benefits, we anticipate a present value of approximately \$6 billion in benefits in each of the years 2023-2025, or \$17.2 billion over that time

²⁹⁵ Pub. L.105-178, § 5206(f), 112 Stat. 107 (1998).

²⁹⁶ Cisco Systems, Inc. Comments at 5-6.

²⁹⁷ Indeed, Cisco admits that “it is true the [TEA] did not call out the 5.9 GHz band or require anything other than a rulemaking proceeding be conducted.” *Id.* at n.4.

²⁹⁸ *Amendment of Parts 2 and 90 of the Commission’s Rules to Allocate the 5.850-5.925 GHz Band to the Mobile Service for Dedicated Short Range Communications of Intelligent Transportation Services*, ET Docket No. 98-95, RM-9096, Report and Order, 14 FCC Rcd 18221 (1999) (1999 DSRC Allocation R&O).

²⁹⁹ 47 U.S.C. § 303; *Teledesic*, 275 F.3d at 79.

³⁰⁰ ITS America Comments at ii-iii, 12-15.

³⁰¹ ITS America Comments at ii-iii, 12-15.

³⁰² 47 U.S.C. § 151.

frame.³⁰³ We present the methodology and steps underlying this calculation in Appendix C. We also note that unlicensed use of the 5.9 GHz band may lead to benefits well beyond 2025, which underscores the conservative nature of our estimates. At the same time, by preserving the upper 30 megahertz for ITS, we are permitting current and future licensees to continue to offer such service in the band. We therefore take into consideration the one-time transaction costs associated with incumbent licensees transitioning their operations to the upper 30 megahertz of spectrum,³⁰⁴ and determine that these costs are significantly less than the present value of the benefits.

1. Record

122. *Benefits.* Proponents of the Commission proposal generally refer to a RAND Corporation study (RAND 5.9 GHz Study) which finds that repurposing the 5.9 GHz for unlicensed use could generate between \$82.2 billion and \$189.9 billion in economic welfare per year,³⁰⁵ or the substantially lower benefits estimate of approximately \$28 billion between 2022 and 2025 put forth by WiFiForward (2020 WiFiForward Study)³⁰⁶ to argue that costs related to the automotive industry were small by comparison. Conversely, advocates for ITS argued that unlicensed benefits put forth in these studies were outweighed by those of retaining the band for ITS.³⁰⁷ While few commenters disputed the benefits put forth by RAND and WiFiForward,³⁰⁸ below, we present our own estimate, which errs toward underestimating benefits by using an approach that likely overcounts prospective usage of the 6 GHz band and omits various consumer benefits as well as benefits that could be achieved prior to 2023 or after 2025.

123. Other commenters supporting the Commission's proposal refer to the economic value of Wi-Fi in general and the numerous use cases that Wi-Fi enables.³⁰⁹ Commenters argue that increased Wi-

³⁰³ This specification discounts benefits by 7% each year. See Office of Management and Budget, Circular A-4, *Regulatory Analysis*, 33 (Sept. 17, 2003), https://obamawhitehouse.archives.gov/omb/circulars_a004_a-4/#a (OMB Circular A-4) (stating that a real discount rate of 7% should be used as a base-case for regulatory analysis). If we instead discount by 3%, the present value of benefits over 2023-2025 is \$19.3 billion.

³⁰⁴ Specifically, we limit cost considerations to the costs of transitioning existing licensees to the upper 30 megahertz of the 5.9 GHz band. As discussed below, we do not recognize additional costs of transitioning to C-V2X or irrecoverable, sunk costs. *Infra* para. 139. Nor do we recognize costs associated with advanced applications without demonstration that such applications would yield benefits above and beyond those already anticipated from basic ITS and non-ITS safety applications. *Infra* para. 136.

³⁰⁵ Letter from Diana Gehlhaus Carew, Doctoral Fellow, RAND Corporation, to Marlene H. Dortch, Secretary, FCC, ET Docket No. 13-49, Attach. at x (filed Dec. 13, 2018) (RAND 5.9 GHz Study); see OTI and Public Knowledge Comments at 10; TechFreedom at 5; see also Letter from Thomas A. Schatz, President, Citizens Against Government Waste, et al., to Ajit Pai, Chairman, FCC, ET Docket No. 19-138, at 2 (filed Dec. 4, 2019) (CAGW, et al. Dec. 4, 2019 *Ex Parte*) (claiming that "opening the 5.9 GHz spectrum for unlicensed use will contribute up to \$100 billion to GDP").

³⁰⁶ Raul Katz, Telecom Advisory Services, LLC, *Assessing the Economic Value of Unlicensed Use in the 5.9 GHz & 6 GHz Bands* at 5 (Apr. 2020), <http://wififorward.org/wp-content/uploads/2020/04/5.9-6.0-FINAL-for-distribution.pdf> (2020 WiFiForward Study); see CAGW Reply Comments at 2; Comcast Reply Comments at 6; ICLE Reply Comments at 3; NCTA Reply Comments at 61-62; Letter from Bartlett Cleland, Executive Director, Innovation Economy Institute, et al., to Ajit Pai, Chairman, FCC, ET Docket No. 19-138, at 1 (filed Apr. 27, 2020).

³⁰⁷ AASHTO Comments at 21; Honda Comments at 10; IEEE 1609 Comments at 3; ITS of America Comments at 24; New York City Comments at 3; US TAG Comments at 4; Washington State DOT Comments at 3; Dr. Richard Roy Reply Comments at 3; ITS of America Reply Comments at 13.

³⁰⁸ Some commenters argue that the RAND estimates are based on Wi-Fi usage in all 75 megahertz of the 5.9 GHz band rather than 45 megahertz as the Commission proposed. See, e.g., Dynamic Spectrum Alliance Comments at 3; IEEE 1609 Comments at 4; ITS of America Comments at 24; Panasonic Comments at 10; US TAG Comments at 4.

³⁰⁹ NCTA Comments at 27, n.109; OTI and Public Knowledge Comments at 9, n.14; Comcast Reply Comments at 5.

Fi capacity will allow new data-intensive Internet of Things applications³¹⁰ and complement 5G development by facilitating the off-loading of a growing percentage of mobile traffic.³¹¹ Other Wi-Fi benefits include its importance to education, medicine, smart agriculture, and industry.³¹² Commenters assert that benefits from repurposing the 5.9 GHz band would arise from the increased Wi-Fi capacity attendant with the creation of additional channels—including an 80-megahertz channel and a 160-megahertz channel.³¹³

124. *Costs.* Various commenters claim that the costs of reducing the spectrum dedicated for ITS substantially outweigh the benefits of dedicating 45 megahertz for unlicensed operations. However, rather than quantifying costs specific to the reduction in ITS, most commenters point to the economic impact caused by automobile collisions in aggregate throughout the United States each year. Commenters generally refer to U.S. DOT estimates of the economic impact of lives lost and injuries resulting from police-reported vehicle crashes in the United States³¹⁴ as well as other studies and statistics that were not ITS-specific.³¹⁵ Some commenters, however, refer to ITS-specific analyses, including to National Highway Traffic Safety Administration (NHTSA) estimates of economic cost savings associated with V2V³¹⁶ and other studies.³¹⁷

125. Commenters also argue that repurposing ITS spectrum would lead to costs associated with traffic congestion, fuel consumption, and auto emissions, but in most instances, do not connect these

³¹⁰ NCTA Comments at 5; OTI and Public Knowledge Comments at 10.

³¹¹ CAGW, et al. Dec. 4, 2019 *Ex Parte* at 1; NCTA Comments at 5-6; OTI and Public Knowledge Comments at 10.

³¹² NCTA Comments at 5; OTI and Public Knowledge Comments at 11-15; NCTA Reply Comments at 1-2.

³¹³ Dynamic Spectrum Alliance Comments at 2-3; NCTA Comments at 16-17; OTI and Public Knowledge Comments at 7, 15, 31; WISPA Comments at 3-4; Comcast Reply Comments at 10-12.

³¹⁴ Commenters citing a November 20, 2019 *Ex Parte* include AASHTO Comments at 2-3, 6, 20-21; COTA Comments at 7; CVSA Comments at 1; DSRC Auto Safety Alliance Comments at 5; GWTC Comments at 2; HATCI at 2; Honda Comments at 10; IEEE 1609 Comments at 4; ITS MI Comments at 2; MEMA Comments at 3; SAFE Comments at 3; US TAG Comments at 5; AAI Reply Comments at 14; Dr. Richard Roy Reply Comments at 3. See Letter from Elaine L. Chao, Secretary, U.S. DOT, to Ajit Pai, Chairman, FCC at 1 (filed Nov. 20, 2019), <https://www.highways.org/wp-content/uploads/2019/12/sec-chao-letter-5.9-11-20-19.pdf>. Commenters citing U.S. DOT Reply Comments include AT&T Reply Comments at 13-14; Continental Reply Comments at 26; ITS of America Reply Comments at 10; Texas DOT Reply Comments at 1-2. See U.S. DOT Reply Comments, attaching Letter from Steven G. Bradbury, General Counsel, U.S. DOT, to Ajit Pai, Chairman, FCC, Supplementary Technical Comments at 8.

³¹⁵ Car 2 Car Communication Consortium Comments at 7; COTA Comments at 7; DSRC Auto Safety Coalition Comments at 4, n.6; HATCI Comments at 18; Minnesota DOT at 2, n.iii; NAFA Comments at 2; SANDAG Comments at 4-5; Volkswagen Comments, Attach. at 5; Advocates for Highway & Auto Safety at 1.

³¹⁶ AAI Comments at 7; DSRC Auto Safety Alliance Comments at 10; Car 2 Car Communication Consortium Comments at 7; HATCI Comments at 2; ITS of America Comments at 25; NXP Semiconductors Comments, Attach. at 1; Panasonic at 6; AAI Reply Comments at 9; ITS of America Reply Comments at 10; TxDOT Reply Comments at 2. The NHTSA analysis is part of NHTSA's 2017 V2V NPRM. See U.S. DOT, NHTSA, Federal Motor Vehicle Safety Standards; V2V Communications, 82 Fed. Reg. 3854 (January 12, 2017), <https://www.govinfo.gov/content/pkg/FR-2017-01-12/pdf/2016-31059.pdf> (NHTSA V2V NPRM).

³¹⁷ AAI Comments at 7; u-blox comments at 3-4 (citing James R. Sayer, Carol A. C. Flannagan, Andrew J. Leslie, *The Cost in Fatalities, Injuries and Crashes Associated with Waiting to Deploy Vehicle-to-Vehicle Communication*, University of Michigan Transportation Research Institute Report (Mar. 1, 2018), <http://www.umtri.umich.edu/what-were-doing/news/cost-fatalities-injuries-and-crashes-associated-waiting-deploy-vehicle-vehicle> (University of Michigan V2V Report)); IEEE 1609 Comments at 8-9; US TAG Comments at 8 (citing J. Chang et al., *Estimated Benefits of Connected Vehicle Applications: Dynamic Mobility Applications, AERIS, V2I Safety, and Road Weather Management Applications*, U.S. DOT, ITS Joint Program Office Report No. FHWA-JPO-15-255, at vii (Aug. 2015), <https://rosap.ntl.bts.gov/view/dot/3569> (US DOT 2015 Connected Vehicle Report)).

costs to ITS.³¹⁸ Certain commenters refer to annual traffic reductions and reduced carbon dioxide emissions associated with V2X,³¹⁹ while others claim that the repurposing could inhibit technology advancements, including in truck platooning, road weather information technologies, and logistics.³²⁰

126. More generally, commenters express concern that repurposing spectrum in the 5.9 GHz band would delay the spread of ITS applications in the United States.³²¹ Relatedly, the Alliance for Automotive Innovation (AAI) asserts that “[w]ithin 5 years, a total of at least 5 million radios on vehicles and roadway infrastructure will have been deployed, including any previous V2X deployments,” but only if the entire 5.9 GHz band is preserved for ITS.³²²

127. Finally, ITS advocates argue that existing ITS licensees would face a transition cost above \$500 million,³²³ with specific reference to U.S. DOT estimates of infrastructure and equipment replacement, engineering, and related costs.³²⁴ Commenters also claim that substantial investments in research, development, and testing would be lost as a result of the Commission’s proposed rule.³²⁵

128. In response, various commenters argue that the Commission’s proposal leaves sufficient spectrum to meet automotive needs³²⁶ and that references to economic valuations based on the sum of U.S. police-reported vehicle crashes erroneously suggest that 100% of crashes and congestion will be avoided if all 75 megahertz in the 5.9 GHz band is dedicated to ITS.³²⁷ Commenters also note claims about advanced ITS-based applications that could permit congestion-related and environmental benefits are speculative and that automotive technologies could use other licensed or unlicensed spectrum for many of the non-safety-of-life services that automakers contend would rely on ITS.³²⁸ Proponents of the Commission’s proposal agree that there would be costs associated with moving ITS licensees from the

³¹⁸ AAI Comments at 13; AASHTO Comments at 3; Honda Comments at 10; ITS of America Comments at 14; Panasonic Comments at 7; SAFE Comments at 3; Washington State DOT Comments at 3; U.S. DOT Reply Comments at 2; AAI Reply Comments at 7; ITS of America Reply Comments at 13-14; Texas DOT Reply Comments at 2.

³¹⁹ ITS of America Comments at 26-27; SAFE Comments at 3; US TAG Comments at 4, 8; Dr. Richard Roy Reply Comments at 3; ITS of America Reply Comments at 11-12.

³²⁰ *See e.g.*, Minnesota DOT Comments at 2; NXP Semiconductors Comments, Attach. at 2, 3. Truck platooning refers to the use of ITS to link multiple trucks in a convoy.

³²¹ *See, e.g.*, AASHTO Comments at 3; Car 2 Car Communication Consortium Comments at 1; Continental Comments at 9; Minnesota DOT Comments at 2; U.S. DOT Reply Comments at 35, 38-39.

³²² Letter from John Bozzella, President and CEO, AAI, to Elaine Chao, Secretary, US DOT and Ajit Pai, Chairman, FCC, ET Docket No. 19-138, at 2 (filed Apr. 23, 2020) (AAI Apr. 23, 2020 *Ex Parte*).

³²³ AASHTO Comments at 7; DSRC Auto Safety Coalition Comments at 13; Minnesota DOT Comments at 2; NXP Semiconductors Comments, Attach. at 2; AAI Reply Comments at 13.

³²⁴ U.S. DOT Reply Comments at 37-38. Certain state DOTs also enumerated costs specific to DSRC projects in their state. *See, e.g.*, Minnesota DOT Comments at 5; George DOT Comments at 2.

³²⁵ Idaho DOT Comments at 2; Montana DOT Comments at 2; New York City Comments at 1-2; North Dakota DOT Comments at 2; Washington State DOT Comments at 2; Wyoming DoT Comments at 3; U.S. DOT Reply Comments at 35-36.

³²⁶ CAGW Reply Comments at 2-3; Comcast Reply Comments at 17; ICLE Reply Comments at 5; NCTA Reply Comments at 65; Brattle 5.9 GHz Analysis at 5-7.

³²⁷ Brattle 5.9 GHz Analysis at 9-10.

³²⁸ Comcast Reply Comments at 17; NCTA Reply Comments at 23-26, 65.

lower 45 megahertz, but that these were overstated by the U.S. DOT³²⁹ and should not include sunk costs that cannot be recouped regardless of Commission action.³³⁰

2. Benefits of Unlicensed Spectrum in the Lower 45 Megahertz of the 5.9 GHz Band

129. We evaluate the economic benefits of dedicating the lower 45 megahertz of the 5.9 GHz band for unlicensed use by estimating the expected contribution to Gross Domestic Product (GDP) resulting from additional Wi-Fi traffic once this spectrum is made available to augment existing Wi-Fi capacity. Additional Wi-Fi capacity is valuable as future U.S. Wi-Fi demand is expected to greatly increase.³³¹ The additional, wider channels made possible by repurposing spectrum in the 5.9 GHz band will allow more devices to connect at a given time. The additional traffic will produce new productive economic activity, including through additional online transactions between Internet users, additional transactions between Internet users and Internet Service Providers (ISPs), and equipment, infrastructure, and labor needed to facilitate these transactions, together, comprising the added value of additional spectrum. We focus here on the additional GDP created by transactions between ISPs and their customers since estimating additional online transactions between Internet users is difficult due to lack of data. Thus, our estimate is conservative, capturing the economic value to the ISPs directly (i.e., producer surplus) and the indirect producer surplus of the equipment and labor that the ISPs acquire or hire to implement this new traffic, while ignoring consumer surplus gains.

130. Wi-Fi traffic occurs on discrete channels of 20 megahertz, 40 megahertz, 80 megahertz and potentially 160-megahertz bandwidth. Larger bandwidths improve the speed of traffic on the bands and additional channels increase the aggregate capacity of Wi-Fi. Our baseline calculation of the increase in traffic is based on the idea that the additional 45 megahertz of 5.9 GHz spectrum will, when combined with spectrum from the 5.725-5.850 GHz (U-NII-3) band, enable Wi-Fi users to access an additional 160-megahertz channel and 80-megahertz channel,³³² two additional 40-megahertz channels, and three additional 20-megahertz channels in addition to channels that are already available, including those in the 6 GHz band.³³³ This will give consumer devices additional channels to establish connections to mitigate congestion. Because future Wi-Fi traffic is expected to greatly increase and strain capacity today and in the future, we assume that the additional 5.9 GHz spectrum will be fully used by consumers.³³⁴ This implies that we can estimate additional traffic for channels of a specific bandwidth as

³²⁹ Brattle 5.9 GHz Analysis at 14.

³³⁰ NCTA Reply Comments at 67-68; Brattle 5.9 GHz Analysis at 12.

³³¹ The Free State Foundation Comments at 7-8; OTI and Public Knowledge Comments at 16-17. *See also, supra* para. 123.

³³² Although much of the spectrum that makes up these additional channels is located in the U-NII-3 band, we attribute the entire benefit to the spectrum being made available because these channels would not exist but for the additional 45 megahertz of spectrum made available in the U-NII-4 band through this First Report and Order.

³³³ For a table of available channels, including those in the 6 GHz band, *see 6 GHz Report and Order*, 35 FCC Rcd at 3902, Table 6. We note that because we include channels in the 6 GHz band, our calculations are likely conservative because of the power limitations in that band compared to those in the U-NII-4 band, which would likely lead to greater reliance on the latter. For examples, indoor devices using 160-megahertz channels in the U-NII-4 band will be able to rely on 36 dBm of power compared to 27 dBm in the 6 GHz band. *See 6 GHz Report and Order*, 35 FCC Rcd at 3889-90, para. 103.

³³⁴ The Free State Foundation Comments at 7-8 (noting that existing unlicensed bands “could be rendered unusable by increasing demand,” and that “by one estimate we’re going to need to find 1600 [megahertz] of additional unlicensed spectrum to meet busy-hour demand by 2025”); NCTA Comments at 5-7 (asserting that although 5G will provide more bandwidth, “it will also support so much more data usage that even more [Wi-Fi] offload is require[ed].”). Moreover, as we show in Appendix C, our finding that benefits outweigh costs does not require full use of the U-NII-4 band. *Infra* Appendix C, para. 11.

a proportion of new Wi-Fi channels that this spectrum would create relative to existing channels of that bandwidth.³³⁵ Using this and reasonable assumptions on the distribution of traffic across Wi-Fi channels of different bandwidths, we calculate that Wi-Fi traffic would increase by 8.4%.³³⁶ We note that although there are means to augment capacity other than through additional spectrum, such as with greater investment in infrastructure,³³⁷ our result maintains as long as capacity remains a bottleneck to service quality.

131. As we show in greater detail in Appendix C, to calculate additional GDP, we multiply 8.4% by an extrapolation of U.S. Wi-Fi traffic to determine additional traffic per year in gigabytes (GBs).³³⁸ We then multiply this figure by an estimate of the average ISP revenue generated by an additional GB of traffic.³³⁹ We estimate benefits only through 2025 to avoid relying on current data for projecting too far into the future, but note that because our estimates incorporate existing sources of unlicensed spectrum, including in the 6 GHz band, we believe that the benefits of repurposing the 5.9 GHz band would continue beyond 2025. Moreover, although we anticipate that benefits could arise earlier, we do not calculate benefits prior to 2023 to allow time for devices to be updated and adopted by consumers. Using a discount rate of 7%, our conservative approach leads to a present value of approximately \$6 billion in benefits in each of the years 2023-2025, or \$17.2 billion over that time frame.³⁴⁰

132. *Alternative Estimates of Unlicensed Spectrum Value in the Record.* In the 5.9 GHz NPRM, we noted that the RAND 5.9 GHz Study attempted to value additional traffic expected to result from repurposing the entire 5.9 GHz band for unlicensed use.³⁴¹ Although commenters generally did not

³³⁵ For example, there are already two 80-megahertz channels used commonly by Wi-Fi. The additional spectrum would allow use of one additional 80-megahertz channel. Assuming that this new channel would be fully used, traffic would increase by 50% based on the proportion, one new channel to two old channels.

³³⁶ Our traffic distribution assumptions are specified in Electronic Communications Committee, ECC Report 302, at 22 (May 29, 2019), <https://docdb.cept.org/download/cc03c766-35f8/ECC%20Report%20302.pdf>.

³³⁷ Additional infrastructure investment includes alternatives such as multiple input/multiple output (MIMO). With massive MIMO, a future is envisioned where hundreds or thousands of antennas are used to serve a set of users. There are, however, practical limits to how many antennas can be deployed at conventional towers and rooftop locations, for example, determined by the array dimensions allowed by the site owner, the weight, and the wind load. Additionally, massive MIMO faces deployment challenges, including pilot contamination, channel estimation, precoding, user scheduling, hardware impairments, energy efficiency, and signal detection that need to be addressed before it can achieve its promised advantages. See, e.g., Björnson, Emil, et al., *Massive MIMO is a reality—What is next?: Five promising research directions for antenna arrays*, 94 *Digital Signal Processing* (2019); Robin Chataut and Robert Akl, *Massive MIMO Systems for 5G and beyond Networks—Overview, Recent Trends, Challenges, and Future Research Direction*, 20 *Sensors* (2020).

³³⁸ CISCO, VNI Complete Forecast Highlights, United States - 2022 Forecast Highlights, at 1-2 (2018).

³³⁹ Specifically, we use projections of the price per GB for fixed U.S. broadband plans based on the Consumer Price Index (CPI) for “Internet services and electronic information providers” and a baseline price estimate from the Commission’s 2018 International Broadband Data Report. U.S. Bureau of Labor Statistics, Databases, Tables & Calculators by Subject, *Internet Services and Electronic Information Providers*, https://data.bls.gov/timeseries/CUUR0000SEEE03?output_view=data (last visited Oct. 27, 2020); *International Comparison Requirements Pursuant to the Broadband Data Improvement Act*, GN Docket No. 17-199, Sixth Report, 32 FCC Rcd 978, 1035, Table 3. We also used alternative approaches that led to higher GDP estimates. Every approach assumes that Wi-Fi revenue from transactions between ISPs and their customers is proportional to increases in Wi-Fi traffic. Additionally, each approach incorporates fixed broadband prices and revenues because Wi-Fi traffic is typically paid for indirectly via a fixed broadband subscription.

³⁴⁰ If we instead discount by 3%, the present value of benefits over 2023-2025 is \$19.3 billion. Alternatively, discounting by 7%, but relying instead on the Census Bureau’s national revenues data for fixed Internet services, we estimated a present value of benefits of \$34.8 billion over 2023-2025.

³⁴¹ 5.9 GHz NPRM, 34 FCC Rcd at 12626-27, para. 65.

dispute RAND's assessment, per the *5.9 GHz NPRM*, we had reservations with these valuations.³⁴² The RAND evaluation of additional traffic was the sum of extra value from the additional number of gigabytes (GBs) transmitted times an average broadband price per GB, plus the cost to consumers of new Wi-Fi-using devices that RAND found would have to be purchased to support this new traffic.³⁴³ While we agree that the availability of additional unlicensed spectrum in the 5.9 GHz band will create additional traffic, we find that RAND's device-based component likely overstates benefits because it assumes that Wi-Fi devices in use are substantially limited by capacity constraints, and thus, any increase in Wi-Fi capacity would generate new traffic that would be accommodated entirely by the purchase of new devices. We anticipate that existing Wi-Fi devices will handle most of the additional traffic, focusing instead on the value of the extra traffic itself based on our calculation above. Additionally, unlike the RAND 5.9 GHz Study, we incorporate 6 GHz spectrum into our analysis.

