October 26, 2017

FCC FACT SHEET*

Use of Spectrum Bands Above 24 GHz for Mobile Radio Services

Second Report and Order, Second Further Notice of Proposed Rulemaking, Order on Reconsideration, and Memorandum Opinion and Order, GN Docket No. 14-177

Background: In recent years, technological advances have increased our ability to harness millimeter wave (mmW) technology for fixed and mobile wireless communications in high band spectrum, while demand for connected products and services continues to grow. This item would take further action to facilitate the development of advanced wireless services and provide greater and more flexible access in spectrum bands above 24 GHz.

What the Second Report and Order, Order on Reconsideration, and Memorandum Opinion and Order Would Do:

- Make available an additional 1700 megahertz of high band spectrum for flexible terrestrial wireless use in the 24 GHz and 47 GHz bands.
- Maintain the spectrum allocations adopted in the 28 GHz, 37 GHz, and 39 GHz bands, with several minor modifications to the rules that were previously established.
- Maintain 4 gigahertz of spectrum in the 48.2-50.2 GHz and 40-42 GHz bands as core satellite bands, including end user devices.
- Maintain the unlicensed use of the 64-71 GHz band, and modify Part 15 rules to allow unlicensed operation on board most aircraft during flight in the 57-71 GHz band.
- Focus development of the 70/80 GHz bands on fixed and other newer, innovative uses.
- Adjust the earth station siting rules and satellite interference standards to ensure flexibility in deployment while limiting the potential for interference between satellite and mobile users.
- Decline to artificially limit bidders in the 24 GHz and 47 GHz bands in an auction, and incorporate these two bands into the previously-adopted mmW spectrum threshold for reviewing proposed secondary market transactions.

What the Second Further Notice Would Do:

- Propose to allow more flexible FSS (fixed-satellite service) use of the 24.75-25.25 GHz band.
- Seek comment on another option for terrestrial mmW licensees to meet performance obligations, which could accommodate IoT deployments and other innovative services.
- Propose to eliminate the pre-auction mobile spectrum holdings limits for the 28, 37, and 39 GHz bands and seek comment on case-by-case reviews of post-auction applications for licenses in the 24, 28, 37, 39, and 47 GHz bands.

* 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 GN Docket No. 14-177, 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 Spectrum Bands Above 24 GHz For Mobile Radio Services	)	GN Docket No. 14-177
	)	
Establishing a More Flexible Framework to Facilitate Satellite Operations in the 27.5-28.35 GHz and 37.5-40 GHz Bands	)	IB Docket No. 15-256
	)	
Amendment of Parts 1, 22, 24, 27, 74, 80, 90, 95, and 101 To Establish Uniform License Renewal, Discontinuance of Operation, and Geographic Partitioning and Spectrum Disaggregation Rules and Policies for Certain Wireless Radio Services	)	WT Docket No. 10-112
	)	
Allocation and Designation of Spectrum for Fixed-Satellite Services in the 37.5-38.5 GHz, 40.5-41.5 GHz and 48.2-50.2 GHz Frequency Bands; Allocation of Spectrum to Upgrade Fixed and Mobile Allocations in the 40.5-42.5 GHz Frequency Band; Allocation of Spectrum in the 46.9-47.0 GHz Frequency Band for Wireless Services; and Allocation of Spectrum in the 37.0-38.0 GHz and 40.0-40.5 GHz for Government Operations	)	IB Docket No. 97-95

SECOND REPORT AND ORDER, SECOND FURTHER NOTICE OF PROPOSED RULEMAKING, ORDER ON RECONSIDERATION, AND MEMORANDUM OPINION AND ORDER*

Adopted: [] **Released: []**

Comment Date:
Reply Comment Date:

By the Commission:

* This document has been circulated for tentative consideration by the Commission at its November 16, 2017 open meeting. The issues referenced in this document and the Commission's ultimate resolution of those issues remain under consideration and subject to change. This document does not constitute any official action by the Commission. However, the Chairman has determined that, in the interest of promoting the public's ability to understand the nature and scope of issues under consideration, the public interest would be served by making this document publicly available. The FCC's *ex parte* rules apply and presentations are subject to "permit-but-disclose" *ex parte* rules. *See, e.g.*, 47 C.F.R. §§ 1.1206, 1.1200(a). Participants in this proceeding 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(a), 1.1203.

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I. INTRODUCTION

1. Today, we take further actions in this proceeding to make available millimeter wave (mmW) spectrum, at or above 24 GHz, for fifth-generation (5G) wireless, Internet of Things, and other advanced spectrum-based services. In doing so, we help ensure continued American leadership in wireless broadband, which represents a critical component of economic growth, job creation, public safety, and global competitiveness.

2. In particular, we make available an additional 1700 megahertz of mmW spectrum for flexible wireless use, in the 24.25-24.45 and 24.75-25.25 GHz band (24 GHz band) and the 47.2-48.2 GHz band. When added to the mmW spectrum already made available for flexible wireless use in the 27.5-28.35 GHz (28 GHz), 37-38.6 GHz (37 GHz), 38.6-40 GHz (39 GHz band), and 64-71 GHz bands, the Commission has now made available approximately 13 gigahertz of mmW spectrum in this proceeding, and we will continue to evaluate additional mmW bands in this proceeding and in a separate proceeding on bands above 95 GHz.

3. At the same time, we adopt rules that will allow the mmW bands to be shared with a variety of other uses, including satellite, fixed, and Federal government uses. Specifically, we target the 40-42 GHz and 48.2-50.2 GHz bands for expansion of Fixed Satellite Service (FSS), and we adjust previously adopted earth station requirements in the 28 GHz and 39 GHz bands to permit greater satellite flexibility, particularly in rural areas. We also preserve the 70 and 80 GHz bands for traditional and innovative fixed wireless uses, which we will continue to explore in a separate proceeding. In addition, we allow for expanded unlicensed use of the 57-71 GHz band on-board aircraft.

4. In addition, we reconsider several mmW band service rules previously adopted in this proceeding to ensure that we maximize flexibility and encourage innovation in the mmW bands. For

example, we propose to eliminate the *ex ante* auction limit on spectrum holdings in the 28, 37, and 39 GHz bands, consistent with our decision not to adopt an *ex ante* auction limit for the 24 GHz and 47.2-48.2 GHz bands. Further, we conclude that it would serve the public interest to rescind the previously adopted cybersecurity reporting requirements, and instead to seek input through the Communications Security, Reliability, and Interoperability Council (CSRIC) process.

5. We also affirm a number of the decisions previously made in this proceeding to provide certainty so that licensees can continue to invest in networks that provide high speed and low latency services available to consumers and businesses. We note that major carriers and smaller operators are beginning to develop the mmW frequencies' potential for low-cost wireless equivalents of fiber to homes and small businesses.

6. Our efforts in this proceeding to make mmW spectrum for wireless broadband available are part of the Commission's broader initiative to make available additional spectrum for wireless broadband across a range of frequencies. For example, 65 megahertz of AWS-3 spectrum was won at auction in 2015, while 70 megahertz of 600 MHz spectrum was won in the recently concluded broadcast television incentive auction.[1] Earlier this year, the Commission sought input on potential opportunities in spectrum bands between 3.7 GHz and 24 GHz.[2] We will continue these efforts to facilitate access to low-band, mid-band, and high-band spectrum for the benefit of American consumers.

II. BACKGROUND

7. Recent technological advances have unlocked the potential of millimeter wave (mmW) frequencies to support fixed and mobile wireless services that that need flexible access to spectrum. While mmW bands feature short transmission paths and high propagation losses, those features can be useful in developing high-capacity networks because cells can be placed close to each other without causing interference to each other. In addition, where longer paths are desired, the extremely short wavelengths of mmW signals make it feasible for very small antennas to concentrate signals into highly focused beams with enough gain to overcome propagation losses. The short wavelengths of mmW signals also make it possible to build multi-element, dynamic beam-forming antennas that will be small enough to fit into handsets – a feat that might not be possible at the lower, longer, wavelength frequencies below 6 GHz where cell phones operate today.

8. On July 14, 2016, the Commission adopted and released the *Report and Order and Further Notice of Proposed Rulemaking* in this proceeding.[3] The *R&O* made mmW spectrum available through both licensed and unlicensed mechanisms. The Commission created a new Upper Microwave Flexible Use Service, which authorized both fixed and mobile operations in the 28 GHz and 39 GHz bands using geographic area licensing.[4] In the 28 GHz band, the Commission adopted county-sized

[1] *Auction Of Advanced Wireless Services (AWS-3) Licenses Closes, Winning Bidders Announced For Auction 97, Public Notice*, 30 FCC Rcd 630 (2015); *Incentive Auction Closing and Channel Reassignment Public Notice; The Broadcast Television Incentive Auction Closes; Reverse Auction and Forward Auction Results Announced; Final Television Band Channel Assignments Announced; Post-Auction Deadlines Announced*, Public Notice, 32 FCC Rcd 2786 (MB, WTB 2017) (*Closing and Channel Reassignment Public Notice)*.

[2] *Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz*, Notice of Inquiry, FCC 17-104 (Aug. 3, 2017) (*Mid-Band Spectrum NOI*).

[3] *Use of Spectrum Bands Above 24 GHz For Mobile Radio Services, et al*., Report and Order and Further Notice of Proposed Rulemaking, 31 FCC Rcd 8014 (2016). When citing to the *Report and Order* portion of the document, we will refer to the *R&O*. When citing to the *Further Notice of Proposed Rulemaking* portion of the document, we will refer to the *FNPRM*. For background on earlier actions in this proceeding, see earlier orders released in this proceeding.

[4] *R&O*, 31 FCC Rcd at 8023-56, paras. 19-100.

geographic area licenses.[5] In the 39 GHz band, it adopted Partial Economic Area (PEA) licenses.[6] The Commission also adopted geographic area licensing using PEAs for the 37.6-38.6 GHz band.[7] In the 37-37.6 GHz band, it established coordinated co-primary shared access between Federal and non-Federal users.[8] The Commission also protected a limited number of Federal military sites across the full 37 GHz band and maintained the existing Federal fixed and mobile allocations throughout the band.[9] In the 64-71 GHz band, the Commission authorized unlicensed operations under Part 15 based on the rules for the adjacent 57-64 GHz band.[10] This action provided more spectrum for unlicensed uses such as Wi-Fi-like "WiGig" operations and short-range devices for interactive motion sensing.

9. In the *R&O*, the Commission also established licensing and operating rules for the Upper Microwave Flexible Use Service (UMFUS). It granted mobile operating rights to existing Local Multipoint Distribution Service (LMDS) and 39 GHz band licensees, while subdividing their existing licenses to either the county or PEA level.[11] The Commission revised the 39 GHz band plan to provide licensees with wider blocks of contiguous spectrum, and established a mechanism for existing licensees to transition to the new band plan.[12] It adopted service and technical rules designed to facilitate full and complete use of the bands, including an operability requirement for equipment.[13] It adopted spectrum holdings policies for the 28 GHz, 37 GHz, and 39 GHz bands that apply to licenses acquired through auctions and the secondary market.[14] The Commission also adopted performance requirements for mobile, point-to-multipoint, and fixed uses.[15] The Commission adopted a requirement that UMFUS licensees submit a statement describing their security plans and related information prior to commencing operations.[16] Finally, it deleted the broadcasting and broadcasting-satellite service allocations from the 42-42.5 GHz band (42 GHz band) and declined to allocate the band to the Fixed-satellite service (space-to-Earth).[17]

10. The *FNPRM* sought comment on authorizing fixed and mobile use of the following bands: 24.25-24.45 GHz together with 24.75-25.25 GHz (24 GHz band), 31.8-33 GHz (32 GHz band), 42-42.5 GHz (42 GHz band), the 47.2-50.2 GHz (47 GHz band), 50.4-52.6 GHz (50 GHz band), and the 71-76 GHz band together with the 81-86 GHz bands (70/80 GHz bands).[18] The Commission also sought comment on use of bands above 95 GHz.[19] It sought comment on the details of the sharing framework

[5] *R&O*, 31 FCC Rcd at 8029-30, paras. 35-36.

[6] *R&O*, 31 FCC Rcd at 8046-47, para. 82.

[7] *R&O*, 31 FCC Rcd at 8059-60, paras. 111-113.

[8] *R&O*, 31 FCC Rcd at 8059-60, paras. 111-113.

[9] *R&O*, 31 FCC Rcd at 8070-71, paras. 148-151.

[10] *R&O*, 31 FCC Rcd at 8064-65, para. 130.

[11] *R&O*, 31 FCC Rcd at 8031, 8038, paras. 41-42, 86-87.

[12] *R&O*, 31 FCC Rcd at 8053-56, paras. 95-96, 98-100.

[13] *R&O*, 31 FCC Rcd at 8127, paras. 321-324.

[14] *R&O*, 31 FCC Rcd at 8081-84, paras. 183-190.

[15] *R&O*, 31 FCC Rcd at 8084-92, paras. 191-223.

[16] *R&O*, 31 FCC Rcd at 8101-06, paras. 255-265.

[17] *R&O*, 31 FCC Rcd at 8144, paras. 367-368.

[18] *FNPRM*, 31 FCC Rcd at 8145-69, paras. 370-441.

[19] *FNPRM*, 31 FCC Rcd at 8169-70, paras. 442-445. We note that we are seeking further comment on bands above 95 GHz in a separate Further Notice.

adopted for the 37-37.6 GHz band, both among non-Federal operators and with the Federal government.[20] It also sought comment on circumstances under which Federal government users could gain coordinated access to spectrum in the 37.6-38.6 GHz band (in addition to the protected sites) in the future.[21]

11. The *FNPRM* also sought comment on possible changes to the licensing and technical rules. The Commission sought comment on establishing performance requirements for innovative uses associated with the Internet of Things (IoT) such as machine-to-machine communications, healthcare devices, autonomous driving cars, and home and office automation.[22] It also sought comment on adding a use-or-share obligation to our performance requirements.[23] It asked questions about supplementing the spectrum holdings policies adopted in the *R&O*, and on applying spectrum holdings policies as new "frontier" spectrum bands become available.[24] The Commission also sought comment on whether it would be possible for satellites in the 37.5-40 GHz band to radiate a higher power flux density without harming terrestrial operations and to allow user terminals to receive transmissions in the band.[25] The *FNPRM* also included questions about the feasibility and desirability of a digital station identification requirement for UMFUS licensees.[26] Comment was also sought on various refinements to the UMFUS technical rules, including (1) whether antenna height limits are necessary, (2) how to apply power limits to bandwidths less than 100 megahertz, (3) whether to modify the coordination criteria for fixed point-to-point operations at market borders, and (4) the state of development of mmW band propagation models.[27] Finally, the Commission asked whether it was possible to allow Part 15 operation on-board aircraft in the 57-71 GHz band.[28]

12. Petitions for reconsideration of the *R&O* were due on December 14, 2016.[29] We received thirteen petitions for reconsideration. A list of petitions for reconsideration, oppositions and comments, and replies is contained in Appendix H.[30]

13. Comments on the *FNPRM* were due September 30, 2016, and reply comments were due October 31, 2016.[31] We received 57 comments and 38 reply comments.[32] A list of commenters, reply

[20] *FNPRM*, 31 FCC Rcd at 8170-72, paras. 446-459.

[21] *FNPRM*, 31 FCC Rcd at 8173-74, para. 464.

[22] *FNPRM*, 31 FCC Rcd at 8174-75, paras. 465-470.

[23] *FNPRM*, 31 FCC Rcd at 8175-78, paras. 471-482.

[24] *FNPRM*, 31 FCC Rcd at 8178-80, paras. 483-491.

[25] *FNPRM*, 31 FCC Rcd at 8180-83, paras. 492-502.

[26] *FNPRM*, 31 FCC Rcd at 8183-84, paras. 503-504.

[27] *FNPRM*, 31 FCC Rcd at 8184-87, paras. 505-513.

[28] *FNPRM*, 31 FCC Rcd at 8187-88, paras. 514-516.

[29] *See Use of Spectrum Bands Above 24 GHz for Mobile Radio Services*; Final Rules, 81 FR 79894 (Nov. 14, 2016).

[30] When citing petitions for reconsideration, we will use the short name of the petitioner contained in Appendix H, followed by the word "Petition." We will cite to oppositions to petitions for reconsideration using the short name of the filer followed by the word "Opposition." We will cite to comments to petitions for reconsideration as "[Party Name] Reconsideration Comments at X." Finally, replies to opposition or comments will be cited as the name of the filer followed by the word "Reply."

[31] *See Use of Spectrum Bands Above 24 GHz for Mobile Radio Services*; Proposed Rules, 81 FR 58270 (Aug. 14, 2016).

[32] In addition to the comments listed in Appendix G, the Commission received many comments expressing concerns about radiofrequency (RF) electromagnetic field exposure and health in WT Docket No. 14-177. We decline to consider the merits of these comments here for three reasons. First, the Commission already decided in the *Report and Order* that consideration of alternative exposure limits is beyond the scope of this proceeding, and no party

commenters, and *ex parte* filings is contained in Appendix G.[33]

III. SECOND REPORT AND ORDER

A. Additional Bands[34]

1. 24 GHz Bands (24.25-24.45 GHz and 24.75-25.25 GHz)

14. *Background*. The 24 GHz band is split into the "lower segment" from 24.25-24.45 GHz and the "upper segment" from 24.75-25.25 GHz. In the 24.45-24.75 GHz segment, which was not part of the *FNPRM*, there are Federal and non-Federal allocations for Inter-Satellite links, Radionavigation (24.45-24.65 GHz), and Radiolocation-Satellite (24.65-24.75 GHz).[35] There is no mobile allocation in either of the 24 GHz band segments, and no fixed allocation at 24.75-25.05 GHz.[36] There are no Federal allocations in either segment. [37] Currently, non-Federal Fixed Service use is allocated in the "lower segment." There is a non-Federal Fixed-Satellite Service (FSS) allocation on a co-primary basis in the "upper segment." [38] There is a non-Federal Fixed Service allocation from 25.05-25.25 GHz. A footnote to the U.S. Table of Frequency Allocations provides that feeder links for the Broadcast Satellite Service (BSS) have priority over other FSS uses of the 24.75-25.05 GHz band, and the only permitted use of the 25.05-25.25 GHz band is for BSS feeder links.[39]

15. Currently, there are two types of fixed licenses in this band. The 24 GHz Service has a total of 176 EA or EA-like service areas.[40] In 2004, the Commission held Auction 56, in which it made 880 24 GHz licenses available. Only seven of the 880 licenses were sold, and of those five licenses are currently active.[41] In addition, FiberTower holds a total of 33 active pre-auction Digital Electronic Messaging Service (DEMS) licenses licensed on a Standard Metropolitan Statistical Area basis in this band.

16. Section 25.203(l) of the Commission's rules provides that applicants for BSS feeder link earth station facilities operating in the 25.05-25.25 GHz band may be licensed only where no existing

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sought reconsideration of that determination. Second, the comments do not otherwise address the other technical issues that are properly the subject of this decision (*e.g.*, those raised in the *FNPRM*). Third, the Commission has an ongoing review of the Commission basic exposure limits and RF and health issues in ET Docket No. 13-84. *See Reassessment of Federal Communications Commission Radiofrequency Exposure Limits and Policies*, ET Docket No. 13-84, Notice of Inquiry, 28 FCC Rcd 3498, 3570 (2013). We have therefore added those comments to ET Docket No. 13-84, and those comments will be considered part of the record in that proceeding.

[33] When citing comments, we will use the short name of the commenter contained in Appendix G, followed by the words "Comments" or "Reply Comments." Similarly, for *ex parte* filings, we will use the name of the commenter along with the date the *ex parte* was filed as listed in ECFS (this date may be different from the date on the actual *ex parte* letter).

[34] We will not address the 32 GHz, 42 GHz, or 50 GHz bands at this time. We also will not act on petitions for reconsideration or issues raised in the *FNPRM* relating specifically to the 37-38.6 GHz band (37 GHz band) or the operability requirement adopted by the Commission. The record on these bands and issues remains open, and we will act on those bands and issues in a future phase of this proceeding.

[35] *See* 47 CFR § 2.106.

[36] *See* 47 CFR § 2.106.

[37] *See* 47 CFR § 2.106.

[38] *See* 47 CFR § 2.106. Specifically, the entire upper segment (24.75-25.25 GHz) is allocated for non-Federal FSS, and the 25.05-25.25 GHz portion has a co-primary allocation for non-Federal Fixed Service.

[39] *See* 47 CFR § 2.106 n.NG 535.

[40] *See* 47 CFR § 101.523.

[41] *See 24 GHz Service Spectrum Auction Closes, Winning Bidders Announced*, Public Notice, 19 FCC Rcd 14738 (WTB 2004).

Fixed Service licensee has been authorized, and shall coordinate their operations with 24 GHz Fixed Service operations if the power flux density of their transmitted signal at the boundary of the Fixed Service license area is equal to or greater than −114 dBW/m^2 in any 1 MHz.[42] The *17/24 GHz Broadcasting-Satellite Service Report and Order* determined that future Fixed Service systems locating near an authorized 17/24 GHz BSS feeder link earth station may not claim protection from interference from the feeder link earth station's transmissions, provided that those transmissions are compliant with the Commission's rules, and that future 24 GHz Fixed Service applicants would be required to take into account the transmissions from the previously authorized earth station when considering system designs, including their choices of locations for their license areas.[43] There are four active licenses for feeder link earth stations in the 24.75-25.25 GHz band segment and one pending application, all of them held by DIRECTV.[44]

17. There is no mobile allocation in either of the 24 GHz band segments, and no fixed allocation at 24.75-25.05 GHz.[45] In the *24 GHz Report and Order*, the Commission found that it would be premature to allow mobile operations in the 24 GHz bands but reserved the discretion to revisit that issue if it is presented with technical information demonstrating that such operations would be technically feasible without generating interference to fixed operations and BSS feeder links in 24 GHz band segments.[46] As discussed below, we are adding a mobile allocation and establishing mobile service rules for both segments of the 24 GHz band.

a. Suitability for Mobile Use

18. *Background.* In the *FNPRM* we proposed to add a mobile allocation on a primary basis to both segments of the 24 GHz band, 24.25-24.45 GHz and 24.75-25.25 GHz, in part because "[t]he existing manufacturing base and global harmonization of this band make it an attractive option for mobile use"[47] We asked for comment on this arrangement.[48] The Commission also proposed to authorize both mobile and fixed operations in those segments under the new Part 30 Upper Microwave Flexible Use Service rules.[49]

19. The response in the record was overwhelmingly positive, with a large number of commenters supporting this proposal.[50] In addition to general expressions of support, commenters mentioned that 24 GHz is particularly attractive for mobile use due to its international harmonization

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[42] 47 CFR § 25.203(l).

[43] *Establishment of Policies and Service Rules for the Broadcasting-Satellite Service at the 17.3-17.7 Frequency Band and at the 17.7-17.8 GHz Frequency Band Internationally, and at the 24.75-25.25 GHz Frequency Band for Fixed-Satellite Services Providing Feeder Links to the Broadcasting-Satellite Service*, Report and Order and Further Notice of Proposed Rulemaking, 22 FCC Rcd 8842, 8895, para. 128 (2007) (*17/24 GHz Broadcasting-Satellite Service Report and Order*).

[44] *See* DIRECTV Enterprises, LLC, call signs E070027, E130081, E140116, E150138, and E160062.

[45] *See* 47 CFR § 2.106.

[46] *See Amendments to Parts 1, 2, 87 and 101 of the Commission's Rules to License Fixed Services at 24 GHz*, Report and Order, 15 FCC Rcd 16934, 16938, para. 7 (2000).

[47] *FNPRM*, 31 FCC Rcd at 8148, para.384.

[48] *FNPRM*, 31 FCC Rcd at 8148, para. 384.

[49] *FNPRM*, 31 FCC Rcd at 8148, para. 384.

[50] 5G Americas Comments at 4-5, CTA Comments at 4-5, Facebook Comments at 4, FiberTower Comments at 2-3, Nokia Comments at 6-7 NSMA Comments at 2, Qualcomm Comments at 5-6, TIA Comments at 3-4, AT&T Reply Comments at 4-6, CTIA Reply Comments at 3-4, T-Mobile Reply Comments at 3.

potential,[51] proximity to the previously-established 28 GHz band,[52] and its relatively low frequency (for a mmW band) and related propagation attributes.[53]

20. No commenters directly challenged the suitability of the 24 GHz band for mobile services, but a few had related objections. CCA advocated waiting to expand mobile use or UMFUS into additional bands, including 24 GHz, until after more development occurs in existing bands.[54] Echodyne and The National Academy of Sciences, through its Committee on Radio Frequencies (CORF) had no objections to mobile operations in the proposed band segments, but urged the Commission not to expand the band further.[55] CORF was concerned that extending the band below 24.25 GHz, which is below the range proposed in the *FNPRM*, would interfere with weather satellites,[56] and Echodyne cautioned that the "middle piece" of the 24 GHz band (24.45-24.75 GHz, which we have not proposed to allocate for mobile) should be preserved for its currently allocated radionavigation use.[57]

21. *Discussion.* In view of the extensive support in the record, and our analysis, we find 24 GHz suitable for mobile and flexible use, and therefore add the proposed mobile and fixed allocations. As explained in further detail below, we find that issuing flexible use licenses that authorize both fixed and mobile use will address our prior concerns about compatibility between fixed and mobile use. We also conclude, as discussed below, that mobile and BSS feeder links can coexist. We also note that these frequencies are part of the bands being studied internationally for mobile use. After these changes, 24.25-24.45 GHz will be allocated for non-Federal Fixed and Mobile services on a co-primary basis, and 24.75-25.25 GHz will be allocated for non-Federal Fixed, Mobile, and Fixed-Satellite services on a co-primary basis, subject to the existing footnote.[58] CORF and Echodyne do not generally oppose mobile use in the specific frequencies we act on today. Nevertheless, acknowledging specific CORF concerns [cite], we note that ongoing international studies include analyses to determine IMT-2020 out-of-band (OOB) emission limits necessary to protect passive sensors onboard weather satellites in the 23.6-24.0 GHz band. The Commission recognizes the need to protect these passive satellite operations that provide important data necessary for weather predictions and warnings. Once the international studies have been completed, interested parties may propose revisions to the Commission's rules as necessary for protection of weather satellites operating in the 23.6-24.0 GHz band. We also reject CCA's suggestion that we hold back new bands until further mmW development has occurred. Our priority is making spectrum available quickly so that it can be utilized by potential users, technology developers, and innovators. Given the present demand for both mobile and mmW spectrum, we see no reason to artificially delay this process.

b. Licensing the 24 GHz Band - Use of Geographic Area Licensing

22. *Background.* In the *FNPRM*, the Commission proposed to add the 24 GHz band segments to the new Part 30 Upper Microwave Flexible Use Service. This would entail licensing the spectrum by exclusive geographical areas, as in the 28 GHz and 39 GHz bands, with each licensee having

[51] Ericsson Comments at 9-10, Huawei Comments at 4-6, Samsung Comments at 4-5, Intel Reply Comments at 3-4.

[52] Samsung Comments at 4-5, Intel Reply at 3-4, Verizon Reply at 1.

[53] Google Reply Comments at 4-5.

[54] CCA Comments at 9-10.

[55] CORF Comments at 5-6, Echodyne Comments at 4.

[56] CORF Comments at 5-6.

[57] Echodyne Comments at 4.

[58] The addition of Fixed and Mobile allocations in the relevant portions of the band does not change the current satellite allocation. Specifically, the current restriction on satellite operations in 24.75-25.25 GHz to Broadcast Satellite Service (BSS) feeder link stations only remains in place at this time. *See* 47 CFR § 2.106 n.NG 535. *See also* Sections III.A.1.d (Satellite Sharing in the Upper Segment of the 24 GHz Band) and IV.A (FSS Use of the 24.75-25.25 GHz Band) *infra*.

the flexibility to deploy mobile services, fixed services, or both, within its license area.

23. The majority of commenters addressing this issue supported using geographic area licensing, either in general[59] or specifically by adding the band to UMFUS.[60] Commenters cited the market certainty that would be granted by using an established and exclusive-use model, and the accompanying encouragement of investment in the band.[61] Some also mentioned that using a traditional licensing model aligned with the 28 GHz and 39 GHz bands would encourage development and allow for economies of scale and more rapid deployment in the 24 GHz band.[62]

24. Regarding license area size, the Commission did not make a specific proposal in the *FNPRM* beyond adding the band to UMFUS.[63] Under UMFUS, the 28 GHz band is licensed by county due to transition considerations, and the 39 GHz band is licensed by Partial Economic Area (PEA).[64] Commenters overwhelmingly supported using PEAs as the license area size for 24 GHz.[65] Several commenters mentioned harmonization with the 39 GHz band as a key benefit.[66] Mobile Future and Qualcomm advocated for the use of the larger Economic Areas (EAs), to encourage additional investment,[67] while Google and Mimosa suggested sizes smaller than PEAs, due to the propagation characteristics of spectrum at this high frequency.[68]

25. A few commenters suggested adding the 24 GHz band to Part 96 instead, and implementing sharing via a Spectrum Access System (SAS).[69] These commenters suggested that a SAS would improve spectrum efficiency, and allow for greater use of the band overall.[70] Mimosa also argued that Part 96 was appropriate because PEAs are too large a license area for mmW spectrum,[71] while Microsoft suggested that either Part 96 or unlicensed use would be desirable in order to have some non-exclusive-use spectrum below the 30 GHz breakpoint for indoor/outdoor penetration.[72] Other commenters strongly disagreed, however, saying that a SAS-based model is currently untested, and would

[59] 5G Americas Comments at 4-5, AT&T Comments at 11-12, Mobile Future Comments at 4, Verizon Comments at 3, US Cellular Reply Comments at 4-5.

[60] CTIA Comments at 8-10, Facebook Comments at 4, Huawei Comments at 6, Nokia Comments at 6-7, Samsung Comments at 5, Straight Path Comments at 3, TIA Comments at 3-4, T-Mobile Comments at 7, AT&T Reply Comments at 4, Qualcomm Reply Comments at 2.

[61] AT&T Comments at 11-12, CTIA Comments at 8-10, Verizon Comments at 3.

[62] TIA Comments at 3-4, Verizon Comments at 3, Qualcomm Reply Comments at 2.

[63] *Cf. FNPRM*, 31 FCC Rcd at 8148, para. 383.

[64] *See* 47 CFR § 30.5, *R&O*, 31 FCC Rcd at 8029, para. 35.

[65] AT&T Comments at 12-13, Samsung Comments at 6, T-Mobile Comments at 7, US Cellular Reply Comments at 6.

[66] Samsung Comments at 6, T-Mobile Comments at 7.

[67] Mobile Future Comments at 4, Qualcomm Comments at 7.

[68] Google Reply Comments at 5-6, Mimosa Reply Comments at 2-3.

[69] DSA Comments at 3, Google Reply Comments at 5-7, Microsoft Comments at 11-13, Mimosa Reply Comments at 2, OTI/PK Comments at 15-16. A Spectrum Access System manages all spectrum users, grants permission to transmit, and assigns frequencies to users.

[70] DSA Comments at 2, Google Reply at 5-7.

[71] Mimosa Reply Comments at 2.

[72] Microsoft Comments at 11-13. OTI/PK also supported this idea. OTI/PK Comments at 15-16.

introduce uncertainty and hamper and delay deployment.[73] Microsoft also suggests authorizing unlicensed use in the lower 24 GHz band.[74]

26. *Discussion.* We adopt the proposal in the *FNPRM* to implement geographic area licensing throughout the 24 GHz band, by adding both the upper and lower segments to UMFUS. Geographic area licensing will provide licensees with the flexibility to provide a variety of services, will expedite deployment, and will be consistent with the existing licensing scheme in previously-adopted mmW bands. In addition, adding the 24 GHz band to UMFUS will speed development and deployment by harmonizing our requirements with the nearby 28 GHz band. As part of UMFUS, the 24 GHz band will be subject to the rules established for UMFUS both here and in the *R&O* regarding construction requirements, geographic partitioning and spectrum disaggregation, discontinuance of service, and license term.

27. We will adopt PEAs as the license area size for Upper Microwave Flexible Use Service (UMFUS) licenses in the 24 GHz band. Our goal is to harmonize the regulatory environment of the various mmW bands as much as possible, in order to encourage and streamline development of equipment and deployment of services in these bands. Using PEAs as the license area is consistent with our existing rules for the 39 GHz band.[75] In addition, PEAs provide a balance between the larger areas that might encourage more investment, and the smaller areas that more efficiently accommodate mmW propagation characteristics. To the extent licensees are interested in smaller areas, partitioning is an available option.

28. We decline to adopt a Part 96-style or SAS-based framework for the band. Unlike the 3.5 GHz band, with its complex incumbent coordination considerations, this band does not require the functionality of a SAS to enable or enhance meaningful spectrum use. There is also a benefit to harmonizing the regulatory environment of nearby bands as much as possible. Adopting the same licensing scheme in 24 GHz as the Commission previously implemented in 28 GHz would facilitate deployment by making it easier to incorporate spectrum from both bands into the same network. In short, implementing a SAS-based system in the 24 GHz band presents clear challenges and is of questionable benefit, and we therefore decline to do so.

29. Similarly, we decline to adopt the proposals of Microsoft to authorize unlicensed use in 24 GHz. The 24 GHz band is near other licensed bands, and the band is being studied internationally for mobile use. Changing to unlicensed use could delay development and deployment significantly. In addition, we have already made a further seven gigahertz of spectrum available for use by unlicensed devices in the 64-71 GHz band, and we are not convinced that additional unlicensed spectrum is needed in the mmW bands at this time.

c. Band Plan

30. *Background.* In the *FNPRM*, the Commission proposed to modify the existing band plan for new licenses in the 24 GHz band.[76] Currently, the 24 GHz band is channelized into five 40 megahertz by 40 megahertz channel pairs.[77] The Commission expressed the belief that "as with the 39 GHz band, we see benefits to converting the 24 GHz band plan to unpaired blocks."[78] The Commission therefore proposed to license the lower segment of the 24 GHz band (24.25-24.45 GHz) as one unpaired block of

[73] AT&T Comments at 11-12, CTIA Reply at 4 ("providing a stable regulatory environment is critical to allowing such development and investment to occur"), Intel Reply at 4, Qualcomm Reply at 4.

[74] Microsoft Reply Comments at 8.

[75] In contrast, in the 28 GHz band, there were special circumstances involving incumbent licenses that supported the use of counties. *See R&O*, 31 FCC Rcd at 8029, para. 35.

[76] *FNPRM*, 31 FCC Rcd at 8148, para. 385.

[77] *See* 47 CFR § 101.147(r)(13).

[78] *FNPRM*, 31 FCC Rcd at 8148, para. 385.

200 megahertz, and the upper segment (24.75-25.25 GHz) as two unpaired blocks of 250 megahertz each.[79] The Commission also sought comment on the alternative arrangement of splitting the upper segment into three channels, of 200 megahertz, 200 megahertz, and 100 megahertz, and the option of using 100 megahertz unpaired channels across the entire band.[80]

31. Commenters were split on the issue of the upper segment, but largely supported the second option (three channels of 200, 200, and 100 megahertz).[81] Equipment manufacturers cited developing standards that are likely to use 100 megahertz building blocks, suggesting that it would be much easier for a licensee to use a 100 megahertz block, or aggregate a 100 megahertz and a 200 megahertz channel, than to make full use of a more "irregular" 250 megahertz.[82] TIA also suggested that the 100 MHz channel be located at the bottom of the segment, from 24.75-24.85 GHz, to support an easier repacking process for incumbents.[83]

32. Some commenters preferred the 2x250 megahertz band plan, largely because they supported the widest possible channel size in order to maximize potential bandwidth.[84] These commenters did not offer specific technical reasons (beyond the increased bandwidth) for why 250 megahertz channels would be superior. AT&T preferred 250 megahertz channels, although they described the 100-200-200 megahertz band plan as acceptable.[85] T-Mobile and US Cellular, on the other hand, supported 100 megahertz channels. T-Mobile expressed concern that a 200/250/250 band plan would "limit the number of potential entrants to the band."[86] US Cellular supported 100 megahertz channels because the 24 GHz has less spectrum available than other mmW bands, and in general any band with less than one gigahertz of spectrum available should use 100 megahertz channels.[87] One commenter, Cambridge Broadband, opposed any new band plan, instead advocating the continued use of paired channels to support FDD use of the band.[88]

33. *Discussion*. We will license the 24 GHz band according to the second option that the Commission proposed. The lower segment (24.25-24.45 GHz) will be licensed as one 200 MHz channel, and the upper segment (24.75-25.25) will be licensed as one 100 MHz channel and two 200 MHz channels. In order to facilitate repacking, the specific band plan for the upper segment will be as follows: 24.75-24.85 GHz, 24.85-25.05 GHz, and 25.05-25.25 GHz. We note in response to Cambridge Broadband that this arrangement will not foreclose FDD use of this band.

34. This band plan strikes a balance between authorizing the widest possible channels, while facilitating efficient use of the spectrum, with each license being used to the fullest possible extent. We want to be cognizant of developing technical standards, so that licensees are not left with an amount of spectrum that can support only a fraction of a channel. We therefore adopt a band plan that results in only slightly smaller channels, rather than adopt a band plan with 250 megahertz channels that may leave

[79] *FNPRM*, 31 FCC Rcd at 8148, para. 385.

[80] *FNPRM*, 31 FCC Rcd at 8148, para. 385.

[81] CTIA Comments at 11 n.29; FWCC Comments at 4; Huawei Comments at 8; Qualcomm Comments at 7; TIA Comments at 6, 8.

[82] Qualcomm Comments at 7.

[83] TIA Comments at 6, 8.

[84] FiberTower Comments at 3; Nokia Comments at 7.

[85] AT&T Reply Comments at 12.

[86] T-Mobile Comments at 10.

[87] US Cellular Reply Comments at 7-9.

[88] Cambridge Reply at 8.

licensees with an "extra" 50 MHz that would be unwieldy to use.

d. Satellite Sharing in the Upper Segment of the 24 GHz Band

35. *Background*. The upper segment of the proposed 24 GHz band (24.75-25.25 GHz) is divided into two parts. The upper part (25.05-25.25 GHz) is currently restricted to BSS feeder link earth stations,[89] in Economic Areas where there is no Fixed Service licensee.[90] The lower part (24.75-25.05 GHz), which has no terrestrial licensees, is open for all FSS use, though BSS feeder links have priority.[91] BSS feeder link earth stations can be licensed to operate in the 24.75-25.05 GHz and 25.05-25.25 GHz bands.[92] The Commission sought comment in the *FNPRM* on the appropriate satellite sharing regime going forward, given its proposed increased terrestrial use of the band.[93] Specifically, the Commission sought comment on whether to maintain existing limits on satellite use, whether to apply the regime it adopted for the 28 GHz band, where FSS has the right to have up to three earth station locations in each county, or whether some other alternative would be most appropriate.[94] The Commission did not seek comment on whether to expand satellite use of the band to allow all FSS use, as opposed to the current limitation to BSS feeder links.

36. Commenters were split on the issue of earth station siting in the 24 GHz band. Some commenters urged us not to change or expand the existing rules.[95] AT&T and CTIA supported adopting a 28 GHz-style regime,[96] while Inmarsat and SES urged us not to "reflexively" apply that approach across all mmW bands, but instead consider each band's unique characteristics in crafting specific approaches.[97] Other suggestions for coordination mechanisms included a SAS,[98] a database of satellite locations with which terrestrial licensees would be required to coordinate,[99] and making terrestrial UMFUS secondary to FSS, and eliminating siting restrictions altogether.[100] Although the Commission did not specifically seek comment on the issue of whether to allow broader FSS use, several commenters addressed this issue: satellite entities were broadly in favor of expansion, while others generally opposed it.[101]

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[89] *See* 47 CFR. § 2.106 n.NG535 and § 25.202(a)(1).

[90] 47 CFR § 25.203(l). When there is a fixed service licensee in a neighboring Economic Area, the applicant for the BSS feeder link earth station must coordinate with that licensee if the BSS feeder link earth station would generate a PFD of at least -114 dBW/m^2/MHz at the boundary of the Economic Area containing the fixed service licensee. *Id.* There is no provision in our rules that requires a fixed service licensee to coordinate with the BSS feeder link earth station applicant.

[91] *See* 47 CFR § 2.106 n.NG 535.

[92] *See* 47 CFR § 2.106 n.NG535 and § 25.202(a)(1).

[93] *FNPRM*, 31 FCC Rcd at 8148, paras. 384-85.

[94] *FNPRM*, 31 FCC Rcd at 8148, paras. 384-85.

[95] FiberTower Comments at 3; FWCC Comments at 4; Nokia Comments at 7; TIA Comments at 8; T-Mobile Comments at 9-10.

[96] AT&T Comments at 13; CTIA Reply Comments at 4-6.

[97] Inmarsat Reply Comments at 14-15; SES Reply Comments at 7-9.

[98] Federated Wireless Reply at 4-6.

[99] SIA Reply Comments at 17-18. FWCC specifically opposed this option. FWCC Reply Comments at 4.

[100] SIA Reply at 17-18.

[101], AT&T, EchoStar, ESOA, SES, and SIA were in favor of expanded satellite access; FiberTower, FWCC, Nokia, TIA, and T-Mobile were opposed. FiberTower Comments at 3; FWCC Comments at 4; Nokia Comments at 7; TIA Comments at 8; AT&T Reply Comments at 4-6; EchoStar Reply Comments at 9-10; ESOA Reply Comments at 4-5; SES Reply Comments at 6-7; SIA Reply Comments at 17-18; T-Mobile Reply Comments at 3.

37. *Discussion.* We decline to make any changes to the current rules for earth station siting at this time. The record on these points is not sufficiently developed or cohesive to indicate the best approach. Instead, we seek further comment on this issue in the *Further Notice of Proposed Rulemaking* below in connection with a proposal to allow wider FSS use of the band for earth stations.[102]

38. In the interim, satellite operators may continue to apply for and deploy any earth station facilities consistent with our current rules. This means that new BSS feeder link earth stations may be authorized across the entire upper segment (24.75-25.25 GHz), while non-BSS FSS earth stations may be authorized in the 24.75-25.05 GHz portion.[103] All earth stations either authorized or for which applications have been filed as of the release date of this *Second Report and Order* will be grandfathered into the eventual sharing regime on a co-primary basis. Earth stations whose applications are filed after release of this Order may be processed subject to compliance with any rules we adopt as a result of the proposals in the *Second FNPRM*. It is our intention to finalize sharing rules prior to any auction of terrestrial licenses in this band.

e. Mobile Rights for Incumbents

39. *Background*. In the *FNPRM*, the Commission sought comment on treatment of incumbent licensees. Specifically, the *FNPRM* asked whether incumbent terrestrial licensees should be converted to UMFUS licensees, as will be done in the 28 and 39 GHz bands, and whether it is necessary to repack current licensees into the new band plan.[104] As noted above, there are 38 current licenses in the band. Commenters who addressed the issue unanimously supported converting existing licensees to UMFUS.[105] Commenters generally did not address the repacking issue, though TIA appeared to support repacking by implication.[106]

40. *Discussion.* We will convert existing licenses in the 24 GHz band to UMFUS. This is consistent with the Commission's treatment of incumbents in the 28 GHz and 39 GHz bands, and will allow already-licensed spectrum to be developed for mobile or flexible use as soon as possible.

41. Converting existing licenses to UMFUS will also subject incumbent licensees to the performance requirements applicable to Part 30. Consistent with the treatment of 28 GHz and 39 GHz licensees, we will apply the Part 30 buildout requirements at the next license renewal, but allow incumbents with renewals in the near future additional time to meet those standards. Specifically, licensees whose license terms end between the date of publication of this order in the *Federal Register*, and June 1, 2024, will have until that later date to demonstrate fulfillment of the Part 30 buildout requirements. This approach will allow current licensees to focus on growing and transitioning their networks in line with new and developing industry standards, which will support earlier and more robust deployment of next-generation services in these bands.

2. 47.2-48.2 GHz Band

42. *Background*. The 47.2-48.2 GHz band is part of the 47.2-50.2 GHz band (47 GHz band). While there are primary non-Federal fixed, mobile, and FSS allocations throughout the 47 GHz band,

[102] *See* Section IV.A (FSS Use of 24.75-25.25 GHz Band), *infra*.

[103] As discussed above, after the adoption of this Order, the Fixed and Mobile Services will be co-primary with FSS in the 24.75-25.05 GHz portion, and co-primary with BSS in the 25.05-25.25 GHz portion. *See supra* Section III.A.1.a (Suitability for Mobile Use).

[104] *FNPRM*, 31 FCC Rcd at 8148, para. 386.

[105] FiberTower Comments at 2-3, FWCC Comments at 4, Nokia Comments at 7, NSMA Comments at 2, Qualcomm Comments at 6-7, TIA Comments at 8, T-Mobile Comments at 11.

[106] TIA Comments at 4 (advocated a band plan that would facilitate repacking).

there currently are no service rules for terrestrial operations in this band.[107] The Commission, however, has designated the 47.2-48.2 GHz segment of the 47 GHz band for wireless services use and the 48.2-50.2 GHz segment for FSS use.[108] There is no Federal allocation in the 47.2-48.2 GHz band.

43. In the *FNPRM*, the Commission proposed to authorize fixed and mobile operations in the entire 47 GHz band under the Part 30 Upper Microwave Flexible Use Service rules.[109] The 47 GHz band potentially offers 3 gigahertz of spectrum and is being studied internationally for possible mobile use. As discussed below, we are not establishing terrestrial service rules in the 48.2-50.2 GHz band, and that band will be discussed below in the *MO&O*.[110]

a. Suitability for Mobile Service

44. *Background*. The Commission in the *FNPRM* proposed to authorize fixed and mobile operations in the 47 GHz band.[111] The Commission also recognized that the 47 GHz band is authorized for FSS use and may be paired with the 40-42 GHz FSS downlink band,[112] though there are no current authorized FSS operations. Unlike in the 28 GHz or 39 GHz bands, where FSS can use other spectrum to operate user equipment, FSS would have to use some portion of the 47 GHz band to operate user equipment.[113] The Commission in the *FNPRM* noted that sharing between terrestrial mobile and FSS user equipment is more complicated, particularly when the FSS user equipment is transmitting.[114]

45. Terrestrial operators, equipment manufacturers, and other interests support mobile operations in the band.[115] Certain satellite interests urge the Commission to retain FSS access to the entire 47 GHz band for satellite operations, including primary status for FSS in the 48.2-50.2 GHz band, unencumbered by terrestrial operations.[116] Those satellite interests argue that UMFUS operators offer no persuasive rationale for reallocating the band.[117] Subsequently, satellite providers EchoStar, Hughes, OneWeb, Inmarsat, and Intelsat filed a joint *ex parte* supporting the designation of UMFUS as primary in the 47.2-48.2 GHz band and arguing that FSS be permitted to deploy individually licensed earth stations on a protected basis, through mechanisms similar to those the Commission is adopting today on reconsideration in the 28 GHz band. Microsoft opposes the Commission's authorizing fixed and mobile operations in the 47.2-48.2 GHz band; it maintains that the Commission has failed to address how mobile operations would share with High Altitude Platform Service (HAPS) stations operating between 47.2-

[107] *See* 47 CFR § 2.106.

[108] *Allocation and Designation of Spectrum for Fixed-Satellite Services in the 37.5-38.5 GHz, 40.5-41.5 GHz and 48.2-50.2 GHz Frequency Bands; Allocation of Spectrum to Upgrade Fixed and Mobile Allocations in the 40.5-42.5 GHz Frequency Band; Allocation of Spectrum in the 46.9-47.0 GHz Frequency Band for Wireless Services; and Allocation of Spectrum in the 37.0-38.0 GHz and 40.0-40.5 GHz for Government Operations*, First Report and Order, 13 FCC Rcd 24649, 24651 para. 2 (1999) (*V-Band First Report and Order*).

[109] *FNPRM*, 31 FCC Rcd at 8155, para. 410.

[110] *See* Section VI.A, *infra*.

[111] *FNPRM*, 31 FCC Rcd at 8155, para. 410.

[112] *FNPRM*, 31 FCC Rcd at 8155, para. 411.

[113] *FNPRM*, 31 FCC Rcd at 8155-56, para. 411.

[114] *FNPRM*, 31 FCC Rcd at 8156, para. 411.

[115] Straight Path Comments at 3; T-Mobile Comments at 15-16; AT&T Reply at 4,8; Qualcomm Comments at 5-6; CTIA Comments at 10; Facebook Comments at 4; TIA at 2-5; Verizon Comments at 3-4.

[116] O3b Reply Comments at 4; Comments of ViaSat at 5-7; Boeing Comments at 14-17; Inmarsat Comments at 17-19. *See also*, EchoStar Comments at 4-6 (proposing that UMFUS licensees be given priority in a limited number of urban core areas, while outside of these urban cores, FSS and UMFUS licensees would be co-primary).

