

FEDERAL COMMUNICATIONS COMMISSION**47 CFR Parts 1, 2, 15, 25, 30, and 101**

[GN Docket No. 14–177, IB Docket Nos. 15–256 and 97–95, RM–11664, WT Docket No. 10–112; FCC 16–89]

Use of Spectrum Bands Above 24 GHz for Mobile Radio Services

AGENCY: Federal Communications Commission.

ACTION: Final rule.

SUMMARY: In this document, the Federal Communications Commission (Commission or FCC) adopts rules for specific millimeter wave (mmW) bands above 24 GHz. This action is undertaken to establish a regulatory framework for the use of these bands for the development of the next generational evolution of wireless technology. Once effective, these rules will promote the development of highly beneficial technologies, in particular the so-called 5G technology.

DATES: Effective December 14, 2016, except for §§ 25.136 and 30.8 which contain information collection requirements that are not effective until approved by the Office of Management and Budget. The FCC will publish a document in the **Federal Register** announcing the effective date for those sections.

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. For information regarding the PRA information collection requirements contained in this PRA, contact Cathy Williams, Office of Managing Director, at (202) 418–2918, or via email at Cathy.Williams@fcc.gov.

SUPPLEMENTARY INFORMATION: This is a summary of the Commission's *Report and Order* GN Docket No. 14–177, FCC 16–89, adopted and released on July 14, 2016. The complete text of this document is available for public inspection and copying from 8 a.m. to 4:30 p.m. Eastern Time (ET) Monday through Thursday or from 8 a.m. to 11:30 a.m. ET on Fridays in the FCC Reference Information Center, 445 12th Street SW., Room CY–A257, Washington, DC 20554. The complete text is available on the Commission's

Web site at <http://wireless.fcc.gov>, or by using the search function on the ECFS Web page at <http://www.fcc.gov/cgb/ecfs/>. Alternative formats are available to persons with disabilities by sending an email to fcc504@fcc.gov or by calling the Consumer & Governmental Affairs Bureau at 202–418–0530 (voice), 202–418–0432 (tty).

Ex Parte Presentations

This proceeding shall continue to be treated as a “permit-but-disclose” proceeding in accordance with the Commission's *ex parte* rules. 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 § 1.1206(b). In proceedings governed by § 1.49(f) or for which the Commission has made available a method of electronic filing, written *ex parte* presentations and memoranda summarizing oral *ex parte* presentations, and all attachments thereto, must be filed through the electronic comment filing system available for that proceeding, and must be filed in their native format (e.g., .doc, .xml, .ppt, searchable .pdf). Participants in this proceeding should familiarize themselves with the Commission's *ex parte* rules.

Paperwork Reduction Act

The *Report and Order* contains new information collection requirements subject to the Paperwork Reduction Act of 1995 (PRA), Public Law 104–13. It will be submitted to the Office of

Management and Budget (OMB) for review under § 3507(d) of the PRA. OMB, the general public, and other Federal agencies will be invited to comment on the new information collection requirements contained in this proceeding.

Comment Filing Procedures

Pursuant to §§ 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/> or the Federal eRulemaking Portal: <http://www.regulations.gov>. Filers should follow the instructions provided on the Web site for submitting comments and transmit one electronic copy of the filing to GN Docket No. 14–177. For ECFS filers, in completing the transmittal screen, filers should include their full name, U.S. Postal Service mailing address, and the applicable docket number.

- **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 9300 East Hampton Drive, Capitol Heights, MD 20743.

- U.S. Postal Service first-class, Express, and Priority mail must be

addressed to 445 12th Street, SW., Washington DC 20554.

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

Congressional Review Act

The Commission will send a copy of this *Report and Order* in a report to be sent to Congress and the Government Accountability Office pursuant to the Congressional Review Act (CRA), see 5 U.S.C. 801(a)(1)(A).

Synopsis

I. Introduction

1. In this *Report and Order*, the Commission adopts new licensing, service, and technical rules for three bands. In so doing, the Commission attempts to follow a consistent framework across all of the bands that can serve as a template for additional bands in the future. The Commission adopted 10 year license terms and performance requirements that are flexible to allow multiple use cases to evolve over time. These basic building blocks are modified in order to meet the specific characteristics of a particular band.

2. The Commission also took significant steps forward on solutions to spectrum sharing in the millimeter wave (mmW) bands. The Commission adopted rules that will allow both satellite and terrestrial networks to continue to expand in a flexible manner. The Commission continues to facilitate co-primary shared access to the 39.5–40 GHz band for Federal and non-Federal users, and building off of recent policy developments in spectrum sharing, it also created a new approach to Federal sharing in the 37 GHz band. Specifically, instead of relying on static exclusion zones, the Commission created a space for both Federal and non-Federal users to share on a coequal basis and set out a process for defining how that sharing will be implemented. Finally, the Commission substantially increases the amount of unlicensed spectrum available by adding another seven gigahertz to the existing 57–64 GHz band, and adopting flexible technical rules.

A. 28 GHz Band

1. Suitability for Mobile Use

3. Some satellite operators, satellite equipment suppliers and satellite-focused trade associations urge the

Commission not to authorize terrestrial mobile services in the 28 GHz band. This perspective is by no means unanimous or unqualified even among that group, however. SES, for example, says that it expects to support terrestrial mobile services in bands above 24 GHz by providing video distribution, providing backhaul services, and by extending terrestrial network coverage to sea, air, and remote land masses. EchoStar says that satellite operators could coexist with mobile services in the band by avoiding deployment of gateway earth stations in large urban centers. ViaSat estimates that the compatibility distance between satellite earth stations and terrestrial mobile in the 28 GHz band would be in the range of 160 meters, and could be further reduced by additional mitigation techniques. Nearly all other commenters who address the topic emphatically support mobile service authorization in the 28 GHz band.

4. Perhaps more so than other mmW bands, the 28 GHz band has been the focus of academic research and industry prototyping efforts to develop mobile service technologies. The 28 GHz band is attractive for research on enabling mobility in mmW bands because, with 850 megahertz of contiguous bandwidth, it has ample capacity to accommodate a wide range of high data-rate applications, and it has global co-primary allocations for fixed and mobile services. There are no Federal allocations in the band. Further, because this is an active service with Local Multipoint Distribution Service (LMDS) licenses covering about 75 percent of the U.S. population, it can be quickly repurposed for new flexible uses, including mobile. The ready availability of the spectrum will also help drive the development of a robust ecosystem at a large scale.

5. Opponents of authorizing new flexible and mobile use in the 28 GHz band raise three basic objections: (1) That there is no international consensus to authorize mobile services in the band; (2) that LMDS operators do not have an equitable expectation of mobile rights in the band; and (3) that mobile services in the 28 GHz band would impair vital satellite services. The Commission discusses the first of those issues below, reserving discussion of the second and third issues for Section I.4.c (Aggregate Interference to Satellite Receivers).

6. Regarding the alleged absence of international consensus expressed by some of the commenting parties, the Commission notes that the 28 GHz band already has a primary worldwide mobile service allocation, which embodies a previously agreed consensus among

International Telecommunication Union (ITU) members. Although World Radiocommunication Conference (WRC) 2015 (WRC-15) omitted 27.5–28.35 GHz from a list of mmW bands that it invited ITU-Radiocommunication (ITU-R) to study for mobile service, the record in this proceeding makes it abundantly clear that there are significant benefits to authorizing mobile use in the 28 GHz band regardless of that international decision.

7. Administrations and wireless industry representatives that have been major leaders in the mobile industry support authorization of mobile services in the 27.5–28.35 GHz band. Verizon notes that countries supporting mobile use in the band include South Korea, Japan, Sweden, Finland, and Singapore—“technology powerhouses with their sights set on 5G”—and argues that this Commission should not delay repurposing the 28 GHz band while its counterparts in those countries support their industries’ efforts to develop mobile technologies for the band. Intel says that major markets like the U.S., Japan, and Korea are moving expeditiously, “blazing the trail for mobile 5G services in the 28 GHz band, in spite of the WRC-15 decision not to study the 28 GHz band leading up to WRC-19.” Ericsson contends that, regardless of the outcome of WRC-15, spectrum from this general range very likely will be used for 5G around the world, as evidenced by the fact that Japan and Korea appear to be pressing ahead to use frequencies in this range for their Olympic Game deployments. Nokia expresses disappointment with the outcome of WRC-15, sees “great potential” for the 28 GHz band and urges the Commission to “unlock the promise of that band for mobile use.” Internationally, Huawei and Alcatel-Lucent are also focusing on the 28 GHz band as key spectrum for mobile use. T-Mobile USA, whose majority owner is the flagship German telecommunications company, Deutsche Telekom, filed comments in this proceeding expressing its support for mobile services in the 28 GHz band. Other comments reflect near-unanimous support among carriers, equipment suppliers, and associations that represent them.

8. The Commission acknowledges the comments of parties that emphasize the importance of international harmonization, but in this case, it appears there is sufficient international interest (including from Japan and South Korea) for using the 28 GHz band and adjacent bands to justify making the 28 GHz band available for mobile use. Intel and Ericsson both state that the

mobile industry could readily create integrated circuits with tuning ranges for various bands in that part of the spectrum, and the Republic of Korea submitted a proposal to WRC-15 stating that the “frequency range from 24.25 GHz to 29.5 GHz proposed from regional groups could be implemented by one single device to facilitate global roaming around the year 2020.” These kinds of capabilities are already being reflected in standards development. Microsoft explains that 3GPP release 13 will allow for carrier aggregation of multiple bands of spectrum, both licensed and unlicensed, in the 5 GHz band, and it says that, once 5G service is defined, the committee will likely extend its standards to encompass the millimeter wave bands. Microsoft argues that carriers should ultimately be able to aggregate low-, medium-, and high-band spectrum. The significant domestic and international interest in making the 28 GHz band available for new mobile uses clearly supports taking action in this *Report and Order* to create new flexible use licenses.

2. Licensing the 28 GHz Band

a. Use of Geographic Area Licensing

9. The Commission adopted its proposal to implement geographic area licensing throughout the 28 GHz band because geographic area licensing will expedite deployment, provide licensees with the flexibility to provide a variety of services, and is consistent with the existing licensing scheme. One significant advantage to this approach is that the Commission can expedite use of the band for advanced services because it is consistent with the existing framework in this band.

10. In contrast, if the Commission adopted a separate framework for mobile use of the band, the Commission needs to develop a Spectrum Access System (SAS), define the specific rights held by the existing licensees, and work out rules for coordination with the existing licensees. Adopting geographic area licensing for this band is also consistent with the Commission’s goal of adopting a balanced licensing approach that includes licensed, unlicensed, and innovative sharing approaches across a variety of bands. For these reasons, the Commission is not adopting a 3.5 GHz-style SAS framework for this band.

11. Similarly, the Commission declines to adopt Microsoft’s proposal to create an unlicensed portion of the band. The Commission believes splitting the band into unlicensed and licensed segments would potentially hinder deployment by making it more

difficult for licensees to use the full 850 megahertz of spectrum. The Commission nonetheless agrees that a balance between licensed and unlicensed usage is important, and as described below, the Commission is also making seven gigahertz of spectrum available for use by unlicensed devices in the 64–71 GHz band, and create an opportunity for shared access in the 37–37.6 GHz band segment.

b. License Area Size

12. The Commission adopted counties as the license area size for Upper Microwave Flexible Use Service (UMFUS) licenses in the 28 GHz band. The Commission also adopted its proposal to subdivide existing LMDS licenses on a county basis. As the Commission explained in the *Notice of Proposed Rulemaking (NPRM)*, a county-based license affords a licensee the flexibility to develop localized services, allows for targeted deployments based on market forces and customer demand, and facilitates access by both smaller and larger carriers. In the Commission views, the claims of certain commenters that larger license areas will better fit the services contemplated for these bands lack specificity and do not take into account the potential need for targeted deployment. It is unclear that providers need to—or will want to—aggregate nationwide licenses, as mobile operations in the band may initially be deployed. On a mobile basis, this band is envisioned for mobile operations in denser population centers or around highway corridors. While it is true that county-sized licenses will result in more borders, the Commission adopted a power flux density (PFD) limit at the border that will facilitate coordination between licensees. Furthermore, no party offered evidence that there have been problems providing service near existing Basic Trading Area (BTA) borders. The Commission notes that licensees in other services regularly coordinate their operations along shared borders and have well established procedures for conducting this coordination. The Commission expects that licensees will be able to apply these same procedures in this band without any undue burden. To the extent existing BTA licensees do not believe it is economically viable to build within certain counties of a BTA, the Commission believes it would be appropriate to give other interested parties an opportunity to license and to make use of the spectrum. Finally, establishing smaller license areas is fair to existing licensees because those licensees are also obtaining valuable

new rights and they are keeping the same bundle of rights they had previously. Overall, the Commission believes the benefits of smaller license areas for this specific band outweigh any administrative burden on licensees and the Commission.

13. In this proceeding, the Commission is endeavoring to create a regulatory scheme that will suit the development of innovative wireless services for years to come. The Commission in recent years has sought greater consistency in its approach to geographic license area sizes to help providers aggregate licenses in a more targeted and efficient manner, gravitating toward license areas that are derived from Economic Area (EA) units. BTAs have only been used as the license area for a few commercial wireless services. Counties, however, are the base unit that make up common commercial wireless license sizes, including EAs and the new Partial Economic Area (PEA) license areas. There is also a practical advantage to issuing county-based licenses. Specifically, the Commission would be required to negotiate a new licensing agreement with Rand McNally to use BTAs in UMFUS. In recent years, the Commission has avoided using license areas controlled by third parties in order to eliminate the time and expense involved in negotiating such agreements.

3. Mobile Rights for Incumbents

14. The Commission adopted its proposal to grant mobile operating rights to existing active LMDS licensees. This grant is in fulfillment of the Commission’s original mobile allocation for 28 GHz and its stated expectation of allowing mobile use in the band in “providing LMDS licensees with maximum flexibility in designing their systems.” The Commission adopted the rules; therefore, licensees are able to provide mobile services consistent with part 30 licensing and technical rules. Granting mobile operating rights to existing licensees will expedite the deployment of service, minimize the difficulties involved in coordinating fixed and mobile deployments, and provide a uniform licensing scheme throughout the United States. The Commission remains concerned that awarding fixed and mobile rights separately would lead to disputes between fixed and mobile licensees that could make it more difficult for both licensees to provide service.

15. The Commission recognizes that awarding mobile rights to incumbent licensees could be viewed as a windfall to those licensees, although the

Commission contemplated granting mobile rights when it first created LMDS. Here, the benefits of expediting service and ease of coordinating fixed and mobile service outweigh any foreseeable disadvantages of granting mobile rights to incumbents. In this instance, the Commission finds that expedition is particularly important because of the need to make mmW spectrum available for innovative and novel issues.

4. Satellite Terrestrial Sharing

a. Sharing With FSS (Fixed Satellite Service) Earth Stations

16. The record demonstrates that FSS earth stations in the 28 GHz band can share the band with minimal impact on terrestrial operations. For example, EchoStar argues that 28 GHz Earth-to-space stations would not curtail the deployment of 5G systems outside a few very small non-urban areas. EchoStar and ViaSat both estimate that terrestrial mobile stations could be deployed as close as 170 meters to their Earth-to-space transmitters in the 28 GHz band. SES Americom suggests “carving out some rural areas where future gateway earth stations can be licensed for use in the 28 GHz band.” With respect to terrestrial operations, AT&T, Nokia, Samsung, T-Mobile, and Verizon estimate that the necessary separation distances between FSS earth stations and terrestrial deployments are between 50 and 400 meters depending on the type of earth stations. Therefore, the Commission finds that it is in the public interest to create rules that allow for continued and expanded sharing between terrestrial operations and FSS earth stations in the 28 GHz band.

17. The Commission recognizes that sharing may be more difficult for non-geostationary satellite systems, such as the system operated by O3b. While O3b argues that it needs multiple sites in a county in order to serve customer locations, it ignores the Commission’s decision that it was allowing FSS to access the 28 GHz band solely for the purpose of providing limited Earth-to-space gateway-type services. O3b had no reasonable expectation that the Commission would grant earth stations designed to serve customer locations priority over fixed LMDS services and mobile services that the Commission contemplated would become part of LMDS. O3b estimates that the preclusive distance for its gateway earth stations with respect to mmW mobile stations is between 1.2 and 13.8 kilometers. Nonetheless, the Commission believes that sharing is feasible for O3b. First, as discussed

below, the Commission is grandfathering O3b’s existing earth stations in Texas and Hawaii. Second, O3b has the option of locating future earth stations in relatively remote areas. Third, O3b can obtain protection by purchasing an exclusive use terrestrial license at auction or by working with a licensee in the secondary market to partition a license area with sufficient size to allow it to deploy additional earth stations without impacting terrestrial operations, or enter into a different type of negotiated sharing arrangement. Fourth, O3b can take advantage of shielding or other mitigation techniques. Comsearch characterizes satellite operators’ use of naturally occurring terrain features as follows:

Before the great explosion of satellite communications for all types of uses, earth station sites were carefully selected with protection from interference the primary consideration. Most locations were many miles from the cities that they were serving, with the ideal earth station site being naturally shielded by terrain at a spot, which was calculated to be virtually free of interfering signals. For most types of communication, this type of isolation is not required, although it is still true that the most important aspect of a site is its shielding.