133. We also previously addressed another approach to evaluating unlicensed use: estimating the GDP increase due to the resulting broadband speed increase.³⁴⁴ An alternative quantification in the RAND 5.9 GHz Study as well as the 2020 WiFiForward Study of the value of repurposing 5.9 GHz both rely on such estimates, but based on different data. We have not found an appropriate way to address our concerns regarding this estimate in either comments to this proceeding, the public record, or in the academic literature, and so decline to include a benefit of speed increases in our analysis.³⁴⁵

3. Costs of Repurposing the Band to Limit ITS Use to the Upper 30 Megahertz of the 5.9 GHz Band

134. In conducting our analysis of benefits and costs, an underlying objective is to identify benefits and costs causally related to the Commission action being undertaken.³⁴⁶ As such, we can credit economic losses only if they would be expected to result from repurposing the 5.9 GHz band; we cannot (and should not) attempt to attribute losses to this proceeding that would have occurred regardless of our rule changes.³⁴⁷ Thus, we reject cost quantifications based on enumerations of the economic harms resulting from police-reported vehicle crashes in the U.S. that are not specifically tied to changes to ITS spectrum.³⁴⁸

³⁴² *5.9 GHz NPRM*, 34 FCC Rcd at 12626, para. 65 & n.108.

³⁴³ RAND 5.9 GHz Study at 25-32.

³⁴⁴ *5.9 GHz NPRM*, 34 FCC Rcd at 12626-27, para. 65 & n.109. Specifically, the RAND 5.9 GHz study attempts to estimate the percent by which GDP would increase in response to a broadband speed percentage increase (an elasticity) by regressing U.S. state GDPs on U.S. state broadband speeds. RAND then uses this elasticity to predict the added GDP based on their estimate of the increased broadband speed from repurposing 5.9 GHz spectrum. RAND 5.9 GHz Study at 14-21.

³⁴⁵ The 2020 WiFiForward Study attempted to resolve our concerns with the regression found in the RAND 5.9 GHz Study by including quarterly-lags of GDP as an independent variable to capture factors omitted from the RAND regression. 2020 WiFiForward Study at 25-26. However, this does not address our core concern that speeds could be explained by GDP, as we noted that GDP could determine speeds over long time periods when we discussed the use of lagged speeds in the RAND 5.9 GHz Study. *5.9 GHz NPRM*, 34 FCC Rcd at 12626-27, para. 65 & n.109.

³⁴⁶ See OMB Circular A-4 at 2 (stating that in evaluating properly the benefits and costs of regulations, we must explain how the actions required by the rule are linked to expected benefits).

³⁴⁷ As an example of how actions required by a rule are linked to expected benefits, OMB Circular A-4 suggests that agencies might "indicate how additional safety equipment will reduce safety risks." We interpret this guidance to mean that we cannot accept commenter assessments of prospective safety improvements or reductions unless these are linked to the Commission's proposal. OMB Circular A-4 at 2.

³⁴⁸ In doing so, we reject comments advancing such quantifications for the purpose of comparing benefits and costs. Specifically, we reject comments listed in *supra* note 314, note 315, and note 318.

135. In general, commenters have provided very limited information that would allow us to quantify any costs associated with a reduction in ITS spectrum. Certain commenters pointed to analyses, such as in the NHTSA V2V NPRM,³⁴⁹ seeking to quantify specific safety benefits of ITS to argue that such benefits may be diminished by the Commission. We find that benefits attributed to ITS in these studies are likely overstated and inappropriate to view as costs resulting from the Commission's proposal. As discussed above, we find that the 30 megahertz of spectrum that is being retained for ITS applications is sufficient to support many ITS applications. For example, in estimating the benefits of a proposal to mandate DSRC-based vehicle-to-vehicle (V2V) communications, the NHTSA V2V NPRM found that substantial benefits could be achieved using 10 megahertz of ITS spectrum,³⁵⁰ 20 megahertz less than the spectrum that we retain for ITS. Additionally, NHTSA analysis forecasts benefits based on the state of technology in the 2010-2013 base period, which likely substantially overestimates the benefits of DSRC in later years, when reliance on complementary or substitute safety systems (e.g., based on cameras, lasers, and radars) would likely be far more widespread than in 2010-2013.³⁵¹ Because commenters neither show that hypothetical ITS benefits described in the NHTSA and other studies would be lost as a result of our actions, nor establish that such benefits are accurately calculated, we reject comments advancing quantifications from these studies.³⁵²

136. More generally, we do not believe that this proceeding will lead to cognizable costs due to automobile collisions that may be linked to our actions. Commenters argue that certain advanced features, including those pertaining to life and property, may require additional bandwidth.³⁵³ NHTSA's own prior analysis suggests, however, that V2V safety applications that could eliminate a large proportion of crashes may require much less spectrum.³⁵⁴ And while commenters speculate about certain additional benefits (i.e., to pedestrians), they have not demonstrated whether such benefits would arise nor quantified the incremental benefit given the V2V safety applications that would be expected to be preserved. Further, commenters have not demonstrated that advanced applications, even if presumed to offer additional safety benefits,³⁵⁵ need to rely on ITS spectrum or would be largely obviated by developing safety features outside ITS.

137. Commenters also claim various benefits of ITS from non-safety applications. As explained above, we decline to rely upon estimates of use of ITS spectrum for applications like road weather information technologies that are more appropriately provided using other spectrum bands not dedicated for safety-of-life applications. Moreover, we find that commenters have not effectively

³⁴⁹ See NHTSA V2V NPRM.

³⁵⁰ NHTSA V2V NPRM, 82 Fed. Reg. 3885, 3969, 3986. Specifically, NHTSA proposed to require basic safety message transmissions on a single 10 megahertz channel paired with secondary cellular, Wi-Fi, or satellite communications. NHTSA V2V NPRM, 82 Fed. Reg. 3969, 3986. NHTSA's analysis focused on the intersection movement assist and left turn across path applications, safety benefits the agency viewed as being least likely to be replicated by alternative non-ITS safety enhancing technologies. NHTSA V2V NPRM, 82 Fed. Reg. 3969.

³⁵¹ Similarly, the University of Michigan V2V Report sought to estimate the cumulative cost associated with a delay in mandating V2V capability on new vehicles caused by waiting for a new technology like C-V2X (University of Michigan V2V Report at 2-4). The report relied on the counterfactual assumption that a DSRC-based V2V technology could be ready to deploy on all new vehicles starting in 2019. Because we know this was not the case, the ensuing cost estimate is made inaccurate by continued development of C-V2X technology.

³⁵² Specifically, we disagree with comments of AAI, DSRC Auto Safety Alliance; Car 2 Car Communication Consortium, HATCI, ITS of America, NXP Semiconductors, Panasonic, TxDOT, u-blox, IEEE 1609, and US TAG on this point.

³⁵³ See, e.g., Car 2 Car Communication Consortium Comments at 2-4; Continental Comments at 4-5; U.S. DOT Mar. 13, 2020 *Ex Parte* at 30-32.

³⁵⁴ NHTSA V2V NPRM, 82 Fed. Reg. 3885, 3969, 3986.

³⁵⁵ See e.g., 5GAA Comments at 28-31.

demonstrated that advanced ITS features would reduce congestion or environmental or other costs that are not directly related to safety. We have already noted that 30 megahertz of spectrum is sufficient to support many ITS applications and existing studies do not show that more spectrum would give rise to additional benefits.³⁵⁶ For example, whereas commenters claim that commercial platooning systems are expected to improve fuel efficiency by 7.25%,³⁵⁷ other public estimates of these impacts are lower,³⁵⁸ and there may be offsetting congestion, safety, and other concerns that could diminish the benefits from this technology (if not eliminate them entirely),³⁵⁹ leading certain truck manufacturers to reconsider its use.³⁶⁰

138. Nor do we view the transition by existing DSRC licensees to the upper 30 megahertz in the 5.9 GHz band to be a substantial cause of delays to deployment of basic ITS applications in the foreseeable future. First, as other commenters point out, we note that C-V2X has had no spectrum dedicated to its deployment, but this has not prevented rapid innovation in that technology, which in part, necessitates this proceeding.³⁶¹ Second, the band plan proposed by AAI suggests that a transition by DSRC licensees would have been necessitated, even if our rules proceeded exactly as AAI envisioned.³⁶² The Alliance for Automotive Innovation proposal initially stipulates a transition of DSRC licensees from the upper 20 megahertz of the 5.9 GHz band to make way for C-V2X.³⁶³ The proposal then stipulates a second transition after five years, following selection of a single technology (either DSRC or C-V2X)

³⁵⁶ For example, extrapolating from estimates in a US DOT connected vehicle report, commenters (US TAG Comments at 4, 8; Dr. Richard Roy Reply at 3) claim an estimated annual reduction in traffic of 280 million hours and reduced carbon dioxide emissions of 400,000 tons associated with V2I. However, this and other studies do not stipulate that 75 megahertz of ITS spectrum is necessary to achieve this. US DOT 2015 Connected Vehicle Report at 18. In particular, many connected vehicle studies studying the potential environmental benefit of ITS assess the efficacy of algorithms (e.g., for signal control) in a simulated environment irrespective of the underlying communications technology or spectrum band that permits connectivity. See e.g., Hao Liu, Xiao-Yun Lu, and Steven E. Shladover, Traffic signal control by leveraging Cooperative Adaptive Cruise Control (CACC) vehicle platooning capabilities, 104 Transportation Research Part C: Emerging Technologies (2019); Jongryeol Jeong et al., *Implementation of Model Predictive Control into Closed-Loop Micro-Traffic Simulation for Connected Automated Vehicle*, 52 IFAC-PapersOnLine (2019); Yunfei Hou and Qing He, *Cooperative and Integrated Vehicle and Intersection Control for Energy Efficiency (CIVIC-E2)*, 19 IEEE Transactions of Intelligent Transportation Systems (2018).

³⁵⁷ ITS of America Comments at 27.

³⁵⁸ See, e.g., Department of Energy, Office of Energy Efficiency & Renewable Energy, *Platooning Trucks to Cut Cost and Improve Efficiency* (Feb. 5, 2018), <https://www.energy.gov/eere/articles/platooning-trucks-cut-cost-and-improve-efficiency> (citing a figure of 4%).

³⁵⁹ Recent research is concerned with potential adverse impacts of truck platoons on other traffic and safety. See e.g., Meng Wang, et al., *Benefits and Risks of Truck Platooning on Freeway Operations Near Entrance Ramp*, 2673 Transportation Research Record, 588 (2019); Timo Faber, et al., *Evaluating Traffic Efficiency and Safety by Varying Truck Platoon Characteristics in a Critical Traffic Situation*, Transportation Research Record, DOI: 10.1177/0361198120935443 (2020).

³⁶⁰ Press Release, Daimler, Daimler Trucks invests half a billion Euros in highly automated trucks (Jan. 2019), <https://media.daimler.com/marsMediaSite/en/instance/ko/Daimler-Trucks-invests-half-a-billion-Euros-in-highly-automated-trucks.xhtml?oid=42188247> (Daimler notes that it is “reassessing its view of platooning” because years of testing “show that fuel savings, even in perfect platooning conditions, are less than expected and that those savings are further diminished when the platoon gets disconnected and the trucks must accelerate to reconnect.” Daimler further indicated that its analysis “shows no business case for customers driving platoons” in the U.S.)

³⁶¹ Brattle 5.9 GHz Analysis at 10-11.

³⁶² Letter from John Bozzella, President and CEO, Alliance for Automotive Innovation (AAI), to Elaine Chao, Secretary, US DOT, ET Docket No. 19-138, at 1-2 (filed Apr. 28, 2020) (AAI Apr. 28, 2020 *Ex Parte*).

³⁶³ AAI Apr. 28, 2020 *Ex Parte* at 1.

with a ten-year phaseout period for the technology that does not prevail.³⁶⁴ Because there is no guarantee that DSRC would prevail, this would forestall its transition by several years, even assuming it was ultimately determined to be the prevailing technology—an assumption we find unconvincing for the reasons discussed above. Moreover, we find that the Alliance for Automotive Innovation’s proposed commitment to deploy 5 million radios if the entire 5.9 GHz band is preserved for ITS is not enforceable,³⁶⁵ and importantly, represents a relatively modest ITS deployment that is not necessarily at variance with deployments that might be anticipated without the proposal.³⁶⁶ The proposed commitment and band plan do not contemplate the additional length of time necessary to deploy the prevailing technology nor the time that it would take for sufficient adoption by consumers to have meaningful benefits, a timeframe during which alternative safety applications may substantially diminish the incremental benefits achievable from ITS. For these reasons, we decline to credit claims that our actions could impose costs stemming from delays in ITS deployment.

139. Finally, we believe that the U.S. DOT’s estimate of transitioning existing licensees is at the high end of total ITS transition costs, and is, in any event, well below our estimated benefits of repurposing the 5.9 GHz band for unlicensed use. In particular, the U.S. DOT confounds the costs of transitioning to the upper 30 megahertz of the 5.9 GHz band with those of transitioning to C-V2X.³⁶⁷ However, the latter cost is necessitated by market factors, including substantial support for the technology by proponents of ITS, including the Alliance for Automotive Innovation. Moreover, existing DSRC licensees have recently begun to employ C-V2X on an experimental basis, telling us that the transition to C-V2X is already ongoing.³⁶⁸ Thus, we view it as inappropriate to include as part of the transition calculation, costs of transitioning to C-V2X.³⁶⁹ Additionally, in general, expenses on research, development, and testing referenced by ITS proponents represent typical examples of sunk costs that are irrecoverable irrespective of any action that we take.³⁷⁰ Specifically, we agree with comments noting that expenses on grants and research projects referenced by the U.S. DOT,³⁷¹ represent typical examples of such sunk costs, which we decline to recognize.

IV. FURTHER NOTICE OF PROPOSED RULEMAKING

140. In the First Report and Order we adopted a revised band plan for the 5.9 GHz band that continues to designate the upper 30-megahertz portion (5.895-5.925 GHz) of the 5.9 GHz band for ITS and stipulates rules for unlicensed devices operating in the lower 45-megahertz portion of the band (5.850-5.895 GHz). With respect to unlicensed operations under the revised band plan, we established technical and operational rules that (1) allow immediate access for unlicensed indoor operations at

³⁶⁴ AAI Apr. 28, 2020 *Ex Parte* at 1-2.

³⁶⁵ In particular, the “industry-wide build out requirement” (AAI Apr. 23, 2020 *Ex Parte* at 2) does not lay out an enforcement mechanism for individual participants to ensure that the proposed commitment is satisfied in the aggregate. *See* NCTA Reply Comments at 40.

³⁶⁶ For instance, the proposed commitment is incremental to existing deployments and consists of two, competing, non-interoperable technologies. Moreover, even if each radio represented deployment of a single V2X capable vehicle—which the proposed commitment makes clear is likely not the case—the final deployment would represent less than 2% of the more than 270 million registered vehicles in the U.S. *See* AAI Apr. 23, 2020 *Ex Parte* at 2; U.S. DOT, Bureau of Transportation Statistics, *Number of U.S. Aircraft, Vehicles, Vessels, and Other Conveyances*, <https://www.bts.gov/content/number-us-aircraft-vehicles-vessels-and-other-conveyances> (last visited Oct. 27, 2020).

³⁶⁷ U.S. DOT Reply Comments at 37.

³⁶⁸ *See, e.g.*, Colorado DOT Comments at 1-2; Georgia DOT Comments at 4.

³⁶⁹ We note that this is notwithstanding certain commenters’ alternative arguments for why transition costs are likely overstated. *See, e.g.*, Brattle 5.9 GHz Analysis at 13-15.

³⁷⁰ *See, e.g.*, Brattle 5.9 GHz Analysis at 12-13.

³⁷¹ U.S. DOT Reply Comments at 36.

specified power levels across the entire 5.850-5.895 GHz portion of the 5.9 GHz band; and (2) allow for limited full power outdoor operations at specified geographic locations through the STA, or other existing regulatory process, during the transition period.

141. The First Report and Order determined that ITS operations on channels in the 5.850-5.895 GHz band portion of the 5.9 GHz band will be required to cease within one year of the effective date of the First Report and Order, and that ITS operations in the revised ITS band ultimately must use C-V2X technology instead of DSRC-based technology. In this Further Notice, we address the remaining issues before the Commission as we finalize the 5.9 GHz band restructuring to the modified band plan. Specifically, we address: (1) the transition of all ITS operations to C-V2X-based technology; (2) the codification of C-V2X technical parameters in the Commission's rules; (3) other transition considerations; and (4) the transmitted power and emission limits, and other issues, related to full-power outdoor unlicensed operations across the entire 5.850-5.895 GHz portion of the 5.9 GHz band.

A. Transitioning Licensed ITS Operations in the 5.9 GHz Band to C-V2X Technology

142. Under the First Report and Order, all existing ITS operations using channels in the lower 45 megahertz of the 5.9 GHz band will be required to transition out of that spectrum and into the upper 30 megahertz (5.895-5.925 GHz) of the 5.9 GHz band that will continue to be designated for ITS. ITS licensees must take necessary steps to assess their existing equipment and infrastructure and either retune their devices to access only the spectrum in this 30 megahertz that will remain available for ITS operations or replace their equipment with transmitters designed to use only the revised ITS band. In this Further Notice, we propose to address remaining issues that must be resolved regarding the transition of ITS, including the timing and procedures needed to ensure a smooth transition to the 5.895-5.925 GHz band. We also seek comment on additional or alternative measures that may be helpful, appropriate, or necessary.

1. Timeline

143. In the First Report and Order, we require that ITS operations in the 5.895-5.925 GHz band ultimately must use C-V2X technology. In order to complete the transition of the band to C-V2X, we propose that all operations in the 5.895-5.925 GHz band either convert to C-V2X or cease operating two years after the effective date of a Second Report and Order adopted in response to this Further Notice. We seek comment on this proposal.

144. As we first proposed to authorize C-V2X operations in the 5.9 GHz band in December 2019, manufacturers and licensees have had significant time to begin planning for the eventual entry of C-V2X into the band. We seek comment on the state of development of C-V2X equipment, both roadside and on-board units. We believe that two-years beyond the effective date of the rules the Commission adopts in the Second Report and Order will allow the ITS supply chains to become replete with C-V2X equipment. This is also consistent with the Department of Transportation's view that vehicle manufacturer product cycles necessitate two years lead time to ensure new V2X equipment is installed in new vehicles.³⁷² Indeed, some commenters have explained that they have already deployed equipment that is both DSRC and C-V2X compatible.³⁷³ We seek comment on the state of development of C-V2X equipment, both roadside and on-board unit, on whether manufacturers can distribute equipment through their existing supply chains, and on whether vehicle manufacturers can install C-V2X equipment into new vehicles within this timeframe. Moreover, we expect that many licensees will begin planning for the eventual transition to C-V2X now and, thus, may take advantage of available opportunities to

³⁷² See National Highway Traffic Safety Administration (NHTSA), Department of Transportation (DOT), Federal Motor Vehicle Safety Standards; V2V Communications Notice of Proposed Rulemaking (NPRM). 82 FR 3854, which states new V2X requirements, if adopted, would phase-in two model years after the final rule is adopted to accommodate vehicle manufacturers' product cycles.

³⁷³ GDOT Comments at 4.

immediately operate C-V2X facilities in the upper 30 megahertz of the band under our STA, experimental licensing, or other existing regulatory process without first implementing interim DSRC operations. We seek comment on the number of licensees that may decide to operate in such a fashion and the number that plan to continue offering DSRC in the 30-megahertz band during the transition period. We assume that the transition process to C-V2X would primarily involve replacing DSRC transmitters with C-V2X transmitters, since we propose C-V2X technical rules consistent with the current rules for DSRC and therefore no antenna changes are needed to cover the same area based on the identical propagation characteristics between DSRC and C-V2X. We seek comment on the steps involved with converting all ITS operations in the 5.9 GHz band to C-V2X technology and the expected time to complete the entire process. Further, as stipulated in the First Report and Order, licensees will not need to initiate changes to their authorizations at this future date they simply will need to use equipment that meets the operational and technical rules we adopt in the Second Report and Order for C-V2X technology. If, however, a licensee needs to concurrently make adjustments to its system to add sites, increase power, or modify emissions, those changes will require modifications to the underlying RSU registration information.

145. We also seek comment on how to treat DSRC OBUs at the final transition date. Can manufacturers or DSRC system operators send over-the-air instructions to these units to turn off? Can OBUs be modified through software or hardware changes to operate using C-V2X-based technology? Absent other operating DSRC infrastructure (such as RSUs), would OBUs continue to communicate with each other and, if so, what would such communications entail? Is there any potential for harmful interference that could occur if DSRC OBUs continue to operate after the final transition date? We seek comment on our proposed two-year sunset date for DSRC-based OBU operations and any alternative date that commenters might suggest. Commenters should be specific as to the merits of any date they prefer for ceasing DSRC operations in the 5.9 GHz band.

146. Finally, recognizing that OBUs are licensed by rule under Part 95³⁷⁴ and, as a result, the Commission does not have detailed information and records on the exact number and location of users of such equipment, we seek comment on whether there are any specific issues related to modifying OBUs that are not reflected in the questions already raised. As an initial matter, we assume that most OBUs should be easily identified because very few vehicles sold to date are equipped with OBUs and the vast majority of existing units are associated with the various ITS trial programs occurring throughout the U.S. We seek comment on this notion. Are there estimates of the number of vehicles on the road today that incorporate DSRC-based OBUs independent of a trial or pilot program (i.e., as part of a commercial deployment of DSRC services)? Does the Commission need to take steps to make owners of these vehicles aware of the changes being adopted? Or would automobile manufacturers take primary responsibility for notifying their customers of these rule changes? If the Commission should make owners aware of rule changes affecting OBUs, then how should the Commission conduct such consumer outreach? Commenters should provide specific details to justify their positions regarding our proposals.

2. Technical Parameters

147. The Commission's ITS rules set forth basic technical parameters such as power, height, and available channels.³⁷⁵ Further, to ensure interoperability within the ITS, DSRC operations are required to adhere to the provisions specified in the ASTM E2213-03 Standard (ASTM-DSRC), which is

³⁷⁴ 47 CFR § 95.305 Authorization to operate Personal Radio Services stations; Part 95, Subpart L DSRCs On-Board Units. Part 95 rules apply to the Personal Radio Services and provide for a variety of personal communications, radio signaling, and business communications. "Licensed-by-rule" means that an authorized user can access the entire available spectrum without an individual station license document and is instead authorized to operate as long as the operations are in accordance with the applicable service rules. *See* 47 U.S.C. § 307(e). Thus, while all spectrum use is shared among users who meet the eligibility and technical qualifications and no one has exclusive rights to any portion of the spectrum, those users are collectively afforded interference protection *vis-à-vis* other services, based on the allocation status under which they operate.

³⁷⁵ 47 CFR 90.377.

incorporated by reference in the Commission's rules.³⁷⁶ These rules divide the current 5.9 GHz band into seven, 10-megahertz channels, with an allowance to combine two pairs of channels into 20-megahertz channels.³⁷⁷ Further, specific channels are intended for public safety use only; one channel in particular, the "control channel," which is outside the modified ITS band plan,³⁷⁸ is intended to be used for messages that coordinate channel usage and prioritize public safety messages.³⁷⁹ The modified ITS band plan eliminates the lower four, 10-megahertz channels, including the current control channel, and one of the public safety channels. These changes necessitate that we further propose to modify the ITS technical rules to ensure that ITS delivers its intended safety-related applications to the American public.