[117] O3b Reply Comments at 5-6.

48.2 GHz.[118]

46. *Discussion.* We will establish UMFUS service rules in the 47.2-48.2 GHz band, as discussed below, and we will issue UMFUS licenses in that band with both fixed and mobile rights. We will address the 48.2-50.2 GHz band below in the *MO&O*.[119] The 47.2-48.2 GHz band has existing fixed and mobile allocations, and there are no Federal allocations in this band. We also believe that the significant amount of bandwidth available in this band will help to accommodate the expected continued increase in demand for mobile data. Commenters, including incumbent terrestrial licensees and the Satellite Broadband Companies in their joint *ex parte*, support mobile operations in the 47.2-48.2 GHz band.[120] We acknowledge Microsoft's concern about sharing between mobile operations and HAPS stations, but agree with Facebook that our approach is flexible enough to accommodate a variety of uses.[121]

b. Licensing the 47.2-48.2 GHz Band

47. *Background.* In the *FNPRM*, the Commission sought comment on the option of licensing the 47 GHz band using geographic area licensing on a PEA basis.[122] The Commission also sought comment on the alternative of using a Spectrum Access System (SAS) or other form of database sharing.[123]

48. Terrestrial operators argue that the Commission should focus on making the additional mmW spectrum bands available on a geographic area licensed, exclusive basis.[124] With respect to license area size, several commenters suggested that PEAs are appropriate because they are large enough to promote efficient network development.[125] In contrast, Mobile Future argues that the Commission should use license areas larger than PEAs to encourage investment and minimize the need to coordinate operation at license area borders.[126] CCA suggests that the Commission wait for research and testing to be further along on the mmW bands before developing comprehensive licensing rules.[127]

49. *Discussion*. We will license the 47.2-48.2 GHz band using geographic area licensing using PEAs because we find that use of this license mechanism will facilitate access to spectrum and rapid deployment of service in the band. Given that this band does not involve sharing among multiple classes of primary users, we conclude that is not necessary to develop the functionality of an SAS for this band." Given the record, now is the appropriate time to move forward with making an additional one gigahertz of spectrum available, allowing CCA members and others to accommodate a wide variety of innovative use cases for the 47.2-48.2 GHz band. As Samsung suggests, licensing the 47.2-48.2 GHz spectrum using geographic area licensing with PEAs is consistent with license areas for the 39 GHz band

[118] Microsoft Comments at 17-18. While there is an international designation for HAPS in the 47.2-47.5 GHz and 47.9-48.2 GHz bands (*see* 47 CFR § 2.106 n.5.552A, the Commission has not incorporated that designation into the domestic Table of Allocations.

[119] *See* Section VI.A, *infra*.

[120] Straight Path Comments at 3; T-Mobile Comments at 15-16; AT&T Reply Comments at 4,8; Qualcomm Comments at 5-6; CTIA Comments at 10; Facebook Comments at 4; TIA Comments at 2-5; Verizon Comments at 3-4; Satellite Broadband Companies April 25, *Ex Parte* Letter at 3.

[121] Facebook Comments at 5.

[122] *FNPRM*, 31 FCC Rcd at 8156, para. 413.

[123] *FNPRM*, 31 FCC Rcd at 8156, para. 413.

[124] AT&T Reply Comments at 2; CTIA Comments at 8-12; Qualcomm Comments at 5-6; Verizon Comments at 3-4.

[125] AT&T Comments at 11-13; Samsung Comments at 5-6; T-Mobile Reply Comments at 31.

[126] Mobile Future Comments at 4.

[127] *See* CCA Comments at 9-10.

and the upper segment in the 37 GHz band.[128] Licensing the 47.2-48.2 GHz band on a PEA basis strikes an appropriate balance between facilitating access to spectrum by both large and small providers and simplifying frequency coordination, while incentivizing investment in, and rapid deployment of, new technologies. We believe PEAs are more appropriate than larger geographic areas because of the limited propagation range of this band. Geographic area licensing will provide users with flexible, exclusive use licenses.

c. Non-Federal Satellite Terrestrial Sharing – Licensing of Gateway Earth Stations

50. *Background*. With respect to individually licensed earth stations, in the *FNPRM* the Commission invited comment on adopting the sharing framework for the 47 GHz band that it previously adopted for the 28 GHz band.[129] While there are no current authorized operations, the 47 GHz band may be paired with the 40-42 GHz downlink band. Specifically, the Commission proposed that in each PEA there could be one location where FSS earth stations could be located on a co-primary basis, subject to the conditions and limitations that the Commission adopted in other bands.[130]

51. In the *FNPRM*, the Commission also invited comments on three approaches for sharing between FSS user equipment and terrestrial operations in the band from 47 GHz to 50 GHz.[131] The Commission first asked whether we should have geographic area licensing on a PEA basis, but also authorize database-driven sharing between FSS operations and stationary FSS user equipment.[132] The Commission also asked whether it should divide the band into a segment where FSS has priority and a segment where UMFUS operations have priority.[133] The Commission asked supporters of this option to propose a split for the band and explain how their proposed split best balances the needs of UMFUS and FSS licensees.[134] Finally, as a third option, the Commission asked whether it should adopt specific criteria for assigning priority between FSS and terrestrial operations, including requiring both FSS and UMFUS licensees to register their operations in a database, allowing the Commission to assign interference protection on a first-come, first-serve basis.[135]

52. In its comments, Boeing argues that broadband satellite systems must have unfettered access to the three GHz of spectrum in the 47 GHz band to operate transmitting satellite end user terminals.[136] In contrast, satellite providers EchoStar, Hughes, OneWeb, Inmarsat, and Intelsat support the Commission's designating UMFUS as primary in the 47.2-48.2 GHz band and argue that FSS should "be permitted to deploy individually licensed earth stations on a protected basis, through mechanisms similar to those adopted in the 28 GHz band . . ."[137]

53. *Discussion.* The record demonstrates that individually licensed earth stations in the 47.2-48.2 GHz band can share the band with minimal impact on terrestrial operations. We note that there are

[128] Samsung Comments at 6. *See R&O*, 31 FCC Rcd at 8046, para. 82 and 8060, para. 116. *See also*, T-Mobile Reply at 31.

[129] *FNPRM*, 31 FCC Rcd at 8156, para. 412.

[130] *FNPRM*, 31 FCC Rcd at 8156, para. 412.

[131] *FNPRM*, 31 FCC Rcd at 8156, paras. 412-415.

[132] *FNPRM*, 31 FCC Rcd at 8156, para. 413.

[133] *FNPRM*, 31 FCC Rcd at 8156, para. 414.

[134] *FNPRM*, 31 FCC Rcd at 8156, para. 414.

[135] *FNPRM*, 31 FCC Rcd at 8156, para. 415.

[136] Boeing Comments at 14-17.

[137] Satellite Broadband Companies April 25 *Ex Parte* at 3; *see also* Satellite Broadband Companies October 2 *Ex Parte*.

similarities between the 28 GHz band and the 47.2-48.2 GHz band, both of which will be used for Earth-to-space transmissions. Therefore, we find that it is in the public interest to add the 47.2-48.2 GHz band to Section 25.136(d) of the Commission's rules, which allows for sharing between terrestrial operations and FSS earth stations in uplink bands.[138] Under that rule a limited number (three in each county, up to a maximum of 15 in each PEA) of FSS earth stations will be permitted to deploy under similar conditions as in the 28 GHz band without having to protect UMFUS stations. We are also adopting a U.S. Table of Allocations footnote specifying the relative interference protection obligations of FSS and UMFUS stations in this band.

54. We decline to provide any mechanism for satellite user equipment in this band. Boeing has not provided any engineering studies to support its claim that it needs access to the full 47 GHz band for user equipment. In contrast, most other satellite operators believe that use of 47.2-48.2 GHz by individually licensed earth stations would be sufficient. As noted below, we are not adopting UMFUS rules for 48.2-50.2 GHz, so satellite user devices will have 2 by 2 gigahertz of spectrum available for satellite end user devices.

55. In addition, we recognize that concerns regarding aggregate interference to satellite receivers from UMFUS operations in the 28 GHz band also could apply in the context of the 47 GHz band, which similarly is an uplink band for satellites. Consistent with the long-term designation of the 47 GHz band for terrestrial use, we intend that this band will remain predominantly a terrestrial band. UMFUS licensees will be permitted to operate in conformance with the technical rules contained in 47 C.F.R. Part 30, and FSS licensees should expect to have to coexist with these operations. Unlike the 28 GHz band, where there are currently operational satellites, satellites receiving in the 47 GHz band are either currently being designed or still to be designed. As in the context of the 28 GHz band, we encourage both industries to continue working cooperatively on coexistence in this band. Parties should submit any relevant data demonstrating changes in the amount of aggregate interference as UMFUS services are deployed in the docket the International Bureau, the Office of Engineering and Technology, and the Wireless Telecommunications Bureau have jointly established regarding aggregate interference in the 28 GHz band.[139]

d. Band Plan

56. *Background*. In the *FNPRM*, the Commission sought comment on the appropriate band plan for the entire 47 GHz band.[140] One option the Commission proposed was to divide the band into six channels of 500 megahertz each.[141] The Commission suggested that one advantage of that band plan is that the channels would align with 48.2 GHz, which is where the Federal allocation and current FSS designation begin and where FSS user equipment can begin to be deployed.[142] The Commission noted, however, that 500 megahertz channels would not align with the band plan in other bands, where the Commission is using multiples of 200 megahertz.[143]

[138] *See* 47 C.F.R § 25.136. To reference § 25.136 in our rule addressing filing requirements for transmitting earth stations we also make consequential modifications to paragraphs (b) and (g) of § 25.130. *See* 47 C.F.R § 25.130.

[139] *See* Docket Established for 28 GHz Aggregate Interference Analysis, 32 FCC Rcd 5022 (IB 2017).

[140] *FNPRM*, 31 FCC Rcd at 8157, para. 417.

[141] *FNPRM*, 31 FCC Rcd at 8157, para. 417.

[142] *FNPRM*, 31 FCC Rcd at 8157, para. 417.

[143] *FNPRM*, 31 FCC Rcd at 8157, para. 417.

57. Commenters generally support large channel sizes.[144] They differ, however, on their preferred channel size, their preferred mix of channel sizes, and the appropriate minimum and maximum channel sizes. Some commenters favor a minimum channel size of 200 megahertz.[145] Other commenters generally favor 200 megahertz channel sizes or multiples thereof.[146] Nokia specifically favors six 500 MHz blocks.[147]

58. *Discussion.* We will license the 47.2-48.2 GHz band as five 200 megahertz blocks. We believe that 200 megahertz channels will be sufficient for a licensee to provide the type of high rate data services and other innovative uses and applications contemplated for this spectrum. Several carriers support dividing the band into multiple blocks.[148] Since we are making one gigahertz available at this time, establishing five 200 megahertz channels represents a reasonable balance of channel size and number of channels.[149] To the extent that licensees are interested in having a contiguous block of one gigahertz of spectrum,[150] they are free to acquire all five licenses, subject to compliance with our spectrum aggregation policies.

B. Performance Requirements – Additional Metrics

59. *Background*. Under the Communications Act, we have an obligation to adopt rules for licenses subject to competitive bidding that prevent the warehousing of spectrum, and promote investment in new technologies and services.[151] It is our goal to create a regulatory scheme that promotes the rapid and widespread deployment of wireless broadband, to consumers' benefit. One way to both fulfill our statutory obligation and promote widespread deployment is to impose enforceable buildout or coverage requirements.

60. In the *Report and Order*, the Commission set out the framework for performance requirements for UMFUS licenses.[152] Rather than adopt a substantial service requirement with a nonexhaustive list of safe harbors, the Commission adopted a finite set of standards, with licensees required to meet at least one in order to be eligible for license renewal.[153] Licensees may choose the metric that best fits their deployment model, but they may not use other, unlisted metrics to demonstrate sufficient buildout.[154] The Commission adopted population-based metrics for mobile and fixed services, and an absolute number for satellite earth stations.[155] The Commission noted that the mmW bands are currently being considered for other, innovative services, such as IoT, whose networks might not fit

[144] AT&T Comments at 9-11; AT&T Reply Comments at 12-13; CTIA Comments at 11; Huawei Comments at 8; Nokia Comments at 9; Qualcomm Reply Comments at 3; Qualcomm Comments at 10; TIA Comments at 5-7; T-Mobile Reply Comments at 29; Samsung Comments at 5-6.

[145] AT&T Comments at 9-10; AT&T Reply Comments at 12-13; Qualcomm Comments at 10; Qualcomm Reply Comments at 3.

[146] CTIA Comments at 11; Huawei Comments at 8; T-Mobile Comments at 16; T-Mobile Reply Comments at 29; TIA Comments at 5-7; Samsung Comments at 5.

[147] Nokia Comments at 9.

[148] *See e.g.*, Huawei Comments at 8; Qualcomm Comments at 10.

[149] As discussed in the *MO&O*, *infra*, we decline to authorize UMFUS in the 48.2-50.2 GHz portion of this band, so no further discussion of a band plan for that segment is necessary.

[150] *See e.g.*, AT&T Reply Comments at 12-13.

[151] 47 U.S.C. § 309(j)(4)(B).

[152] *FNPRM*, 31 FCC Rcd at 8085-90, paras. 196-210.

[153] *FNPRM*, 31 FCC Rcd at 8088, para. 203.

[154] *FNPRM*, 31 FCC Rcd at 8088, para. 203.

[155] *FNPRM*, 31 FCC Rcd at 8088-90, paras. 206-210, 47 CFR § 30.104.

within the buildout requirements it adopted, and sought comment on additional metrics that might be more appropriate.[156]

61. The record is not well-developed on this issue. Most commenters who addressed this issue urged us not to adopt any performance requirements for IoT-type services, as the technology is insufficiently developed to establish reasonable requirements.[157] Other commenters suggest only that we adopt requirements that are "flexible."[158] Nextlink proposed that we require only one "installation" or "system" per license area, with no stipulations on how extensive the "system" must be.[159] O3b urges us not to adopt any additional metrics because geographic area coverage is the only appropriate measure of spectrum use in a license area.[160]

62. Some commenters proposed usage-based metrics that would enable the Commission to measure provision of service without regard for the network architecture used to provide it.[161] Of these commenters, only CTIA submitted a concrete proposal complete with suggested levels of required use;[162] the others merely expressed general support for the idea, or a list of possible directions with no details.[163] On the other hand, Nextlink opposed adopting any usage-based metric, on the grounds that it would "discourage deployment of innovative use cases that do not fit squarely within these metrics," such as remote surgery, which might be very beneficial without involving a large number of sessions or connected devices.[164]

63. *Discussion.* We decline to adopt usage-based metrics at this time. We agree with commenters that it is premature to predict the uses of innovative, IoT-type services with sufficient specificity to calculate a meaningful usage-based metric.[165] Though IoT-type services nonetheless are required to meet the UMFUS buildout rules, we acknowledge that some IoT-type services may have difficulty meeting the population-based metrics that the Commission adopted for fixed and mobile services. In that regard, in the *Second Further Notice* below, we propose a more traditional, geographic area coverage metric for fixed and mobile services that is intended to provide a more viable option for IoT-type services to demonstrate performance, without the complications of predicting usage.[166]

64. In addition, we recognize the possibility that, rather than facing challenges in meeting the buildout metrics for fixed and mobile services, certain IoT-type services may be able to avoid meaningful

[156] *FNPRM*, 31 FCC Rcd at 8088, para. 204.

[157] AT&T Reply at 13, CCA Comments at 7-8, Intel Reply at 7-9, T-Mobile Reply at 30-31, Verizon Comments at 8.

[158] Ericsson Comments at 18, FWCC Comments at 14, NSMA Comments at 5, Straight Path Comments at 11, Qualcomm Reply at 5, CTIA Reply at 8.

[159] Nextlink Reply at 15-16.

[160] O3b Comments at 11-12.

[161] CTIA Comments at 18, FWCC, Qualcomm Comments at 13-14, Southern Co. Comments at 2-7, Starry Comments at 5.

[162] CTIA Comments at 18. CTIA also argued separately that "[t]he Commission should not complicate performance review by adopting a separate rubric for evaluating IoT-type services." CTIA Comments at 16.

[163] Qualcomm Comments at 13-14 (e.g., "It will be more appropriate to base a performance requirement for the millimeter wave bands upon the number of connected devices, the volume of transmitted data, and/or the number of communications sessions rather than on population coverage or a level of infrastructure deployment.").

[164] Nextlink Comments at 20-22.

[165] AT&T Reply at 13, CCA Comments at 7-8, Intel Reply at 7-9, T-Mobile Reply at 30-31, Verizon Comments at 8.

[166] *See* Section IV.B (Performance Requirements – Geographic Area Metric), *infra*.

buildout by taking advantage of a potential loophole in the buildout rules for mmW services. In order to allow licensees as much flexibility as possible to design and construct their networks, these rules have not placed any limits on what types of licensees or services must use which performance metric. However, in the case of IoT-type services, including networks of sensors and "smart" devices,[167] a licensee using the buildout metric for fixed services could fulfill the performance requirements for an entire multi-county license area (in 39 GHz) with a deployment spanning a single building,[168] by counting each connection between the sensors as a fixed point-to-point link. We do not believe this result is consistent with our obligation to prevent spectrum warehousing.

65. To address this issue, we modify our existing Part 30 rules to adopt a specific definition of "fixed point-to-point link," which includes the use of point-to-point stations as already defined in Part 30 and is based on power level. This definition is intended to separate "traditional" point-to-point links from the sensor and device connections we anticipate will be part of new Internet of Things networks in these bands. This definition would apply to a network of fixed sensors or smart devices operating at low power over short distances.

66. Traditional point-to-point links use relatively high power, while the details that currently exist for Internet of Things services indicate that most sensor or smart device networks will use very low power[169] and are not likely to incorporate highly directional antennas due to size and cost constraints. We therefore believe that power level is an appropriate metric to distinguish between traditional fixed links and IoT deployments. To the extent that any sensor networks do use higher power, it is likely that they will be connecting over longer distances, and therefore resemble a more traditional fixed network in terms of magnitude of deployment and scope of service provided.

67. Specifically, we define a "fixed point-to-point link" as "a radio transmission between point-to-point stations (as already defined in Part 30), where the transmit power exceeds +43 dBm." This power limit is the limit we previously adopted for mobile handsets transmitting in UMFUS bands.[170] The maximum power (average EIRP) allowed for fixed point-to-point stations in UMFUS bands under our current rules is +55 dBW, which is equivalent to +85 dBm.[171] Under this definition, stations or devices transmitting using lower power levels will not count towards the number of fixed links required under that performance metric. Licensees whose networks include such low-power connections must either rely on another part of their network to demonstrate buildout (e.g., mobile area coverage or higher-power fixed backhaul links), or offer detailed responses to the Commission's proposal in the *Second FNPRM*

[167] Darrell M. West, How 5G Technology Enables the Health Internet of Things, Center for Technology Innovation at Brookings, at 2 (July 2016), https://www.brookings.edu/wpcontent/uploads/2016/07/5G-Health-Internet-of-Things_West.pdf.

[168] For example, suppose a licensee wants to equip an office building with environmental sensors to increase the efficiency of its HVAC system. A building with ten floors, and one sensor on each corner of each floor, would have forty sensors. If each sensor were connected to its four neighbors (those in adjacent corners, and in the same corner on adjacent floors) over UMFUS spectrum, this sensor network would have 152 connections (32*4 + 8*3; the sensors on the first and tenth floor would have only 3 connections each). Under the performance metric we adopted for fixed point-to-point services, which requires one link per 67,000 population, this sensor network would fulfill buildout requirements for a license area of up to 10.1 million people. According to 2010 Census data, that limit encompasses every county, and thus every 28 GHz license area, in the United States.

[169] For example, 3GPP specifications designed to accommodate IoT uses reference a 23 dBm power class and a 33 dBm power class. 3GPP Standards for the Internet of Things, Phillippe Reininger, Chairman of 3GPP RAN WG 3, at 6.

[170] 47 CFR § 30.202.

[171] 47 CFR § 30.405.

below[172] to work out a more suitable alternative.

68. Performance requirements for point-to-point services have always been calculated assuming that point to point links consist of communications between specified points using highly directional antennas and relatively high power; this definition merely makes that assumption explicit.[173] This explicit statement is necessary in light of new technological developments, in order to prevent unintended consequences and gamesmanship of our rules. We remind commenters that we continue to explore new metrics that will accommodate innovative services in UMFUS bands, including a proposal in the *Second FNPRM* below.[174]

C. Mobile Spectrum Holdings Policies

69. We find that it is unnecessary to set pre-auction limits on the amount of spectrum an entity may acquire at auction in the bands proposed for flexible terrestrial wireless use in the *FNPRM*. We also conclude that the bands that we make available for flexible terrestrial wireless use in this *Second R&O* – the 24 GHz and 47 GHz bands – should be newly included as part of the total mmW spectrum threshold for reviewing proposed secondary market transactions. In the *Second FNPRM*, we propose to eliminate the pre-auction limits on the amount of spectrum in the 28 GHz, 37 GHz and 39 GHz bands that an entity may acquire at auction. In addition, we seek comment on whether there is a need to review mmW band holdings (24 GHz, 28 GHz, 37 GHz, 39 GHz, and 47 GHz) on a case-by-case basis when applications for initial licenses are filed post-auction to ensure that, while providing flexibility to bidders and assigning licenses to those who value them the most, the public interest benefits of having a threshold on mmW spectrum applicable to secondary market transactions are not rendered ineffective.

70. *Background*. In the *R&O*, the Commission adopted mobile spectrum holdings policies that it applied collectively to the 28 GHz, 37 GHz, and 39 GHz bands, observing that these bands have similar technical characteristics and potential uses.[175] Specifically, the Commission established a pre-auction limit of 1250 megahertz that applies to entities acquiring spectrum in those bands through competitive bidding in an auction.[176] The Commission also adopted a mmW spectrum threshold of 1250 megahertz of holdings in these three bands for purposes of the Commission's case-by-case review of proposed secondary market transactions, to help to identify those markets that may warrant further competitive analysis. The Commission found it unnecessary to apply band-specific aggregation limits in each of these three mmW bands because any technical differences among the bands were not sufficient to affect significantly how these spectrum bands might be used.[177]

71. In the *FNPRM*, the Commission sought comment on two implementation issues related to the pre-auction limit that it had adopted in the R&O: first, the methodology to calculate a bidder's existing spectrum holdings; and second, a proposal to adopt a holding period that would preclude certain secondary market transactions subsequent to acquisition of spectrum at auction.[178] In addition, the

[172] *See* Section IV.B (Performance Requirements – Geographic Area Metric), *infra*.

[173] 47 CFR § 101.115 defines minimum standards for directionality of antennas for point-to-point services. With respect to transmitter power, while there are specific circumstances in which low-power point-to-point links may operate, those circumstances are generally limited to specific bands under certain conditions. *See* 47 CFR §§ 101.147(r)(14), (s)(8).

[174] *See* Section IV.B (Performance Requirements – Geographic Area Metric), *infra*.

[175] *R&O*, 31 FCC Rcd at 8082, paras. 185-186.

[176] *R&O*, 31 FCC Rcd at 8081, paras. 183-184. The 1250 megahertz threshold is slightly more than one-third of the total available spectrum in the three mmW bands made available in the R&O.

[177] *R&O*, 31 FCC Rcd at 8082, paras. 185-186. In the *Order on Reconsideration infra*, we deny a request for reconsideration of this decision.

[178] *FNPRM*, 31 FCC Rcd at 8178, para. 483.

Commission sought comment on applying the same mobile spectrum holding policies that it adopted in the *R&O* to the additional mmW bands proposed for UMFUS rules in the *FNPRM* and sought comment on alternatives.[179]

72. *Discussion*. We decline to adopt a pre-auction limit, as proposed in the *FNPRM* and suggested by certain commenters,[180] on the amount of 24 GHz and 47 GHz band spectrum that an entity can acquire through competitive bidding in an auction. Generally, bright-line, pre-auction limits may restrict unnecessarily the ability of entities to participate in and acquire spectrum in an auction, and we are not inclined to adopt such limits on auction participation absent a clear indication that they are necessary to address a specific competitive concern. In the case of the mmW bands, we are not persuaded by commenters' generalized assertions that a bright-line, pre-auction limit in these bands is necessary to protect competition in the provision of wireless services. First, we note that the 24 GHz and 47 GHz bands that we make available in this Second R&O will add 1700 megahertz to the 3250 megahertz of mmW spectrum made available in the *R&O*, for a total of 4950 megahertz of mmW spectrum for flexible terrestrial wireless use. Furthermore, the spectrum in these new bands, as well as the 3250 megahertz of spectrum previously made available, will be licensed in multiple blocks of different sizes and geographic areas, providing many spectrum opportunities for various types of auction bidders.[181] In addition, as indicated in the record, development of the 24 GHz and 47 GHz bands and the mmW bands overall is still in the early stages, with a myriad of potential use cases that may require varying amounts of bandwidth for providers to offer consumers innovative services.[182] Under these circumstances, we find that establishing pre-auction limits for the 24 GHz and 47 GHz bands would not serve the public interest.

73. Although we decline to adopt a pre-auction limit for the 24 GHz and 47 GHz bands, we conclude that it is in the public interest to include these two bands as part of the previously-adopted mmW spectrum threshold for reviewing proposed secondary market transactions. This secondary market mmW spectrum threshold, in contrast to a pre-auction limit, does not establish a bright line that would prohibit a provider from acquiring spectrum. Rather, the mmW spectrum threshold for secondary markets review merely identifies those markets that may warrant further competitive analysis, similar to the Commission's spectrum screen for review of secondary market transactions involving other lower frequency spectrum bands.[183] Given that the 24 GHz and 47 GHz bands share similar technical characteristics and potential uses with the 28 GHz, 37 GHz, and 39 GHz bands already included in the

[179] FNPRM, 31 FCC Rcd at 8180, para. 491.

[180] *See* CCA Comments at 3-4 (arguing for a one-third aggregation limit as a helpful first step to curbing anti-competitive aggregation and for in-band limits to prevent "anti-competitive aggregation" of a single band); Straight Path Comments at 26-27 (stating that competition will be stymied if spectrum is concentrated in the hands of a limited number of licensees); US Cellular Reply Comments at 13-14 (arguing that limits are needed to promote competition); T-Mobile Comments at 28 (arguing that limits help prevent any one provider from obtaining a competitive advantage).

[181] *See 2nd R&O*, *supra*, at paras. 57 (licensing the 47 GHz band in five 200 megahertz blocks as opposed to one proposal to divide that band into 500 megahertz blocks), 32-33 (licensing the lower segment of the 24 GHz band as one 200 megahertz channel and the upper segment as one 100 megahertz channel and two 200 megahertz channels).

[182] *See* AT&T Reply Comments at 15-17 (arguing that limits restrict consideration of performance factors and other unique circumstances that may be relevant to the still emerging 5G competitive landscape); Verizon Reply Comments at 4 (noting that it is "too early in the 5G innovation cycle to know how much bandwidth operators will need"); TIA Comments at 21 (stating that technologies for using mmW spectrum remain at the nascent stage of technological development); Mobile Future Comments at 6 (stating that many use cases for this spectrum are not yet defined and therefore applying limits are premature).

[183] R&O, 31 FCC Rcd at 8078, para. 178; *see also Applications of Softbank Corp., Starburst II, Inc., Sprint Nextel Corp., & Clearwire Corp*., Memorandum Opinion and Order, Declaratory Ruling, and Order on Reconsideration, 28 FCC Rcd 9642, 9656, para. 34 (2013) (screen helps identify local markets where changes in market concentration or spectrum holdings from a transaction may be of particular concern).

mmW spectrum threshold, we will group all five bands together for purposes of applying the mmW spectrum threshold to review secondary market transactions.[184] Taking into consideration the additional 1700 megahertz of mmW spectrum that we are making available in the 24 GHz and 47 GHz bands, we add 600 megahertz, or approximately one-third of this additional spectrum, to the 1250 megahertz mmW spectrum threshold, for a combined threshold of 1850 megahertz for proposed secondary market transactions.

D. Part 15 Operation On-board Aircraft in the 57-71 GHz Band

74. *Background*. We are adopting rules to allow unlicensed operation on-board most aircraft in the 57-71 GHz band under Part 15 of our rules.[185] Under Part 15, the 57-71 GHz band is available for unlicensed operations, but operation on-board aircraft is currently prohibited.[186] Our decision opens this band for unlicensed use on-board aircraft and would allow up to six (6) non-overlapping WiGig channels of 2160 megahertz each.[187] We find that allowing 60 GHz unlicensed transmitters to operate in all flight phases of aircraft operation in the 57-71 GHz spectrum, with the limitations described herein, will not cause harmful interference to other authorized radio services, including EESS and the radio astronomy service (RAS), while facilitating expanded access to broadband services in flight.

75. The Fixed Wireless Communications Coalition (FWCC), the National Spectrum Management Association (NSMA), and the Aerospace Vehicle Spectrum Institute (AVSI) filed in support of allowing on-board aircraft operations in the 60 GHz spectrum.[188] In particular, the AVSI (with the cooperation of Airbus, Boeing, the Federal Aviation Administration, Intel, Panasonic Avionics Corporation, and Zodiac Inflight Innovations (ZII)) filed an extensive interference analysis report (AVSI Study) to demonstrate that the use of WiGig equipment on-board aircraft in the 57-71 GHz band does not cause harmful interference to passive services.[189]

76. FWCC supports limited unlicensed operation at 57–71 GHz aboard aircraft at power levels suitable for a 30–60 cm range on in-seat entertainment while avoiding the first WiGig channel (*i.e.*, 57-59.3 GHz) but only if EESS satellites will have adequate protection.[190] NSMA favors carefully controlling any operation on board aircraft to fully protect EESS. NSMA also notes that unlicensed fixed microwave operations are authorized in the 57-64 GHz frequency band and these services should also be

[184] *R&O*, 31 FCC Rcd at 8082, paras. 185-186.

[185] 47 CFR § 15.255; *FNPRM*, 31 FCC Rcd at 8187-8188, paras. 515-516.

[186] 47 CFR § 15.255(a)(1). This requirement was adopted in 1995 pursuant to a request of the National Academy of Sciences, Committee on Radio Frequencies (CORF) to protect radio astronomy (RAS) operations. *See Amendment of Parts 2, 15, and 97 of the Commission's Rules to Permit Use of Frequencies Above 40 GHz for New Radio Applications*, First Report and Order and Second Notice of Proposed Rulemaking, 11 FCC Rcd 4481, 4496-97, para. 35 (1995). The Commission did not lift this prohibition in the 2016 *R&O* adopting the 64-71 GHz band for unlicensed operations under the same rules in 47 CFR § 15.255. *R&O*, 31 FCC Rcd at 8131-8132, paras. 331-333.

[187] *See* IEEE 802.11-2016, *IEEE Standard for Information technology-Telecommunications and information exchange between systems-Local and metropolitan area networks-Specific requirements, Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications*.

[188] Boeing, Intel and ZII filed separate comments to support on-board aircraft usage prior to joining AVSI in *ex parte* filings. Boeing Comments at 54-55; Intel Reply at 14-15, ZII Comments. The Wi-Fi Alliance also filed in support of on-board aircraft usage in the 57-71 GHz band. Wi-Fi Alliance Comments at 9-10.

[189] *See* Aerospace Vehicle Spectrum Institute AFE 85 Project Report, *Analysis of Potential Interference from WiGig Radios on Aircraft to EESS Passive Sensors*, dated August 30, 2017, at https://ecfsapi.fcc.gov/file/10831759627379/AVSI%20WiGig%20Cover%20Letter%20and%20Report%20for%20FCC%20Filing.pdf (filed by David Redman) (AVSI Study).

[190] FWCC Comments at 9.

protected.[191]

77. In the AVSI Study, AVSI provides detailed analyses, dynamic simulations,[192] and corroborating field testing results to demonstrate that WiGig transmitters operating in the 57-71 GHz band on-board commercial passenger transport aircraft will not cause harmful interference to EESS passive service, based on protection criteria developed for this service by the ITU-R.[193] Specifically, AVSI results and analyses show that the protection criterion for EESS as published in ITU-R Recommendation RS.2017 of -169dBW/100MHz[194] is satisfied with a significant margin (at least 20 dB) when considering worst-case peak air traffic (multiple aircraft) and worst-case aircraft emissions.[195] AVSI also found that typical aircraft effective fuselage attenuation is 40 dB in the 57-71 GHz frequency range.[196]

78. On the other hand, CORF, representing the interest of the passive services of EESS and RAS, continues to be specifically concerned about protecting the 57-59.3 GHz EESS passive service, and does not think that prohibiting the use of this channel will ameliorate the effect on RAS from transmissions in the rest of the band.[197] Regarding RAS, for which there is no allocation in the 57-71 GHz band, CORF is concerned mainly about WiGig spurious emissions on harmonic frequencies that fall in RAS bands.[198] CORF recommends that any aeronautical use of these bands require strict out-of-band (OOB) emission limits at the harmonic frequencies[199] and should be considered in the aggregate within the airplane, as well as in aggregate from all planes within the beam and side lobes of the radio telescope.[200] In addition, CORF strongly urges the Commission to prohibit wireless avionics intra-communications (WAIC)[201] operations in this band in order to protect vital weather forecasting data

[191] NSMA Comments at 4.

[192] Dynamic simulation is the use of a computer program to model the time-varying behavior of a system. The systems are typically described by ordinary differential equations or partial differential equations.

[193] *See* International Telecommunication Union Radiocommunication Sector (ITU-R), *Performance and interference criteria for satellite passive remote sensing*, Recommendation ITU-R RS.2017-0 (Aug 2012) (https://www.itu.int/dms_pubrec/itu-r/rec/rs/R-REC-RS.2017-0-201208-I!!PDF-E.pdf) ; *Characterization and assessment of aggregate interference to the Earth exploration-satellite service (passive) sensor operations from multiple sources of man-made emissions*, Recommendation ITU-R RS.1858-0 (Jan 2010) (https://www.itu.int/dms_pubrec/itu-r/rec/rs/R-REC-RS.1858-0-201001-I!!PDF-E.pdf); *Reference antenna pattern for passive sensors operating in the Earth exploration-satellite service (passive) to be used in compatibility analyses in the frequency range 1.4-100 GHz*, Recommendation ITU-R RS.1813-1 (Feb 2011) (https://www.itu.int/dms_pubrec/itu-r/rec/rs/R-REC-RS.1813-1-201102-I!!PDF-E.pdf).

[194] *Performance and interference criteria for satellite passive remote sensing*, Recommendation ITU-R RS.2017-0 (Aug 2012) at Table 2, at 5.

[195] AVSI Study at 18-20.

[196] AVSI Study at 79.

[197] CORF Comments at 11-13.

[198] CORF Comments at 13-14.

[199] Harmonics are component frequencies of a radio frequency signal that are integer multiples of the fundamental frequency.

[200] CORF Comments at 14.

[201] WAIC systems provide radio communication between two or more stations on a single aircraft and constitute exclusive closed on-board networks required for the operation of an aircraft. Examples of WAIC applications that could benefit from the high-data rate provided by 60 GHz transmitters are flight deck and cabin crew communications, still-frame and video imagery, high-data rate engine sensors, or avionics data bus communications throughout the aircraft. High-data rate WAIC applications could also encompass external structural sensors or external cameras mounted on the outside of the aircraft structure to monitor the taxi, take-off, landing, cruise, etc.

collection.

79. *Discussion*. We are modifying our Part 15 rules to allow unlicensed operation on-board most aircraft during flight in the 57-71 GHz band. We find that allowing unlicensed use of this spectrum on-board aircraft while airborne, with certain limitations, will facilitate air travelers' expanded access to broadband/internet services during flight and provide an opportunity to reduce aircraft weight from connecting wires, all without causing harmful interference to authorized radio services, as we elaborate further below.

80. In the *R&O* in this proceeding, the Commission determined that the record did not reflect a clear perspective of the types of unlicensed applications envisioned on-board aircraft that would provide an adequate assessment of their harmful interference profile.[202] Thus in the *FNPRM* in this proceeding, the Commission set out to request further information and analyses with respect to the various types of unlicensed applications envisioned on-board aircraft, the priority/order of their planned introduction, as well as their associated potential harmful interference profile with respect to passive sensor services.[203] The use cases outlined in the AVSI Study suggest that planned WiGig systems use access point stations affixed to the interior ceiling in commercial passenger transport aircraft to deliver internet/entertainment products wirelessly to travelers' laptops/tablets, or to in-seat display monitors on the aircraft.[204] We are also aware that WAIC applications (as studied by the ITU in lower frequency bands) would be highly useful in providing wireless back-up connections for primary wired connections between various electrical systems of the aircraft, to lighten the aircraft's total weight.[205] We are therefore adopting unlicensed technical rules herein with these two types of applications, broadband internet/entertainment access in closed networks on-board aircraft, and certain WAIC applications, in mind.

81. As we observed in the *R&O*, the existing ITU studies on wireless avionics applications only cover frequency bands lower than the 60 GHz band.[206] However, we expect that the propagation characteristics of radio waves in the 57-71 GHz band would result in even greater attenuation than was documented in these ITU studies of lower frequency bands.[207] We note that extensive simulations and actual measurement data presented in the AVSI Study confirm that typical aircraft effective fuselage attenuation is 40 dB in the 57-71 GHz frequency range,[208] which is in line with the ITU findings of up to 45 dB aircraft fuselage attenuation at other frequencies.[209]

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phases of aircraft operation. WAIC systems do not provide air-to-ground, air-to-satellite or air-to-air communications. *See Technical characteristics and spectrum requirements of Wireless Avionics Intra-Communications systems to support their safe operation*, ITU-R Report M.2283-0 (November 2013), at 6. *See also* discussion in *FNPRM*, 31 FCC Rcd at 8187, para. 515 and n.1236.

[202] *R&O*, 31 FCC Rcd at 8132, para. 332.

[203] *FNPRM*, 31 FCC Rcd at 8187, para. 515.

[204] AVSI Study at 24-25.

[205] *See Technical characteristics and spectrum requirements of Wireless Avionics Intra-Communications systems to support their safe operation*, ITU-R Report M.2283-0 (November 2013), at 6.

[206] *R&O*, 31 FCC Rcd at 8131-8132, para. 331.

[207] All radio signals attenuate as they travel in space away from the transmitter. Free-space propagation loss (path loss) increases as a function of both the distance traveled and the frequency of the signal. Free space path loss (FSPL) is calculated according to the formula FSPL = 20 log F(GHz) + 20 log D(m) + 32.5, with frequency F in GHz and distance D in meters.

[208] AVSI Study, at p. 79-88.

[209] The ITU found that in general, fuselage attenuation of any given aircraft is not a constant, but rather is a directional property of the aircraft – different attenuation values may be found from different viewing angles of the aircraft, ranging from 0 dB attenuation for transmitters installed in unshielded external areas of the aircraft, to 45 dB attenuation for transmitters installed within the cabin when viewed outside the aircraft from certain angles. *See*

82. We find that use of the 57-71 GHz spectrum on-board aircraft would not cause harmful interference to authorized services for several reasons. First, signals at these frequencies have high propagation losses and are easily blocked by obstacles, including seats, bulkheads and human bodies on the aircraft. Second, the aircraft fuselage provides significant attenuation of signals, as supported by the ITU studies and the AVSI Study, discussed above. Third, although unshielded aircraft windows provide significantly less attenuation than the aircraft fuselage,[210] the risk of these beams being misdirected out of a window is minimal because 60 GHz transmitters use directional antenna beams to deliver the signals to the intended receivers inside the airplane.[211] We observe that the AVSI Study data indicate that the average effective aircraft attenuation (including transmissions through windows and inside aircraft cabin at multiple antenna steering angles) is on the order of 40 dB and is by and large independent of antenna location and antenna type used by either access point stations or mobile devices inside the aircraft.[212] We further find that because the aircraft fuselage attenuation plays an important role in the link budget[213] for the prevention of harmful interference caused by 60 GHz signals on-board aircraft to EESS (as computer-modeled and measured on commercial passenger transport aircraft by the AVSI Study; and as assessed by the ITU-R studies), we will exclude use of 60 GHz unlicensed transmitters on-board aircraft where there is little attenuation of RF signals by the body/fuselage of the aircraft. These aircraft include, for example, toy/model aircraft, unmanned aerial vehicles (UAV) such as drones, small/light crop-spraying aircraft and aerostats.[214]

83. With respect to WAIC applications, as indicated above, CORF strongly urges the Commission to prohibit this type of operation in the band to protect vital weather forecasting data collection. We find that the combination of high fuselage attenuation in commercial passenger transport aircraft and free-space propagation loss along with the directionality of the WiGig antenna beams inside the aircraft cabin will prevent harmful interference to passive sensor services. However, we note that WAIC applications could encompass external structural sensors or external cameras mounted on the outside of the aircraft structure to monitor the different phases of aircraft operation. These externally located transmitters may generate RF signals that would not be attenuated by the fuselage while the aircraft is in flight; thus, 60 GHz signals have the potential to escape into the air at various altitudes of flight and may present a potential for harmful interference to passive sensors. We are therefore

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ITU-R Report M.2283-0, at Table 5, Section 4.3.1. *See also, Co-existence study considering UWB applications inside aircraft and existing radio services in the frequency bands from 3.1 GHz to 4.8 GHz and from 6.0 GHz to 8.5 GHz*, European Conference of Postal and Telecommunications Administrations (CEPT) Electronic Communications Committee (ECC) ECC Report 175 (March 2012).

[210] ITU-R Report M.2283-0, Appendix A, Table A-3.3 found that unshielded aircraft windows only provide minimal attenuation. The AVSI Study also confirmed this result. AVSI Study at 28. However, AVSI also found that cockpit windows that are coated with indium tin oxide (ITO) for defrosting purposes increase the attenuation of 60 GHz line-of-sight RF signals by approximately 25 dB. AVSI Study at 87.

[211] AVSI asserts that "WiGig medium access control (MAC) layer protocols incorporate continuous beam forming and beam steering functions to optimize communications between devices. WiGig devices cannot transmit directly out of an aircraft window during normal communications because there is no associated device outside the window with which to communicate. WiGig emissions outside of the aircraft will be the result of non-line-of-sight emissions from antenna side lobes or signals bounced off one or more interior surfaces; …these emissions are typically heavily attenuated." AVSI Study at 88. AVSI further proved through computer simulations and measurement field data that non-line-of-sight transmissions in the frequency range 57–62 GHz inside the cabin are attenuated by about 40 dB relative to the direct line-of-sight signal. AVSI Study at 86.

[212] AVSI Study at 57.

[213] A link budget is an accounting of all the gains and losses from the transmitter, through the medium (free space, cable, waveguide, fiber, etc.) to the receiver in a telecommunication system.

[214] Aerostat refers to any aircraft that remains aloft primarily using aerostatic buoyancy, such as balloons which are unpowered and could be tethered or free-floating. Aerostats may also refer to powered, free-flying airships.

addressing CORF's concern by prohibiting operation of 60 GHz transmitters in WAIC applications on the outside of the aircraft body/fuselage while airborne, to ensure that passive services continue to be protected.

84. On the other hand, we deny CORF's recommendations that any aeronautical use of the 57-71 GHz bands must require strict out-of-band (OOB) emission limits at the harmonic frequencies (which fall into passive service spectrum such as RAS[215]) and should be considered in the aggregate within the airplane, as well as aggregated over multiple planes within the beam and side lobes of the passive service telescope.[216] We note that the AVSI Study generally addressed CORF's concerns by analyzing via dynamic simulation the effects of out-of-band and spurious emissions of on-board aircraft WiGig devices on passive services, both in a single aircraft with aggregate multiple equipment factor[217] and worst-case emission levels;[218] and in multiple aircraft in the aggregate during worst-case peak air traffic;[219] the results demonstrated that passive services continue to be protected by a significant margin.[220] This study suitably supplements the Wi-Fi Alliance Industry Interference Report (Wi-Fi Alliance Report) previously submitted in the record of this proceeding, in which it found comparable results while assuming a more conservative aircraft attenuation of 25 dB, instead of 40 dB.[221]

85. We find that the existing spurious emission limits in Section 15.255(c) of the rules are sufficient to protect passive services. Section 15.255(c) already restricts spurious emissions to a very low power density limit of 90 pW/cm^2 at a distance of 3 meters for frequencies between 40 GHz and 200 GHz,[222] and to the general limit for intentional radiators in Section 15.209 for frequencies below 40 GHz.[223] We determine that RF signals in this spectrum suffer from severe propagation losses, and are

[215] RAS has no allocation in the 64-71 GHz frequency band, but does have allocations above 76 GHz.

[216] CORF Comments at 14.

[217] AVSI assumed usage of 6 WiGig Channels by 30 access point stations on a single aircraft, resulting in an aggregate multiple equipment factor of 7. The Multiple Equipment Factor (MEF) is used to represent the maximum number of simultaneously transmitting devices in a WiGig aircraft installation. AVSI Study at 18-19.

[218] The AVSI Study assumed interference from a single aircraft by summing the worst-case in-band, out-of-band and spurious emissions from all WiGig devices operating in various WiGig channels, including a multiple equipment factor to account for the number of devices that can simultaneously transmit in the aircraft at the considered frequencies; in addition, attenuation due to the fuselage or antenna directivity was also considered. AVSI Study at 3.

[219] To determine aggregation effects from multiple aircraft, the AVSI Study followed the ITU recommendation that emissions from multiple devices within a two million square kilometer reference area be dynamically simulated to determine if the EESS interference protection threshold is exceeded. *Performance and interference criteria for satellite passive remote sensing*, Recommendation ITU-R RS.2017-0 (Aug 2012) at Table 1, note 1, p. 4. *See also, Characterization and Assessment of Aggregate Interference to the Earth Exploration-Satellite Service (passive) Sensor Operations from Multiple Sources of Man-made Emissions*, Recommendation ITU-R RS.1858-0 (Jan 2010).

[220] AVSI Study at 2-23.

[221] Wi-Fi Alliance Reply Comments, submitted Feb 26, 2016 (https://ecfsapi.fcc.gov/file/60001520419.pdf). The Commission did not react favorably to this report because of "…substantial technical disagreements …regarding the attenuation provided by aircraft components (e.g., windows and fuselage) and how WiGig signals would propagate (e.g., by direct line-of-sight or reflections, etc.) and aggregate." *Spectrum Frontiers Report and Order*, 31 FCC Rcd at 8131-8132, para. 331. The AVSI Study generally resolves these technical issues.

[222] A power density of 90 pW/cm^2 is equivalent to a field strength of 18430 µV/m or 85.3 dBµV/m; and to an EIRP of -10 dBm. Power density (P_D), EIRP and field strength (E) are readily converted through the following formulae: $P_D = E^2/120(Pi) = EIRP / (4 Pi D^2)$, where D is the separation distance in meters, provided measurements are performed in the far field.

[223] 47 CFR § 15.255(c); 47 CFR § 15.209(a). The limit for emissions above 960MHz is 500 µV/m (54 dBµV/m) as measured at 3 meters.

blocked easily by obstacles inside the aircraft, as well as heavily attenuated by the aircraft fuselage; therefore, 60 GHz operation on-board aircraft would not increase the potential for harmful interference to passive services, when compared to 60 GHz operation on the ground, indoors or outdoors. We also determine that spurious and harmonic emissions generally roll off (i.e., reduce in amplitude) the further they are in frequency from the fundamental emission; therefore, if fundamental emissions are severely attenuated, harmonics would be affected proportionally; thus, we find that unlicensed operations in the 57-71 GHz spectrum would not adversely affect passive services operating in frequency bands that contain the harmonics of this spectrum.[224] We further find that, depending on their angle of escape out of the aircraft fuselage, the probability of any of these stray harmonic emissions finding their way into the main beam/side lobes of the victim telescope is virtually non-existent. The AVSI Study results generally confirm our assessments by its dynamic simulations supported by corroborating measurements, as discussed above.[225] We therefore deny CORF's request for rule changes with respect to specific conditions on spurious emissions limits.

86. Based on the above, we find that, absent any record evidence to the contrary, it is our predictive judgment that 60 GHz transmitters operating on-board an aircraft in the 57-71 GHz band, with the limitations that we are imposing herein, will not cause harmful interference, which is defined not to protect against isolated occurrences, but only against interference that "seriously degrades, obstructs, or repeatedly interrupts."[226] The final Part 15 rules are set forth in Appendix A, *infra.*

E. Amendments to Certain Part 1 Rules

87. *Background.* Appendix A of the *R&O* added Part 30 (Upper Microwave Flexible Use Service) to the list of rule parts included in the definition of Wireless Radio Services in Subpart F of Part 1 of the Commission's rules. At the time, the Commission added UMFUS to the definitions of Wireless Radio Service and Wireless Telecommunications Service in Section 1.907 of the Commission's rules but refrained from modifying other existing rules in other rule parts.[227] On further reflection, we believe it would have been appropriate to amend Sections 1.901 (Basis and Purpose) and 1.902 (Scope) to make it unambiguously clear that UMFUS is subject to the Subpart F rules.