There are many naturally occurring terrain features that are capable of providing terrain shielding for NGSO gateway stations and shielding can also be provided by creating berms or other man-made barriers.

18. In short, while allowing new earth stations in the 28 GHz band is not without cost to terrestrial licensees, the Commission believes that the small area encumbered by a new earth station (with the limits noted below) will minimize such costs and will allow both satellite and terrestrial services to expand and coexist. Furthermore, satellite operators deployed in this band knowing that they were secondary licensees with respect to LMDS, that the Commission had chosen to allow only limited satellite use, and that the Commission had long envisioned allowing mobile use in the band. Despite these facts, below the Commission creates a path to further expand satellite gateways that could add thousands of new sites because the Commission believes the relatively small protection zones will have little impact on terrestrial use.

b. Licensing of FSS Earth Stations

19. The Commission maintains the current status of FSS, and as described below, creates new opportunities for continued expansion of FSS earth stations on a protected basis. Upgrading

the FSS designation to co-primary status, even if limited to individually licensed earth stations, would be inconsistent with terrestrial use of this band and the Commission’s decision to facilitate expanded terrestrial use, and would not effectively facilitate sharing in the band. The Commission believes the 28 GHz band will play a vital role in the deployment of advanced mmW services, and fully upgrading FSS under the Commission’s service rules to co-primary status would be inconsistent with this goal and would be unnecessary to meet the FSS community’s needs.

20. The Commission recognizes, however, that FSS operators rely on this band for gateway connectivity and have invested significant capital in the band and will continue to do so in the future. The Commission believes there is value in creating meaningful, targeted opportunities to deploy additional FSS earth stations in the band without harming terrestrial operations. The *NPRM*’s proposals encouraging satellite operators to participate in county-sized (or smaller) market transactions were predicated in part on the vast protection zones that satellite operators have traditionally claimed were necessary, either to protect their operations or to protect others from them. Here, there is a consensus that much smaller protection zones are needed. EchoStar and ViaSat have both estimated that terrestrial mobile stations could be deployed as close as 170 meters to their Earth-to-space transmitters in the 28 GHz band. Most other satellite operators either support those specific calculations, agree in general terms that the necessary preclusive zones can be very small, or state that gateway earth stations can be located in rural areas far away from the urban cores where mmW mobile operations will be most viable.

21. The ability of satellite earth stations and terrestrial operations to coexist in close proximity to each other has two significant ramifications. First, it should be possible for satellite and terrestrial services to share the 28 GHz band with *de minimis* impairment of each other’s operations. Second, the disparity between the county-sized license areas the Commission has established for 28 GHz UMFUS licensees and the extremely small areas required for FSS earth stations makes it inappropriate for the Commission to rely exclusively on a market-based mechanism for assigning rights to FSS earth stations, although the Commission retains this option as one means through which FSS operators may expand.

22. In addition to acquiring the terrestrial license rights, the

Commission also concludes that it would be efficient to continue to authorize gateway satellite earth stations under the existing part 25 first-come, first-served basis. The Commission adopts a mechanism under which FSS earth stations will, so long as they comply with conditions noted below, be able to deploy new gateways in limited circumstances without being required to take any additional actions to provide interference protection to UMFUS licensees. The Commission builds this upon record support for several different approaches to sharing in the 28 GHz band.

23. The authorization of FSS earth stations in the 27.5–28.35 GHz band that will not be required to take any additional actions to provide interference protection to UMFUS licenses is subject to the following conditions. First, the Commission will authorize no more than three locations in each county where FSS may deploy earth stations on a protected basis. Second, an FSS applicant must demonstrate in its license application that the permitted interference zone around its earth station, which the Commission will define as the contour within which FSS licensees generate a PFD, at 10 meters above ground level, of no more than $-77.6 \text{ dBm/m}^2/\text{MHz}$, together with any preexisting earth stations located in the same county on a protected basis, will, in the aggregate, cover no more than 0.1 percent of the population of the county license area where the earth station is located.¹ Third, the applicant must show that the permitted interference zone does not infringe upon any major event venue, arterial street, interstate or U.S. highway, urban mass transit route, passenger railroad, or cruise ship port. The Commission notes that Verizon supports prohibiting siting earth stations near athletic and/or entertainment venues, interstate and U.S. highways, and port facilities. The Commission believes the other locations the Commission has identified are similarly areas where the Commission could expect to have high demand for wireless services. Fourth, prior to filing its application, if there is an existing 28 GHz UMFUS licensee in the county

where it is proposing to locate its earth station, the earth station applicant must coordinate its operation with the existing UMFUS licensees using the coordination procedures contained in § 101.103(d) of the Commission's rules. The purpose of the coordination is to ensure that the earth station will not interfere with existing facilities operating under the UMFUS license. The Commission expects that UMFUS licensees will cooperate in good faith in the coordination process and only raise objections if there is a legitimate concern about interference to existing UMFUS facilities or failure to comply with the criteria listed above.

24. These conditions are designed 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. Since there are over 3,000 counties in the United States, with a potential for up to three locations in each county, FSS licensees would have many choices for earth station locations. Furthermore, even with the conditions the Commission has imposed, FSS operators will have great flexibility in selecting earth station locations that meet their needs. Taking ViaSat's 160-meter radius estimate as a point of departure, the typical interference zone for terrestrial operations around a gateway earth station would cover about 0.08 square kilometers. As ViaSat notes, this zone could be reduced further by reducing the preclusive distance around the earth station, using mitigation techniques such as shielding. Even without such reductions, the interference zone would represent only about 0.0033 percent of the area of an average U.S. county. If one were to assume an even population distribution throughout every county, ViaSat's interference zone would cover no more than 0.1 percent of the population of any county that covers more than 80 square kilometers. There are only four counties in the United States that cover less than 80 square kilometers. In addition, any interference zone will be allowed to accommodate multiple FSS earth stations that could, for instance, be serving different satellites in the geostationary orbit, as long as these earth stations, in the aggregate, do not cause the interference zone to exceed the limits the Commission adopted in this *Report and Order*.

25. Conversely, the Commission believes that allowing FSS earth stations to share the 28 GHz band under these conditions will not unduly hinder terrestrial deployment in the band. The

Commission notes that existing LMDS licensees are obtaining valuable mobile rights, and the value of those rights far outweighs any impairment imposed by this sharing mechanism. In addition, under the rules the Commission adopted, the Commission believes that FSS operations will encumber only a small geographic area and a small portion of the population of the license area. While the Commission maintains flexibility for FSS operators to choose the areas that fit within these conditions, current and future licensees will have some ability to predict the potential impact on the license area.

26. Other than applying those conditions, the Commission does not propose to designate the locations of any county's satellite permitted interference zones in advance—*i.e.*, the Commission will leave the choices of locations to the discretion of the satellite operators, conditional upon the licensees constructing and activating their earth stations within 12 months, pursuant to § 25.133 of the Commission's rules.

27. The Commission also notes that FSS operators will have other mechanisms available to deploy earth stations that do not have to protect terrestrial services. The Commission will adopt its proposal to grant such rights to any FSS earth stations for which the FSS operator also holds the UMFUS license that covers the earth station's permitted interference zone. To the extent FSS operators and UMFUS licensees enter into private agreements, their relationship will be governed by those agreements. Finally, FSS earth stations may continue to be authorized without the benefit of an interference zone. In this respect, taking into account the small size of the area around an earth station where terrestrial operations would not be protected, the Commission encourages 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. The Commission emphasizes that these FSS earth stations will 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.

28. The Commission also modifies its proposal in the *NPRM* for treatment of existing FSS gateway earth stations. Since the Commission is no longer requiring FSS operators to obtain an UMFUS license in order to obtain the right to interfere, the Commission will not grant UMFUS licenses to existing FSS earth station holders. Instead, the Commission will grandfather all

¹ The International Bureau will 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 will also seek comment on best practices for earth station siting to minimize the impact on UMFUS services, collocation of earth stations, and accommodating multiple earth station interference zones without exceeding 0.1 percent of population in a given county.

existing 28 GHz FSS earth stations authorized as of the adoption date (July 14, 2016) of this *Report and Order* and grant them the right to operate under the terms of their existing authorizations without taking into account possible interference to UMFUS operations. The Commission will also grandfather pending applications for 28 GHz earth stations filed prior to the adoption date of this *Report and Order* if such applications are subsequently granted pursuant to the existing part 25 rules (*i.e.*, without regard to the criteria the Commission adopted). The Commission notes that in many instances, these earth stations are used to provide valuable services to customers. In areas where there is no existing LMDS licensee, a new UMFUS licensee will have the ability to take the existing FSS earth station into account before it acquires the license or plans deployment. Even in areas where there is an existing LMDS licensee, Samsung's analysis demonstrates that existing earth stations will have a small impact on the terrestrial licensee. Finally, the Commission notes that AT&T and Verizon support grandfathering existing earth stations.

29. In adopting these rules, the Commission acknowledges with appreciation the efforts that AT&T and EchoStar have made to forge a compromise proposal that would be acceptable to other parties. The Commission declines to adopt their compromise proposal because it would have provided less predictability regarding the locations of future earth stations, and it would have limited the ability of FSS to deploy near population centers even if the deployment affected a small percentage (or even none) of the population. By contrast, the sharing mechanism that the Commission adopted will provide predictability to terrestrial licensees while giving FSS the opportunity to greatly expand their operations to over 9,500 locations. The Commission believes the rules that the Commission adopted will encourage intensive use of the band by both UMFUS and FSS licensees.

c. Aggregate Interference to Satellite Receivers

30. The second issue that must be considered with respect to satellite-terrestrial system coexistence is aggregate skyward interference to satellite receivers. There is a concern on the record 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. The most detailed

concerns about aggregate interference are raised in *ex parte* presentations by O3b, SES, ViaSat, and a group referring to themselves as Satellite Operators. For the reasons noted below, the Commission concludes that the potential for aggregate interference rising to the level of harmful interference is unlikely and thus is not a basis for refusing to authorize mobile service in the 28 GHz band, and the Commission declines to establish any regulatory limit on aggregate power levels.

31. Under the Commission's rules, FSS is secondary to LMDS fixed and mobile operations in the 28 GHz band. The Commission's rules specifically state, "FSS is secondary to LMDS in [the 27.5–28.35 GHz] band." Internationally, this band is allocated to the FSS and the fixed and mobile services on a co-primary basis. The Commission recognizes that there are non-U.S. licensed FSS networks in this band, and that the United States needs to protect those systems consistent with its relevant international obligations. This framework exists in other bands where FSS shares spectrum with terrestrial services internationally, such as the C-band. Contrary to Lockheed Martin's assertions, the Commission is not violating U.S. international treaty obligations by adopting rules that will enable the provision of UMFUS in the 28 GHz band without first resolving potential aggregate interference issues. As discussed below, the Commission concludes that the risk of aggregate interference is low. In the event, however, that there is an instance where a non-U.S.-licensed FSS network receives harmful interference, the Commission intends to address such interference in accordance with applicable U.S. international treaties, and will monitor industry developments to that end. The Commission rejects ViaSat's argument that the Commission granted FSS primary status over mobile operations. ViaSat relies in part on the following passage from the *LMDS First Report and Order*:

We are designating discrete spectrum bands for specific types of systems. Services designated for domestic licensing priority are specified in capital letters in the graphic depiction of the band plan. These services have licensing priority vis-à-vis any other type of service allocated domestically or internationally in the band. Lower-case letters indicate services in a particular band segment which also have licensing priority vis-à-vis any third service allocated domestically or internationally in the band, but have no licensing priority over the service in capital letters in the band segment and must operate on a non-interference basis

and must accept interference vis-à-vis that service.

Contrary to ViaSat's view, the Commission can, and in fact did, establish priority for mobile services through its service rules. ViaSat claims that FSS retains primary status over any new mobile service, because the Commission established priority only for LMDS. This argument fails because mobile service is part of LMDS, and is not a "third service" or a "new service." The mobile allocation already existed at the time of the *LMDS First Report and Order*, but the Commission made no distinction between fixed and mobile service in terms of priority—it established priority for a terrestrial service over a satellite service. The Commission contemplated that LMDS, the designated primary service, could eventually obtain mobile rights. Indeed, it "kn[e]w of no reason why we would not allow mobile operations if they are proposed and we obtain a record in support" thereof. It declined to authorize mobile operations "for now," not because of concerns about coexistence with FSS (which it had already designated as secondary due to the infeasibility of sharing at that time), but because it was unclear that the technology existed to facilitate mobile operations and whether mobile operations could share with fixed operations. The actions, the Commission is taking, are precisely the actions the Commission contemplated when it established service rules for LMDS—adding mobile rights to existing LMDS licenses.

32. The Commission also notes that if the Commission had intended to make mobile operations secondary to FSS, it could have very clearly done so by explicitly stating that FSS had priority over the mobile allocation. In the *LMDS First Report and Order*, when the Commission intended to discuss the mobile allocation, it specifically referred to the mobile allocation. If the Commission intended to make mobile secondary to FSS, it could have specifically referred to mobile instead of a "third service." Indeed, when the Commission talked of mobile services in the 28 GHz band, it said that authorizing such services "would be consistent with the Commission's goal of providing LMDS licensees with maximum flexibility in designing their systems." If the Commission intended to treat mobile services independently of LMDS, it would not have referred to providing flexibility to LMDS licensees.

33. FSS operators received multiple notices of their secondary status. Indeed, in the *LMDS First Report and*

Order, the Commission specifically rejected a request from GE Americom to provide some protection to FSS gateways as “inconsistent with the designation of FSS for secondary licensing priority in the 27.5–28.35 GHz band.” As ViaSat recognizes, FSS license conditions in the 28 GHz band explicitly state that FSS operations in the 28 GHz band are on an “unprotected, non-harmful interference basis relative to LMDS.” The *NPRM* in this proceeding noted, “Twenty stations are licensed for Earth-to-space transmissions on a secondary basis in the 28 GHz band. . . .” That much being said, the Commission recognizes that FSS operators use the 28 GHz band to provide services and intend to provide additional services in the future.

34. However, the record in this proceeding does not demonstrate that the rules that the Commission adopted would significantly risk harmful interference to satellite operations because of aggregate interference received at the satellite receiver. Under the existing rules, LMDS stations have a maximum authorized transmit power of 55 dBW (85 dBm), versus the 75 dBm the Commission adopted. Furthermore, LMDS can operate in either point-to-point or point-to-multipoint mode, and there are no existing limits on upward emissions. In contrast, the Commission adopted lower power limits for base-station and mobile operations in UMFUS. Furthermore, the systems contemplated for these bands have several characteristics that will tend to limit transmissions towards satellite receivers. As noted in the *NPRM*, most industry evaluations of potential mmW mobile base station deployments appear to assume that such stations’ antennas will be tilted downward at a slight angle, typically from a street lamp pole or a location on a building at a similar height. Intel explains that this configuration is necessary not only to direct transmissions toward user equipment but also to limit interference between adjacent cellular base stations. In fact, says Intel, failure to adopt this downtilt configuration would impair throughput to users at cell edges by about 60 percent. Although ViaSat expresses concern that in some limited locations mobile base stations might be directed skyward to provide coverage to users in the upper floors of tall buildings, because of this need for downward coverage such mobile providers can rely on wired in-building facilities where necessary. Mobile base stations in this band will probably use antenna systems that employ dynamic

beamforming techniques to produce beams as narrow as 1.0 degree, which will substantially reduce the likelihood that such beams will point directly at satellite receivers. User equipment will also employ antenna arrays to generate dynamic beamforming, varying both azimuth and elevation in order to maintain signal connections with their base stations. Again, terrestrial operators are likely to deploy this technology of their own accord: By Intel’s analysis, choosing not to use dynamic beamforming technology would reduce throughput at cell edges by about 70 percent. Base stations and user equipment will also likely employ dynamic power control, both to avoid draining batteries and to limit intersystem interference. In fact, both base stations and user equipment could be entirely silent much of the time; terrestrial operators report that, in current deployments, network loading rarely exceeds 30 percent. All of these features will limit the extent of skyward transmissions from terrestrial mobile systems.

35. In addition, it is important to recognize that most mmW transmissions will likely not occur in environments that have line of sight to satellites. By some estimates, as much as 80 percent of smartphone use occurs indoors, with much of the remainder occurring in vehicles. Because mmW signals are heavily attenuated by exterior walls, roofs and windows, signals originating from handheld smartphones will be largely confined within any buildings or vehicles where they are used, and would need to be relayed to mobile base stations by other devices with exterior antennas that will likely have sufficient beamforming ability to limit skyward transmissions. In principle, spilling signal power uselessly into outer space would represent a source of inefficiency, so it is likely that dynamically beamformed signals will be aimed at receivers on the ground or not far above it. The most vulnerable satellites—those situated at elevations close to the horizon—will be protected further by the path losses that terrestrial signals will encounter in the cluttered environments of street canyons, suburban foliage, and other obstacles.