148. Our goal is to facilitate a smooth transition and ensure that existing ITS services continue with minimal or no interruption. Accordingly, we must address the technical rules through the transition process whereby C-V2X will replace DSRC technology in the 5.9 GHz band and after that transition when C-V2X is the sole technology in the 5.9 GHz ITS band. In the sections below, we seek comment on the technical considerations related to the simultaneous operation of DSRC and C-V2X in the 5.895-5.925 GHz portion of the 5.9 GHz band and, ultimately, exclusive operation of C-V2X in that band. In particular, as commenters consider the various technical issues addressed here, they should also frame their comments around considerations necessary during and after the transition. Specifically, for each technical issue, commenters should also answer whether there are technical issues that preclude simultaneous DSRC and C-V2X operations in this band. What spectral and/or geographic separation requirements, if any, are necessary to prevent harmful interference between the two types of operations? As ITS licenses generally specify a defined geographic area and are required to operate within as small a "communications zone" as necessary, can we permit existing licensees to modify to C-V2X operations premised simply on not exceeding their existing footprint? Can new licensees be authorized to use C-V2X in the near term, provided that they avoid existing geographic licensed areas or simply avoid existing registered roadside units? Are there any adjacent-channel issues that need to be considered between DSRC and C-V2X to enable nearby operation? What accommodations can be made to protect roadside unit sites operated pursuant to the four nationwide ITS authorizations? Commenters should consider how best to balance C-V2X band entry and co-existence with DSRC during the transition period, in light of the technical rules we are proposing herein and recommend if there are any interim measures that may be needed to ensure short-term compatibility prior to exclusive C-V2X use. We also seek information informed by current C-V2X tests being conducted under experimental licenses as to how best to enable a smooth transition from DSRC to C-V2X.³⁸⁰

149. *Bandwidth.* We propose light touch changes to minimize disruption and simplify the transition from DSRC-based technology to C-V2X-based technology. The existing ITS band plan contains three, 10-megahertz channels: channels 180, 182, and 184 corresponding to 5.895-5.905, 5.905-5.915 and 5.915-5.925 GHz, respectively. We seek comment on whether this plan should continue for C-V2X. We also seek comment on whether the band plan should continue to accommodate combining two channels to provide a single 20-megahertz channel. Currently, channels 180 and 182 can be combined into channel 181 (5.895-5.915 GHz).³⁸¹ Should such channel combining be permitted under the modified

³⁷⁶ 47 CFR §§ 90.375, 90.379, 95.3189.

³⁷⁷ 47 CFR §§ 90.377(b), 95.3163.

³⁷⁸ 47 CFR §§ 90.377(b), 95.3163.

³⁷⁹ 47 CFR §§ 90.377(b), 90.377(d)(2), 95.3163, 95.3159(a)(2).

³⁸⁰ Similarly, as the First Report and Order allows parties to use existing regulatory processes such as STA or experimental licensing to operate C-V2X stations now, we are particularly interested in steps these licensees can take to enable coexistence with DSRC and their effectiveness—recognizing that STA operations occur on a secondary, non-interfering basis to licensed operations (such as ITS licensees with DSRC deployments operating during the transition period).

³⁸¹ 47 CFR §§ 90.377(b), 95.3163.

ITS band plan? Alternatively, should channels 182 and 184 be permitted to combine into a single 20-megahertz channel spanning 5.905-5.925 GHz? Should the Commission permit maximum flexibility by allowing each of these potential channel combinations to be used as necessary to accommodate various ITS applications and services? What about allowing all three channels to be combined and used as a single 30-megahertz channel? What are the consequences for any of these channel bandwidth choices on C-V2X? How would a completely flexible band plan versus a prescriptive band plan affect the ability of C-V2X to maximize efficient use of the band? We seek comment on each of these possibilities and striking the right balance to ensure efficient and effective band use can be maximized. Further, commenters should provide sufficient detail regarding their preferred band plan and how that may work with C-V2X and all other operational and technical rules that are addressed herein, such as power limits, out-of-band emission limits, channel use designations, etc.

150. *The control channel and the public safety priority channel.* Currently the rules designate channel 178 (5.885-5.895 GHz) as the control channel and channel 184 (5.915-5.925 GHz) as a public safety channel.³⁸² We seek comment on whether there is a compelling reason to have specific use designations on any or all of the channels used by C-V2X. Would designating any of the channels for a specific purpose, e.g., a control channel, help maximize band use efficiency? Does C-V2X need access to a control channel in a similar fashion as DSRC? If so, what is the best alternative for accommodating a control channel for C-V2X? Commenters should provide specific reasoning to support their preference. How would any channel designation work with the potential flexibility to combine any two or all three channels?

151. Commenters in favor of any channel designations should include detail regarding which designations they prefer we retain, which channel(s) those designations should pertain to, why they make those particular choices and how those choices will maximize use of the band and promote safety-related vehicular services. Alternatively, we could leave the issue of how best to use any of the channels to the standards-setting process and permit the industry to agree on use standards, but not designate those in our rules. We seek comment on the advantages and disadvantages of deferring to industry standardization processes in lieu of adopting prescriptive rules. Commenters in favor of using the standards process should also comment on expected timeframes for such bodies to produce relevant standards and how those timeframes complement the transition timeframe we propose in this Further Notice.

152. Relatedly, the existing rules lay out a hierarchical priority system for messages.³⁸³ Communications involving the safety of life have access priority over all other ITS communications. Next, communications involving public safety have the next priority level with a presumption that roadside units operated by state or local governmental entities are engaged in public safety priority communications. At the lowest tier of the hierarchy are non-priority communications, which are all other communications. We seek comment on whether to retain this message priority hierarchy. Because the stated purpose of the ITS is to promote safety, our inclination is that this message prioritization system should be retained as it helps to ensure that the most important messages are successfully transmitted. This may become even more important as ITS operations must adjust to delivering service in less spectrum than under the current band plan. We seek comment on this position. Would such a system work with C-V2X? If we retain the channel designations, do they need to be modified for C-V2X? More broadly, are the existing channel designations and operating protocols still technically relevant under the new band plan? Further, commenters should address whether this priority system should be modified in any way. Should there be more granularity in the priority tiers? If so, then how should such messages be designated? Should they continue to be associated with specific types of licensees or should the message type be the determining factor? Should we continue to maintain priority system based on our expectation that dedicated ITS spectrum will be used primarily (if not exclusively) for safety-of-life applications?

³⁸² 47 CFR §§ 90.377(b), 95.3163.

³⁸³ 47 CFR §§ 90.377(d), (e).

153. *Power and antenna height.* The 5.9 GHz band ITS spectrum is shared and licensed on a non-exclusive geographic area basis based on geo-political boundaries.³⁸⁴ To maximize the use within this shared spectrum, the rules require that each registered roadside unit designate its intended area of operation or “communication zone” and that such communication zones be the smallest necessary.³⁸⁵ The rules provide for four communication zones designated “A” through “D” for coverage areas ranging from 15 meters to 1000 meters. Correspondingly, each zone is associated with a maximum permitted output power ranging from 0 dBm to 28.8 dBm. While this rule specifies output power, which is power supplied to the antenna,³⁸⁶ another rule specifies the maximum radiated power permitted on each channel ranging generally from 23 dBm to 33 dBm, but permitting state and local government entities to radiate at higher levels on the control channel (channel 178) at up to 44.8 dBm and on the public safety priority channel (channel 184) at up to 40 dBm.³⁸⁷ The Commission’s rules also limit roadside unit antenna height as another way of ensuring these units do not transmit beyond their designated zone. Roadside unit antenna height is limited to 8 meters at full power and may be as high as 15 meters with a corresponding power reduction.³⁸⁸ Notably, these rules working together require licensees in many cases to use directional antennas to attain the highest radiated power levels, which also serves to focus the energy to only the desired coverage areas.

154. We seek comment on what the appropriate power levels under the modified ITS band plan should be. As an initial matter, to maximize spectrum use among all users, we propose to retain the “communication zone” designations currently in the rules and require roadside units to specify their intended zone. We believe this will continue to ensure that stations only cover their intended area and provide opportunities for other licensees to install roadside units for other nearby areas without mutually interfering. We seek comment on this proposal and what effect, if any, it will have on C-V2X. 5GAA in a recent filing modified its initial position and now requests that the Commission delete the “communication zone” rules.³⁸⁹ Thus, we ask commenters to address whether the current communication zone distance limits should be retained or are there reasons to modify or eliminate them? Should they provide for more extended coverage areas? Or smaller areas? Or are they effective without change? Commenters advocating changes to the communication zones should provide specific information on what limits they favor and why and what effect those changes will have on the ability for C-V2X to deploy new systems and continue operating into the future.

155. We also seek comment on the appropriate output and radiated power levels that should be associated with each communication zone, channel, and user. The Commission, based on 5GAA’s waiver petition, proposed in the *5.9 GHz NPRM* power limits based on the most recent 3GPP standard (which at the time was Release 14).³⁹⁰ Specifically, the Commission proposed that C-V2X devices limit output power to no more than 20 dBm and limit EIRP to no more than 33 dBm.³⁹¹ We are not aware of any changes to the power requirements in subsequent iterations of the 3GPP standard and thus, propose that C-V2X roadside units comply with that limit. Should the rules continue to permit higher radiated power for state and local governmental entities? Or should the rules be consistent among all users as a way of maximizing spectrum use and controlling potential interference between users? Should we limit radiated

³⁸⁴ 47 CFR § 90.375(a).

³⁸⁵ 47 CFR § 90.375(c).

³⁸⁶ 47 CFR § 90.7.

³⁸⁷ 47 CFR § 90.377(b).

³⁸⁸ 47 CFR § 90.377(b) n.1.

³⁸⁹ 5GAA Mar. 9, 2020 *Ex Parte*.

³⁹⁰ *5.9 GHz NPRM*, 34 FCC Rcd at 12618, para. 38; *see also* 5GAA Petition for Waiver at 16 and 3GPP, Release 14, <http://www.3gpp.org/release-14>.

³⁹¹ *5.9 GHz NPRM*, 34 FCC Rcd at 12618, para. 38.

power to 23 dBm as specified for some channels, 33 dBm as specified for others or some other value, such as permitting higher power on a control channel? Likewise, should we continue to specify both output power and radiated power levels for communication zone / channel combinations? Or would it be more appropriate to specify only a radiated power limit, as requested by 5GAA in a recent *ex parte* filing?³⁹² Based on how parties envision future use of the ITS band, are there advantages to continuing to specify both limits and requiring certain installations to use directional antennas to reach maximum power?

156. An alternative would be to specify power as a power density to normalize power for wider bandwidth channels, if we continue to permit such operations. We seek comment on whether that would serve C-V2X better than the current method, which associates a lower power density with wider bandwidth channels. We also seek comment on whether the current antenna height limitations are justified. Are there reasons to permit higher antenna heights? Should we continue to require that licensees reduce their power for higher antenna heights as a way of controlling coverage area and reducing the potential for interference? Further, we seek comment on whether we should specify measurement standards for equipment approval and compliance purposes. For example, should the Commission specify that these values should be measured as root mean square (i.e., average) or peak values? And should the Commission specify the resolution bandwidth settings for compliance measurements in the rules?³⁹³ Commenters should address these questions in conjunction with their comments regarding retention or modifications of the existing communication zones and provide technical information regarding their preference for rules and how they would work to ensure maximum access to the band.

157. Finally, we seek comment on whether we should modify the power rules for C-V2X on-board units. The current rules specify a 1 mW output power maximum for portable on-board units.³⁹⁴ As with roadside units, the Commission proposed in the *5.9 GHz NPRM* limits compatible with the 3GPP Release 14 standard for C-V2X vehicular and portable (i.e. on-board) units, which would limit output power to no more than 20 dBm and EIRP to no more than 23 dBm.³⁹⁵ We believe these power levels continue to be appropriate for C-V2X vehicular and portable devices and propose those levels here. 5GAA, however, recently requested that the Commission eliminate the output power requirement and increase the OBU EIRP limit to 33 dBm.³⁹⁶ Should we adopt this higher power level instead? What effect would such an increase have on the ability of C-V2X roadside units to co-exist with and protect federal radiolocation stations?³⁹⁷ In commenting on these power levels, commenters should keep in mind the need to simultaneously ensure that such portable on-board units comply with the Commission's RF radiation exposure limits.³⁹⁸

158. We also seek comment on how we should handle the standards issue with respect to C-V2X. The *5.9 GHz NPRM* sought comment on incorporating 3GPP Release 14 by reference³⁹⁹ in the

³⁹² 5GAA Mar. 9, 2020 *Ex Parte*.

³⁹³ The Commission asked similar questions regarding measurement standards in the *5.9 GHz NPRM* but received little comment. *See 5.9 GHz NPRM*, 34 FCC Rcd at 12618-19, paras. 39-41.

³⁹⁴ 47 CFR § 95.3167.

³⁹⁵ *5.9 GHz NPRM*, 34 FCC Rcd at 12618, para. 38.

³⁹⁶ 5GAA Mar. 9, 2020 *Ex Parte*.

³⁹⁷ *See* "Compatibility of Federal Systems Operating in the 5850-5925 MHz Band with Intelligent Transportation Systems and Unlicensed National Information Infrastructure Devices." National Telecommunications and Information Administration, Section ITS Deployment and Technical Parameters at 11-.

³⁹⁸ 47 CFR § 1.1310.

³⁹⁹ *Id.*

Commission's rules. We did not receive significant comment on this issue. Subsequent to the NPRM, in July 2020, 3GPP announced the completion of Release 16,⁴⁰⁰ which further enhanced the 5G network capabilities, including C-V2X that were addressed in Release 15. In light of the evolution of the C-V2X standard to a 5G network technology, we seek comment on whether our rules should incorporate the 3GPP standard by reference. Commenters in favor of incorporation by reference should also provide details regarding which version should be incorporated – Release 14 which is based on LTE technology or Release 16 which incorporates 5G technology. Commenters who advocate for Release 16 should address how vehicular safety applications will be delivered to all users given that 5G is not backwards compatible with LTE. One alternative could be to incorporate Release 14 now with a planned transition to Release 16 (or the current version) at some date certain in the future. We seek comment on such an option. Alternatively, is there a compelling argument for not incorporating any C-V2X standard into the rules? We seek comment on each of these options. Commenters should address how the option they favor would promote safety services among all users. Finally, we seek comment on whether we should only incorporate by reference specific aspects of either the 3GPP Release 14 or Release 16 standard? If so, which sections? Or if the Commission does not incorporate by reference any 3GPP standard, are there portions of the standard that need to be placed in our rules?

159. *C-V2X out-of-band emission limits.* Because the existing rules for DSRC do not specify out-of-band emission limits necessary to protect adjacent band services from harmful interference, the Commission sought comment in the *5.9 GHz NPRM* on appropriate out-of-band emission limits for C-V2X devices.⁴⁰¹ Regardless of whether we incorporate the 3GPP standard or not, we continue to believe it is good practice to adopt specific out-of-band emission limits into our rules. Doing so would provide equipment manufacturers with clear guidelines for equipment approval compliance. Furthermore, it would provide adjacent-channel licensees and equipment manufacturers with clear guidelines regarding the expected spectrum environment so they can incorporate appropriate filters and mitigation measures into their products to protect from harmful interference from adjacent channel emissions. Because our previous proposals were consistent with the current 3GPP standard, we propose the same out-of-band emission limits for C-V2X here as we did in the *5.9 GHz NPRM*. Specifically, we propose that all C-V2X equipment limit out-of-band emission limits measured at the antenna input (i.e., conducted limits) to:

- -29 dBm/100 kHz at the band edge;
- -35 dBm/100 kHz \pm 1 megahertz from the band edge;
- -43 dBm/100 kHz \pm 10 megahertz from the band edge; and
- -53 dBm \pm 20 megahertz from the band edge.

We also propose to limit out-of-band radiated emissions to -25 dBm/100 kHz EIRP or less outside the band edges of 5.895 GHz and 5.925 GHz.⁴⁰²

160. We seek comment on these out-of-band emission limits and whether they continue to be appropriate for C-V2X equipment. In this connection, we note that 5GAA recently requested that we adopt more relaxed OOB requirements.⁴⁰³ It specifically requests that RSUs limit out-of-band emissions to:

- -16 dBm/100 kHz \pm 1 megahertz of the band edge;
- -13 dBm/MHz \pm 5 megahertz of the band edge;

⁴⁰⁰ 3GPP Release 16, 3rd Generation Partnership Project Technical Specification Group Services and System Aspects (2020). <https://www.3gpp.org/release-16>.

⁴⁰¹ *5.9 GHz NPRM*, 34 FCC Rcd at 12618, para. 38.

⁴⁰² These out-of-band emission limits are consistent with those requested by 5GAA. See 5GAA Apr. 3, 2019 *Ex Parte* at Appendix C.

⁴⁰³ 5GAA Mar. 9, 2020 *Ex Parte*.

- -16 dBm/MHz \pm 30 megahertz of the band edge; and
- -28 dBm/MHz beyond 30 megahertz from the band edges.

Should we adopt these alternative OOB limits instead? What would the effect of these relaxed limits be on the ability to design and manufacture C-V2X equipment? How would they affect equipment cost? Will these limits ensure compatibility with adjacent U-NII devices in both the U-NII-4 and U-NII-5 bands, which are below and above the modified ITS band, respectively? What effect would these limits have on adjacent band fixed services in the 6 GHz band? We also seek comment on the measurement standards that should be associated with equipment approval compliance for verifying that C-V2X equipment meets whatever OOB limits we adopt.

3. Other Transition Considerations

161. In *5.9 GHz NPRM*, we requested comment generally on the various transition-related considerations that we should take into account if we adopted our proposal to provide only 30 megahertz for ITS. For example, we asked about any re-channelization of DSRC-based operations in the upper 30 megahertz or the migration of ITS to C-V2X-based technology in the spectrum that remains reserved for ITS.⁴⁰⁴ To inform our consideration of issues relating to transitioning of ITS operations, we asked that commenters provide up-to-date information on actual DSRC operations under existing licenses (including the number of roadside units and on-board units) and the various uses that have been implemented.⁴⁰⁵ The Commission received several comments that involved some estimation of the potential cost considerations associated with these transition issues.⁴⁰⁶

162. We take this opportunity to update the record on our inquiry in the *5.9 GHz band NPRM* regarding transition cost considerations in light of the 5.9 GHz band plan that we have adopted in the First Report and Order. We recognize that, in light of our decision, commenters will be in a much better position to evaluate the necessary transitions of their respective systems. We note that many of the DSRC projects appeared to be associated with demonstration projects designed to address particular traffic and safety concerns,⁴⁰⁷ and we seek any updates about DSRC demonstration projects or deployment, as well as any C-V2X demonstration or pilot projects, including any funding grants that have been provided or are anticipated.⁴⁰⁸ To what extent can existing funding at the Federal or state or local level readily be used with regard to the necessary transition costs, including use of C-V2X-based technology?

163. We note that ITS America suggested that the Commission consider according ITS licensees reasonable compensation related to our decision to require relocation of ITS out of the lower 45 megahertz of spectrum.⁴⁰⁹ While we did not propose in the *5.9 GHz NPRM* to provide compensation for such relocation, we nonetheless seek further comment, including suggestions on which particular types of costs should be considered as appropriate for possible compensation (including how such costs would be documented) as well as the process by which such compensation might be determined or implemented. Finally, we request comment on any other actions the Commission should consider that would be helpful to ITS licensees with respect to these transition matters.

⁴⁰⁴ *5.9 GHz NPRM*, 34 FCC Rcd at 12618, para. 36.

⁴⁰⁵ *5.9 GHz NPRM*, 34 FCC Rcd at 12616-17, para. 32.

⁴⁰⁶ See, e.g., U.S. DOT Reply Comments at 35-39; MnDOT Comments at 5; GDOT Comments at 1-2, 9-13; Texas DOT Comments at 2; Pennsylvania DOT Comments at 4; Connecticut DOT Comments at 3.

⁴⁰⁷ *5.9 GHz NPRM*, 34 FCC Rcd at 12611, para. 18.

⁴⁰⁸ As the U.S. DOT has indicated, ITS operations to date have received substantial research and deployment investments, including Federal, state, and local investment, over the years, and we seek comment on the availability of that or similar funding for transitioning associated with the new band plan for ITS.

⁴⁰⁹ ITS America Reply Comments at 44.

B. More Flexible Use of Unlicensed Service

164. The First Report and Order takes an initial step at providing unlicensed U-NII device access to the 5.850-5.895 GHz band. Our decision to generally restrict U-NII devices to indoor locations⁴¹⁰ until ITS operations transition to the 5.895-5.925 GHz band provides flexibility for unlicensed devices to begin using the 5.850-5.895 GHz band, but in a way that avoids the potential for harmful interference to vehicular safety-related applications. Once ITS operations have finished transitioning to the upper 30 megahertz, however, we can permit outdoor operations at full power, subject to such outdoor use protecting from harmful interference both co-channel federal radiolocation operations (which will remain in the band) and adjacent-band ITS operations.

1. Federal Radiolocation System Protection from Outdoor Unlicensed Operations

165. The First Report and Order finds that some mitigation measures are needed to ensure that outdoor U-NII point-to-point and point-to-multipoint operations do not cause harmful interference to federal radiolocation systems operating at 30 sites within the U.S.⁴¹¹ The First Report and Order also finds that exclusion zones may be the best method for ensuring such protection. We seek comment on this finding. Compliance with an exclusion zone implies some degree of location awareness, either within a device or by an installer. In crafting rules for outdoor use, we seek to protect important DoD radars from harmful interference, provide flexibility to U-NII system operators, minimize equipment complexity and capitalize on the greatest degree of harmonization with U-NII-3 devices as possible. We seek comment on how best to adopt rules that satisfy each of these goals to the greatest extent possible.

166. The Commission has required other unlicensed devices to incorporate geographic awareness (i.e., a geolocation capability) and use a database to avoid areas where the potential for causing harmful interference would exist. For example, white space devices are required to incorporate a geolocation capability and check a white space database for a list of available channels before they can operate⁴¹² and 6 GHz standard power U-NII devices are similarly required to incorporate a geolocation capability and consult an automated frequency coordination database prior to operating to avoid causing harmful interference to fixed service incumbents.⁴¹³ Should the Commission require a similar system here? The advantage of using geolocation and a database is that such systems have already been successfully deployed and we believe protecting only 30 Federal radiolocation sites would be a relatively simple undertaking under this regime. But incorporating geolocation capability does increase the complexity of a device and add overhead (both hardware and software) necessary for such a system to work. In addition, requiring U-NII-4 devices to operate in this manner would entail many differences from U-NII-3 device operation and could limit their usefulness in providing the ability to use a 160-megahertz wide channel that spans the U-NII-3 and U-NII-4 bands. On the other hand, we expect many devices to operate throughout all the U-NII bands including the 6 GHz U-NII-5 and U-NII-7 bands⁴¹⁴ which would already require this capability. In this case, how difficult would it be to similarly add the geolocation and database capability to U-NII-4 devices? Would there be any incremental cost for incorporating such a requirement? How would such a requirement affect the utility of U-NII-4 devices and their ability to work seamlessly with U-NII-3 devices to deliver applications over a 160-megahertz

⁴¹⁰ The First Report and Order allows outdoor U-NII device operation under certain conditions and with Commission authorized special temporary authority.

⁴¹¹ See Appx. A; NTIA Sept. 9, 2020 *Ex Parte*.

⁴¹² 47 CFR § 15.711.

⁴¹³ 47 CFR § 15.407(k).

⁴¹⁴ For example, we expect that new devices would have capability to operate across multiple bands including the 5.150-5.250 U-NII-1 band, the 5.725-5.850 U-NII-3 band, the 5.850-5.895 GHz U-NII-4 band, the 5.925-6.425 U-NII-5 band and the 6.525-6.875 U-NII-7 band.

channel? If we were to adopt such a requirement, we anticipate the rules being consistent with the 6 GHz automatic frequency coordination rules, except that the exclusion zones are already known and do not need to be calculated by the automated frequency coordination system. We seek comment on using the 6 GHz framework for outdoor U-NII-4 devices.