88. *Discussion.* We amend Sections 1.901 and 1.902 of the Commission's rules to include Part 30 in the list of sections to which the Part 1, Subpart F rules apply. The *R&O* clearly expressed the Commission's intent to apply the Part 1, Subpart F rules to UMFUS.[228] Amending Sections 1.901 and 1.902 to include UMFUS will be consistent with that intent. Notice and comment is not required for this change because the changes go to rules of practice and procedure.[229]

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[224] While the AVSI Study mainly concentrated on EESS protection, the Wi-Fi Alliance Report analyzed the effect of WiGig transmitters on RAS frequencies at 120 GHz, 180 GHz and 240 GHz, and found that the ITU protection criteria for RAS in ITU-R RA.769 of -179 dBm/MHz was satisfied with an appropriate margin, despite the lower assumed aircraft attenuation (25 dB instead of 40 dB). Wi-Fi Alliance Report at p. 16-20. *See also*, International Telecommunication Union Radiocommunication Sector, *Recommendation RA.769-2: Protection criteria used for radio astronomical measurements* (May 2003) (https://www.itu.int/dms_pubrec/itu-r/rec/ra/R-REC-RA.769-2-200305-I!!PDF-E.pdf).

[225] AVSI Study at 90-96.

[226] 47 CFR § 2.1(c).

[227] *R&O*, 31 FCC Rcd at 8097, para. 243.

[228] *R&O*, 31 FCC Rcd at 8097, para. 243.

[229] 5 U.S.C. § 553(b)(3)(A). In addition, we are amending Section 101.115 of our rules to fix a footnote numbering error in the Antenna Standards table in Section 101.115. The change clarifies that the footnote applicable to the 70 GHz and 80 GHz bands should be labelled footnote 14.

IV. SECOND FURTHER NOTICE OF PROPOSED RULEMAKING

A. FSS Use of 24.75-25.25 GHz Band

89. *Background*. In a 2010 petition for rulemaking, Xanadoo Company and Spectrum Five LLC asked the Commission to delete the Federal and non-Federal radio-navigation system allocations from the 24.75-25.05 GHz band.[230] In response to the petition, the Commission allocated the 300 megahertz of spectrum exclusively to the FSS (Earth-to-space) for non-Federal use. The Commission also expanded the FSS allocation from BSS feeder links to all FSS uses. In doing so, the Commission adopted footnote NG535 to the U.S. Table of Allocations, which provides BSS priority over all other FSS uses in the 24.75-25.05 GHz band, and restricts FSS use of the 25.05-25.25 GHz band to feeder links for BSS.[231] The Commission also stated that, if in the future, requests for licensing or other market developments suggest a demand for additional FSS uses of the 24.75-25.05 GHz band, it would initiate a separate rulemaking proceeding to examine whether any specific rules are necessary to support uses consistent with the priority afforded to BSS feeder links in this band.[232]

90. In the *R&O*, the Commission established rules to allow UMFUS licenses to provide any form of fixed or mobile service in the 28 GHz and 39 GHz bands.[233] These rules include section 25.136, a new rule specifying the conditions under which FSS earth stations in these bands can operate with respect to UMFUS.[234] Section 25.136(a) permits a limited number of FSS earth stations in the 27.5-28.35 GHz band to be licensed in each county on a secondary basis without providing additional interference protection to UMFUS, provided that the interference zones around those earth stations do not affect UMFUS beyond limits prescribed in the rule.[235] Section 25.136(b)-(c) of the Commission's rules permits a limited number of FSS earth stations in the 37.5-40 GHz band to be licensed in each PEA and to receive interference protection from UMFUS, provided that the protection zones around those earth stations do not constrain UMFUS beyond limits prescribed in the rule.[236]

91. The *FNPRM* proposed authorizing flexible use licenses that would permit fixed and mobile services in additional frequency bands under Part 30 of the Commission's rules, including the 24 GHz band. Specifically, the *FNPRM* proposed to add a mobile allocation to the 24.25-24.45 GHz and 24.75-25.25 GHz segments of the band, a fixed allocation to 24.75-25.05 GHz, and to authorize both mobile and fixed operations in those band segments under the Part 30 Upper Microwave Flexible Service

[230] Petition for Rulemaking to Establish Rules Permitting Blanket Licensing of Two-Way Earth Stations with End Users Uplinks in the 24.25-25.05 GHz band (filed Apr. 16, 2010).

[231] Amendment of Parts 2, 15, 80, 90, 97, and 101 of the Commission's Rules Regarding Implementation of the Final Acts of the World Radiocommunication Conference (Geneva, 2012) (WRC-12), Other Allocation Issues, and Related Rule Updates, Report and Order, and Further Notice of Proposed Rulemaking, 30 FCC Rcd 4183, 4212para. 71 (2015) (*WRC-12 Report and Order*); and 47 CFR § 2.106, NG535.

[232] *WRC-12 Report and Order*, 30 FCC Rcd at 4212-13, para. 71.

[233] *Use of Spectrum Bands Above 24 GHz for Mobile Radio Services, Report and Order and Further Notice of Proposed Rulemaking*, FCC 16-89, 31 FCC Rcd 8014 (2016) (*Spectrum Frontiers Report and Order*). In the 27.5-28.35 GHz band, the Commission adopted county size geographic area licenses, and in the 38.6-40.0 GHz band, the Commission adopted partial economic area (PEA) licenses. *Id.* at 8148, ¶ 383.

[234] Section 25.136 became effective on June 1, 2017. Use of Spectrum Bands Above 24 GHz for Mobile Radio Services, 82 Fed. Reg. 25205 (June 1, 2017).

[235] 47 CFR § 25.136(a), and *R&O*, 31 FCC Rcd at 8036, para. . The International Bureau was directed to release a public notice seeking comment on the methodology for determining interference or protection zones. *Id* at 8036, n.120. *See* Public Notice, International Bureau Seeks Comment on Implementing Earth Station Siting Methodologies, DA 17-606 (June 21, 2017).

[236] 47 CFR § 25.136(b)-(c).

rules.[237] Today, we adopt rules consistent with that proposal.[238]

92. In comments to the *FNPRM*, SIA, SES, and O3b, ask that the Commission authorize broader FSS use of the 24.75-25.25 GHz band.[239] SIA points out that FSS has a primary allocation in the band and it believes that individually licensed earth stations can coexist with UMFUS.[240]

93. *Discussion.* We propose to license FSS earth stations in this band on a co-primary basis under the provisions in section 25.136(d), as revised today in the *Second Report and Order* for the 47.2-48.2 GHz band by adding the 24.75-25.25 GHz band to this rule section. This means that the 24.75-25.25 GHz band would only be available for individually-licensed FSS earth stations that meet specific requirements applicable to earth stations in other bands shared with UMFUS (*e.g.*, limitations on population covered, number of earth station locations in a PEA, and a prohibition on earth stations in places where they would preclude terrestrial service to people or equipment that are in transit or are present at mass gatherings). As a consequence of this change, we propose conforming modifications to various earth station application requirements specified in sections 25.115(e) and 25.130(b), and deleting as obsolete the licensing requirements for the 25.05-25.25 GHz band specified in section 25.203(l).[241] We are also proposing to add a U.S. Table of Allocations footnote specifying the relative interference protection obligations of FSS and UMFUS stations in the 24.75-25.25 GHz band. It appears that allowing broader FSS use in the 24.75-25.25 GHz band may be appropriate, and to provide for more flexible FSS use of the band, we propose to eliminate footnote NG535. This would make the 24.75-25.25 GHz band available for general FSS uplink operations, without restricting these operations to, or affording priority for, the provision of feeder links for the 17/24 GHz BSS space stations. Given the very light use of the 24.75-25.25 GHz band for BSS feeder links, the earth station two-degree spacing rules that would protect BSS feeder links from other FSS earth stations in the band,[242] and the power limits placed on BSS feeder link earth stations,[243] it does not appear necessary to give BSS feeder link earth station transmissions priority over other uses of the FSS for earth stations located within the United States, or to preclude other FSS stations from claiming protection from feeder link earth station transmissions located within the United States. To accommodate more diverse FSS operations in the band and to further increase flexibility for all FSS uses in this new sharing regime, we also propose to eliminate the Appendix F orbital-location restrictions for 17/24 GHz BSS space stations specified in section 25.262(a).[244] We seek comment on these proposals.

94. Though we are proposing to allow broader and more flexible FSS use of the 24.75-25.25 GHz band consistent with the predominant use of the band for terrestrial wireless services, we recognize that aggregate interference to the satellite receivers from UMFUS operations may be a concern in this band, similar to concerns raised in the context of the 28 GHz and 47 GHz bands. There are currently

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[237] *Spectrum Frontiers Report and Order*, 31 FCC Rcd at 8148.

[238] *See* Section III.A.1, *supra*.

[239] SIA Comments at 7-9; SES/O3b March 23 *Ex Parte* at 2.

[240] SIA Comments at 7-8, 9-11.

[241] 47 CFR §§ 25.115(e), 25.130(b), and 25.203(l).

[242] 47 CFR § 25.212(f).

[243] 47 CFR §§ 25.212(f), 25.223.

[244] *Establishment of Policies and Service Rules for the Broadcasting-Satellite Service at the 17.3-17.7 GHz Frequency Band and at the 17.7-17.8 GHz Frequency Band Internationally, and at the 24.75-25.25 GHz Frequency Band for Fixed-Satellite Services Providing Feeder Links to the Broadcasting-Satellite Service and for the Satellite Services Operating Bi-directionally in the 17.3-17.8 GHz Frequency Band*, Report and Order, 22 FCC Rcd 8842 (2007) (*17/24 GHz BSS Report and Order*), on reconsideration, 22 FCC Rcd 17951 at 17972, Appendix F. *See also*, *17/24 GHz BSS Report and Order*, at 8869-70, para. 66. We will maintain the four-degree spacing framework for the 17.3-17.8 GHz (space-to-Earth) operations outlined in the *17/24 GHz BSS Report and Order*.

earth stations and space stations that operate in this band. Should the Commission take any action to address the potential of aggregate interference to impact satellite receivers in this band? How likely is it that such interference will occur? Should the Commission treat such interference to existing satellites, should it occur, differently from satellites deployed in the future? Should the Commission adopt a U.S. Table of Allocations footnote specifying the relative interference protection obligations of FSS and UMFUS stations in the 24.75-25.25 GHz band and what should be the content of such a footnote?

95. Consistent with these proposals, in addition to modifications to section 25.136, we propose several rule changes to part 25. To harmonize the treatment of BSS feeder links and other FSS transmissions, we propose first to modify section 25.138 to extend applicability of the Ka-band off-axis EIRP density limits in paragraph (a) to the 24.75-25.25 GHz band. Then we would eliminate the nearly identical BSS feeder link-specific earth station off-axis EIRP density limits for the 24.75-25.25 GHz band in section 25.223(b). We propose to eliminate the coordination provisions sections 25.223(c) and (d), and to add the 24.75-25.25 GHz band to the list of frequency bands in our general FSS earth station coordination rules in section 25.220(a). These changes would allow us to remove and reserve section 25.223, because there would be no need for these provisions, which currently provide alternative means of licensing BSS feeder links. As a consequence, we would also eliminate cross references to the rule contained in section 25.209(f).[245] In section 25.204, we propose to eliminate paragraph (e)(4), which contains rain fade specifications specific to 17/24 GHz BSS feeder link transmissions, and instead to include the 24.75-25.25 GHz band in paragraph (e)(3), which contains nearly identical Ka-band FSS rain fade specifications. We also propose to modify the interference-showing requirements for FSS applicants in section 25.140(a)(3) to make clear its applicability to FSS (Earth-to-space) transmissions to 17/24 GHz BSS space stations. In addition, we propose to add a new subparagraph (iv) requiring applicants for space stations receiving uplinks in the 24.75-25.25 GHz band to certify, among other things, that the earth stations transmitting to such space stations will not exceed the off-axis EIRP density limits in section 25.138(a). As a result, we also propose consequential modifications to the definitions of "routine processing or licensing" and "two-degree compliant space station" contained in section 25.103. We seek comment on these proposals.

96. In addition, we propose to eliminate the operational requirements associated with the Appendix F orbital-location constraints in section 25.262 by deleting paragraphs (a) and (d), and modifying paragraphs (b) and (e).[246] We further propose to modify sections 25.140(b), (c) and (d) to reflect changes in the interference showing required by 17/24 GHz BSS applicants, which is currently defined in part by the applicant's orbital position relative to Appendix F locations, and to eliminate an operational requirement made moot by deleting section 25.262(b). Similarly, we propose to delete Appendix F specific requirements contained in section 25.114(d)(17), and to eliminate a reference in Section 25.114(d)(7) to a deleted subparagraph in section 25.140(b). Finally, to provide for consistent treatment of 17/24 GHz feeder uplinks with other FSS transmissions in the 24.75-25.25 GHz band, we propose to modify the cross-polarization isolation requirement in section 25.210(i) to make clear that it applies only to 17/24 GHz BSS space-to-Earth transmissions. These proposed rule changes are shown in detail in Appendix E.

B. Performance Requirements – Geographic Area Metric

97. *Background*. In the *FNPRM*, the Commission sought comment on adopting a performance metric tailored to Internet of Things-type deployments or other innovative services that may not be a good fit for traditional metrics.[247] Because the record on this issue was not sufficiently detailed, we decline to adopt any additional metric today and seek comment on additional proposals discussed

[245] Other cross references to section 25.223 are eliminated in conjunction with other edits to the rule section. *E.g.* Sections 25.103 and § 25.115(g)(1)(vii).

[246] The remaining paragraphs in this section will be renumbered, not reserved.

[247] *FNPRM*, 31 FCC Rcd at 8174-75, paras. 467-69.

below.[248]

98. *Discussion.* We recognize the difficulty of crafting an IoT-specific metric, especially while the relevant technologies and use cases are still being developed. Today, we instead seek additional comment on whether to adopt a more traditional or other metric that may nevertheless accommodate these types of services. For example, a performance metric based on geographic area coverage (or presence) could allow for networks that provide meaningful service but deploy along lines other than residential population. Such a metric could be easier to implement than any of the novel metrics proposed in the record, which could reduce uncertainty among licensees wishing to deploy innovative services and thereby encourage such deployment.

99. We seek comment on the following metric as an option for UMFUS licensees to fulfill their buildout requirements: geographic area coverage of 25% of the license area, or presence in 25% of census tracts within the license area. The latter standard is intended to accommodate deployments, such as sensor networks, that are not designed to provide mobile or point-to-multipoint area coverage, and for whom calculating "coverage of 25% of the area" would therefore not be a meaningful standard. Equipment or deployments relied on to demonstrate compliance with this metric would be required, as with our previously-adopted metrics, to be part of a network that is actually providing service, either to external customers or for internal uses.

100. Specifically, we seek input on whether 25% would be the appropriate level of coverage for a geographic area metric in the mmW bands. We suggest this level as an attempt to maintain parity between the requirements of this metric and the requirements of our previously-established metric based on population coverage.[249] The physical characteristics of the mmW bands, particularly shorter propagation distances and the consequent smaller coverage area, are also important considerations. We seek comment on this coverage level, including any suggestions of alternative levels of coverage that might be more appropriate.

101. We also seek comment more generally on whether geographic area coverage is the most appropriate metric for accommodating innovative services in the mmW bands, or whether some other metric might be more appropriate. We welcome any alternative suggestions for metrics that might better accommodate innovative services, without raising artificial regulatory barriers to particular use cases. For example, have there been any technological or industry developments that would better enable us to craft a meaningful usage-based metric? Are there additional options that have not yet been mentioned in the record? We particularly seek comment from entities who believe that our mobile and fixed metrics would not be adequate to measure deployment of services they might seek to provide in UMFUS bands. We ask that these commenters identify additional types of performance metrics that may be better suited to measuring deployment of services that they might seek to provide in UMFUS bands.

102. We emphasize that any metric we adopt to accommodate IoT services would, like the existing population coverage and fixed link metrics, be available to any UMFUS licensee. While we suggest an additional metric in order to facilitate the deployment of IoT and other innovative services, there would be no requirement that a licensee build a particular type of network or provide a particular type of service in order to use whatever metric we ultimately adopt.

103. We strongly encourage stakeholders to fully develop a record on this issue. Under our current Part 30 rules, licensees have limited options for fulfilling buildout requirements: fixed links, population-based area coverage, or some combination thereof.[250] Part 30 does not use a "substantial

[248] *See supra* Section III.B (Performance Requirements – Additional Metrics).

[249] In most license areas, the residential population is unevenly distributed. In those areas, building a network covering 40% of the geographic area would require more intensive deployment than one covering 40% of the population, suggesting that a lower percent coverage requirement for geographic area could be appropriate.

[250] 47 CFR § 30.104.

service" framework; if a licensee does not meet the requirements specifically set out in the rules, it cannot demonstrate buildout in some other way.[251] If we do not adopt any other metrics, services with non-traditional network structures may be effectively barred from mmW bands by inappropriate and inapplicable buildout requirements. This is especially important given the changes to the definition of "fixed link" that we adopt today.[252] Without an additional metric, any low-power deployments that do not use mobile or point-to-multipoint network architecture will not be able to qualify for license renewal.

C. Mobile Spectrum Holdings

104. For many of the reasons that we declined to adopt a pre-auction limit for the 24 GHz and 47 GHz bands in the Second R&O, we propose to eliminate the pre-auction limit of 1250 megahertz that the *R&O* had adopted for the 28 GHz, 37 GHz and 39 GHz bands.[253] Given the nascent stage of technological development in these mmW bands and the fact that we are continuing to make additional mmW spectrum available through this proceeding, retaining a pre-auction limit for the 28 GHz, 37 GHz, and 39 GHz bands may be unnecessary. Moreover, given the technical similarity between all five bands and our decision in the Second R&O to group these five bands for purposes of secondary market transactions review, we find that it would be inconsistent to retain the pre-auction limit for the 28 GHz, 37 GHz, and 39 GHz bands. We seek comment on this proposal. To the extent that commenters advocate the retention of this pre-auction limit, commenters should discuss how the limit should be implemented and the likely effects of having two different policy frameworks applicable to mmW spectrum acquired at auction.

105. We also seek comment on whether, in the absence of pre-auction limits for mmW spectrum, there is a need to apply a case-by-case review of mmW spectrum holdings to post-auction applications for initial mmW licenses. Prior to the articulation of a different policy in the *Mobile Spectrum Holdings Order* adopted in 2014, the Commission applied its case-by-case review for secondary market transactions to the initial licensing of spectrum post-auction, and similarly allowed for divestiture of licenses to address potential competitive harms identified in that review.[254] Is it necessary and appropriate to apply an 1850 megahertz threshold to the initial licensing of mmW spectrum post-auction? In the absence of such review, would the public interest benefits of having a mmW spectrum threshold applicable to secondary market transactions be rendered ineffective during the initial licensing of these mmW spectrum? To the extent that commenters support a case-by-case review, commenters should discuss how the review should be implemented, including what the Commission should consider when undertaking such a review, how an entity's mmW spectrum holdings should be calculated, and potential remedies to ameliorate any potential competitive concerns identified in the review.

V. ORDER ON RECONSIDERATION

A. Security

106. *Background*. In the *R&O*, the Commission adopted rules requiring licensees, prior to commencing operations, to submit to the Commission security plans and related information indicating how confidentiality, integrity, and availability[255] principles are applied in its network security design

[251] *R&O*, 31 FCC Rcd at 8088, para. 203, 47 CFR § 30.104.

[252] *See supra* Section III.B (Performance Requirements – Additional Metrics).

[253] *R&O*, 31 FCC Rcd at 8081, paras. 183-184.

[254] *See* Mobile Spectrum Holdings Order [FCC 14-63] at para. 136. *See also* Applications of Union Telephone Company and Cellco Partnership d/b/a Verizon Wireless Applications for 700 MHz Band Licenses, Auction No. 73, *Order*, 23 FCC Rcd 16787, 16791-92 ¶ 9, 16796 ¶ 18 (2008).

[255] Confidentiality refers to the protection of data from unauthorized access and disclosure, both while at rest and in transit. *See, e.g.*, ATIS, ATIS Telecom Glossary, http://www.atis.org/glossary/definition.aspx?id=6609 (defining "confidentiality") (last visited Oct. 20, 2017). Integrity refers to the protection against the unauthorized modification or destruction of information. *See, e.g.*, ATIS, ATIS Telecom Glossary,

processes.[256] Several parties filed petitions for reconsideration, which ask the Commission to eliminate the security reporting requirements.[257] NCTA argues that the *R&O's* reporting and security requirements would adversely affect innovative cybersecurity practices.[258] NCTA further states that there is "no reasonable fit" between the goal of fostering more secure 5G networks and devices and the Commission's chosen mechanism of reporting and security requirements.[259] Some parties opposing the security reporting requirements believe that the requirements would be onerous. For instance, CCA affirms that the security and reporting requirements could "saddle carriers with administrative and competitive burdens."[260] Also, T-Mobile emphasizes that the reporting and security requirements would place a burden on licensees that is "substantial based on the number of topics to be covered, the difficulty in balancing the need to be forthright with the Commission while keeping matters relating to security and competitively sensitive information confidential, and the requirement for senior executive involvement."[261]

107. *Discussion.* We acknowledge that there may be other mechanisms that foster more secure networks without imposing the burden of additional regulation. We therefore believe that more flexible security mechanisms should be fully explored, including ones employing voluntary means, in order to achieve a narrowly tailored fit with our goal of secure 5G networks and devices.

108. By exploring flexible security mechanisms as our next step, we can avoid the costs of implementing the *R&O's* reporting and security requirements, which could slow the development of innovative 5G services. For example, NCTA claims that these requirements would "impose substantial compliance costs on 5G network operators with no meaningful corresponding benefit in light of the fact that network providers already have enormous incentives to adopt measures to protect their networks."[262] NCTA further argues that "a band-by-band approach to cybersecurity . . . would increase compliance costs."[263]

109. We also believe that a regulatory approach to 5G security is premature at this time. As CTIA states, the "supporting architecture for 5G is presently in development and is likely to remain in flux."[264] Similarly, TIA maintains that it is not clear yet how 5G networks will operate.[265] Given these considerations, we believe that it would serve the public interest to rescind the reporting and security

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http://www.atis.org/glossary/definition.aspx?id=4584 (defining "integrity") (last visited Oct. 20, 2017). Availability refers to the accessibility and usability of a network upon demand. *See, e.g.*, ATIS, ATIS Telecom Glossary, http://www.atis.org/glossary/definition.aspx?id=5637 (defining "availability") (last visited Oct. 20, 2017). For a discussion of all three constructs of confidentiality, integrity and availability, *see also In the Matter of Use of Spectrum Bands Above 24 GHz for Mobile Radio Services*, Notice of Proposed Rulemaking, 30 FCC Rcd 11878, 11953 paras. 262-64 (2015).

[256] *R&O*, 31 FCC Rcd at 8206-07, para. 263; and Appendix A, Final Rules, § 30.8 5G Provider Cybersecurity Statement Requirements.

[257] *See* CCA Petition at 15; CTIA Petition at 11-12; NCTA Petition at 1, 3, 4, 7; T-Mobile Petition at 13.

[258] NCTA indicates that while overall the *R&O* would promote 5G innovation, it believes that the security and reporting requirements "would significantly undermine [the] industry's investment in and integration of leading and innovative cybersecurity practices in 5G deployments." NCTA Petition at 1.

[259] *Id.* at 7.

[260] *See* CCA Petition at 15.

[261] T-Mobile Petition at 13.

[262] NCTA Petition at 1.

[263] *Id.* at 3.

[264] CTIA Petition at 16.

[265] TIA Petition at 8.

requirements. To reduce the risk to network reliability and security, we instead seek industry input through the Communications Security, Reliability, and Interoperability Council (CSRIC) process. We believe that CSRIC is an appropriate vehicle to explore these network security issues given its track record of addressing cybersecurity issues through flexible, voluntary means.[266] As CTIA states, the Commission generally favors a "business-driven cybersecurity risk management" approach because a "flexible, adaptable approach" offers a "workable strategy for securing commercial networks."[267] We expect tangible, practical security benefits from the CSRIC processes as part of the public-private partnership which, as NCTA notes, already exist to address best practices.[268] We have asked CSRIC to identify the network reliability and security risks associated with 5G networks and develop best practices to mitigate those risks.[269] The Commission may also use CSRIC recommendations to help inform any additional steps that may be necessary.

B. Earth Station Siting Rules

1. Background

110. The 27.5-29.5 GHz band has had long-standing allocations for the fixed, mobile, and Fixed-Satellite Service (Earth-to-space) services.[270] In the 1996 *LMDS First Report and Order,* the Commission designated the 27.5-28.35 GHz band for LMDS on a primary basis and determined that satellite services would be permitted in that band on a non-interference basis to LMDS systems, and only for the purpose of providing limited gateway-type services.[271]

111. The U.S. Table of Frequency Allocations accords co-primary status to FSS earth stations (space-to-Earth) in the 37.5-40 GHz band.[272] Under the rules in effect prior to the *NPRM*, gateway earth stations in the 39 GHz band could be deployed only if the FSS licensee obtained a 39 GHz license for the area where the earth station would be located, or if it entered into an agreement with the corresponding 39 GHz licensee.[273]

112. In the *R&O*, the Commission found that "FSS earth stations in the 28 GHz band can

[266] *See* CTIA Petition at 11-12.

[267] *Id.* at 11.

[268] NCTA Petition at 4.

[269] The charter of CSRIC states that the purpose of the CSRIC is to "provide recommendations to the FCC regarding ways it can strive for security, reliability, and interoperability of communications systems. CSRIC's recommendations will focus on a range of public safety- and homeland security-related communications matters, including . . . the reliability of communications systems and infrastructure . . . ." Federal Communications Commission, *Charter of the FCC's Communications Security, Reliability, and Interoperability Council* (March 19, 2017), https://drupal7admin.fcc.gov/files/csric-charter-2017pdf. The FCC has charged the current CSRIC (CSRIC VI) to study and recommend, *inter alia,* mechanisms to reduce risks to network reliability and security, including ones to "best design and deploy 5G networks to mitigate risks to network reliability and security", and "best practices . . . to improve reliability and reduce security risks . . . ." Federal Communications Commission, *CSRIC VI Working Group Descriptions* at 2-3 (June 23, 2017) (stating the description for "Working Group 3: Network Reliability and Security Risk Reduction"), https://www.fcc.gov/files/csric6wgdescriptions6-2017pdf.

[270] *In the Matter of Rulemaking to Amend Parts 1, 2, 21, and 25 of the Commission's Rules to Redesignate the 27.5-29.5 GHz Frequency Band, to Reallocate the 29.5-30.0 GHz Frequency Band, to Establish Rules and Policies for Local Multipoint Distribution Service and for Fixed-Satellite Services*, First Report and Order and Fourth Notice of Proposed Rulemaking, 11 FCC Rcd 19005, 19008, para. 6 (1996) (*LMDS First Report and Order*).

[271] *LMDS First Report and Order*, 11 FCC Rcd at 19025, para. 45.

[272] 47 CFR § 2.106.

[273] *See* 47 CFR § 25.202(a)(1) n.3. There was no corresponding rule for the 37 GHz band because the Commission had not yet adopted service rules for that band.

share the band with minimal impact on terrestrial operations."[274] Based upon that finding, the Commission grandfathered all existing 28 GHz FSS earth stations authorized as of the adoption date of the *Report and Order* and granted them the right to operate under the terms of their existing authorizations without taking into account possible interference to UMFUS operations.[275] It also grandfathered pending applications for 28 GHz earth stations filed prior to the adoption date of the *R&O* if such applications were subsequently granted pursuant to the existing Part 25 rules.[276] The Commission also gave FSS operators multiple mechanisms for deploying earth stations. First, it granted status to any FSS earth stations for which the FSS operator also holds the UMFUS license, whether through participation in an auction or the secondary markets, that covers the earth station's permitted interference zone. To the extent FSS operators and UMFUS licensees enter into private agreements, the Commission held that their relationship will be governed by those agreements. The Commission also determined that FSS earth stations may continue to be authorized without the benefit of an interference zone, *i.e.*, on a secondary basis.[277]

113. Finally, the Commission decided that it would continue to authorize satellite earth stations on a first-come, first-served basis in the 28 GHz band, but adopted guidelines for their deployment. First, it would authorize no more than three locations in each county where FSS would be allowed to deploy earth stations that do not have to protect UMFUS stations from interference. Second, an FSS applicant would be required to demonstrate in its license application that the permitted interference zone around its earth station would cover no more than 0.1 percent of the population of the county license area where the earth station was to be located.[278] Third, the applicant would be required to show that the permitted interference zone would not infringe upon any major event venue, arterial street, interstate or U.S. highway, urban mass transit route, passenger railroad, or cruise ship port. Fourth, to ensure that the earth station would not interfere with existing facilities operating under a 28 GHz UMFUS license, the Commission required that the satellite operator coordinate with the UMFUS licensee in the county where it proposed to locate its earth station using the coordination procedures contained in Section 101.103(d) of the Commission's rules.[279]

114. In contrast to the 28 GHz band, where FSS earth stations transmit, FSS earth stations in the 37.5-40 GHz band receive. Accordingly, earth stations in that band need protection against interfering signals from terrestrial operations. Prior to the *NPRM*, Commission rules for the 39 GHz band provided that gateway earth stations would be allowed only if the satellite licensee obtained a license for the terrestrial geographic service area where the earth station would be located, or if the satellite operator

[274] *R&O*, 31 FCC Rcd at 8032, para. 45.

[275] *R&O*, 31 FCC Rcd at 8037, para. 59.

[276] *R&O*, 31 FCC Rcd at 8037, para. 59.

[277] *R&O*, 31 FCC Rcd at 8037, para. 58. The Commission encouraged UMFUS licensees to be flexible in providing certainty to the operation of FSS earth stations in areas where they do not intend to deploy terrestrial services, but emphasized that FSS earth stations will otherwise have no expectation of interfering rights and will have to cease operation if requested by UMFUS licensees at any time on the basis of harmful interference to their services. *Id.*

[278] *R&O* at 31 FCC Rcd 8036, para. 54. The Commission defined the permissible interference zone as the contour within which all the FSS licensees at a given location would, in the aggregate, generate a power flux density (PFD), at 10 meters above ground level, of no more than -77.6 dBm/m^2/MHz. The Commission also stated that the International Bureau would issue a public notice seeking comment on the appropriate methodology to calculate the 0.1 percent population limit and further details regarding earth station interference zone calculation (including propagation models, *e.g.* free space versus probabilistic), and would also seek comment on best practices for earth station siting to minimize the impact on UMFU services, colocation of earth stations, and accommodating multiple earth station interference zones without exceeding 0.1 percent of population in a given county.

[279] *R&O* at 31 FCC Rcd 8036, para. 54. *See* 47 CFR § 101.103(d).

entered into an agreement with the corresponding terrestrial licensee.[280] In the *R&O*, the Commission allowed FSS operators to place earth stations using any of the market-based mechanisms adopted for the 28 GHz band.[281]

115. The Commission further determined that it would authorize non-Federal satellite earth stations in the 37.5-40 GHz band on a first-come, first-served basis and give them protection from terrestrial transmissions subject to the following conditions.[282] First, the earth station applicant must define a protection zone in its application around its earth station where no terrestrial operations may be located. The FSS applicant may self-define this protection zone, but it must demonstrate using reasonable engineering methods that the designated protection zone is no larger than necessary to protect its earth station. Second, the Commission determined that it would authorize a maximum of three protection zones in each Partial Economic Area (PEA). Accordingly, the applicant was required to demonstrate either that there are no more than two existing protection zones in the PEA or to demonstrate that its protection zone would be contiguous to any preexisting satellite protection zone.[283] Third, the applicant must demonstrate that the existing and proposed protection zones, in the aggregate, would not cover more than 0.1 percent of the PEA's population. Fourth, the Commission required the applicant to show that the protection zone would not infringe upon any major event venue, arterial street, interstate or U.S. highway, urban mass transit route, passenger railroad, or cruise ship port.[284] Finally, the earth station applicant is required to coordinate with terrestrial fixed and mobile licensees whose license areas overlap with the protection zone, in order to ensure that the protection zone does not encompass existing terrestrial operations.[285] If the earth station is authorized, our rules prohibit UMFUS licensees from placing facilities within the protection zone absent consent from the FSS operator, and the FSS operator must respond in good faith to requests to place facilities within a protection zone.

116. In petitions for reconsideration, some satellite operators seek a relaxation of the 0.1 percent limits on populations affected by exclusion zones around their earth stations,[286] curtailment of the rules that limit the impact of satellite operations on the provision of terrestrial services to users in transit,[287] and elimination of the rules that limit earth station zones to three per geographic area.[288] Parties also seek various clarifications, which we address below.

117. The burden of proof falls upon petitioners to demonstrate that FSS needs additional flexibility to locate earth stations in the 28 GHz and 37.5-40 GHz bands, which primarily are designated

[280] *R&O* at 31 FCC Rcd 8048, para. 89.

[281] *R&O* at 31 FCC Rcd 8051, para. 92.

[282] *R&O*, 31 FCC Rcd at 8051-52, para. 93. The main body of the text refers to the 39 GHz segment of the 37.5-40 GHz band, but its reasoning applies to the entirety of the band, as does the newly adopted Rule 25.136 as set forth in Appendix A of the *R&O*. *See* 47 CFR § 25.136.

[283] *R&O*, 31 FCC Rcd at 8051, para. 93.

[284] *R&O*, 31 FCC Rcd at 8051-52, para. 93.

[285] The Commission stated that those coordination requirements would be based on its existing requirements contained in Section 101.103(d) of the Commission's rules. *R&O*, 31 FCC Rcd at 8051, para. 93, *citing* 47 CFR § 101.103(d).

[286] *See* Petitions of SES and O3b at 6-7 and Boeing at 24-25; Satellite Broadband Companies Reply at 7. *But see* ViaSat April 12, 2017, Ex Parte.

[287] *See* Petitions of EchoStar and Inmarsat at 11-12 and SES and O3b at 14-15; Replies to Oppositions of Satellite Broadband Operators at 10-12 and SES and O3b at 8-9, and Ex Partes of Satellite Broadband Operators on March 3, 2017, at 5-6, and June 13, 2017, at 3 and 5.

[288] *See* Petitions of Boeing at 23-24, EchoStar and Inmarsat at 20-21, and ViaSat at 6-7; SES and O3b Opposition at 6; Replies to Oppositions of Boeing at 9, Satellite Broadband Operators at 13, SES and O3b at 9, and ViaSat at 3, and Ex Partes of Boeing on June 19, 2017, at 4 and Satellite Broadband Operators on June 13, 2017, at 2 and 5.

for terrestrial use. They fail to meet that burden, except in the limited instances discussed below.

2. 0.1 Percent Population Limit

118. *Background.* Satellite petitioners and their supporters propose various ways to relax the rules that limit earth station exclusion zones to 0.1 percent of the population of UMFUS license areas. Their proposals include applying the 0.1 percent limit to the entire country or Basic Trading Areas (BTAs) rather than to counties or PEAs,[289] increasing the limit to 0.2 percent,[290] allowing satellite operators to deploy earth stations anywhere outside of urban cores,[291] and modifying the rule's limits with respect to small and medium-sized markets.[292] SES and O3b seek to modify the 0.1 percent rule to allow earth station exclusion zones in the 28 GHz band to cover as many as 600 people in what it calls medium-density counties with between 6,000 and 300,000 people,[293] and to cover as much as 10 percent of the population in what it calls low density counties, those with fewer than 6,000 people.[294] They also seek to raise the 0.1 percent limit to 0.2 percent in the largest counties, those with more than 300,000 people.[295] For the 39 GHz band, SES and O3b ask the Commission to allow protection zones to cover 0.2 percent of the population in PEAs with population of over 1,500,000, up to 3,000 people in PEAs with population between 60,000 and 1,500,000,[296] and up to five percent of the population in PEAs with population with fewer than 60,000 people.[297] Later, the Satellite Broadband Operators, who consist of EchoStar/Hughes, Inmarsat, Intelsat, Boeing, SES, O3b, Telesat Canada, and OneWeb, modified this position, stating that: "in recognition of the UMFUS operators' stated intention to use this spectrum for deployment in the densest urban areas, we decided to preserve the existing 0.1% population impact restriction for those counties [and PEAs] above the upper inflection point."[298] Boeing argues that it would be sufficient to

[289] Boeing Petition at 24-25; SES/O3b Petition at 12-13.

[290] Satellite Broadband Operators Reply to Oppositions at 7.

[291] EchoStar/Inmarsat Petition at ii and 7-8; Satellite Broadband Operators June 13, *Ex Parte* at 4-5, and SES/O3b Opposition at 2 and 7-8.

[292] SES/O3b Petition at i, 7, 10-11; SES/O3b Opposition at 5-7, and Replies of Boeing at 9, Satellite Broadband Operators at i and 4-8, SES/O3b at 3-8, and ViaSat at 3-4.

[293] In their October 19 *Ex Parte*, the Satellite Broadband Operators replaced the flat limit of 600 people with a formula that varied the percentage by license area population. Using the formula, however, would result in a total limit of 600 people for various populations in this tier. *See* Satellite Broadband Operators October 19 *Ex Parte* at 5 (examples in Tier 2 markets). We see no benefit to adopting a formula that adds complexity without resulting in any material change to the proposal, and we will consider the original proposal to have a flat limit of 600 people.

[294] SES/O3b Petition at 10. *See also* SES/O3b Opposition at 5-7; Replies of Boeing at 9 (supporting tiered approach), Satellite Broadband Operators at 4-8 (supporting), and SES/O3b at 3-8, *Ex Partes* of CCA on May 3, 2017, at 4 (allowing FSS operations to inflict interference up to 10% of population in a rural county would severely encumbering a carrier's scope), FWCC on April 17, 2017, at 2 (supporting three-tier approach in principle but proposing 0.1% limit in high-density counties, 300-person limit in medium-density counties, and 5% of population limit in low density counties), Nextlink on April 20, 2017, at 6 (opposing), Rural LMDS Licensees on June 29, 2017, at 2-3 (opposing), and Satellite Broadband Operators on March 31, 2017, at 5 (supporting and recommending extension of tier concept to 39 GHz band).

[295] SES/O3b Petition at 10.

[296] In their October 19 *Ex Parte*, the Satellite Broadband Operators replaced the flat limit of 3,000 people with a formula that varied the percentage by license area population. Using the formula, however, would result in a total limit of 3,000 people for various populations in this tier. *See* Satellite Broadband Operators October 19 *Ex Parte* at 7 (examples in Tier 2 markets). We see no benefit to adopting a formula that adds complexity without resulting in any material change to the proposal, and we will consider the original proposal to have a flat limit of 3,000 people.

[297] SES/O3b March 23 *Ex Parte*.

[298] Satellite Broadband Operators October 19 *Ex Parte* at 7.

raise the population limit to 0.5 percent of the population in "very rural PEAs."[299]

119. Wireless providers and ViaSat, an FSS operator, oppose changes to the rules adopted in the *R&O*.[300] CTIA argues that the rules adopted in the *R&O* give FSS providers sufficient flexibility to locate earth stations.[301] Nextlink argues that increasing the 0.1 percent criterion to 0.2 percent "would potentially deny the benefits of terrestrial-based 5G services to thousands of people."[302] Rural LMDS providers argue that losing even 600 potential customers in markets could lead to "insurmountable" hurdles to providing service.[303] ViaSat cites studies it has conducted that show that, in many instances, exclusion zones will be almost nonexistent, particularly if the FSS operator installs shielding around the earth station.[304]

120. *Discussion.* We reject the request to increase 0.1 percent population to 0.2 percent in larger markets. As Nextlink argues, that change could have a significant adverse impact on terrestrial service in urban areas. Moreover, none of the proponents of this change have demonstrated that increasing the population threshold in larger markets is necessary to provide sufficient opportunity for siting earth stations in these bands. As the Commission observed in the *R&O*, satellite operators will not necessarily need to deploy earth stations in the more densely populated markets.[305] Indeed, the Satellite Broadband Operators have indicated that they can accept a limit of 0.1 percent in the largest markets.[306] In addition, ViaSat, the FSS operator that appears to be most interested in locating earth stations in urban markets, supports the existing 0.1 percent limit.[307]

121. On the other hand, we conclude that for smaller markets, relaxing the 0.1 percent population metric is consistent with the Commission's goal of creating meaningful, targeted opportunities to deploy additional FSS earth stations without harming terrestrial operations.[308] Maintaining the 0.1 percent limit in smaller markets could make it more difficult for FSS operators to site earth stations in those markets, which could drive earth station siting towards more heavily populated places and centers of commercial activity.[309] In contrast, relaxing the 0.1 percent limit in smaller markets is more consistent with our goal of providing targeted opportunities for siting earth stations in more remote, less-densely populated areas.[310]

122. On the other hand, we believe that SES and O3b have not justified the level of impact on

[299] Boeing October 17 *Ex Parte* at 2.

[300] *See* ViaSat Opposition at 19-23. Although ViaSat says that it opposes fundamental changes to the rules adopted in the *R&O*, it does not oppose minor refinements such as allowing more than three earth stations per license area so long as their exclusion zones do not cover more than 0.1 percent of the population, or applying a more relaxed population coverage threshold in counties with fewer than 300,000 people. ViaSat Reply to Oppositions at 3-4.

[301] CTIA Opposition at 5-6.

[302] Nextlink April 20 *Ex Parte* at 5.

[303] Rural LMDS Operators June 29 *Ex Parte*.

[304] ViaSat April 12 *Ex Parte* at 1.

[305] *See R&O*, 31 FCC Rcd at 8049, para. 92.

[306] Satellite Broadband Operators October 19 *Ex Parte* at 5, 7.

[307] ViaSat Opposition at 19-23.

[308] *See R&O*, 31 FCC Rcd at 8035, para. 51.

[309] For example, in a market with 60,000 people, an earth station could be placed in the market only if it avoided all but 60 persons (0.1 percent of the 60,000).

[310] The *R&O* explained that it should be possible to deploy gateway earth stations in relatively remote areas because the purpose of gateways is to relay large amounts of data between satellites and Internet backbone networks, and there are many long-haul Internet nodes in remote areas. *See R&O*, 31 FCC Rcd at 8049, para. 92.

terrestrial service that they seek. In the smallest markets, they have not justified limiting access to terrestrial services to up to 10 percent of the population in the 28 GHz band. Since many of the smallest markets cover large geographic areas, FSS operators should have sufficient flexibility with a 7.5 percent population limit. In the middle tier of markets, we note the concern of the Rural LMDS Operators that losing even 600 potential customers could make providing service uneconomic.[311] While SES and O3b attempt to justify the 600 person limit based on an analysis of one of their existing, grandfathered earth station,[312] given the trend towards smaller, lower impact earth stations identified by ViaSat and others, it is equitable to require FSS operators to make additional efforts to limit their impact on UMFUS in bands that are designated primarily for terrestrial use. We anticipate that satellite operators will substantially reduce the sizes of the exclusion zones that they require by constructing artificial site shields or by taking advantage of naturally occurring terrain features.[313]

123. Taking the entire record into account, we will adopt a modified version of the SES/O3b proposal for providing additional flexibility in second- and third-tier markets. For the 28 GHz band, the limits will be as follows:

Population within UMFUS License Area	Maximum permitted aggregate population within PFD contour of earth stations
Greater than 450,000	0.1 percent of population in UMFUS license area
Between 6,000 and 450,000	450 people
Fewer than 6,000	7.5 percent of population in UMFUS license area

For the 37.5-40 GHz band, the population limits will apply on a PEA basis as follows:

Population within Partial Economic Area (PEA) where earth station is located	Maximum permitted aggregate population within PFD contour of earth stations
Greater than 2,250,000	0.1 percent of population in PEA
Between 60,000 and 2,250,000	2,250 people
Fewer than 60,000	3.75 percent of population in PEA

The additional flexibility will encourage siting of earth stations in areas with less population, decrease potential conflicts between FSS and UMFUS, and maintain the primacy of UMFUS in the 28 GHz and 39 GHz bands.

3. Other Limits on Earth Station Siting

124. Some satellite operators request that we repeal, modify, and clarify the *R&O*'s limitations on deployment of earth stations in places where they preclude terrestrial service to people or equipment that are in transit or are present at mass gatherings.[314] EchoStar and Inmarsat also argue that our transient population rules impair their ability to deploy gateway stations in places with ready sources of electricity, adequate roads to permit access for maintenance, neighborhoods with appropriate commercial zoning,

[311] Rural LMDS Operators June 29 *Ex Parte* at 3.

[312] *See* SES/O3b March 23 *Ex Parte*.

[313] *See R&O,* 31 FCC Rcd at 8049, para. 92.

[314] *See* Petitions of EchoStar and Inmarsat at 12-14 and SES/O3b at ii and 14; SES/O3b Opposition at 6 and 8-9; Replies of

sufficient space for installation and expansion of large satellite antennas with an unobstructed view of the sky, and sufficient cooling capacity for large amounts of computing equipment.[315] The Satellite Broadband Operators, which include the petitioners, recommend that our prohibition against earth station interference with passenger railroads be limited to Amtrak trains.[316] The petitioners also urge us to eliminate or curtail sharply the rule barring FSS deployments near major event venues in the 28 and 37.5-40 GHz bands.[317] The Satellite Broadband Operators ask that they be allowed to extend their exclusion zones over major event venues except for those with a seating capacity exceeding 10,000 people.[318]

125. We deny the requests to modify the additional limits on earth station siting, with certain exceptions discussed below. EchoStar and Inmarsat contend that one of the reports cited in the *R&O* demonstrates that fiber connectivity needed by earth station facilities is highly correlated with major roadways and railways,[319] We disagree. The authors of the *InterTubes Report*, which petitioners cite, emphasize that they are exclusively interested in the long-haul fiber-optic portions of the Internet and do not even attempt to portray any of the short-haul fiber routes that are used to add or drop off network services in many different places within metropolitan areas.[320] Moreover, we note that in the 28 GHz band, where there are incumbent earth stations, no licensed earth station is co-located with a long-haul Internet node[321] and the average distance by road from a 28 GHz earth station to the nearest long-haul Internet node is 37.5 miles, with a median distance of 22.4 miles.[322] Notably, a recent application for 20 gateway earth stations states that they will be "at sites distributed throughout the United States that comply with the Commission's 28 GHz siting rules and have sufficient electrical facilities, reliable fiber-delivered broadband capacity, and ease of access for personnel to provide operational support."[323]

126. Furthermore, we continue to believe that the limitations that we have placed on earth station siting provide incentives for FSS operators to avoid areas where there is going to be high demand for terrestrial service using mmW bands. The wide bandwidths that are available to terrestrial services in the 28 GHz and 37.5-40 GHz bands will support vital new terrestrial services on roads, railroads, and mass transit routes, and at ports, major event venues, homes and offices. The current need for wireless service along transit routes is clear for a variety of uses, including navigation, and demand is likely to increase with advances in technology. Like people in transit, many who attend major events use cell phones to obtain information, to exchange text and images with others, and to engage in other forms of communication.[324] That is why mobile carriers often deploy temporary cellular base stations at major

[315] *See* EchoStar/Inmarsat Petition at 10.

[316] *See* Satellite Broadband Companies Reply to Oppositions at 12 and March 31, 2017, Ex Parte at 6.

[317] EchoStar/Inmarsat Petition at ii and 14.

[318] Satellite Broadband Companies Reply to Oppositions at 10-11.

[319] *See* EchoStar and Inmarsat Petition at ii and 12-13, *citing R&O* at 31 FCC Rcd 8049-50, para. 92 (*citing* R. Durairajan, P. Barford, J. Sommers and W. Willinger, InterTubes: A Study of the US Longhaul Fiber-optic Infrastructure, in Proceedings of ACM SIGCOMM (2015), available at http://www.sigcomm.org/node/3852 ("*InterTubes Report*")), *and citing InterTubes Report* at 570.

[320] *InterTubes Report* at 565.

[321] The shortest distance between a long-haul Internet node and any 28 GHz earth station is 0.9 miles. This calculation was provided courtesy of the University of Wisconsin's Internet Atlas project, Paul Barford and Ramakrishnan Durairajan, June 2017.

[322] The data underlying these calculations was provided courtesy of the University of Wisconsin's Internet Atlas project, Paul Barford and Ramakrishnan Durairajan, June 2017.

[323] *See* Hughes Network Systems Application, File No. SES-LIC-20170807-00884 (filed Aug. 7, 2017), Attachment 1 at 2.