36. The Commission has reviewed the studies submitted by the various parties, including the satellite operators. As discussed in the Technical Rules section, *infra*, the Commission concludes that the various studies submitted by the parties do not support establishment of an aggregate interference limit. From the satellite operators’ perspective, part of the challenge is that mmW mobile is a new,

rapidly evolving technology, and the terrestrial mobile industry is still developing system designs and propagation models. Even so, there has been substantial progress in that regard, and 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. O3b, for example, assumes that mmW mobile user equipment will employ no beamforming at all, and will generate omnidirectional signals. Interference models submitted by other parties do not adequately account for, and in some cases do not take into account at all, antenna beamwidths, downtilts, beamforming, power control, traffic patterns, number of simultaneously transmitting stations, the obstruction losses that terrestrial signals are likely to encounter before reaching satellites at low elevations, and the fact that the majority of transmissions will occur indoors. Terrestrial operators have every incentive to design networks that direct the signals they are transmitting to the locations of the receivers—either another fixed point on a vertical structure, or a mobile unit within a couple of meters of the ground—especially given the propagation characteristics of these frequencies. Furthermore, mobile units, which are likely to be transmitting at angles more skyward, are operating at powers significantly lower than base stations. These are both true regardless of the types of systems that are ultimately deployed in these bands. Nonetheless, given the wide variety of deployments and uses the Commission expects to see in these bands, it would be inappropriate to universally mandate these design features in every deployment, in the absence of more credible support for the proposition that satellite systems will receive harmful interference from mmW mobile systems.

37. The Commission’s decision not to set specific limits on aggregate interference is consistent with the Commission’s treatment of that issue in other bands. In AWS–3, the Commission declined to establish aggregate power limits to protect Federal satellites in the 1761–1780 MHz band because it was unlikely that aggregate interference was likely to occur. Similarly, in the 10.7–11.7 GHz band, which is shared between FSS and Fixed Service (FS), the Commission held with respect to concerns regarding a different type of aggregate interference: “[W]e view rule changes that would allow greater FS use of the 11 GHz band as beneficial to the

public interest, so long as existing users would not be harmed.” Similarly, the Commission sees great public benefit to more intensive terrestrial use of the 28 GHz band where terrestrial use is the primary designated service in the band.

38. The Commission has concluded that the satellite industry has not shown that it has a legal right to protection from aggregate interference or that harmful aggregate interference is likely to occur from the mobile operations now being authorized for LMDS. The Commission also recognizes that SES, EchoStar, and ViaSat believe that satellite and mobile operations can coexist. Nonetheless, the Commission is sensitive to the concerns raised. The Commission notes that the satellite and wireless industries have begun the process of modeling the terrestrial systems under consideration for this band to provide further information concerning their potential impact on satellites. The Commission encourages both industries to continue working cooperatively on this issue, including by submitting any relevant data demonstrating changes in the amount of aggregate interference on record as UMFUS services are deployed. The Commission directs the International Bureau (IB), the Office of Engineering and Technology (OET), and the Wireless Telecommunications Bureau (WTB) to jointly establish a separate docket that parties can use to file the relevant data and analyses, and the Commission reserves the right to revisit this issue should additional information or other circumstances warrant further Commission review or action.²

5. Band Plan

39. The Commission will license the 28 GHz band as two 425 megahertz blocks. The Commission believes 425 megahertz channels will be sufficient for a licensee to provide the type of high data rate services and other innovative uses and applications contemplated for this spectrum. The fact that several carriers support dividing the bands into multiple blocks supports that conclusion. The Commission also agrees with T-Mobile that there are benefits to competition in allowing multiple licensees to provide service in the 28 GHz band.

² In the *NPRM*, the Commission also sought comment on the possibility of repealing the prohibition on FSS user equipment in the 28 GHz band. While there has been considerable comment on this issue, in light of the evolving nature of technology and deployment in the band, the Commission does not believe the issue is ripe for action at this time. Accordingly, the Commission will consider this issue in the future, either in this proceeding or in a separate proceeding.

40. The Commission emphasizes that existing LMDS Channel A1 licensees will receive licenses for both channels, so they will maintain their existing license rights. To the extent licensees are interested in having a contiguous block of 850 megahertz of spectrum, they are free to acquire both licenses, subject to compliance with the Commission's spectrum aggregation policies.

B. 39 GHz Band (38.6–40 GHz)

41. In the *NPRM*, the Commission proposed to develop service rules for mobile operations in the 38.6–40 GHz band (the “39 GHz Band”). This band is currently allocated to the fixed, fixed satellite (space-to-Earth), and mobile services on a primary basis for non-Federal use. There are Federal FSS (space-to-earth) and Mobile Satellite Service (MSS) (space-to-Earth) allocations in the 39.5–40 GHz band, limited to military systems.

42. The 39 GHz band is licensed by EA and consists of 14 blocks of 50 by 50 megahertz channels. Out of the 2,464 possible terrestrial fixed service EA licenses available in this band (14 channel pairs for each of 176 EAs) only 870 licenses currently exist. Other licenses were voluntarily cancelled or terminated for failure to meet substantial service requirements. In addition, there are currently 229 active Rectangular Service Area (RSA) licenses that predate the creation of the EA licenses in which the licensees self-defined their service area, and where they retain the exclusive right to operate. The populations in licensed areas (both EA and RSA licenses) vary by channel, but in aggregate they cover about 49 percent of the U.S. population. The Commission has previously indicated that licensees of the band could have the flexibility to provide mobile service and stated the belief that “the issue of technical compatibility of fixed and mobile operations within a service area is one that can and should be resolved by the licensee.” The Commission declined, however, to permit mobile operations until it conducted a separate proceeding to resolve any inter-service and inter-licensee interference issues. As a result, no mobile operations currently exist in the 39 GHz band. To accommodate high-density fixed terrestrial systems under a “soft segmentation” band plan, the Commission has established lower PFD limits for satellite transmissions in the 37.5–40 GHz band than in other satellite bands. The Commission notes that there are no commercial satellite operations in the band.

1. Suitability for Mobile Service

43. The Commission will authorize mobile operation in the 39 GHz band (38.6–40 GHz), and the Commission will issue new licenses granting existing and new 39 GHz licensees both fixed and mobile rights. The Commission believes that the significant bandwidth available in this band will help to accommodate the expected continued rise in demand for mobile data. Commenters, including incumbent terrestrial licensees, overwhelmingly support opening the band for mobile use and expanding their reach to mobile. The Commission agrees and believes the band can be used by both mobile and satellite because satellite use can be accommodated with minimal impact on terrestrial service. The Commission created the service rules to enable such mobile use, and the Commission detailed the means by which satellite must cooperate with new mobile services in these bands to reduce interference and improve service.

2. Licensing the 39 GHz Band

a. Use of Geographic Area Licensing

44. The Commission adopted geographic area licenses that will grant licensees the flexibility to provide fixed and mobile services. As with the 28 GHz band, the Commission finds that in this band, geographic area licensing will expedite deployment, provide licensees with the flexibility to provide a variety of services, and is consistent with the existing licensing scheme in the band. The Commission will maintain the current co-primary Federal FSS and MSS allocations and associated regulations in this band. The Commission also finds that the presence of incumbent geographic area licenses in a large part of the country renders the 39 GHz band a poor candidate for implementing an SAS-based sharing model.

b. License Area Size

45. The Commission will license the 39 GHz band using PEAs, because the Commission finds that use of this license area size will facilitate access to spectrum and the rapid deployment of service in the band. PEAs are smaller than BTAs or EAs, and therefore are more realistically obtainable by smaller bidders, yet are larger than counties which various commenters deem too small. Licensing the 39 GHz band on a PEA basis strikes the 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. PEAs also nest into

EAs but can also be broken down into counties, allowing operators to combine or partition their PEAs into the license areas of their choice. The Commission believes that the size and ability to combine/partition will aid in the rapid deployment of these licenses. The Commission's decision to license the 39 GHz band on a PEA basis is distinguishable from the Commission's decision to use counties as the license area in the 28 GHz band, because, as previously discussed, the latter band is currently licensed by BTAs and cannot readily be reformed into either EAs or PEAs.

3. Mobile Rights for Incumbents

46. The Commission adopted its proposal to grant mobile operating rights to existing active 39 GHz licensees for the same reasons the Commission granted mobile operating rights to LMDS incumbent licensees. Granting mobile operating rights to existing licensees will expedite the deployment of service, minimize the difficulties involved in coordinating fixed and mobile deployments, and provide a uniform licensing scheme throughout the United States. In contrast, separating fixed and mobile rights through assignment of overlay licenses would delay the implementation of mobile service. The Commission remains concerned that awarding fixed and mobile rights separately would lead to disputes between fixed and mobile licensees that could make it more difficult for both licensees to provide service.

47. The Commission recognizes that awarding mobile rights to incumbent licensees could be viewed as a windfall to those licensees, although the Commission contemplated granting mobile rights when it first created LMDS. Here, the benefits of expediting service and facilitating the coordination of fixed and mobile service outweigh any potential disadvantages of granting mobile rights to incumbents.

4. Non-Federal Satellite Terrestrial Sharing—Licensing of Gateway Earth Stations

48. The *NPRM* invited comments on three issues relating to FSS use of the radiofrequency spectrum from 37.5 GHz to 40 GHz, encompassing both the 38.6–40 GHz (39 GHz) band and the 37–38.6 GHz (37 GHz) band. The first question was whether the Commission should make any changes to its treatment of gateway earth station applications; the second, whether it would be reasonable to eliminate the prohibition against ubiquitous deployment of user equipment; and the third question,

whether it would be feasible to allow satellite operators to increase their PFDs above existing limits during heavy rain storms. In none of those cases did the Commission foresee any reason to differentiate between the 37 GHz and 39 GHz bands with respect to satellite sharing issues.

49. The U.S. Table of Frequency Allocations accords co-primary status to FSS earth stations in the 37.5–40 GHz frequencies, but Commission rules provide that gateway earth stations in the 39 GHz band may be deployed only if the FSS licensee obtains a 39 GHz license for the area where the earth station will be located, or if it enters into an agreement with the corresponding 39 GHz licensee. The Commission mentioned the changes that the *NPRM* was proposing for the licensing of satellite operations in the 28 GHz band and sought comment on whether similar changes should be adopted for the 37.5–40 GHz channel groups. The *NPRM* asked whether the Commission should establish a waiver process by which non-Federal FSS earth stations in the 37.5–40 GHz bands could acquire co-primary status in areas where there is no geographic service area licensee, if they can demonstrate that doing so would not have a negative impact on future terrestrial service. The Commission asked if the fact that 37.5–40 GHz FSS operations are space-to-Earth, rather than Earth-to-space as in the 28 GHz band, should lead to different answers to these questions. The Commission also sought comment on any other changes it should make to the existing rules.

50. Commenters acknowledge that the space-to-Earth nature of satellite operations in the 37.5–40 GHz bands means that it is earth stations that need protection against interfering signals from terrestrial operations rather than the opposite situation that applies for Earth-to-space operations in the 28 GHz band. EchoStar calculates that satellite earth stations in the 37.5–40 GHz band will need exclusion zones with radii extending no more than about two kilometers. EchoStar states this radius in the 37.5–40 GHz bands is about 12 times the radius (170 meters) circumscribing the exclusion zone that EchoStar says is required for earth stations in the 28 GHz band. The areas required for the resulting exclusion zones would be about 138 times as large—12.6 square kilometers (4.9 square miles) for the 37.5–40 GHz bands versus 0.09 square kilometers (0.03 square miles) for the 28 GHz band. By comparison with the 28 GHz band, therefore, accommodating satellite earth stations in the 39 GHz band is

approximately two orders of magnitude more difficult.

51. The smallest counties mentioned in the Commission's discussion of satellite interference zones for the 28 GHz band each cover about 80 square kilometers. The exclusion area that EchoStar says is required for the 37.5–40 GHz frequencies would cover about 16 percent of such a county—a proportion that could seriously impair the growth prospects for mmW mobile. The challenge is less daunting when the Commission considers the possibility of authorizing earth station sites on a PEA basis rather than a county basis. The average PEA in the 48 contiguous U.S. states covers about 18,692 square kilometers (7,217 square miles). Therefore, the requisite exclusion zone would cover about 0.0674 percent of the average PEA's land mass in the contiguous U.S. If people were evenly distributed across this hypothetical average PEA, substantially less than 0.1 percent of its population would fall in the earth station's exclusion zone.

52. These calculations show that some PEAs should be able to host a 39 GHz earth station without placing more than 0.1 percent of the PEA's population in the earth station's exclusion zone. Most PEAs cover substantially less territory than the average PEA does; *i.e.*, even for some PEAs, a five square-mile exclusion zone might affect an unacceptably high proportion of their populations. But satellite operators will not necessarily need to deploy 39 GHz earth stations in the smaller, more densely populated PEAs. For satellite gateway earth stations in particular, the *sine qua non* is not proximity to population centers, *per se*, but access to long-haul, high data-rate Internet facilities. Direct access to long-haul Internet nodes is available not just in major population centers but also in some of the more remote parts of the U.S. Many of those nodes are in places with comparatively low population densities—*i.e.*, near areas where it should be possible to deploy earth stations without creating exclusion zones that affect unacceptably high proportions of the population. In addition, as the Commission suggested for the 28 GHz band, satellite operators can 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. Spatial analysis software can process digital elevation data to identify geographic depressions, which are capable of providing natural site-shielding in all directions. For earth stations that communicate only with geosynchronous satellites, more limited site shielding would typically suffice. In

addition, satellite operators may continue to protect their earth stations from interference using any of four market-oriented mechanisms: Purchasing geographic area licenses at auction, acquiring licenses from existing licensees, obtaining partitioned segments of existing geographic area licenses from existing licensees, or obtaining contractual agreements from nearby licensees not to interfere into their earth station operations.

53. Based on those considerations, the Commission will authorize non-Federal satellite earth stations in the 39 GHz band on a first-come, first-served basis that will entitle them to protection from terrestrial transmissions subject to the following conditions.³ 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 will authorize a maximum of three protection zones in each PEA, so the applicant must demonstrate that there are no more than two existing protection zones in the PEA or demonstrate that its protection zone will be contiguous to any preexisting satellite protection zone. Third, the applicant must demonstrate the existing and proposed protection zones, in the aggregate, will not cover more than 0.1 percent of the PEA's population.⁴ Fourth, the applicant must show that the protection zone does not infringe upon any major event venue, arterial street, interstate or U.S. highway, urban mass transit route, passenger railroad, or cruise ship port. Finally, the earth station applicant must 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. The coordination requirements will be based on the Commission's existing requirements contained in § 101.103(d) of the Commission's rules. If the earth station

is authorized, UMFUS licensees will be prohibited 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.

5. Band Plan

54. The Commission will create seven 200 megahertz bands out of the 39 GHz band (38.6–40 GHz). The Commission finds that this channel size is large enough to take advantage of the data throughput capacity of these bands yet yields a sufficient quantity of channels in the band to provide access to multiple operators simultaneously. The Commission agrees with the comment that next generation 5G networks are expected to depend in part on higher frequencies, increased spectral efficiency and greater density of cell deployments and that these factors alone may be insufficient to meet the expected tenfold increases in peak data rates and user throughput without using ultra-wide channel bandwidths of at least 200 MHz. These wider channels available at higher frequencies could allow for higher data rates in environments constrained by power or signal-to-noise ratios. By facilitating higher throughput, wideband channels will thereby permit more users to simultaneously use the band.

55. The Commission also modified the current band plan that is based on paired spectrum blocks in favor of larger, unpaired channels to enable Time Division Duplexing (TDD) which commenters believe will best enable a 5G mobile service environment. Straight Path asserts that TDD is preferable in these frequencies given the current lack of adequate frequency duplexers capable of meeting the performance, cost or form factor requirements necessary to facilitate Frequency Division Duplexing (FDD) at these higher wavelengths. TDD does not require a frequency duplexer and allows flexible downlink-uplink ratios that depend on traffic and result in efficient utilization of spectrum. While these and other commenters note the benefits of TDD in the context of 5G, commenters overwhelmingly support rules that allow for flexible duplexing schemes, and the rules the Commission adopted will allow any type of duplexing. Licensees may also continue to offer FDD service by acquiring and pairing multiple spectrum blocks. Because the existing channel plan favors FDD operation and limits flexibility to accommodate other duplexing schemes, reconfiguring the channel plan will remove obstacles to TDD schemes while

still allowing for flexibility to accommodate FDD. Furthermore, larger bandwidths may optimize traffic management and improve system performance because a single, wide carrier permits centralized spectrum management whereas aggregation and use of various narrow bandwidth channels requires greater power consumption and equipment complexity. Finally, 200 megahertz channels will potentially create several empty channels for new entrants after incumbent licensees swap or repack their existing systems into consecutive or adjacent channels. Given all of the considerations above, the Commission finds that 200 MHz channels are the best band size for 39 GHz.