167. Because the U-NII-4 band exclusion zones are known in advance, are there simpler methods for ensuring that outdoor U-NII-4 devices respect the need to avoid operating near the federal radiolocation systems? For example, could we simply rely on professional installation to ensure that outdoor U-NII-4 devices do not operate in those areas? Under a professional installation regime, what rules and requirements would the Commission need to put in place to ensure that U-NII-4 devices do not operate in any of the exclusion zones? Similarly, because these exclusion zones are known, could devices simply have a geolocation capability and either be preloaded with the exclusion zone coordinates and/or download those coordinates once or on a periodic basis, such as every time the device is turned on or at some set interval (e.g., once a week or once a month)? We seek comment on whether this is a viable alternative to the other suggested methods. Commenters in favor of such a mitigation method should provide detailed comment regarding how the internal device database would work, the necessary update frequency, and the costs involved in developing equipment. We also seek comment on other alternatives that achieve the same goal; that is, methods that achieve the required protection and are easy and cost effective to implement and maximize utility of the U-NII-4 band.

2. Outdoor Unlicensed Operations Transmitted Power and Emission Limits

168. *Transmitted Power.* In the 5.9 GHz NPRM, the Commission proposed that U-NII-4 devices be permitted to operate at the same power levels (e.g., radiated power, power spectral density) as U-NII-3 devices and sought comment on whether it should adopt different power levels.⁴¹⁵

169. The Wi-Fi Alliance agrees that the Commission should adopt its proposal to apply the same power levels (radiated power, PSD) to U-NII-4 devices as apply to U-NII-3 devices because their efficacy has been proven by years of application in practice. Wi-Fi Alliance contends that to recognize the full benefit of the U-NII-4 spectrum, including expanded operations of existing U-NII devices, the technical rules governing the band must be aligned with the rules covering the U-NII-3 band; permitting U-NII-4 devices to operate at the same power levels as U-NII-3 devices will maximize the utility of both bands. It states that if a different power level is adopted for the U-NII-4 band, U-NII devices would not be able to operate across both the U-NII-3 and U-NII-4 bands, eliminating the potential use of wider channels, equipment commonality, reduced cost and complexity, superior performance, and other benefits that may be realized by the Commission's proposal.⁴¹⁶ WISPA states the Commission's proposal to allow U-NII-4 devices to operate at the same power level as U-NII-3 devices is a sensible and efficient approach and consistent with WISPA's recommendations in ET Docket No. 13-49 in that it would permit higher-EIRP fixed wireless operations that will enable use of the 5.9 GHz band for rural broadband deployment, including both outdoor point-to-point operations and point-to-multipoint operations.⁴¹⁷ Comcast asserts that harmonizing the U-NII-4 technical rules with those of the U-NII-3 band, particularly the Commission's proposal to allow U-NII-4 devices to operate at the same power levels as U-NII-3

⁴¹⁵ See 5.9 GHz NPRM, 34 FCC Rcd at 12622-23, para. 53. The maximum conducted output power over the frequency band of operation shall not exceed 1 W. In addition, the maximum power spectral density shall not exceed 30 dBm in any 500-kHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. However, fixed point-to-point U-NII devices operating in this band may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter conducted power. 47 CFR § 15.407(a)(3).

⁴¹⁶ Wi-Fi Alliance Comments at 2-3, 5-6.

⁴¹⁷ WISPA Comments at 6. See also Letter from Claude Aiken, President and CEO, WISPA, to Marlen H. Dortch, Secretary, FCC, ET Docket No. 13-49, at 1 (dated Oct. 26, 2018).

devices, would substantially improve its ability to bring the band into use for consumers quickly and to put it to its best use.⁴¹⁸ NCTA states that applying the U-NII-3 power limits to U-NII-4 will enable network operators and device manufacturers to build on the success of U-NII-3.⁴¹⁹ Microsoft states that extending the U-NII-3 technical rules to the U-NII-4 band, except for the existing OOB limits, will enable the public to realize the maximum benefits from the U-NII-4 band, including accelerating the timeline for initial deployments using this 45 megahertz of spectrum; establishing the same power levels in the U-NII-4 band as the U-NII-3 band is essential for deployment of larger channels.⁴²⁰

170. On the other hand, 5GAA and Qualcomm separately recommend that the Commission impose a power spectral density limit to protect C-V2X receivers from portable client devices that may be operating temporarily outdoors with relaxed OOB limits but connected to an indoor access point in the U-NII-4 band, but did not recommend any specific limit.⁴²¹ Car 2 Car Communication Consortium and US Technical Advisory Group separately urge the Commission to revisit its proposals for maximum transmit power from U-NII-4 devices to avoid harmful interference to ITS operations, but did not recommend any specific level for the maximum transmit power.⁴²² The Alliance for Automotive Innovation expresses concern that the National Highway Transportation Safety Administration's (NHTSA's) testing, which showed varying levels of harmful interference, underestimates the potential for harmful interference from unlicensed operations, since the NHTSA's tests were conducted with a 36 dBm EIRP, but fixed point-to-point U-NII devices could operate at power levels of 62 dBm EIRP using 5G antennas that have 32 dBi of gain.⁴²³ Qualcomm also expresses concern that outdoor point-to-point unlicensed operations high EIRP signals in the U-NII-4 band could have serious performance impacts to installed RSUs and create C-V2X dead zones when vehicles pass nearby, regardless of the OOB level.⁴²⁴ Intelligent Transportation Society of America (ITSA) also expresses concern that outdoor unlicensed point-to-point U-NII-4 band operations from a tower or rooftop alongside a roadway could cause harmful interference to ITS receivers.⁴²⁵

171. For outdoor operation of U-NII-4 access point device after ITS operations move out of the U-NII-4 band, we propose a radiated power of 23 dBm/MHz or 36 dBm radiated power for all bandwidths. When combined with U-NII-3-band spectrum, outdoor access point EIRP can scale to 36 dBm for 40, 80, and 160 megahertz channels. We agree with the Wi-Fi Alliance that permitting U-NII-4 devices to operate at the same power levels as U-NII-3 devices is essential to achieving the full benefits of the U-NII-4 band and maximizing the utility of both bands while protecting incumbent operations in the U-NII-4 band from harmful interference. Allowing outdoor U-NII-4 devices to operate at the full power level permitted for U-NII-3 devices will enable the use of wider channels, promote equipment commonality, reduce costs and complexity, and facilitate broadband deployments in rural areas, including both outdoor point-to-point operations and point-to-multipoint operations. However, to avoid the need for much larger unlicensed exclusion zones where unlicensed operations would be prohibited in order to protect federal radar operations from harmful interference, we propose not to adopt the U-NII-3 point-to-point power limits in the U-NII-4 rules. We also propose that client devices be permitted to operate in the 5.850-5.895 GHz band at power levels that are 6 dB lower than those permitted for outdoor access point devices. We seek comment on these proposals.

⁴¹⁸ Comcast Comments at 10.

⁴¹⁹ NCTA Comments at 45-46.

⁴²⁰ Microsoft Comments at 4, 7.

⁴²¹ 5GAA Comments at 44, n.129; Qualcomm Comments at 23.

⁴²² Car 2 Car Comments at 18; US Technical Advisory Group Comments at 11.

⁴²³ Alliance for Automotive Innovation Comments at 26, n.27.

⁴²⁴ Qualcomm Comments at 19-20.

⁴²⁵ ITSA America Reply Comments at 23, n.59.

172. *OBE Limits.* In the *5.9 GHz NPRM*, the Commission proposed that U-NII-4 devices, or devices that operate across a single channel that spans the U-NII-3 and U-NII-4 bands, meet the same OBE limits as U-NII-3 devices at the upper and lower edges of those bands with no limit at the U-NII-3/U-NII-4 band edge.⁴²⁶ Proponents of ITS suggest that U-NII-4 devices, or devices that operate across a single channel that spans the U-NII-3 and U-NII-4 bands, meet OBE limits that are much more restrictive than the existing U-NII-3 OBE limits to protect adjacent-band ITS operations. Under GM's suggestion (-27 dBm/MHz at or above 5.905 GHz), U-NII-4 devices' OBE would need to be 15 dB lower than the OBE limit (-12 dBm/MHz) for a U-NII-3 device at the same frequency; under the suggestion from Car 2 Car, IEEE 1609 Working Group, US Technical Advisory Group, and Volkswagen (-40 dBm/MHz at 10 megahertz above the band edge), U-NII-4 devices' OBE would need to be approximately 28 dB lower than the OBE limit (-12 dBm/MHz) for a U-NII-3 device at the same frequency.⁴²⁷

173. Proponents of unlicensed operations suggest more relaxed OBE limits for outdoor unlicensed operations in the U-NII-4 band than proposed in the *5.9 GHz NPRM*.⁴²⁸ WISPA submits that outdoor U-NII-4 operations' OBE be limited to -5 dBm/MHz at or above 5.895 GHz.⁴²⁹ Broadcom, CableLabs, Facebook, and NCTA together suggest that OBE for outdoor U-NII-4 operations be limited to 7 dBm/MHz at 5.895 GHz, decreasing linearly to -9 dBm/MHz at 5.925 GHz, measured using the root mean square (RMS) method (agreed to by 5GAA for the top of the 5.9 GHz band), to address concerns raised by ITS stakeholders.⁴³⁰ They claim that -9 dBm at 5.925 GHz will provide more than adequate protection for adjacent ITS operations and is consistent with the roll-off of the IEEE 802.11ac and 802.11ax emission masks. They also assert that this limit would allow 5.9 GHz-capable Wi-Fi devices to deliver sufficient power and throughput to consumers to enable the wide range of use cases—including enhanced in-home Wi-Fi speeds and coverage to support remote learning, telemedicine, and other high-bandwidth applications, as well as more accessible large-scale connectivity to support smart city and agricultural applications in communities across the country—that make the 5.9 GHz band a unique opportunity; too restrictive an OBE limit would make these kinds of use cases impossible.⁴³¹

174. The Wi-Fi Alliance recommends a more nuanced approach based on a the -27 dBm/MHz limit at or above 5.925 GHz that the Commission has effectively applied to U-NII-3 transmissions to protect ITS operations. Specifically, for outdoor U-NII-4 band devices, Wi-Fi Alliance proposes OBE limits that mirror the existing limits for U-NII-3 devices at and above 5.895 GHz (i.e., -5 dBm/MHz at 5.895 GHz, decreasing linearly to -27 dBm/MHz at 5.925 GHz).⁴³² The Wi-Fi Alliance asserts that these U-NII-3 OBE limits have proven to be effective in protecting ITS; there is no basis for imposing more stringent OBE limits on operations in the U-NII-4 band since the Commission has already affirmed that the U-NII-3 OBE limits afford sufficient protection to DSRC systems and C-V2X operations do not require greater protection than DSRC operations. The Wi-Fi Alliance argues that the Commission should

⁴²⁶ See *5.9 GHz NPRM*, 34 FCC Rcd at 12623, paras. 54-55.

⁴²⁷ GM Comments at 11; Toyota Comments at 18; Car 2 Car Comments at 18; IEEE 1609 Working Group Comments at 15, US Technical Advisory Group Comments at 11; Volkswagen Comments at 9; and Ford Comments at 10.

⁴²⁸ See, e.g., Broadcom, Inc. and Facebook, Inc. Comments at 5-6; Dynamic Spectrum Alliance Comments at 4; Wi-Fi Alliance Comments at 6-7.

⁴²⁹ WISPA Comments at 6.

⁴³⁰ Letter from Chris Szymanski, Broadcom; Rob Alderfer, CableLabs; Alan Norman, Facebook; and Danielle Piñeres, NCTA, to Marlene H. Dortch, Secretary, FCC, ET Docket No. 19-138 (filed July 31, 2020) (Compromise Proposal Letter) at 4.

⁴³¹ *Id.* at 1, 5.

⁴³² Wi-Fi Alliance Comments at 7-8; Reply Comments at 7.

reject arguments for more restrictive OOB limits because imposing prohibitively burdensome and unnecessary band coexistence measures on U-NII-4 devices would preclude commercial viability of this band and defeat the objective of making additional spectrum available for unlicensed operations.⁴³³ The Wi-Fi Alliance also supports applying the existing U-NII-3 OOB limits at the lower edge of the U-NII-3 band for outdoor U-NII-4 devices, or devices that operate across a single channel that spans the U-NII-3 and U-NII-4 bands, i.e., at 5.725 GHz, while not imposing any OOB limit for U-NII-4 devices at the U-NII-3/U-NII-4 band edge (i.e., at 5.850 GHz).⁴³⁴

175. For outdoor U-NII-4 access point devices or outdoor access point devices that operate across a single channel that spans the U-NII-3 and U-NII-4 bands, we propose the outdoor U-NII-4 OOB limits recommended by the Wi-Fi Alliance of -5 dBm/MHz at 5.895 GHz, decreasing linearly to -27 dBm/MHz at 5.925 GHz, measured using an RMS measurement. We are not convinced that the more relaxed OOB limits suggested by unlicensed proponents would adequately protect ITS operations from harmful interference since they are less restrictive than existing U-NII-3 OOB limits. We are also not convinced that the more stringent OOB limits suggested by ITS proponents are necessary to protect adjacent-band ITS operations since they are more restrictive than the existing U-NII-3 OOB limits, which the Commission previously affirmed would protect DSRC operations and have already proven to be effective in protecting ITS operations from harmful interference.⁴³⁵ We also propose to apply the existing U-NII-3 OOB limits at the lower edge of the U-NII-3 band for outdoor U-NII-4 devices, or devices that operate across a single channel that spans the U-NII-3 and U-NII-4 bands, i.e., at 5.725 GHz, while not imposing any OOB limits for U-NII-4 devices at the U-NII-3/U-NII-4 band edge, i.e., at 5.850 GHz. We believe that these limits will protect adjacent-band ITS operations from harmful interference due to unlicensed operations in the U-NII-4 band, support separate U-NII-3 and U-NII-4 bands to provide flexibility for designing U-NII-3 equipment under the less stringent OOB rules at the upper edge of the band, and provide flexibility for devices to operate across the U-NII-3 and U-NII-4 bands using the widest channel bandwidths permitted under the IEEE 802.11 standard. We seek comment on these proposals.

176. *Protection of Fixed-Satellite Service Operations.* In the 5.9 GHz NPRM, we proposed not to adopt any restrictions on U-NII-4 devices to account for the existing FSS uplink operations because the expected unlicensed device use cases, which primarily involve delivery of Wi-Fi signals, along with the distance to FSS satellites in geo-stationary orbit, should protect FSS uplink operations from harmful interference. Nevertheless, the Commission sought comment on whether any targeted rules were needed to ensure that incumbent FSS uplink operations are protected and, if so, what types of sharing technology or techniques would be appropriate and what are the implications for manufacturers, vendors, and consumers.⁴³⁶

177. SES Americom, Inc. (SES Americom) and Intelsat License LLC (Intelsat), who provide fixed satellite services relying on the 5.9 GHz band for uplinks, express concerns about the potential for harmful interference to FSS space stations from aggregate unlicensed operations and request that the Commission adopt a maximum permissible aggregate power limit that would be monitored and controlled

⁴³³ Wi-Fi Alliance Reply Comments at 6-7. See also *Revision of Part 15 of the Commission's Rules to Permit Unlicensed National Information Infrastructure (U-NII) Devices in the 5 GHz Band*, ET Docket No. 13-49, First Report and Order, 29 FCC Rcd 4127 (2014) (*U-NII 5 GHz Report and Order*) (adding 5.825-5.850 GHz to the 5.725-5.850 GHz (U-NII-3) band and deferring a decision on whether to allow unlicensed devices to use the 5.350-5.470 GHz (U-NII-2B) and 5.850-5.925 GHz (U-NII-4) bands), *recon. denied*, Memorandum Opinion and Order, 31 FCC Rcd 2317, 2324-25, para. 23 (2016).

⁴³⁴ Wi-Fi Alliance Comments at 2-3.

⁴³⁵ *Revision of Part 15 of the Commission's Rules to Permit Unlicensed National Information Infrastructure (U-NII) Devices in the 5 GHz Band*, Memorandum Opinion and Order, 31 FCC Rcd 2317, 2324, para. 23 (2016).

⁴³⁶ See 5.9 GHz NPRM, 34 FCC Rcd at 12624, para. 58.

by an Automatic Frequency Coordination (AFC) system.⁴³⁷ SES Americom and Intelsat suggest that, at a minimum, the Commission should limit the EIRP of transmissions from 5.9 GHz terrestrial devices above a 30-degree elevation angle to protect FSS networks.⁴³⁸ NCTA contends that special frequency avoidance techniques or similar constraints are unnecessary to protect incumbents, and states that the Commission should not impose constrictive operational rules for U-NII-4 operations, which would dramatically decrease the band's utility with no offsetting public benefit.⁴³⁹ The Wi-Fi Alliance agrees with the Commission's tentative conclusion that U-NII-4 devices will not interfere with FSS uplink operations; it contends that years of operational experience amply demonstrate that low-power Wi-Fi transmissions pose no harmful interference potential to FSS satellite uplinks in geostationary orbit.⁴⁴⁰ WISPA agrees with the Commission's judgment that no other mitigation measures for unlicensed devices are required to protect other users in the band. WISPA asserts that the compatible transmission characteristics of the adjacent and co-frequency services should allow both unlicensed devices and FSS uplink operations to operate successfully without any harmful interference to either.⁴⁴¹

178. Considering that the FSS satellites receiving in the 5.850-5.925 GHz band are limited to geostationary orbits, approximately 35,800 kilometers above the equator, we believe it is unlikely that relatively low-power unlicensed devices would cause harmful interference to the space station receivers. SES Americom's and Intelsat's filing indicates a general concern about potential harmful interference, including aggregate interference, from low-power devices due to the potential that the large geographic coverage of a satellite receiver's beam could see large numbers of unlicensed devices.⁴⁴² However, they do not include any specific technical analysis for their particular position. Thus, we decline to propose SES Americom's and Intelsat's suggestion for an aggregate power limit from unlicensed devices to be enforced through use of an AFC system.

179. We will, however, propose to require outdoor standard-power access points to limit the maximum EIRP above a 30 degree elevation angle to 21 dBm, which is similar to what the Commission already requires in the U-NII-1, U-NII-5, and U-NII-7 bands to protect fixed satellite services.⁴⁴³ This skyward restriction should address SES Americom's and Intelsat's concerns. We adopt this restriction rather than an aggregate power limit for two reasons. First, outdoor access points are not expected to radiate significant power skyward, so we do not believe this requirement will impose a burden on or affect the utility of standard-power access point users. Second, designing an AFC system to undertake aggregate power limit monitoring would be very complex, requiring the AFC system to know how much energy is being emitted to each portion of the geostationary arc for each unlicensed device. That in turn would require the AFC system to have knowledge of each outdoor access point's antenna pattern, orientation, actual transmit power levels, and percent of time it transmits as well as similar information for unlicensed client devices operating outdoors. Given the skyward EIRP restrictions we are placing on outdoor unlicensed devices and the low likelihood of aggregate interference, we conclude that an AFC system with this level of complexity is not required to ensure that FSS space station receivers are protected from harmful interference.

180. We do not find it necessary to restrict the power radiated upward from client devices as we are requiring for standard-power access points. We believe it is unlikely that relatively low-power

⁴³⁷ SES Americom and Intelsat Comments at 4, 8-9.

⁴³⁸ SES Americom and Intelsat Reply Comments at 5.

⁴³⁹ NCTA Comments at 46.

⁴⁴⁰ Wi-Fi Alliance Comments at 5.

⁴⁴¹ WISPA Comments at 7.

⁴⁴² SES Americom and Intelsat Comments at 4.

⁴⁴³ 47 CFR §§ 15.401(a)(1), 15.407(a)(4). See also *Unlicensed Use of the 6 GHz Band*, ET Docket No. 18-295, Report and Order and Further Notice of Proposed Rulemaking, 35 FCC Rcd 3852, 3886-87, para. 92 (2020).

unlicensed devices will cause harmful interference to receivers on geostationary satellites approximately 35,800 km above the equator. We are limiting upward power from standard-power access points merely as a precautionary measure, as they are more likely to operate outdoors and with higher power. While client devices can operate with an EIRP as high as 30 dBm (6 dB lower than access points' maximum allowed power), we find that they are less likely to cause interference to satellite receivers than similarly powered outdoor access points due to the nature of their operation. We expect them to generally operate at much lower power levels to maximize battery life and comply with radiofrequency (RF) exposure limits.⁴⁴⁴ In addition, client devices communicate with access points in an asymmetric nature, in that relatively little data is transmitted in the uplink direction (i.e. from the client device) as compared to the downlink direction where any single access point may be serving many client devices. Moreover, client devices typically operate with omnidirectional antennas at low antenna heights and in a mobile or portable mode (i.e., not installed in permanent outdoor locations). Thus, we expect that upwardly directed client device emissions will often be at low power levels and shielded to some extent by buildings, foliage, or other obstructions.

3. Increased Transmit Power for Indoor U-NII-4 Access Points

181. In the First Report and Order, we adopt a 20 dBm/MHz limit for indoor U-NII-4 access points, largely to protect co-channel ITS incumbent operations. We propose that indoor U-NII-4 devices be permitted to increase power to 23 dBm/MHz or 36 dBm radiated power for all bandwidths upon the later of one year following the effective date of the First Report and Order (i.e., the date by when ITS operations must transition out of the 5.850-5.895 GHz band) or the effective date of a Second Report and Order adopting these proposed power increases. We seek comment on this proposal. We note that these proposed limits are consistent with NTIA's radiolocation protection analysis. In making this proposal, we do not propose to change any other aspect of indoor U-NII-4 devices; they would still be required to incorporate all the mitigation features we adopted in the First Report and Order, including the requirement to obtain power from a wired connection, a prohibition on weatherized enclosures and a requirement for an integrated antenna. Client devices would be limited to power levels 6 dB below the power limits for access points.

4. U-NII-4 Client to Client Communications

182. The rules adopted in the First Report and Order prohibit U-NII-4 client-to-client communications to protect co-channel incumbent ITS operations and federal radiolocation stations. But only the federal radiolocation stations will require protection after ITS operations transition out of the 5.850-5.895 GHz band. We seek comment on whether we can remove the client-to-client communications prohibition upon the later of one year following the effective date of the First Report and Order (i.e., the date by when ITS operations must transition out of the 5.850-5.895 GHz band) or the effective date of a Second Report and Order eliminating the prohibition. As an initial matter, we note that NTIA's analysis for protecting these 30 radiolocation sites concludes that C-V2X on-board units can operate throughout the U.S. with no limitation. That analysis assumed that such on-board units operate with power levels up to 17 dBm/20 MHz or 50 mW.⁴⁴⁵ The equivalent power for wider channels is 20 dBm / 40 MHz (100 mW), 23 dBm/ 80 MHz (200 mW) and 26 dBm/160 MHz (400 mW). Our proposal for C-V2X on-board units would limit power to no more than 23 dBm EIRP. We therefore seek comment on whether we can allow U-NII-4 client-to-client device communications at that same 23 dBm EIRP power level. Such communications could enable innovative new virtual reality or augmented reality

⁴⁴⁴ Although one filer submitted letters on RF radiation concerns, that issue is outside the scope of this proceeding. See, e.g., Letter from Kevin Mottus, Outreach Director, California Brain Tumor Association (Aug. 20, 2020).

⁴⁴⁵ See "Compatibility of Federal Systems Operating in the 5850-5925 MHz Band with Intelligent Systems and Unlicensed National Information Infrastructure Devices." National Telecommunications and Information Administration, ITS Deployment and Technical Parameters at 11.

applications in much the way similar applications have been envisioned under the Commission's proposals for ubiquitous operation of very low power devices in the 6 GHz U-NII bands.