[324] *See* Fed. R. Evid. 201 (judicial notice of adjudicative facts).

events.[325] We anticipate that 5G services supported by millimeter-wave spectrum will engender more use of mobile telecommunications at live events.

127. We agree with the petitioners, however, that it would be helpful to clarify the types of roads that earth station siting should avoid. The *R&O* restricted earth station interference zones from infringing upon any arterial streets or interstate or U.S. highway.[326] On review, we find that limitation may be unclear and could have the unintended effect of discouraging FSS operators from locating earth stations in remote areas. We therefore narrow this prohibition to include only the following types of roads, as they are defined and classified by the U.S. Department of Transportation:

- Urban Interstate
- Urban Other Freeways and Expressways
- Urban Other Principal Arterial
- Rural Interstate, and
- Rural Other Freeways and Expressways.[327]

128. Regarding the *R&O*'s restrictions on earth station interference to "major event venues," the record does not provide a sufficient basis to specify which locations are considered such venues. Generally speaking, we consider a major event venue as any location where large numbers of people could gather on a regular basis in a setting where they would expect to use wireless service. We recognize that there are multiple types of locations that could qualify. To the extent that an UMFUS licensee is concerned that the interference or protection contour of a proposed FSS earth station might encompass a major event venue, we expect that the UMFUS licensee will identify the venue as part of the coordination process, and we expect that the parties will work cooperatively to identify and avoid major event venues.

4. Numerical Limits on Earth Stations

129. As noted above, the *R&O* limited the number of earth station locations to three per county in the 28 GHz band and three per Partial Economic Area in the 37.5-40 GHz band.[328] Satellite operators urge us to eliminate those limits on the grounds that they are redundant,[329] that it would be impractical for multiple satellite operators to share the same sites,[330] that the thousands of small footprints produced by large fleets of NGSO satellites will each require a gateway earth station,[331] and that a numeric limitation might have the perverse effect of forcing satellite operators to deploy gateway stations in urban areas before they have exhausted the siting opportunities of rural geographic service areas with

[325] *See, e.g.,* Edward C. Baig, Cell-Phone Providers Roll Out COWs to Handle Massive Surge on Inauguration Day, Jan. 19, 2017 (https://www.usatoday.com/story/tech/columnist/baig/2017/01/19/cell-phone-providers-roll-out-cows-handle-massive-surge-inauguration-day/96786674/).

[326] *R&O,* 31 FCC Rcd at 8036, para. 54.

[327] *See* 23 CFR § 470.105. For additional information on the classification system used by the Department of Transportation, *see* Appendix B.

[328] *R&O* at 31 FCC Rcd 8036, para. 54, and 8051, para. 93.

[329] *See* EchoStar/Inmarsat Petition at 20; Replies to Oppositions of Boeing at 9, Satellite Broadband Companies at 13, and SES/O3b at 9, and Satellite Broadband Operators June 13, 2017, Ex Parte at 5.

[330] *See* EchoStar/Inmarsat Petition at 21, *citing* Satellite Broadband Companies June 10, 2016, Ex Parte at 2-5.

[331] *See* Boeing Petition at 23 (each of the satellites in NGSO systems like the ones it is proposing will require many dozens of gateways to support their traffic); Satellite Broadband Operators June 13, 2017, Ex Parte at 5 (large numbers of satellites will each produce hundreds or thousands of individual beams to serve end users; a separate gateway earth station will be needed for each reuse of the same spectrum.).

wide expanses of thinly populated territory.[332] Straight Path argues that we should continue to apply numeric limits to earth station deployments because there is no data in the record to support the claim that the satellite industry will need more than 1,200 ground stations in the 39 GHz band.[333] FWCC says that it is not opposed in principle to dropping the numeric earth station limits if the Commission maintains reasonable limits on population coverage.[334]

130. In the 28 GHz band, which is licensed for terrestrial use on a county basis, we decline to eliminate the three locations per license area limit on earth stations. The numerical limitations that we imposed were part of the framework that the Commission adopted "to provide FSS licensees with substantial opportunities to expand their limited use of the 28 GHz band to deploy earth stations that do not have to protect terrestrial services, while minimizing the impact on terrestrial operations."[335] FSS operators have failed to demonstrate that they have a substantial need to exceed the limits imposed in the *R&O*. Furthermore, eliminating those limits would be inconsistent with the decision to prioritize terrestrial deployment in these bands. In particular, eliminating the numerical limits in smaller markets where we today grant additional flexibility to FSS providers could inappropriately hinder deployment of terrestrial service in less populated areas. We note that in the smallest markets, allowing FSS providers to have an interference zone covering up to 10 percent of the population could impact a substantially larger amount of area, since populations may not be evenly distributed in rural areas.

131. We will, however, increase the three locations per license area limit on earth stations in the 37.5-40 GHz band, which is licensed for terrestrial use on a PEA basis.[336] The existing limit in that band was based on the Commission's calculations of population coverage extrapolated from the size of the protection zone that would be required to protect 37.5-40 GHz receiving earth stations. The protection zone area that the Commission used for these calculations was provided in comments from EchoStar, which stated that the radius of the exclusion zone around a 37.5-40 GHz earth station would be up to two kilometers. Recently, Inmarsat, SES and O3b provided an analysis that represents a separation distance of less than 1100 meters from the center of a terrestrial mobile deployment area that occupies an area of one square kilometer would be sufficient to protect an FSS earth station.[337] In another study, ViaSat purports to show that moderately sized stations on roof tops, with appropriate shielding, could be embedded in urban or suburban settings where 5G systems are deployed without requiring interference protection from the 5G system.[338] Boeing analyzes both studies, concludes that each is based on valid assumptions and employ appropriate technical analysis, but believes that the Inmarsat/SES/O3b submission used unnecessarily conservative assumptions and that a separation distance of less than 500 meters would be sufficient.[339] While the assumptions ViaSat uses will not apply to every earth station (not every earth station will be located on a roof or will be shielded), based on our analysis of the contribution submitted into the record of this proceeding by Inmarsat, SES and O3b, and the ViaSat filing, it now appears that earth stations can be designed that require substantially smaller exclusion zones than the two-kilometer radius estimate available to the Commission at the time of the *R&O*. With smaller

[332] *See* Boeing Petition at 23-24.

[333] Straight Path May 17 *Ex Parte* at 13, Straight Path May 26 *Ex Parte* at 4-5.

[334] *See* FWCC April 17 *Ex Parte*.

[335] *R&O*, 31 FCC Rcd at 8036, para. 55. *See also R&O*, 31 FCC Rcd at 8051-52, para. 93 (39 GHz band).

[336] We note that there are a little over seven counties per PEA.

[337] Inmarsat, SES and O3b October 12 *Ex Parte*. The companies submitted a study entitled "Sharing and Compatibility Studies of FSS (Space-to-Earth) and IMT Operating in the 37-50.2 GHz Frequency Range," dated September 11, 2017, which the United States submitted as a U.S. contribution to a recent meeting of ITU Task Group 5/1. The analysis presumes a minimum earth station elevation angle of 10 degrees.

[338] ViaSat October 2 *Ex Parte* and October 18 *Ex Parte*.

[339] Boeing October 19 *Ex Parte*.

exclusion zones, we can justify allowing more satellite earth stations in a given area because the impact in terms of geographic area will be smaller.

132. Taking into account our current understanding of the required exclusion zone and the fact that this band is primarily a terrestrial band, we believe that it would be reasonable to increase the permissible number of earth station sites in the 37.5-40 GHz band from three to 15 per PEA, but with no more than three earth stations per county. Our grant of relief on the numerical limits in the 37.5-40 GHz band is premised on the idea that the exclusion zones required by FSS to protect their earth stations are substantially smaller than we originally believed. If, in reviewing FSS earth station applications, we see that FSS providers are claiming substantially larger protection zones, we reserve the right to take appropriate action.

5. Placement of Additional Antennas at Grandfathered 28 GHz Sites

133. EchoStar and Inmarsat ask us to clarify the extent to which additional earth station antennas may be placed at grandfathered 28 GHz earth station sites,[340] and SES and O3b specifically request that we exempt additional earth stations from the 0.1 percent population limitation rule if they are located within one second of latitude and one second of longitude of grandfathered sites.[341] EchoStar and Inmarsat argue that, if we require grandfathered sites to count against the 0.1 percent cap, other FSS operators will be unable to deploy precisely in those areas that have been identified as most attractive to date.[342]

134. We reject the petitioners' requests for three reasons. First, the modifications that we are making today to the 0.1 percent population limit provide substantial and adequate relief to the requesting parties. Second, no material purpose would be served by adding a *de minimis* exception: one second of latitude equals about 31 meters, and one second of longitude in any of the contiguous 48 states would be fewer than 30 meters. Third, EchoStar and Inmarsat state elsewhere in their petition that it would be impractical in any case for multiple satellite operators to share the same sites.[343] If it is true that other operators would be reluctant in any case to deploy their antennas at a grandfathered site that is licensed to another operator, we need not be concerned that they would be deterred from doing so by the absence of a further exception to our rules.

C. Secondary Status of FSS in 28 GHz Band

135. *Background.* In the *R&O*, after evaluating in detail prior rulemakings involving the 28 GHz band, the Commission rejected arguments from FSS providers and determined that FSS would be secondary to both fixed and mobile terrestrial operations in the 28 GHz band.[344] The Commission found that upgrading the FSS designation in the 28 GHz band to co-primary status, even if limited to individually licensed earth stations, would be inconsistent with terrestrial use of that band and the Commission's decision to facilitate expanded terrestrial use, and would not effectively facilitate sharing in the band.[345]

136. SIA asks the Commission to clarify that certain protected FSS operations are in fact co-primary with respect to the new UMFUS.[346] SIA argues that the kind of co-primary status that it is seeking for protected FSS operations would not change the established sharing mechanisms, coordination

[340] EchoStar/Inmarsat Petition at 23.

[341] SES/O3b Petition at 19.

[342] EchoStar/Inmarsat Petition at 17.

[343] EchoStar/Inmarsat Petition at 21, *citing* Satellite Broadband Companies June 10, 2016, Ex Parte at 2-5.

[344] *R&O*, 31 FCC Rcd at 8038-40, paras. 62-64.

[345] *R&O*, 31 FCC Rcd 8034-35, para. 50.

[346] SIA Petition at iii.

guidelines, and operational restricts,[347] but elsewhere it renews its argument that FSS should be given co-primary status with respect to terrestrial fixed services and priority over mobile services.[348]

137. *Discussion.* SIA simply repeats arguments that it submitted earlier in response to the *NPRM*,[349] and it presents no new theory or new reason for why FSS should be given co-primary status. The *R&O* thoroughly considered this issue and concluded that, "the 28 GHz band will play a vital role in the deployment of advanced mmW services, and fully upgrading FSS under our service rules to co-primary status would be inconsistent with this goal and would be unnecessary to meet the FSS community's needs."[350] Accordingly, we reject that aspect of SIA's petition as repetitious, pursuant to section 1.429 of our rules.[351] Moreover, we have again reviewed the record in the light of the arguments urged in SIA's petition and we find no reason to depart from the findings of fact and conclusions contained in the decision.

D. 28 GHz Aggregate Interference

138. *Background.* Commenters have expressed concern that upward transmissions from large numbers of terrestrial stations will, in the aggregate, generate enough power to be received at the satellite's receiver, thus degrading the satellite's performance. In the *R&O*, the Commission, after noting that FSS was secondary to both fixed and mobile services, concluded that, "the record in this proceeding does not demonstrate that the rules that we adopt today would significantly risk harmful interference to satellite operations because of aggregate interference received at the satellite receiver."[352] The Commission rejected requests from FSS providers to limit the aggregate skyward transmissions of UMFUS providers in the 28 GHz band. It noted that the maximum authorized power for UMFUS was lower than the existing LMDS power limits and that the systems contemplated for these bands have characteristics that would tend to limit skyward transmissions.[353] The Commission also concluded that the interference models submitted by satellite operators in this proceeding "do not take into account prospective features of mmW mobile systems that are readily accessible on the public record. . ."[354] Recognizing that the satellite and wireless industries had begun the process of modeling the terrestrial systems under consideration for this band, it directed the International Bureau, the Office of Engineering and Technology, and the Wireless Telecommunications Bureau to jointly establish a separate docket that parties can use to file the relevant data and analyses.[355]

139. In petitions for reconsideration, satellite operators argue that we should reconsider our earlier decision and set an overall limit on aggregate interference to satellite receivers.[356] Boeing, SES,

[347] SIA Petition at 8.

[348] SIA Petition at 5-6.

[349] SIA Comments of the Satellite Industry Association (filed Jan. 28, 2016) at ii-iii, 11-12.

[350] *R&O*, 31 FCC Rcd 8035, para. 50.

[351] 47 CFR § 1.429.

[352] *R&O*, 31 FCC Rcd at 8040, para. 65.

[353] *R&O*, 31 FCC Rcd at 8040, para. 65.

[354] *R&O*, 31 FCC Rcd at 8041, para. 67. The Commission also noted that its decision not to set an aggregate interference limit was consistent with its decisions in other bands, including AWS-3 and 11 GHz. *R&O*, 31 FCC Rcd at 8042, para. 68.

[355] *R&O*, 31 FCC Rcd at 8042, para. 69. *See* Docket Established for 28 GHz Aggregate Interference Analysis, 32 FCC Rcd 5022 (IB 2017). As of September 22, 2017, no filings had been made in that docket.

[356] *See* Petitions of SES/O3b at 15 and 23 and SIA at 11-12.

and O3b argue that we should adopt beamforming and power control requirements for UMFUS.[357] Satellite operators also repeat their earlier argument that the Commission's failure to adopt rules to limit aggregate interference would breach this country's obligation under international agreements to protect receivers aboard satellites licensed by adjacent countries.[358]

140. *Discussion.* We deny the petitions for reconsideration on this issue because none of the petitions for reconsideration make the requisite showing under section 1.429 of our Rules[359] with respect to the aggregate interference issue.[360] The petitions filed by satellite operators are deficient in two significant respects. First, they fail to acknowledge the defects identified in the *R&O* in the technical studies that formed the basis for their arguments.[361] Second, and more fundamentally, the requests of the satellite operators are inconsistent with our goal of providing UMFUS licensees with a flexible rules framework that could allow them to provide a variety of services. Boeing and SES/O3b ask us to embed into our rules certain characteristics that are under development for mmW mobile systems, such as beamforming, antenna downtilt, and power control.[362] The Commission adopted technical rules that were as flexible as possible, while at the same time preventing harmful interference. By doing so, the Commission maximized the ability of licensees to design and evolve their networks according to their own judgement and thereby offer new and innovative services to the public. Establishing specific technical parameters in our rules based on our understanding of technological developments at one point in time would risk preventing licensees from developing new services to meet market demand. The limits on emissions that the satellite operators seek could limit the ability of UMFUS licensees to operate certain types of networks.

141. Finally, we reject petitioners' argument that the Commission's failure to adopt rules to limit aggregate interference to satellites licensed by countries that are adjacent to the U.S constitutes a breach of our country's obligations under international agreements.[363] As Intel and CTIA point out, the rules adopted in the *R&O* already provide more protection to other countries' satellites than is required by ITU rules.[364]

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[357] *See* Petitions of Boeing at iii and 13-17 and SES/O3b at 22; SES/O3b Opposition at 2 and 15; Boeing Reply at 5-6, and Boeing Ex Parte on June 19, 2017, at 3-4.

[358] *See* Petitions of SES/O3b at 23-24 and SIA at iv, 3-4 and 12-13.

[359] 47 CFR § 1.429.

[360] *See, e.g.,* Intel Opposition at 11 (the aggregate interference argument in the SES/O3b petition is self-disqualifying because the petitioners openly state that they are asking the Commission to reconsider technical evidence that satellite operators submitted in the initial proceeding); CTIA Reply at 7 (satellite petitioners present no new evidence to justify reconsideration).

[361] *R&O*, 31 FCC Rcd at 8040-41, paras. 65-67.

[362] *See* Petitions of Boeing at iii and 13-17 and SES/O3b at 22; SES/O3b Opposition at 2 and 15; Boeing Reply at 5-6, and Boeing Ex Parte on June 19, 2017, at 3-4.

[363] *See* Petitions of SES/O3b at 23-24 and SIA at iv, 3-4 and 12-13.

[364] *See* Radio Regulations of the International Telecommunication Union Nos. 21.2 and 21.3. Specifically, Intel notes that the ITU Radio Regulations (RR) No. 21.5 cited by SIA is for power to the antenna (conducted power), while this Commission's rules are for maximum EIRP. *See* Intel Opposition at 13-14, *citing* SIA Petition at 13. RR No. 1.161 defines equivalent isotropically radiated power (EIRP) as "The product of the power supplied to the antenna and the antenna gain in a given direction relative to an isotropic antenna (absolute or isotropic gain)." Therefore, says Intel, the U.S. rules regarding EIRP do not contravene RR No. 21.5, which does not take antenna gain into account. Intel further notes that, for the 28 GHz band, No. 21.2 and 21.3 of the ITU's Radio Regulations specify a maximum EIRP of 55 dBW (85 dBm)—a higher value than the Commission's rules, which are referenced to 100 megahertz of bandwidth. On that basis, Intel concludes that for all channel bandwidths below one gigahertz, the Commission is already providing more protection to other services than required by the ITU Radio Regulations,

142. The Commission retains the authority to monitor developments and intervene to prevent unacceptable interference to satellites if that becomes necessary, but we find no evidence to date that suggests that any such intervention will be necessary. The *R&O* explained why it is unlikely that the addition of mobile services to the 28 GHz band will cause significant interference to satellites in the 28 GHz band, and petitioners have provided no basis to revisit that conclusion at this time.[365]

E. Base Station Power Limit

143. *Background.* In the *Report and Order*, the Commission adopted a base station power limit of 75 dBm/100 MHz EIRP for UMFUS.[366] For channel bandwidths less than 100 megahertz, the permitted EIRP was reduced below 75 dBm in proportion to the amount of bandwidth involved.[367] The Commission adopted a higher limit than the 62 dBm/100 MHz EIRP power limit proposed in the *NPRM* for two reasons. First, the 75 dBm limit allowed UMFUS base stations power density much closer to the power density permitted for other mobile services such as PCS and AWS. Second, the Commission noted that the propagation properties of the mmW band made higher powers necessary.[368] The 75 dBm limit was described as "a consensus that has been endorsed by the commenters who have expressed an intention to manufacture UMFUS equipment."[369]

144. Boeing asks the Commission to reconsider the 75 dBm limit and adopt the 62 dBm limit proposed in the *NPRM*.[370] Boeing claims that most proponents of terrestrial service have described systems that would employ much lower power.[371] Boeing further claims that allowing UMFUS base stations to operate continuously at 75 dBm would reduce the throughput of Boeing's proposed satellite system by more than half.[372] Boeing also claims that the Commission is inconsistent in relying on the existing rules prohibiting the deployment of satellite user equipment in the UMFUS bands while simultaneously seeking comment on repealing that prohibition in the *FNPRM*.[373] Boeing also asks the Commission to adopt a total radiated power (TRP) density specification.[374]

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and there is no justifiable reason to supplement the existing FCC rules with additional regulations. Intel Opposition at 14.

[365] *See R&O*, 31 FCC Rcd 8038-8042, paras. 61-69.

[366] *R&O*, 31 FCC Rcd at 8110, para. 277.

[367] For example, a 50 MHz channel would be permitted to transmit with half the power—i.e., 72 dBm.

[368] *R&O*, 31 FCC Rcd at 8110, para. 276.

[369] *R&O*, 31 FCC Rcd at 8110, para. 277.

[370] Boeing Petition at 7-10.

[371] Boeing Petition at 8.

[372] Boeing Petition at 8-9.

[373] Boeing Petition at 9.

[374] Boeing Petition at 9-10. Boeing specifically asks, "The TRP density specification should be based on the expected antenna gain to be applied by the UMFUS device and be specified over a coverage volume. For example, an UMFUS base station should limit its emissions to a maximum TRP density of 34 to 42 dBm/100 MHz integrated over a large sector (such as 120 degrees). End-user UMFUS handsets and transportable CPEs should observe TRP densities of 30 dBm/100 MHz and 34 dBm/100 MHz respectively, both over a 4π steradian spherical volume." Boeing Petition at 10 n.29. SES and O3b support Boeing's request to adopt the 62 dBm limit. O3b is particularly concerned that because it operates at low elevation angles, a higher terrestrial power limit could limit its ability to site earth stations in the 37.5-40 GHz band. SES/O3b Opposition at 14-15.

145. 5G Americas,[375] CTIA,[376] Intel,[377] Nokia,[378] and T-Mobile[379] opposed Boeing's requests. They argue that the Commission reasonably based the higher power limit on the PCS and AWS power limits, as well as the propagation characteristics of millimeter wave spectrum.[380] With respect to TRP measurements, Intel contends that TRP is a difficult and time-consuming measurement and is not a useful in-band measure because off-axis energy declines significantly away from the main axis.[381] T-Mobile argues that the EIRP limit is sufficient and an additional TRP limit is unnecessary.[382]

146. *Discussion.* We deny Boeing's petition on this issue. Boeing claims that the Commission adopted the 75 dBm power limit without a "real technical or policy foundation . . ."[383] That characterization is inaccurate. As noted above, the 75 dBm power limit made the UMFUS rules consistent with rules for other mobile services and reflected a consensus of parties involved in developing equipment and service. To the extent Boeing and O3b are concerned about the ability to place earth stations in the 37.5-40 GHz band, we note that UMFUS licensees will be required to protect earth station facilities pursuant to Section 25.136 of the Commission's rules. To the extent that Boeing's advocacy is based on its desire to operate user equipment in the 37.5-40 GHz band, our decision today denying its request to allow operation of FSS user equipment in 37.5-40 GHz makes this concern irrelevant.[384] While Boeing's technical study assumed that UMFUS base stations were operating continuously at 75 dBm,[385] that deployment scenario is unrealistic because UMFUS facilities will have incentives to operate at the minimum power necessary. We acknowledge that many terrestrial service proponents have described systems that have lower transmitted power, but our UMFUS rules are designed to facilitate the deployment of a wide variety of millimeter wave technology. We do not believe it would be appropriate to limit the development of new technology or deployment of novel services by needlessly limiting the power of UMFUS equipment.

147. We also deny Boeing's request to establish a separate total radiated power limit. We agree with Intel and T-Mobile that such a limit is unnecessary and burdensome. Boeing has not explained why the UMFUS bands are meaningfully different from other bands where we have only adopted EIRP limits.

F. Base Station Location Disclosure

148. *Background.* EchoStar/Inmarsat and SES/O3b ask the Commission to require the creation of a database of UMFUS facilities to facilitate coordination between FSS and UMFUS.[386] They claim that such a database is needed to assist FSS in determining where to place earth stations. 5G Americas and Straight Path oppose this request on the grounds that it is overly burdensome and would

[375] 5G Americas Opposition at 8.

[376] CTIA Opposition at 7-8.

[377] Intel Opposition at 12-13.

[378] Nokia Opposition at 8.

[379] T-Mobile Opposition at 9-11.

[380] T-Mobile Opposition at 9-10; Intel Opposition at 13.

[381] Intel Opposition at 14.

[382] T-Mobile Opposition at 11-12.

[383] Boeing Petition at 8.

[384] *See* SectionVI.D.2, *infra*.

[385] Boeing Petition at 8.

[386] EchoStar/Inmarsat Petition at 21-23; SES/O3b Petition at 17-18.

require disclosure of competitively sensitive information.[387]

149. *Discussion*. Given the potentially huge number of deployments in these bands, it would be extremely burdensome to require UMFUS licensees to maintain and update information on each deployment. On the other hand, FSS providers would only need this information when they were planning to coordinate an earth station location. We disagree with SES/O3b that the existing coordination procedures are inadequate for them to obtain the information they need to coordinate with existing UMFUS licensees. The Part 101 coordination rules, which apply to coordination of proposed earth stations, require UMFUS licensees to specify the technical details relevant to any objection.[388] We conclude that the burden of the disclosure requirement would far outweigh any benefit. We therefore deny the petitions on this issue.

G. 64-71 GHz

150. *Background*. In the *R&O*, the Commission made available the 64-71 GHz frequency band for use by unlicensed devices pursuant to technical rules similar to those applicable to the adjacent 57-64 GHz band.[389] In providing this 7-gigahertz of unlicensed spectrum, the Commission's objectives were two-fold: (1) to encourage the development of new and innovative unlicensed applications; and (2) to alleviate spectrum congestion from carrier licensed networks by enabling mobile data off-loading[390] through Wi-Fi and other unlicensed connections.[391] In its decision, the Commission declined to wait for the outcome of future ITU studies of licensed use in the 66-71 GHz band because that could cause 5 gigahertz of spectrum to lie fallow for years, while unlicensed applications are ready to make use of this spectrum in the near future, given existing and planned deployments of WiGig[392] products in the adjacent 57-64 GHz band.[393] Moreover, the Commission rejected comparisons in the record of the amount of spectrum used by unlicensed vs. licensed services,[394] given that spectrum characteristics vary at different frequencies.

151. CCA, CTIA and T-Mobile each request that the Commission allocate the upper five gigahertz of the 64-71 GHz band for exclusive licensed use instead of allowing unlicensed operations throughout the entire band. These commenters generally assert that this spectrum could lead to greater 5G deployment, that there is no evidence that unlicensed devices could make use of this band, and that the Commission provided insufficient mmW spectrum for licensed use relative to licensed use.[395] Boeing, DSA, Intel, Microsoft, NCTA, Public Knowledge/OTI and the Wi-Fi Alliance support the Commission's decision to make 64-71 GHz available for unlicensed use, asserting that there is significant interest,

[387] 5G Americas Opposition at 8; T-Mobile Opposition at 17-18

[388] *See* 47 CFR § 101.103(d)(2)(iv).

[389] 47 CFR § 15.255.

[390] Mobile data offloading is the use of complementary network technologies for delivering data originally targeted for cellular networks to reduce the amount of data being carried on the cellular bands, freeing bandwidth or allowing users to obtain better connectivity via wired services in situations where local cell reception may be poor.

[391] *R&O*, 31 FCC Rcd at 8062-8063, paras. 125-126.

[392] Multi-band WiFi-certified WiGig devices can provide continuous connectivity with transfer between the 2.4, 5, or 60 GHz bands. *See* http://www.wi-fi.org/discover-wi-fi/wi-fi-certified-wigig.

[393] *R&O*, 31 FCC Rcd at 8064-8065, para. 130. The Commission also noted that the "study" of a frequency band by the ITU does not mean necessarily that the band will be automatically designated for licensed use, because licensing of spectrum is deferred to "the sovereign right of each State to regulate its telecommunication", according to the *Constitution and Convention* of the ITU, at http://www.itu.int/en/history/Pages/ConstitutionAndConvention.aspx.

[395] *See, e.g.*, CCA Petition at 8; CTIA Petition at 20; T-Mobile Petition at 5, 8.

potential, and benefit in unlicensed use throughout the band.[396]

152. *Discussion*. We affirm the Commission's decision to authorize unlicensed operations across the entire 64-71 GHz band. Contrary to petitioner's arguments, the Commission thoroughly articulated the public interest benefits of making 64-71 GHz available for unlicensed use,[397] and the Commission's decision took into account the needs of both licensed and unlicensed services.[398] In contrast, petitioners have provided no explanation as to how they would make use of this band as a licensed band, and they mostly repeat arguments previously considered and rejected by the Commission.

153. Petitioners' focus on the amount of spectrum made available for licensed versus unlicensed use is misguided. The Commission has previously explained that this was not a valid comparison when responding to claims of "gigahertz parity" from commenters who shared the same view as CTIA.[399] Furthermore, we make additional spectrum available for licensed use today, and we will continue to work to make more licensed spectrum available.

154. Our expectation that unlicensed services would quickly serve the public interest in the 64-71 GHz band, based on the band's adjacent location to the 57-64 GHz band where WiGig devices are being actively deployed, is supported by the fact that the FCC Equipment Authorization Database shows close to 200 product certification grants for operation in the 57-64 GHz band.[400] Furthermore, we note that the technical specifications for 802.11ad unlicensed devices to operate in the 64-71 GHz band are already supported in the approved IEEE 802.11-2016 standard, using the same communication protocols for six 2160-megahertz wide channels.[401]

H. Mobile Spectrum Holdings (In-Band Aggregation Limits)

155. CCA requests reconsideration of the Commission's decision not to adopt band-specific limits for each of the 28 GHz, 37 GHz and 39 GHz bands.[402] In the *R&O*, the Commission found that band-specific limits were unnecessary, stating because any technical differences between these three bands is not sufficient to significantly affect how these spectrum bands might be used.[403] We find that CCA merely restates general arguments previously considered and rejected, and we therefore deny its request for reconsideration.

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[396] *See, e.g.*, Boeing Opposition at 3, 4-6; DSA Opposition at 2; Wi-Fi Alliance Opposition at 7; Intel Opposition at 5-6; Microsoft Opposition at 9; NCTA Opposition at 5-6; Public Knowledge/OTI Opposition at 18-19.

[397] *R&O*, 31 FCC Rcd at 8062-63, para. 125.

[398] CTIA references in its reply comments filed Feb 24, 2017 to the Accenture Report dated Jan 2017 and to the Deloitte Report, also dated Jan 2017, which extol the economic benefits of 5G wireless networks in general, but did not bring any new information that the Commission has not considered previously, since the Commission's decision with respect to the 64-71 GHz band would also greatly benefit licensed services with unlicensed operations mobile data offloading. *See* CTIA reply at 9-10; *see also* fn. **Error! Bookmark not defined.**, *supra.*

[399] *R&O*, 31 FCC Rcd at 8064-8065, paras. 129-130.

[400] *See* https://apps.fcc.gov/oetcf/eas/index.cfm. There are 195 product certification grants for operation in the 57-64 GHz band as of June 15, 2017.

[401] *See* IEEE 802.11-2016, *IEEE Standard for Information technology-Telecommunications and information exchange between systems-Local and metropolitan area networks-Specific requirements, Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications*, at Annex E, p. 3277. *See also* Intel Opposition at 6.

[402] CCA Petition at 12-14.

[403] *R&O*, 31 FCC Rcd at 8082, para. 186.

I. 28 and 39 GHz License Area Sizes

1. 28 GHz Band

156. In the *R&O*, the Commission selected counties as the base geographic unit for UMFUS license areas in the 28 GHz band and subdivided existing Basic Trading Area (BTA) licenses into counties.[404] The Commission saw several advantages to county-based licenses: they provided licensees with the flexibility to develop localized services, allowed for targeted deployments based on market forces and customer demand, and facilitated access by both smaller and larger carriers. The Commission also noted that county-based licenses facilitated efficient use of spectrum, stating that if a licensee was not interested in building in a particular county, other parties should have the opportunity to apply for the license in that county.[405]

157. Several petitioners seek reconsideration of the Commission's choice of counties in the *R&O*. Their arguments in favor of reconsideration largely involve what they see as an increased monetary, administrative and technological burden created by switching to counties as opposed to BTAs.[406] They restate prior arguments that because there are many more counties than BTAs, the move to counties will unfairly burden incumbents – particularly "rural and regional carrier licenses" or those that would serve federal lands – by increasing the number of buildouts as well as the administrative burden and cost necessary to retain each county in the same area previously encompassed by BTAs.[407] Petitioners assert that in order to justify the costs of deployment in rural areas, network operators must typically realize 'economies of scale' and recoup sunk costs – which they can only do by first deploying in urban regions associated with these same rural areas.[408]

158. Nextlink also argues that when incumbents initially acquired licenses and decided on network build-out plans, they did so in light of then-existing requirements, and that changing the rules for this band now would interfere with incumbents' reasonable investment-backed expectations.[409] Accordingly, commenters conclude switching to county license areas now would be *per se* unreasonable without express statutory authorization and would raise serious due process concerns and constitute a taking.[410]

159. *Discussion.* We deny these arguments because they were fully considered and rejected by the Commission in its *R&O*, and petitioners have failed to present any basis for revisiting our decision.[411] The Commission fully considered and rejected the following concerns before reaching its decision, namely that (1) counties did not fit the contemplated services to be offered using mmW spectrum; (2) counties would result in more border areas requiring greater coordination; (3) the number of counties would impose administrative burdens on licensees and the Commission; and (4) requiring buildout showings on a county basis would increase licensees' costs.[412] The Commission also noted that

[404] *See R&O*, 31 FCC Rcd at 8029, para. 35.

[405] *R&O*, 31 FCC Rcd at 8029, para. 35.

[406] *See* CCA Petition at 9-10, Nextlink Petition at 8-11; Petition of Adams Telcom Inc., Central Texas Communications, Inc., E.N.M.R. Telephone Cooperative, Louisiana Competitive Telecommunications, Inc., and Pine Belt Communications, Inc. at 1-2, 4-5 & n.14; (together, the "Rural LMDS Licensees"); Skyriver Opposition at 8, 11-12; *see also* Blooston Reconsideration Comments at 2, 4.

[407] *See id.*

[408] Nextlink Petition at 3; Skyriver Opposition at 9-10.

[409] Nextlink Petition at 9.

[410] Nextlink Petition at 9 & nn.21 & 22; Blooston Reconsideration Comments at 3.

[411] *See* 47 CFR § 1.429(l)(3).

[412] *R&O*, 31 FCC Rcd at 8028-29, paras. 34-35.

it had moved towards license areas based on Economic Areas (EAs) and that counties were more consistent with EAs.[413] Finally, it noted that using BTAs for UMFUS would require a new licensing agreement with Rand McNally, the owner of BTAs.[414] It concluded that county-based licenses would afford a licensee the flexibility to develop localized services, target deployment based on market forces and consumer demand, and facilitate access by both smaller and larger carriers – and that these benefits outweighed any administrative burden on licensees or the Commission.[415] The Commission, rejecting the arguments that many counties previously included in BTAs would be abandoned because it was not economically viable or administratively cost-effective to build them out, concluded that it would be better to allow new providers to obtain licenses and make use of that spectrum.[416] We believe this logic applies equally to rural areas, tribal land, counties containing military bases, or counties that contain federal lands such as the National Parks. To the extent licensees previously acquired these areas under the expectation that they would provide service, it is inconsistent for licensees to now deny such intent. If there is no intent to provide service in an area, they should surrender these license rights and give others the opportunity to provide service in those areas.

160. The Commission considered the move to a county-based license fair to incumbents because they not only retained their fixed license rights but also would gain valuable mobile rights by virtue of acquiring UMFUS licenses.[417] The Commission concluded generally that the benefits of these smaller license areas outweighed any administrative burden on licensees and on the Commission.[418] To the extent Petitioners are now making new arguments, such claims would appear to be barred because they have not justified why they failed to raise such arguments previously or why it is incumbent upon us to review them in the public interest.[419]

161. We reject the takings argument raised by Nextlink and CCA. "[C]ourts have concluded that licensees do not have property rights in any license that the Commission issues to them, and so are not protected by the Fifth Amendment."[420] It is also "undisputed that the Commission has always retained the power to alter the term of existing licenses by rulemaking."[421] Nor is there anything inherently unfair in the Commission's action. LMDS licenses have received mobile use rights they previously lacked and these licensees were given extra time to fulfill their buildout requirements.

2. 39 GHz Band

162. *Background.* CCA requests that we reconsider the Commission's decision to divide the 39 GHz band into PEAs from previous EA-based license areas because it allegedly will harm incumbents

[413] *R&O*, 31 FCC Rcd at 8029, para. 36.

[414] *R&O*, 31 FCC Rcd at 8029-30, para. 36.

[415] *See R&O*, 31 FCC Rcd at 8029, para. 35.

[416] The Commission noted that "[t]o the extent BTA licensees do not believe it is economically viable to build within certain counties of a BTA, we believe it would be appropriate to give other interested parties an opportunity to license and to make use of the spectrum." *See R&O*, 31 FCC Rcd at 8029, para. 35.

[417] *See R&O*, 31 FCC Rcd at 8029, para. 35.

[418] *See R&O*, 31 FCC Rcd at 8029, para. 35.

[419] *See* 47 CFR § 1.429(b).

[420] *Promoting Expanded Opportunities for Radio Experimentation and Market Trials under Part 5 of the Commission's Rules and Streamlining Other Related Rules*, Report and Order, 28 FCC Rcd 758, 781 n.116 (2013), *citing FCC v. Sanders Bros. Radio Station*, 309 U.S. 470, 475 (1940); *CBS, Inc. v. FCC*, 453 U.S. 367, 395 (1981); *Prometheus Radio Project v. FCC*, 373 F.3d 372, 428 (3rd Cir., 2004).

[421] *Celtronix Telemetry, Inc. v. FCC*, 272 F.3d 585, 589 (D.C. Cir. 2001) (citing cases).

by increasing the burdens and costs of buildout.[422] Since the Commission's action increases the number of license areas, as it did with the 28 GHz band, petitioners claim that many small and regional carriers simply will not have the resources or the technology available to comply with the increased buildout requirements and costs, including the increase in interference negotiation costs at many more license boundaries.[423] CCA claims that these smaller carriers may lose their licenses or be put in dire straits in various license areas if they do not have sufficient demand to warrant buildout in those areas, and it argues that this could limit or reduce service to rural America.[424] These petitioners further argue that carriers should not be forced to invest in new license areas after already having invested significant resources to meet existing requirements,[425] and that such mandated reallocation amounts to a regulatory taking.[426] Petitioners submit that licensees should be exempted from any and all new performance requirements, retain their original geographic license size, or be subject to lessened performance requirements.[427] Alternatively they argue for retaining the same substantial service safe harbor benchmark as applied to the 39 GHz band previously.[428]

163. *Discussion.* We reject these arguments for most of the same reasons we reject these arguments with respect to the 28 GHz band.[429] One distinction we observe between the 28 GHz bands and 39 GHz bands, however, is that in the 39 GHz band, the decision to allocate license areas by PEA should address many of the petitioners' concerns. Specifically, the magnitude of change between EAs and PEAs is far smaller than the change from BTAs to counties in the 28 GHz band. There are 176 EAs and 416 PEAs, whereas there are 493 BTAs and 3,174 counties or county-like areas.[430] The Commission correctly concluded that use of the PEA formed the appropriate middle ground between counties and EAs because PEAs were small enough to permit access to licenses by smaller carriers while still large enough to incentivize investment in new technologies.[431] The PEA license size should thus address many of the monetary and administrative cost burdens that Petitioners decry.[432]

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[422] CCA Petition at 9. Blooston, Cambridge Broadband, Nextlink, Rural LMDS licensees, and Skyriver support CCA's request. *See* Blooston Reconsideration Comments at 2; Nextlink Reply at 3; Skyriver Opposition at 8; Rural LMDS Licensees Reply at 2-3; Cambridge Broadband Reconsideration Response at 11.

[423] *See* CCA Petition at 9-10; Blooston Reconsideration Comments at 2-3; Skyriver Opposition at 8, 10-11; Rural LMDS Licensees Reply at 3.

[424] *See* CCA Petition at 9-10, 11; Blooston Reconsideration Comments at 3; Skyriver Opposition at 8-9, 10; Rural LMDS Licensees Reply at 3-4.

[425] *See* CCA Petition at 9.

[426] *See* Blooston Reconsideration Comments at 3.

[427] *See* CCA Petition at 11; Rural LMDS Licensees Petition at 7-8; Blooston Reconsideration Comments at 2, 4;; *see also* Skyriver Opposition at 8.

[428] Blooston Reconsideration Comments at 3, 4 (the substantial service standard was four permanent links per one million people in their licensed service area).

[429] *See* Section V.I.1, *supra*.

[430] *Wireless Telecommunications Bureau Provides Details About Partial Economic Areas*, Public Notice, 29 FCC Rcd 6491 (WTB 2014).

[431] *See R&O*, 31 FCC Rcd at 8046, para. 82.

[432] Cambridge Broadband argues that the new 39 GHz band plan of seven 200 megahertz channels does not accommodate the existing FDD users of the band that traditionally keep 700 megahertz of separation between uplink and downlink bands. *See* Letter from Dr. John Naylon, CTO, Cambridge Broadband Networks Limited, to Whom it May Concern (filed Sep. 5, 2016). Alternatively, Cambridge Broadband asks that the 39 GHz band be auctioned as paired 400 megahertz blocks. *See* Cambridge Broadband Reply at X. The 39 GHz band plan was established in the *R&O* (*see* 31 FCC Rcd at 8053, paras. 95-96), and none of Cambridge Broadband's filings were within the window

J. Performance Requirements for Incumbent Licenses

164. As an alternative to reconsidering its decision to divide the current 28 GHz BTA-based LMDS license areas into counties, several petitioners argue the Commission should either reduce its performance requirements or provide incumbent licensees with greater flexibility in meeting these requirements.[433] Parties also seek similar relief for incumbent 39 GHz licenses.[434] We decline to adopt either of these proposals.

165. *Background.* In order to fulfill its statutory obligation to prevent warehousing and to promote widespread deployment, the Commission adopted enforceable performance metrics in the *R&O* that were tailored for each type of UMFUS service a licensee may choose to offer in the 28 GHz band.[435] Under the Commission's rules, failing to serve county license areas will result in termination of the license for that county.[436]

166. With respect to incumbent licenses, the Commission recognized that those with license terms concluding before 2020 could not meet new, more rigorous buildout requirements before the end of their license terms because of the nascent state of technology.[437] It also recognized that providing additional time to licensees would provide more effective opportunities for licensees to use the spectrum in ways that maximized the flexibility provided by the new rules. Accordingly, current licensees in the 28 GHz and 39 GHz bands who had complied with performance requirements in the prior license term were required to meet the new performance requirements by June 1, 2024.[438]

167. Nextlink, CCA, the Rural LMDS Licensees, and Blooston argue that the relief granted to incumbent licensees is insufficient and that requiring licensees to cover at least 40 percent of a county's population will exacerbate the burden resulting from the increased number of county license areas and make certain counties inherently unsuitable to deployment, regardless of cost.[439] They also contend that many licensees will not have resources available to comply with increased buildout requirements and will lose their licenses. [440]

168. Petitioners propose a wide variety of remedies, including exempting incumbents from meeting "any and all new performance requirements" with respect to new county areas,[441] requiring incumbents to meet buildout requirements for only one county within an area that was once a BTA,[442]

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for petitions for reconsideration. Nevertheless, we note that Cambridge Broadband's arguments would be denied in any event because the band plan can accommodate FDD operations with careful spectrum planning.

[433] *See* Nextlink Petition at 9-10 & nn.23-24; CCA Petition at 11; Rural LMDS Licensees Petition at 7; Blooston Reconsideration Comments at 4; FWCC Reconsideration Comments at 9; Nextlink Reply at 4-5; Rural LMDS Reply at 4.

[434] *See* T-Mobile Petition at 9; CCA Petition at 11; FWCC Reconsideration Comments at 10; Blooston Reconsideration Comments at 4; Nextlink Reply at 5.

[435] *R&O*, 31 FCC Rcd at 8088, para. 203. For further information on the specific buildout requirements adopted, *see* para. 60, *supra*.

[436] 47 CFR §§ 1.946(c), 1.955(a)(2).

[437] *R&O*, 31 FCC Rcd at 8091, para. 219.

[438] *R&O*, 31 FCC Rcd at 8091, para. 219.

[439] *See* Nextlink Petition at 4, 6, 8; Nextlink Reply at 4 n.6.

[440] *See* CCA Petition at 9-10; Rural LMDS Licensees Reply at 3-4.

[441] CCA Petition at 11; Blooston Reconsideration Comments at 4; Rural LMDS Licensees Reply at 4; *see also* FWCC Reconsideration Comments at 9.

[442] CCA Petition at 11; Nextlink Petition at 10; Rural LMDS Licensees Petition at 7; Blooston Reconsideration Comments at 4; Rural LMDS Licensees Reply at 4; *see also* FWCC Reconsideration Comments at 9.

allowing incumbents to meet their old Part 101 substantial service requirement by the end of their current license term – i.e., by 2024,[443] extending incumbents' deployment deadlines,[444] reducing the requirement in rural areas,[445] or excluding counties that encompass tribal or federal land from meeting performance requirements.[446] SES and O3b oppose relaxing performance requirements and giving county licensees extended time to hold onto their areas on the grounds this amounts to promoting warehousing, when other services, namely satellite, could better use the spectrum.[447]

169. *Discussion.* We continue to believe that extending the deadline for meeting the new performance requirements to 2024 for incumbent licensees provides sufficient relief. Petitioners ignore the fact that buildout obligations serve the important purpose of ensuring that scarce spectrum resources are put to use and deployed in a manner that serves all communities.[448] Indeed, the Commission's construction obligations promote the Commission's objective of making spectrum "available, so far as possible, to all the people of the United States" regardless of where they live.[449] We reject as unsupported and contrary to the public interest the idea that, in this instance, allowing licensees to hold on to unused spectrum indefinitely would promote service. In the *R&O*, the Commission noted the various proposals by parties that would have permitted incumbent licensees to meet their then existing performance requirements before the end of their license terms.[450] Petitioners largely repeat the same arguments and we deny them on the ground they are plainly repetitious. To the extent petitioners attempt to craft variations on those previous performance proposals or propose entirely new performance standards, they have not adequately explained why they could not have raised these arguments at the earlier stage of the proceeding, and we see no reason to review our performance requirements on public interest grounds.[451]

170. We continue to believe that the 2024 deadline for incumbents to meet buildout requirements is reasonable. Indeed, developments since release of the *R&O* indicate that the

[443] T-Mobile Petition at 10; *see also* FWCC Reconsideration Comments at 9.

[444] Nextlink Petition at 10-11; Nextlink Reply at 6 n.15; Rural LMDS Licensees Petition at 7-8; Blooston Reconsideration Comments at 2; FWCC Reconsideration Comments at 10; Nextlink Reply at 5; Rural LMDS Licensees Reply at 4.

[445] Nextlink Petition at 5; *see also* FWCC Reconsideration Comments at 9.

[446] Nextlink Petition at 6-7; Nextlink Reconsideration Reply at 6 & n.16 (citing Serv. Rules for the 698-746, 747-762 & 777-792 MHz Bands, et al., *Second Report and Order*, 22 FCC Rcd. 15289, 15350, para. 160 (2007); *see also* FWCC Comments at 9.

[447] *See* SES and O3b Opposition at 9-12.

[448] *See, e.g.*, 47 U.S.C. § 309. *See also, e.g.*, *Amendment of the Commission's Rules to Establish New Personal Communications Services*, Memorandum Opinion and Order, 9 FCC Rcd 4957, 5018-19, paras. 154-56 (1994) (imposing construction requirements to ensure effective spectrum use and promote nationwide coverage notwithstanding varying population densities); *Service Rules for the 698-746, 747-762 and 777-792 MHz Bands*, Second Report and Order, 22 FCC Rcd 15289, 15348-49, paras. 154-155 (2007) (highlighting several important policy goals advanced by adoption of performance requirements, including to "better promote access to spectrum and the provision of service, especially in rural areas"); *Service Rules for Advanced Wireless Services in the 2000-2020 MHz and 2180-2200 MHz Bands*, Report and Order and Order of Proposed Modification, 27 FCC Rcd 16102, 16173-74, para. 187 (2012) ("The Commission establishes performance requirements to promote the productive use of spectrum, to encourage licensees to provide service to customers expeditiously, and to promote the provision of innovative services throughout the license area(s), including in rural areas").

[449] *See, e.g.*, 47 U.S.C. § 151.

[450] *See R&O*, 31 FCC Rcd at 8091, paras. 217-18.

[451] 47 CFR § 1.429(b).

Commission's 2020 estimate for availability of equipment may have been pessimistic.[452] Both Verizon and AT&T have commenced trials for roll-out of commercial 5G services. Verizon has begun offering 5G mobile and broadband service to pilot customers in 11 cities,[453] and AT&T conducted its first 5G business customer trial in 2016 and states that it is currently pursuing 5G video trials with DirecTV NOW as well as additional fixed and mobile 5G trials with Qualcomm and Ericsson.[454] Furthermore, it is estimated that 3GPP standards for Non-Standalone New Radio (NSA NR) will be completed by March 2018, and that full Standalone New Radio with Next Generation Core will be completed by September 2018.[455] We believe these developments belie petitioners' claims that they will not have sufficient time to meet performance requirements by 2024 due to the inability to obtain equipment.

171. Finally, we reject the argument that parity requires that incumbent licensees receive the same amount of time as new licensees to meet their buildout requirements. Incumbents have an advantage over potential new UMFUS licensees because they have immediate access to spectrum and can begin planning for deployments now.