6. Pre-Auction License Reconfiguration

56. Straight Path's proposal contains the clearest delineation of rules and steps necessary to align adjacent spectrum tranches to create contiguous bands—the goal advocated by commenters. The Commission agrees with Straight Path that in EAs where only it holds licenses, the Commission should accept any exchange application in which Straight Path or others propose to acquire the same amount of spectrum in the market that it proposes to relinquish as long as it meets the end goal of creating a contiguous block or blocks of spectrum. In instances where there are multiple geographic area licensees, Straight Path advocates that the Commission should first accept any band plan mutually acceptable to the various licensees as long as it also increases the amount of contiguous spectrum for at least one of the licensees. If licensees do not agree on a band plan, Straight Path argues the Commission should accept applications in which an incumbent geographic area licensee seeks to acquire any contiguous spectrum blocks adjacent to spectrum blocks it already holds subject to two limitations (i) the target spectrum block is not already occupied by another incumbent geographic area licensee; and (ii) the target spectrum block could not be requested by another incumbent geographic area licensee on the grounds that it is adjacent to a block it holds or that it could hold. A licensee should be able to continue to add contiguous unused blocks in a row until it reaches a prohibited block—*i.e.*, a spectrum block that could also be claimed by another incumbent licensee. Straight Path suggests that in this way, contiguous occupied bands could be aligned starting at the lower edge of the band—at 38.6 GHz—and moving up toward 40 GHz. Because the Commission adopted a band plan for the

³ The Commission adopted a new footnote, NG63, to the Allocation Table that reflects the existing limitation to gateway earth stations. See 47 CFR 25.202(a)(1) n.3.

⁴ The IB will issue a public notice seeking comment on the appropriate methodology to calculate the 0.1 percent population limit and will also seek comment on best practices for earth station siting to minimize impact on UMFU services, collocation of earth stations, and accommodating multiple earth station interference zones without exceeding 0.1 percent of population in a given PEA.

37 GHz band that provides for continuity of commercial operations across the 37 GHz and 39 GHz bands, when the bands are viewed together, Straight Path's swapping plan results in occupied spectrum in the middle of the combined bands. One alternative might be to push incumbents to the upper end of the band near 39.5 GHz, in order to create larger available swathes of spectrum by combining the lower frequencies with the open bands in the 37 GHz band. However, in the interest of addressing mobile data demand as quickly as possible, 39 GHz licensees at the bottom of the band will provide the first market for mmW mobile equipment as soon as it becomes available, and this will further the goal of interoperability by allowing fixed licensees to more rapidly foster the development of mobile in their bands.

57. Some of the 200 MHz spectrum blocks offered at auction will also contain at least one incumbent RSA licensee occupying some portion of the spectrum. Straight Path argues that where the incumbent geographic license holder is also the RSA licensee, the RSA license will be deemed not to exist and will be cancelled upon an exchange. Otherwise, incumbent licensees will only be permitted to elect to add contiguous channels with greater encumbrances than *vice versa*; accordingly, a geographic area licensee can always opt to exchange a block without an RSA for an adjacent block with an RSA whose operations it will have to protect, and similarly it can always opt to take a license area with a more encumbered RSA over a block it holds with a less encumbered RSA, but it cannot "upgrade" to an RSA-free block or a license with an embedded RSA that is less encumbered. Overall, although Intel and Straight Path have argued that EAs are the appropriate geographic area for new licenses given their historical use and the complexity of the swap process, as discussed above, the Commission's preferred license area size for the 39 GHz band are PEAs, and such PEAs neatly fit into the EAs they comprise. Accordingly, once incumbents' spectrum swapping has run its course at the EA level, the resulting license area/band combinations should be further broken down into PEAs, which 'nest' into EAs.

58. The Commission believes this reconfiguration process will yield a band, and licenses, that are more useable by incumbents as well as new entrants for the new flexible use services, including mobile broadband that the Commission is authorizing in this *Report and Order*. Straight Path currently holds 931 licenses out of

1,098. If Straight Path voluntarily reconfigures its rights as it has advocated, this will substantially reduce encumbrances (*i.e.*, remaining RSAs or blocks within EAs that have not been reconfigured) that might exist in new license areas before a future auction. While the Commission adopted a voluntary reconfiguration approach, it is its hope and expectation that all licensees will take advantage of this opportunity to convert their licenses to the new flexible use licensing scheme and band plan. Furthermore, while the Commission adopted a voluntary approach, the Commission notes that under Section 316 of the Act the Commission retains the right to modify any license consistent with the public interest.

C. 37 GHz Band (37–38.6 GHz)

59. The 37 GHz band presents a number of opportunities because, other than a limited number of existing Federal uses that need protection, the band is a greenfield—there are no existing non-federal operations, terrestrial or mobile. In addition, it is adjacent to the 39 GHz band, which presents an opportunity to create a larger, contiguous 37/39 GHz band, subject to similar technical and operational rules. Also, the Federal fixed and mobile service allocations are lightly used. The approach the Commission adopted takes full advantage of these opportunities.

60. Specifically, the Commission can meet the twin goals of expanding commercial access in this band while facilitating continued and expanded Federal use. Because there are both Federal and non-Federal fixed and mobile rights and there are minimal incumbency issues (or an installed base of equipment), the approach the Commission adopted in this band can significantly further the regulatory, policy, and technical approaches to Federal and non-Federal sharing. As discussed in greater detail below, the Commission adopted a band plan that allows for continuity of commercial operations between the 37 and 39 GHz bands, the Commission protects a limited number of Federal military sites across the full 37 GHz band, and the Commission identifies 600 megahertz of spectrum that will be available for coordinated coequal shared access between Federal and non-Federal users. Through this structure, additional proposals in the *Further Notice of Proposed Rulemaking (FNPRM)*, and the collaborative industry/government process that will take place to further define the sharing process and paradigm, the Commission will take

substantial strides forward on Federal and non-Federal sharing in the mmW bands while also making a significant amount of spectrum available for wireless broadband.

1. Suitability for Mobile Use

61. The Commission adopted rules to permit fixed and mobile terrestrial operation in the 37 GHz band to enable as wide a range of services as possible. The Commission finds that there are several important characteristics of the 37 GHz band that make the provision of fixed and mobile terrestrial operations especially promising: It contains 1.6 gigahertz of contiguous spectrum, which could support ultra-high data rates; it is contiguous with the 39 GHz band, which will permit operators to aggregate spectrum across both bands; and it has global co-primary fixed and mobile allocations, which could enable operators to achieve economies of scale. Cisco urges us to proceed cautiously, and Boeing urges the Commission to wait until the studies called for by the WRC-15 are completed, the Commission is persuaded that fixed and mobile terrestrial services can be provided in the 37 GHz band. In this regard, in analyzing the suitability of the 37 GHz band for mobile service, the band is very similar to the 39 GHz band. It has an existing mobile allocation, the propagation characteristics are very similar to the 39 GHz band, and the Commission does not see any inconsistency with other allocations that would make the band unsuitable for mobile service. In terms of timing of the Commission's action, considering the potential benefit for 5G services and the significant lead time that will be necessary to develop the services in this band, the Commission believes that the Commission should move forward and develop fixed and mobile terrestrial services rules for the 37 GHz band. Moreover, as discussed more fully below, the rules the Commission adopted accommodate the needs of National Aeronautics and Space Administration (NASA), National Science Foundation (NSF), the military, and FSS operations in the 37 GHz band as well as Earth Exploration Satellite Service (EESS) (passive) and Space Research Service (SRS) (passive) operations in the adjacent 36–37 GHz band.

2. Licensing the 37 GHz Band

62. The Commission adopted a licensing approach that makes five 200 megahertz blocks available on a geographic area-licensed basis in the 37.6–38.6 GHz portion of the band (upper band segment). The Commission

will make the 37–37.6 GHz block (lower band segment) available for coordinated co-primary sharing between Federal and non-Federal users, where non-Federal rights are granted by rule. The Commission notes that the entire band is subject to Federal co-primary fixed and mobile allocations. The Commission declines to adopt the hybrid authorization licensing scheme because it is unsupported by the record. Specifically, commenters oppose it because they do not believe that the 37 GHz band is appropriate for this particular scheme, though it could be used for other bands. In addition, the satellite industry expresses concern that the hybrid licensing approach does not provide satellite operators with any meaningful certainty that they will be able to expand into the 37 GHz band.

63. Of the three licensing options that the Commission sought comment on in the *NPRM*, the Commission finds that a variation of the Commission's alternative proposal best enables the band to be used for new commercial uses while simultaneously allowing fixed and mobile Federal use to expand. Although there is support in the record to license the entire 37 GHz band by geographic area, the Commission finds that it is in the public interest to license a portion of this band on a non-exclusive shared basis, and to license the remainder of the band by geographic area to give potential licensees additional opportunity to access large blocks of spectrum or to use 37 GHz spectrum in combination with, and similarly to, 39 GHz spectrum. Allowing part of the band to be made available on a non-exclusive, shared basis will promote access to spectrum by a wide variety of entities, support innovative uses of the band, and help ensure that spectrum is widely utilized. Adopting geographic area licensing for the other portion of the band will expeditiously make spectrum available and allow common development of the 37 GHz and 39 GHz bands. Furthermore, users in the shared portion of the band will benefit from efforts by equipment manufacturers and licensees to develop equipment for the portion of the band licensed on a geographic area basis. Thus, the Commission finds that adopting the alternative proposal, as modified below, should promote investment and deployment in both bands. As explained below, the Commission agrees that there are benefits to adopting the same geographic area licensing framework for the 37 GHz and 39 GHz spectrum bands. Also, the Commission finds that adopting the alternative proposal, in

addition to other decisions made by the Commission, provides satellite operators the certainty they need to be able to expand their operations into the 37 GHz band in the future.

64. The Commission adopted a modified version of the alternative proposal as follows: The Commission will create a band plan with a 600 megahertz shared block in 37–37.6 GHz and a geographically-licensed portion in 37.6–38.6 GHz. The lower band segment will be fully available for use by both Federal and non-Federal users on a coordinated co-equal basis. Non-Federal users, which the Commission will identify as Shared Access License (SAL), will be authorized by rule. Federal and non-Federal users will access the band through a coordination mechanism, including exploration of potential dynamic sharing through technology in the lower 600 megahertz, which the Commission will more fully develop through the *FNPRM* and through government/industry collaboration. The Commission envisions this segment serving as a proving ground for Federal and non-Federal sharing in the mmW bands, as a way to facilitate expanded Federal use in the band, an opportunity to facilitate lower-cost access to mmW bands, and a means for all providers to gain additional capacity where and when it is needed.

65. As described below, the Commission adopted the same technical rules for the shared band segment as the Commission does for the rest of the 37 GHz band. These technical rules are also consistent with the 39 GHz band. The Commission also adopted an operability requirement that will ensure equipment developed for the 37 and 39 GHz bands is able to operate across the entire 37–40 GHz band. This will help drive scale in the development and access to the equipment, and allow users in the shared portion of the band, including Federal users, to benefit. In order to ensure a sharing environment in 37–37.6 GHz that is predictable, manageable, and efficient, the Commission strongly encourages Federal users to comply with the same technical rules, and will work with National Telecommunications and Information Administration (NTIA) to explore establishment of guidance in its regulations.

66. Following the adoption of this *Report and Order*, the WTB and OET will, in collaboration with NTIA and Federal stakeholders, work with industry stakeholders and other interested parties to further define the sharing framework. The Commission will hold one or more public meetings

to examine the state of innovative sharing techniques and technologies and to have an open dialogue about how sharing can best be implemented and achieved in the 37–37.6 GHz band. The Commission strongly encourages both industry and Federal stakeholders to use new and existing experimental testbeds to develop sharing approaches and technologies. Based on stakeholder feedback, the WTB and OET may, jointly with NTIA, issue a public notice seeking comment on a refined and detailed 37 GHz sharing framework. In response to the record developed, the Commission, jointly with NTIA, will establish the 37 GHz sharing mechanism. The Commission believes this inclusive and collaborative process ensures that all parties' needs are met and that an effective and robust sharing mechanism will be developed.

67. In the upper band segment (37.6–38.6 GHz), the Commission will use geographic area licensing with PEAs as the licensing unit, which is consistent with the licenses in the 39 GHz band. In this band, there will be Federal co-primary use coordination zones around 14 military sites where the military will have the right to operate fixed and mobile operations, and the three SRS sites as described below. Non-Federal users will be able to access these locations through a coordination mechanism that will be developed and established by WTB and OET in conjunction with NTIA and announced via Public Notice. The Commission also recognizes that there are existing Federal and non-Federal fixed and mobile allocations in the upper band segment, and in the *FNPRM*, the Commission seeks comment on developing additional criteria under which Federal users can obtain access to the upper band segment.

68. The Commission believes licensing the 37 GHz band in this manner has many benefits. In the lower band segment, the Commission is creating an innovative shared space that can be used by a wide variety of Federal and non-Federal users. SALs will be widely available to provide easy access to spectrum, including for new innovative uses and for targeted access where and when providers need additional capacity. It will help further efforts to facilitate sharing between Federal and non-Federal users, and will give Federal users and consumers an opportunity to take advantage of speed-to-market and lower cost of broadly deployed commercial technologies, and provide Federal users opportunities for current use and future growth. In the upper band segment, the Commission notes that the 37 GHz band and the 39

GHz band will be licensed under the same framework, with identical technical and licensing rules. They will both be licensed by PEAs, which will allow licensees in the 37 GHz and 39 GHz bands to aggregate blocks of spectrum or to pair blocks of spectrum.

69. Below, the Commission discusses in further detail some of the decisions the Commission has made concerning the 37 GHz band. In the *FNPRM*, the Commission seeks comment on refining the sharing framework the Commission adopted.

3. License Area Size

70. The Commission is presented with a unique opportunity to adopt a licensing scheme that will apply to 2,400 megahertz of contiguous spectrum, the upper segment from 37.6–38.6 GHz together with the 38.6–40 GHz band. In the shared band segment, the Commission will authorize fixed and mobile users on a site-based coordinated basis. The Commission believes this approach will allow users to access spectrum where and when it is needed, which will help maximize spectrum by providing opportunities for each user to target just the areas it needs. The Commission is licensing the 39 GHz band by PEA. The Commission's reasons for adopting PEAs as the geographic area for the 39 GHz band apply here as well. Specifically, as the Commission noted with respect to the 39 GHz band, after reviewing the record, the Commission now believes that PEAs strike the 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. Thus, the Commission adopts the same geographic license structure for both the upper band segment of the 37 GHz band and the 39 GHz band. This decision will give licensees the flexibility that they need and will encourage investment in a wide variety of services and technologies.

4. Band Plan for Upper Band Segment

71. The Commission will divide the upper band segment into five blocks of 200 megahertz each for non-Federal users. As explained in this *Report and Order*, the Commission is attempting to create a consistent and coherent licensing framework that can be applied throughout the mmW bands, with modifications based on the characteristics of a particular band. The Commission's decision to choose 200 megahertz channels rather than 533 megahertz channels also stems, in part, from the Commission's previous

decision to create two licensing segments for the 37 GHz band: A 600 megahertz lower band segment licensed by rule, and a 1,000 megahertz upper segment, which will be licensed geographically by PEA. Adopting 200 megahertz channel sizes for the upper band segment is consistent with the 200 megahertz channels the Commission adopted for the 39 GHz band. Because the Commission licenses the upper band segment of the 37 GHz band and the 39 GHz band by PEA, licensees will have the flexibility to pair their 37 GHz license with a 39 GHz license.

72. In addition, the provision of fixed and mobile terrestrial operations at this frequency will depend upon large blocks of spectrum and a single 200 megahertz block provides a sufficient amount of spectrum for the provision of high-capacity wireless broadband. Those licensees needing more spectrum than a 200 megahertz channel can combine channels to create contiguous blocks of 200 megahertz channels, either within the 37 GHz band or by combining 37 GHz spectrum with 39 GHz spectrum. Licensees also have the option of acquiring 425 megahertz channels in the 28 GHz band.

D. 64–71 GHz Band

73. The Commission is making available the 64–71 GHz frequency band for use by unlicensed devices pursuant to the same technical standards as in the 57–64 GHz frequency band under § 15.255 of the Commission's rules, with slight modifications. As the Commission has consistently stated, it is optimal to include a balance of licensed rights and opportunities to operate on an unlicensed basis in order to meet the country's wireless broadband needs. The Commission's action here creates a 14-gigahertz segment of contiguous spectrum in these frequency bands to encourage the development of new and innovative unlicensed applications, and promote next-generation high-speed wireless links with higher connectivity and throughput, while alleviating spectrum congestion from carrier networks by enabling mobile data off-loading through Wi-Fi and other unlicensed connections.

74. The Commission is adopting rules to allow for unlicensed operations in the 64–71 GHz band, subject to the technical standards in § 15.255, thus creating a contiguous spectrum segment with the 57–64 GHz band. The Commission observes that unlicensed WiGig devices using the 57–64 GHz band are just beginning to be marketed and these products are standardized pursuant to an internationally harmonized channelization scheme,

which should promote their growth and usage. Making available additional spectrum contiguous to the existing 57–64 GHz band may enable higher throughputs and enhanced use of present spectrum, as well as to permit an increase in the number of simultaneous high-bandwidth users. The Commission agrees with Intel that a lesser amount of spectrum would limit the growth potential of 60 GHz applications. The Commission also agrees with the WISPA that "because ITU may study a band is an insufficient reason for the Commission to delay making a valuable spectrum resource available for unlicensed use." The Commission acknowledges that eventual harmonization with international requirements will benefit consumers by promoting a global marketplace and enhancing the international competitiveness of U.S. manufacturers. However, notwithstanding a desire for harmonization with international standards, the Commission determines to make these frequencies available for unlicensed use based on the Commission's analysis of U.S.-specific factors. Here, the Commission determines that the Commission should not wait for the outcome of the ITU study of this band, contrary to what T-Mobile advocates, because that could take years, leaving 5 gigahertz of spectrum to lie fallow in the meantime, when unlicensed applications are ready in the very near future to make use of this spectrum, given current planned deployments of WiGig products in the adjacent 57–64 GHz band.⁵ In addition, note that spectrum characteristics vary at different frequencies, due to different propagation losses and other atmospheric and sharing conditions, thus a strict linear comparison per frequency unit of the Commission amounts in different frequency bands as "gigahertz parity" (e.g., 3.85 gigahertz of spectrum in lower bands vs. 14 gigahertz of spectrum in upper bands) is not a valid comparison. Based on the above, the Commission is permitting use of the 57–71 GHz band by unlicensed devices pursuant to the technical rules in § 15.255.