183. Although U-NII-4 devices would not necessarily be in moving vehicles like C-V2X on-board units, would their operations still be functionally similar to such operations so as to allow the same power levels and still protect federal radiolocation operations? If concerns regarding potential harmful interference to federal operations persists, are there measures we could take to enable U-NII-4 client-to-client communications in areas outside the exclusion zones or with lower power within the exclusion zones? For example, because client devices are often smart phones with embedded geolocation technology, could an app or database connection or other mitigation method be used to control power or avoid certain areas where the potential for causing harmful interference is the greatest? We also note that 5GAA requests that we permit on-board units to transmit with as much as 33 dBm EIRP.⁴⁴⁶ How would on-board units at higher power levels affect the ability to permit client-to-client communications? We seek comment on whether we can permit client-to-client communication and under what conditions. Commenters should provide technical and operations details as to how devices operating in a client to client mode would avoid causing harmful interference.

C. Other Spectrum for ITS

184. As discussed in the First Report and Order, the record supports 30 megahertz of spectrum as sufficient to provide basic safety functions of ITS currently deployed and under consideration in the near future. Commenters have suggested, however, that additional spectrum may be needed either to support simultaneous deployment of 4G and 5G-NR C-V2X service or to support other advanced capabilities beyond the basic safety messages currently available.⁴⁴⁷

185. We seek comment on whether, notwithstanding our determination that current safety-of-life services can continue to operate using 30 megahertz of spectrum, we should consider allocating additional spectrum for ITS applications. For what purposes would additional spectrum be needed? We note that the record evidence indicates that several categories of transportation-related communications and other ITS applications are currently being met through spectrum outside of the 5.9 GHz band. For example, capabilities like blind spot detection, lane-keep assist, and features that do not operate in the 5.9 GHz band, which provide substantial automotive and vehicular safety functions.⁴⁴⁸ Panasonic in its comments states that while technologies like LIDAR, 76-81 GHz band radar, or other line-of-sight sensors can support advance driver assistance systems (e.g. automatic emergency braking or lane-keeping).⁴⁴⁹ To the extent some ITS applications (or their functional equivalent) are currently being provided using alternative spectrum bands, commenters should explain with specificity why existing spectrum resources are inadequate and what specific safety benefits would result from making additional spectrum available for such services.

186. Panasonic suggests that harnessing the advantages of fully automated transportation requires cooperation between different vehicles with different levels of automation and the transportation infrastructure.⁴⁵⁰ Similarly, the U.S. DOT stated that in-vehicle sensors are susceptible to "blind spots" when they are operating outside of line-of-sight scenarios.⁴⁵¹ DOT claims that the combination of sensors and V2X, with access to dedicated spectrum, will best provide enhancements to driver safety and will

⁴⁴⁶ 5GAA Ex Parte, Mar. 9, 2020.

⁴⁴⁷ See, e.g., Letter from Sean T. Conway, Counsel to the 5G Automotive Association, to Marlene H. Dortch, Secretary, FCC, ET Docket No. 19-138 (filed Sept. 9, 2020).

⁴⁴⁸ NCTA Reply Comments at 2-4

⁴⁴⁹ Panasonic Comments at 14.

⁴⁵⁰ Panasonic Comments at 14.

⁴⁵¹ U.S. DOT Reply Comments at 16.

support automated driving behavior in the future.⁴⁵²

187. We have already recognized that C-V2X is the preferred choice for deployment in the upper 30 megahertz portion of the band.⁴⁵³ How, in particular, would additional spectrum be used to leverage this technology and aid in its deployment? Should we determine that additional spectrum is needed to provide advanced ITS applications, what spectrum band(s) should we consider? OTI and PK have mentioned the 3450-3550 MHz band.⁴⁵⁴ Other commenters, like Dynamic Spectrum Alliance and NCTA, proposed allowing C-V2X to operate in the 4.9 GHz band.⁴⁵⁵ Other commenters provided similar views.⁴⁵⁶ In the intervening period since adoption of the 5.9 GHz NPRM, however, the Commission has adopted rule changes for the 4.9 GHz band to allow for non-public safety operation and leasing arrangements and has proposed allocating the 3.45-3.55 GHz band for flexible-use service.⁴⁵⁷ We also note that that commenters have mentioned a “clean sheet” approach when considering the best spectrum band in which to locate the proposed C-V2X operations.⁴⁵⁸ Others mention allowing ITS to use flexible use licensed or unlicensed spectrum in the way other technologies do.⁴⁵⁹ Commenters addressing this issue should provide specific information regarding spectrum bands that could support ITS operations, the types of applications or services they envision for that particular band and how C-V2X could coexist with existing spectrum users in that band(s). We also note that the commenters should consider the propagation characteristics of the spectrum they identify relative to the technology needs of ITS services (e.g. low latency, reliability, non-line of sight communications, processing capabilities, international trends, and relevant standards-setting factors). Are there other rule changes we could make to enable vehicular safety-related applications in other bands on a shared basis?

V. PROCEDURAL MATTERS

188. *Final Regulatory Flexibility Analysis.*—As required by the Regulatory Flexibility Act of 1980 (RFA),⁴⁶⁰ as amended, the Commission has prepared a Final Regulatory Flexibility Analysis (FRFA) regarding the possible significant economic impact on small entities of the policies and rules adopted in this First Report and Order, which is found in Appendix D. The Commission’s Consumer and Governmental Affairs Bureau, Reference Information Center, will send a copy of the First Report and

⁴⁵² *Id* at 9.

⁴⁵³ Don Butler, Ford Executive Director for Connected Vehicle and Services, Why We’re Working with Qualcomm to Ensure Everything in Cities Speaks the Same Language, Medium (Jan. 9, 2018), <https://medium.com/cityoftomorrow/why-were-working-with-qualcomm-to-ensure-everything-in-cities-speaks-the-same-language-98e0cc1bff18> (accessed Sept. 28 2020); 5GAA Comments at 9-10.

⁴⁵⁴ Michael Calabrese and Amir Nasr, New America Open Technology Institute, “The 5.9 GHz Band: Removing the Roadblock to Gigabit Wi-Fi” at 36 (2020).

⁴⁵⁵ Dynamic Spectrum Alliance Comments at 6; NCTA Comments at 2-3, 19.

⁴⁵⁶ ITS America Comments at 11-12; NCTA Comments at 2-3, and 19; Open Technology Institute at New America and Public Knowledge Comments at 4-5; New America’s Open Technology and Public Knowledge Comments at 26-28; Michael Calabrese and Amir Nasr, New America Open Technology Institute, “The 5.9 GHz Band: Removing the Roadblock to Gigabit Wi-Fi” at 28-35 (2020); Dynamic Spectrum Alliance Comments at 6.

⁴⁵⁷ *Amendment of Part 90 of the Commission’s Rules*, WP Docket No. 07-100, Sixth Report and Order and Seventh Notice of Proposed Rulemaking, FCC 20-137 (rel. Oct. 2, 2020); *Facilitating Shared Use in the 3100-3550 MHz Band*, WT Docket No. 19-348, Report and Order and Further Notice of Proposed Rulemaking, FCC 20-138 (rel. Oct. 2, 2020).

⁴⁵⁸ DSA Comments at 6.

⁴⁵⁹ NCTA at 3.

⁴⁶⁰ *See* 5 U.S.C. § 603.

Order, including the FRFA, to the Chief Counsel for Advocacy of the Small Business Administration.⁴⁶¹

189. *Initial Regulatory Flexibility Analysis.*—As required by the RFA, the Commission has prepared an Initial Regulatory Flexibility Analysis (IRFA) of the possible significant economic impact on a substantial number of small entities of the proposals addressed in this Further Notice of Proposed Rulemaking. The IRFA is found in Appendix E. Written public comments are requested on the IRFA. These comments must be filed in accordance with the same filing deadlines for comments on the Further Notice, and they should have a separate and distinct heading designating them as responses to the IRFA. The Commission’s Consumer and Governmental Affairs Bureau, Reference Information Center, will send a copy of this Further Notice, including the IRFA, to the Chief Counsel for Advocacy of the Small Business Administration, in accordance with the RFA.⁴⁶²

190. *Paperwork Reduction Act.*—This First Report and Order, Further Notice of Proposed Rulemaking, and Order of Proposed Modification contains new or modified information collection requirements subject to the Paperwork Reduction Act of 1995 (PRA), Public Law No. 104-13. It will be submitted to the Office of Management and Budget (OMB) for review under section 3507(d) of the PRA. OMB, the general public, and other Federal agencies will be invited to comment on the new or modified information collection requirements contained in the proceeding. In addition, we note that pursuant to the Small Business Paperwork Relief Act of 2002, Public Law 107-198, see 44 U.S.C. 3506(c)(4), we previously sought comment on how we might “further reduce the information collection burden for small business concerns with fewer than 25 employees.” We have described impacts that might affect small businesses, which includes most businesses with fewer than 25 employees, in the Final Regulatory Flexibility Analysis (FRFA), attached as Appendix D.

191. *Congressional Review Act.* — The Commission will submit this draft First Report and Order to the Administrator of the Office of Information and Regulatory Affairs, Office of Management and Budget, for concurrence as to whether this rule is “major” or “non-major” under the Congressional Review Act, 5 U.S.C. § 804(2). The Commission will send a copy of this First Report and Order, Further Notice of Proposed Rulemaking, and Order of Proposed Modification to Congress and the Government Accountability Office pursuant to the Congressional Review Act, see 5 U.S.C. § 801(a)(1)(A).

192. *Ex Parte Rules – Permit but Disclose.* Pursuant to Section 1.1200(a) of the Commission’s rules,⁴⁶³ this Further Notice of Proposed Rulemaking shall be treated as a “permit-but-disclose” proceeding in accordance with the Commission’s *ex parte* rules.⁴⁶⁴ Persons making *ex parte* presentations must file a copy of any written presentation or a memorandum summarizing any oral presentation within two business days after the presentation (unless a different deadline applicable to the Sunshine period applies). Persons making oral *ex parte* presentations are reminded that memoranda summarizing the presentation must (1) list all persons attending or otherwise participating in the meeting at which the *ex parte* presentation was made, and (2) summarize all data presented and arguments made during the presentation. If the presentation consisted in whole or in part of the presentation of data or arguments already reflected in the presenter’s written comments, memoranda or other filings in the proceeding, the presenter may provide citations to such data or arguments in his or her prior comments, memoranda, or other filings (specifying the relevant page and/or paragraph numbers where such data or arguments can be found) in lieu of summarizing them in the memorandum. Documents shown or given to Commission staff during *ex parte* meetings are deemed to be written *ex parte* presentations and must be filed consistent with rule 1.1206(b). In proceedings governed by rule 1.49(f) or for which the

⁴⁶¹ See 5 U.S.C. § 603(a). In addition, the *Notice* and RFA (or summaries thereof) will be published in the Federal Register.

⁴⁶² See 5 U.S.C. § 603(a).

⁴⁶³ 47 CFR § 1.1200(a).

⁴⁶⁴ 47 CFR §§ 1.1200 *et seq.*

Commission has made available a method of electronic filing, written *ex parte* presentations and memoranda summarizing oral *ex parte* presentations, and all attachments thereto, must be filed through the electronic comment filing system available for that proceeding, and must be filed in their native format (e.g., .doc, .xml, .ppt, searchable .pdf). Participants in this proceeding should familiarize themselves with the Commission's *ex parte* rules.

193. *Comment Period and Filing Procedures.* Pursuant to Sections 1.415 and 1.419 of the Commission's rules, 47 CFR §§ 1.415, 1.419, interested parties may file comments and reply comments on or before the dates indicated on the first page of this document. All filings must refer to ET Docket No. 19-138.

- Electronic filers: Comments may be filed electronically using the Internet by accessing the Commission's Electronic Comment Filing System (ECFS): <https://www.fcc.gov/ecfs>. See *Electronic Filing of Documents in Rulemaking Proceedings*, 63 FR 24121 (1998).
- Paper Filers: Parties who choose to file by paper must file an original and one copy of each filing.
 - Filings can be sent by commercial overnight courier, or by first-class or overnight U.S. Postal Service mail. All filings must be addressed to the Commission's Secretary, Office of the Secretary, Federal Communications Commission.
 - Commercial overnight mail (other than U.S. Postal Service Express Mail and Priority Mail) must be sent to 9050 Junction Drive, Annapolis Junction, MD 20701.
 - U.S. Postal Service first-class, Express, and Priority mail must be addressed to 45 L Street NE, Washington, DC 20554.
- Effective March 19, 2020, and until further notice, the Commission no longer accepts any hand or messenger delivered filings. This is a temporary measure taken to help protect the health and safety of individuals, and to mitigate the transmission of COVID-19. See FCC Announces Closure of FCC Headquarters Open Window and Change in Hand-Delivery Policy, Public Notice, DA 20-304 (March 19, 2020). <https://www.fcc.gov/document/fcc-closes-headquarters-open-window-and-changes-hand-delivery-policy>.

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

195. *Availability of Documents:* Comments, reply comments, and *ex parte* submissions will be publicly available online via ECFS.⁴⁶⁵ When the FCC Headquarters reopens to the public, these documents will also be available for public inspection during regular business hours in the FCC Reference Center, Federal Communications Commission, 45 L Street NE, Washington, DC 20554.

196. *Further Information.*—For further information, contact Jamie Coleman of the Office of Engineering and Technology, at 202-418-2705 jamie.coleman@fcc.gov.

VI. ORDERING CLAUSES

197. Accordingly, **IT IS ORDERED** that, pursuant to the authority found in Sections 1, 4(i),

⁴⁶⁵ Documents will generally be available electronically in ASCII, Microsoft Word, and/or Adobe Acrobat.

301, 302, 303, 309, 316, and 332 of the Communications Act of 1934, as amended, 47 U.S.C. §§ 151, 154(i), 301, 302, 303, 309, 316, and 332, and Section 1.411 of the Commission's Rules, 47 CFR § 1.411, that this First Report and Order, Further Notice of Proposed Rulemaking, and Order of Proposed Modification IS HEREBY ADOPTED.

198. IS FURTHER ORDERED that the amendments of the Commission's rules as set forth in Appendix A ARE ADOPTED, effective sixty days from the date of publication in the Federal Register, with the exception of section 90.372, which contains new or modified information collection requirements that require review by the Office of Management and Budget (OMB) under the Paperwork Reduction Act. The Commission directs the Wireless Telecommunications Bureau to announce the effective date of section 90.372 in a document published in the Federal Register after the Commission receives OMB approval.

199. IT IS FURTHER ORDERED that, pursuant to sections 309 and 316 of the Communications Act of 1934, as amended, 47 U.S.C. §§ 309 and 316, in this Order of Proposed Modification, the Commission proposes that all ITS licenses in the 5.9 GHz band will be modified pursuant to the conditions specified in this First Report and Order. Specifically, the Commission proposes to modify the licenses of all DSRC incumbents to add authorization to operate in the 5.895-5.925 megahertz band to any RSU registrations currently lacking authority to do so. In addition, the Commission will modify all DSRC licenses to provide that after the end of the sunset period their authorizations will be limited to the 5.895-5.925 megahertz band. These modification conditions will be effective 60 days after publication of this First Report and Order in the Federal Register; provided, however, that in the event that any ITS licensee, or any other licensee or permittee who believes that its license or permit would be modified by this proposed action, seeks to protest this proposed modification and its accompanying timetable, the proposed license modifications specified in this First Report and Order and contested by the licensee or permittee shall not be made final as to such licensee or permittee unless and until the Commission orders otherwise. Pursuant to section 316(a)(1) of the Communications Act of 1934, as amended, 47 U.S.C. § 316(a)(1), publication of this First Report and Order in the Federal Register shall constitute notification in writing of our Order proposing the modification of the ITS licenses, and of the grounds and reasons therefore, and those licensees and any other party seeking to file a protest pursuant to section 316 shall have 30 days from the date of such publication to protest such Order.

200. IT IS FURTHER ORDERED that the Commission's Consumer and Governmental Affairs Bureau, Reference Information Center, SHALL SEND a copy of this First Report and Order, Further Notice of Proposed Rulemaking, and Order of Proposed Modification, including the Initial and Final Regulatory Flexibility Analyses, to the Chief Counsel for Advocacy of the Small Business Administration.

201. IT IS FURTHER ORDERED that the Commission's Consumer and Governmental Affairs Bureau, Reference Information Center, SHALL SEND a copy of this First Report and Order, Further Notice of Proposed Rulemaking, and Order of Proposed Modification, including the Initial and Final Regulatory Flexibility Analysis, to Congress and the Government Accountability Office pursuant to the Congressional Review Act, *see* 5 U.S.C. § 801(a)(1)(A).

FEDERAL COMMUNICATIONS COMMISSION

Marlene H. Dortch
Secretary

APPENDIX A
FINAL RULES

For the reasons set forth in the preamble, the Federal Communications Commission amends Part 0, Part 2, Part 15, and Part 90 of Title 47 of the Code of Federal Regulations as follows:

Part 0 – Commission Organization

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

Authority: Secs. 5, 48 Stat. 1068, as amended; 47 U.S.C. 155.

2. Amend Section 0.241(i) to read as follows:

§ 0.241 Authority delegated.

* * * * *

(i) The Chief of the Office of Engineering and Technology is delegated authority to make nonsubstantive, editorial revisions to the Commission's rules and regulations contained in parts 2, 4, 5, 15, and 18 of this chapter. In addition, revisions to the Government Radiolocation list in § 15.407(a)(3)(viii) of this chapter need not be referred to the Commission.

* * * * *

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

3. The authority citation for Part 2 continues to read as follows:

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

4. Amend Section 2.106 by revising footnote NG160 to read as follows

§ 2.106 Allocations.

* * * * *

NG160 In the band 5895-5925 MHz, the use of the non-Federal mobile service is limited to operations in the Intelligent Transportation System radio service.

* * * * *

Part 15 – Radio Frequency Devices

5. 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.

6. Amend Section 15.401 to read as follows:

§ 15.401 Scope.

This subpart sets out the regulations for unlicensed National Information Infrastructure (U-NII) devices operating in the 5.15-5.35 GHz, 5.47-5.895 GHz bands, and 5.925-7.125 GHz bands.

7. Amend Section 15.403 by revising the definitions for Indoor Access Point and U-NII devices to read as follows:

§ 15.403 Definitions.

* * * * *

Indoor Access Point. For the purpose of this subpart, an access point that operates in the 5.850-5.895 GHz or the 5.925-7.125 GHz band, is supplied power from a wired connection, has an integrated antenna, is not battery powered, and does not have a weatherized enclosure. Indoor access point devices must bear

the following statement in a conspicuous location on the device and in the user's manual: FCC regulations restrict operation of this device to indoor use only.

U-NII devices. Intentional radiators operating in the frequency bands 5.15-5.35 GHz, 5.470-5.895 GHz, and 5.925-7.125 GHz that use wideband digital modulation techniques and provide a wide array of high data rate mobile and fixed communications for individuals, businesses, and institutions.

8. Amend Section 15.407 by revising paragraphs (a)(3) and (a)(12), revising paragraph (b)(4), redesignating paragraphs (b)(5) through (b)(10) as paragraphs (b)(6) through (b)(11), adding new paragraph (b)(5), and revising paragraph (e) to read as follows:

§ 15.407 General technical requirements.

* * *

(a) ***

(3) For the band 5.725-5.895 GHz

(i) For the band 5.725-5.850 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W. In addition, the maximum power spectral density shall not exceed 30 dBm in any 500-kHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. However, fixed point-to-point U-NII devices operating in this band may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter conducted power. Fixed, point-to-point operations exclude the use of point-to-multipoint systems, omnidirectional applications, and multiple collocated transmitters transmitting the same information. The operator of the U-NII device, or if the equipment is professionally installed, the installer, is responsible for ensuring that systems employing high gain directional antennas are used exclusively for fixed, point-to-point operations.

(ii) For an indoor access point operating in the 5.850-5.895 GHz band, the maximum power spectral density must not exceed 20 dBm e.i.r.p. in any 1-megahertz band. In addition, the maximum e.i.r.p. over the frequency band of operation must not exceed 33 dBm. Indoor access points operating on a channel that spans the 5.725-5.850 GHz and 5.850-5.895 GHz bands must not exceed an e.i.r.p. of 36 dBm.

(iii) For client devices operating under the control of an indoor access point in the 5.850-5.895 GHz band, the maximum power spectral density must not exceed 14 dBm e.i.r.p. in any 1-megahertz band, and the maximum e.i.r.p. over the frequency band of operation must not exceed 27 dBm. Client devices operating on a channel that spans the 5.725-5.850 GHz and 5.850-5.895 GHz bands must not exceed an e.i.r.p. of 36 dBm.

(iv) Client devices and indoor access points operating in the 5.850-5.895 GHz band must employ a contention-based protocol.

(v) In the 5.850-5.895 GHz band, client devices must operate under the control of an indoor access point. In all cases, an exception exists for transmitting brief messages to an access point when attempting to join its network after detecting a signal that confirms that an access point is operating on a particular channel. Access points may connect to other access points. Client devices are prohibited from connecting directly to another client device.

(vi) Operation of outdoor U-NII devices in the 5.850-5.895 GHz band within the

exclusion zones listed in the table below, to which NTIA may amend, modify, or revoke locations and associated parameters, is not permitted. The outdoor U-NII exclusion zones for each federal facility location are characterized by a center point (latitude/longitude) and radius (to define a circular area) to facilitate the regulator process of coordination.

Facility Name	Latitude DD-MM-SS North	Longitude DD-MM-SS West	Exclusion Zone Radius (km)
Anclote, Florida	28-11-18	82-47-40	54
Cape Canaveral, Florida	28-28-54	80-34-35	53
Cape San Blas, Florida	29-40-31	85-20-48	55
Carabelle Field, Florida	29-50-38	84-39-46	54
Charleston, South Carolina	32-51-48	79-57-48	55
Edwards, California	34-56-43	117-54-50	51
Eglin, Florida	30-37-51	86-24-16	116
Fort Walton Beach, Florida	30-24-53	86-39-58	56
Kennedy Space Center, Florida	28-25-29	80-39-51	98
Key West, Florida	24-33-09	81-48-28	54
Kirtland AFB, New Mexico	34-59-51	106-28-54	15
Kokeepark, Hawaii	22-07-35	159-40-06	49
MacDill, Florida	27-50-37	82-30-04	58
NV Test Training Range, Nevada	37-18-27	116-10-24	184
Patuxent River, Maryland	38-16-55	76-25-12	7
Pearl Harbor, Hawaii	21-21-17	157-57-51	55
Pillar Point, California	37-29-52	122-29-59	10
			58
Poker Flat, Alaska	65-07-36	147-29-21	
Port Canaveral, Florida	28-24-42	80-36-17	54
Port Hueneme, California	34-08-60	119-12-24	54
Point Mugu, California	34-07-17	119-9-01	81
Saddlebunch Keys, Florida	24-38-51	81-36-22	54
San Diego, California	32-43-00	117-11-00	54
San Nicolas Island, California	33-14-47	119-31-07	166
Tonopah Test Range, Nevada	37-44-00	116-43-00	48
Vandenberg, California	34-34-58	120-33-42	74
Venice, Florida	27-04-37	82-27-03	54
Wallops Island, Virginia	37-51-23	75-30-41	68
White Sands Missile Range, New Mexico	32-58-26	106-23-43	160
Yuma, Arizona	32-54-03	114-23-10	49

NOTE TO PARAGRAPH (a)(3): The Commission strongly recommends that parties employing U-NII devices to provide critical communications services should determine if there are any nearby Government radar systems that could affect their operation.

* * * * *

(12) Power spectral density measurement. The maximum power spectral density is measured as a conducted emission by direct connection of a calibrated test instrument to the equipment under test. If the device cannot be connected directly, alternative techniques acceptable to the Commission may be used. Measurements in the 5.725-5.895 GHz band are made over a reference bandwidth of 500 kHz or the 26 dB emission bandwidth of the device, whichever is less. Measurements in all other bands are made over a bandwidth of 1 MHz or the 26 dB emission bandwidth of the device, whichever is less. A narrower

resolution bandwidth can be used, provided that the measured power is integrated over the full reference bandwidth.

* * * * *

(b)(4) For transmitters operating solely in the 5.725-5.850 GHz band:

(i) ***

(ii) ***

(b)(5) For transmitters operating solely in the 5.850-5.895 GHz band or operating on a channel that spans across 5.725-5.895 GHz:

(i) For an indoor access point, all emissions at or above 5.895 GHz shall not exceed an e.i.r.p. of 15 dBm/MHz and shall decrease linearly to an e.i.r.p. of -7 dBm/MHz at or above 5.925 GHz.