K. Splitting of 28 GHz Band into Two Licenses

172. *Background.* Nextlink asks that the Commission reconsider its decision to split the 850 MHz A1 Band into two 425 MHz segments and instead make this spectrum available for UMFUS as a single band. We deny this request both because it is plainly repetitive and because petitioners have failed to rebut the reasoning of the *R&O* which found that a split band would increase competition.[456]

173. While the Commission initially had proposed to license the 28 GHz band as a single 850 megahertz channel at the NPRM stage,[457] it decided to split the band into two 425 MHz segments in the *R&O*.[458] The Commission explained that doing so would accomplish several goals, including facilitating the provision of high data rate services and other innovative uses as well as allowing some competition through multiple possible licenses in the spectrum.[459] The Commission also suggested that licensees interested in having a contiguous block of 850 megahertz of spectrum could still acquire both channels under our spectrum aggregation policies.[460]

174. In its Petition for Reconsideration, Nextlink argues the Commission failed to provide a valid reason to split incumbents' A1 band licenses into upper and lower segment licenses of 425 MHz each.[461] It asserts the rationale given for splitting unassigned A1 bands – creating more competition from

[452] *See* Rural LMDS Licensees June 29 *Ex Parte* at 2 (""Now, with the help of technological advancements, new investment in the band suggests the appropriate equipment will soon be available to allow expanded fixed and mobile networks in the 28 GHz band.")

[453] *See* Press Release, Verizon, Verizon to deliver 5G service to pilot customers in 11 markets across U.S. by Mid 2017 (Feb. 22, 2017), http://www.verizon.com/about/news/verizon-deliver-5g-service-pilot-customers-11-markets-across-us-mid-2017.

[454] *See* Press Release, AT&T, AT&T Details 5G Evolution (Jan. 4, 2017), http://about.att.com/story/att_details_5g_evolution.html.

[455] *See* Dino Flore, 3GPP RAN Chairman, 5G-NR workplan for eMBB (Mar. 9, 2017), http://www.3gpp.org/news-events/3gpp-news/1836-5g_nr_workplan.

[456] *See R&O*, 31 FCC Rcd at 8043, para. 72.

[457] *NPRM*, 30 FCC Rcd at 11914, para. 116.

[458] *R&O*, 31 FCC Rcd at 8043, para. 72.

[459] *See id.*

[460] *See id.*

[461] Nextlink Petition at 13.

new entrants – does not apply to bands that already have incumbents.[462] Rather, it argues that these incumbents will face new licensing and buildout requirements for each new half band they obtain, "stranding" incumbents' current deployments in one half of their band, and requiring completely new deployment in the other half.[463] Nextlink argues that at a minimum, the Commission should clarify that incumbents will be allowed to satisfy their performance obligations in the lower A1 band through upper A1 band deployment – and vice versa – and that deployments on either side of a link should count toward both service requirements.[464]

175. *Discussion.* We deny Nextlink's request on the merits and because Nextlink seeks to reargue matters that the Commission thoroughly considered. Nextlink's assertion that we did not provide a valid basis for splitting the A1 band into two 425 megahertz licenses is incorrect. As T-Mobile argued in response to the *NPRM*, "where available bandwidth is more limited, as it is at 28 GHz and may be in other lower bands, smaller license blocks should be licensed in order to preserve competition."[465] AT&T and NSMA also support smaller channels in the 28 GHz band.[466] Nextlink previously had alleged that bifurcating the A1 band would exacerbate the problems it had raised against county based licensing, such as increased costs and 'stranding' deployments in different halves of the A1 band, but those arguments were considered and rejected by the Commission.[467] On balance, we continue to believe that the benefits to competition of having multiple licenses in an area outweigh any marginal increase in costs to licensees.

L. Applicability of Part 30 Rules to Satellite Operations

176. *Background.* EchoStar and Inmarsat note that Section 30.6 of the Commission's rules states that when providing FSS services, UMFUS licensees must operate consistent with Part 25 of our rules governing satellite communications. EchoStar and Inmarsat ask for a clarification that FSS operators holding licenses "for the purpose of protecting FSS operations" would only be subject to the following UMFUS service rules: (1) Section 30.5 (Service Areas); Section 30.104 (License Term); and (3) Section 30.106 (Geographic partitioning and spectrum disaggregation).[468] The EchoStar/Inmarsat petition is unopposed on this issue.

177. *Discussion.* EchoStar and Inmarsat are correct that the Commission did not intend to apply Part 30 technical rules to satellite operations. Accordingly, we will revise Section 30.6 to state explicitly that Part 30 technical rules do not apply when UMFUS licenses are used in connection with satellite operations. The Part 30 licensing rules do apply, however, to all UMFUS licenses, regardless of use. For example, if a satellite operator acquired an UMFUS license at auction, it would acquire those licenses pursuant to the competitive bidding rules in Part 30, Subpart D. Furthermore, our buildout requirements apply to all UMFUS licenses, but there is a special provision in the rules allowing FSS operators to comply with those requirements in a given county section by demonstrating that an earth station is in service, operational, and using the spectrum associated with the license.[469] Accordingly, we deny the petition to the extent it seeks to broadly exclude FSS operations from the UMFUS licensing rules.

[462] Nextlink Petition at 13.

[463] Nextlink Petition at 14.

[464] Nextlink Petition at 14.

[465] T-Mobile NPRM Comments at 11.

[466] *See* AT&T Comments at 7 & n.12; NSMA Comments at 3.

[467] *See* Nextlink June 30, 2016 Ex Parte at 2, 5.

[468] EchoStar/Inmarsat Petition at 23.

[469] 47 CFR § 30.105(c).

VI. MEMORANDUM OPINION AND ORDER

A. 48.2-50.2 GHz

178. *Background*. While there are primary non-Federal fixed and mobile allocations in the 48.2-50.2 GHz band, there currently are no service rules for terrestrial operations in this band.[470] The Commission previously designated the 48.2-50.2 GHz segment for FSS use.[471] Airborne mobile operations are prohibited in the 48.94-49.04 GHz segment.[472] There is a non-Federal Fixed-Service Satellite (Earth-to-space) allocation throughout this band, and service rules currently exist for satellite operation under Part 25. The 48.2-49.2 GHz band is also available for BSS feeder links.[473] In the 48.2-50.2 GHz band, there also are primary Federal allocations for fixed, mobile, and Fixed-Satellite (Earth-to-space) services. The 48.94-49.04 GHz band is also used by radio astronomy for spectral line observations, and all practicable steps must be taken to protect radio astronomy in that band from interference.[474]

179. In the *FNPRM*, the Commission proposed to authorize fixed and mobile operations in the band under the Part 30 Upper Microwave Flexible Use Service rules.[475] Recognizing that the 47 GHz band is currently authorized for FSS use,[476] the Commission invited comments on three approaches for sharing between FSS user equipment and terrestrial operations in the radiofrequency from 47 GHz to 50 GHz.[477]

180. In addition, the Commission sought comment in the *FNPRM* on adopting the sharing framework for individually licensed earth stations adopted in the *R&O* for the 28 GHz band.[478] The Commission proposed that in each PEA there could be one location where FSS earth stations can be located on a co-primary basis, subject to the conditions and limitations the Commission adopted in other bands.[479] The Commission sought comment on this proposal, as well as alternatives.[480]

181. Satellite operators argue that transmitting end-user terminals will not be able to share uplink spectrum with UMFUS systems that are widely deployed and they ask the Commission to maintain

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[470] *See* 47 CFR § 2.106.

[471] *Allocation and Designation of Spectrum for Fixed-Satellite Services in the 37.5-38.5 GHz, 40.5-41.5 GHz and 48.2-50.2 GHz Frequency Bands; Allocation of Spectrum to Upgrade Fixed and Mobile Allocations in the 40.5-42.5 GHz Frequency Band; Allocation of Spectrum in the 46.9-47.0 GHz Frequency Band for Wireless Services; and Allocation of Spectrum in the 37.0-38.0 GHz and 40.0-40.5 GHz for Government Operations*, First Report and Order, 13 FCC Rcd 24649, 24651 para. 2 (1999) (*V-Band First Report and Order*).

[472] *See* 47 CFR § 2.106 n.US264.

[473] *See* 47 CFR § 2.106 n.US297.

[474] *See* 47 CFR § 2.106 nn.5.555, US342.

[475] *FNPRM*, 31 FCC Rcd at 8155, para. 410.

[476] *FNPRM*, 31 FCC Rcd at 8155, para. 411.

[477] *FNPRM*, 31 FCC Rcd at 8156, paras. 413-415. The first proposal was to supplement geographic area licensing with database-driven sharing between FSS operations and stationary FSS user equipment. *FNPRM*, 31 FCC Rcd at 8156, para. 413. The second option was dividing the band into a segment where FSS has priority and a segment where UMFUS operations have priority. *FNPRM*, 31 FCC Rcd at 8156, para. 414. Under the third option, the Commission would develop specific criteria for assigning priority between FSS and terrestrial operations, including requiring both FSS and UMFUS licensees to register their operations in a database, allowing the Commission to assign interference protection on a first-come, first-serve basis. *FNPRM*, 31 FCC Rcd at 8156, para. 415.

[478] *FNPRM*, 31 FCC Rcd at 8156, para. 412.

[479] *FNPRM*, 31 FCC Rcd at 8156, para. 412.

[480] *FNPRM*, 31 FCC Rcd at 8156, para. 412.

the primary FSS designation in the band.[481] Boeing, for example, argues that broadband satellite systems must have unfettered access to the 3 gigahertz of spectrum in the 47 GHz band to operate transmitting satellite end user terminals.[482] ViaSat argues that satellite networks need access to 48.2-50.2 GHz as a "core" band where user devices can be placed without restrictions.[483] Wireless carriers, on the other hand, support authorizing fixed and mobile use in the band on a primary basis.[484] Terrestrial interests do not support sharing the band with satellite uplinks. CTIA suggests that FSS should be limited to 50.4-51.4 GHz, "to the extent that it does not interfere with terrestrial use."[485] T-Mobile suggests that, to the extent the Commission decides sharing is appropriate, the Commission should divide the band into segments in which different users have priority.[486] Additionally, several commenters oppose the use of a Spectrum Access System ("SAS") to govern spectrum sharing in the 47 GHz band.[487]

182. *Discussion.* At this time, we decline to authorize fixed and mobile use in the 48.2-50.2 GHz, but rather retain that band as a "core" satellite band. We believe the satellite broadband services that could be delivered over the networks proposed by Boeing, SpaceX, and others could play a useful role in bringing the benefits of broadband to more Americans. Given the current state of satellite technology, these systems would need access to spectrum where satellite end user devices can operate. Our actions today will provide FSS operators with 2 gigahertz of both uplink and downlink spectrum where they can operate satellite end user devices and earth stations without having to share with terrestrial licensees. In addition, we recognize the importance to the satellite industry of having spectrum to freely deploy uplink user terminals across the United States.[488] Further, we note that there is no explanation in the record for how the V-band could work successfully for both satellite and terrestrial providers without dedicated spectrum for FSS end-user terminals. Accordingly, while we are making additional spectrum, including the 47.2-48.2 GHz band, available for terrestrial use today, we will reserve the 48.2-50.2 GHz band for FSS use at this time, pursuant to the existing Part 25 rules, in order to give satellite operators an opportunity to provide services in the V-band.

B. 40-42 GHz

183. *Background.* This band has not been previously considered in this proceeding. In the 40-40.5 GHz band, there is currently no Fixed or Mobile allocation; rather, there are non-Federal FSS (space-to-earth) and MSS (space-to-earth) allocations, as well as various Federal satellite and space research allocations.[489] In the 40.5-41 GHz band, there are both Federal and non-Federal FSS (space-to-earth) and MSS (space-to-earth) allocations, as well as non-Federal allocations for Broadcasting, Broadcasting Satellite Service (BSS), Fixed, and Mobile.[490] In the 41-42 GHz band, there are non-Federal allocations for FSS (space-to-earth), Fixed, Mobile, Broadcasting, and BSS, but no Federal allocations.[491] The

[481] Boeing Comments at 16; ViaSat Comments at 10; ViaSat Reply Comments at 4-5; O3b Comments at 7.

[482] Boeing Comments at 14-17. *See also*, SIA Reply Comments at 13-14.

[483] ViaSat Comments at 8-12.

[484] T-Mobile Comments at 15-18; CTIA July 14 *Ex Parte* at 5.

[485] CTIA July 14 *Ex Parte* at 5.

[486] T-Mobile Comments at 17.

[487] Boeing Reply Comments at 26; T-Mobile Comments at 16-18.

[488] *See* Boeing Comments at 15; O3b Reply Comments at 6-7; ViaSat Comments at 10; Inmarsat Comments at 17; SIA Comments at 13.

[489] *See* 47 CFR § 2.106.

[490] *See* 47 CFR § 2.106.

[491] *See* 47 CFR § 2.106.

Commission has designated the 40-42 GHz band for FSS use.[492]

184. CTIA, Ericsson, Huawei, Straight Path, and T-Mobile ask the Commission to make the 40-42 GHz band available for mobile use. They argue that the 40-42 GHz band is being studied internationally for mobile use and could be combined with the 37 GHz, 39 GHz, and 42-42.5 GHz band to create 5.5 gigahertz of contiguous spectrum.[493] Satellite interests oppose mobile use of the 40-42 GHz band, arguing that satellite systems need dedicated spectrum where they can operate user devices.[494]

185. *Discussion.* We decline to propose mobile use in the 40-42 GHz band at this time. No proponent of mobile use for this band has explained how such use would be consistent with the operation of satellite user devices in this band. This analysis is different from the sharing analysis between UMFUS and individually licensed earth stations because the number and location of individually licensed earth stations can be controlled. As with 48.2-50.2 GHz, we will reserve the 40-42 GHz band for FSS use at this time, pursuant to the existing Part 25 rules, in order to give satellite operators an opportunity to provide services in V-band.

C. 71-76 and 81-86 GHz Bands (70/80 GHz Band)

1. Introduction

186. *Background.* On October 16, 2003, the Commission adopted a *Report and Order* establishing service rules to promote non-Federal development and use of the millimeter wave spectrum in the 71-76 GHz (70 GHz), 81-86 GHz (80 GHz), and 92-95 GHz (90 GHz) bands, which are allocated to non-Federal and Federal users on a co-primary basis.[495] Based on the determination that highly directional, "pencil-beam" signal characteristics permit systems in these bands to be engineered so that many operations can co-exist in the same vicinity without causing interference to one another, the Commission in 2003 adopted a flexible and innovative regulatory framework for the bands.[496] Specifically, the Commission created a two pronged authorization scheme for non-Federal entities for the entire 12.9 GHz of spectrum in the band. First, a licensee applies for a non-exclusive nationwide license; second, the licensee registers individual point-to-point links. Under this licensing scheme, a non-exclusive license serves as a prerequisite for registering individual point-to-point links. Licensees may operate a link only after the link is both registered with a third-party database and coordinated with NTIA.[497] This flexible and streamlined regulatory framework was designed to encourage innovative uses of the millimeter wave spectrum, facilitate future development in technology and equipment, promote competition in the communications services, equipment, and related markets, and advance sharing

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[492] *Allocation and Designation of Spectrum for Fixed-Satellite Services in the 37.5-38.5 GHz, 40.5-41.5 GHz and 48.2-50.2 GHz Frequency Bands; Allocation of Spectrum to Upgrade Fixed and Mobile Allocations in the 40.5-42.5 GHz Frequency Band; Allocation of Spectrum in the 46.9-47.0 GHz Frequency Band for Wireless Services; and Allocation of Spectrum in the 37.0-38.0 GHz and 40.0-40.5 GHz for Government Operations*, Second Report and Order, 18 FCC Rcd 25428, 245XX paras. 12-15 (2003) (*V-Band Second Report and Order*).

[493] CTIA Comments at 12-13; Ericsson Comments at 10-12; Huawei Comments at 6; Straight Path Comments at 5-7; T-Mobile Comments at 4-5;

[494] Boeing Reply Comments at 24-25; O3b Reply Comments at 11-12; SIA Reply Comments at 10-12; ViaSat Reply Comments at 4-5.

[495] The bands are allocated to both Federal and non-Federal users on a co-primary basis, except the 94.0-94.1 GHz portion, which is allocated for Federal use on a primary basis. *See generally Allocations and Service Rules for the 71-76 GHz, 81-86 GHz, and 92-95 GHz Bands*, Report and Order, 18 FCC Rcd 23318, 23322-23331, paras. 6-26 (2003) (*70-80-90 GHz Report and Order*).

[496] *70-80-90 GHz Report and Order*, 18 FCC Rcd at 23337-39, paras. 44-47.

[497] *See Wireless Telecommunications Bureau Announces Permanent Process for Registering Links in the 71-76 GHz, 81-86 GHz, and 92-95 GHz Bands*, Public Notice, 20 FCC Rcd 2261 (WTB BD 2005).

between non-Federal and Federal systems.

187. As of June 12, 2017, there were 454 active non-exclusive nationwide licenses covering the 70 GHz, 80 GHz, and 90 GHz bands.[498] Based upon information available from the third-party database managers that are responsible for registering links in those bands, as of June 10, 2016, there were approximately 11,882 registered fixed links[499] in the 70 GHz and 80 GHz bands.[500]

188. Access to these bands is based on a set of spectrum rights and sharing mechanisms between Federal and non-Federal users, and among different types of non-Federal uses (fixed and satellite). In these bands, non-Federal operations may not cause harmful interference to, nor claim protection from, Federal Fixed-Satellite Service operations located at 28 military bases.[501] In addition, in the 80 GHz band, licensees proposing to register links located near 18 radio astronomy observatories must coordinate their proposed links with those observatories.[502] Third-party database managers are responsible for recording each proposed non-Federal link in the third-party database link system and for coordinating with NTIA's automated "green light/yellow light" mechanism, under which a non-federal link entered into NTIA's system is either approved for 60 days (green light) or subject to further coordination (yellow light), to determine the potential for harmful interference to Federal operations and radio observatories.[503]

189. The 71-74 GHz band segment has co-primary allocations for Federal and non-Federal Fixed, FSS, Mobile, and MSS (space-to-Earth) operations.[504] The 74-76 GHz band segment has co-primary allocations for Federal and non-Federal Fixed, FSS (space-to-Earth), Mobile, and SRS operations.[505] In addition, there are non-Federal allocations in that band segment for Broadcasting and BSS operations.[506] The 81-86 GHz band has co-primary allocations for Federal and non-Federal Fixed, FSS (Earth-to-space), and Mobile, and within that band the 81-84 GHz band segment also has a Federal and non-Federal allocation for MSS (Earth-to-space).[507] The Commission has recently adopted rules to authorize non-Federal radar applications in the 76-81 GHz band on a licensed basis under Part 95.[508] These rules shift vehicular radars away from the Part 15 unlicensed model that had previously been

[498] These statistics are based on a review of the Universal Licensing System on June 12, 2017.

[499] A link in this context is defined as a communication path between one location and another in a single direction, regardless of frequency channel. In other words, multiple channels registered between the same transmit and receive location are not considered separate links. Bi-directional communications are counted as separate links.

[500] These statistics are based on a review of the third party database managers' data on June 12, 2017. *See* www.micronetcommunications.com/LinkRegistration/ ; www.comsearch.com/applications/link7090/index.jsp ; http://mmradioforms.com/mmRadioForms/FrontPage.aspx

[501] *See* 47 CFR § 2.106 n.US389.

[502] *See* 47 CFR § 2.106 n.US388.

[503] *See Wireless Telecommunications Bureau Announces Permanent Process for Registering Links in the 71-76 GHz, 81-86 GHz, and 92-95 GHz Bands*, Public Notice, 20 FCC Rcd 2261 (WTB BD 2005).

[504] *See* 47 CFR § 2.106.

[505] *See* 47 CFR § 2.106.

[506] *See* 47 CFR § 2.106.

[507] *See* 47 CFR § 2.106.

[508] *See* 47 CFR part 95 subpart M; Amendment of Parts 1, 2, 15, 90 and 95 of the Commission's Rules to Permit Radar Services in the 76-81 GHz Band, *Notice of Proposed Rulemaking and Reconsideration Order*, 30 FCC Rcd 1625, 1632-1638, paras. 24-44 (2015); ET Docket No. 15-26, *Report and Order*, FCC 17-94, paras. 52-60 (Adopted July 13, 2017).

used in the 76-77 GHz portion of the band.[509]

2. Mobile Use

190. *Background.* In the *FNPRM*, the Commission sought comment on whether to authorize flexible use services, including mobile use, in these bands using a Spectrum Access System (SAS), similar to the system established in the 3.5 GHz band. It asked a series of questions about how an SAS-based regulatory framework would work in these bands, including questions about incumbent fixed links, tiers of service, protection methodology, and technical rules.[510] The Commission also sought comment on alternative methods of authorizing additional access to the 70 GHz and 80 GHz bands, including exclusive use licensing.[511]

191. Commenters initially raised considerable doubt about the advisability and desirability of introducing mobile services into the 70/80/90 GHz bands in the near future. In comments, CTIA, Verizon, and AT&T urge the Commission to focus on improvements to the existing fixed rules, at least in the short term.[512] In a subsequent *ex parte*, CTIA now supports mobile use of the 70 GHz band and suggests that the 80 GHz band could be reserved for satellite uplinks.[513] Ericsson believes these bands could represent up to 20 percent of all new backhaul deployments as early as 2020.[514] Google supports maintaining the existing framework with updates to registration parameters and minimum antenna gain to allow point-to-multipoint operations.[515] Aeronet expresses interest in using the bands to provide broadband connectivity to airplanes and cruise ships and suggests that its proposed operations would be compatible with existing fixed links.[516] FWCC, NSMA, and existing license holders and registrants in the 70 GHz and 80 GHz bands argue that mobile service is inconsistent with their existing fixed links and that the bands are needed to meet the growing demand for backhaul.[517] Scientel Solutions, while not explicitly opposing mobile use, "urges the agency to make certain that the introduction of shared mobile 5G technology use into the 70/80 GHz Bands is in fact compatible with incumbent operations, without disrupting those existing systems."[518]

192. Commenters who support mobile use of the 70/80 GHz bands propose a variety of methods for reconciling mobile use with incumbent uses. Aeronet, Federated Wireless, and InterDigital

[509] *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, *Notice of Proposed Rulemaking and Reconsideration Order*, 30 FCC Rcd 1625, 1632-1638, paras. 24-44 (2015).

[510] *FNPRM*, 31 FCC Rcd at 8165-67 para. 440.

[511] *FNPRM*, 31 FCC Rcd at 8168 para. 441.

[512] AT&T Reply Comments at 4 ("Due to its significant usage today for point-to-point and anticipated growth in demand, AT&T recommends the Commission make allocation of the 70/80 GHz band for mobile a lower priority."); CTIA Comments at 14 ("CTIA believes that the Commission should largely retain its existing 70/80 GHz licensing framework."); Verizon Reply Comments at 3-4 (Verizon supports existing framework, although it is interested in Google's proposal to authorize point-to-multipoint operations).

[513] CTIA July 14 *Ex Parte* at 8-9.

[514] Ericsson Comments at 14.

[515] Google Comments at 2-5.

[516] Aeronet July 12 *Ex Parte*.

[517] FWCC Comments at 11; NSMA Comments at 4-5; Anova Comments at 5-6; Collinear Networks Comments at 5-15; E-Band Comments at 1-2; Moseley Associates Comments at 1-2; NEC Comments at 1-2; REMEC Comments at 1-2.

[518] Scientel Solutions Comments at 3.

support the SAS concept as described in the *FNPRM*, with some adjustments.[519] Other commenters who support mobile use reject an SAS approach and suggest alternatives. T-Mobile calls an SAS approach "untested in real-world environments" and proposes geographic area licensing combined with a requirement to coordinate with incumbent Federal and non-Federal users.[520] Nokia proposes an arrangement in which mobile user equipment that could interfere with fixed links is identified and then handed off to alternative access points along beams that would not interfere with the fixed links.[521]

193. *Discussion.* We decline to authorize mobile use in the 70 GHz and 80 GHz bands under UMFUS rules at this time. There is broad support in the record for focusing on and enhancing the existing rules for fixed use of the band, while there is little consensus among the proponents of mobile use as to how to coexist with fixed links. Under the existing licensing mechanism, these bands can play an important role in 5G development by facilitating backhaul and other fixed uses. It is important not only to protect existing links but also to provide an opportunity for future growth of fixed service in these bands as demand for backhaul and other related services increases.

194. We have several proposals pending in our Wireless Backhaul proceeding (WT Docket No. 10-153) to modify the existing rules for these bands. The proposals include adjustments to the antenna standards,[522] allowing +/- 45 degree polarization,[523] establishing a channelization plan,[524] requiring construction certifications for registered links,[525] and allowing minor modifications to link registrations.[526] We also note that companies such as Aeronet, Google, and The Elefante Group have proposed different uses for these bands which neither fit the traditional mobile broadband nor fixed link models.[527] Our best course of action is for the Commission to consider those proposals and possible future uses in the Wireless Backhaul proceeding. Once the Commission decides what changes, if any, to make to the existing rules, we encourage interested parties to discuss possible methods of promoting coexistence between fixed links and mobile operations. We reserve the right to revisit this issue as mobile use deploys in other millimeter wave bands, technology develops, and as further thought is given to mobile/fixed coexistence.

3. Indoor-only Unlicensed Use under Part 15

195. *Background.* In 2003, the Commission declined to authorize unlicensed operation under Part 15 in the 70 GHz and 80 GHz bands.[528] The Commission noted that the equipment being designed

[519] Aeronet Comments at 1-2; Federated Wireless Comments at 12-16; InterDigital Comments at 5-10.

[520] T-Mobile Comments at 20.

[521] *See* Nokia Comments, Appendix 1; Nokia Reply Comments, Appendix 1.

[522] *See* Letter from Mitchell Lazarus, Counsel for the Fixed Wireless Communications Coalition to Marlene H. Dortch, Secretary, Federal Communications Commission, WT Docket No. 10-153 (filed Apr. 4, 2013); Letter from Mitchell Lazarus, Counsel for the Fixed Wireless Communications Coalition to Marlene H. Dortch, Secretary, Federal Communications Commission, WT Docket No. 10-153 (filed Mar. 24, 2014).

[523] Comments of the Fixed Wireless Communications Coalition in Response to the Commission's Notice of Inquiry, WT Docket No. 10-153 (filed Oct. 5, 2012) at 7-8 (FWCC 2nd NOI Comments).

[524] FWCC 2nd NOI Comments at 6.

[525] *Ex Parte* Filing of the Fixed Wireless Communications Coalition, WT Docket 10-153 (filed Nov. 30, 2016) (FWCC November 30th *Ex Parte*) at 4.

[526] FWCC November 30th *Ex Parte* at 5.

[527] Google Comments at 2-3; Aeronet July 12 *Ex Parte*, Elefante Group September 8 *Ex Parte*.

[528] *See 70-80-90 GHz Report and Order*, 18 FCC Rcd at 23336, para. 41.

for this band was not designed to operate with unlicensed devices.[529] The Commission expressed concern that "an underlay of unlicensed devices here could detrimentally affect the quality, and thus, buildout of service."[530] It also observed that the 92-95 GHz band could provide sufficient spectrum for unlicensed devices.[531] It reserved "discretion to revisit this decision as the services in these bands mature and new technology is developed regarding sharing."[532]

196. In the *FNPRM*, the Commission sought comment on the feasibility of authorizing indoor-only unlicensed use under Part 15 of our rules in the 70 GHz and 80 GHz bands.[533] Even though the Commission decided not to adopt a proposal to authorize unlicensed indoor-only operations in the 37 GHz band, the Commission noted in the *FNPRM* that the comparative amount of signal leakage through windows could be much lower in the 70 GHz and 80 GHz bands, and consequently would be less likely to interfere with outdoor operations.[534] Although indoor-only unlicensed operation is permitted in the 90 GHz band, no unlicensed equipment had been authorized under these rules as of the time of the *FNPRM*.[535] Our rules require that equipment authorized to operate in the 90 GHz band must be AC-powered in order to ensure that they only operate indoors.[536] The Commission inquired about whether similar technical rules should apply if we allowed unlicensed operation at 70 GHz/80 GHz and what additional restrictions should be placed on such indoor devices to ensure that this type of equipment would not interfere with authorized services.[537]

197. Commenters are divided on whether to permit indoor-only unlicensed use under Part 15 in the 70 GHz and 80 GHz bands. For example, DSA, Microsoft, OTI/Public Knowledge, and Charter support unlicensed, indoor-only operations across the 70 GHz and 80 GHz bands, subject to the AC power and other technical rules that already apply to indoor-only operation in the 90 GHz band under Part 15.[538] Microsoft, for example, argues that there is a lower probability of harmful interference to licensed services due to unlicensed use because of the limited range of client devices, the geometries involved, and the attenuation of radio waves at these frequencies through windows and other construction materials.[539] DSA contends that there is no risk to either incumbent fixed point-to-point licensees or to Federal satellite operations at military bases.[540] OTI and Public Knowledge suggest that outdoor unlicensed use could be authorized on a secondary basis "subject to coordination by a geolocation database."[541] Federated and

[529] *See 70-80-90 GHz Report and Order*, 18 FCC Rcd at 23336, para. 41.

[530] *See 70-80-90 GHz Report and Order*, 18 FCC Rcd at 23336, para. 41.

[531] *See 70-80-90 GHz Report and Order*, 18 FCC Rcd at 23336, para. 41.

[532] *See 70-80-90 GHz Report and Order*, 18 FCC Rcd at 23336, para. 41.

[533] *See FNPRM*, 31 FCC Rcd at 8168, para. 440.

[534] *See FNPRM*, 31 FCC Rcd at 8168, para. 440.

[535] *See FNPRM*, 31 FCC Rcd at 8167-68, para. 440; 47 CFR § 15.257.

[536] 47 CFR § 15.257(a)(1) requires that "devices operating under the provisions of this section, by the nature of their design, must be capable of operation only indoors. The necessity to operate with a fixed indoor infrastructure, *e.g.*, a transmitter that must be connected to the AC power lines, may be considered sufficient to demonstrate this."

[537] *See FNPRM*, 31 FCC Rcd at 8167-68, para. 440; 47 CFR § 15.257.

[538] *See, e.g.*, DSA Comments at 8-9; Microsoft Comments at 9; OTI/Public Knowledge Reply Comments at 23; Charter Reply Comments at 1-3; Micronet Comments at 4 (supporting unlicensed indoor operation as long as adequate restrictions are placed on the equipment (power limitation, *etc*.) to protect registered links).

[539] Microsoft Comments at 9; DSA Comments at 9.

[540] DSA Comments at 9.

[541] OTI/Public Knowledge Comments at 19-22.

NCTA support traditional Part 15 unlicensed operation indoors *if* the Commission were to adopt an SAS framework, which, in the discussion above, we have declined to do at this time.[542]

198. Other commenters oppose unlicensed indoor use in the 70 GHz and 80 GHz bands.[543] Fastback Networks opposes indoor use, or any other use that would encourage non-directional antennas, because "the extreme directivity requirements of the existing 70 GHz and 80 GHz bands. . . enables equipment in this band to efficiently re-use this spectrum dynamically, whether under the existing lightly licensed regime or a future unlicensed scenario."[544] Parties opposing indoor unlicensed use in the 70 GHz and 80 GHz bands generally argue that additional study is necessary before the Commission should authorize indoor unlicensed use in the 70 GHz and 80 GHz bands[545] and such unlicensed use is not necessary at this time given the availability of 14 gigahertz of contiguous unlicensed millimeter-wave spectrum between 57-71 GHz and the permissibility of unlicensed indoor use at 90 GHz.[546]

199. *Discussion.* We decline at this time to authorize indoor-only unlicensed use under Part 15 of our rules in the 70 GHz and 80 GHz bands. We find that little has changed since the Commission rejected the use of unlicensed devises in the 70 GHz and 80 GHz bands in 2003.[547] We further find that, given the risks of interference to existing fixed uses, additional studies are warranted before considering indoor unlicensed use in the 70 GHz and 80 GHz bands. Parties supporting unlicensed indoor use in the 70 GHz and 80 GHz bands fail to provide sufficient evidence that such use would cause no interference to authorized uses. Rather, they rely on general references to the propagation characteristics in these bands, building materials, device limitations (*e.g.*, a requirement that equipment comply with Section 15.257 of the rules), or they advocate the adoption of an SAS framework to protect authorized uses from interference.

200. We further find that the current availability of 14 gigahertz of contiguous spectrum for unlicensed operations immediately below the 70 GHz band reduces the urgency to introduce unlicensed indoor use in the 70 GHz and 80 GHz bands. In this regard, we note that, while unlicensed indoor use is permitted under Part 15 at 90 GHz, no equipment has been authorized for use as of June 12, 2017, so it would be premature to extend the rules of a yet-to-be successful service to the bands immediately below it that, as demonstrated by the record, support a thriving millimeter wave service. We further find that it is neither necessary nor cost-effective to establish a geolocation database to facilitate coordination of unlicensed devices at this time, as proposed by OTI and Public Knowledge. Our decision to delay introducing unlicensed indoor use at this time furthers the public interest by protecting existing operations and successful services in the 70 GHz and 80 GHz bands without foreclosing future innovations in these

[542] Federated Wireless Comments at 17-18; NCTA Comments at 11.

[543] Ericsson Comments at 15; Fastback Networks Comments at 3; FWCC Reply Comments at 4 and n.17; Huawei Comments at 10; NEC Comments at 1; Qualcomm Comments at 12; Sprint Reply Comments at 14-15; TIA Comments at 15.

[544] Fastback Networks Comments at 3.

[545] Ericsson Comments at 15; NEC Comments at 1; Qualcomm Comments at 12; TIA Comments at 15. Parties particularly emphasize the need for further study of the risk of interference to outdoor backhaul from unlicensed indoor use. Ericsson Comments at 15; Qualcomm Comments at 12; TIA Comments at 15. The FWCC, which earlier in this proceeding would have supported indoor unlicensed operation at the emission levels specified for 92-95 GHz band, now opposes unlicensed indoor use in the 70 and 80 GHz bands because, it is no longer confident that outdoor links are safe at the 92-95 GHz band power levels given the largely glass facades of modern office buildings. FWCC Reply Comments at 4 n.17.

[546] Ericsson Comments at 15; Huawei Comments at 10; Qualcomm Comments at 12; TIA Comments at 15; Sprint Reply Comments at 14-15.

[547] *70-80-90 GHz Report and Order*, 18 FCC Rcd at 23336, para. 41.

bands.

D. 37.5-40 GHz Band Satellite Issues

1. Satellite Power Flux Density Limits

201. *Background.* In the *V-Band Second Report and Order*, the Commission determined that Fixed Service use of the 37.5-40 GHz band would be primarily for high density FS operations[548] while Fixed-Satellite Service use of that band would be for gateway earth stations.[549]

202. To accommodate FS in the 37.5-40.0 GHz band and FSS in the 40.0-42.0 GHz band, the Commission adopted what it called a "soft segmentation" approach by implementing power flux density (PFD) limits on FSS at a level 12 dB lower in the 37.5-40.0 GHz band than in the 40.0-42.0 GHz band.[550] The Commission stated that it was making higher power levels available for satellite operations in the 40.0-42.0 GHz band in order to motivate high density FSS (HDFSS) to use that band rather than the 37.5-40.0 GHz band, and that it was setting satellite PFD limits at a lower level in the 37.5-40.0 GHz band in order to protect ubiquitously deployed high density FS stations from interference from satellite signals.[551] The Commission adopted rules that contemplated allowing satellites to raise the power levels of their spot beams during rain fade events, but did not define the conditions under which satellites could do so.[552]

203. In the *FNPRM* in this proceeding, the Commission acknowledged that the record was insufficient for the Commission to conclude that authorizing satellites to operate at the higher PFD of -105 dBW/m^2/MHz would be consistent with terrestrial use of the 37.5-40 GHz band.[553] The Commission observed that, in theory, the same rain storm that impairs satellite reception might be able to shield earth stations if the satellite were to raise its power level, but noted that rain will rarely be uniformly present throughout a spot beam's footprint, leaving at least some terrestrial stations unshielded or inadequately shielded by rain and, hence, vulnerable to any increase in the spot beam's PFD level.[554] The Commission

[548] *See V-band Second Report and Order*, 18 FCC Rcd at 25438, para. 23.

[549] *See V-band Second Report and Order*, 18 FCC Rcd at 25442, para. 33. The Commission defined high density FS as follows: High density systems and usages in the fixed service are generally characterized by applications requiring the ability to: (1) operate on a point-to-point or point-to-multipoint basis, or a combination of both; (2) flexibly achieve, over short periods of time, a concentration of links on the same channel(s) within an area; (3) increase frequency reuse; and (4) decrease terminal size and cost of equipment. The term "high density fixed service" does not refer to a particular application or band in the fixed service, but does describe the phenomena of maximized deployment densities, spectrum reuse and spectral efficiencies realized by concentrated deployments. Often these deployment density, spectrum reuse and spectral efficiency factors become more pronounced in the higher bands. *See In the Matter of Amendment of Part 2 of the Commission's Rules to Allocate Additional Spectrum to the Inter-Satellite, Fixed, and Mobile Services and to Permit Unlicensed Devices to Use Certain Segments in the 50.2-50.4 GHz and 51.4-71.0 GHz Bands*, Report and Order, 15 FCC Rcd 25264 at _, para. 24, n. 46 (2000).

[550] *See V-Band Third FNPRM*, 25 FCC Rcd at 15675, para. 31, *citing V-Band Second Report and Order*, 18 FCC Rcd at 25438, para. 23, and 47 CFR § 25.208(q)-(t) (PFD limits for FSS).

[551] *See V-Band Third FNPRM*, 25 FCC Rcd at 15675, para. 31.

[552] 47 CFR § 25.208(q) (GSO satellites) "The conditions under which satellites may exceed the power flux-density limits for normal free space propagation described in paragraph (p)(1) to compensate for the effects of rain fading are under study and have therefore not yet been defined. Such conditions and the extent to which these limits can be exceeded will be the subject of a further rulemaking by the Commission on the satellite service rules."). *See also* 47 CFR § 25.208(r) (similar note for NGSO satellites).

[553] *FNPRM*, 31 FCC Rcd at 8182, para. 497.

[554] *FNPRM*, 31 FCC Rcd at 8182, para. 497.

also recognized that Boeing had submitted a study showing that coexistence is possible.[555]

204. On that basis, the Commission sought further comment on whether there are any circumstances under which allowing FSS satellites in the 37.5-40 GHz band to operate at a higher PFD level than permitted under the existing rules would be consistent with terrestrial use of the 37.5-40 GHz band.[556] The *FNPRM* emphasized that the burden is on FSS interests to show that a higher PFD level would be consistent with terrestrial use, but it also reminded terrestrial interests that they have an obligation to provide sufficient information concerning the nature of their systems to allow other parties to analyze the interference impact of a higher PFD level.[557]

205. Boeing responded to the Commission's invitation by conducting a series of computer simulations for nine cities, including "detailed simulation of 22 different multipath scenes including 58 different UMFUS receiver types and locations with more than one million trials at each location to assess the various satellite signal paths at each location, resulting in 448 million simulations."[558] According to Boeing, its studies "demonstrate that broadband satellite systems can operate in the 39 GHz band on an opportunistic basis without causing harmful interference to co-frequency UMFUS systems."[559] Boeing maintains that its modeling simulated all possible reflection trajectories, including double reflections, to capture all situations where a signal could reach an UMFUS receiver.[560] Boeing emphasizes that it is not seeking an increase in the clear-sky power flux density (PFD) limits for space-to-Earth transmissions in the 37.5-40 GHz band, but rather is requesting only that the Commission complete the rain-fade studies that are still codified in notes to section 25.208 of our Rules.[561]

206. Straight Path opposes authorizing higher satellite PFD in the 37.5-40 GHz band.[562] Straight Path argues that the existing PFD limits cause "non-negligible impairment" and increasing the PFD limits would "severely impact the 5G user experience."[563] With respect to the Boeing study, Straight Path argues that (1) the source of Boeing's building data is not clear, (2) the study fails to consider the increased utilization of spectrum by massive multiple input, multiple output ("MIMO") techniques, and (3) fails to consider interference on a per-cell basis.[564]

207. *Discussion.* We conclude that the record does not establish conditions under which FSS could operate at a higher PFD consistent with terrestrial use of the band. We recognize that Boeing has devoted considerable effort to address the Commission's questions about the rain fading issue. At this time, however, we believe that allowing FSS to operate with a higher PFD would be inconsistent with our decisions to designate 37.5-40 GHz as an UMFUS band and to grant UMFUS licensees the flexibility to provide a wide variety of fixed and mobile technologies. UMFUS technologies are new, rapidly evolving, and proliferating. Boeing's studies emphasize coexistence with mobile broadband systems, but that is not the only use case being developed for this band. Verizon announced that it will begin offering

[555] *See FNPRM*, 31 FCC Rcd at 8182, para. 498, *citing Ex Parte* Letters of Boeing on May 9, 2016, and June 17, 2016.

[556] *See FNPRM*, 31 FCC Rcd at 8182-8183, para. 499.

[557] *See FNPRM*, 31 FCC Rcd at 8182-8183, para. 499.

[558] Boeing May 15, 2017, *Ex Parte* Letter at 3.

[559] Boeing May 15 *Ex Parte* at 3.

[560] Boeing June 19, 2017 *Ex Parte* Letter at 9.

[561] Boeing May 15, 2017, *Ex Parte* Letter at 1. *See* 47 CFR §25.208, notes to paragraphs (q) and (r).

[562] Straight Path Comments at 13-16.

[563] Straight Path Comments at 14.

[564] Straight Path June 21 *Ex Parte* at 8-9.

5G fixed wireless service to pilot customers in 11 cities in the first half of 2017,[565] and AT&T conducted its first 5G business customer trial in 2016 and states that it is currently pursuing 5G video trials with DirecTV NOW as well as additional fixed and mobile 5G trials with Qualcomm and Ericsson.[566] We note that the existing PFD limits for satellite signals were designed to protect fixed systems. Another use case is IoT devices, which Boeing did not specifically consider. By one informed estimate, the IoT market could grow from an installed base of 15.4 billion devices in 2015 to 30.7 billion devices in 2020 and 75.4 billion in 2025.[567] The most salient issue, however, is not the sheer number of IoT devices that are likely but the plethora of designs being developed.[568]

208. Boeing's analysis proposes to impose limits on equivalent power-flux density (EPFD) instead of PFD on the ground.[569] EPFD limits have been used in our rules to address the interference from NGSO FSS systems to GSO space stations as well as to earth stations receiving from such space stations.[570] In these situations, the pointing direction of the interfered-with earth station antenna is fixed, the antenna pattern of the earth station is known, and the radio propagation conditions can be approximated by line of sight propagation. By contrast, UMFUS receivers use phased array antennas to dynamically form beams in the direction of the transmitter over the relative path of motion, and the received signals are generally subject to multipath propagation conditions. Boeing's analysis addressed the dynamic nature of UMFUS beamforming by modeling the random pointing of UMFUS antennas while using a 3GPP-suggested antenna pattern, and Boeing also presented computer simulation results for multipath environments in nine cities. Boeing's computer simulations illustrate the complexity of characterizing the interference performance of these systems and, even if we were to adopt EPFD-based limits, additional work would be required. Furthermore, UMFUS receivers are in the early stage of development and have

[565] *See* Press Release, Verizon, Verizon to deliver 5G service to pilot customers in 11 markets across U.S. by Mid 2017 (Feb. 22, 2017), http://www.verizon.com/about/news/verizon-deliver-5g-service-pilot-customers-11-markets-across-us-mid-2017.

[566] *See* Press Release, AT&T, AT&T Details 5G Evolution (Jan. 4, 2017), http://about.att.com/story/att_details_5g_evolution.html.

[567] *See* Sam Lucero, *IoT Platforms: Enabling the Internet of Things*, IHS Technology, March 2016, at 5 (https://cdn.ihs.com/www/pdf/enabling-IOT.pdf).

[568] One analysis depicts the situation as follows: *Market fragmentation and complexity:* In some sectors, such as healthcare, automotive and smart homes, there is a wide range of proprietary [IoT] solutions in use, which can make interoperability difficult to achieve. A lack of standards encourages the creation of applications that are highly customer-specific to a vertical sector, often involving labor-intensive development by highly specialized integrators and developers with deep vertical knowledge. 4G Americas, *Cellular Technologies Enabling the Internet of Things* (November 2015) at 9.

[569] *See* 47 CFR §§ 2.106, International Footnote 5.551H to Table of Frequency Allocations (EPFD of space station signals in the 42.5-43.5 GHz band when reaching radio astronomy stations), 25.103 (definition of EPFD), 25.208(g)-(j) (EPFD of space-to-Earth signals in the 10.7-11.7 GHz and 11.7-12.2 GHz bands), 25.208(k) (EPFD of Earth-to-space signals in the 12.75-13.15 GHz, 13.2125-13.25 GHz and 13.75-14.5 GHz bands), 25.208(l) (EPFD of space-to-Earth signals in the 11.7-12.2 GHz and 12.5-12.75 GHz bands in Region 3, 11.7-12.5 GHz bands in Region 1, and 12.2-12.7 GHz band in Region 2), 25.208(m) (EPFD of space-to-Earth signals in the 11.7-12.2 GHz and 12.5-12.75 GHz bands in Region 3, 11.7-12.5 GHz band in Region 1, and 12.2-12.7 GHz band in Region 2), 25.146 (licensing and operating rules for the non-geostationary orbit Fixed-Satellite Service in the 10.7 GHz-14.5 GHz bands), 101.105(a) (4)(ii) (definition of EPFD and permissible EPFD levels of MVDDS signals reaching direct broadcast satellite service earth stations). *See also* Recommendation ITU-R 2.1503-2, Functional description to be used in developing software tools for determining conformity of non-geostationary-satellite orbit fixed-satellite system networks with limits contained in Article 22 of the Radio Regulations; ITU Radio Regulations Article 22 (EPFD used for coordination between GSO and NGSO satellite systems). *But see* Straight Path June 21, 2017, *Ex Parte* Letter at 10 (EPFD as a metric for measuring satellite interference to terrestrial operations has only been used to model interference to fixed services with dish antennas, for which fairly restrictive assumptions can be made).

[570] 47 CFR § 25.103; ITU Radio Regulations Article 22.5C.1 (2016 edition).

not yet been manufactured for deployment. Any EPFD limit set at this time based on a 3GPP-suggested antenna pattern may limit the future development of antenna reception technology for known applications or for applications that have not even been conceived.

209. Boeing has made a good faith effort to model a broadly representative range of UMFUS devices and pointing conditions,[571] but at this nascent stage of the technology it would be impossible to capture all variants of UMFUS use cases that could yet emerge. Under these circumstances, Boeing and others have not yet met the burden of proving that they can strengthen their satellite signals during rain storms without interfering with terrestrial systems in the 37.5-40 GHz band. Accordingly, we will not make any changes to sections 25.208(q) or (r) of the Commission's rules.

2. Authorizing Satellite User Equipment

210. *Background.* By rule, satellite earth station facilities in the 37.5-40 GHz band (space-to-Earth) may not be ubiquitously deployed and may not be used to serve individual consumers.[572] The *FNPRM* sought comment on the possibility of repealing that prohibition.[573] The Commission asked satellite interests to provide information concerning the need and demand for user equipment in the 37.5-40 GHz band and noted that FSS user equipment is already allowed to receive in the adjacent 40-42 GHz band, which is designated as primary for satellite operations. The Commission asked whether there are uses for which access to the 40-42 GHz band is insufficient, and, if so, asked FSS providers to provide specific examples and data demonstrating the need for user equipment in the 37.5-40 GHz band.[574]

211. Boeing and ViaSat support repealing the ban.[575] Both companies assert that generous amounts of bandwidth are required to support demonstrated consumer demand for high-speed Internet downloads, but neither company provides data that could support a meaningful estimate of the number of customers that satellite operators would likely enroll if given the opportunity.[576] Their main argument is that allowing ubiquitous deployment of consumer earth stations in the band would not burden or impair terrestrial services, because earth stations would be secondary and receive-only in the band.[577] Boeing notes satellites' ability to complement terrestrial mmW services by providing service to rural and other areas with low population densities.[578] CTIA opposes allowing satellite user devices in the band because such deployment "would lead to broader coverage by satellite beams - and unpredictable interference to 5G base stations and mobile receivers. CTIA is also concerned that "permitting satellite user terminals would unduly burden terrestrial users either by imposing restrictions on operations or by subjecting terrestrial operators to onerous requirements to identify sites serving mobiles."[579] Straight Path acknowledges that consumer earth stations do not directly cause interference when they are receiving, but it says that they attract interference from the sky because they provide an audience for satellite signals.[580] Straight Path further argues that the extent of that interference would be compounded by the fact that satellite consumer terminals typically have 10-to-20 dB less antenna gain than satellite gateway stations,

[571] *See, e.g.*, Boeing June 29, 2017, *Ex Parte* Letter, Attachment 2 at 19.