75. With respect to the additional requests from Microsoft *et al* to extend

⁵ The Commission also notes 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". See International Telecommunication Union, *Constitution and Convention* (<http://www.itu.int/en/history/Pages/ConstitutionAndConvention.aspx>).

the band up to 72.5 GHz, and to allow indoor use of the 72.5–76 GHz band by unlicensed devices, the Commission does not find that additional spectrum above and beyond the very large 14-gigahertz of contiguous spectrum in the 57–71 GHz band that the Commission is providing for unlicensed operations herein is warranted at this time, due to the presence of the numerous existing fixed links in the 71–76/81–86 GHz bands. When the Commission adopted rules for licensed operations in these bands in 2003, it did not permit unlicensed sharing of these bands because “an underlay of unlicensed devices in the bands could detrimentally affect the quality and buildout of service.” In addition, the fixed point-to-point equipment that has been developed for deployment in the 71–76 GHz and 81–86 GHz bands were not engineered to operate in a part 15 unlicensed environment. Subsequently, in 2014, the Commission adopted part 15 rules to permit a special type of unlicensed device, level probing radars (LPR), to share the 75–85 GHz band; these devices, however, must be operated in a vertically downward position at fixed locations with severe limitations on antenna beamwidth. In contrast, the 5G unlicensed transmitters envisioned here would be both mobile and fixed and would not have such limitations. The Commission finds that parties requesting to extend the band beyond 71 GHz for unlicensed operation did not submit any persuasive technical arguments to prove that unlicensed sharing with the 71–76/81–86 GHz licensed services is feasible at this time. Accordingly, the Commission denies these requests at this time.

E. Federal Sharing Issues

76. Many bands above 24 GHz have Federal allocations on a primary basis. As the Commission continues to increase flexibility in the non-Federal use of these bands, the Commission must consider appropriate mechanisms and tools to share these bands that recognize the co-primary rights in these bands. In this *Report and Order*, the Commission facilitates sharing in the 39.5–40 GHz band and 37–38.6 GHz band, including through new sharing schemes that promote dynamic and flexible access in the 37–37.6 GHz band. In order to continue to evolve spectrum access and sharing regimes that meet both Federal and non-Federal needs, it will be imperative for all stakeholders, including wireless and satellite industries, to engage proactively to help shape these solutions.

1. 39.5–40 GHz

77. The 39.5–40 GHz portion of the 39 GHz band is allocated to the Federal FSS and MSS a primary basis, limited to space-to-Earth (downlink) operations. However, Federal MSS earth stations in this band may not claim protection from non-Federal fixed and mobile stations in this band.

78. In the *NPRM*, the Commission explained that when the *39 GHz Report and Order* was adopted, Federal use of the band was limited to military systems in the 39.5–40 GHz band segment, that the Department of Defense (DoD) stated that it had plans to implement satellite downlinks at 39.5–40 GHz in the future, and that the NASA identified 39.5–40 GHz as a possible space research band to accommodate future Earth-to-space wideband data requirements. The *39 GHz Report and Order* expressed optimism that such plans would not affect the continued development of the 39 GHz band for non-Federal use, but the Commission said that it intended to address those interference issues in a future, separate proceeding that would focus on developing inter-licensee and inter-service standards and criteria. At present, the U.S. Table of Frequency Allocations provides that Federal satellite services in the 39.5–40 GHz band are limited to military systems.

79. Although only four commenters responded to the Commission’s questions on these issues, all four agreed that it is possible for Federal and non-Federal operations to share the 39 GHz band. They also agreed that the Commission should adopt coordination zones to mitigate interference between Federal and non-Federal operations. For instance, AT&T argues that the Commission should adopt coordination zones rather than novel spectrum sharing techniques because coordination zones balance the twin goals of efficient spectrum utilization and the prevention of harmful interference to incumbents. Intel argues that portions of the band that are strictly Federal use could be separated from those for commercial use. Cisco states that while coordination will have to be done by the Commission staff and their counterparts at NTIA, co-existence is achievable. Finally, Nokia argues that the Commission should continue work with NTIA and other Federal agencies to minimize Federal coordination zones, which would maximize the value of the spectrum.

80. In 2016, NTIA sent a letter to the Commission addressing issues raised in the *NPRM*, regarding, in part, military operations in the 39.5–40 GHz portion of the 38.6–40 GHz band. NTIA

explained that the 39.5–40 GHz band is allocated to military MSS and FSS earth stations. Federal MSS earth stations cannot claim protection from non-Federal fixed and mobile stations as specified in footnote US382 of the table of frequency allocations. However, Federal earth stations in the MSS are not required to protect non-Federal fixed and mobile services. NTIA stated that given the existing regulatory constraints in the 39.5–40 GHz band, the *NPRM*’s proposed non-Federal fixed and mobile operations will not impact Federal satellite operations in the 39.5–40 GHz band.

81. The Commission concludes that it is possible for Federal operations to share the band with non-Federal fixed and mobile terrestrial operations because the protections offered by footnote US382 are sufficient to protect both Federal and non-Federal operations in this band. Thus, no changes to the Commission’s rules are necessary.

2. 37–38.6 GHz

82. The Commission concludes that non-Federal fixed and mobile operations can share the 37–38 GHz band with SRS downlink operations under certain conditions. First, as a result of discussions between NTIA and the Commission, NTIA indicated that it would request protection for only three SRS earth station sites: Goldstone, California; White Sands, New Mexico; and Socorro, New Mexico. Second, to address NTIA’s recommendations, the Commission will establish coordination zones for these three sites by adding a footnote to the US Table of Allocations listing the locations to be protected and their respective coordination zones. Third, with respect to operations, at Green Bank, West Virginia, NTIA indicated that since Green Bank, West Virginia is located in an existing quiet zone, any new or modified stations including in the fixed and mobile services, within the zone are required by § 1.924(a) of the Commission’s rules to notify the National Radio Astronomy Observatory (NRAO), and thus Green Bank would not be included in the footnote. Therefore, the Commission adopted footnote US151, which requires that, in the 37–38 GHz band, fixed and mobile stations not cause harmful interference to Federal SRS earth station at three sites and that non-Federal applications for such use be coordinated with NTIA in accordance with new § 30.205 of the Commission’s rules.

83. The Commission concludes that non-Federal fixed and mobile operations can share the 37–38.6 GHz band with DoD operations. With regard

to Federal co-primary access to the 37 GHz band, the Commission will adopt rules that entail the coordination zones recommended by NTIA for the 14 military sites, and the ability for Federal agencies to add future sites on a coordinated basis. The Commission will make the 37–37.6 GHz block (lower band segment) available for coordinated co-primary sharing between Federal and non-Federal users, where non-Federal rights are granted by rule. This framework will facilitate access by DoD and other Federal users. In the *FNPRM*, the Commission seeks comment on defining the sharing framework in greater detail. In the upper band segment, the Commission seeks comment on facilitating Federal coordination with licensees for access to licensed areas.

84. The Commission also does not believe that it is necessary to take action to protect the weather satellites, which according to Committee on Radio Frequency (CORF), will operate above 37 GHz until at least 2020 because it will take a significant amount of time for mmW devices to be developed and deployed in the 37 GHz band. Therefore, the Commission expects that relatively few mmW devices will be operating in the band while the weather satellites are still in use.

85. Under the plan the Commission adopted, the Commission enables the deployment of new commercial services while protecting Federal agency missions. This balances the needs of commercial operators with the needs of Federal agencies for protection and future growth by creating an environment where Federal and non-Federal users can share the band on a co-primary basis and providing enough certainty to future commercial users to stimulate investment in the spectrum.

3. Passive Services Below 37 GHz

86. The Commission believes that the out-of-band emission (OOBE) limit that the Commission adopts in this *Report and Order* will provide adequate protection to the passive sensors in the adjacent 36–37 GHz band. The OOBE limit will keep emissions from an UMFUS device into the 36–37 GHz band well below the –10 dBW level specified by footnote US550A. The Commission notes that the –10dBW power limit was adopted to protect passive sensors in the 36–37 GHz band in accordance with ITU Resolution 752 (WRC–07). Because this limit was adopted by the ITU to protect passive sensors from harmful interference from fixed and mobile transmitters in the 36–37 GHz band, the Commission concludes that it will provide

appropriate protection to the passive sensors from transmitters in the adjacent band.

87. The Commission will not adopt a guard band at 37 GHz to protect the EESS and SRS in the 36–37 GHz band as suggested by CORF and IEEE Frequency Allocations in Remote Sensing (FARS). Neither CORF nor IEEE FARS make a specific recommendation on the necessary size of the guard band, although CORF requests a guard band of at least 100 MHz. Because a guard band will reduce the spectrum available for mmW devices, the Commission does not want to take this step without compelling evidence that it is necessary. No one has provided information on the specific benefits and necessity of adopting a guard band of at least 100 MHz to protect EESS and SRS. Given the lack of data supporting adoption of a guard band, the Commission believes that the out-of-band emission limit that the Commission has adopted will provide adequate protection to the EESS and SRS without the need for a guard band at 37 GHz.

88. With regard to protecting radio astronomy at the three locations specified by CORF, the Commission is not convinced that additional measures are needed to protect radio astronomy. The radio astronomy observations that CORF is concerned about will be conducted in the 36.43–36.5 GHz band, which is 500 megahertz from the 37 GHz band, so the emission limits that the Commission is adopting for mmW devices should sufficiently protect radio astronomy.

F. Licensing, Operating, and Regulatory Issues

1. Creation of New Rule Service and Part

89. The Commission adopted in its proposal to create a new service, the UMFUS under a new part 30 of the Commission's rules to include the 28 GHz, 39 GHz, and 37 GHz bands. Licensing the millimeter wave bands under part 27, as CTIA suggests, would produce a less flexible regime than the Commission intend while the rules the Commission adopted in part 30 will provide much of the flexibility present in the part 27 rules. Part 27 would be a poor fit for the point-to-point services currently operating in the 28 and 39 GHz bands, and for the backhaul uses other licensees may wish to include in their services. Part 96, which Google suggests, is designed for a specific regime of intensive, three-tier sharing. As the Commission is not adopting this type of sharing regime for these bands at this time, using this rule part would

be inappropriate. The Commission concludes that establishing a new rule part will allow us to have one unified set of rules governing the various types of operations the Commission contemplates licensees will offer, which will provide more clarity to licensees and more accurately reflect the nature of these licenses.

2. Regulatory Status

90. The Commission adopted in its proposal from the *NPRM* to implement a flexible regulatory framework for the UMFUS. As the Commission proposed, UMFUS licensees in the 28, 39, and 37 GHz bands will be able to choose the regulatory status (common carrier, non-common carrier, or both) that best fits their business models and the services they seek to provide. This approach will maintain an open and flexible framework that will allow the business judgments of individual applicants and licensees in these bands to shape the nature of the services offered pursuant to their licenses.

91. The Commission also adopts its proposal to rely on the applicant's designation of its common carrier or non-common carrier status, to enable us to fulfill our obligations to enforce the common carrier requirements contained in statutes and the Commission's regulations. An election to provide service on a common carrier basis requires that the elements of common carriage be present, and the applicant is in the best position to ascertain the presence of these elements. This approach is consistent with the Commission's past decisions regarding the classification of mobile services.

3. Foreign Ownership Reporting

92. Certain foreign ownership and citizenship requirements are imposed by subsections (a) and (b) of Section 310 of the Act, as modified by the 1996 Act. These provisions prohibit the issuance of licenses to certain applicants. For current LMDS, 37 GHz, and 39 GHz licensees, these statutory provisions are adopted in part 101 of the Commission's rules at § 101.7 of the Commission's rules. Specifically, § 101.7(a) prohibits the granting of any license to be held by a foreign government or its representative. Section 101.7(b) prohibits the granting of any common carrier license to be held by individuals that fail any of the four citizenship requirements listed.

93. In the *NPRM*, the Commission tentatively concluded that the Section 310 requirements would apply to any applicants in the UMFUS. Based on this interpretation of the requirements of Section 310, the Commission proposed

in the *NPRM* to include a provision in the new part 30 that would mirror the current § 101.7 of the Commission's rules. In addition, the Commission proposed that all applicants for part 30 licenses be required to report the same foreign ownership information, regardless of the specific type of service they sought to provide. An applicant requesting authorization for broadcast, common carrier, aeronautical en route, or aeronautical Fixed Services, alone or in combination with other services, would be prohibited from holding a license if it met any of the criteria in Section 310(b). If the applicant requested authorization for services other than for broadcast, common carrier, aeronautical en route, or aeronautical Fixed Services, it could hold a license if it met the single alien ownership requirement in Section 310(a), regardless of whether it would otherwise be disqualified for a common carrier authorization. No commenters addressed the issue of foreign ownership reporting requirements, or opposed the Commission's proposals.

94. The Commission adopted in its proposals from the *NPRM* to require the same foreign ownership reporting from all applicants for part 30 licenses, regardless of the specific type of service they seek to provide, and to implement this requirement by including a provision in part 30 that mirrors § 101.7 of the Commission's current rules. This approach will properly implement the restrictions contained in Sections 310(a) and (b) of the Act, and is consistent with the Commission's treatment of flexible use services regulated under part 27 of the Commission's rules.

4. Eligibility

95. In the *NPRM*, the Commission adopted an open eligibility standard for the UMFUS. The Commission noted that an open eligibility approach would not affect citizenship, character, or other generally applicable qualifications that may apply under the Commission's rules. Cisco and CTA support this proposal, citing uncertainty as to how the UMFUS bands will develop, and the need to allow innovation from all parties. No commenters opposed the Commission's proposal.

96. The Commission adopted its proposal to implement an open eligibility standard for the UMFUS. This approach is in keeping with the flexibility of the other licensing rules the Commission adopted in this *Report and Order*, as well as the Commission's treatment of other flexible use services, and will encourage innovation and efficient use of spectrum in these bands.

5. License Term

97. The Commission adopted its proposal to establish a 10-year license term for all UMFUS licenses, and the Commission's proposal to award a renewal expectancy for subsequent license terms if the licensee continues to provide at least the initially-required level of service. While the Commission has pursued shorter license terms and non-renewable licenses in other bands, and continue to believe there are circumstances where those structures are appropriate, here the Commission adopted a 10 year license term that can be renewed. The Commission believes a 10-year license term will give licensees sufficient certainty to invest in their systems, particularly as the new technology is still nascent and will require time to fully develop. If the standards for mobile service in the mmW bands are established by, at the latest, 2020, new licensees would still have the majority of the license term after that point to plan and to deploy service. Neither XO nor any other commenter has presented facts that would justify a longer license term. A 10-year license term is also consistent with existing license terms in a wide variety of services.

98. The Commission also adopted in its proposal to award a renewal expectancy for subsequent license terms if the licensee continues to provide at least the initially-required level of service through the end of any subsequent license terms. That treatment is consistent with the Commission's treatment of many other licensed services and will provide incentives for licensees to continue to provide service.

6. Mobile Spectrum Holdings Policies

99. The Commission found it essential to establish clear and transparent mobile spectrum holdings policies that will promote competition in the future, including competition in the development of 5G services, as well as promote the efficient use of mmW spectrum, and avoid an excessive concentration of licenses. As mentioned in the *NPRM*, demand for mobile service that mmW spectrum is expected to enhance and improve has been increasing, and the Commission's predictive judgment is that interest in the spectrum will be high. Thus, the Commission finds that it would provide regulatory certainty, flexibility in planning, and expedited deployment if the Commission supplies guidance on application of these policies at this stage when the Commission authorizes mobile service in these bands and adopt

related rules governing the terms of service, rather than at some later stage. In the Commission's consideration of whether to adopt a mobile spectrum holdings limit for the licensing spectrum through competitive bidding and, if so, what type of limit to apply, the Commission's evaluation includes, among other things, the promotion of competition in relevant markets, the acceleration of private sector deployment of advanced services, and generally managing the spectrum in the public interest. The Commission evaluates how a limit would likely affect the quality of communications services or result in the provision of new or additional services to consumers, as well as any other statutory goals and directives applicable to a particular spectrum band being licensed by competitive bidding.