(ii) For a client device, all emissions at or above 5.895 GHz shall not exceed an e.i.r.p. of -5 dBm/MHz and shall decrease linearly to an e.i.r.p. of -27 dBm/MHz at or above 5.925 GHz.

(iii) For a client device or indoor access point, all emissions below 5.725 GHz shall not exceed an e.i.r.p. of -27 dBm/MHz at 5.65 GHz increasing linearly to 10 dBm/MHz at 5.7 GHz, and from 5.7 GHz increasing linearly to a level of 15.6 dBm/MHz at 5.72 GHz, and from 5.72 GHz increasing linearly to a level of 27 dBm/MHz at 5.725 GHz.

* * * * *

(e) Within the 5.725-5.850 GHz and 5.850-5.895 GHz bands, the minimum 6 dB bandwidth of U-NII devices shall be at least 500 kHz.

* * * * *

Part 90 – PRIVATE LAND MOBILE RADIO SERVICES

9. The authority citation for Part 90 continues to read as follows:

Authority: 47 U.S.C. 154(i), 161, 303(g), 303(r), 332(c)(7), 1401-1473.

10. Amend Subpart M to the Table of Contents of Part 90 by revising the subheading after section 90.365 and add Section 90.370 and Section 90.372 to read as follows:

Subpart M – Intelligent Transportation Systems Radio Service

* * * * *

Regulations Governing the Licensing and Use of Frequencies in the 5895-5925 MHz Band for Dedicated Short-Range Communications Service (DSRCS).

* * * * *

§ 90.370 Permitted Frequencies.

* * * * *

§ 90.372 DSRCS Notification Requirement.

* * * * *

Subpart B—PUBLIC SAFETY RADIO POOL

11. Amend Section 90.20 by revising the table in paragraph (c)(3) to read as follows:

[Insert public safety pool frequency table – revise frequency to read 5895-5925]

Subpart C—INDUSTRIAL/BUSINESS RADIO POOL

12. Amend Section 90.35 by revising the table in paragraph (b)(3) to read as follows:

[Insert industrial/business pool frequency table – revise frequency to read 5895-5925]

Subpart G—APPLICATIONS AND AUTHORIZATIONS

13. Amend Section 90.149 by revising paragraph (b) to read as follows:

§ 90.149 License term.

* * * * *

(b) Non-exclusive geographic area licenses for DSRCs Roadside Units (RSUs) under subpart M of this part in the 5895-5925 MHz band will be issued for a term not to exceed ten years from the date of original issuance or renewal. The registration dates of individual RSUs (see § 90.375) will not change the overall renewal period of the single license.

14. Amend Section 90.155 by revising paragraph (i) to read as follows:

§ 90.155 Time in which station must be placed in operation.

* * * * *

(i) DSRCs Roadside Units (RSUs) under subpart M of this part in the 5895-5925 MHz band must be placed in operation within 12 months from the effective date of registration (see § 90.375) or the authority to operate the RSUs cancels automatically (see § 1.955 of this chapter). Such registration date(s) do not change the overall renewal period of the single license. Licensees must notify the Commission in accordance with § 1.946 of this chapter when registered units are placed in operation within their construction period.

Subpart H—POLICIES GOVERNING THE ASSIGNMENT OF FREQUENCIES

15. Amend Section 90.175 by revising paragraph (j)(16) to read as follows:

§ 90.175 Frequency coordinator requirements.

* * * * *

(j) * * *

(16) Applications for DSRCs licenses (as well as registrations for Roadside Units) under subpart M of this part in the 5895-5925 GHz band.

* * * * *

Subpart I—GENERAL TECHNICAL STANDARDS

16. Amend Section 90.203 by redesignating paragraph (a)(2) as paragraph (a)(3) and adding new paragraph (a)(2).

§ 90.203 Certification Required.

* * * * *

(2) Effective [Insert date of DSRC sunset], an equipment approval may no longer be obtained for DSRCs equipment (RSUs and OBUs) operating under the provisions of this part.

17. Amend Section 90.205 by revising paragraph (q) to read as follows:

§ 90.205 Power and antenna height limits.

* * * * *

(q) 5895-5925 MHz. Power and height limitations are specified in subpart M of this part.

* * * * *

18. Amend Section 90.210 by revising the entry for 5850-5925 in the table and footnote 4 of the table to read as follows:

§ 90.210 Emission masks.

* * * * *

Applicable Emission Masks Frequency band (MHz)	Mask for equipment with audio low pass filter	Mask for equipment without audio low pass filter
* * * * *	* * * * *	* * * * *
5895-5925 ⁴		
* * * * *	* * * * *	* * * * *

⁴ DSRCS Roadside Units in the 5.895-5.925 GHz band are governed under Subpart M of this part.

* * * * *

19. Amend Section 90.213 by revising footnote 10 of the table in paragraph (a) to read as follows:

§ 90.213 Frequency stability.

(a) ***

¹⁰ Frequency stability for DSRCS equipment in the 5895-5925 MHz band is specified in subpart M of this part. For all other equipment, frequency stability is to be specified in the station authorization.

* * * * *

SUBPART M—INTELLIGENT TRANSPORTATION SYSTEMS RADIO SERVICE

20. Amend Subpart M to the Table of Contents of Part 90 by modifying the subheading after section 90.365 to read as follows:

Regulations Governing the Licensing and Use of Frequencies in the 5895-5925 MHz Band for Dedicated Short-Range Communications Service (DSRCS)

* * * * *

21. Amend subpart M by adding Section 90.370 to read as follows:

§ 90.370 Permitted frequencies.

(a) Dedicated Short-Range Communications Service (DSRCS) systems are permitted to operate in the 5895-5925 MHz band.

(b) DSRCS authorizations granted prior to the [insert R&O effective date] may remain on existing frequencies in the 5850-5895 MHz band until [insert date one year after R&O effective date], at which time they may only operate in the 5895-5925 MHz band.

(c) Frequencies in the 5895-5925 MHz band will not be assigned for the exclusive use of any licensee; Channels are available on a shared basis only for use in accordance with the Commission's rules. All licensees shall cooperate in the selection and use of channels in order to reduce interference. This includes monitoring for communications in progress and any other measures as may be necessary to minimize interference.

(d) Licensees of Roadside Units (RSUs) suffering or causing harmful interference within a communications zone, as defined in section 90.375 of this part, are expected to cooperate and resolve this problem by mutually satisfactory arrangements. If the licensees are unable to do so, the Commission may

impose restrictions including specifying the transmitter power, antenna height and direction, additional filtering, or area or hours of operation of the stations concerned. The use of any channel at a given geographical location may be denied when, in the judgment of the Commission, its use at that location is not in the public interest; use of any such channel may be restricted as to specified geographical areas, maximum power, or such other operating conditions, contained in this part or in the station authorization.

22. Amend Section 90.371 by revising paragraph (b) and (c) to read as follows:

§ 90.371 Dedicated Short Range Communications Service.

* * * * *

(b) DSRCS Roadside Units (RSUs) operating in the band 5850-5925 MHz shall not receive protection from Government Radiolocation services in operation prior to the establishment of the DSRCS station. Operation of DSRCS RSU stations within the radius centered on the locations listed in the table below must be coordinated through the National Telecommunications and Information Administration.

Location	Latitude	Longitude	Coordination Zone Radius (km)
	DD-MM-SS North	DD-MM-SS West	
Anclote, Florida	28-11-18	82-47-40	45
Cape Canaveral, Florida	28-28-54	80-34-35	47
Cape San Blas, Florida	29-40-31	85-20-48	47
Carabelle Field, Florida	29-50-38	84-39-46	36
Charleston, South Carolina	32-51-48	79-57-48	16
Edwards, California	34-56-43	117-54-50	53
Eglin, Florida	30-37-51	86-24-16	103
Fort Walton Beach, Florida	30-24-53	86-39-58	41
Kennedy Space Center, Florida	28-25-29	80-39-51	47
Key West, Florida	24-33-09	81-48-28	12
Kirtland AFB, New Mexico	34-59-51	106-28-54	15
Koikepark, Hawaii	22-07-35	159-40-06	5
MacDill, Florida	27-50-37	82-30-04	47
NV Test Training Range, Nevada	37-18-27	116-10-24	186
Patuxent River, Maryland	38-16-55	76-25-12	6
Pearl Harbor, Hawaii	21-21-17	157-57-51	16
Pillar Point, California	37-29-52	122-29-59	36
Poker Flat, Alaska	65-07-36	147-29-21	13
Port Canaveral, Florida	28-24-42	80-36-17	19
Port Hueneme, California	34-08-60	119-12-24	24
Point Mugu, California	34-07-17	119-09-1	18
Saddlebunch Keys, Florida	24-38-51	81-36-22	29
San Diego, California	32-43-00	117-11-00	11
San Nicolas Island,	33-14-47	119-31-07	195
Tonopah Test Range,	37-44-00	116-43-00	2
Vandenberg, California	34-34-58	120-33-42	55
Venice, Florida	27-04-37	82-27-03	50
Wallops Island, Virginia	37-51-23	75-30-41	48
White Sands Missile	32-58-26	106-23-43	158

Yuma, Arizona	32-54-03	114-23-10	2
---------------	----------	-----------	---

(c) NTIA may authorize additional station assignments in the federal Radiolocation service and may amend, modify, or revoke existing or additional assignments for such service. Once a federal assignment action is taken, the Commission’s Universal Licensing System database will be updated accordingly and the list in paragraph (b) of this section will be updated as soon as practicable.

23. Amend subpart M by adding Section 90.372 to read as follows:

§ 90.372 DSRCS Notification Requirement.

(a) DSRCS licensees authorized pursuant to 90.370(b) must notify the Commission that as of the transition deadline of [insert sunset date], they have ceased operating in the 5.850-5.895 GHz portion of the band. This notification must be filed via ULS within 15 days of the expiration of the transition deadline.

(b) Continued operation in the 5.850-5.895 GHz portion of the band after the transition deadline, will result in automatic termination of that licensee's authorization without specific Commission action.

24. Amend Section 90.375 by revising paragraph (a) and paragraph (c) to read as follows:

§ 90.375 RSU license areas, communication zones, and registrations

(a) Roadside Units (RSUs) in the 5895-5925 MHz band are licensed on the basis of non-exclusive geographic areas. Governmental applicants will be issued a geographic area license based on the geographical area encompassing the legal jurisdiction of the entity. All other applicants will be issued a geographic area license for their proposed area of operation based on county(s), state(s) or nationwide.

* * * * *

(c) Licensees must operate each RSU in accordance with the Commission's Rules and the registration data posted on the ULS for such RSU. Licensees must register each RSU for the smallest communication zone needed for the intelligent transportation systems application using one of the following four communication zones:

RSU class	Maximum output power (dBm) ¹	Communications zone (meters)
A	0	15
B	10	100
C	20	400
D	28.8	1000

¹ As described in the IEEE 802.11p-2010 (incorporated by reference, see § 90.379).

25. Amend Section 90.379 to read as follows:

§ 90.379 Technical standards for Roadside Units

(a) DSRCS Roadside Units (RSUs) operating in the 5895-5905 MHz band must comply with the technical standard Institute of Electrical and Electronics Engineers (IEEE) 802.11p-2010.

(b) The standards required in this section are incorporated by reference into this section with the approval of the Director of the Federal Register under 5 U.S.C. § 552(a) and 1 CFR part 51. All approved material is available for inspection at the Federal Communications Commission, 445 12th Street SW., Washington, D.C. 20554 and is available from the sources indicated below. It is also available for inspection at the National Archives and Records Administration (NARA). For information on the availability of this material at NARA, call 202-741-6030 or go to www.archives.gov/federal-register/cfr/ibrlocations.html.

(1) 802.11p-2010, IEEE Standard for Information technology– Local and metropolitan area networks – Specific requirements – Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications Amendment 6: Wireless Access in Vehicular Environments (2010). This standard is available from the Institute of Electrical and Electronics Engineers (IEEE), 3025 Boardwalk Drive, Suite 220, Ann Arbor, MI 48108, 1-855-999-9870, <http://www.techstreet.com/ieee>.

26. Amend Section 90.383 by revising the introductory text and paragraph (b) to read as follows:

§ 90.383 RSU sites near the U.S./Canada or U.S./Mexico border.

Until such time as agreements between the United States and Canada or the United States and Mexico, as applicable, become effective governing border area use of the 5895-5925 MHz band, authorizations to operate Roadside Units (RSUs) are granted subject to the following conditions:

* * * * *

(b) Authority to operate RSUs is subject to modifications and future agreements between the United States and Canada or the United States and Mexico, as applicable.

Part 95 -Personal Radio Services

27. The authority citation for Part 95 continues to read as follows:

Authority: 47 U.S.C. 154, 303, and 307.

Subpart L -DSRCS On-Board Units

28. Amend Section 95.3101 to read as follows:

§ 95.3101 Scope.

This subpart contains rules that apply only to On-Board Units (OBUs) transmitting in the 5895-5925 MHz frequency band in the Dedicated Short-Range Communications Services (DSRCS) (see § 90.371 of this chapter).

29. Remove and reserve Section 95.3159.

30. Amend Section 95.3163 to read as follows:

§ 95.3163 OBU frequencies.

DSRCS On-Board Units (OBUs) are permitted to operate in the 5895-5925 MHz band.

31. Amend Section 95.3167 to read as follows:

§ 95.3167 OBU transmit power limit.

(a) The maximum output power for portable DSRCS On-Board Unit (OBU) transmitter types is 1.0 mW.

(b) The power limits in paragraph (a) of this section may be referenced to the antenna input, so that cable losses are taken into account.

(c) For purposes of this section, a portable unit is a transmitting device designed to be used so that the radiating structure(s) of the device is/are within 20 centimeters of the body of the user.

32. Amend Section 95.3189 to read as follows:

§ 95.3189 OBU technical standard.

(a) DSRCS On-Board Unit (OBU) transmitter types operating in the 5895-5925 MHz band must be designed to comply with the technical standard Institute of Electrical and Electronics Engineers (IEEE) 802.11p-2010.

(b) The standards required in this section are incorporated by reference into this section with the approval of the Director of the Federal Register under 5 U.S.C. § 552(a) and 1 CFR part 51. All approved material is available for inspection at the Federal Communications Commission, 445 12th Street SW., Washington, D.C. 20554 and is available from the sources indicated below. It is also available for inspection at the National Archives and Records Administration (NARA). For information on the availability of this material at NARA, call 202-741-6030 or go to www.archives.gov/federal-register/cfr/ibrlocations.html.

(1) 802.11p-2010, IEEE Standard for Information technology – Local and metropolitan area networks – Specific requirements – Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications Amendment 6: Wireless Access in Vehicular Environments (2010). This standard is available from the Institute of Electrical and Electronics Engineers (IEEE), 3025 Boardwalk Drive, Suite 220, Ann Arbor, MI 48108, 1-855-999-9870, <http://www.techstreet.com/ieee>.

33. Amend Appendix A to part 95 by removing the entry in the table for “95.1509 - ASTM E2213-03 DSRC Standard.”

APPENDIX B
PROPOSED RULES

Part 15 – Radio Frequency Devices

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

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

2. Amend Section 15.407 by revising paragraphs (a)(3) and (b)(5) to read as follows:

§ 15.407 General technical requirements.

* * *

(a) ***

(3) For the band 5.725-5.895 GHz

(i) ***

(ii) For an indoor access point operating in the 5.850-5.895 GHz band, the maximum power spectral density must not exceed 23 dBm e.i.r.p. in any 1-megahertz band. In addition, the maximum e.i.r.p. over the frequency band of operation must not exceed 36 dBm. Indoor access points operating on a channel that spans the 5.725-5.850 GHz and 5.850-5.895 GHz bands must not exceed an e.i.r.p. of 36 dBm.

(iii) For client devices operating under the control of an indoor access point in the 5.850-5.895 GHz band, the maximum power spectral density must not exceed 17 dBm e.i.r.p. in any 1-megahertz band, and the maximum e.i.r.p. over the frequency band of operation must not exceed 30 dBm. Client devices operating on a channel that spans the 5.725-5.850 GHz and 5.850-5.895 GHz bands must not exceed an e.i.r.p. of 36 dBm.

(iv) For an outdoor access point operating in the 5.850-5.895 GHz band, the maximum power spectral density must not exceed 23 dBm e.i.r.p. in any 1-megahertz band. In addition, the maximum e.i.r.p. over the frequency band of operation must not exceed 36 dBm. Outdoor access points must limit their maximum e.i.r.p. at any elevation angle above 30 degrees as measured from the horizon to 21 dBm (125 mW) to protect fixed satellite services. Outdoor access points operating on a channel that spans the 5.725-5.850 GHz and 5.850-5.895 GHz bands must not exceed an e.i.r.p. of 36 dBm.

(v) Client devices and indoor access points operating in the 5.850-5.895 GHz band must employ a contention-based protocol.

(vi) In the 5.850-5.895 GHz band, client devices must operate under the control of an indoor access point. In all cases, an exception exists for transmitting brief messages to an access point when attempting to join its network after detecting a signal that confirms that an access point is operating on a particular channel. Access points may connect to other access points.

(vii) For client devices operating under the control of an outdoor access point in the 5.850-5.895 GHz band, the maximum power spectral density e.i.r.p. must not exceed 17 dBm in any 1-megahertz band, and the maximum e.i.r.p. over the frequency band of operation must not exceed 30 dBm. Client devices operating on a channel that spans the 5.725-5.850 GHz and 5.850-5.895 GHz bands must not exceed an e.i.r.p. of 36 dBm.

(viii) Operation of outdoor U-NII devices in the 5.850-5.895 GHz band within the exclusion zones listed in the table below, to which NTIA may amend, modify, or revoke locations and associated parameters, is not permitted. The outdoor U-NII

exclusion zones for each federal facility location are characterized by a center point (latitude/longitude) and radius (to define a circular area) to facilitate the regulator process of coordination.

Facility Name	Latitude DD-MM-SS North	Longitude DD-MM-SS West	Exclusion Zone Radius (km)
Anclote, Florida	28-11-18	82-47-40	54
Cape Canaveral, Florida	28-28-54	80-34-35	53
Cape San Blas, Florida	29-40-31	85-20-48	55
Carabelle Field, Florida	29-50-38	84-39-46	54
Charleston, South Carolina	32-51-48	79-57-48	55
Edwards, California	34-56-43	117-54-50	51
Eglin, Florida	30-37-51	86-24-16	116
Fort Walton Beach, Florida	30-24-53	86-39-58	56
Kennedy Space Center, Florida	28-25-29	80-39-51	98
Key West, Florida	24-33-09	81-48-28	54
Kirtland AFB, New Mexico	34-59-51	106-28-54	15
Kokeepark, Hawaii	22-07-35	159-40-06	49
MacDill, Florida	27-50-37	82-30-04	58
NV Test Training Range, Nevada	37-18-27	116-10-24	184
Patuxent River, Maryland	38-16-55	76-25-12	7
Pearl Harbor, Hawaii	21-21-17	157-57-51	55
Pillar Point, California	37-29-52	122-29-59	10
			58
Poker Flat, Alaska	65-07-36	147-29-21	
Port Canaveral, Florida	28-24-42	80-36-17	54
Port Hueneme, California	34-08-60	119-12-24	54
Point Mugu, California	34-07-17	119-9-01	81
Saddlebunch Keys, Florida	24-38-51	81-36-22	54
San Diego, California	32-43-00	117-11-00	54
San Nicolas Island, California	33-14-47	119-31-07	166
Tonopah Test Range, Nevada	37-44-00	116-43-00	48
Vandenberg, California	34-34-58	120-33-42	74
Venice, Florida	27-04-37	82-27-03	54
Wallops Island, Virginia	37-51-23	75-30-41	68
White Sands Missile Range, New Mexico	32-58-26	106-23-43	160
Yuma, Arizona	32-54-03	114-23-10	49

NOTE TO PARAGRAPH (a)(3): The Commission strongly recommends that parties employing U-NII devices to provide critical communications services should determine if there are any nearby Government radar systems that could affect their operation.

*** (b)(5) For transmitters operating solely in the 5.850-5.895 GHz band or operating on a channel that spans across 5.725-5.895 GHz:

(i) ***

(ii) For a client device or an outdoor access point, all emissions at or above 5.895 GHz shall not

exceed an e.i.r.p. of -5 dBm/MHz and shall decrease linearly to an e.i.r.p. of -27 dBm/MHz at or above 5.925 GHz.

(iii) All emissions below 5.725 GHz shall not exceed an e.i.r.p. of -27 dBm/MHz at 5.65 GHz increasing linearly to 10 dBm/MHz at 5.7 GHz, and from 5.7 GHz increasing linearly to a level of 15.6 dBm/MHz at 5.72 GHz, and from 5.72 GHz increasing linearly to a level of 27 dBm/MHz at 5.725 GHz.

* * * * *

Part 90 – PRIVATE LAND MOBILE RADIO SERVICES

3. Amend Subpart M to the Table of Contents of Part 90 by modifying the subheading after section 90.365 and add Section 90.370 to read as follows:

Subpart M – Intelligent Transportation Systems Radio Service

* * * * *

Regulations Governing the Licensing and Use of Frequencies in the 5895-5925 MHz Band for Cellular Vehicle to Everything Service (C-V2X).

90.370 Permitted Frequencies.

* * * * *

4. The authority citation for Part 90 continues to read as follows:

Authority: 47 U.S.C. 154(i), 161, 303(g), 303(r), 332(c)(7), 1401-1473.

Subpart A – GENERAL INFORMATION

5. Amend Section 90.7 is by removing the entry to Dedicated Short Range Communication Service (DSRCS), adding an entry for Cellular Vehicle to Everything Service (CV2X) in alphabetical order, and modifying the entries for On-Board unit (OBU), Roadside unit (RSU) and Roadway bed surface to read as follows:

§ 90.7 Definitions.

* * * * *

Cellular Vehicle to Everything Service (C-V2X). The use of cellular radio techniques defined by the 3rd Generation Partnership Program (3GPP) to transfer data between roadside and mobile units, between mobile units, and between portable and mobile units to perform operations related to the improvement of traffic flow, traffic safety, and other intelligent transportation service applications in a variety of environments. C-V2X systems may also transmit status and instructional messages related to the units involved.

* * * * *

On-Board Unit (OBU). An On-Board Unit is a C-V2X transceiver that is normally mounted in or on a vehicle, or which in some instances may be a portable unit. An OBU can be operational while a vehicle or person is either mobile or stationary. The OBUs receive and transmit on one or more radio frequency (RF) channels. Except where specifically excluded, OBU operation is permitted wherever vehicle operation or human passage is permitted. The OBUs mounted in vehicles are licensed by rule under part 95 of this chapter and communicate with Roadside Units (RSUs) and other OBUs. Portable OBUs are also licensed by rule under part 95 of this chapter.

Roadside Unit (RSU). A Roadside Unit is a C-V2X transceiver that is mounted along a road or pedestrian passageway. An RSU may also be mounted on a vehicle or is hand carried, but it may only operate when the vehicle or hand-carried unit is stationary. Furthermore, an RSU operating under this part is restricted to the location where it is licensed to operate. However, portable or hand-held RSUs are permitted to

operate where they do not interfere with a site-licensed operation. An RSU broadcasts data to or exchanges data with OBUs.

Roadway bed surface. For C-V2X, the road surface at ground level.

Subpart H—POLICIES GOVERNING THE ASSIGNMENT OF FREQUENCIES

6. Amend Section 90.175 by revising paragraph (j)(16) to read as follows:

§ 90.175 Frequency coordinator requirements.

* * * * *

(j) * * *

(16) Applications for C-V2X licenses (as well as registrations for Roadside Units) under subpart M of this part in the 5895-5925 GHz band.

* * * * *

7. Amend Section 90.179 by revising paragraph (f) to read as follows:

§ 90.179 Shared use of radio stations.