[572] 47 CFR § 25.202(a)(1) n.1.

[573] *See FNPRM*, 31 FCC Rcd 8183, paras. 500-502.

[574] *See FNPRM*, 31 FCC Rcd 8183, para. 501.

[575] *See* Comments of Boeing at 9 and ViaSat at 17.

[576] *See* Boeing Comments at 7-13 and Boeing Reply Comments at 21-24.

[577] *See* Boeing Comments at 23-24; ViaSat Comments at 18.

[578] *See* Boeing Comments at ii, vii, 2-4, 6, 7, 8, 11, 12, 13, 15.

[579] CTIA Reply Comments at 15.

[580] Straight Path June 21 *Ex Parte* at 2.

which requires an increase in satellite transmission power to maintain effective communication links.[581]

212. *Discussion.* We find that allowing satellite earth stations in the 37.5-40 GHz band has the potential to result in a negative customer experience for satellite broadband consumers. It is true that no earth stations in the 37.5-40 GHz band will generate any direct interference because earth stations operate in a receive-only mode in that band, where satellite operations are authorized only in a space-to-Earth mode. In general, however, consumer earth stations tend to need stronger satellite signals than larger, more sophisticated gateway earth stations. We have denied Boeing's request for increased power levels at this time, but Boeing could renew its request. If we allowed satellite user equipment to use 37.5-40 GHz on an opportunistic basis, but the buildout of terrestrial systems eventually required FSS operators to relinquish their use of channels below 40 GHz, customers could experience a reduction in service quality. We do not agree with Boeing's argument that consumers could simply narrow their usage to bands above 40 GHz, where satellite is primary.[582] If it is true, as Boeing argues, that additional bandwidth below 40 GHz is necessary to provide adequate high-speed Internet service to consumers,[583] then surely those same consumers would experience a decline in the quality of their services if they were required to relinquish those channels. Alternatively, if those consumers would not experience a decline in the quality of their service upon relinquishing channels below 40 GHz, the implication is that those channels are not necessary for the delivery of high-quality satellite service.

213. We agree with Boeing that satellites could complement terrestrial services by providing assured coverage to rural areas, and we acknowledge that mmW mobile services will likely appear first in high-traffic areas. Recent developments, however, suggest that the same technologies that will support non-line-of-sight service to mobile users over short distances will also be able to support non-line-of-sight service to fixed users over longer distances. For example, Starry says that it can provide fixed mmW service to consumers at distances up to 1 kilometer.[584] However, we find that FSS proponents have not met their burden of demonstrating that allowing satellite end user devices in 37.5-40 GHz is necessary and appropriate. FSS will retain the 40-42 GHz band where satellite end user devices can be located without restriction. In addition, FSS can use the 37.5-40 GHz band for a limited number of individually licensed earth stations. We believe this framework promotes efficient spectrum use while providing both UMFUS and FSS with the opportunity to provide service.

E. LMDS A2/A3/B

214. *Background.* The Commission licensed spectrum for the use of LMDS in two blocks per BTA—an 1,150 megahertz A Block comprised of varying noncontiguous spectrum swathes at 27.50-28.35 GHz (the A1 Band); 29.10-29.25 GHz (the A2 Band); and 31.075-31.225 GHz (the A3 Band)[585] and a 150 megahertz B Block consisting of the spectrum at 31.00-31.075 GHz (the B1 Band) and 31.225-

[581] Straight Path May 17 *Ex Parte* at 13.

[582] *See* Ericsson Comments at 21 and Boeing Reply at 22-23.

[583] *See, e.g.,* Boeing Reply at 21.

[584] *See* Starry July 5, 2016, Ex Parte, Attachment 2 at 2. S*ee also R&O* at 31 FCC Rcd 8163, para. 434 (smaller wavelength of mmW signals enables proportionally greater antenna gain for the same physical antenna size; consequently, the higher frequencies of mmW signals do not in themselves result in any increased free space propagation loss, provided the antenna area remains fixed and suitable directional transmissions are used).

[585] *See* 47 CFR 101.1005. The LMDS A1 Band consists of 850 megahertz of spectrum, the A2 band contains the 150 megahertz, and the A3 Band has 150 megahertz for a total 1150 megahertz. *See* Rulemaking to Amend Parts 1, 2, 21, and 25 of the Commission's Rules to Redesignate the 27.5 GHz Frequency Band, to Reallocate the 29.5-30.0 GHz Frequency Band, to Establish Rules and Policies For Local Multipoint Distribution Service and For Fixed-Satellite Services, CC Docket No. 92-297, *Second Report and Order, Order on Reconsideration and Fifth Notice of Proposed Rulemaking*, 12 FCC Rcd 12545, 12556 ¶ 12 (1997)("*Second LMDS Report and Order"*);

31.3 GHz (the B2 Band).[586]

215. In the *NPRM*, the Commission sought comment on authorizing mobile use of the A1 band, but declined to seek comment on the remaining LMDS bands, "primarily because the bands offer considerably less than 500 megahertz of contiguous spectrum as commenters have suggested is necessary for mobile operations."[587]

216. In the *R&O*, the Commission authorized Part 30 UMFUS mobile use in the 850 megahertz A1 band and did not address the remaining LMDS bands.

217. Several commenters to the *FNPRM* support making the entire LMDS band available for Part 30 licensing, in effect seeking reconsideration of the Commission's decision not to designate remaining LMDS band portions for UMFUS.[588] Straight Path supports authorizing mobile use in the A3 and B bands.[589] Nextlink and CTIA argue that these lower frequency bands will propagate better than all the higher frequency bands considered for Part 30 uses.[590] Furthermore, Verizon and CTIA argue that adding these disparate bands together would enable device manufacturers to build equipment capable of using the entire LMDS band at only marginal additional cost.[591] They further argue that failing to include all bands for UMFUS will instead introduce confusion in the equipment ecosystem and create inefficiencies as manufacturers have to specialize equipment to differing uses based on the Commission's mandate, impairing the use and value of the bands.[592] Nextlink states that its system uses an FDD band plan where point-to-multipoint deployments use the A2 band for downlink and the upper A1 band for uplink, respectively, with 1,008 megahertz of duplex spacing.[593] With adoption of UMFUS rules for only the A1 band, Nextlink argues that different performance metrics will apply to different ends of point-to-multipoint links in these bands.[594] If the Commission does not adopt flexible use rules for the remaining LMDS bands, Nextlink asks, in the alternative, that it should clarify that such deployments will be able to satisfy their performance obligations for either band by relying on the same equipment.[595]

218. In opposition, Iridium, SES, and O3b contend there is no evidence in the record that the A2 band's mere 150 megahertz of spectrum would be well suited to UMFUS operations when various commenters have asked for a minimum of at least 200 megahertz.[596] Nextlink replies that the record supports that bands narrower than 200 megahertz can be useful to providing 5G services,[597] with the band potentially bonded to another paired band using carrier aggregation and usable for supplemental

[586] *See* 47 CFR 101.1005.

[587] *NPRM*, 30 FCC Rcd at 11902, para. 70.

[588] Nextlink Comments at 2; Straight Path Comments at 3; CTIA Reply Comments at 7.

[589] Straight Path Comments at 3-5.

[590] *See* Nextlink Comments at 4; CTIA Reply Comments at 7.

[591] *See* Verizon Comments at 5; CTIA Reply Comments at 7 (citing Comments of Ericsson Inc., GN Docket No. 14-177, at 37 (filed Jan. 15, 2015)); *see also* Nextlink Petition at 11.

[592] *See* Verizon Comments at 5; *see also* Nextlink Petition at 11-12.

[593] Nextlink June 30, 2016 Ex Parte at 6. Nextlink states most of its lessees utilize the same band plan. *Id.*

[594] Nextlink Petition at 11. Nextlink argues the A1 band would be subject to the newly formed population-based metric and the A2 band would remain subject to the traditional substantial service showing. *Id.*

[595] Nextlink Petition at 13; *see also* Cambridge Broadband Reconsideration Response at 8 (arguing that existing licensees operating in the A1 band should benefit from renewal under the terms of their existing LMDS licenses).

[596] SES and O3b Opposition at 16; Iridium Opposition at 3-6; *see also* Cambridge Broadband Reconsideration Response at 8-9 (supporting the view that the A2 band should not be considered for mobile given it only contains 150 MHz and that addition of the A3 and B bands for UMFUS may also be problematic)..

[597] Nextlink Reply at 7 n.20 (citing XO Communications, LLC, Jan. 28, 2016 NPRM Comments at 16) .

downlink.[598] Iridium points out that it supports the core operations of the U.S. military and intelligence agencies in the A2 band, and serves as the last line of communications for many commercial users and that these services should not be jeopardized.[599] Finally, Iridium points out the band is not under consideration internationally for mobile service.[600]

219. *Discussion.* We affirm the Commission's prior decision to not consider the LMDS A2, A3, and B bands for mobile use. This prior decision not to consider these bands had been motivated largely by the Commission's goal of providing spectrum bands for UMFUS that contained at least 500 megahertz of spectrum.[601] Unlike other bands where we could provide a single band greater than 500 megahertz, through consolidation or otherwise, the A2, A3 or B bands are not near other bands that could be used for mobile. Additionally, the 31-31.3 GHz band is split among different LMDS licensees, which would make it more difficult to aggregate even 300 megahertz of spectrum.[602] In addition, as Iridium points out, these bands were not identified for further study at WRC-15, which makes it less likely that equipment will be manufactured for the entire band. The presence of the Iridium satellite system (which is co-primary) in the A2 band presents complex coexistence issues for which petitioners have proposed no workable solution.

220. Finally, protection of federal systems in an adjacent no transmit "passive" band could reduce the amount of its usable bandwidth or otherwise encumber the 31-31.3 GHz A3 and B bands.[603] No transmissions are authorized in the 31.3-31.8 GHz band which contains the Radio Astronomy Service (RAS), Earth Exploration Satellite Service (EESS), and Space Research Service (SRS) services.[604] Nextlink claims that coexistence is possible between 5G and RAS and EESS in the adjacent no transmit band so long as radio astronomy sites are protected using exclusion zones and that the out-of-band emissions limits adopted for UMFUS are maintained.[605] In an update to the Reed study, Nextlink acknowledged some uncertainty regarding application of the ITU protection criteria.[606] We believe further study would be required before we could conclude that UMFUS deployments in the 31-31.3 GHz band would be practical and consistent with protection of the passive band.

221. The concerns raised by Nextlink and others about the splitting of LMDS licenses do not provide any basis for revisiting the Commission's prior decision. Nextlink and its lessees can continue to operate the FDD equipment they describe, using the UMFUS rules in the A1 band and the Part 101

[598] Nextlink Reply at 7. Nextlink points to a "European Band Plan" that pairs a portion of the upper A1 band with a portion of the A2 band – a plan that "guarantees that equipment will be available that can support next-generation fixed use cases that can involve both the A1 and A2 bands." Nextlink April 20, 2017 *Ex Parte* at 3 & Ex. B, 27.5-29.5 GHz Band Plan for Europe and U.S.

[599] Iridium Opposition at 4.

[600] Iridium states the World Radiocommunication Conference decided not to identify the A2 band as even a candidate band for IMT-2020. Iridium Opposition at 6-7, n.24. Nextlink responds that the Commission has taken positions at odds with international interests. Nextlink Reply at 8-9.

[601] *See NPRM*, 30 FCC Rcd at 11887, para.20.

[602] *See NPRM*, 30 FCC Rcd at 11902, para.70.

[603] *See* NPRM, 30 FCC Rcd at 11902, para.69; *see also id.* at para.73 (discussing the need to protect the 31.3-31.8 GHz passive band and the severe limitations this placed on making adjacent spectrum at 31.8-32.3 available for mobile use).

[604] *See* U.S. Table of Frequency Allocations, 47 CFR § 2.106 n.US246.

[605] Nextlink April 20, 2017 *Ex Parte* at 2 (citing Reed Engineering, Co-Existence of 5G Mobile Service and RAS, EESS, and SRS at 31 GHz (April 2017)). *Compare* U.S. Table of Frequency Allocations, 47 CFR § 2.106 n.US246 ("No station shall be authorized to transmit in the following bands . . .").

[606] Nextlink Oct. 17, 2017 *Ex Parte* at 1 (citing Reed Engineering, Co-Existence of 5G Mobile Service and RAS, EESS, and SRS at 31 GHz, Version 3.0 (Oct. 2017)).

LMDS rules in the A2 band. While the parties are correct that UMFUS and LMDS have different buildout requirements, that difference is insignificant because licensees who meet the UMFUS buildout requirements will most likely have met the less stringent LMDS substantial service requirement.[607] Furthermore, incumbent licensees will have ample time to adjust to the new standards because they will not be required to comply with the new UMFUS buildout requirements until June 1, 2024, and LMDS licensees will not be required to comply with the new renewal requirements recently adopted in the *Renewal and Service Continuity Proceeding* until the first license term after January 1, 2023.[608] Finally, Nextlink's claims about confusion in the equipment market are not supported by any equipment manufacturer.

F. Performance Requirements – Non-Federal Use-or-Share

222. *Background*. In the *FNPRM*, the Commission proposed a "use-or-share" rule that would supplement performance requirements to ensure that spectrum is put to efficient and productive use.[609] Mechanisms for sharing unused spectrum are currently present in other bands licensed by the Commission, including a "keep what you use" regime in the 700 MHz band,[610] and a three-tier shared access system in the 3.5 GHz band that makes geographically licensed spectrum available opportunistically.[611] These mechanisms allow licensees to construct networks consistent with their deployment plans and business models, while making spectrum that a licensee has chosen not to use available for other users.

223. In the *FNPRM*, the Commission sought comment more specifically on whether to implement a "use-or-share" regime in any or all of the UMFUS bands.[612] It sought comment on whether, and how, to allow opportunistic use of portions of a license area not in actual use by the licensee.[613] The Commission also sought comment on whether a use-or-share regime should be implemented specifically in the upper portion of the 37 GHz band (37.6-38.6 GHz), as a potential complement to or extension of a possible Federal sharing mechanism in the lower portion.[614] Finally, it also sought comment on whether any use-or-share regime should operate in addition to traditional performance requirements, or whether it should replace those requirements as sufficient to ensure efficient spectrum use on its own.[615]

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[607] UMFUS licensees operating fixed links must demonstrate operation of at least four links or one link per 67,000 people in areas with a greater than 268,000 population. *See* 47 CFR § 30.104. For LMDS, operations of four fixed links per million population is sufficient to meet a substantial service safe harbor. *See* Rulemaking To Amend Parts 1, 2, 21, and 25 of the Commission's Rules To Redesignate the 27.5-29.5 GHz Frequency Band, To Reallocate the 29.5-30.0 GHz Frequency Band, To Establish Rules and Policies for Local Multipoint Distribution Service and for Fixed-Satellite Services, Petitions for Reconsideration of the Denial of Applications for Waiver of the Commission's Common Carrier Point-to-Point Microwave Radio Service Rules; *Second Report and Order, Order on Reconsideration, and Fifth Notice of Proposed Rulemaking*, 12 FCC Rcd 12545, 12660, para. 270 (1997).

[608] *See WRS 2nd R&O, para. 6 (6/30 version).*

[609] *NPRM*, 30 FCC Rcd at 11941, para. 215.

[610] 47 CFR § 27.14(h). WCS licensees with REAG authorizations in Block C and Block C2 must meet construction requirements for each EA within the REAG. Authorization terminates automatically at the end of the license term for any EA in which the licensee has not met the construction requirements.

[611] 47 CFR §§ 96.15 – 96.38.

[612] *FNPRM*, 31 FCC Rcd at 8176-78, paras. 474-482.

[613] *FNPRM*, 31 FCC Rcd at 8176-78, paras. 474-482.

[614] *FNPRM*, 31 FCC Rcd at 8176-78, paras. 474-482.

[615] *FNPRM*, 31 FCC Rcd at 8176-78, paras. 474-482.

224. The majority of commenters opposed the idea of any use-or-share mechanism.[616] Some claim that such a mechanism would introduce uncertainty into the regulatory environment of UMFUS bands.[617] Many commenters stated that a use-or-share regime would impede development or deployment in the UMFUS bands, by introducing uncertainty or risk.[618] Samsung maintained that a use-or-share regime would be too burdensome on licensees.[619] Intel also suggested that no operators would be interested in spectrum shared under these conditions, as there is already a 14 GHz band of unlicensed spectrum at 57-71 GHz.[620]

225. Starry, Federated Wireless and Public Knowledge/OTI support use-or-share requirements because they believe it supports opportunistic use of the spectrum and allows more efficient use of spectrum without limiting any rights of incumbent licensees.[621] SIA favored a use-or-share regime that allowed only satellite operators to take advantage of the resulting shared spectrum.[622] O3b proposed that non-satellite users of shared spectrum "should be required both to complete coordination [with UMFUS and FSS licensees] before construction and to continue to protect the higher status UMFUS and FSS licensees after construction."[623] Both SIA and O3b argued that adopting an opportunistic sharing system limited to satellite operators would increase efficient use of the spectrum.[624]

226. *Discussion.* We decline to adopt any use or share regime for any of the Part 30 bands at this time.[625] Given the general opposition among commenters and only one terrestrial provider expressing an interest in participating in a use-or-share regime themselves, we conclude that any demand for such a regime is greatly outweighed by its potential to discourage investment and delay deployment in these bands.[626]

227. In particular, administering the shared areas would be overly burdensome, whether that burden fell on the Commission, the licensee, or the incoming shared users. We note the burden would be particularly high in mmW bands, given the very large number of possible deployments due to the limited

[616] 5G Americas Comments at 15-23; CCA Comments at 6, CTIA Comments at 19; Ericsson Comments at 19-20; Intel Comments at 16-21; NSMA Comments at 5; Qualcomm Comments at 15-16; Straight Path Comments at 8-10; T-Mobile Comments at 24-25; AT&T Reply Comments at 19-20; Nextlink Reply Comments at 19-23; Samsung Reply Comments at 7; Sprint Reply Comments at 5; TIA Reply Comments at 3-4.

[617] Qualcomm Comments at 15-16; Straight Path Reply Comments at 22-24; US Cellular Reply Comments at 17.

[618] 5G Americas Comments at 15-23; CCA Comments at 6; CTIA Comments at 19; Ericsson Comments at 19-20; Nextlink Comments at 22-28; Qualcomm Comments at 15-16; AT&T Reply at 19-20; Samsung Reply Comments at 7; Straight Path Reply Comments at 22-24; TIA Reply Comments at 3-4; T-Mobile Reply Comments at 22; Verizon Reply Comments at 2.

[619] Samsung Reply at 7.

[620] Intel Comments at 16-21.

[621] Starry Comments at 5; Federated Wireless Comments at 11-12; Public Knowledge/OTI Comments at 17-19.

[622] SIA Comments at 16-19.

[623] O3b Comments at 17. Because there seems to be some confusion on this point, we note for clarification that any hypothetical opportunistic users of shared spectrum would also be operating an UMFUS service, in accordance with UMFUS regulatory and technical rules. If we adopted a use-or-share regime, we would change or add to the UMFUS rules to encompass such opportunistic use. Those users would not be traditional licensees, but they would not be operating "non-UMFUS/non-FSS services," as O3b describes them.

[624] SIA Comments at 16-19, O3b Comments at 12-16.

[625] This section only addresses use-or-share between non-Federal licensees. Our decision here does not limit or prejudge any actions we may take concerning sharing mechanisms with Federal users in shared bands.

[626] Because we do not adopt any use-or-share regime or mechanism, we do not address the issue of whether such a mechanism should replace traditional performance requirements or add to them.

propagation in these bands. Moreover, potential business models in these bands might not necessarily blanket large portions of the geography or population in the licensed areas during the initial term. Some commenters indicated cautious support for a use-or-share mechanism that would enable the licensee to "claw back" previously-shared spectrum if their future expansion required it,[627] but such clawing back would be difficult in practical terms, and would necessarily cause disruption to the operations of the shared users, potentially including customers among the public.[628] Any SAS we adopted to administer this system would face all the challenges we have discussed in other contexts, including difficulty defining appropriate terms and equitably distributing the cost of establishing and maintaining it.[629] We would also be risking significant delays in deployment of mmW networks during the time required to address these concerns.[630]

228. Discouraging investment is also a serious consideration. A prospective licensee purchases rights to a defined area, subject to a defined license term with defined buildout requirements at the end of it, which are calculated to be reasonably achievable within that timeframe. Prospective licensees plan their auction bids with these specifications in mind. A use-or-share regime divorced from buildout requirements, which opened up the entire portion of the license area not in actual use by the licensee on some date, would undermine this system and introduce uncertainty and instability into the auction process. Given the record on this issue, we find that imposing a use-or-share regime at this time would discourage investment.[631] We believe our concerns are particularly relevant in these bands given the nascent state of technology and the potential scale and cost of deployments.

229. Given the well-documented challenges that would accompany the adoption of a use-or-share regime, we would need a clear showing of benefits from a use-or-share regime in order to adopt such a regime. No such showing has been made here. In the 3.5 GHz band, the Part 96 SAS-based system provides a form of use-or-share. The UMFUS bands that we have established so far generally do not have similar incumbent or Federal coordination issues.[632] Although some commenters argue that use-or-share would increase the efficiency of spectrum use in UMFUS bands,[633] any such increase would require both entities willing and able to take advantage of such a regime, and a mechanism to be in place, while also preserving licensees' rights.

230. The difficulty of crafting such a balanced mechanism is discussed above. In the matter of willing entities, we note that there is only one terrestrial operator on the record as supporting use-or-share;[634] all others who commented are opposed.[635] With regard to the comments from Inmarsat and O3b, we do not believe that a use-or-share regime that is useful only to the satellite industry, at the cost of complicating terrestrial deployment, is in the public interest. The use-or-share concept was proposed as a way to encourage additional *flexible* use of the UMFUS bands. That goal certainly encompasses

[627] NSMA Comments at 5.

[628] T-Mobile Reply at 20.

[629] *See, e.g., supra* Section III.A.1.b (Licensing the 24 GHz Band).

[630] US Cellular Reply at 17.

[631] 5G Americas Comments at 18-19; CCA Comments at 6; CTIA Comments at 19; Ericsson Comments at 19-20; Nextlink Comments at 23-25; Qualcomm Comments at 15-16; AT&T Reply Comments at 19-20; T-Mobile Reply Comments at 22; Verizon Reply Comments at 2.

[632] With the exception of the 37 GHz band, for which sharing with Federal users will be addressed in a future phase of this proceeding.

[633] Starry Comments at 5, OTI/PK Reply at 7-16.

[634] Starry Comments at 5.

[635] CCA Comments at 6, CTIA Comments at 19, Nextlink Comments at 22-28, T-Mobile Comments at 24-25, Sprint Reply at 16-17, Straight Path Reply at 22-24, AT&T Reply at 19-20.

additional sharing opportunities for satellite operators, but not to the extent that it impedes terrestrial deployment. Sharing mechanisms that will allow satellite operators to coexist with terrestrial licensees in the UMFUS bands have already been established, and will continue to be refined.

231. We also reject O3b's argument that a use-or-share regime is required by the Communications Act.[636] The Communications Act requires us to "include performance requirements, such as appropriate deadlines and penalties for performance failures, to ensure prompt delivery of service to rural areas, to prevent stockpiling or warehousing of spectrum by licensees or permittees, and to promote investment in and rapid deployment of new technologies and services."[637] We have, in fact, included performance requirements in our regulations for the new UMFUS bands.[638] Those requirements include appropriate deadlines and penalties for performance failures.[639] We have promulgated similarly-structured requirements in other bands and services. We have designed the current performance requirements for UMFUS to balance encouraging deployment of potentially novel services with ensuring accountability in terms of actually providing service, and we are satisfied that our requirements meet the requirements of the Communications Act.

232. Wi-Fi Alliance and Intel both suggested that given the difficulties of implementing a use-or-share regime, the best alternative to exclusive geographic area licensing is unlicensed spectrum.[640] We agree. Unlicensed spectrum provides the low barriers to entry that can encourage innovative business models, while not undermining the substantial investments of which more established operators are capable. Given that the Commission has already made available a full 14 gigahertz of unlicensed spectrum in the mmW bands, we do not believe that it is in the public interest to complicate terrestrial deployment in the UMFUS bands.

G. Digital Station Identification

233. *Background*. In the *FNPRM*, the Commission invited comment on whether we should require millimeter wave licensees or operators to transmit digital identifiers (*e.g.*, call signs) in a readily observable and decipherable manner in order to make it easier for the Commission or other parties to locate sources of interference to millimeter wave band operations.[641] In addition, the Commission sought comment on the details of a digital station identification (digital ID) requirement in the event it adopts such a requirement.[642]

234. The record on this issue is generally opposed to the Commission adopting a digital ID requirement, with some commenters focusing broadly on the idea of such a requirement, while other commenters focusing on whether a specific format would be required for a digital ID. A number of parties state that cellular and broadband Personal Communications Service (PCS) licensees are not required to transmit IDs, and contend that this has not caused problems in finding interfering signals.[643] T-Mobile and Samsung assert that a digital ID requirement is particularly unnecessary in services in which there is only one licensee authorized in a geographic area, because there would be only one licensee in a given area using the spectrum at issue.[644] Verizon and AT&T question whether the costs of

[636] O3b Comments at 12-16.

[637] 47 U.S.C. § 309(j)(4)(B).

[638] 47 CFR § 30.104.

[639] 47 CFR § 30.104(d).

[640] Intel Comments at 16-21, Wi-Fi Alliance Reply at 5.

[641] *FNPRM*, 31 FCC Rcd at 8183-84, para. 503.

[642] *FNPRM*, 31 FCC Rcd at 8184, para. 504.

[643] Ericsson Comments at 21; Samsung Comments at 7; AT&T Reply at 14; Samsung Reply at 13.

[644] T-Mobile Comments at 30; Samsung Comments at 7; Samsung Reply at 13.

developing a specific identification protocol would outweigh the benefits of such a protocol.[645] AT&T and T-Mobile further argue that a digital ID requirement generally is unnecessary.[646] Verizon, however, states that requiring unlicensed users and users in sharing regimes to transmit a digital ID could allow such users to be efficiently identified if they cause interference to licensed users.[647]

235. Several parties specifically oppose the Commission requiring a specific format for a digital ID. T-Mobile and Samsung maintain generally that mandating a particular format could limit innovation in the millimeter wave bands.[648] Ericsson and Samsung note that any standards-based mobile network will transmit identifying information as part of the data stream, and asserts that the Commission's digital ID proposal is an unnecessary intrusion into the standards-setting process.[649] Although Starry opposes the Commission mandating a particular type of announcement ID or beacon, it supports requiring operators to provide some kind of announcement ID.[650]

236. Finally, TIA and AT&T are concerned that a digital ID requirement could increase power requirements, and thereby impede development of applications using low-duty-cycle devices.[651]

237. *Discussion.* We decline to require mmW band licensees or operators to transmit digital identifiers. The record provides insufficient support for the adoption of digital ID requirements for these mmW bands, particularly if we were to specify a particular format. In particular, commenters have pointed out that treatment of interference in these mmW bands would differ from how the Commission handles similar issues in most other wireless bands if the Commission were to require transmission of digital ID.[652] We observe that characteristics of the mmW bands at issue in the *Report and Order* and in this *Second Report and Order* make the occurrence of interference less likely in the first instance, relative to other bands.[653] Licensees and operators in the bands being authorized generally will use short-distance transmissions, creating more potential for spectrum reuse by multiple licensees in one area and generally limiting the location of an interfering party to a relatively small area. Further, "pencil-beam" signal characteristics and other technologies being developed specifically for these bands should also make it easier for operations to co-exist in the same vicinity without causing interference to one another. We acknowledge the important role of the agency in identifying and locating devices that cause harmful interference, but we find that it is unnecessary and unsupported in the case of these mmW bands to adopt

[645] Verizon Comments at 10; AT&T Reply at 14.

[646] AT&T Reply at 13-14; T-Mobile Reply at 32-33; *see also* Qualcomm *Ex Parte* Statement of June 5, 2017 (asserting "that that there are commercially available apps that can be used to obtain base station identifiers for 4G services and should also provide base station identifiers for future 5G services").

[647] Verizon Comments at 10.

[648] T-Mobile Comments at 30; Samsung Reply Comments at 13.

[649] Ericsson Comments at 21; Samsung Reply Comments at 13; *see also* TIA Comments at 22 (standards bodies are better positioned to address digital ID issue).

[650] Starry Comments at 6.

[651] TIA Comments at 21; AT&T Reply Comments at 13-14.

[652] *See* Ericsson Comments at 21; AT&T Reply Comments at 13; Samsung Reply Comments at 13

[653] In other instances, when evaluating whether an identification requirement is necessary to detect and resolve interference, the Commission has assessed the likelihood of interference in the first instance. *See* Revision of Part 15 of the Commission's Rules Regarding Operation in the 57-64 GHz Band, 28 FCC Rcd 12517, 12534, para. 43 (2013) (modifying Part 15 rules to eliminate a transmitter ID requirement for all devices operating in the 57-64 GHz band); Revision of Part 15 of the Commission's Rules to Permit Unlicensed National Information Infrastructure (U-NII) Devices in the 5 GHz Band, 29 FCC Rcd 4127, 4144-45para. 60 (2014) (declining to require Unlicensed National Information Infrastructure (U-NII) devices in the 5.15-5.35 GHz and 5.47-5.850 GHz bands to transmit identifying information).

a digital ID requirement.

H. Technical Issues

1. Antenna Height

238. *Background*. In the *FNPRM*, the Commission sought comment on adopting antenna height and power limits similar to those in our Part 27 rules. It noted that based on the record, mmW base stations in this band may likely be deployed at street lamp post height rather than at the heights of traditional mobile base station deployments. In light of this, the Commission sought comment on whether the 305 meter threshold in Part 27 was valid. The Commission also asked whether power limits based on antenna height are necessary and/or whether any modifications should be made to either the height thresholds or the power limits at specific heights that it had proposed. The Commission also asked whether antenna height restrictions and corresponding power reductions were necessary given the existing PFD limits that were adopted to control interference at market boundaries and at the edge of earth station contours. Finally, the Commission also sought comment on whether requiring antenna downtilt for antennas above a certain height would be beneficial.[654]

239. Several commenters argue that antenna restrictions and corresponding reductions in power are unnecessary. 5G Americas contends that licensees should be permitted to work together to coordinate the height of facilities, beam tilt and angular discrimination as needed to protect multiple licensees in the same market, and meet the power levels at a given border to protect adjacent service areas.[655] 5G Americas and Qualcomm note that these bands may be used for backhaul, which requires line of sight typically well above street level facilities. 5G Americas and Qualcomm also argue that PFD limits at the market boundaries are sufficient to prevent interference between licensees and therefore additional antenna height thresholds and corresponding power reductions should not be mandated.[656] They believe antenna beam tilt or lower heights should not be mandated, but instead be a tool used by operators to meet the power level at a given border.[657] Ericsson maintains that antenna downtilt should not be mandated because experienced system designers and operators already use downtilt where it is needed.[658]

240. In contrast, Samsung and T-Mobile support the Commission's proposal to adopt antenna height and power limits. They claim that it would be consistent with how other wireless technology services are regulated, with base station transmit power reduced for antenna heights above 305 meters.[659] Boeing argues that the proposed antenna height and EIRP limits are appropriate particularly given the increased likelihood of clear line of sight conditions as the base station tower height increases.[660] Starry in general supports the proposed rules, but advocates for specific language to be added to the rules to account for the variations in technical characteristics between mmWave and low band spectrum.[661]

241. *Discussion*. Based on the record, we decline to adopt antenna height limits. We agree with 5G Americas and Qualcomm that there may be uses in these bands that could require higher antenna heights. We also agree that licensees are in the best position to determine their network configuration and when antenna downtilt is necessary. We find that the comments in support of adopting antenna height

[654] *FNPRM*, 31 FCC Rcd at 8184, para. 506.

[655] 5G Americas Comments at 24.

[656] 5G Americas Comments at 23-24; Qualcomm Comments at 14-15.

[657] 5G Americas Comments at 23-24; Qualcomm Comments at 14-15.

[658] Ericsson Comments at 20.

[659] Samsung Comments at 6; T-Mobile Comments at 31.

[660] Boeing Comments at 45.

[661] Starry Comments at 7.

limits and corresponding power reductions have failed to demonstrate that limits are necessary to avoid interference. The supporters of antenna height limits have not provided any engineering analysis or examples of deployments supporting the need for antenna height limits. In the absence of a clear showing that antenna and power limits are necessary, we believe that we should minimize regulatory burdens and maximize flexibility for licensees to deploy diverse systems and to coordinate with adjacent licensees to avoid interference.

242. While Samsung and T-Mobile argue that adopting antenna height restrictions would be consistent with how other wireless technology services are regulated, antenna height limits do not apply to all Part 27 radio services. For instance, the 305 meter threshold limitation does not apply to the Advanced Wireless Services (AWS), the Broadband Radio Service (BRS), or the Educational Broadband Service (EBS).[662] We also note that antenna height thresholds and corresponding power reductions primarily apply to lower frequency bands,[663] while higher frequency bands generally do not have such limits.

243. We agree with Boeing that there is an increased likelihood of clear line of sight conditions as the base station tower height increases. As 5G Americas and Qualcomm note, however, service providers also may operate facilities in these bands that require line of sight operations hundreds of meters above ground level.[664] We do not want to adopt rules that would unnecessarily restrict licensee's flexibility to deploy diverse systems. Further, as 5G Americas notes, licensees can work together coordinating height of facilities, beam tilt and angular discrimination as needed to protect each other in the same market, and meet the power levels at a given border to protect adjacent service.[665] In the absence of clear evidence that PFD limits and licensee to licensee coordination are insufficient to prevent interference, we conclude that additional regulatory requirements are not necessary.

244. Finally, while Starry asks that specific language be added to Part 27 rules to account for the variations in technical characteristics between mmWave and low band spectrum, it has not provided sufficient detail or an explanation of what this proposed language should include. For the reasons noted above, we decline to adopt antenna height thresholds and corresponding power reductions.

2. Coordination Criteria at Market Borders for Fixed Point-to-Point Operations

245. *Background.* Under the existing rules, fixed point-to-point operations within 16 kilometers (in the 39 GHz band) or 20 kilometers (in the 28 GHz band) of a licensee's market boundary must coordinate with co-channel licensees in adjacent market areas.[666] This rule adopted the same coordination criteria that applied in the former Part 101 rules applicable to those bands.[667] With the change to smaller licensed areas (counties for 28 GHz, PEAs for 39 GHz), the Commission recognized that the existing rule could result in coordination zones that encompass a large part of many license areas. It believed that the change to smaller market sizes might warrant re-examination of the market boundary coordination requirements. The Commission therefore sought comment on whether the existing coordination distances for traditional fixed point-to-point operations were still appropriate given the smaller market area sizes and whether the coordination distance should incorporate other technical criteria into factoring the distance (for example, antenna orientation). The Commission requested that

[662] *See* 47 CFR § 27.50(d), (h).

[663] *See* 47 CFR § 27.50(b), (c).

[664] See 5G Americas Comments at 23-24; Qualcomm Comments at 14.

[665] 5G Americas Comments at 24.

[666] 47 CFR § 30.204(d).

[667] 47 CFR §§ 101.103(g), (i) (2016).

commenters support any proposal with technical analysis.[668]

246. Few commenters addressed this issue. T-Mobile recommends that the Commission retain the existing Part 101 requirements for traditional point-to point deployments and argues that the existing rules generally have been effective and should protect adjacent area mobile operations as well as fixed operations.[669] Nextlink and Starry, on the other hand, support changes to the criteria. Nextlink contends that the current coordination distances that apply under the Commission's rules are incongruent with county-based licensing and urges the Commission to adopt alternatives to the existing coordination distances for fixed point-to-point operations.[670] Nextlink proposes that the Commission should consider the orientation and power of links, in addition to distance, when setting coordination distances criteria. Nextlink suggests finding the path loss at 20 kilometers using free space path loss and setting 20 kilometers as the coordination distance in the direction of the antenna's maximum gain. Nextlink proposes the free space path loss formula could be used to calculate applicable coordination distances in all directions based on the antenna's horizontal pattern to develop a coordination zone. If the calculated zone intersects another market, then the licensee would need to coordinate the station with the licensee in that neighboring market. Nextlink suggests that calculating the distances at 360 points—one for each degree around the station—would be relatively trivial and would produce a coordination zone that more realistically represents the possibility that the station could cause interference to stations in a neighboring market.[671]

247. Starry believes the existing coordination distances for traditional fixed point-to-point operations are no longer appropriate given the smaller market area sizes and should be reduced.[672] Starry proposes establishing a contour zone at 50 meters height above average ground level for traditional fixed point-to-point operations. Starry contends that contours are a more sophisticated and comprehensive approach that takes into account the technological diversity that may exist in a band. Starry states that establishing a distance threshold is no longer sufficient to support a wide-variety of uses in a single band given that a variety of system types and usages are likely to exist.[673]

248. *Discussion*. We decline to revise the coordination criteria for point-to-point operations. While we appreciate Nextlink's and Starry's efforts to develop alternative coordination criteria, no party has identified any concrete defect or problem with the existing coordination criteria. While it is true that we have established smaller license areas in these bands, no showing has been made that changes in coordination criteria are needed to accommodate those smaller license areas. Indeed, T-Mobile believes the existing criteria work well. Furthermore, under Nextlink's and Starry's proposals, applicants would have to conduct an engineering analysis in order to determine whether a link needed to be coordinated. We do not believe the benefit of having to avoid coordination in certain circumstances justifies requiring applicants to do an engineering analysis to identify whether links require coordination. The existing rules provide clear standards that licensees can readily apply to determine when coordination is needed.

249. Another problem with the Nextlink and Starry proposals is that they are not supported by the technical analysis requested in the *FNPRM*. Starry's proposal lacks specific details as to how the contour zone would be calculated, what protection threshold would be provided within the contour zone, or how the 50 meter height was derived. Because of the lack of details in Starry's proposal, we are not able to determine whether it would adequately mitigate interference and therefore cannot adopt it. Nextlink's proposal, while more developed than Starry's, also was not supported with technical analysis

[668] *FNPRM*, 31 FCC Rcd at 8185-86, para. 510.

[669] T-Mobile Comments at 32.

[670] Nextlink Comments at 30-31.

[671] Nextlink Comments at 30-31.

[672] Starry Comments at 7.

[673] Starry Comments at 7.

that describes how their method would ensure adequate mitigation of interference between adjacent area licensees. Specifically, Nextlink's methodology appears to assume that the signal level produced by a transmitter operating at maximum EIRP oriented directly at the market border, taking into account free space loss at 20 km, will not cause interference to adjacent licensees. This may not be the case. Given the lack of technical analysis and the failure to demonstrate a need for revised criteria, we conclude that retaining the existing coordination criteria at market borders for fixed point-to-point operations is most appropriate.

3. Minimum Bandwidth for Given BS/MS/Transportable Transmit Power Levels

a. Bandwidth Scaling

250. *Background.* In the *Report and Order*, the Commission adopted a limit on the average power transmitted by a base station of 75 dBm/100 megahertz with the power limit scaled proportionally and linearly for bandwidths of less than 100 MHz.[674] For mobile stations and transportable stations, the Commission adopted average transmitted power limits of 43 dBm and 55 dBm, respectively, with no scaling depending on the signal bandwidth.[675] More specifically, the Commission sought comment on establishing bandwidth scaling limits for mobile and transportable classes, as the Commission previously has done for base stations, and on the minimum bandwidth for these classes of equipment based on the power levels adopted in the *R&O*.[676]

251. Commenters disagree on this issue. Boeing, Samsung, and T-Mobile support establishing bandwidth scaling limits for mobile and transportable classes. Boeing urges the Commission to revise the language of the *R&O* to mandate a maximum EIRP *density* of 43 dBm/100 megahertz for mobile stations, and 55 dBm/100 megahertz for transportables. Boeing argues that such a revision would limit interference among the UMFUS providers and all other services using these bands. Boeing supports higher power density transmission for indoor-only applications, however, to combat fading due to interior wall penetration conditions.[677] Samsung and T-Mobile support the same bandwidth scaling limits that were adopted for base stations.[678]

252. Nextlink and Qualcomm oppose scaling limits.[679] Nextlink urges regulatory flexibility. Nextlink contends that 5G technology is nascent and establishing power scaling factors based on bandwidth for transportable and mobile stations could inadvertently preclude some use cases that are not yet developed, as well as some that are already envisioned.[680] Qualcomm argues that bandwidth scaling limit should not be adopted so that the 3GPP standards body can continue to study whether 5G millimeter wave equipment would benefit from such flexibility. Qualcomm further states that imposing such bandwidth scaling limits at this time would override the standards process unnecessarily and constrain equipment design flexibility by lowering currently permissible transmit power levels for next generation devices that operate using less bandwidth.[681]

253. *Discussion*. At this time, we maintain our current power limit rules for mobile and transportable classes without scaling. While we recognize that power scaling can potentially help limit

[674] 47 CFR § 30.202(a); *R&O*, 31 FCC Rcd at 8108, para. 270.

[675] 47 CFR § 30.202(b),(c); *R&O*, 31 FCC Rcd at 8112, 8114, paras. 286,

[676] *FNPRM*, FCC Rcd at 8185, para. 507.

[677] Boeing Comments at 45-47.

[678] Samsung Comments at 6-7; T-Mobile Comments at 31.

[679] Nextlink Reply Comments at 30-31; Qualcomm Reply Comments at 7.

[680] Nextlink Reply Comments at 30-31.

[681] Qualcomm Reply Comments at 7.

interference among UMFUS providers and other services using these bands, we also recognize that there are other methods that can help limit interference, such as power control. Furthermore, UMFUS providers have an incentive to maintain a balanced power spectral density among all their network components if they wish to avoid interference within their own networks. We agree with Nextlink and Qualcomm that at this nascent stage of 5G technological development establishing power scaling factors could inadvertently preclude some yet-to-be-developed use cases and prematurely constrain development of the next generation of devices.

b. Minimum Bandwidth

254. *Background*. In the *FNPRM*, the Commission sought comment on establishing a minimum bandwidth requirement for base stations, transportable stations, and mobile stations.[682] Specifically, the Commission sought comment on networks that might operate with bandwidths less than 100 megahertz for applications and technologies that function under the umbrella of the next generation of wireless networks.[683] We received few comments on this topic. T-Mobile and Nextlink state that to avoid hampering future developments, the Commission should not specify a minimum bandwidth for base stations, transportable devices, and mobile devices.[684] Starry argues that the Commission should specify bandwidths of 20 megahertz or greater, because channel sizes of less than 20 megahertz are not feasible given the frequency stability of commonly derived local oscillators.[685]

255. *Discussion*. We decline to establish a minimum bandwidth requirement because there is no need for such a requirement and establishing such a requirement could accidentally preclude uses of this spectrum. These bands can facilitate data exchange for a great number of devices embedded with electronics, software, sensors, and actuators (*e.g.*, IoT). Different types of devices may have significantly different bandwidth requirements. For example, a utility meter that exchanges data on monthly or even daily bases requires far less bandwidth than a live video streaming device monitoring an intersection. Given the early stage of 5G technological development, we choose not to impose a regulatory requirement and provide equipment developers with flexibility to design equipment to meet market needs. Consequently, we will not adopt a minimum bandwidth for UMFUS devices.

4. Sharing Analysis and Modeling

256. *Background*. Industry, standards groups, government organizations and academia are engaged in on-going development of propagation models and deployment scenarios for millimeter wave bands. In the *FNPRM*, the Commission asked for comment on appropriate propagation models to apply when analyzing inter-service interference between terrestrial millimeter wave systems. The Commission asked for comment on which millimeter wave propagation models are most appropriate for sharing analyses where the interfering emitters may be assembled from a group of indoor and outdoor emitters, and it asked interested parties to submit propagation analyses and path loss models for both indoor and outdoor environments. The Commission also asked specifically about the Alpha-Beta-Gamma (ABG) and Close-in (CI) models for use in inter-service interference analyses and about the application of statistical probability to interference versus worse case assumptions.[686]

257. Commenters generally agree that the ABG and CI models are appropriate for intra-system analysis.[687] However, inter-system studies such as those that would need to be undertaken to

[682] *FNPRM*, 31 FCC Rcd at 8185, paras. 507-08.

[683] *FNPRM*, FCC Rcd at 8185, para. 507.

[684] T-Mobile Comments at 31; Nextlink Reply Comments at 30-31.

[685] Starry Comments at 7.

[686] *FNPRM*, 31 FCC Rcd at 8186, para. 512.

[687] Boeing Comments at 52; Ericsson Comments, Appendix A at A-1; Nokia Comments at 21.

determine the extent of potential interference between different spectrum users, require propagation models that are appropriate over longer distances and that account for clutter and other environmental factors.[688] Several commenters point to the work of International Telecommunications Union (ITU) Study Group 3 in developing or updating propagation models for use in the millimeter wave bands,[689] including the collection of measurement data in support of updated clutter loss and Building Entry Loss models.[690] 5G Americas points out that the ongoing modeling efforts in 3GPP, 5GPPP, NIST and others are focused on channel models and intra-system characteristics and would not be appropriate for inter-system interference at larger distances.[691] Generally, commenters supported inter-system interference models that address the increased statistical variability of interference due to highly directional smart antennas and cluttered environments. Nokia points out that short range models such as CI and ABG do not provide time percentages for which a given propagation loss is not exceeded.[692] Starry asks the Commission "continue to remain open-minded and flexible in developing its assumptions on the performance and interference issues posed by these bands."[693]

258. *Discussion*. We will remain flexible with respect to the appropriate propagation model to apply when analyzing sharing in the millimeter wave bands. As many commenters pointed out, the appropriate sharing model at millimeter wave frequencies will depend on the particular sharing environment, including whether the interference path is terrestrial, air-to-ground or space-to-ground, as well as the technologies deployed. As a general principle, we concur with the commenters who support models and scenarios that consider a statistical probability of interference based on deployment, propagation, and usage scenarios as opposed to a worse case approach.

VII. PROCEDURAL MATTERS

A. *Ex Parte* Rules – Permit-But-Disclose

259. Pursuant to Section 1.1200(a) of the Commission's rules,[694] this *Second FNPRM* shall be treated as a "permit-but-disclose" proceeding in accordance with the Commission's *ex parte* rules.[695] Persons making *ex parte* presentations must file a copy of any written presentation or a memorandum summarizing any oral presentation within two business days after the presentation (unless a different deadline applicable to the Sunshine period applies). Persons making oral *ex parte* presentations are reminded that memoranda summarizing the presentation must (1) list all persons attending or otherwise participating in the meeting at which the *ex parte* presentation was made, and (2) summarize all data presented and arguments made during the presentation. If the presentation consisted in whole or in part of the presentation of data or arguments already reflected in the presenter's written comments, memoranda or other filings in the proceeding, the presenter may provide citations to such data or arguments in his or her prior comments, memoranda, or other filings (specifying the relevant page and/or paragraph numbers where such data or arguments can be found) in lieu of summarizing them in the memorandum. Documents shown or given to Commission staff during *ex parte* meetings are deemed to be written *ex parte* presentations and must be filed consistent with rule 1.1206(b). In proceedings governed by rule 1.49(f) or for which the Commission has made available a method of electronic filing, written *ex parte* presentations and memoranda summarizing oral *ex parte* presentations, and all attachments thereto, must be filed through the electronic comment filing system available for that proceeding, and must be filed in

[688] Ericsson Comments, Appendix A at A-1; Nokia Comments at 21.

[689] 5G Americas Comments at 25; Ericsson Comments, Appendix A at A-1-A-2; Nokia Comments at 22.

[690] 5G Americas Comments at 26; Nokia Comments at 22; Ericsson Comments, Appendix A at A-3.

[691] 5G Americas Comments at 27.

[692] Nokia Comments at 21.

[693] Starry Comments at 7.

[694] 47 CFR § 1.1200(a).

[695] 47 CFR §§ 1.1200 *et seq.*

their native format (e.g., .doc, .xml, .ppt, searchable .pdf). Participants in this proceeding should familiarize themselves with the Commission's *ex parte* rules.

B. Comment Period and Procedures

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

- Electronic Filers: Comments may be filed electronically using the Internet by accessing the ECFS: http://fjallfoss.fcc.gov/ecfs2/.

- Paper Filers: Parties who choose to file by paper must file an original and one copy of each filing. If more than one docket or rulemaking number appears in the caption of this proceeding, filers must submit two additional copies for each additional docket or rulemaking number.

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

  - All hand-delivered or messenger-delivered paper filings for the Commission's Secretary must be delivered to FCC Headquarters at 445 12th St., SW, Room TW-A325, Washington, DC 20554. The filing hours are 8:00 a.m. to 7:00 p.m. All hand deliveries must be held together with rubber bands or fasteners. Any envelopes and boxes must be disposed of before entering the building.