100. As the Commission noted in the Mobile Spectrum Holdings Report and Order, the mobile wireless marketplace is highly concentrated, and with continually increasing consumer demand for mobile broadband, "in order for there to be robust competition, multiple competing service providers must have access to or hold sufficient spectrum to be able to enter a marketplace or expand output rapidly in response to any price increase or reduction in quality, or other change that would harm consumer welfare." In addition, the Commission has found that holding a mix of spectrum bands is advantageous to providers and that consumers' benefit when multiple providers have access to a mix of spectrum bands. The Commission concludes here that with the rapid rate of technological advance, mmW spectrum is likely to be a critical component in the development of 5G, and the Commission must take steps to ensure its optimal use to the benefit of all American consumers. For these reasons, the Commission adopted an *ex ante* spectrum aggregation limit of 1250 megahertz that will apply to licensees acquiring spectrum in the 28 GHz, 37 GHz, and/or 39 GHz bands, through competitive bidding in auction. The Commission adopted for these same reasons a spectrum threshold of 1250 megahertz for proposed secondary market transactions in these three bands.⁶

101. Historically, mmW frequencies have been considered unsuitable for

⁶ The Commission notes that this 1250 megahertz spectrum threshold helps to identify those markets that provide particular reason for further competitive analysis, but that the Commission's consideration of potential competitive harms would not be limited solely to those markets identified by the threshold.

mobile applications because of propagation losses at such high frequencies and the inability of mmW signals to propagate around obstacles. As noted in the *NPRM*, bands above 24 GHz were not typically considered for stand-alone mobile services but rather as supplementary channels to deliver ultra-high speed data in specific places. Due to technological advances, the mmW bands could potentially be used for mobile broadband and are likely to serve as an important supplement to lower-band spectrum. Specifically, the mmW bands potentially will be used for supporting very high capacity networks in areas that require such capacity, as well as for machine-to-machine communications, and in the development of various Internet of Things (IoT) applications including wearables, fitness and healthcare devices, autonomous driving cars, and home and office automation.

102. The Commission finds that grouping the 28 GHz, 37 GHz, and 39 GHz bands together for purposes of applying these spectrum holdings policies, either at auction or in the secondary market, is appropriate in view of the interchangeability of the spectrum in these bands, *i.e.*, similar technical characteristics and potential uses of this spectrum that are unique to the mmW bands. While certain differences across the mmW bands exist, the Commission finds these technical differences are not sufficient to significantly affect how these spectrum bands might be used and to require separate band-specific limits. This approach mirrors the Commission's existing Commercial Mobile Radio Service (CMRS) spectrum screen, which applies across a number of bands that do not have the same technical characteristics and not on a band-specific basis. Even assuming that more 37 GHz to 39 GHz spectrum would be needed to provide the same performance, there will be 2400 megahertz of 37 GHz and 39 GHz spectrum available for service providers' use, almost three times as much as in the 28 GHz band. And, in any event, all the particular facts of any proposed secondary market transaction will be carefully evaluated on a case-by-case basis to ensure that the public interest is served. For these reasons, the Commission does not find that adopting a band-specific spectrum aggregation limit is necessary, and the Commission finds that the spectrum holdings policies adopted in the *Report and Order* will best support its objective of ensuring that multiple providers have access to this high band spectrum that

is likely to be critically important in the development of 5G services moving forward. The Commission anticipates that applying these spectrum holdings policies to spectrum with similar technical characteristics that may become available in the future is also likely to be appropriate.

103. *Competitive Bidding.* The Commission concludes that an approach based on limiting an entity's holding to approximately one-third of the relevant spectrum will help to ensure that multiple providers are able to access a sufficient amount of spectrum to the benefit of consumers. In the Commission's consideration of the appropriate limit to set at auction, the Commission notes that as a result of the various license sizes in these bands, setting a limit at approximately one-third would as a practical matter result in a limit notably lower than a one-third limit.⁷ Given the varied license sizes of spectrum blocks in each band, as well as the total amount of mmW spectrum available, the Commission finds that permitting licensees to acquire somewhat more than one-third of the spectrum available in these bands at auction is appropriate. The Commission therefore will not permit licensees to acquire more than 1250 megahertz across the three bands at auction.⁸ The Commission finds that the spectrum aggregation limit the Commission adopted will help ensure that multiple providers will be able to access a sufficient amount of mmW spectrum to facilitate the deployment of new services and innovation that will benefit consumers, while guarding against the excessive concentration of licenses. The

⁷ The total available amount of the mmW spectrum in the 28 GHz, 37 GHz, and 39 GHz bands today is equal to 3250 megahertz, approximately one-third of which is 1100 megahertz. Given the sizes of the spectrum blocks in these bands, however, no entity could hold more than 1050 megahertz, and an entity interested in holding only licenses in the 37 and 39 MHz bands could hold no more than 1000 megahertz. More specifically, the latter entity would be able to hold no more than five licenses of 200 megahertz each across the 37 GHz and 39 GHz bands for a total of 1000 megahertz. An entity interested in holding some 28 GHz spectrum could hold either two 28 GHz licenses and one license of 200 megahertz for a total of 1050 megahertz, or one 425 megahertz license in the 28 GHz band and three licenses of 200 megahertz for a total of 1025 megahertz.

⁸ The Commission recognizes that there are incumbent licensees in the 28 GHz and 39 GHz bands that currently hold varying amounts of spectrum. These licensees would be able to bid in the auction to an amount that would be no more than 1250 megahertz in total, taking existing spectrum holdings into account. Service providers' existing spectrum holdings across the 28 GHz, 37 GHz, and 39 GHz bands therefore will be counted for purposes of the Commission's application of the 1250 megahertz limit.

Commission asks for comment below on how this limit might be implemented.

104. *Secondary Market.* The Commission adopted its proposal to exclude mmW spectrum from the current spectrum screen that includes those spectrum bands that the Commission has determined are suitable and available for the provision of mobile telephony/broadband services. As the Commission has previously explained, spectrum is considered "available" if it is "fairly certain that it will meet the criteria for suitable spectrum in the near term, an assessment that can be made at the time the spectrum is licensed or at later times after changes in technology or regulation that affect the consideration." The Commission does not find that the mmW bands are suitable and available for the provision of mobile telephony/broadband services in the same manner as other spectrum bands that are currently included in the Commission's spectrum screen as applied to secondary market transactions. The Commission makes this finding based on the unique characteristics of these bands as described above. Accordingly, the Commission does not include the mmW bands in the spectrum screen.

105. However, the Commission recognizes that this frontier spectrum is likely to become increasingly valuable to the advent of 5G services. In its competitive analysis of wireless transactions, the spectrum screen applicable to lower-band spectrum has been one tool used to help identify particular markets for further competitive analysis; it is applied on a county-by-county basis and identifies local markets where an entity would hold approximately one-third or more of the total spectrum suitable and available for the provision of mobile telephony/broadband services, post-transaction. Similarly, for proposed secondary market transactions that would result in an entity holding 1250 megahertz or more of the total spectrum in the 28 GHz, 37 GHz, and 39 GHz bands, the Commission will apply its threshold on a county-by-county basis, and subject such transactions to the Commission's case-by-case review in order to ensure that the public interest is served. As noted above, while this 1250 megahertz spectrum threshold helps to identify those markets that provide particular reason for further competitive analysis, the Commission's consideration of potential competitive harms will not be limited solely to those markets identified by the threshold. Establishing this spectrum aggregation threshold in the secondary market context recognizes the specific characteristics of the

spectrum while helping to ensure that multiple entities have an opportunity to obtain mmW spectrum for deployment of innovative mobile technologies.

106. *Summary.* The Commission finds, on balance, that the potential public interest benefits of adopting a 1250 megahertz limit for auctions of this spectrum, and a 1250 megahertz threshold for secondary market transactions for these unique spectrum bands outweigh any potential public interest harms. Further, adopting these spectrum holdings policies is consistent with the Commission's previous determination that an "approximately one-third threshold for total spectrum that the Commission uses to identify those holdings in local markets that may raise particular competitive concerns" is an effective analytical tool in the secondary market context. The Commission anticipates that the potential costs of adopting such spectrum holdings policies will be low. The Commission disagrees with commenters who argue that it is premature for the Commission to establish any spectrum aggregation policies in these bands and that such policies will undermine the potential use of this spectrum. On the contrary, the Commission finds that establishing such policies that will apply as mmW spectrum is introduced into the marketplace will help promote competition from the outset. The Commission has explained that mmW spectrum holds the potential for a range of uses from supporting high capacity networks to use with various IoT applications. While the Commission cannot be certain at this time how this spectrum will be used, the Commission finds that its anticipated value to the future of 5G makes it critical that multiple providers have access to it. The spectrum holdings policies the Commission adopted will guard against consolidation of this spectrum by one or two providers and will encourage the development of innovative services to the benefit of the American consumer.

7. Performance Requirements

a. Performance Metrics and Milestones

107. The Commission declines to adopt a unified performance metric at this time. Based on the criticisms and alternative suggestions in the record, the Commission concludes that such an approach would not provide the flexibility necessary to support innovative uses of the spectrum, as it would favor one deployment approach over another. A unified approach might also deter investment and deployment in these bands. The Commission also

declines to adopt a "substantial service" standard of performance for the UMFUS. The Commission determines that such a standard, with no firm minimum requirements, would not adequately safeguard effective use of spectrum in these bands. The Commission also declines to adopt a usage-based metric for performance requirements because it is not clear that there is a workable method of measuring or enforcing such a requirement. Instead, the Commission adopted a series of metrics, tailored for each type of service a licensee might choose to offer. Licensees may fulfill their performance requirements by showing that they meet their choice of any one of the below standards, or a combination of several. This framework is intended to provide enough certainty to licensees to encourage investment and deployment in these bands as soon as possible, while retaining enough flexibility to accommodate both traditional services and new or innovative services or deployment patterns. Its increased level of firmness over a substantial service metric is also consistent with the Commission's recent approach in other services.

108. The Commission notes that this list of metrics is not intended to be exhaustive. The Commission recognizes that the metrics the Commission adopted does not cover all possible types of service that licensees may seek to offer in these bands, and that new, innovative services may be developed with different characteristics that the Commission cannot foresee at this time. The Commission therefore seeks further comment in the *FNPRM* on additional metrics that should be applied to these innovative services.

109. The Commission adopted these performance requirements only in relation to the end of the initial license terms in these bands. Because the Commission believes it is taking action with significant lead time before the full development of the technology, the Commission believes an interim benchmark might be difficult to meet and may result in a substantial number of waiver and extension requests. While the Commission does not adopt any ongoing or subsequent performance requirements at this time, the Commission strongly encourages licensees to deploy networks and services in a timely manner consistent with the development of the technology for these bands. The Commission emphasizes, however, that the Renewal and Service Continuity proceeding (WT Docket No. 10–112), which addresses this issue, remains open, and that licensees may be subject to any

requirements adopted as part of that proceeding at some later date.

110. *Mobile and point-to-multipoint.* For mobile and point-to-multipoint services in the 28 GHz, 37 GHz (geographic area licenses only), and 39 GHz bands, the Commission adopted a modified version of the Commission's proposal in the *NPRM*. In order to meet the standards for license renewal, a licensee providing mobile service must provide coverage to 40 percent of the population of the license area and must be using the facilities to provide service. This is a lower portion of the population than is the standard for lower frequency bands because this level of coverage strikes the appropriate balance between ensuring sufficient use of the spectrum and allowing licensees flexibility to deploy an emerging technology which may be more suitable for smaller coverage areas. The Commission views the current safe harbor of 20 percent population coverage as inappropriate going forward because the new technologies being developed will dramatically increase the opportunities to use these bands. Since the Commission is not requiring service demonstrations until the end of the license term, the Commission believes licensees will have more than adequate time to meet this benchmark. Similarly, the Commission does not believe CTIA's suggestions of 10 "connections" per 10,000 population, or 50 connections per county, will result in robust build out in these bands. Under CTIA's proposed definition of a "connection," these 10 connections could represent as little as one subscriber accessing the network 10 times in one month. This is a particularly low benchmark for mobile operations, which is one of the primary target use cases for this new service. The Commission does not believe this standard represents a sufficient level of service to justify renewal.

111. The Commission declines to adopt the measurement method the Commission proposed in the *NPRM* and concludes that requiring a specific methodology is unnecessary. Instead, the Commission will provide licensees with flexibility in terms of how they make their service showings, but Commission staff will continue to review showings to ensure that they accurately reflect coverage.

112. *Fixed.* The Commission does not adopt its proposed method of "keyhole contours" for assigning fixed links a population equivalent. Instead, the Commission adopted a more traditional method of demonstrating fixed service: the number of links per population in the license area. Specifically, the Commission adopted a requirement that

geographic area licensees providing Fixed Service in the 28 GHz, 39 GHz, or 37 GHz bands must construct and operate at least four links in license areas with less than 268,000 population, and at least one link per 67,000 population in license areas with greater population. This standard is similar to the standard the Commission established for fixed point-to-point services in the 2.3 GHz band. While links in mmW bands will presumably be shorter because of the propagation characteristics, the higher frequencies will allow more reuse of spectrum in a given area. These links must be part of a network that is actually providing service, whether to unaffiliated customers or private, internal uses, and all links must be present and operational at the end of the license term. As with the mobile performance milestone, for bands licensed by areas larger than counties the number of links and the size of the population will be calculated over the entire license area, not county by county.

113. *Satellite*. The Commission adopted its proposal from the *NPRM*. A licensee who purchases a 28 GHz UMFUS license may fulfill build-out requirements for the license by deploying an earth station in the license area that is operational and providing service. The Commission notes that a licensee may not fulfill this requirement by leasing a portion of its license area to a satellite operator that builds and operates an earth station within the leased area. In 37 and 39 GHz, because the Commission adopted significantly larger geographic license areas than counties, constructing and operating an earth station will fulfill the performance requirement only for the county in which it is constructed, and not for the entire license area. Satellite operators who develop earth stations under the satellite sharing mechanisms the Commission adopted for the 28 GHz and 39 GHz bands will continue to be subject to the applicable part 25 build-out requirements.

114. *Combination*. Licensees whose deployments contain a mix of services, for example mobile service combined with fixed backhaul may meet the relevant fixed or mobile/point-to-multipoint standard separately. The Commission declines to establish a specific formula for evaluating such buildouts on a combined basis. Instead, the Commission will evaluate such showings on a case-by-case basis, as the Commission has done for LMDS.

b. Failure To Meet Buildout Requirements

115. The Commission adopted a modified version of its proposal, tailored to the different license area sizes the Commission adopted for each band. For all bands, the Commission adopted its proposal to terminate licenses (or portions of licenses, as appropriate) automatically if a licensee fails to meet the applicable performance requirements, which is widely applied in many wireless services. The band-specific approaches to license renewal and termination are explained in more detail below. In the accompanying *FNPRM*, the Commission seeks to further develop the record on use-or-share obligations.

116. *28 GHz*. The 28 GHz band will be licensed by county because partitioning licenses in these bands into license areas smaller than counties would be administratively burdensome without providing any off-setting benefits to licensees or service providers. Accordingly, if a licensee in the 28 GHz band fails to meet the applicable performance requirements at the end of its license term, the license for that county will terminate immediately in its entirety. As the Commission is reissuing the licenses in these band by county rather than by BTA, the Commission declines to implement EchoStar's proposal to continue to evaluate incumbent licensees' performance on a BTA-wide basis.

117. *37 and 39 GHz*. The 39 GHz band, as well as the 37.6–38.6 GHz band, will be licensed by PEAs, rather than counties. In order to balance the need to ensure productive use of spectrum with the need to encourage investment and deployment, the Commission adopted a modified approach to performance requirements in this band.

118. A licensee who meets the applicable performance requirements for the entire PEA, taken as a whole, will be eligible to renew the entire license. A licensee who does not meet the requirements for the entire license area will have two options: (1) automatic termination of the entire license, or (2) partition the license at the county level, and return a portion of the license to the Commission such that the applicable performance requirements are met for the remaining non-forfeited area. For example, a licensee of a PEA containing five counties of 100,000 people each, who deployed mobile service covering 60 percent of the population in each of two counties, and made no deployments in the other three

counties, would be covering only 24 percent of the total population of the license area. This would not be enough to meet performance requirements across the entire license. However, the licensee could forfeit the portion of the license covering the three un-deployed counties, and retain and renew the portion of the license covering the remaining two counties. Similarly, a licensee of the same hypothetical PEA who deployed mobile service covering 80 percent of one county, and 30 percent of another, could retain and renew the portion of the license for those two counties because the resulting two-county license area would have coverage of 55 percent of its population, which exceeds the 40 percent requirement.

c. Treatment of Incumbents

119. The Commission declines to adopt its proposal from the *NPRM*. For license terms concluding before 2020, licensees may be unable as a practical matter to meet the new, more rigorous requirements the Commission adopted for these bands at the end of their current license terms because of the nascent state of technology. Moreover, providing for additional time will provide more effective opportunities for licensees to use the spectrum in ways that maximize the flexibility now afforded by the Commission's new rules. For example, the transition toward providing innovative mobile services is likely to require complex business decisions and changes in plans. In short, it is the Commission's intent to encourage deployment of new and innovative services—particularly mobile service—as efficiently and effectively as possible.

120. Thus, the Commission slightly modifies and extends the deadline for meeting the performance requirements pertaining to licensees' current licenses for licenses expiring after the adoption date of the rules in this proceeding. Specifically, current licensees in the 28 GHz and 39 GHz bands who, under the current rules, face a deadline for demonstrating substantial service after the adoption date of this *Report and Order* will not be required to demonstrate substantial service at renewal. Instead, those licensees will be required to fulfill the performance requirements the Commission adopted for their respective licenses by June 1, 2024. 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.

d. Alternatives to Performance Requirements

121. The Commission declines to adopt either of these alternatives for these bands. The Communications Act contemplates that the Commission will take measures “to prevent stockpiling or warehousing of spectrum by licensees.” The Commission believes the foregoing performance requirements are feasible in these bands, and the best method to prevent warehousing in this context. O3b argues that such “consecutive license terms with recurring payments” would simply change the financial calculation underpinning warehousing: while the initial bid would be smaller and discounted less, the lower price of entry could encourage warehousing by reducing the amount initially needed to hold on to the spectrum. In the absence of any discussion of the “option payment” concept, the Commission will not adopt the proposal at this time.