* * * * *

(f) Above 800 MHz, shared use on a for-profit private carrier basis is permitted only by SMR, Private Carrier Paging, LMS, and C-V2X licensees. See subparts M, P, and S of this part.

Subpart I—GENERAL TECHNICAL STANDARDS

8. Amend Section 90.210 by revising footnote 4 of the table to read as follows:

§ 90.210 Emission masks.

* * * * *

Applicable Emission Masks Frequency band (MHz)	Mask for equipment with audio low pass filter	Mask for equipment without audio low pass filter
* * * * *	* * * * *	* * * * *
5895-5925 ⁴		
* * * * *	* * * * *	* * * * *

4 CV2X Service Roadside Units equipment in the 5895-5925 MHz band is governed under Subpart M of this part.

* * * * *

9. Amend Section 90.213 by revising footnote 10 of the table in paragraph (a) to read as follows:

§ 90.213 Frequency stability.

(a) ***

¹⁰ Frequency stability for C-V2X Service equipment in the 5895-5925 MHz band is specified in subpart M of this part. For all other equipment, frequency stability is to be specified in the station authorization.

* * * * *

Subpart M—Intelligent Transportation Systems Radio Service

10. Amend Section 90.350 to read as follows:

§ 90.350 Scope.

The Intelligent Transportation Systems (ITS) radio service is for the purpose of integrating radio-based technologies into the nation's transportation infrastructure and to develop and implement the nation's intelligent transportation systems. It includes the Location and Monitoring Service (LMS) and the Cellular Vehicle to Everything Service (C-V2X). Rules as to eligibility for licensing, frequencies available, and any special requirements for services in the Intelligent Transportation Systems radio service are set forth in this subpart.

11. Amend the heading prior to section 90.370 to read as follows:

Regulations Governing the Licensing and Use of Frequencies in the 5895-5925 MHz Band for Cellular Vehicle to Everything (C-V2X) Service.

12. Amend Section 90.370 by revising paragraph (a) to read as follows:

§ 90.370 Permitted frequencies.

(a) C-V2X Roadside Units (RSUs) are permitted to operate in the 5895-5925 MHz band.

13. Amend Section 90.371 to read as follows:

§ 90.371 C-V2X.

(a) C-V2X Roadside Units (RSUs) operating in the band 5895-5925 MHz shall not receive protection from Government Radiolocation services in operation prior to the establishment of the RSU. Operation of RSU stations within the zones listed in the table below, to which NTIA may amend, modify, or revoke locations and associated parameters, must be coordinated through the National Telecommunications and Information Administration.

(b) C-V2X Roadside Units (RSUs) operating in the band 5895-5925 MHz shall not receive protection from Government Radiolocation services in operation prior to the establishment of the C-V2X station. Operation of C-V2X RSU stations within the radius centered on the locations listed in the table below, to which NTIA may amend, modify, or revoke locations and associated parameters, must be coordinated through the National Telecommunications and Information Administration.

* * * * *

14. Amend Section 90.373 by revising the heading and the introductory text to read as follows:

§ 90.373 Eligibility in C-V2X.

The following entities are eligible to hold an authorization to operate Roadside units in C-V2X:

* * * * *

15. Amend Section 90.375 to read as follows:

§ 90.375 License areas, communication zones, and registrations

(a) Roadside Units (RSUs) in the 5895-5925 MHz band are licensed on the basis of non-exclusive geographic areas. Governmental applicants will be issued a geographic area license based on the geographical area encompassing the legal jurisdiction of the entity. All other applicants will be issued a geographic area license for their proposed area of operation based on county(s), state(s) or nationwide.

(b) Applicants who are approved in accordance with FCC Form 601 will be granted non-exclusive licenses for the channel(s) corresponding to their intended operations (see § 90.370). Such licenses serve as a prerequisite of registering individual RSUs located within the licensed geographic area described in paragraph (a) of this section. Licensees must register each RSU in the Universal Licensing System (ULS) before operating such RSU. RSU registrations are subject, inter alia, to the requirements of § 1.923 of this chapter as applicable (antenna structure registration, environmental concerns, international coordination, and quiet zones). Additionally, RSUs at locations subject to NTIA coordination (see §

90.371(a)) may not begin operation until NTIA approval is received. Registrations are not effective until the Commission posts them on the ULS. It is the licensee's responsibility to delete from the registration database any RSUs that have been discontinued.

(c) Licensees must operate each RSU in accordance with the Commission's Rules and the registration data posted on the ULS for such RSU. Licensees must register each RSU for the smallest communication zone needed for the intelligent transportation systems application using one of the following four communication zones:

RSU class	Maximum output power (dBm) ¹	Communications zone (meters)
A	0	15
B	10	100
C	20	400
D	28.8	1000

¹ As described in the ATIS transposed standards of the 3GPP (incorporated by reference, *see* § 90.379).

16. Amend Section 90.377 to read as follows:

§ 90.377 Maximum EIRP and antenna height.

(a) C-V2X Service licensees must transmit only the power (EIRP) needed to communicate with an On-Board Unit (OBU) within the communications zone and must take steps to limit the Roadside Unit (RSU) signal within the zone to the maximum extent practicable.

(b) C-V2X licensees must limit RSU output power to 20 dBm and equivalent isotropically radiated power (EIRP) to 33 dBm. The EIRP is measured as the maximum EIRP toward the horizon or horizontal, whichever is greater, of the gain associated with the main or center of the transmission beam.

(c) The radiation center of an RSU antenna shall not exceed 8 meters above the roadway bed surface, except that an RSU may employ an antenna with a height exceeding 8 meters but not exceeding 15 meters provided the EIRP specified in paragraphs (a) and (b) of this section is reduced by a factor of $20 \log(Ht/8)$ in dB where Ht is the height of the radiation center of the antenna in meters above the roadway bed surface. The RSU antenna height must not exceed 15 meters above the roadway bed surface.

17. Amend Section 90.379 to read as follows:

§ 90.379 Technical standards for Roadside Units

(a) C-V2X Service RSUs operating in the 5905-5925 MHz band shall comply with the V2X sidelink service for this band as described in the ATIS transposed standards of the 3GPP specifications except where these rules and regulations take precedence.

(b) The standards required in this section are incorporated by reference into this section with the approval of the Director of the Federal Register under 5 U.S.C. § 552(a) and 1 CFR part 51. All approved material is available for inspection at the Federal Communications Commission, 445 12th Street SW., Washington, D.C. 20554 and is available from the sources indicated below. It is also available for inspection at the National Archives and Records Administration (NARA). For information on the availability of this material at NARA, call 202-741-6030 or go to www.archives.gov/federal-register/cfr/ibrlocations.html.

(1) 3GPP Release 14, 3rd Generation Partnership Project Technical Specification Group Services and System Aspects (2018). This standard is available from ATIS, 1200 G Street NW Suite 500, Washington, D.C. 20005, <https://www.atis.org/docstore/default.aspx>.

18. Amend subpart M adding Section 90.381 to read as follows:

§ 90.381 C-V2X emissions limits.

C-V2X Roadside Units (RSUs) must comply with the following out-of-band emissions limits.

(a) Conducted limits measured at the antenna input must not exceed:

- (1) -29 dBm/100 kHz at the band edge (The band is defined in section 90.370 of this part);
- (2) -35 dBm/100 kHz \pm 1 megahertz from the band edge;
- (3) -43 dBm/100 kHz \pm 10 megahertz from the band edge; and
- (4) -53 dBm/100 kHz \pm 20 megahertz from the band edge.

(b) Radiated limits: All C-V2X Service RSUs must limit radiated emissions to -25 dBm/100 kHz EIRP or less outside the band edges where the band is defined in section 90.370 of this part.

Subpart N—OPERATING REQUIREMENTS

19. Amend Section 90.415 by revising paragraph (b) to read as follows:

* * * * *

(b) Render a communications common carrier service, except for stations in the Public Safety Pool providing communications standby facilities under § 90.20(a)(2)(xi) and stations licensed under this part in the SMR, private carrier paging, Industrial/Business Pool, 220-222 MHz, or C-V2X.

20. Amend Section 90.421 by adding paragraph (d) to read as follows:

§ 90.421 Operation of mobile station units not under the control of the licensee.

* * * * *

(d) C-V2X On-Board Units licensed by rule under part 95 of this chapter may communicate with any roadside unit authorized under this part or any licensed commercial mobile radio service station as defined in part 20 of this chapter.

21. Amend Section 90.425 by revising paragraph (d)(10) to read as follows:

§ 90.425 Station identification.

* * * * *

(d) * * *

(10) It is a Roadside Unit (RSU) in a C-V2X system.

Part 95 -Personal Radio Services

22. The authority citation for Part 95 continues to read as follows:

Authority: 47 U.S.C. 154, 303, and 307.

23. Amend the subtitle for subpart L to read as follows:

Subpart L—C-V2X Service On-Board Units

24. Amend Section 95.3101 to read as follows:

§ 95.3101 Scope.

This subpart contains rules that apply only to On-Board Units (OBUs) transmitting in the 5895-5925 MHz frequency band in the Cellular Vehicle to Everything Service (C-V2X) (see § 90.371 of this chapter).

25. Amend Section 95.3103 by removing the definition for Dedicated Short-Range Communications Services (DSRCS), adding a definition for Cellular Vehicle to Everything Service (CV2X) in alphabetical order, and revising the definition of On-Board Unit (OBU) to read as follows:

§ 95.3103 Definitions, OBUs.

Cellular Vehicle to Everything Service (C-V2X). A service providing for data transfer between various mobile and roadside transmitting units for the purposes of improving traffic flow, highway safety and performing other intelligent transportation functions. See § 90.7 of this chapter for a more detailed definition.

On-Board Units (OBUs). OBUs are low-power devices on vehicles that transfer data to roadside units or other OBUs in the Cellular Vehicle to Everything Service (C-V2X) (see §§ 90.370-90.383 of this chapter), to improve traffic flow and safety, and for other intelligent transportation system purposes. See § 90.7 of this chapter.

* * * * *

26. Amend Section 95.3161 by revising paragraph (a) to read as follows:

§ 95.3161 OBU transmitter certification.

(a) Each On-Board Unit (OBU) that operates or is intended to operate in C-V2X must be certified in accordance with this subpart and subpart J of part 2 of this chapter.

* * * * *

27. Amend Section 95.3163 to read as follows:

§ 95.3163 OBU frequencies.

C-V2X Service OBUs are permitted to operate in the 5895-5925 MHz band.

28. Amend Section 95.3167 by revising paragraph (a) to read as follows:

§ 95.3167 OBU transmit power limit.

(a) The maximum equivalent isotropically radiated power (EIRP) for vehicular and portable C-V2X OBU transmitter types is limited to 33 dBm.

(b) The power limit in paragraph (a) of this section may be referenced to the antenna input, so that cable losses are taken into account.

(c) For purposes of this section, a portable unit is a transmitting device designed to be used so that the radiating structure(s) of the device is/are within 20 centimeters of the body of the user.

29. Add Section 95.3179 to subpart L as follows:

§ 95.3179 Unwanted emissions limits.

C-V2X On Board Units must comply with the following out-of-band emissions limits.

Conducted limits measured at the antenna input shall not exceed:

(a) 29 dBm/100 kHz at the band edge (The band is defined in section 95.3163 of this part.);

(b) -35 dBm/100 kHz \pm 1 megahertz from the band edge;

(c) -43 dBm/100 kHz \pm 10 megahertz from the band edge; and

(d) -53 dBm/100 kHz \pm 20 megahertz from the band edge.

30. Amend Section 95.3189 to read as follows:

§ 95.3189 OBU technical standard.

(a) C-V2X Service OBU transmitter types operating in the 5895-5925 MHz band shall comply with the V2X sidelink service for this band as described in the ATIS transposed standards of the 3GPP specifications except where these rules and regulations take precedence.

(b) The standards required in this section are incorporated by reference into this section with the approval of the Director of the Federal Register under 5 U.S.C. § 552(a) and 1 CFR part 51. All approved material is available for inspection at the Federal Communications Commission, 445 12th Street SW., Washington, D.C. 20554 and is available from the sources indicated below. It is also available for inspection at the National Archives and Records Administration (NARA). For information on the availability of this material at NARA, call 202-741-6030 or go to www.archives.gov/federal-register/cfr/ibrlocations.html.

(1) 3GPP Release 14, 3rd Generation Partnership Project Technical Specification Group Services and System Aspects (2018). This standard is available from ATIS, 1200 G Street NW Suite 500, Washington, D.C. 20005, <https://www.atis.org/docstore/default.aspx>.

31. Amend Appendix A to part 95 by removing the entry in the table for “95.1509 - ASTM E221-03 DSRC Standard.”

APPENDIX C

COST BENEFIT ANALYSIS

1. In this appendix, we supplement our earlier exposition explaining our estimate of the value of unlicensed spectrum in the lower 45 megahertz. We note that our baseline estimation is conservative, as it is limited to expected benefits starting in 2023 and only up to 2025, thereby ignoring likely substantial benefits beyond 2025. The estimate also assumes that unlicensed spectrum made available in the 6 GHz *Report and Order* will be used as quickly and heavily as the spectrum made available here in spite of more stringent power limitations across the 6 GHz band and its potentially longer adoption timescale.⁴⁶⁶ Additionally, commenters have noted that unlicensed spectrum in the lower 45 megahertz likely offers numerous benefits to consumers, who use Wi-Fi to off-load traffic and benefit from the various applications that Wi-Fi enables in, among other areas, agriculture, education, and medicine.⁴⁶⁷ However, due to a lack of quantifiable data on these varied, sometimes only-nascent benefits, we are unable to construct reliable quantitative estimates of associated surplus.⁴⁶⁸ However, we find that the added GDP associated with the transactions between ISPs and their customers are substantial, even while excluding the additional economic value of Wi-Fi supported activities to consumers.

2. We calculate the contribution to GDP of the unlicensed 5.9 GHz spectrum using two approaches that estimate the present value of additional Wi-Fi traffic from new transactions between ISPs and their customers over the period 2023-2025.⁴⁶⁹ In our baseline model, we assume that the increase in traffic is based on the idea that the additional 45 megahertz of 5.9 GHz spectrum will enable Wi-Fi users of the 2.4 GHz, 5.150-5.250 (U-NII-1), and 5.725-5.850 GHz (U-NII-3), and 6 GHz bands to access an additional 160-megahertz channel compared to the seven they would otherwise have, an additional 80-megahertz channel compared to the 16 they would otherwise have, two additional 40-megahertz channels compared to the 34 they would otherwise have, and three additional 20-megahertz channels compared to the 71 they would otherwise have.⁴⁷⁰ Additionally, because future Wi-Fi traffic is expected to outpace capacity, we assume that the additional 5.9 GHz spectrum will be fully used by consumers, implying that

⁴⁶⁶ See Letter from Elizabeth Andron, Senior Vice President, Regulatory Affairs, Charter, to Marlene H. Dortch, Secretary, FCC, ET Docket No. 19-138, at 2 (filed July 2, 2020).

⁴⁶⁷ *Supra* para. 123.

⁴⁶⁸ The closest example in the economic literature that could help put a consumer-centric value on each GB is a 2016 study by Nevo, Turner and Williams, but the text does not provide enough information for the Commission to recreate its results and its data is outdated. Aviv Nevo, John L. Turner, and Jonathan W. Williams, *Usage-based pricing and demand for residential broadband*, 84 *Econometrica* (2016) (Nevo et al. Study). The Nevo et al. Study divides its sample of households into 16,807 types and with a different dollar value for GB consumed for each, given a data download speed and a consumption level of data. Nevo et al. Study, at 423, 428. However, the Nevo et al. Study does not provide these values or information on every type, so the Commission cannot determine how additional value would increase with more data consumption. Further, the study is based on data from May 2011 to June 2012, where consumer value for data would be lower due to a lower quality and variety of online activities and applications and lower familiarity with technology. For the most common type of consumer (28% of the sample, Nevo et al. Study at 429-430, and type-specific parameters, Nevo et al. Study, Supplement at 11), assuming an unlimited plan, and with 1 Gbps download speed (faster speeds increase data consumption in the model), the expected GB consumed monthly would be 52.7 GB (equation 2, Nevo et al. Study at 425). We estimate that the average household already consumed 122.6 GB in 2017 (*infra* Figure C-2), suggesting that the Nevo et al. Study has been outpaced by changes in technology and consumers tastes.

⁴⁶⁹ This includes our baseline approach (*supra* para. 131 **Error! Reference source not found.**) along with an approach using alternative sources of revenue data.

⁴⁷⁰ *Supra* para. 130; 6 GHz *Report and Order*, 35 FCC Rcd at 3902, Table 6.

we can estimate additional traffic for channels of a specific bandwidth as a proportion of new Wi-Fi channels that this spectrum would create relative to existing channels of that bandwidth.⁴⁷¹

3. *Traffic Increase Calculation.* Our baseline assumptions imply that the seven 160-megahertz channels located in the 6 GHz band would be augmented by new 160-megahertz Channel 163 comprised of 115 megahertz of U-NII-3 spectrum and the lower 45 megahertz in the 5.9 GHz band (U-NII-4). Assuming that Channel 163 would be fully used, traffic would increase by roughly 14%. Alternatively, the sixteen 80-megahertz channels, including U-NII-1 Channel 42, U-NII-3 Channel 155, and fourteen channels in the 6 GHz band, would be augmented by new 80-megahertz Channel 171 comprised of the upper 35 megahertz of U-NII-3 spectrum and the lower 45 megahertz in the 5.9 GHz band (U-NII-4). Assuming that Channel 171 would be fully used, traffic would increase by roughly 6%. Proceeding similarly for lower bandwidth channels, we find that the additional 5.9 GHz spectrum would increase traffic by 6% when used by 40-megahertz channels and 4% when used by 20-megahertz channels.

4. We assume that during the period 2023-2025, 30% of traffic will occur over 160-megahertz channels, 50% over 80-megahertz channels, and 10% each over 40- and 20-megahertz channels.⁴⁷² We note that our use and distributional assumptions lead to highly conservative estimate of the reliance on 5.9 GHz channels relative to other studies.⁴⁷³ Based on our assumptions, we calculate a weighted traffic increase of 8.4%.⁴⁷⁴ We provide detailed calculations in Figure C-1.

Fig. C-1: Detailed Traffic Calculations

	Variables	Values	Note
(a)	% Traffic over 20 MHz Channels w/o Order	10%	Table 12 in the ECC Report 302
(b)	% Traffic over 40 MHz Channels w/o Order	10%	Table 12 in the ECC Report 302
(c)	% Traffic over 80 MHz Channels w/o Order	50%	Table 12 in the ECC Report 302
(d)	% Traffic over 160 MHz Channels w/o Order	30%	Table 12 in the ECC Report 302
(e)	Ex Ante 20 MHz Channels	71	
(f)	Ex Ante 40 MHz Channels	34	
(g)	Ex Ante 80 MHz Channels	16	
(h)	Ex Ante 160 MHz Channels	7	
(i)	Ex Post Policy Additional 20 MHz Channels	3	
(j)	Ex Post Policy Additional 40 MHz Channels	2	
(k)	Ex Post Policy Additional 80 MHz Channel	1	
(l)	Ex Post Policy Additional 160 MHz Channel	1	
(m)	% Growth in WiFi Traffic	8.42%	$(a) \times (i)/(e) + (b) \times (j)/(f) + (c) \times (k)/(g) + (d) \times (l)/(h)$

5. *Valuing the Increase in Traffic.* For our first approach to calculate the contribution to GDP of additional traffic, we extrapolate the Census Bureau's national revenues number for fixed Internet

⁴⁷¹ *Supra* para. 130.

⁴⁷² We do not have data on precise traffic distribution over channels of different bandwidths and instead rely on predictions from a recent Electronic Communications Committee report. Electronic Communications Committee, ECC Report 302, at 22 (May 29, 2019), <https://docdb.cept.org/download/cc03c766-35f8/ECC%20Report%20302.pdf>.

⁴⁷³ See, e.g., RAND 5.9 GHz Study at 21-22; 2020 WiFiForward Study at 27.

⁴⁷⁴ Our percentage increase calculation does not directly incorporate channel bandwidths. Instead, channel bandwidths are implicit in our assumptions about traffic prior to the 5.9 GHz spectrum being repurposed.

services between the fourth quarter of 2016 and the first quarter of 2020 to the year 2025.⁴⁷⁵ These are total revenues, so we multiply them by the projected ratio of U.S. Wi-Fi traffic over total U.S. Internet traffic.⁴⁷⁶ We multiply the resulting product by 8.4% to find the additional GDP produced by repurposing the 5.9 GHz spectrum. Over the years 2023-2025, this amounts to a present value of \$34.8 billion using a 7% discount rate and a present value of \$39 billion using a 3% discount rate. We provide detailed calculations in Figure C-2 rows (d) to (h).

6. For the second approach, we obtain two alternative estimates of the price per GB for fixed broadband based on different baselines for the average fixed broadband price. We multiply each of these by estimates of the increase in U.S. Wi-Fi traffic in GBs to find the additional GDP produced by repurposing the 5.9 GHz spectrum. The first baseline price is \$0.34/GB, the average for fixed U.S. broadband plans estimated by the Commission in its 2018 International Broadband Data Report (IBDR).⁴⁷⁷ This price derives from broadband plan data collected in 2017, so we adjust it forward using a projection of the Consumer Price Index (CPI) for “Internet services and electronic information providers.”⁴⁷⁸ Because the adjusted number reflects per household pricing, we divide it by a projection of that year’s residential traffic per household to reflect a per dollar per GB price.⁴⁷⁹ We obtain the second baseline price from the 2020 Urban Rate Survey data that the Commission collects for Universal Service purposes.⁴⁸⁰ In that data, the average monthly price is \$79.67 per month per household,⁴⁸¹ which we adjust using our projections of the Internet CPI and then divide by our projection of residential Internet traffic to project future prices per GB. However, we note that, “AT&T was oversampled due to a change

⁴⁷⁵ Earlier data exists, but Q4-2016 starts a downward trend that continues until Q1-2020. By incorporating only declining revenues, our extrapolation is conservative, likely underestimating the contributions to GDP. We use the time series for “Wired Telecommunication Carriers,” NAICS code 5171 reported from 2010-2019. United States Census Bureau, Business and Industry Time Series / Trend Charts (accessed July 30, 2020), <https://www.census.gov/econ/currentdata/dbsearch?program=QSS&startYear=2010&endYear=2020&categories=5171T&dataType=QREV&geoLevel=US¬Adjusted=1&submit=GET+DATA&releaseScheduleId=>.

⁴⁷⁶ We use CISCO estimates of 2017 and 2022 CISCO total Internet and Wi-Fi traffic and extrapolate these numbers to through year 2025. CISCO, VNI Complete Forecast Highlights, United States - 2022 Forecast Highlights, at 1-2 (2018), https://www.cisco.com/c/dam/m/en_us/solutions/service-provider/vni-forecast-highlights/pdf/United_States_Network_Connections.pdf.

⁴⁷⁷ *International Comparison Requirements Pursuant to the Broadband Data Improvement Act*, GN Docket No. 17-199, Sixth Report, 32 FCC Rcd 978, 1035, Table 3.

⁴⁷⁸ We linearly extrapolate from the average annual CPI in “Internet services and electronic information providers.” U.S. Bureau of Labor Statistics, Databases, Tables & Calculators by Subject, https://data.bls.gov/timeseries/CUUR0000SEEE03?output_view=data (last visited Oct. 27, 2020).

⁴⁷⁹ According to a study by Telecom Advisory Services, LLC, 43.12% of traffic is accessed through the home. Thus, we obtain residential Internet traffic by multiplying total Internet traffic by 43.12%. Letter from Alex Roytblat, Counsel to Wi-Fi Alliance, to Marlene H. Dortch, Secretary, FCC, WT Docket No. 18-295, Attach. 2 at 84 (filed Oct. 12, 2018) (Wi-Fi Alliance Oct. 12, 2018 *Ex Parte*). To derive the monthly residential traffic per household, we divide U.S. residential traffic by the number of households served by fixed broadband Internet, estimated from December 2016 to June 2019 in the Fixed Broadband Form 477 and linearly extrapolated to 2025.