  - Commercial overnight mail (other than U.S. Postal Service Express Mail and Priority Mail) must be sent to 9050 Junction Drive, Annapolis Junction, MD 20701.

  - U.S. Postal Service first-class, Express, and Priority mail must be addressed to 445 12th Street, SW, Washington DC 20554.

261. 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).

C. Regulatory Flexibility Analysis

262. As required by the Regulatory Flexibility Act of 1980 (RFA),[696] the Commission has prepared a Final Regulatory Flexibility Analysis (FRFA) and a Supplementary Final Regulatory Flexibility Analysis (Supplemental FRFA) of the possible significant economic impact on small entities of the policies and rules adopted in the *Second Report and Order and Order on Reconsideration*. The analysis associated with the policies and rules in *Second Report and Order* are contained in the FRFA found in Appendix C, and the Supplemental FRFA in Appendix D contains the analysis associated with the policies and rules in *Order on Reconsideration*.

263. In addition, we have prepared an Initial Regulatory Flexibility Analysis (IRFA) regarding the significant economic impact on small entities of the policies and rules adopted in the *Second Further Notice of Proposed Rulemaking*, which is found in Appendix F. We request written public comment on the IRFA. Comments must be filed in accordance with the same deadlines as comments filed in response to the *2nd FNRPM* and must have a separate and distinct heading designating them as responses to the IRFA.

[696] *See* 5 U.S.C. § 603.

D. Paperwork Reduction Analysis

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

E. Further Information

265. For further information, contact John Schauble of the Wireless Telecommunications Bureau, Broadband Division, at 202-418-0797 or John.Schauble@fcc.gov, Michael Ha of the Office of Engineering and Technology, Policy and Rules Division, at 202-418-2099 or Michael.Ha@fcc.gov, or Jose Albuquerque of the International Bureau, Satellite Division, at 202-418-2288 or Jose.Albuquerque@fcc.gov.

VIII. ORDERING CLAUSES

266. IT IS ORDERED, pursuant to the authority found in Sections 1, 2, 3, 4, 5, 7, 301, 302, 302a, 303, 304, 307, 309, and 310of the Communications Act of 1934, 47 U.S.C. §§ 151, 152, 153, 154, 155, 157, 301, 302, 302a, 303, 304, 307, 309, and 310, Section 706 of the Telecommunications Act of 1996, as amended, 47 U.S.C. § 1302, and Section 1.411 of the Commission's Rules, 47 C.F.R § 1.411, that this *Second Report and Order, Second Further Notice of Proposed Rulemaking, Order on Reconsideration, and Memorandum Opinion and Order* IS HEREBY ADOPTED.

267. IT IS FURTHER ORDERED that the Commission's rules ARE HEREBY AMENDED as set forth in Appendix A.

268. IT IS FURTHER ORDERED that the rules adopted herein WILL BECOME EFFECTIVE 30 days after the date of publication in the *Federal Register*, except for those rules and requirements which contain new or modified information collection requirements that require approval by the Office of Management and Budget under the Paperwork Reduction Act and WILL BECOME EFFECTIVE after the Commission publishes a notice in the *Federal Register* announcing such approval and the relevant effective date.

269. IT IS FURTHER ORDERED that the petitions for reconsideration listed in Appendix E ARE GRANTED to the extent indicated and are otherwise DENIED.

270. IT IS FURTHER ORDERED that the Commission's Consumer and Governmental Affairs Bureau, Reference Information Center, SHALL SEND a copy of this *Second Report and Order, Second Further Notice of Proposed Rulemaking, Order on Reconsideration, and Memorandum Opinion and Order*, including the Final, Supplemental Final, and Initial Regulatory Flexibility Analysis, to the Chief Counsel for Advocacy of the Small Business Administration.

271. IT IS FURTHER ORDERED that the Commission SHALL SEND a copy of this Report and Order 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 discussed in the preamble, the Federal Communications Commission amends 47 CFR parts 1, 2, 15, 25, 30, and 101 as follows:

PART 1—PRACTICE AND PROCEDURE

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

Authority: 47 U.S.C. 151, 154(i), 154(j), 155, 157, 160, 201, 225, 227, 303, 309, 332, 1403, 1404, 1451, 1452, and 1455.

2. Section 1.901 is revised to read as follows:

§ 1.901 Basis and Purpose.

The rules in this subpart are issued pursuant to the Communications Act of 1934, as amended, 47 U.S.C. 151 *et seq.* The purpose of the rules in this subpart is to establish the requirements and conditions under which entities may be licensed in the Wireless Radio Services as described in this part and in parts 13, 20, 22, 24, 27, 30, 74, 80, 87, 90, 95, 96, 97, and 101 of this chapter.

3. Section 1.902 is revised to read as follows:

§ 1.902 Scope.

In case of any conflict between the rules set forth in this subpart and the rules set forth in parts 13, 20, 22, 24, 27, 30, 74, 80, 87, 90, 95, 96, 97, and 101 of title 47, chapter I of the Code of Federal Regulations, the rules in part 1 shall govern.

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

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

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

5. Section 2.106, the Table of Frequency Allocations, is amended as follows:

a. Pages 54 and 59 are revised.

b. In the list of non-Federal Government (NG) Footnotes, footnote NG65 is added.

§ 2.106 Table of Frequency Allocations.

The revisions and additions read as follows:

* * * * *

24-24.05 AMATEUR AMATEUR-SATELLITE 5.150			24-24.05 5.150 US211	24-24.05 AMATEUR AMATEUR-SATELLITE 5.150 US211	ISM Equipment (18) Amateur Radio (97)
24.05-24.25 RADIOLOCATION Amateur Earth exploration-satellite (active) 5.150			24.05-24.25 RADIOLOCATION G59 Earth exploration-satellite (active) 5.150	24.05-24.25 Amateur Earth exploration-satellite (active) Radiolocation 5.150	RF Devices (15) ISM Equipment (18) Private Land Mobile (90) Amateur Radio (97)
24.25-24.45 FIXED	24.25-24.45 RADIONAVIGATION	24.25-24.45 FIXED MOBILE RADIONAVIGATION	24.25-24.45	24.25-24.45 FIXED MOBILE	RF Devices (15) Upper Microwave Flexible Use (30)
24.45-24.65 FIXED INTER-SATELLITE	24.45-24.65 INTER-SATELLITE RADIONAVIGATION 5.533	24.45-24.65 FIXED INTER-SATELLITE MOBILE RADIONAVIGATION 5.533	24.45-24.65 INTER-SATELLITE RADIONAVIGATION 5.533		RF Devices (15) Satellite Communications (25)
24.65-24.75 FIXED FIXED-SATELLITE (Earth-to-space) 5.532B INTER-SATELLITE	24.65-24.75 INTER-SATELLITE RADIOLOCATION-SATELLITE (Earth-to-space)	24.65-24.75 FIXED FIXED-SATELLITE (Earth-to-space) 5.532B INTER-SATELLITE MOBILE 5.533	24.65-24.75 INTER-SATELLITE RADIOLOCATION-SATELLITE (Earth-to-space)		
24.75-25.25 FIXED FIXED-SATELLITE (Earth-to-space) 5.532B	24.75-25.25 FIXED-SATELLITE (Earth-to-space) 5.535	24.75-25.25 FIXED FIXED-SATELLITE (Earth-to-space) 5.535 MOBILE	24.75-25.25	24.75-25.25 FIXED FIXED-SATELLITE (Earth-to-space) NG535 MOBILE	RF Devices (15) Satellite Communications (25) Upper Microwave Flexible Use (30)
25.25-25.5 FIXED INTER-SATELLITE 5.536 MOBILE Standard frequency and time signal-satellite (Earth-to-space)			25.25-25.5 FIXED INTER-SATELLITE 5.536 MOBILE Standard frequency and time signal-satellite (Earth-to-space)	25.25-25.5 Inter-satellite 5.536 Standard frequency and time signal-satellite (Earth-to-space)	RF Devices (15)
25.5-27 EARTH EXPLORATION-SATELLITE (space-to-Earth) 5.536B FIXED INTER-SATELLITE 5.536 MOBILE SPACE RESEARCH (space-to-Earth) 5.536C Standard frequency and time signal-satellite (Earth-to-space) 5.536A			25.5-27 EARTH EXPLORATION-SATELLITE (space-to-Earth) FIXED INTER-SATELLITE 5.536 MOBILE SPACE RESEARCH (space-to-Earth) Standard frequency and time signal-satellite (Earth-to-space) 5.536A US258	25.5-27 SPACE RESEARCH (space-to-Earth) Inter-satellite 5.536 Standard frequency and time signal-satellite (Earth-to-space) 5.536A US258	Page 54

International Table			United States Table		FCC Rule Part(s)
Region 1 Table	Region 2 Table	Region 3 Table	Federal Table	Non-Federal Table	
(See previous page)			46.9-47 MOBILE MOBILE-SATELLITE (Earth-to-space) RADIONAVIGATION-SATELLITE 5.554	46.9-47 FIXED MOBILE MOBILE-SATELLITE (Earth-to-space) RADIONAVIGATION-SATELLITE 5.554	
47-47.2 AMATEUR AMATEUR-SATELLITE			47-48.2	47-47.2 AMATEUR AMATEUR-SATELLITE	Amateur Radio (97)
47.2-47.5 FIXED FIXED-SATELLITE (Earth-to-space) 5.552 MOBILE 5.552A				47.2-48.2 FIXED FIXED-SATELLITE (Earth-to-space) US297 NG65 MOBILE	Satellite Communications (25) Upper Microwave Flexible Use (30)
47.5-47.9 FIXED FIXED-SATELLITE (Earth-to-space) 5.552 (space-to-Earth) 5.516B 5.554A MOBILE	47.5-47.9 FIXED FIXED-SATELLITE (Earth-to-space) 5.552 MOBILE				
47.9-48.2 FIXED FIXED-SATELLITE (Earth-to-space) 5.552 MOBILE 5.552A					
48.2-48.54 FIXED FIXED-SATELLITE (Earth-to-space) 5.552 (space-to-Earth) 5.516B 5.554A 5.555B MOBILE	48.2-50.2 FIXED FIXED-SATELLITE (Earth-to-space) 5.338A 5.516B 5.552 MOBILE		48.2-50.2 FIXED FIXED-SATELLITE (Earth-to-space) US156 US297 MOBILE US264		Satellite Communications (25)
48.54-49.44 FIXED FIXED-SATELLITE (Earth-to-space) 5.552 MOBILE 5.149 5.340 5.555					
49.44-50.2 FIXED FIXED-SATELLITE (Earth-to-space) 5.338A 5.552 (space-to-Earth) 5.516B 5.554A 5.555B MOBILE	5.149 5.340 5.555		5.555 US342		
50.2-50.4 EARTH EXPLORATION-SATELLITE (passive) SPACE RESEARCH (passive) 5.340			50.2-50.4 EARTH EXPLORATION-SATELLITE (passive) SPACE RESEARCH (passive) US246		

* * * * *

NON-FEDERAL GOVERNMENT (NG) FOOTNOTES

* * * * *

NG65 Stations in the fixed and mobile services may not claim protection from individually licensed earth stations authorized pursuant to 47 C.F.R. 25.136. However, nothing in this footnote shall limit the right of UMFUS licensees to operate in conformance with the technical rules contained in 47 C.F.R. Part 30. The Commission reserves the right to monitor developments and to undertake further action concerning interference between UMFUS and FSS, including aggregate interference to satellite receivers, if appropriate.

* * * * *

PART 15 – RADIO FREQUENCY DEVICES

6. The authority citation for part 15 continues to read as follows:

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

7. Amend § 15.255 by revising paragraph (a)(1), adding new paragraph (b), and re-designating paragraphs (b) through (h) as paragraphs (c) through (i) to read as follows:

§ 15.255 Operation within the band 57-71 GHz.

(a) * * *

(1) Equipment used on satellites.

(2) * * *

(b) Operation on aircraft is permitted under the following conditions:

(1) when the aircraft is on the ground.

(2) while airborne, only in closed exclusive on-board communication networks within the aircraft,

* This document has been circulated for tentative consideration by the Commission at its November 16, 2017 open meeting. The issues referenced in this document and the Commission's ultimate resolution of those issues remain under consideration and subject to change. This document does not constitute any official action by the Commission. However, the Chairman has determined that, in the interest of promoting the public's ability to understand the nature and scope of issues under consideration, the public interest would be served by making this document publicly available. The FCC's *ex parte* rules apply and presentations are subject to "permit-but-disclose" *ex parte* rules. *See, e.g.*, 47 C.F.R. §§ 1.1206, 1.1200(a). Participants in this proceeding 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(a), 1.1203.

with the following exceptions:

(i) Equipment shall not be used in wireless avionics intra-communication (WAIC) applications where external structural sensors or external cameras are mounted on the outside of the aircraft structure.

(ii) Equipment shall not be used on aircraft where there is little attenuation of RF signals by the body/fuselage of the aircraft. These aircraft include, but are not limited to, toy/model aircraft, unmanned aircraft, crop-spraying aircraft, aerostats, etc.

* * * * *

PART 25 – SATELLITE COMMUNICATIONS

8. The authority citation for part 25 continues to read as follows:

Authority: Interprets or applies 47 U.S.C. 154, 301, 302, 303, 307, 309, 310, 319, 332, 605, and 721, unless otherwise noted.

9. Amend § 25.130 by revising paragraph (b) and the NOTE to paragraph (g) to read as follows:

§25.130 Filing requirements for transmitting earth stations.

* * * * *

(b)(1) Applicants for earth stations transmitting in frequency bands shared with equal rights between terrestrial and space services must provide a frequency coordination analysis in accordance with §25.203(b), and must include any notification or demonstration required by any other relevant provision in §25.203.

(2) Applicants for user transceiver units associated with the NVNG MSS must provide the information required by §25.135.

(3) Applicants for 1.6/2.4 GHz MSS user transceivers must demonstrate that the transceivers will operate in compliance with relevant requirements in §25.213.

(4) Applicants for earth stations licensed in accordance with §25.136 must demonstrate that the transmitting earth stations will meet the relevant criteria specified in that section, including any showings required under §25.136(a)(4), (c), and/or (d)(4).

* * * * *

(g) ***

NOTE TO PARAGRAPH (g): This paragraph does not apply to applications for blanket-licensed earth station networks filed pursuant to §25.115(c) or §25.218; applications for conventional Ka-band hub stations filed pursuant to §25.115(e); applications for NGSO FSS gateway earth stations filed pursuant to §25.115(f); applications for individually licensed earth stations filed pursuant to §25.136; applications filed pursuant to §§25.221, §25.222, §25.226, or §25.227; or applications for 29 GHz NGSO MSS feeder-link stations in a complex as defined in §25.257.

10. Amend § 25.136 by revising the section heading, paragraphs (a)(introductory text), (a)(4), and (c), adding new paragraph (d), and re-designating current paragraph (d) as paragraph (e), adding new paragraph (f), and revising it to read as follows:

§ 25.136 Earth Stations in the 27.5-28.35 GHz, 37.5-40 GHz, and 47.2-48.2 GHz bands.

(a) FSS is secondary to the Upper Microwave Flexible Use Service in the 27.5-28.35 GHz band. Notwithstanding that secondary status, an applicant for a license for a transmitting earth station in the 27.5-28.35 GHz band that meets one of the following criteria may be authorized to operate without providing interference protection to stations in the Upper Microwave Flexible Use Service:

* * * * *

(4) The applicant demonstrates compliance with all of the following criteria in its application:

(i) There are no more than two other authorized earth stations operating in the 27.5-28.35 GHz band within the county where the proposed earth station is located that meet the criteria contained in either paragraphs (a)(1), (2), (3), or (4) of this section. For purposes of this requirement, multiple earth stations that are collocated with or at a location contiguous to each other shall be considered as one earth station;

(ii) The area in which the earth station generates a power flux density (PFD), at 10 meters above ground level, of greater than or equal to -77.6 dBm/m2/MHz, together with the similar area of any other earth station authorized pursuant to paragraph (a) of this section, does not cover, in the aggregate, more than the amount of population of the UMFUS license area within which the earth station is located as noted below:

Population within UMFUS License Area	Maximum permitted aggregate population within -77.6 dBm/m^2/MHz PFD contour of earth stations
Greater than 450,000	0.1 percent of population in UMFUS license area
Between 6,000 and 450,000	450 people
Fewer than 6,000	7.5 percent of population in UMFUS license area

(iii) The area in which the earth station generates a power flux density (PFD), at 10 meters above ground level, of greater than or equal to -77.6 dBm/m^2/MHz does not contain any major event venue, urban mass transit route, passenger railroad, or cruise ship port. In addition, the area mentioned above shall not cross any of the following types of roads, as defined in functional classification guidelines issued by the Federal Highway Administration pursuant to § 470.105(b) of Title 23: Urban Interstate, Urban Other Freeways and Expressways, Urban Other Principal Arterial, Rural Interstate, and Rural Other Freeways and Expressways. The Federal Highway Administration Office of Planning, Environment, and Realty Executive Geographic Information System (HEPGIS) map contains information on the classification of roads. For purposes of this rule, an urban area shall be an Adjusted Urban Area as defined in § 101(a)(37) of Title 21 of the United States Code.

(iv) The applicant has successfully completed frequency coordination with the UMFUS licensees within the area in which the earth station generates a power flux density (PFD), at 10 meters above ground level, of greater than or equal to -77.6 dBm/m^2/MHz with respect to existing facilities constructed and in operation by the UMFUS licensee. In coordinating with UMFUS licensees, the applicant shall use the applicable processes contained in § 101.103(d) of this part.

* * * * *

(c) The protection zone (as defined in paragraph (b) of this section) shall comply with the following criteria. The applicant must demonstrate compliance with all of the following criteria in its application:

(1) There are no more than two other authorized earth stations operating in the 37.5-40 GHz band

within the county within which the proposed earth station is located that meet the criteria contained in paragraph (c) of this section, and there are no more than 14 other authorized earth stations operating in the 37.5-40 GHz band within the Partial Economic Area within which the proposed earth station is located that meet the criteria contained in paragraph (c) of this section. For purposes of this requirement, multiple earth stations that are collocated with or at a location contiguous to each other shall be considered as one earth station;

(2) The protection zone, together with the protection zone of other earth stations in the same Partial Economic Area authorized pursuant to this section, does not cover, in the aggregate, more than the amount of population of the PEA within which the earth station is located as noted below:

Population within Partial Economic Area (PEA) where earth station is located	Maximum permitted aggregate population within protection zone of earth stations
Greater than 2,250,000	0.1 percent of population in PEA
Between 60,000 and 2,250,000	2,250 people
Fewer than 60,000	3.75 percent of population in PEA

(3) The protection zone does not contain any major event venue, urban mass transit route, passenger railroad, or cruise ship port. In addition, the area mentioned above shall not cross any of the following types of roads, as defined in functional classification guidelines issued by the Federal Highway Administration pursuant to § 470.105(b) of Title 23: Urban Interstate, Urban Other Freeways and Expressways, Urban Other Principal Arterial, Rural Interstate, and Rural Other Freeways and Expressways. The Federal Highway Administration Office of Planning, Environment, and Realty Executive Geographic Information System (HEPGIS) map contains information on the classification of roads. For purposes of this rule, an urban area shall be an Adjusted Urban Area as defined in § 101(a)(37) of Title 21 of the United States Code.

(4) The applicant has successfully completed frequency coordination with the UMFUS licensees within the protection zone with respect to existing facilities constructed and in operation by the UMFUS

licensee. In coordinating with UMFUS licensees, the applicant shall use the applicable processes contained in § 101.103(d) of this part.

(d) Notwithstanding that FSS is co-primary with the Upper Microwave Flexible Use Service in the 47.2-48.2 GHz band, earth stations in the 47.2-48.2 GHz band shall be limited to individually licensed earth stations. An applicant for a license for a transmitting earth station in the 47.2-48.2 GHz band must meet one of the following criteria to be authorized to operate without providing any additional interference protection to stations in the Upper Microwave Flexible Use Service:

(1) The FSS licensee also holds the relevant Upper Microwave Flexible Use Service license(s) for the area in which the earth station generates a power flux density (PFD), at 10 meters above ground level, of greater than or equal to −77.6 dBm/m^2/MHz; or

(2) The earth station in the 47.2-48.2 GHz band was authorized prior to [effective date of second R&O]; or

(3) The application for the earth station in the 47.2-48.2 GHz band was filed prior to [effective date for second R&O]; or

(4) The applicant demonstrates compliance with all of the following criteria in its application:

(i) There are no more than two other authorized earth stations operating in the 47.2-48.2 GHz band within the county where the proposed earth station is located that meet the criteria contained in paragraphs (d)(1), (d)(2), (d)(3) or (d)(4) of this section, and there are no more than 14 other authorized earth stations operating in the 47.2-48.2 GHz band within the Partial Economic Area where the proposed earth station is located that meet the criteria contained in paragraphs (d)(1), (d)(2), (d)(3) or (d)(4) of this section. For purposes of this requirement, multiple earth stations that are collocated with or at a location contiguous to each other shall be considered as one earth station;

(ii) The area in which the earth station generates a power flux density (PFD), at 10 meters above ground level, of greater than or equal to −77.6 dBm/m^2/MHz, together with the similar area of any other earth station authorized pursuant to paragraph (d) of this section, does not cover, in the aggregate, more than the amount of population of the PEA within which the earth station is located as noted below:

Population within Partial Economic Area (PEA) where earth station is located	Maximum permitted aggregate population within −77.6 dBm/m^2/MHz PFD contour of earth stations
Greater than 2,250,000	0.1 percent of population in PEA
Between 60,000 and 2,250,000	2,250 people
Fewer than 60,000	3.75 percent of population in PEA

(iii) The area in which the earth station generates a power flux density (PFD), at 10 meters above ground level, of greater than or equal to −77.6 dBm/m^2/MHz does not contain any major event venue, any highway classified by the U.S. Department of Transportation under the categories Urban Interstate, Urban Other Freeways and Expressways, Urban Other Principal Arterial, Rural Interstate, or Rural Other Freeways and Expressways, or an urban mass transit route, passenger railroad, or cruise ship port; and;

(iv) The applicant has successfully completed frequency coordination with the UMFUS licensees within the area in which the earth station generates a power flux density (PFD), at 10 meters above ground level, of greater than or equal to −77.6 dBm/m^2/MHz with respect to existing facilities constructed and in operation by the UMFUS licensee. In coordinating with UMFUS licensees, the applicant shall use the applicable processes contained in §101.103(d) of this chapter.

(e) If an earth station applicant or licensee in the 27.5-28.35 GHz, 37.5-40 GHz, or 47.2-48.2 GHz bands enters into an agreement with an UMFUS licensee, their operations shall be governed by that agreement, except to the extent that the agreement is inconsistent with the Commission's rules or the Communications Act.

(f) Any earth station authorizations issued pursuant to sections (a)(4), (c), or (d)(4) this rule shall be conditioned upon operation being in compliance with the criteria contained in the applicable section.

PART 30 – UPPER MICROWAVE FLEXIBLE USE SERVICE

11. The authority citation for part 30 continues to read as follows:

Authority: 47 U.S.C. 151, 152, 153, 154, 301, 303, 304, 307, 309, 310, 316, 332, 1302.

12. Amend § 30.4 by redesignating paragraphs (a), (b), and (c) as paragraphs (b), (c), and (d), and adding new paragraphs (a) and (e) to read to read as follows:

§ 30.4 Frequencies.

(a) 24.25-24.45 GHz and 24.75-25.25 GHz bands – 24.25-24.45 GHz; 24.75-24.85 GHz; 24.85-25.05 GHz; and 25.05-25.25 GHz.

* * * * *

(e) 47.2-48.2 GHz band – 47.2-47.4 GHz; 47.4-47.6 GHz; 47.6-47.8 GHz; 47.8-48.0 GHz; and 48.0-48.2 GHz.

13. Amend § 30.6 by revising paragraph (b) to read to read as follows:

§ 30.6 Permissible communications.

* * * * *

(b) Fixed-Satellite Service shall be provided in a manner consistent with part 25 of this chapter. The technical and operating rules in this part shall not apply to Fixed-Satellite Service operation.

§ 30.8 [Remove and Reserve].

14. Remove and reserve § 30.8.

15. Amend § 30.104 by revising paragraph (a) to read as follows:

§30.104 Construction requirements.

(a) Upper Microwave Flexible Use Service licensees must make a buildout showing as part of their renewal applications. Licensees relying on mobile or point-to-multipoint service must show that they are providing reliable signal coverage and service to at least 40 percent of the population within the service area of the licensee, and that they are using facilities to provide service in that area either to customers or for internal use. Licensees relying on point-to-point service must demonstrate that they have four links operating and providing service, either to customers or for internal use, if the population within the license area is equal to or less than 268,000. If the population within the license area is greater than 268,000, a licensee relying on point-to-point service must demonstrate it has at least one link in operation and is providing service for each 67,000 population within the license area. In order to be eligible to be counted under the point-to-point buildout standard, a point-to-point link must operate with a transmit

power greater than +43 dBm.

* * * * *

PART 101 – FIXED MICROWAVE SERVICES

16. The authority citation for part 101 continues to read as follows:

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

§ 101.115 [Amended].

17. Section 101.115 is amended by revising the footnotes in the entries '71,000 to 76,000 (co-polar),' '71,000 to 76,000 (cross-polar),' '81,000 to 86,000 (co-polar),' and '81,000 to 86,000 (cross-polar)' in the table following paragraph (b)(2) to read footnote 14.

APPENDIX B
Federal Highway Administration (FHWA) Office of Planning, Environment, and Realty Executive Geographic Information System (HEPGIS) map

1. As shown in the table below, the roads listed in the revision to Section 25.136 of the Commission's rules together represent approximately 12.1 percent of the total mileage of U.S. streets and roads, and they can readily be identified by consulting the Federal Highway Administration (FHWA) Office of Planning, Environment, and Realty Executive Geographic Information System (HEPGIS) map, which is accessible online.[697] HEPGIS allows the user to enter any street address in the U.S. and display an interactive map with a legend that identifies road classifications as they are defined by the Department of Transportation at 23 C.F.R. section 470.105 pursuant to 23 U.S.C. sections 101 and 103. A supplementary layer of the HEPGIS map shows whether or not the address is within an FHWA Adjusted Urbanized Area as defined by 21 U.S.C. section 101(a)(34).

Type of Road or Street	Urban + Rural Miles	% of Total Urban + Rural	Urban Miles	% of Total Urban + Rural	Rural Miles	% of Total
INTERSTATE	48,053	1.2%	19,063	0.5%	28,990	0.7%
OTHER FREEWAYS AND EXPRESSWAYS	17,986	0.4%	12,038	0.3%	5,948	0.1%
OTHER PRINCIPAL ARTERIAL	156,473	3.8%	66,855	1.6%	89,618	2.2%
MINOR ARTERIAL	246,608	5.9%	113,592	2.7%	133,016	3.2%
MAJOR COLLECTOR	539,353	13.0%	129,677	3.1%	409,676	9.9%
MINOR COLLECTOR	271,878	6.5%	13,885	0.3%	257,993	6.2%
LOCAL	2,874,376	69.2%	854,104	20.6%	2,020,272	48.6%
TOTAL	4,154,727	100.0%	1,209,214	29.1%	2,945,513	70.9%

Table 1: U.S. Streets and Roads in 2015[698]

2. DoT's HEPGIS database mapping system also identifies the following kinds of intermodal transportation facilities:

- AMTRAK Stations
- Airports
- Ferry Terminals

[697] The HEPGIS map is accessible at http://hepgis.fhwa.dot.gov/fhwagis/#.

[698] U.S. Department of Transportation, Federal Highway Administration, Policy and Governmental Affairs, Office of Highway Policy Information, Highway Statistics 2015, Table HM-220 (https://www.fhwa.dot.gov/policyinformation/statistics/2015/hm220.cfm).

- Multipurpose Passenger Facilities
- Port Terminals
- Public Transit Stations
- Truck/Pipeline Terminals
- Truck/Rail Facilities

APPENDIX C

Final Regulatory Flexibility Analysis

1. As required by the Regulatory Flexibility Act of 1980, as amended (RFA),[699] an Initial Regulatory Flexibility Analysis (IRFA) was incorporated in the *Notice of Proposed Rulemaking (NPRM)* released in October 2015 in this proceeding. A Final Regulatory Flexibility Analysis (FRFA) was incorporated in the *Report and Order and Further Notice of Proposed Rulemaking* (*R&O/FNPRM*) released in July 2016 in this proceeding.[700] No comments were filed addressing the IRFA. This present Final Regulatory Flexibility Analysis (FRFA) conforms to the RFA.[701]

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

2. In the attached *Second Report and Order*, we increase the Nation's supply of spectrum for mobile broadband by adopting rules for fixed and mobile services in the 24.25-24.45 GHz and 24.75-25.25 GHz band (24 GHz band), and the 47.2-48.2 GHz band. We include these bands in the Part 30 Upper Microwave Flexible Use Service (UMFUS). This additional spectrum for mobile use will help ensure that the speed, capacity, and ubiquity of the nation's wireless networks keeps pace with the skyrocketing demand for mobile service. It will also make possible new types of services for consumers and businesses. We will award Partial Economic Area-based licenses for these bands.

3. Until recently, the mmW bands were generally considered unsuitable for mobile applications because of propagation losses at such high frequencies and the inability of mmW signals to propagate around obstacles. As increasing congestion has begun to fill the lower bands and carriers have resorted to smaller and smaller microcells in order to re-use the available spectrum, however, industry is taking another look at the mmW bands and beginning to realize that at least some of its presumed disadvantages can be turned to advantage. For example, short transmission paths and high propagation losses can facilitate spectrum re-use in microcellular deployments by limiting the amount of interference between adjacent cells. Furthermore, where longer paths are desired, the extremely short wavelengths of mmW signals make it feasible for very small antennas to concentrate signals into highly focused beams with enough gain to overcome propagation losses. The short wavelengths of mmW signals also make it possible to build multi-element, dynamic beam-forming antennas that will be small enough to fit into handsets—a feat that might never be possible at the lower, longer-wavelength frequencies below 6 GHz where cell phones operate today.

4. We also revise our rules for sharing between UMFUS and satellite services in the 28 GHz, 39 GHz, and 37 GHz bands, and apply the revised rules to the 47 GHz band. Specifically, we revise the population limits and numerical limits on satellite earth stations in those bands. These revisions will facilitate the placement of earth stations in smaller markets and promote coexistence between UMFUS and satellite services.

5. We further revise our rules for the 57-71 GHz band to allow unlicensed operation on board aircraft under Part 15 of the Commission's rules. This rule change will facilitate expanded access to broadband services in flight.

6. Overall, the new provisions we are adopting are designed to allow licensees to choose their type of service offerings, to encourage innovation and investment in mobile and fixed use in this spectrum, and to provide a stable regulatory environment in which fixed, mobile, and satellite deployment will be able to develop through the application of flexible rules. The market-oriented licensing

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

[700] *Use of Spectrum Bands Above 24 GHz For Mobile Radio Services, et al*., Report and Order and Further Notice of Proposed Rulemaking, 31 FCC Rcd 8014 (2016) (*R&O/FNPRM*).

[701] *See* 5 U.S.C. § 604.

framework for these bands will ensure that this spectrum is efficiently utilized and will foster the development of new and innovative technologies and services, as well as encourage the growth and development of a wide variety of services, ultimately leading to greater benefits to consumers.

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

7. No comments were filed that specifically addressed the proposed rules and policies presented in the IRFA.

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

8. Pursuant to the Small Business Jobs Act of 2010, which amended the RFA, the Commission is required to respond to any comments filed by the Chief Counsel for Advocacy of the Small Business Administration (SBA), and to provide a detailed statement of any change made to the proposed rules as a result of those comments.[702] The Chief Counsel did not file any comments in response to the proposed rules in this proceeding.

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

9. The RFA directs agencies to provide a description of, and where feasible, an estimate of the number of small entities that may be affected by the proposed rules and policies, if adopted herein.[703] The RFA generally defines the term "small entity" as having the same meaning as the terms "small business," "small organization," and "small governmental jurisdiction."[704] In addition, the term "small business" has the same meaning as the term "small business concern" under the Small Business Act.[705] A "small business concern" is one which: (1) is independently owned and operated; (2) is not dominant in its field of operation; and (3) satisfies any additional criteria established by the SBA.[706]

10. *Small Businesses, Small Organizations, and Small Governmental Jurisdictions.* Our action may, over time, affect small entities that are not easily categorized at present. We therefore describe here, at the outset, three broad groups of small entities that could be directly affected herein.[707] First, while there are industry specific size standards for small businesses that are used in the regulatory flexibility analysis, according to data from the SBA's Office of Advocacy, in general a small business is an independent business having fewer than 500 employees.[708] These types of small businesses represent 99.9 percent of all businesses in the United States, which translates to 28.8 million businesses.[709] Next, the type of small entity described as a "small organization" is generally "any not-for-profit enterprise

[702] 5 U.S.C. § 604(a)(3).

[703] 5 U.S.C. § 604(a)(3).

[704] 5 U.S.C. § 601(6).

[705] 5 U.S.C. § 601(3) (incorporating by reference the definition of "small-business concern" in the Small Business Act, 15 U.S.C. § 632). Pursuant to 5 U.S.C. § 601(3), the statutory definition of a small business applies "unless an agency, after consultation with the Office of Advocacy of the Small Business Administration and after opportunity for public comment, establishes one or more definitions of such term which are appropriate to the activities of the agency and publishes such definition(s) in the Federal Register."

[706] 15 U.S.C. § 632.

[707] *See* 5 U.S.C. § 601(3)-(6).

[708] *See* SBA, Office of Advocacy, "Frequently Asked Questions, Question 1—What is a small business?," https://www.sba.gov/sites/default/files/advocacy/SB-FAQ-2016_WEB.pdf (June 2016).

[709] *See* SBA, Office of Advocacy, "Frequently Asked Questions, Question 2—How many small business are there in the U.S.?," https://www.sba.gov/sites/default/files/advocacy/SB-FAQ-2016_WEB.pdf (June 2016).

which is independently owned and operated and is not dominant in its field."[710] Nationwide, as of 2007, there were approximately 1,621,215 small organizations.[711] Finally, the small entity described as a "small governmental jurisdiction" is defined generally as "governments of cities, towns, townships, villages, school districts, or special districts, with a population of less than fifty thousand."[712] U.S. Census Bureau data published in 2012 indicate that there were 89,476 governmental jurisdictions in the United States.[713] We estimate that, of this total, as many as 88,761 entities may qualify as "small governmental jurisdictions."[714] Thus, we estimate that most governmental jurisdictions are small.

11. *Wireless Telecommunications Carriers (except Satellite).* This industry comprises establishments engaged in operating and maintaining switching and transmission facilities to provide communications via the airwaves. Establishments in this industry have spectrum licenses and provide services using that spectrum, such as cellular services, paging services, wireless internet access, and wireless video services.[715] The appropriate size standard under SBA rules is that such a business is small if it has 1,500 or fewer employees.[716] For this industry, U.S. Census Bureau data for 2012 show that there were 967 firms that operated for the entire year.[717] Of this total, 955 firms had employment of 999 or fewer employees and 12 had employment of 1,000 employees or more.[718] Thus under this category and the associated size standard, the Commission estimates that the majority of wireless telecommunications carriers (except satellite) are small entities.

12. *Fixed Microwave Services.* Microwave services include common carrier,[719] private-operational fixed,[720] and broadcast auxiliary radio services.[721] They also include the Upper Microwave

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[710] 5 U.S.C. § 601(4).

[711] INDEPENDENT SECTOR, THE NEW NONPROFIT ALMANAC & DESK REFERENCE (2010).

[712] 5 U.S.C. § 601(5).

[713] U.S. CENSUS BUREAU, STATISTICAL ABSTRACT OF THE UNITED STATES: 2012 at 267, Table 428 (2011), http://www2.census.gov/library/publications/2011/compendia/statab/131ed/2012-statab.pdf (citing data from 2007).

[714] The 2012 U.S. Census data for small governmental organizations are not presented based on the size of the population in each organization. There were 89,476 local governmental organizations in the Census Bureau data for 2012, which is based on 2007 data. As a basis of estimating how many of these 89,476 local government organizations were small, we note that there were a total of 715 cities and towns (incorporated places and minor civil divisions) with populations over 50,000 in 2011. *See* U.S. Census Bureau, City and Town Totals Vintage: 2011, http://www.census.gov/popest/data/cities/totals/2011/index.html. If we subtract the 715 cities and towns that meet or exceed the 50,000 population threshold, we conclude that approximately 88,761 are small.

[715] NAICS Code 517210. *See* https://factfinder.census.gov/faces/affhelp/jsf/pages/metadata.xhtml?lang=en&type=ib&id=ib.en./ECN.NAICS2012.517210.

[716] 13 CFR § 121.201, NAICS code 517210.

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

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

[719] *See* 47 CFR Part 10, Subpart I.

[720] Persons eligible under Parts 80 and 90 of the Commission's rules can use Private-Operational Fixed Microwave services. *See* 47 CFR Parts 80 and 90. Stations in this service are called operational-fixed to distinguish them from common carrier and public fixed stations. Only the licensee may use the operational-fixed station, and only for communications related to the licensee's commercial, industrial, or safety operations.

[721] Auxiliary Microwave Service is governed by Part 74 and Part 78 of Title 47 of the Commission's rules. Available to licensees of broadcast stations, cable operators, and to broadcast and cable network entities.

Flexible Use Service[722] and the Millimeter Wave Service[723] where licensees can choose between common carrier and non-common carrier status.[724] At present, there are approximately 66,680 common carrier fixed licensees, 69,360 private and public safety operational-fixed licensees, 20,150 broadcast auxiliary radio licensees, 411 LMDS licenses, 33 24 GHz DEMS licenses, 777 39 GHz licenses, and five 24 GHz licenses, and 467 Millimeter Wave licenses in the microwave services.[725] The Commission has not yet defined a small business with respect to microwave services. The closest applicable SBA category is Wireless Telecommunications Carriers (except Satellite) and the appropriate size standard for this category under SBA rules is that such a business is small if it has 1,500 or fewer employees.[726] For this industry, U.S. Census Bureau data for 2012 shows that there were 967 firms that operated for the entire year. Of this total, 955 had employment of 999 or fewer, and 12 firms had employment of 1,000 employees or more.[727] Thus under this SBA category and the associated standard, the Commission estimates that the majority of fixed microwave service licensees can be considered small.

13. The Commission does not have data specifying the number of these licensees that have more than 1,500 employees, and thus is unable at this time to estimate with greater precision the number of fixed microwave service licensees that would qualify as small business concerns under the SBA's small business size standard. Consequently, the Commission estimates that there are up to 36,708 common carrier fixed licensees and up to 59,291 private operational-fixed licensees and broadcast auxiliary radio licensees in the microwave services that may be small and may be affected by the rules and policies adopted herein. We note, however, that both the common carrier microwave fixed and the private operational microwave fixed licensee categories includes some large entities.

14. *Satellite Telecommunications and All Other Telecommunications.* This category comprises firms "primarily engaged in providing telecommunications services to other establishments in the telecommunications and broadcasting industries by forwarding and receiving communications signals via a system of satellites or reselling satellite telecommunications."[728] The category has a small business size standard of $32.5 million or less in average annual receipts, under SBA rules.[729] For this category, U.S. Census Bureau data for 2012 shows that there were a total of 333 firms that operated for the entire year.[730] Of this total, 299 firms had annual receipts of less than $25 million.[731] Consequently, we estimate that the majority of satellite telecommunications providers are small entities.

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

[722] *See* 47 CFR Part 30.

[723] *See* 47 CFR Part 101, Subpart Q.

[724] *See* 47 CFR §§ 30.6, 101.1017.

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

[726] 13 CFR § 121.201, NAICS code 517210.

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

[728] U.S. Census Bureau, 2012 NAICS Definitions, "517410 Satellite Telecommunications", https://factfinder.census.gov/faces/affhelp/jsf/pages/metadata.xhtml?lang=en&type=ib&id=ib.en./ECN.NAICS2012.517410#.

[729] 13 CFR § 121.201, NAICS code 517410.

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

[731] *Id*.

15. *All Other Telecommunications*. The **"**All Other Telecommunications" category is comprised of establishments primarily engaged in providing specialized telecommunications services, such as satellite tracking, communications telemetry, and radar station operation.[732] This industry also includes establishments primarily engaged in providing satellite terminal stations and associated facilities connected with one or more terrestrial systems and capable of transmitting telecommunications to, and receiving telecommunications from, satellite systems.[733] Establishments providing Internet services or voice over Internet protocol (VoIP) services via client-supplied telecommunications connections are also included in this industry."[734] The SBA has developed a small business size standard for "All Other Telecommunications," which consists of all such firms with gross annual receipts of $32.5 million or less.[735] For this category, U.S. Census Bureau data for 2012 shows that there were a total of 1442 firms that operated for the entire year.[736] Of these firms, a total of 1400 firms had gross annual receipts of under $25 million and 42 firms had gross annual receipts of $25 million to $49, 999,999.[737] Thus, the Commission estimates that a majority of "All Other Telecommunications" firms potentially affected by our actions can be considered small.

16. *Radio and Television Broadcasting and Wireless Communications Equipment Manufacturing.* This industry comprises establishments primarily engaged in manufacturing radio and television broadcast and wireless communications equipment. Examples of products made by these establishments are: transmitting and receiving antennas, cable television equipment, GPS equipment, pagers, cellular phones, mobile communications equipment, and radio and television studio and broadcasting equipment."[738] The SBA has established a size standard for this industry of 1,250 employees or less.[739] U.S. Census Bureau data for 2012 shows that 841 establishments operated in this industry in that year.[740] Of that number, 828 establishments operated with fewer than 1,000 employees, 7 establishments operated with between 1,000 and 2,499 employees and 6 establishments operated with 2,500 or more employees.[741] Based on this data, we conclude that a majority of manufacturers in this industry is small.

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

17. The projected reporting, recordkeeping, and other compliance requirements in the *Second*

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[732] *See* U.S. Census Bureau, 2012 NAICS Definitions, NAICS Code "517919 All Other Telecommunications", https://factfinder.census.gov/faces/affhelp/jsf/pages/metadata.xhtml?lang=en&type=ib&id=ib.en./ECN.NAICS2012.517919#.

[733] *Id*.

[734] *Id*.

[735] 13 CFR 121.201; NAICS Code 517919.

[736] U.S. Census Bureau, *2012 Economic Census of the United States*, Table EC1251SSSZ4, Information: Subject Series - Estab and Firm Size: Receipts Size of Firms for the United States: 2012, NAICS code 517919, https://factfinder.census.gov/bkmk/table/1.0/en/ECN/2012_US/51SSSZ4//naics~517919.

[737] *Id*.

[738] *See* U.S. Census Bureau, 2012 NAICS Definitions, NAICS Code 334220, available at https://factfinder.census.gov/faces/affhelp/jsf/pages/metadata.xhtml?lang=en&type=ib&id=ib.en./ECN.NAICS2012.334220#.

[739] 13 CFR § 121.201, NAICS Code 334220.

[740] U.S. Census Bureau, *2012 Economic Census of the United States*, Table EC1231SG2, Manufacturing: Summary Series: General Summary: Industry Statistics for Subsectors and Industries by Employment Size: 2012 NAICS Code 334220, https://factfinder.census.gov/bkmk/table/1.0/en/ECN/2012_US/31SG2//naics~334220.

[741] *Id*.

Report and Order will apply to all entities in the same manner. The revisions the Commission adopts should benefit small entities by giving them more information, more flexibility, and more options for gaining access to wireless spectrum.

18. Small entities and other applicants for Upper Microwave Flexible Use Service licenses will be required to file license applications using the Commission's automated Universal Licensing System (ULS). ULS is an online electronic filing system that also serves as a powerful information tool, one that enables potential licensees to research applications, licenses, and antenna structures. It also keeps the public informed with weekly public notices, FCC rulemakings, processing utilities, and a telecommunications glossary. Small entities, like all other entities who are Upper Microwave Flexible Use Service applicants, must submit long-form license applications must do so through ULS using Form 601,[742] FCC Ownership Disclosure Information for the Wireless Telecommunications Services using FCC Form 602,[743] and other appropriate forms.[744]

19. We expect that the filing, recordkeeping and reporting requirements associated with the demands described above will require small businesses as well as other entities that intend to utilize these new UMFUS licenses to use professional, accounting, engineering or survey services in order to meet these requirements. As described below, several steps have been taken that will alleviate the burdens of the requirements on small businesses.

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

20. The RFA requires an agency to describe any significant alternatives that it has considered in reaching its approach, which may include the following four alternatives (among others): (1) the establishment of differing compliance or reporting requirements or timetables that take into account the resources available to small entities; (2) the clarification, consolidation, or simplification of compliance or reporting requirements under the rule for small entities; (3) the use of performance, rather than design, standards; and (4) an exemption from coverage of the rule, or any part thereof, for small entities.[745]

21. As noted above, the various construction and performance requirements and their associated showings will be the same for small and large businesses that license the Upper Microwave Flexible Use Service bands. To the extent applying the rules equally to all entities results in the cost of complying with these burdens being relatively greater for smaller businesses than for large ones, these costs are necessary to effectuate the purpose of the Communications Act, namely to further the efficient use of spectrum and to prevent spectrum warehousing. Likewise compliance with our service and technical rules and coordination requirements are necessary for the furtherance of our goals of protecting the public while also providing interference free services. Moreover, while small and large businesses must equally comply with these rules and requirements, we have taken the steps described below to alleviate the burden on small businesses that seek to comply with these requirements.

22. First, the *Second Report and Order* provides that in the 24 GHz and 47.2-48.2 GHz bands small businesses will have the flexibility to provide any fixed or mobile service that is consistent with their spectrum allocation. This breaks with the recent past in which 24 GHz licensees were limited to only a single use licenses in these bands, and such new flexibility benefits small businesses by giving them more avenues for gaining access to valuable wireless spectrum.

23. Furthermore, the Partial Economic Area license areas chosen in the *Second Report and Order* should provide spectrum access opportunities for smaller carriers by giving them access to less densely populated areas that match their footprints. While PEAs and counties are small enough to

[742] 47 CFR § 1.913(a)(1).

[743] 47 CFR § 1.919.

[744] 47 CFR § 1.2107.

[745] 5 U.S.C. § 604(a)(6).

provide spectrum access opportunities for smaller carriers and PEAs could even be further disaggregated, these units of area also nest within and may be aggregated to form larger license areas. Therefore, the benefits and burdens resulting from assigning spectrum in PEA are equivalent for small and large businesses.

24. Finally, the proposals to facilitate satellite service in the 28 GHz and 37.5-40 GHz bands should also assist small satellite businesses by providing them with additional flexibility to locate their earth stations without causing interference to or receiving interference from UMFUS licensees.

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

25. None.

APPENDIX D

Supplemental Final Regulatory Flexibility Analysis

1. As required by the Regulatory Flexibility Act of 1980, as amended (RFA), an Initial Regulatory Flexibility Analysis (IRFA) was incorporated in the Notice of Proposed Rulemaking (NPRM) released in October 2015 in this proceeding. A Final Regulatory Flexibility Analysis (FRFA) was incorporated in the Report and Order and Further Notice of Proposed Rulemaking (R&O) released in July 2016 in this proceeding. The Commission sought written public comment on the proposals in NPRM, including comments on the IRFA. No comments were filed addressing the IRFA. This present Supplemental Final Regulatory Flexibility Analysis (Supplemental FRFA) supplements the FRFA in the R&O and conforms to the RFA.

A. **Need for, and Objective of, the Proposed Rules**

2. In the July 2016 R&O, the Commission made millimeter wave (mmW) spectrum available through both licensed and unlicensed mechanisms. The Commission authorized both fixed and mobile operations in the 28 GHz and 39 GHz bands using geographic area licensing through the creation of a new Upper Microwave Flexible Use Service (UMFUS). The Commission also limited the number of Fixed-Satellite Service (FSS) earth station locations to three per county in the 28 GHz band and three per Partial Economic Area in the 37.5-40 GHz band. It protected a limited number of Federal military sites across the full 37 GHz band and maintained the existing Federal fixed and mobile allocations throughout the band. In the 64-71 GHz band, the Commission authorized unlicensed operations under Part 15 based on the rules for the adjacent 57-64 GHz band, providing more spectrum for unlicensed uses like short-range devices for interactive motion sensing and Wi-Fi-like "WiGig" operations.