8. Permanent Discontinuance of Operations

122. Under § 1.955(a)(3) of the Commission’s rules, an authorization will automatically terminate, without specific Commission action, if service is “permanently discontinued.” In the *NPRM*, the Commission proposed that for UMFUS licensees that identify their regulatory status as common carrier or non-common carrier, “permanently discontinued” should be defined as a period of 180 consecutive days during which the licensee does not provide service to at least one subscriber that is not affiliated with, controlled by, or related to, the provider in the service area of its license (or smaller service area in the case of a partitioned license).

123. The Commission proposed a different approach for licensees that use their licenses for private, internal communications. For these services, the Commission proposes to define “permanent discontinuance” as a period of 180 consecutive days during which the licensee does not operate any facilities under the license. The Commission proposed that licensees not be subject to this requirement until one year after their initial license period ends, to allow them adequate time to construct their networks.

124. The Commission also proposed that when 28 GHz, 37 GHz, or 39 GHz licensees permanently discontinue service, the licensee must notify the Commission of the discontinuance within 10 days, by filing FCC Form 601 and requesting license cancellation. The Commission further proposed that an authorization automatically terminates without specific Commission action if

service is permanently discontinued, even if a licensee fails to file the required form. No commenters discuss the permanent discontinuance of service proposals.

125. The Commission adopted its proposals from the *NPRM* related to permanent discontinuance of operations. Specifically, the Commission adopted the two separate proposed definitions of “permanent discontinuance,” for common carrier and non-common carrier service, and for private communications services. The Commission also adopted its proposal to wait to implement this requirement until one year after the initial license period ends. This approach is consistent with the definitions the Commission has adopted for other spectrum bands that are licensed for mobile use, including the H Block, AWS-3, and AWS-4 bands.

126. The Commission also adopted its proposal that a licensee who permanently discontinues service must notify the Commission within 10 days, and the Commission’s proposal that such licenses terminate automatically even if a licensee fails to appropriately notify the Commission. This approach to permanent discontinuance is consistent with § 1.955(a)(3) of the Commission’s rules. The permanent discontinuance rule is intended to provide operational flexibility while ensuring that spectrum does not lie idle for extended periods, and the rules the Commission adopted support those goals.

9. Secondary Markets Policies

a. Partitioning and Disaggregation

127. The Commission’s part 101 rules generally allow for geographic partitioning and spectrum disaggregation in the LMDS and 39 GHz service. Geographic partitioning refers to the assignment of geographic portions of a license to another licensee along geopolitical or other boundaries. Spectrum disaggregation refers to the assignment of discrete amounts of spectrum under the license to another entity. Disaggregation allows for multiple transmitters in the same geographic area operated by different companies on adjacent frequencies in the same band.

128. In 1997, the Commission determined that all LMDS licensees would generally be permitted to disaggregate and partition their licenses. The Commission later adopted specific procedural, administrative, and operational rules to govern the disaggregation and partitioning of LMDS licenses. Similarly, in the same year, the

Commission concluded that partitioning and disaggregation would be permitted in the 39 GHz band and adopted partitioning and disaggregation rules in this band as well. The rules require the spectrum to be disaggregated by FDD pair in the 39 GHz band.

129. In the *NPRM*, the Commission proposed to continue to allow partitioning and disaggregation in the 28 and 39 GHz bands, and to permit 37 GHz licensees to partition and disaggregate their licenses as well. The Commission also proposed to require all parties to a partitioning or disaggregation agreement to independently fulfill the applicable performance and renewal requirements, which is consistent with the current requirements.

130. Commenters overwhelmingly support allowing secondary market transactions in general, and partitioning and disaggregation in particular. Intel supports expanding disaggregation in the 39 GHz band by also permitting pair-splitting. No commenters oppose allowing secondary market transactions generally, or partitioning or disaggregation specifically. No commenters discuss performance requirements for parties to a partition or disaggregation.

131. The Commission adopted its proposal in the *NPRM* to allow partitioning and disaggregation of licenses in the 28, 37, and 39 GHz bands. As the Commission noted when first establishing partitioning and disaggregation rules, allowing such flexibility could facilitate the efficient use of spectrum by enabling licensees to make offerings directly responsive to market demands for particular types of services, increasing competition by allowing new entrants to enter markets, and expediting provision of services that might not otherwise be provided in the near term. This policy would leave the decision of determining the correct size of licenses to the licensees and the marketplace. Allowing this flexibility is consistent with the record, and with the flexible approach to licensing these bands that the Commission adopted in this *Report and Order*. Because the band plan the Commission adopted for the 39 GHz band does not use paired spectrum blocks, the current rule that licenses in that band must be disaggregated in pairs will no longer apply.

132. The Commission also adopted its proposal to require all parties to a partitioning or disaggregation agreement to independently fulfill applicable performance and renewal requirements. According to the performance requirements framework the Commission adopted, individual

licensees may choose which metric they fulfill (e.g., fixed, mobile, or satellite), but each licensee must make a showing that independently satisfies the requirements. This requirement will facilitate efficient spectrum use, while enabling service providers to configure geographic area licenses and spectrum blocks to meet their operational needs.

b. Spectrum Leasing

133. In 2003, in order to promote more efficient use of terrestrial wireless spectrum through secondary market transactions and in order to eliminate regulatory uncertainty, the Commission adopted the *Secondary Markets First Report and Order*, which contained a comprehensive set of policies and rules to govern spectrum leasing arrangements between terrestrial licensees and spectrum lessees. These policies and rules enabled terrestrially-based Wireless Radio Service licensees holding “exclusive use” spectrum rights to lease some or all of the spectrum usage rights associated with their licenses to third party spectrum lessees. Those third party lessees were then permitted to provide wireless services consistent with the underlying license authorization.

134. This 2003 Order excluded a number of wireless radio services from the spectrum leasing rules and policies, including part 101 services. A year later, the Commission extended the spectrum leasing policies to a number of additional wireless services, including part 101 services. At that time, the Commission also built upon the spectrum leasing framework by establishing immediate approval procedures for certain categories of terrestrial spectrum leasing arrangements.

135. In the *NPRM*, the Commission proposed to apply these spectrum leasing policies to the new part 30 radio service governing UMFUS’s, including all 28 GHz, 37 GHz, and 39 GHz terrestrial licenses. The Commission proposed to apply these policies in the same manner that they apply to part 101 services.

136. Many commenters support allowing secondary market transactions generally and spectrum leasing specifically. Commenters cite the additional flexibility afforded by leasing spectrum, and the market certainty granted by using established rules. Several commenters also mention that spectrum leasing allows a broader range of entities to access licensed spectrum and provides additional competition in the marketplace. No commenters oppose allowing spectrum leasing arrangements.

137. The Commission adopted its proposal to allow spectrum leasing in the 28 and 39 GHz bands, as well as the portion of the 37 GHz band licensed on a geographic area basis. Allowing spectrum leasing in these bands will promote more efficient, innovative, and dynamic use of the spectrum, expand the scope of available wireless services and devices, enhance economic opportunities for accessing spectrum, and promote competition among providers. In addition, spectrum leasing policies in a particular band generally follow the same approach as the partitioning and disaggregation policies for that band. Thus, the Commission’s adoption of spectrum leasing rules for the 28 GHz, 39 GHz, and 37 GHz bands is consistent with the Commission’s decision above to allow partitioning and disaggregation in these bands as well.

10. Other Operating Requirements

138. The Commission adopted its proposal in the *NPRM* to require UMFUS licensees to comply with other rule parts that pertain generally to wireless communications services, and with any applicable service-specific rules. This approach will maintain general consistency among various wireless communications services. Consistent with the Commission’s proposal, the Commission will add UMFUS to the definitions of Wireless Radio Service and Wireless Telecommunications Service in § 1.907 of the Commission’s rules. The Commission refrains from modifying other existing rules in other rule parts at this time, as no commenter has identified any incompatibilities or inconsistencies between the UMFUS Service and the existing service-specific or generally applicable rules. To consolidate the technical rules for all of the types of flexible uses that might be deployed by UMFUS licensees under a single rule part, and to maintain consistency between the rules that the Commission adopted and the current technical requirements that existing LMDS and 39 GHz licensees are subject to, the Commission will move the existing part 101 technical rules for traditional point-to-point and point-to-multipoint operations into part 30.

11. Competitive Bidding Procedures

a. Applicability of Part 1 Competitive Bidding Rules

139. The Commission proposed in the *NPRM* to conduct any spectrum auction of UMFUS licenses in conformity with the general competitive bidding procedures set forth in part 1 subpart Q of the Commission’s rules. No

commenters proposed any alternative or objected. Given the Commission’s experience in successfully conducting auctions using these procedures, the Commission adopted its proposed approach. The Commission will employ the part 1 rules governing competitive bidding design, designated entity preferences, unjust enrichment, application and payment procedures, reporting requirements and the prohibition on certain communications between auction applicants—including those updates made in the *Competitive Bidding Update Report and Order*. The Commission notes however, that the Commission could modify these procedures at a later time.

140. In discussing the competitive bidding rules, one commenter urges that if the Commission adopts county-level licenses, it would be critical to permit ‘package bidding’ so that operators could assemble larger footprints by bidding on multiple counties at one time. In response, two commenters argue that the Commission should not permit any form of package bidding because such bidding procedures may make it more difficult for small bidders to acquire specific licenses that are included in larger packages. Issues involving such bidding procedures are more appropriately addressed in a pre-auction proceeding that will seek public input on the competitive bidding procedures to be used for a particular auction of UMFUS licenses. Accordingly, the Commissions defer consideration of such matters to such proceeding(s) where interested parties are likely to have a more informed context for such input.

b. Small Business Provisions for Geographic Area Licenses

141. In authorizing the Commission to use competitive bidding, Congress mandated that the Commission “ensure that small businesses, rural telephone companies, and businesses owned by members of minority groups and women are given the opportunity to participate in the provision of spectrum-based services.” One of the principal means by which the Commission fulfills this mandate is through the award of bidding credits to small businesses. In the *Competitive Bidding Second Memorandum Opinion and Order*, the Commission stated that it would define eligibility requirements for small businesses on a service-specific basis, taking into account the capital requirements and other characteristics of each particular service in establishing the appropriate threshold. Further, in the *Part 1 Third Report and Order* and the more recent *Competitive Bidding*

Update Report and Order, the Commission, while standardizing many auction rules, determined that it would continue a service-by-service approach to defining small businesses. The Commission recently updated its standardized schedule of small business definitions to reflect the capital challenges small businesses face in the current wireless industry, and in the *NPRM* the Commission sought comment on whether to apply those updated definitions for auctions of spectrum in the UMFUS bands.⁹

142. Based on the Commission's prior experience with the use of bidding credits in spectrum auctions, the Commission believes that the using bidding credits is an effective tool to achieve the statutory objective of promoting participation of designated entities in the provision of spectrum-based service.

143. In adopting competitive bidding rules for the 39 GHz band, the Commission included provisions for designated entities to promote opportunities for small businesses, rural telephone companies, and businesses owned by members of minority groups and women to participate in the provision of spectrum-based services. Specifically, the Commission adopted bidding credits for applicants qualifying as small businesses. For auction of licenses in the 39 GHz band, the Commission adopted two small business definitions. These two small business definitions were later adopted as the highest two of three thresholds in the Commission's standardized schedule of bidding credits. In the *NPRM*, the Commission proposed to adopt for the UMFUS the two small business definitions with higher gross revenues thresholds reflecting the recently adopted updates to the part 1 schedule of small business definitions in the *Competitive Bidding Update Report and Order*. The Commission adopted its proposal to apply the two small business definitions with higher

gross revenues thresholds to auctions of UMFUS licenses in the 28, 37, and 39 GHz bands and any other spectrum bands that the Commission may subsequently designate for inclusion in the UMFUS. Accordingly, an entity with average annual gross revenues for the preceding three years not exceeding \$55 million will qualify as a "small business," while an entity with average annual gross revenues for the preceding three years not exceeding \$20 million will qualify as a "very small business." While the capital requirements of the services to be deployed in these bands is not yet known, the Commission believes that using these gross revenue thresholds will enhance the ability of small businesses to acquire and retain capital and thereby complete meaningfully at auction. The Commission also believes that these thresholds are not overly inclusive, and prevents designated entity benefits from flowing to entities for which such credits are not necessary. The Commission believes that the various spectrum bands included in the UMFUS—spectrum that will be utilized under the same or similar technical rules—will be deployed for the same types of service, and therefore the two small business definitions with higher gross revenues thresholds should apply to all of the bands in the UMFUS.

144. The Commission also adopted its proposal to provide qualifying "small businesses" with a bidding credit of 15 percent and qualifying "very small businesses" with a bidding credit of 25 percent, consistent with the standardized schedule in part 1 of the Commission's rules. This proposal was modeled on the small business size standards and associated bidding credits that the Commission adopted for a range of other services, including Advanced Wireless Services in the AWS-1 band. The Commission believes that this two-tiered approach has been successful in the past, and will once again utilize it. The Commission uses the existing 39 GHz service rules as a starting point, but adjusts the bidding credit levels to be consistent with the schedule in part 1 of the Commission's rules. The Commission believes that use of the small business definitions and associated bidding credits set forth in the part 1 bidding credit schedule will provide consistency and predictability for small businesses. No commenter provides any alternative or reason why the Commission's bidding credit thresholds or small business definitions would not work in this service. Accordingly the Commission adopted

its proposals regarding small business definitions and bidding credits.

c. Rural Service Provider Provisions for Geographic Area Licenses

145. The rural service provider bidding credit awards a 15 percent bidding credit to those servicing predominantly rural areas and that have fewer than 250,000 combined wireless, wireline, broadband and cable subscribers. In the *NPRM*, the Commission stated that in the absence of comments to the contrary, the Commission would leave open the option for future bidding applicants to apply for rural service provider bidding credits in lieu of a small business bidding credits. The Commission now decides that the Commission will apply the rural service provider bidding credit to auctioning the 28 GHz, 37 GHz and 39 GHz bands. Although the Commission has not received comments about this issue, the Commission believes that a targeted bidding credit will better enable rural service providers to compete for spectrum licenses at auction and in doing so, will increase the availability of 5G service in rural areas.

d. Small Business and Rural Service Provider Bidding Credit Caps

146. In the *Competitive Bidding Update Report and Order*, the Commission adopted a process for establishing a reasonable monetary limit or cap on the amount of bidding credits that an eligible small business or rural service provider may be awarded in any particular auction. The Commission established the parameters to implement a bidding credit cap for future auctions on an auction-by-auction basis. Consistent with the Commission's longstanding approach, after adoption of all of the necessary service rules for the UMFUS, the Commission will initiate a public notice process to solicit public input on certain details of auction design and the auction procedures for the initial auction of UMFUS licenses. As part of that process, the Commission will solicit public input on the appropriate amount of the bidding credit cap and subsequently establish the cap that will apply for that auction, based on an evaluation of the expected capital requirements presented by the particular spectrum being auctioned and the inventory of licenses to be auctioned.

e. Tribal Lands Bidding Credit

147. The tribal lands bidding credit program awards a discount to a winning bidder for serving qualifying tribal land that have a wireline telephone

⁹ Under the new standardized schedule, businesses with average annual gross revenues for the preceding three years not exceeding \$4 million would be eligible for a 35 percent bidding credit, businesses with average annual gross revenues for the preceding three years not exceeding \$20 million would be eligible for a 25 percent bidding credit, and businesses with average annual gross revenues for the preceding three years not exceeding \$55 million would be eligible for a 15 percent bidding credit. The Commission also adopted a monetary cap on the total amount of bidding credits that an eligible small business or rural service provider may be awarded in any particular auction. Specifically, the amount of the bidding credit cap for a small business in any particular auction will not be less than \$25 million and the bidding credit cap for the total amount of bidding credits that a rural service provider may be awarded will not be less than \$10 million.

subscription rate equal to or less than 85 percent of the population. The Commission believes that tribal entities involved in the telecommunications industry face unique challenges in participating in spectrum auctions and that the tribal lands bidding credit will promote further deployment and use of spectrum over tribal lands. No commenters oppose the tribal land bidding credit nor suggest that the tribal lands bidding credit is unnecessary. Accordingly, a winning bidder for a market will be eligible to receive a credit for serving qualifying Tribal lands within that market, provided it complies with the applicable competitive bidding rules.

f. Bidding Process Options

148. Finally, the Commission also sought comment in the *NPRM* on whether the Commission should revise any of the Commission's bidding process and payment rules to ameliorate the administrative difficulties the Commission could potentially face in enforcing the construction requirements in the 3,143 counties nationwide. One alternative the Commission discussed was to allow prospective millimeter wave licensees to bid, in a single auction, on licenses that have consecutive terms of license rights in a given geographic area—*i.e.*, licensees could bid at auction for the right to obtain a license in a given county not just for a single license term, but for each subsequent five-year license term; and the winning bidder would pay an auction-determined fee, in lieu of other performance requirements before the start of each term. Once a winning bidder made this payment, a new license would issue for the next consecutive license term. Some commenters support adopting such payments in lieu of performance requirements. However several commenters criticize the approach as incentivizing spectrum warehousing. For example, O3b notes that consecutive license terms with recurring payments would simply change the financial calculation underpinning warehousing: while the initial bid would be smaller and discounted less, the lower price of entry could encourage warehousing by reducing the amount initially needed to hold on to the spectrum. The Commission declines to adopt recurring payments as an alternative to performance requirements in this order and note it is unlikely the Commission would adopt such payments given the Commission's review of the record and further consideration of the factors affecting these bands. In the *NPRM*, the Commission speculated that these

payments could incentivize deployment of network facilities and discourage spectrum warehousing because a licensee would be unlikely to pay the auction price for successive terms for spectrum it did not intend to use. However, the Commission believes there is a strong likelihood that bidders would still warehouse spectrum and leave it fallow if the cost of the recurring payment to the spectrum holder was outweighed by the benefit derived from foreclosing other operators' access to the spectrum. This would counter the Commission's goal of accelerating deployment in these bands. Accordingly the Commission declines to adopt this proposal.