⁴⁸⁰ FCC, Urban Rate Survey Data and Resources, <https://www.fcc.gov/economics-analytics/industry-analysis-division/urban-rate-survey-data-resources> (last visited Oct. 27, 2020).

⁴⁸¹ This is a weighted average using weights included with the published data. FCC, Urban Rates Survey Broadband Survey Results (2020), <https://www.fcc.gov/file/17600/download>. The weights are a combination of sampling weights, nonresponse weights, weights to correct for respondents reporting multiple plans, and weights to correct for the number of potential subscribers each respondent has. FCC, 2020 Urban Rate Survey – Fixed Broadband Service Analysis (2020), <https://www.fcc.gov/file/17911/download>.

in its reporting for Form 477 and Urban Rate Survey purposes” in this edition of the Urban Rate Survey, so that we prefer the IDBR-based estimate in our second approach.⁴⁸²

7. To estimate the increase in U.S. Wi-Fi traffic, we first extrapolate U.S. Wi-Fi traffic for the years 2023-2025 using CISCO estimates of Wi-Fi traffic in 2017 and 2022.⁴⁸³ We find the additional traffic per year by multiplying the CISCO estimates by 8.4%. We then multiply the resulting number by our per dollar per GB price estimates to obtain the contribution to GDP. Using the IBDR baseline price, over the years 2023-2025, this amounts to a present value of \$17.2 billion using a 7% discount rate and a present value of \$19.3 billion using a 3% discount rate. Alternatively, using the Urban Rate Survey baseline, over the years 2023-2025, this amounts to a present value of \$32.7 billion using a 7% discount rate and a present value of \$36.6 billion using a 3% discount rate. We provide detailed calculations in Figure C-2 rows (a) to (c) together with rows (i) to (w).

8. *Robustness of baseline analysis.* In addition to applying different revenue projections and discount rates to our baseline traffic assumptions, we have also found that our analysis is robust to several variations of our model. In particular, we have repeated our calculations accounting for additional U-NII-2 channels, though we note that most Wi-Fi use occurs within the 2.4 GHz, U-NII-1, and U-NII-3 bands.⁴⁸⁴ As in our baseline model, this variation assumes that the 6 GHz channels would be used at the time that 5.9 GHz spectrum would also become available. As we show below, if we alternatively assumed that 6 GHz spectrum would not be available during 2023-2025, our estimates of the contribution of 5.9 GHz spectrum for unlicensed use rise substantially.

9. To further account for potential usage of the U-NII-2 band, we suppose, instead that there are initially eighty-seven 20-megahertz channels, forty-two 40-megahertz channels, twenty 80-megahertz channels, and nine 160-megahertz channels⁴⁸⁵ which reduces the baseline weighted traffic increase from repurposing 5.9 GHz spectrum to 6.7%, as opposed to 8.4% in our baseline model.⁴⁸⁶ Using our lowest estimate of the value of this traffic leads to a present value GDP contribution of \$13.6 billion over the years 2023-2025.⁴⁸⁷

10. If we instead assumed that 6 GHz spectrum would not be available during 2023-2025, while supposing that U-NII-2 channels would be fully used during this timeframe, the weighted traffic increase from repurposing 5.9 GHz spectrum goes up to 25.9%. Using our lowest estimate of the value of this traffic leads to a present value GDP contribution of \$53.1 billion over the years 2023-2025. The

⁴⁸² FCC, Urban Rate Survey Broadband Survey Results (2020), <https://www.fcc.gov/file/17600/download>.

⁴⁸³ CISCO estimates that United States Internet traffic will be 2.8 exabytes (EB) per day (or 1,022 EB per year) by 2022, up from 924 petabytes (PB) per day (or 337.26 EB per year) in 2017. Additionally, CISCO estimates that the United States fixed/Wi-Fi ratio was 50.4% of total Internet traffic in 2017, and will be 56.6% of total Internet traffic by 2022. CISCO, VNI Complete Forecast Highlights, United States - 2022 Forecast Highlights, at 1-2 (2018).

⁴⁸⁴ *6 GHz Report and Order*, 35 FCC Rcd at 3937, n.602 (“most use occurs within the 2.400-2.483.5 GHz band, the 5.150-5.250 GHz U-NII-1 band and the 5.725-5.850 GHz U-NII-3 band”).

⁴⁸⁵ Specifically, we include additional U-NII-2 channels together with those listed in Table 6 of the *6 GHz Report and Order* as follows. We include 20-megahertz channels 52, 56, 60, 64, 100, 104, 108, 112, 116, 120, 124, 128, 132, 136, 140, and 144. We include 40-megahertz channels 54, 62, 102, 110, 118, 126, 134, and 142. We include 80-megahertz channels 58, 106, 122, 138. We also include 160-megahertz channels 50 and 114, the former of which is comprised of both U-NII-1 and U-NII-3 spectrum.

⁴⁸⁶ We observe that U-NII-2 devices must employ dynamic frequency selection to protect Federal radar operations and transmit power control to protect the Earth exploration satellite service, leading to lower usage of these channels than those included in our baseline model. See C.F.R. § 15.407(h).

⁴⁸⁷ This figure is based on our IBDR price per GB estimate and a 7% discount rate.

weighted traffic increase and GDP contribution would rise even further if we excluded usage of U-NII-2 channels.

11. Finally, in our baseline analysis, we assumed that 5.9 GHz spectrum would be fully used by consumers, leading to our baseline weighted traffic increase of 8.4%.⁴⁸⁸ However, as we previously stated, relaxing this assumption does not change our findings.⁴⁸⁹ For example, suppose that, conservatively, the increase in traffic were only 1%. Using our lowest estimates of the value of this traffic still leads to a present value GDP contribution of \$2 billion over 2023-2025, which is still higher than expected one-time transition costs.

⁴⁸⁸ *Supra* para. 130.

⁴⁸⁹ *Supra* note 334.

Fig. C-2: Benefit Calculations

	Year					Notes	
	2017	2019	2023	2024	2025		2023-2025
Traffic Projections							
(a)	Total Internet Traffic (Billions GB)	337.26	1,159	1,296	1,433		From CISCO Projections
(b)	Wi-Fi Traffic (Billions GB)		660	742	824		From CISCO Projections
(c)	Increase Wi-Fi Traffic (Billions GB)		56	62	69		$8.4\% \times (b)$
Revenues Based Analysis							
(d)	Wired Revenue (\$ Billion)		\$298	\$295	\$291		From US Census
(e)	Wi-Fi Revenue (\$ Billion)		\$170	\$169	\$168		$(d) \times (b) / (a)$
(f)	Impact (\$ Billion, Revenues)		\$14.3	\$14.2	\$14.1	\$42.6	$8.4\% \times (e)$
(g)	Impact, 3% Discount (\$ Billion, Revenues)		\$13.5	\$13.0	\$12.5	\$39.0	$(f) / 1.03\%^{(Year-2021)}$
(h)	Impact, 7% Discount (\$ Billion, Revenues)		\$12.5	\$11.6	\$10.8	\$34.8	$(f) / 1.07\%^{(Year-2021)}$
IBDR Based Analysis							
(i)	Unit Internet Price Level (100.0 = 1997)	76.5	77.1	77.5	77.6	77.6	From CPI
(j)	Residential Traffic (Billions GB)	145		500	559	618	$43.1\% \times (a)$
(k)	Number of Internet Residential Households (Billions)	0.10		0.12	0.12	0.13	From Form 477
(l)	Monthly Residential Per Household GB Usage	123		346	375	403	$(j) / (k) / 12 \text{ months}$
(m)	Internet Price Level (100.0 = 1997) Per GB	0.62		0.22	0.21	0.19	$(i) / (l)$
(n)	Internet Price Level Per GB (1.00 = 2017)			0.36	0.33	0.31	$(m) / \text{Value from 2017}$
(o)	Average Fixed Broadband Price (\$/GB)			\$0.12	\$0.11	\$0.10	$\$0.34 / \text{GB (From IDBR (2018))} \times (n)$
(p)	Impact (\$ Billion, IDBR)			\$6.8	\$7.0	\$7.3	$(o) \times (c)$
(q)	Impact, 3% Discount (\$ Billion, Revenues)			\$6.4	\$6.4	\$6.5	$(p) / 1.03\%^{(Year-2021)}$
(r)	Impact, 7% Discount (\$ Billion, Revenues)			\$5.9	\$5.7	\$5.6	$(p) / 1.07\%^{(Year-2021)}$
URS Based Analysis							
(s)	Internet Price Level Household (1.00 = 2019)			1.00	1.01	1.01	$(i) / \text{Value from 2019}$
(t)	Average Fixed Broadband Price (\$/GB, URS)			\$0.23	\$0.21	\$0.20	$\$79.67 \text{ (From URS (2020))} \times (s) / (l)$
(u)	Impact (\$ Billion, URS)			\$12.9	\$13.3	\$13.8	$(c) \times (t)$
(v)	Impact, 3% Discount (\$ Billion, Revenues)			\$12.1	\$12.2	\$12.3	$(u) / 1.03\%^{(Year-2021)}$
(w)	Impact, 7% Discount (\$ Billion, Revenues)			\$11.2	\$10.9	\$10.5	$(u) / 1.07\%^{(Year-2021)}$

APPENDIX D
FINAL REGULATORY FLEXIBILITY ANALYSIS

APPENDIX E
INITIAL REGULATORY FLEXIBILITY ANALYSIS

APPENDIX F
LIST OF COMMENTERS

5G Americas
5G Automotive Association
A. Catherine Reid, PE
AAA
ACEA, CLEPA
Advocates for Highway and Auto Safety
Airbus UM
Airbus Urban Mobility
Alan R. Chapman, Thomas A. Sever, B. Alexander Hofelich (Gwinnett County Department of Transportation)
Alexandre Petrescu
Alliance for Automotive Innovation
Alliance of Automobile Manufacturers
Aly Geller, Stephen Bingham, Alvin Lester, Julie Mitchell, John Alex Lowell, Fenell Doyle, Jen Holt, Nancy Harrison, Jenny Yu, Amanda Lamb
Alyssa Ryan
Amanda Erickson
Amateur Radio
Amateur Television Network
Amateur Television Network - California Chapter
American Association of State Highway and Transportation Officials (AASHTO)
American Highway Users Alliance
American Honda Motor Co., Inc.
American Public Transportation Association
American Public Works Association (APWA)
American Society of Civil Engineers (ASCE)
American Traffic Safety Services Association
American Trucking Associations
Amul Gadhia
Amy MacKinnon
Andrew Kading
Andrew Ludlum
Ann Dorsey

Applied Information Inc.
Applied Information Inc., Temple, Inc., Traffic Products LLC
AREDN
Argo AI, LLC
Arizona Chapter, Amateur Television Network
Arkansas Department of Transportation
ARRL, National Association of Amateur Radio
Association of Global Automakers, Inc.
Association of Metropolitan Planning Organizations
AT&T Services, Inc.
August H Johnson
Automotive Safety Council
Autonomy Institute
Autotalks
Ben McFarlin
Benjamin K. Derry
Benjamin Mills
Bill Panos
Blayne Ence, Tracy Ence
BMW Group – AJ6AW
Bob Thorpe
Brandon Kay
Brett Popovich
Brian Heinitz
Brian L Short
Brian Worley, Association of Oregon Counties, Oregon Association of County Engineers and Surveyors
Brian Yee
Broadcom Inc.
Broadcom, Inc., CableLabs, Facebook, Inc., NCTA - The Internet & Television Association
Broadcom, Inc., Facebook, Inc.
Bruce Billedeaux
Bruce D. Bonbright
Bruce M. Warren
Burton Peake

C. Rantala
California Department of Transportation
Candace A. Miller – KE6KYA
CAR 2 CAR Communication Consortium
Carlos Crespo
Center for Auto Safety
Chad J Gross – W0SAV
Charles A. Moorwood
Charles E. Gelm
Charter Communications, Inc.
Chris Spear, President & CEO American Trucking Associations
Christopher Parise
Christopher Peters
Christopher S. Webster
Chuck DeWeese
Cintra US
Cirrus Aircraft
Cisco Systems, Inc.
Citizens Against Government Waste
Citizens Against Government Waste, Innovation Economy Institute, Institute for Freedom, TechFreedom, American Commitment, Institute for Policy Innovation, Less Government, Market Institute, FreedomWorks, Taxpayers Protection Alliance, Center for Individual Freedom, Innovation Defense, National Taxpayers Union, Lincoln Network, American Conservative Union, American Legislative Exchange Council, ALEC Action, Consumer Action for a Strong Economy, Americans for Tax Reform, Digital Liberty, Technology & Democracy Project of the Discovery Institute
City of Arlington, Texas
City of Fremont
City of Frisco, Texas
Cohda Wireless Pty Ltd
Collin Mooney
Colorado Department of Transportation
Comcast Corporation
Commercial Vehicle Safety Alliance
Commercial Vehicle Training Association

Commsignia, Inc.
Competitive Enterprise Institute
Connecticut Department of Transportation
Consumer Action for a Strong Economy, Inc.
Consumer Reports
Continental AG
Continental Automotive Systems
Contra Costa Transportation Authority (CCTA)
Damon Schaefer
Dan D. Tomlinson
Dan Tomlinson
Daniel Krones
Daniel Sohn, Juliet A Sohn
Daniel Ruderman
Darryl Quinn
David A. Lathrop, PhD
David Bauer
David Bell
David Hinkley
David J. Kreizinger
David Kaczorowski
David Molinaro
David West
David Williams
Denis J Couture
Dennis A. Yard
Dennis Baker
DENSO Corporation
Denso International America, Inc.
DJI Technology, Inc.
Donald Backstrom
Donald Hill
Dr. Richard Roy
DriveOhio

DSRC Auto Safety Coalition
Dwight A. Henderson
Dynamic Spectrum Alliance
Edward S. Colonna, K4ESC
Elizabeth Pestolesi
Emiko Thompson, Los Angeles County Public Works
Energy Security Leadership Council (ESLC), Securing America's Future Energy (SAFE)
Engine
Environmental Health Trust
Eric Satterlee
Facebook, Inc.
Faller, Davis and Associates, Inc.
Farren Constable
FCA US LLC
Ford Motor Company
Gary Hinton
Gary Spurr
Gary Thomas
General Aviation Manufacturers Association
General Motors LLC
Georenz Koo
Georgia Department of Transportation
Georgia Lieutenant Governors Office, Georgia DOT, Forsyth County, Atlanta Regional Commission, KCI Technologies, Greater North Fulton Chamber, North Fulton CID, Gresham Smith, Kimley Horn, City of Alpharetta, City of Johns Creek, Stantec Consulting Services, Intelligent Transportation Society - Georgia, Georgia Institute of Technology, Modern Mobility Partners, Atlas Technical Consultants, Utilicom Supply, City of Savannah, Aerotropolis Atlanta CID, Applied Information, Inc, Gwinnett County, Cobb County DOT, Metropolitan Atlanta Rapid Transit Authority, Douglas County DOT, City of Roswell, Barge Design Solutions, HNTB, ACEC Georgia, State Road and Tollway Authority, Georgia Regional Transportation Authority, Atlanta-region Transit Link Authority, Clayton County
German Association of the Automotive Industry
Government Wireless Technology & Communications Association
Governor Bill Lee, State of Tennessee
Gregory T. Lane - K7SDW

Guy S. Chabot
HARMAN International Inc.
Harvey Chin
Hawaii Bicycling League
Heidi Brewer
Heidi J Williams
Hyundai America Technical Center, Inc.
IEEE 1609 Working Group
IEEE 802 LAN/MAN Standards Committee
Innovation Economy Institute, International Center for Law and Economics, Citizens Against Government Waste, Taxpayers Protection Alliance, American Commitment, American Conservative Union, Innovation Defense Foundation, Consumer Action for a Strong Economy, Lincoln Network, Digital Liberty, Center for Individual Freedom, Institute for Policy Innovation, FreedomWorks, Market Institute, National Taxpayers Union, Discovery Institute, Less Government
Institute for Policy Innovation, Dan Garretson
Institute of Transportation Engineers
Intel Corp.
Intelligent Transportation Society of America
Intelligent Transportation Society of America, American Association of State Highway and Transportation Officials
Intelligent Transportation Society of Michigan
International Association of Fire Chiefs
International Association of Fire Fighters
International Center for Law & Economics
International Municipal Signal Association
ISO/TC 204 Intelligent Transport Systems
J. Allison Hollier
J. S. Paige
Jaguar Land Rover Limited
James Bass, Texas Department of Transportation
James C Merritt - KK4IUH
James Dahl
James Erickson, Mansfield Johnson Radio Service
James Gatwood

James J. Stagnone
James Laning
James Nelson
James R. Walls
James S. Paige
James Strasma - N9ZKP
Jason Baack
Jason Levine - Center for Auto Safety
Jeff Beck
Jeff Orr
Jeff Palmer
Jeff Phillips
Jeffrey D. Hendricks
Jeffrey Libby
Jeremiah Bagula
Jeremy Jackson - KE7MWG
Jesse Kanda
Joanna Pinkerton, Patrick Harris
Joe K. Gillis
Joe Kane, Will Rinehart
Joel Jundt, SDDOT
Joel Kelley
John E. Davis
John Hickey
John Penney - AA6JN
John Skier
Jon M. Peha
Jonathan F. Blincoe
Jonathan Riehl, PhD, PE
Jordan Mills
Jose Melendres
Joseph B. Allee - KD6MJR
Joseph David Cook
Joseph W. Partlow

Joseph William Hutchinson

Judy Cox

Julie Evans

Julie McGrew

Juniper Networks

KA7HAK, Chad Smith

Karl MacNair, PE

Katherine Yehl, Volvo Cars

Kathleen Freitag, A.J. O'Connor

Keith S. Gordon

Kenneth Hutchinson - K6KWH

Kenneth Vaughn

Kent Olson

Kentucky Transportation Cabinet

Kevin Bourgault

Kevin Mottus

Kevin Olm

Kevin O'Neill

Kingsley Swanson

Krishna C Patnam

Kristin R. White

Kristopher J. Ulmer

Kyle Henderson

L. Stephen Bell

Larry Kapp

Larry Trullinger

League of American Bicyclists, East Coast Greenway, Bicycle Advocacy of Central Arkansas, California Association of Bicycling Organizations, San Diego County Bicycle Coalition, BikeWalkSolana, Florida Bicycle Association, Georgia Bikes, Treasure Valley Safe Routes to School Program, Ride Illinois, Friends of Cycling Elk Grove, Bicycle Indiana, Bicyclists of Iowa City, MassBike, Bicycle Alliance of Minnesota, Missouri Bicycle & Pedestrian Federation, BikeWalkKC, New Jersey Bike & Walk Coalition, Law Office of Diane Albert, Long Island Steets, Inc, Po Campo Company, Transportation Alternatives NYC, Bike Cleveland, Bicycle Coalition of Greater Philadelphia, Bike Pittsburgh, Palmetto Cycling Coalition, Walk/Bike Nashville, Local Motion- Burlington, VT, Cascade Bicycle Club, West Virginia

Connecting Communities, Wyoming Pathways
Lenora R Allee - KE6IRH
LG Electronics, Inc.
Loren Kellogg - KE7RXD
Lt. Governor Geoff Duncan
Macomb County Department of Roads, Director Bryan Santo, John Abraham
Mansfield-Johnson Amateur Radio Service
Marc Longstreet
Marco Friend
Maricopa County Department of Transportation
Mark D. Braunstein
Mark O. Jensen
Mark. D. Braunstein
Martin A. Woll
Martin R. Rothfield
Maryland Department of Transportation (MDOT)
Matthew E. "Matt" Moore, M.A., Idaho Transportation Department
Matthew E. Moore, M.A.
Matthew Letourneau
Matthew Spencer
Max Donath
MEMA
Michael H. Stevens
Michael H. Stevens, City of Columbus, Smart Columbus
Michael J. Bailey
Michael Kelly
Michael Newman
Michael T. Schlenker
Michigan Department of Transportation
Microsoft Corporation
Mineta Transportation Institute
Mitchell Mouser
Montana Department of Transportation Director Mike Tooley
Morgan Collins

Motor & Equipment Manufacturers Association (MEMA)
Mr. Gregory Slater, Secretary, Maryland Department of Transportation
NAFA Fleet Management Association
Nathan Fernaays
National Association of City Transportation Officials
National Electrical Manufacturers Association (NEMA)
National Federation of the Blind
National Public Safety Telecommunications Council
National Safety Council
National School Transportation Association
National Sheriffs' Association
National Telecommunications and Information Administration
NCTA - The Internet & Television Association
Neil Gray, Patrick Jones
New America's Open Technology Institute
Niels Peter Skov Andersen
Nissan North America, Inc.
Nokia
North Central Texas Council of Governments
NTCA - The Rural Broadband Association
NXP Semiconductors
Office of Engineering & Technology
OmniAir Consortium, Inc.
Open Technology Institute and Public Knowledge
Open Technology Institute at New America
Orange County Transportation Authority
Oregon Department of Transportation
Panasonic Corporation of North America
Parkofon
Paul Estes
Pennsylvania Department of Transportation (PennDOT)
Perry Ogletree
Peter A. Laudenslager
Peter R Bergstrom

Peter Skweres
Phil Stegall
Prem Marimuthu
PrePass Safety Alliance
Public Interest Organizations
Public Knowledge
Public Safety & Homeland Security Bureau
Qualcomm Incorporated
R Street Institute
Raj Rajkumar, Carnegie Mellon University
Ray David Congdon
Rep. Jim Cooper
Richard F. Daugherty II
Robert Andrews
Robert Barkley
Robert Bosch LLC
Robert Bowes
Robert Brammer
Robert Casey
Robert Evans
Robert Freeburn - K6RJF
Robert L. Bertini
Robert L. Sumwalt, III
Robert Lovejoy
Robert Moore - KW6B
Robert Pestolesi - KE6GYD
Roger Wentz
Royce F. Crocker
RS&H, Inc
Ryan Pierce
Ryan Promack
SAE International
SAE International: V2X Core Technical Committee & Infrastructure Applications Technical Committee
Safer Motorcycling Research Consortium (SMRC)

Safety Research Using Simulation University Transportation Center
San Bernardino Microwave Society
San Diego Association of Governments
Sandra Cullen
Sandy Klausner
Savari
Seaver Klug
Securing America's Future Energy (SAFE)
SES Americom, Inc., Intelsat License LLC
Seth W. Chalmers
Shane Huston - KG7QWH
Shireesh Verma
Shirley Tseng
Sibrtech inc.
South Dakota Department of Transportation
Stanley Tahara
Stephen Lewis
Stephen Skwarlo
Steve Anness
Steve J. Noll
Steven Cummings
Steven Farinella
Susan Best
Tampa Hillsborough County Expressway Authority (THEA)
TechFreedom
Tennessee Department of Transportation, Chairman of Transportation Committee- Dan Howell
Tennessee Department of Transportation
TennSMART Board of Directors
Texas A&M Transportation Institute
The Association for Unmanned Vehicle Systems International
The City of New York
The Free State Foundation
Thomas C. Eagle
Thomas H. Weyhrauch - KD0DOS

Thomas I. Breed
Tim Irish, Johnson County Amateur Radio Club
T-Mobile USA, Inc.
Tom Preston
Toyota Motor Corporation
Toyota Motor North America, Inc.
Transbase.US, PBC
Transportation for America
Truck and Engine Manufacturers Association
U-blox America
United Parcel Service, Inc.
US Technical Advisory Group to ISO/TC 204 Intelligent Transport Systems
Utah Department of Transportation
Vincent Sabia
Virginia Tech Transportation Institute
Vision Zero Network
Volkswagen Group of America, Inc.
Volvo Group North America
W0SV SCARC
Walker Consultants
Washington State Department of Transportation
Wednesday Warford
Wi-Fi Alliance
William Arthur
William C. Hymes
William Gery
William M VanKirk
William R. Miller - KE6KYH
William Rantala
William T. Panos, Director - North Dakota Department of Transportation
William Woods
Wireless Internet Service Providers Association
WSP USA
Wyoming Department of Transportation