3. The Commission also set up licensing and operating rules for the UMFUS. It granted mobile operating rights to existing Local Multipoint Distribution Service (LMDS) and 28 GHz band licensees, while subdividing their existing licensees to either the county or Partial Economic Area (PEA) level. The Commission adopted service and technical rules to facilitate full and complete use of the bands. It also adopted spectrum holdings policies for the 28GHz, 37 GHz, and 39 GHz bands that apply to licenses acquired through auctions and the secondary market. It also adopted performance requirements for mobile, point-to-multipoint, and fixed uses. The Commission adopted a requirement that UMFUS licensees submit a statement describing their security plans and related information prior to commencing operations. It also restricted earth station interference zones from infringing upon any arterial streets or interstate or U.S. highway. Lastly, it deleted the broadcasting and broadcasting-satellite service allocations from the 42-42.5 GHz band (42 GHz band) and declined to allocate the band to the Fixed-satellite service (space-to-Earth).

4. In this Order on Reconsideration, we rescind the reporting and security requirements for UMFUS licensees. Instead, we seek industry input through the Communications Security, Reliability, and Interoperability Council (CSRIC) process. The Commission will also provides additional flexibility in smaller markets. We modify and limit the prohibition of earth station interference zones from infringing on a specific set of roads, as defined and classified by the U.S. Department of Transportation: Urban Interstate, Urban Other Freeways and Expressways, Urban Other Principal Arterial, Rural Interstate, and Rural Other Freeways and Expressways. Finally, we increase the three locations per license area limit on earth stations in the 37.5-40 GHz band to 15 in each PEA, subject to an additional limitation of no more than three earth stations per county.

5. The analysis of the Commission's efforts to minimize the possible significant economic impact on small entities as described in the previous FRFA in this proceeding is hereby incorporated by reference. As a result of our actions in this Order on Reconsideration small entities as well as other licensees will save time and resources that would have been spent complying with the service and technical rule. The cost of compliance with the July 2016 R&O is relatively greater for smaller businesses, however with the rescission of the security measures, that compliance cost is eliminated. We

believe this should result in small businesses having an easier time providing service.

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

6. No comments were filed that specifically addressed the proposed rules and policies presented in the IRFA.

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

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

8. The Chief Counsel did not file any comments in response to the proposed rules in this proceeding.

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

9. The RFA directs agencies to provide a description of, and where feasible, an estimate of the number of small entities that may be affected by the proposed rules and policies, if adopted herein. The RFA generally defines the term "small entity" as having the same meaning as the terms "small business," "small organization," and "small governmental jurisdiction." In addition, the term "small business" has the same meaning as the term "small business concern" under the Small Business Act. A "small business concern" is one which: (1) is independently owned and operated; (2) is not dominant in its field of operation; and (3) satisfies any additional criteria established by the SBA.

10. As noted above, a FRFA was incorporated into July, 2016 R&O. In that analysis, we described in detail the small entities that might be significantly affected by the rules adopted in the R&O. In this Order on Reconsideration, we hereby incorporate by reference the descriptions and estimates of the number of small entities from the previous FRFA in this proceeding.

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

11. The reporting, recordkeeping and other compliance requirements for small entities required by the July 2016 R&O as described in the previous FRFA in this proceeding is hereby incorporated by reference. The actions taken in this Order on Reconsideration revise those requirements by no longer requiring small entities as well as other licensees to submit general statements of their plans for safeguarding their networks and devices from security breaches. The changes to the Earth station siting requirement will not change the reporting and recordkeeping requirements applicable to the rules.

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

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

14. The analysis of the Commission's efforts to minimize the possible significant economic impact on small entities as described in the previous FRFA in this proceeding is hereby incorporated by reference. The analysis of the Commission's efforts to minimize the possible significant economic impact on small entities as described in the previous FRFA in this proceeding is hereby incorporated by

reference. As a result of our actions in this Order on Reconsideration small entities as well as other licensees will save time and resources that would have been spent complying with the security reporting requirement. We believe this should result in small businesses having an easier time providing service. The changes to the Earth station limits from three per PEA to 15 per PEA should increase competition and allow more opportunities for small businesses.

J. G. Report to Congress

15. The Commission will send a copy of this Order, including this Supplemental FRFA, in a report to be sent to Congress and the Government Accountability Office pursuant to the Small Business Regulatory Enforcement Fairness Act of 1996. In addition, the Commission will send a copy of this Order, including the Supplemental FRFA, to the Chief Counsel for Advocacy of the Small Business Administration. A copy of this Order and Supplemental FRFA (or summaries thereof) will also be published in the Federal Register.

APPENDIX E

Proposed Rules

For the reasons discussed in the preamble, the Federal Communications Commission proposes to amend 47 CFR parts 2, 25, and 30 as follows:

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

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

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

2. In § 2.106, the Table of Frequency Allocations is amended as follows:

a. Page 54 is revised.

b. In the list of non-Federal Government (NG) Footnotes, footnote NG535 is removed.

§ 2.106 Table of Frequency Allocations.

The revisions read as follows:

* * * * *

24-24.05 AMATEUR AMATEUR-SATELLITE 5.150			24-24.05 5.150 US211	24-24.05 AMATEUR AMATEUR-SATELLITE 5.150 US211	ISM Equipment (18) Amateur Radio (97)
24.05-24.25 RADIOLOCATION Amateur Earth exploration-satellite (active) 5.150			24.05-24.25 RADIOLOCATION G59 Earth exploration-satellite (active) 5.150	24.05-24.25 Amateur Earth exploration-satellite (active) Radiolocation 5.150	RF Devices (15) ISM Equipment (18) Private Land Mobile (90) Amateur Radio (97)
24.25-24.45 FIXED	24.25-24.45 RADIONAVIGATION	24.25-24.45 FIXED MOBILE RADIONAVIGATION	24.25-24.45	24.25-24.45 FIXED MOBILE	RF Devices (15) Upper Microwave Flexible Use (30)
24.45-24.65 FIXED INTER-SATELLITE	24.45-24.65 INTER-SATELLITE RADIONAVIGATION 5.533	24.45-24.65 FIXED INTER-SATELLITE MOBILE RADIONAVIGATION 5.533	24.45-24.65 INTER-SATELLITE RADIONAVIGATION 5.533		RF Devices (15) Satellite Communications (25)
24.65-24.75 FIXED FIXED-SATELLITE (Earth-to-space) 5.532B INTER-SATELLITE	24.65-24.75 INTER-SATELLITE RADIOLOCATION-SATELLITE (Earth-to-space)	24.65-24.75 FIXED FIXED-SATELLITE (Earth-to-space) 5.532B INTER-SATELLITE MOBILE 5.533	24.65-24.75 INTER-SATELLITE RADIOLOCATION-SATELLITE (Earth-to-space)		
24.75-25.25 FIXED FIXED-SATELLITE (Earth-to-space) 5.532B	24.75-25.25 FIXED-SATELLITE (Earth-to-space) 5.535	24.75-25.25 FIXED FIXED-SATELLITE (Earth-to-space) 5.535 MOBILE	24.75-25.25	24.75-25.25 FIXED FIXED-SATELLITE (Earth-to-space) MOBILE	RF Devices (15) Satellite Communications (25) Upper Microwave Flexible Use (30)
25.25-25.5 FIXED INTER-SATELLITE 5.536 MOBILE Standard frequency and time signal-satellite (Earth-to-space)			25.25-25.5 FIXED INTER-SATELLITE 5.536 MOBILE Standard frequency and time signal-satellite (Earth-to-space)	25.25-25.5 Inter-satellite 5.536 Standard frequency and time signal-satellite (Earth-to-space)	RF Devices (15)
25.5-27 EARTH EXPLORATION-SATELLITE (space-to-Earth) 5.536B FIXED INTER-SATELLITE 5.536 MOBILE SPACE RESEARCH (space-to-Earth) 5.536C Standard frequency and time signal-satellite (Earth-to-space) 5.536A			25.5-27 EARTH EXPLORATION-SATELLITE (space-to-Earth) FIXED INTER-SATELLITE 5.536 MOBILE SPACE RESEARCH (space-to-Earth) Standard frequency and time signal-satellite (Earth-to-space) 5.536A US258	25.5-27 SPACE RESEARCH (space-to-Earth) Inter-satellite 5.536 Standard frequency and time signal-satellite (Earth-to-space) 5.536A US258	Page 54

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PART 25 – SATELLITE COMMUNICATIONS

3. The authority citation for part 25 continues to read as follows:

Authority: Interprets or applies 47 U.S.C. 154, 301, 302, 303, 307, 309, 310, 319, 332, 605, and 721, unless otherwise noted.

4. Amend § 25.103 by revising the definitions of "Routine processing or licensing" and "Two-degree-compliant space station" to read as follows:

§25.103 Definitions.

* * * * *

Routine processing or licensing. Expedited processing of unopposed applications for earth stations in the FSS communicating with GSO space stations, except for earth stations licensed pursuant to §25.136, that satisfy the criteria in §25.138(a), §25.211(d), §25.212(c), §25.212(d), §25.212(e), §25.212(f), §25.218, include all required information, are consistent with all Commission rules, and do not raise any policy issues. Some, but not all, routine earth station applications are eligible for an autogrant procedure under §25.115(a)(3).

* * * * *

Two-degree-compliant space station. A GSO FSS space station operating in the conventional or extended C-bands, the conventional or extended Ku-bands, the 24.75-25.25 GHz band, or the conventional Ka-band within the limits on downlink EIRP density or PFD specified in §25.140(a)(3) and communicating only with earth stations operating in conformance with routine uplink parameters specified in §25.138(a), §25.211(d), §25.212(c), (d), or (f), §25.218, §25.221(a)(1) or (a)(3), §25.222(a)(1) or (a)(3), §25.226(a)(1) or (a)(3), or §25.227(a)(1) or (a)(3).

* * * * *

5. Amend § 25.114 by revising paragraph (d)(7) and removing and reserving paragraph (d)(17) to read as follows:

§25.114 Applications for space station authorizations.

* * * * *

(d)* * *

(7) Applicants for authorizations for space stations in the Fixed-Satellite Service must also include the information specified in §25.140(a). Applicants for authorizations for space stations in the 17/24 GHz Broadcasting-Satellite Service must also include the information specified in §25.140(b);

* * * * *

(17) [Reserved]

* * * * *

6. Amend § 25.115 by revising paragraphs (e)(1) and paragraph (g)(1)(vii) to read as follows:

§25.115 Applications for earth station authorizations.

* * * * *

(e) GSO FSS earth stations in 17.8-30 GHz. (1) An application for a GSO FSS earth station license in the 17.8-19.4 GHz, 19.6-20.2 GHz, 24.75-25.25 GHz, 27.5-29.1 GHz, or 29.25-30 GHz bands not filed on FCC Form 312EZ pursuant to paragraph (a)(2) of this section must be filed on FCC Form 312, Main Form and Schedule B, and must include any information required by paragraph (g) or (j) of this section or by §25.130.

* * * * *

(g) * * *

(1) * * *

(vii) The relevant off-axis EIRP density envelopes in §25.138, §25.218, §25.221, §25.222, §25.226, or §25.227 must be superimposed on plots submitted pursuant to paragraphs (g)(1)(i) through

(vi) of this section.

* * * * *

7. Amend § 25.136 by revising the section heading and paragraphs (d) and (e) to read as follows:

§25.136 Earth Stations in the 24.75-25.25 GHz, 27.5-28.35 GHz, 37.5-40 GHz and 47.2-48.2 GHz bands.

* * * * *

(d) Notwithstanding that FSS is co-primary with the Upper Microwave Flexible Use Service in the 24.75-25.25 GHz and 47.2-48.2 GHz bands, earth stations in those bands shall be limited to individual licensed earth stations. An applicant for a license for a transmitting earth station in the 24.75-25.25 GHz or 47.2-48.2 GHz band must meet one of the following criteria to be authorized to operate without providing any additional interference protection to stations in the Upper Microwave Flexible Use Service:

(1) The FSS licensee also holds the relevant Upper Microwave Flexible Use Service license(s) for the area in which the earth station generates a power flux density (PFD), at 10 meters above ground level, of greater than or equal to −77.6 dBm/m^2/MHz; or

(2) The earth station in the 47.2-48.2 GHz band was authorized prior to [effective date of second R&O] or the earth station in the 24.75-25.25 GHz band was authorized prior to [effective date of this rule]; or

(3) The application for the earth station in the 47.2-48.2 GHz band was filed prior to [effective date for second R&O] or the application for the earth station in the 24.75-25.25 GHz band was filed prior to [effective date of this rule]; or

(4) The applicant demonstrates compliance with all of the following criteria in its application:

(i) There are no more than two other authorized earth stations operating in the same band within the county where the proposed earth station is located that meet the criteria contained in either paragraphs

(d)(1) (d)(2), (d)(3) or (d)(4) of this section, and there are no more than 14 other authorized earth stations operating in the same band within the Partial Economic Area where the proposed earth station is located that meet the criteria contained in paragraphs (d)(1) (d)(2), (d)(3) or (d)(4) of this section. For purposes of this requirement, multiple earth stations that are collocated with or at a location contiguous to each other shall be considered as one earth station;

(ii) The area in which the earth station generates a power flux density (PFD), at 10 meters above ground level, of greater than or equal to −77.6 dBm/m^2/MHz, together with the similar area of any other earth station authorized pursuant to paragraph (d) of this section, does not cover, in the aggregate, more than the amount of population of the PEA within which the earth station is located as noted below:

Population within Partial Economic Area (PEA) where earth station is located	Maximum permitted aggregate population within −77.6 dBm/m^2/MHz PFD contour of earth stations
Greater than 2,250,000	0.1 percent of population in PEA
Between 60,000 and 2,250,000	2,250 people
Fewer than 60,000	3.75 percent of population in PEA

(iii) The area in which the earth station generates a power flux density (PFD), at 10 meters above ground level, of greater than or equal to −77.6 dBm/m^2/MHz does not contain any major event venue, any highway classified by the U.S. Department of Transportation under the categories Urban Interstate, Urban Other Freeways and Expressways, Urban Other Principal Arterial, Rural Interstate, or Rural Other Freeways and Expressways, or an urban mass transit route, passenger railroad, or cruise ship port; and;

(iv) The applicant has successfully completed frequency coordination with the UMFUS licensees within the area in which the earth station generates a power flux density (PFD), at 10 meters above ground level, of greater than or equal to −77.6 dBm/m^2/MHz with respect to existing facilities constructed and in operation by the UMFUS licensee. In coordinating with UMFUS licensees, the applicant shall use the applicable processes contained in §101.103(d) of this chapter.

(e) If an earth station applicant or licensee in the 24.75-25.25 GHz, 27.5-28.35 GHz, 37.5-40 GHz and/or 47.2-48.2 GHz bands enters into an agreement with an UMFUS licensee, their operations shall be governed by that agreement, except to the extent that the agreement is inconsistent with the Commission's rules or the Communications Act.

* * * * *

8. Amend § 25.138 by revising the section heading and the introductory text of paragraph (a) to read as follows:

§25.138 Licensing requirements for GSO FSS earth stations in the conventional Ka-band and the 24.75-25.25 GHz band.

(a) Applications for earth station licenses in the GSO FSS in the conventional Ka-band or the 24.75-25.25 GHz band that indicate that the following requirements will be met and include the information required by relevant provisions in §§25.115 and 25.130 may be routinely processed:

* * * * *

9. Amend § 25.140 by revising paragraphs (a)(2), paragraph (a)(3)(introductory text), and paragraphs (a)(3)(iii) through (v), adding a new paragraph (a)(3)(vi), revising paragraph (b)(introductory text) and paragraphs (b)(3) through (b)(5), removing paragraph (b)(6), removing and reserving paragraph (c), and revising the introductory text to paragraph (d) to read as follows:

§25.140 Further requirements for license applications for GSO space station operation in the FSS and the 17/24 GHz BSS.

(a)(1) * * *

(2) In addition to the information required by §25.114, an applicant for GSO FSS space station operation, including applicants proposing feeder links for space stations operating in the 17/24 GHz BSS, that will be located at an orbital location less than two degrees from the assigned location of an authorized co-frequency GSO space station, must either certify that the proposed operation has been coordinated

with the operator of the co-frequency space station or submit an interference analysis demonstrating the compatibility of the proposed system with the co-frequency space station. Such an analysis must include, for each type of radio frequency carrier, the link noise budget, modulation parameters, and overall link performance analysis. (See Appendices B and C to Licensing of Space Stations in the Domestic Fixed-Satellite Service, FCC 83-184, and the following public notices, copies of which are available in the Commission's EDOCS database: DA 03-3863 and DA 04-1708.) The provisions in this paragraph do not apply to proposed analog video operation, which is subject to the requirement in paragraph (a)(1) of this section.

(3) In addition to the information required by §25.114, an applicant for a GSO FSS space station, including applicants proposing feeder links for space stations operating in the 17/24 GHz BSS, must provide the following for operation other than analog video operation:

* * * * *

(iii) With respect to proposed operation in the conventional Ka-band, a certification that the proposed space station will not generate power flux-density at the Earth's surface in excess of −118 dBW/m^2/MHz and that associated uplink operation will not exceed applicable EIRP density envelopes in §25.138(a) unless the non-routine uplink and/or downlink operation is coordinated with operators of authorized co-frequency space stations at assigned locations within 6 degrees of the orbital location and except as provided in paragraph (d) of this section.

(iv) With respect to proposed operation in the 24.75-25.25 GHz band (Earth-to-space), a certification that the proposed space station will not generate a power flux density at the Earth’s surface in excess of the applicable limits in this part and that the associated uplink operation will not exceed applicable EIRP density envelopes in §25.138(a) unless the non-routine uplink and/or downlink operation is coordinated with operators of authorized co-frequency space stations at assigned locations within six degrees of the orbital location and except as provided in paragraph (d) of this section.

(v) With respect to proposed operation in the 4500-4800 MHz (space-to-Earth), 6725-7025 MHz (Earth-to-space), 10.70-10.95 GHz (space-to-Earth), 11.20-11.45 GHz (space-to-Earth), and/or 12.75-13.25 GHz (Earth-to-space) bands, a statement that the proposed operation will take into account the applicable requirements of Appendix 30B of the ITU Radio Regulations (incorporated by reference, *see* §25.108) and a demonstration that it is compatible with other U.S. ITU filings under Appendix 30B.

(vi) With respect to proposed operation in other FSS bands, an interference analysis demonstrating compatibility with any previously authorized co-frequency space station at a location two degrees away or a certification that the proposed operation has been coordinated with the operator(s) of the previously authorized space station(s). If there is no previously authorized space station at a location two degrees away, the applicant must submit an interference analysis demonstrating compatibility with a hypothetical co-frequency space station two degrees away with the same receiving and transmitting characteristics as the proposed space station.

(b) Each applicant for a license to operate a space station transmitting in the 17.3-17.8 GHz band must provide the following information, in addition to that required by §25.114:

* * * * *

(3) An applicant for a license to operate a space station transmitting in the 17.3-17.8 GHz band must certify that the downlink power flux density on the Earth's surface will not exceed the values specified in §25.208(c) and/or (w), or must provide the certification specified in §25.114(d)(15)(ii) of this part.

(4) An applicant for a license to operate a space station transmitting in the 17.3-17.8 GHz band to be located less than four degrees from a previously licensed or proposed space station transmitting in the 17.3-17.8 GHz band, must provide an interference analysis of the kind described in paragraph (a) of this section, except that the applicant must demonstrate that its proposed network will not cause more interference to the adjacent space station transmitting in the 17.3-17.8 GHz band operating in compliance

with the technical requirements of this part, than if the applicant were locate at an orbital separation of four degrees from the previously licensed or proposed space station.

(5) In addition to the requirements of paragraphs (b)(3) and (b)(4) of this section, the link budget for any satellite in the 17.3-17.8 GHz band (space-to-Earth) must take into account longitudinal stationkeeping tolerances. Any applicant for a space station transmitting in the 17.3-17.8 GHz band that has reached a coordination agreement with an operator of another space station to allow that operator to exceed the pfd levels specified in the rules for this service, must use those higher pfd levels for the purpose of this showing.

(c) [Reserved]

(d) An operator of a GSO FSS space station in the conventional or extended C-bands, conventional or extended Ku-bands, 24.75-25.25 GHz band (Earth-to-space), or conventional Ka-band may notify the Commission of its non-routine transmission levels and be relieved of the obligation to coordinate such levels with later applicants and petitioners.

* * * * *

10. Amend §25.203 by removing and reserving paragraph (l).

§25.203 Choice of sites and frequencies.

* * * * *

(l) [Reserved]

* * * * *

11. Amend § 25.204 by revising paragraphs (e)(introductory text), (e)(1), and (e)(3), and removing paragraph (e)(4) to read as follows:

§25.204 Power limits for earth stations.

* * * * *

(e) To the extent specified in paragraphs (e)(1) through (e)(3) of this section, earth stations in the Fixed-Satellite Service may employ uplink adaptive power control or other methods of fade compensation to facilitate transmission of uplinks at power levels required for desired link performance while minimizing interference between networks.

(1) Except when paragraphs (e)(2) through (e)(3) of this section apply, transmissions from FSS earth stations in frequencies above 10 GHz may exceed the uplink EIRP and EIRP density limits specified in the station authorization under conditions of uplink fading due to precipitation by an amount not to exceed 1 dB above the actual amount of monitored excess attenuation over clear sky propagation conditions. EIRP levels must be returned to normal as soon as the attenuating weather pattern subsides.

* * * * *

(3) FSS earth stations transmitting to geostationary space stations in the 24.75-25.25 GHz, 28.35-28.6 GHz, and/or 29.25-30.0 GHz bands may employ uplink adaptive power control or other methods of fade compensation. For stations employing uplink power control, the values in paragraphs (a)(1), (a)(2), and (a)(4) of §25.138 may be exceeded by up to 20 dB under conditions of uplink fading due to precipitation. The amount of such increase in excess of the actual amount of monitored excess attenuation over clear sky propagation conditions must not exceed 1.5 dB or 15 percent of the actual amount of monitored excess attenuation in dB, whichever is larger, with a confidence level of 90 percent except over transient periods accounting for no more than 0.5 percent of the time during which the excess is no more than 4.0 dB.

* * * * *

12. Amend § 25.209 by revising paragraph (f) to read as follows:

§25.209 Earth station antenna performance standards.

* * * * *

(f) A GSO FSS earth station with an antenna that does not conform to the applicable standards in paragraphs (a) and (b) of this section will be authorized only if the applicant demonstrates that the antenna will not cause unacceptable interference. This demonstration must comply with the requirements in §25.138, §25.218, §25.220, §25.221, §25.222, §25.226, or §25.227, as appropriate.

* * * * *

13. Amend § 25.210 by revising paragraph (i) to read as follows:

* * * * *

(i) 17/24 GHz BSS space station antennas transmitting in the 17.3-17.8 GHz band must be designed to provide a cross-polarization isolation such that the ratio of the on axis co-polar gain to the cross-polar gain of the antenna in the assigned frequency band is at least 25 dB within its primary coverage area.

* * * * *

14. Amend § 25.220 by revising paragraph (a) to read as follows:

§25.220 Non-routine transmit/receive earth station operations.

(a) The requirements in this section apply to applications for, and operation of, earth stations transmitting in the conventional or extended C-bands, the conventional or extended Ku-bands, the 24.75-25.25 GHz band, or the conventional Ka-band that do not qualify for routine licensing under relevant criteria in §25.138, §25.211, §25.212, §25.218, §25.221(a)(1) or (a)(3), §25.222(a)(1) or (a)(3), §25.226(a)(1) or (a)(3), or §25.227(a)(1) or (a)(3).

* * * * *

§ 25.223 [Reserved].

15. Remove and reserve § 25.223.

16. Revise § 25.262 to read as follows:

§25.262 Licensing and domestic coordination requirements for 17/24 GHz BSS space stations.

(a) An applicant may be authorized to operate a space station transmitting in the 17.3-17.8 GHz band at the maximum power flux density limits defined in §25.208(c) and/or §25.208(w) of this part, without coordinating its power flux density levels with adjacent licensed or permitted operators, only if there is no licensed space station, or prior-filed application for a space station transmitting in the 17.3-17.8 GHz band at a location less than four degrees from the orbital location at which the applicant proposes to operate.

(b) Any U.S. licensee or permittee authorized to transmit in the 17.3-17.8 GHz band that does not comply with the power flux-density limits set forth in §25.208(c) and/or §25.208(w) of this part shall bear the burden of coordinating with any future co-frequency licensees and permittees of a space station transmitting in the 17.3-17.8 GHz band under the following circumstances:

(1) If the operator's space-to-Earth power flux-density levels exceed the power flux-density limits set forth in §25.208(c) and/or §25.208(w) of this part by 3 dB or less, the operator shall bear the burden of coordinating with any future operators proposing a space station transmitting in the 17.3-17.8 GHz band in compliance with power flux-density limits set forth in §25.208(c) and/or §25.208(w) of this part and located within ±6 degrees of the operator's 17/24 GHz BSS space station.

(2) If the operator's space-to-Earth power flux-density levels exceed the power flux-density limits set forth in §25.208(c) and/or §25.208(w) of this part by more than 3 dB, the operator shall bear the burden of coordinating with any future operators proposing a space station transmitting in the 17.3-17.8 GHz band in compliance with power flux-density limits set forth in §25.208(c) and/or §25.208(w) of this part and located within ±10 degrees of the operator's space station.

(3) If no good faith agreement can be reached, the operator of the space station transmitting in the 17.3-17.8 GHz band that does not comply with §25.208(c) and/or §25.208(w) of this part shall reduce its space-to-Earth power flux-density levels to be compliant with those specified in §25.208(c) and/or §25.208(w) of this part.

(c) Any U.S. licensee or permittee using a space station transmitting in the 17.3-17.8 GHz band that is required to provide information in its application pursuant to §25.140(b)(4) of this part must accept any increased interference that may result from adjacent space stations transmitting in the 17.3-17.8 GHz band that are operating in compliance with the rules for such space stations.

(d)(1) Notwithstanding the provisions of this section, licensees and permittees will be allowed to apply for a license or authorization for a replacement satellite that will be operated at the same power level and interference protection as the satellite to be replaced.

(2) In addition, applicants for licenses or authority for a satellite to be operated at an orbit location that was made available after a previous license for a space station transmitting in the 17.3-17.8 GHz band was cancelled or surrendered will be permitted to apply for authority to operate a satellite at the same power level and interference protection as the previous licensee at that orbit location, to the extent that their proposed operations are consistent with the provisions of this part. Such applications will be considered pursuant to the first-come, first-served procedures set forth in §25.158 of this part.

PART 30 – UPPER MICROWAVE FLEXIBLE USE SERVICE

17. The authority citation for part 30 continues to read as follows:

Authority: 47 U.S.C. 151, 152, 153, 154, 301, 303, 304, 307, 309, 310, 316, 332, 1302.

18. Amend § 30.104 by redesignating paragraphs (b), (c), (d) and (e) as paragraphs (c), (d), (e), and (f), adding new paragraph (b), and revising redesignated paragraphs (c), (e), and (f) to read to read as follows:

§ 30.104 Performance Requirements

* * * * *

(b) In the alternative, a licensee may make its buildout showing on the basis of geographic area coverage. To satisfy the requirements of this section using this metric, licensees relying on mobile or point-to-multipoint service must show that they are providing reliable signal coverage and service to at

least 25% of the geographic area of the license. The geographic area of the license shall be determined by the total land area of the county or counties covered by the license. Licensees relying on fixed point-to-point links or other, low-power point-to-point connections must show that they have deployed at least one transmitter or receiver in at least 25% of the census tracts within the license area. All equipment relied upon in the showing, whatever type of service or connection it provides, must be operational and providing service, either to customers or for internal use, as of the date of the filing.

(c) Showings that rely on a combination of multiple types of service will be evaluated on a case-by-case basis. Licensees may not combine population-based showings with geographic area-based showings.

* * * * *

(e) Failure to meet this requirement will result in automatic cancellation of the license. In bands licensed on a Partial Economic Area basis, licensees will have the option of partitioning a license on a county basis in order to reduce the population or land area within the license area to a level where the licensee's buildout would meet one of the applicable performance metrics.

(f) Existing 24 GHz, 28 GHz and 39 GHz licensees shall be required to make a showing pursuant to this rule by June 1, 2024.

APPENDIX F

Initial Regulatory Flexibility Analysis

1. As required by the Regulatory Flexibility Act of 1980, as amended (RFA),[746] the Commission has prepared this present Initial Regulatory Flexibility Analysis (IRFA) of the possible significant economic impact on a substantial number of small entities by the policies and rules proposed in the attached *Further Notice of Proposed Rulemaking (FNPRM)*. Written public comments are requested on this IRFA. Comments must be identified as responses to the IRFA and must be filed by the deadlines specified in the *FNPRM* for comments. The Commission will send a copy of this *FNPRM*, including this IRFA, to the Chief Counsel for Advocacy of the Small Business Administration (SBA).[747] In addition, the *FNPRM* and IRFA (or summaries thereof) will be published in the Federal Register.[748]

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

2. In the *Second Further Notice of Proposed Rulemaking*, we propose to authorize Fixed-Satellite Service (FSS) use of the 24.75-25.25 GHz band for individually licensed earth stations. We also propose to create a buildout standard for Upper Microwave Flexible Use Service (UMFUS) licensees based on geographic area coverage that would be an alternative to the current population coverage standard in the current rules.

3. Under the current rules, Broadcasting Satellite Service (BSS) feeder links have priority over other FSS uses in the 24.75-25.25 GHz band. Given the very light use of the 24.75-25.25 GHz band for BSS feeder links, the existence of our earth station two-degree spacing rules that can protect BSS feeder links from other FSS earth stations in the band, and the power limits placed on BSS feeder link earth stations, it appears there is no need to give BSS feeder link earth stations priority over other uses of the FSS for earth stations located within the United States, or to preclude other FSS earth stations from claiming protection from feeder link earth stations located within the United States.

4. A performance metric based on geographic area coverage (or presence) would allow for networks that provide meaningful service but deploy along other lines than residential population. Such a metric could be useful for sensor-based networks, particularly for uses in rural areas. We propose to adopt the following metric as an option for UMFUS licensees to fulfill their buildout requirements: geographic area coverage of 25% of the license area, or presence in 25% of census tracts within the license area. The latter standard is intended to accommodate deployments, such as sensor networks, that are not designed to provide mobile or point-to-multipoint area coverage, and for whom calculating "coverage of 25% of the area" would therefore not be a meaningful standard.

L. B. Legal Basis

5. The proposed action is authorized pursuant to Sections 1, 2, 3, 4, 5, 7, 301, 302, 302a, 303, 304, 307, 309, and 310 of the Communications Act of 1934, 47 U.S.C. §§ 151, 152, 153, 154, 155, 157, 301, 302, 302a, 303, 304, 307, 309, and 310, Section 706 of the Telecommunications Act of 1996, as amended, 47 U.S.C. § 1302.

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

[747] *See* 5 U.S.C. § 603(a).

[748] *See* 5 U.S.C. § 603(a).

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

6. *Wireless Telecommunications Carriers (except Satellite).* This industry comprises establishments engaged in operating and maintaining switching and transmission facilities to provide communications via the airwaves. Establishments in this industry have spectrum licenses and provide services using that spectrum, such as cellular services, paging services, wireless internet access, and wireless video services.[749] The appropriate size standard under SBA rules is that such a business is small if it has 1,500 or fewer employees.[750] For this industry, U.S. Census Bureau data for 2012 show that there were 967 firms that operated for the entire year.[751] Of this total, 955 firms had employment of 999 or fewer employees and 12 had employment of 1,000 employees or more.[752] Thus under this category and the associated size standard, the Commission estimates that the majority of wireless telecommunications carriers (except satellite) are small entities.

7. *Fixed Microwave Services.* Microwave services include common carrier,[753] private-operational fixed,[754] and broadcast auxiliary radio services.[755] They also include the Upper Microwave Flexible Use Service[756] and the Millimeter Wave Service[757] where licensees can choose between common carrier and non-common carrier status.[758] At present, there are approximately 66,680 common carrier fixed licensees, 69,360 private and public safety operational-fixed licensees, 20,150 broadcast auxiliary radio licensees, 411 LMDS licenses, 33 24 GHz DEMS licenses, 777 39 GHz licenses, and five 24 GHz licensees, and 467 Millimeter Wave licenses in the microwave services.[759] The Commission has not yet defined a small business with respect to microwave services. The closest applicable SBA category is Wireless Telecommunications Carriers (except Satellite) and the appropriate size standard for this

[749] NAICS Code 517210. *See* https://factfinder.census.gov/faces/affhelp/jsf/pages/metadata.xhtml?lang=en&type=ib&id=ib.en./ECN.NAICS2012.517210.

[750] 13 CFR § 121.201, NAICS code 517210.

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

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

[753] *See* 47 CFR Part 10, Subpart I.

[754] Persons eligible under Parts 80 and 90 of the Commission's rules can use Private-Operational Fixed Microwave services. *See* 47 CFR Parts 80 and 90. Stations in this service are called operational-fixed to distinguish them from common carrier and public fixed stations. Only the licensee may use the operational-fixed station, and only for communications related to the licensee's commercial, industrial, or safety operations.

[755] Auxiliary Microwave Service is governed by Part 74 and Part 78 of Title 47 of the Commission's rules. Available to licensees of broadcast stations, cable operators, and to broadcast and cable network entities. Auxiliary microwave stations are used for relaying broadcast television signals from the studio to the transmitter, or between two points such as a main studio and an auxiliary studio. The service also includes TV pickup and CARS pickup, which relay signals from a remote location back to the studio.

[756] *See* 47 CFR Part 30.

[757] *See* 47 CFR Part 101, Subpart Q.

[758] *See* 47 CFR §§ 30.6, 101.1017.

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

category under SBA rules is that such a business is small if it has 1,500 or fewer employees.[760] For this industry, U.S. Census Bureau data for 2012 shows that there were 967 firms that operated for the entire year. Of this total, 955 had employment of 999 or fewer, and 12 firms had employment of 1,000 employees or more.[761] Thus under this SBA category and the associated standard, the Commission estimates that the majority of fixed microwave service licensees can be considered small.

8. The Commission does not have data specifying the number of these licensees that have more than 1,500 employees, and thus is unable at this time to estimate with greater precision the number of fixed microwave service licensees that would qualify as small business concerns under the SBA's small business size standard. Consequently, the Commission estimates that there are up to 36,708 common carrier fixed licensees and up to 59,291 private operational-fixed licensees and broadcast auxiliary radio licensees in the microwave services that may be small and may be affected by the rules and policies adopted herein. We note, however, that both the common carrier microwave fixed and the private operational microwave fixed licensee categories includes some large entities.

9. *Satellite Telecommunications and All Other Telecommunications.* This category comprises firms "primarily engaged in providing telecommunications services to other establishments in the telecommunications and broadcasting industries by forwarding and receiving communications signals via a system of satellites or reselling satellite telecommunications."[762] The category has a small business size standard of $32.5 million or less in average annual receipts, under SBA rules.[763] For this category, U.S. Census Bureau data for 2012 shows that there were a total of 333 firms that operated for the entire year.[764] Of this total, 299 firms had annual receipts of less than $25 million.[765] Consequently, we estimate that the majority of satellite telecommunications providers are small entities.

10. *All Other Telecommunications*. The **"**All Other Telecommunications" category is comprised of establishments primarily engaged in providing specialized telecommunications services, such as satellite tracking, communications telemetry, and radar station operation.[766] This industry also includes establishments primarily engaged in providing satellite terminal stations and associated facilities connected with one or more terrestrial systems and capable of transmitting telecommunications to, and receiving telecommunications from, satellite systems.[767] Establishments providing Internet services or voice over Internet protocol (VoIP) services via client-supplied telecommunications connections are also

[760] 13 CFR § 121.201, NAICS code 517210.

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

[762] U.S. Census Bureau, 2012 NAICS Definitions, "517410 Satellite Telecommunications", https://factfinder.census.gov/faces/affhelp/jsf/pages/metadata.xhtml?lang=en&type=ib&id=ib.en./ECN.NAICS2012.517410#.

[763] 13 CFR § 121.201, NAICS code 517410.

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

[765] *Id*.

[766] *See* U.S. Census Bureau, 2012 NAICS Definitions, NAICS Code "517919 All Other Telecommunications", https://factfinder.census.gov/faces/affhelp/jsf/pages/metadata.xhtml?lang=en&type=ib&id=ib.en./ECN.NAICS2012.517919#.

[767] *Id*.

included in this industry."[768] The SBA has developed a small business size standard for "All Other Telecommunications," which consists of all such firms with gross annual receipts of $32.5 million or less.[769] For this category, U.S. Census Bureau data for 2012 shows that there were a total of 1442 firms that operated for the entire year.[770] Of these firms, a total of 1400 firms had gross annual receipts of under $25 million and 42 firms had gross annual receipts of $25 million to $49, 999,999.[771] Thus, the Commission estimates that a majority of "All Other Telecommunications" firms potentially affected by our actions can be considered small.

11. *Radio and Television Broadcasting and Wireless Communications Equipment Manufacturing.* This industry comprises establishments primarily engaged in manufacturing radio and television broadcast and wireless communications equipment. Examples of products made by these establishments are: transmitting and receiving antennas, cable television equipment, GPS equipment, pagers, cellular phones, mobile communications equipment, and radio and television studio and broadcasting equipment."[772] The SBA has established a size standard for this industry of 1,250 employees or less.[773] U.S. Census Bureau data for 2012 shows that 841 establishments operated in this industry in that year.[774] Of that number, 828 establishments operated with fewer than 1,000 employees, 7 establishments operated with between 1,000 and 2,499 employees and 6 establishments operated with 2,500 or more employees.[775] Based on this data, we conclude that a majority of manufacturers in this industry is small.

N. D. Description of Projected Reporting, Recordkeeping, and other Compliance Requirements

12. The projected reporting, recordkeeping, and other compliance requirements proposed in the *Second Further Notice of Proposed Rulemaking* will apply to all entities in the same manner. The revisions the Commission adopts should benefit small entities by giving them more information, more flexibility, and more options for gaining access to wireless spectrum.

13. Small entities and other applicants in the Upper Microwave Flexible Use Service will be required to meet buildout requirements at the end of their initial license terms. In doing so, they will be required to provide information to the Commission on the facilities they have constructed, the nature of the service they are providing, and the extent to which they are providing coverage in their license area.

14. Because we have already adopted performance requirements for UMFUS licensees, the proposal in the *Second FNPRM* will not change the recordkeeping and compliance requirements for small

[768] *Id.*

[769] 13 CFR 121.201; NAICS Code 517919.

[770] U.S. Census Bureau, *2012 Economic Census of the United States*, Table EC1251SSSZ4, Information: Subject Series - Estab and Firm Size: Receipts Size of Firms for the United States: 2012, NAICS code 517919, https://factfinder.census.gov/bkmk/table/1.0/en/ECN/2012_US/51SSSZ4//naics~517919.

[771] *Id.*

[772] *See* U.S. Census Bureau, 2012 NAICS Definitions, NAICS Code 334220, available at https://factfinder.census.gov/faces/affhelp/jsf/pages/metadata.xhtml?lang=en&type=ib&id=ib.en./ECN.NAICS2012.334220#.

[773] 13 CFR § 121.201, NAICS Code 334220.

[774] U.S. Census Bureau, *2012 Economic Census of the United States*, Table EC1231SG2, Manufacturing: Summary Series: General Summary: Industry Statistics for Subsectors and Industries by Employment Size: 2012 NAICS Code 334220, https://factfinder.census.gov/bkmk/table/1.0/en/ECN/2012_US/31SG2//naics~334220.

[775] *Id.*

entities and other UMFUS licensees. The *Second FNPRM* proposes to give small entities and other UMFUS licensees another means of meeting those requirements. We expect that the filing, recordkeeping and reporting requirements associated with the demands described above, will require small entities as well as other entities that intend to utilize these new UMFUS licenses, to use professional, accounting, engineering or survey services to meet these requirements. As noted below, we seek comment on any steps that could be taken to minimize any significant economic impact on small businesses.

O. E. Steps taken to Minimize Significant Economic Impact on Small Entities, and Significant Alternatives Considered

15. The RFA requires an agency to describe any significant alternatives for small businesses that it has considered in reaching its proposed approach, which may include the following four alternatives (among others): (1) the establishment of differing compliance or reporting requirements or timetables that take into account the resources available to small entities; (2) the clarification, consolidation, or simplification of compliance and reporting requirements under the rule for such small entities; (3) the use of performance rather than design standards; and (4) an exemption from coverage of the rule, or any part thereof, for such small entities.[776] Accordingly, we seek comment on whether any of burdens associated the filing, recordkeeping and reporting requirements described above can be minimized for small businesses. In particular, we seek comment on whether any of the costs associated with our construction or performance requirements in these bands can be alleviated for small businesses.

16. As noted above in Section D, the buildout requirements and information reported to the Commission will be the same for small and large businesses in the Upper Microwave Flexible Use Service. To the extent applying the rules equally to all entities results in the cost of complying with these burdens being relatively greater for smaller businesses than for large ones, these costs are necessary to effectuate the purpose of the Communications Act, namely to ensure that spectrum is being put into use. Moreover, while small and large businesses must equally comply with these rules and requirements, the proposed rule changes would grant additional flexibility to all licensees, including small businesses. Specifically, opening 24.75-25.25 GHz for general Fixed-Satellite Service use will provide small satellite entities with access to additional spectrum which they can use in connection with individually licensed earth stations. Creating a geographic area buildout metric for UMFUS licensees will give those licensees, including small businesses, an option for providing service that does not cover a large population.

17. To assist the Commission's evaluation of the economic impact on small entities, as a result of actions that have been proposed in this *Second FNPRM*, and to better explore options and alternatives, the Commission has sought comment from the parties. The Commission seeks comment on whether any of the burdens associated the filing, recordkeeping and reporting requirements described above can be minimized for small businesses. In addition, the *Second FNPRM* seeks comment on whether any of the costs associated with our construction or performance requirements in these bands can be alleviated for small businesses. The Commission expects to more fully consider the economic impact and alternatives for small entities following the review of comments filed in response to the *Second FNPRM*.

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

18. None.

[776] 5 U.S.C. § 604(a)(6).

APPENDIX G

List of Commenters to *FNPRM*

Comments

5G Americas
Aeronet Global Communications Inc.
Anova Technologies, LLC
AT&T Services Inc.
Cambridge Broadband Networks
CBF Networks, Inc. (aka Fastback Networks)
Competitive Carriers Association (CCA)
Collinear Networks, Inc.
Comsearch
Consumer Technology Association (CTA)
CTIA
Dynamic Spectrum Alliance (DSA)
E-Band Communications, LLC
Echodyne Corp.
EchoStar Satellite Operating Corporation
Ericsson
Facebook, Inc.
Federated Wireless, Inc.
FiberTower Spectrum Holdings, LLC
Fixed Wireless Communications Coalition, Inc. (FWCC)
Google Fiber Inc.
Google Inc.
Huawei Technologies, Co., LTD
Huawei Technologies, Inc. (USA)
Hughes Network Systems, LLC
Inmarsat, Inc.
Intel Corporation
InterDigital, Inc.
Lockheed Martin Corporation
Microsoft Corporation
Mobile Future
Moseley Associates, Inc.
MVDDS 5G Coalition
National Academy of Sciences, Committee on Radio Frequencies (CORF)
National Spectrum Management Association (NSMA)
NCTA — The Internet & Television Association (NCTA)
NEC
Nextlink Wireless, LLC
Nokia
O3b Limited
Open Technology Institute at New America (OTI)
Public Knowledge
Qualcomm Incorporated
REMEC Broadband Wireless Networks, LLC
Samsung Electronics America, Inc.
Samsung Research America

Scientel Solutions LLC
Satellite Industry Association (SIA)
Southern Company Services, Inc.
Starry, Inc.
Straight Path Communications Inc.
Telecommunications Industry Association (TIA)
The Boeing Company
T-Mobile USA, Inc.
Verizon
Verizon Wireless
ViaSat, Inc.
Wi-Fi Alliance
Zodiac Inflight Innovations (Zii)

Reply Comments
AT&T Services Inc.
Computer & Communications Industry Association (CCIA)
Charter Communications, Inc.
Collinear Networks, Inc.
CTIA
EchoStar Satellite Operating Corporation
EMEA Satellite Operators Association (ESOA)
Federated Wireless, Inc.
FiberTower Spectrum Holdings, LLC
Fixed Wireless Communications Coalition, Inc. (FWCC)
Google Fiber Inc.
Google Inc.
Hughes Network Systems, LLC
Inmarsat, Inc.
Intel Corporation
Iridium Communications, Inc.
Microsoft Corporation
Mimosa Networks, Inc.
MVDDS 5G Coalition
NCTA — The Internet & Television Association
Netcompetition.org
Nextlink Wireless, LLC
Nokia
O3b Limited
Open Technology Institute at New America (OTI)
Public Knowledge
Qualcomm Incorporated
Samsung Electronics America, Inc.
Samsung Research America
Scientel Solutions LLC
SES Americom, Inc.
Satellite Industry Association (SIA)
Sprint Corporation
Straight Path Communications Inc.
The Boeing Company
Telecommunications Industry Association (TIA)

T-Mobile USA, Inc.
United States Cellular Corporation
Verizon
Verizon Wireless
ViaSat, Inc.
Wi-Fi Alliance

***Ex Parte* Comments**

Adams Telecom, Inc. (Rural LMDS Licensees)
Aeronet Global Communications Inc.
Alta Wireless, Inc.
Central Texas Communications, Inc. (Rural LMDS Licensees)
CTIA
EchoStar Satellite Operating Corporation
E.N.M.R. Telephone Cooperative (Rural LMDS Licensees)
FiberTower Spectrum Holdings, LLC
Horry Telephone Cooperative (Rural LMDS Licensees)
Hughes Network Systems, LLC
Inmarsat, Inc.
Intelsat Corporation
Louisiana Competitive Telecommunications, Inc. (Rural LMDS Licensees
Nextlink Wireless, LLC
Nokia
O3b Limited
Pine Belt Communications, Inc. (Rural LMDS Licensees)
Public Knowledge
Satellite Industry Association
SES Americom, Inc.
Straight Path Communications, Inc.
Starry, Inc.
The Boeing Company
ViaSat, Inc.
WorldVu Satellites Ltd. d/b/a/ One Web

APPENDIX H

List of Petitioners to *Spectrum Frontiers Report and Order*

Petitions for Reconsideration

5G Americas
Adams Telecom Inc. (Rural LMDS Licensees)
Central Texas Communications, Inc. (Rural LMDS Licensees)
Competitive Carriers Association
CTIA
E.N.M.R. Telephone Cooperative (Rural LMDS Licensees)
Louisiana Competitive Telecommunications, Inc. (Rural LMDS Licensees)
NCTA — The Internet & Television Association
Nextlink Wireless, LLC
O3b Limited
Pine Belt Communications, Inc. (Rural LMDS Licensees)
Satellite Industry Association
SES Americom, Inc.
Telecommunications Industry Association (TIA)
T-Mobile USA, Inc.
ViaSat, Inc.

Oppositions/Comments to Petitions for Reconsideration

5G Americas
Consolidated Telecom (Blooston Rural Carriers)
CTIA
Dynamic Spectrum Alliance (DSA)
EchoStar Satellite Operating Corporation
Fixed Wireless Communications Coalition, Inc. (FWCC)
Hughes Network Systems, LLC
Intel Corporation
Iridium Communications, Inc.
Lockheed Martin Corporation
Mashell Telecom, Inc. d/b/a Rainier Connect (Blooston Rural Carriers)
Microsoft Corporation
Mobile Future
NCTA — The Internet & Television Association
Nokia
O3b Limited
Open Technology Institute at New America
Public Knowledge
PVT Networks, Inc. (Blooston Rural Carriers)
SES Americom, Inc.
Skyriver Communications, Inc.
Straight Path Communications Inc.
Starry, Inc.
The Boeing Company
T-Mobile USA, Inc.

United States Cellular Corporation (USCC)
Venture Wireless, Inc. (Blooston Rural Carriers)
Verizon
Verizon Wireless
ViaSat, Inc.
Wi-Fi Alliance

Reply to Oppositions to Petitions for Reconsideration

Adams Telecom Inc. (Rural LMDS Licensees)
AT&T Services Inc.
Cambridge Broadband Networks
Central Texas Communications, Inc. (Rural LMDS Licensees)
Competitive Carriers Association (CCA)
CTIA
EchoStar Satellite Operating Corporation
E.N.M.R. Telephone Cooperative (Rural LMDS Licensees)
Hughes Network Systems, LLC
Inmarsat, Inc.
Intelsat Corporation
Louisiana Competitive Telecommunications, Inc. (Rural LMDS Licensees)
Nextlink Wireless, LLC
O3b Limited
Pine Belt Communications, Inc. (Rural LMDS Licensees)
SES Americom, Inc.
Telecommunications Industry Association (TIA)
The Boeing Company
T-Mobile USA, Inc.
Verizon
Verizon Wireless
ViaSat, Inc.
WorldVu Satellites Ltd. d/b/a/ One Web