12. Security

149. The FCC's approach to cybersecurity proceeds from the view that communications providers are generally in the best position to evaluate and address risks to their network operations. This approach recognizes the importance of private sector leadership and innovation in cybersecurity, and it reduces the need for ongoing regulatory involvement in private sector security practices. It will prove successful, though, only if the private sector aggressively addresses evolving threats through security-by-design, even where short-term market incentives may not be sufficient to drive long-term security investments before harm is realized.

150. Emerging security standards for new flexible uses of the mmW bands (and "5G" more broadly) are developing in parallel, but not necessarily at the same pace, with the emerging networks, devices, and equipment. While CTIA has observed that significant, multi-stakeholder, multi-disciplinary, and "multi-layered" efforts are ongoing, domestically and globally, "to assure that [5G] network and [mmW] device security is preserved to the maximum extent feasible," the Commission must acknowledge that to date many wireless communications systems have not been successful at implementing security-by-design. The Commission recognizes that, in the race to market, vital security protections too often fall by the wayside.

151. The Commission took narrowly tailored steps to help promote an environment that encourages the early and ongoing consideration of security issues by all private sector participants, including infrastructure and device firms, established communications firms, and new entrants to communications markets. New mmW-based networks will enable valuable new services, and accelerating the

deployment of those services is a national priority. Those benefits, however, will be undermined if security risks are not managed by licensees. Accordingly, the Commission is moving expeditiously both to meet the need for new mmW spectrum for next generation services and to help ensure that security for these services is built in from the beginning, not left as an afterthought. In this approach, the Commission concurs with stakeholders who identify that there is an opportunity to take action now—before the technology is mature or the services deployed—to encourage, from the outset, the development of necessary cybersecurity protections alongside the development of emerging services and technologies.

152. In the *NPRM*, the Commission recognized the significance of security to 5G networks and the future devices enabled by and connecting to them. Because of the implications related to both sets of issues, the Commission sought comment on how to secure mmW band devices, networks, and their communications, and specifically on "how to ensure that effective security features are built into key design principles for all mmW band communications devices and networks." The Commission expressed a belief in the value of "security-by-design" that is motivated by the Commission's expectations that these networks may provide capabilities for a wide variety of new devices and applications, including, among others, traditional mobile communications capabilities, IoT and other applications as well as devices critical to public safety and related services that provide essential protections to the nation. The Commission indicated that security by design means ensuring that the goals that drive the development of networks and devices include achieving an objective state of security. In that context, the Commission explained that the security constructs of confidentiality, integrity, and availability help us gain insight into security generally, and that security-by-design can help ensure that the next generation of wireless networks meets these critical components of a secure network. Several commenters expressed their support for this approach.

153. The Commission continues to believe in the significant benefits of security by design, including the benefits that the Commission would expect to flow from using the confidentiality, integrity, and availability construct for assessing, planning and incorporating security elements into networks and devices as early as possible in their developmental

stages. Indeed, the record demonstrates that security elements are appropriate and important for service providers and equipment developers to consider now, during the development process, as well as part of an ongoing discussion as networks and devices are deployed and operated.

154. For example, one commenter notes that the “network-based hop-to-hop security approach used to secure the path between communications users will not be sufficient for differentiated end-to-end security for certain 5G services.” Systems are in need of a “secure architecture, stringent identity management and data protection, more rigorous authentication methods, and an array of system-level protections to defend against distributed denial of service . . . attacks and other intrusions.” Accordingly, the commenter believes that security features that are incorporated into 5G systems by design would provide a significant advantage over any “built on top of” system design. Since the service and network architecture of 5G is going through dramatic remodeling, the commenter maintains it will “improve the feature and competitive strength for 5G if security protection is included at an early stage.”

155. The view that security should be a fundamental component in the design of any new network architecture and protocols is also shared by 5G Americas, which underscores the heightened sense that security is expected to take on as new technology and services are deployed. For example, 5G Americas states that 5G systems are expected to provide important applications such as “smart grids, telemedicine, industrial control, public safety and automotive, [which] have security requirements to defend against intrusion and to ensure uninterrupted operations.” Other commenters offer additional examples illustrating why it is appropriate and important to build security elements into considerations that go into developing networks and devices. For instance, AT&T notes a variety of developments that will have security implications: “machine to machine communications will contemplate energy optimization, reduced signaling, and massive connectivity. With these advancements, IoT [Internet of Things] will become a reality. 5G systems will be capable of supporting a range of machine-to-machine services, from connected cars to smart cities to telemedicine and beyond.” Highly secure 5G systems will be expected even in times of stress. As FiberTower notes, “reliance on 5G will only increase in the event of a man-made or naturally

occurring outage in a critical service.” To support these needs, the Commission believes 5G services will need to be highly secure prior to deployment, and the Commission thinks it reasonable that the Commission be apprised of security plans in place prior to 5G services becoming operational.

156. Based on the Commission’s analysis of the record, the Commission can best facilitate adoption of security-by-design approaches by promoting an open dialogue about security practices that would be consistent with a discussion at a standards organization. Therefore, the Commission is asking to receive from licensees—before they begin operations—general statements, at a level consistent with the open forum standards body discussions, of their plans for safeguarding their networks and devices from security breaches. Requiring licensees to submit that information at that juncture creates an incentive for them to engage in the development of security measures at an earlier stage. The specific information that the Commission receives will also facilitate the Commission’s ability to help in identifying security risks, including areas where more attention to security may be needed, and in disseminating information about successful practices for addressing the risks. Moreover, this approach avoids the drawbacks of imposing prescriptive security mandates—e.g., downsides such as the likelihood that one size will not fit all, the lack of agility in responding to changing circumstances and technologies, and the rigidity that such mandates tend to introduce into systems at the outset—thereby preserving for operators, equipment developers, and other interested parties significant flexibilities for addressing security concerns.

157. As described in detail below, the provision that the Commission adopted promotes “security-by-design” approaches within the mmW network and product development environment, in ways that should (i) minimally impact (but appropriately enhance the prospects for security “assurance”) ongoing design and development with respect to this nascent technology, (ii) facilitate integration of network and product development with the timeline for standards development, and (iii) encourage early participation in and monitoring of such standards development. This provision—a requirement that each licensee discuss at a high level how confidentiality, integrity, and availability principles are reflected in its network security design planning in a Statement submitted to the Commission prior to commencing

operations—should also help inform the Commission’s collective understanding and strategies for addressing security issues in the next generation of communications networks. More specifically, the Commission is requiring licensees to file a Statement with the Commission within three years after grant of the license, but no later than six months prior to deployment. This time period accords with the Commission’s security-by-design goals while leaving flexibility for licensees depending on when they are able to deploy service. The Statement must be signed by a senior executive within the licensee’s organization with personal knowledge of the organization’s security plans and practices, within the licensee’s organization, and must include, at a minimum, the following elements:

- A high-level, general description of the licensee’s security approach designed to safeguard the planned network’s confidentiality, integrity, and availability with respect to communications from: a device to the licensee’s network; one element of the licensee’s network to another element on the licensee’s network; the licensee’s network to another network; and device to device (with respect to telephone voice and messaging services).

- A high-level, general description of the licensee’s anticipated approach to assessing and mitigating cyber risk induced by the presence of multiple participants in the band. This should include the high level approach taken toward ensuring consumer network confidentiality, integrity, and availability security principles, which are to be protected in each of the following use cases: communications between a wireless device and the licensee’s network; communications within and between each licensee’s network; communications between mobile devices that are under end-to-end control of the licensee; and communications between mobile devices that are not under the end-to-end control of the licensee.

- A high-level description of cybersecurity standards and practices to be employed, whether industry-recognized or related to some other identifiable approach;

- A description of the extent to which the licensee participates in standards bodies or industry-led organizations pursuing the development or maintenance of emerging security standards and/or best practices;

- The high-level identification of any other approaches to security, unique to the services and devices the licensee intends to offer and deploy; and

- Plans to incorporate relevant outputs from Information Sharing and Analysis Organizations (ISAOs) as elements of the licensee's security architecture. Plans should include comment on machine-to-machine threat information sharing, and any use of anticipated standards for ISAO-based information sharing.

158. The intent of the disclosures is to facilitate multi-stakeholder peer review and earlier development of devices and a commercially viable market for the service. The Commission recognizes that the Statements concern the cybersecurity of the Commission's nation's critical communications infrastructure and, accordingly, the content of the Statements should be at a high-level and not include information that, if publicly disclosed, would create a significant risk to the security of this infrastructure or related systems and networks. The Commission also recognizes that an entity's cybersecurity posture can be a competitive differentiator and that unauthorized disclosures of Statements containing more detailed information could result in competitive harm to the licensee. Here again, the Commission concludes that the Statements should not provide information at a level of granularity that its public disclosure would jeopardize the competitive position of the licensee. For example, the Commission expects that these disclosures will contain information that could be disclosed at a standards meeting where stakeholders gather to share ideas and information for the purpose of advancing the state of the art. If, however, licensees intend to submit information that warrant confidential treatment, they may seek confidential treatment pursuant to the Commission's rules. Furthermore, the information required to be submitted under this rule as it relates to security plans and practices will not be used for the purpose of enforcing compliance with the Communications Act or any of the Commission's rules, other than the requirement of filing such Statements.

159. The Commission finds that appropriate cybersecurity safeguards are a fundamental part of the development and deployment of mmW systems and services contemplated by this *Report and Order*. The reporting requirement the Commission adopted will not only help ensure that industry focuses the necessary degree of attention throughout these development and deployment processes on the most effective ways to include these safeguards at the earlier possible points, but it will also keep the Commission informed of the ongoing progress in this area so the Commission can provide timely, measured and

effective responses to address any emerging problems before they become intractable. It will also be important to consider how best to ensure that the types of cyber safeguards that the Commission encourages for the mmW bands will be incorporated more broadly into future so called 5G networks and services. Consequently, the Commission directs the OET, the Public Safety and Homeland Security Bureau (PSHSB), and the WTB to, by not later than October 31, 2016, issue in a separate docket a *Notice of Inquiry (NOI)* exploring the security implications and solutions in future 5G networks, beyond the actions the Commission took in this *Report and Order*. The Commission believes this *NOI* is an opportunity to look holistically at the potential security implications in future 5G networks offering different types of services to different types of users (e.g., wireless broadband, low-data-rate IoT applications, high-data-rate IoT applications). It will also provide a collaborative vehicle for exploring 5G security-related threats, solutions, and best practices in order to address the implications more effectively. The *NOI* is not intended to duplicate or replace ongoing or future 5G security architecture and 5G design work by standards bodies, industry or academic groups, but instead to facilitate common appreciation across the 5G ecosystem for the evolving security standards. The *NOI* will also provide an opportunity for stakeholders to identify new 5G issues as new IoT functions are developed in 5G, and as national security, public safety, critical infrastructure industries, and consumers begin to understand the implications and potential opportunities of 5G.

G. Technical Rules

1. Flexible Duplexing Rules

160. Consistent with the Commission's proposal in the *NPRM*, the Commission adopted flexible duplexing rules for the 27.5–28.35 GHz, 37–38.6 GHz, and 38.6–40 GHz bands. While the comments indicate that TDD is the duplexing scheme licensees are most likely to deploy in the bands, the Commission sees no reason to prevent them from using other technologies. Therefore, the rules the Commission adopted will allow any type of duplexing to be deployed, subject to other technical rules to manage interference. The Commission also adopted changes to the 39 GHz channel plan, as discussed in more detail in Section I.B.5 (39 GHz Band (38.6–40

GHz)), which will accommodate more flexible duplexing schemes.

2. Transmission Power Limits and Antenna Height

a. Base Stations

161. The Commission believes that an increase in the maximum base station power from what the *NPRM* proposed is necessary for two reasons. First, the 62 dBm/100 MHz EIRP power limit proposed in the *NPRM* will limit UMFUS base stations to a much lower power density than is permitted for other mobile services. For example, Personal Communications Service (PCS) and AWS base stations are permitted to transmit at 62 dBm/MHz EIRP, which would permit a total EIRP of 82 dBm for a 100 MHz signal. The Commission sees no reason why UMFUS should be limited to a lower power density than PCS and AWS. Second, the propagation properties in the mmW band make higher powers necessary. Signal attenuation with distance is higher in the mmW bands than at lower frequencies and signals are more severely attenuated due to obstacles such as foliage and walls. As the simulations submitted by commenters illustrate, higher signal powers are necessary to permit relatively modest base station coverage areas and to increase data throughput. Unnecessarily limiting the base station power in the mmW bands by applying the existing part 27 base station limit could unduly inhibit future technologies and applications.

162. The Commission adopted a base station power limit of 75 dBm/100 MHz EIRP as the base station power limit for the 28 GHz, the 37 GHz and 39 GHz bands. For channel bandwidths less than 100 megahertz the permitted EIRP will be reduced below 75 dBm proportionally and linearly based on the bandwidth relative to 100 megahertz. Because the technology for providing mobile services in these bands is still being developed, the appropriate transmitted power requirements for this equipment cannot be definitively known at this time. This 75 dBm/100 MHz limit represents a consensus that has been endorsed by the commenters who have expressed an intention to manufacture UMFUS equipment. Therefore, the Commission is confident that this power level will provide the equipment manufacturers and future licensees with the flexibility needed to deploy service in these bands. Because of the early stage of development of UMFUS technology, the Commission will monitor how this technology develops and revisit the base station

power limit in the future if it becomes necessary.

163. The Commission is not persuaded by those commenters who do not favor increasing the base stations power limit above the level proposed in the *NPRM*. Boeing's claim that the 75 dBm limit is inconsistent with the operational range of 5G applications is contradicted by the simulation results that show the benefits of increasing the maximum power beyond 62 dBm and the consensus among equipment manufacturers that 75 dBm is a reasonable power limit for UMFUS base stations. Furthermore, the Commission's rules for the 37.5–40.0 GHz band, about which Boeing expresses sharing concerns, limit the FSS to gateway-type earth station operations and prohibit the ubiquitous deployment of satellite earth stations designed to serve individual consumers. The Commission does not believe that the higher power limit the Commission is adopting will significantly affect the limited gateway FSS operations permitted in the band because the Commission is providing a means for gateway earth stations in the band to obtain protection from terrestrial transmissions. As for SES Americom's and Avanti's concerns, the Commission explained in Section I.G.2.d. (Terrestrial Aggregate Interference Concerns to FSS Satellite Receivers in 28 GHz), that the Commission does not believe the Commission needs to take specific action with respect to aggregate interference to satellite receivers in the 28 GHz band at this time. The Commission therefore will not unduly restrict the development of UMFUS by limiting the base station transmit power.

164. The Commission will not adopt a different power limit for equipment that is used to provide both mobile services and backhaul. As the *NPRM* noted, several commenters to the *NOI* suggested that it might be feasible to deploy such 5G equipment. The Commission notes that those commenters did not address this subject in response to the *NPRM* and no other commenters specifically request higher power limits for such equipment. The Commission believes that by adopting a higher power limit for base stations than proposed in the *NPRM*, the Commission is also providing adequate power to ensure successful deployment for combined access/backhaul equipment. In addition, the Commission will not limit base station antenna height at this time because no commenters address the issue. Instead, the Commission shall seek further comment on this topic in the *FNPRM*.

165. Compliance with the transmit power limit shall be ascertained with over the air measurement of EIRP of the device under test (DUT). As Qualcomm has stated, mmW devices are being designed with an array of multiple antennas employing dynamic beamforming and that these designs make verification of transmitter power, EIRP, and antenna gain challenging. In this early stage of mmW development, compliance testing will be challenging because of lack of test equipment and/or facilities that can accurately measure over the air EIRP of the DUT and the need to account for the introduction of antenna arrays and beamforming. Even so, OET has issued a number of Knowledge Database (KDB) publications that delineate measurement procedures for testing of antenna arrays.¹⁰ Moreover, OET will address the further development of mmW measurement procedures with input from industry stakeholders and other interested parties and issue further KDB guidance.

b. Mobile Stations

166. As proposed in the *NPRM*, the Commission adopted a 43 dBm EIRP maximum mobile power limit in the 27.5–28.35 GHz, 37–38.6 GHz, and 38.6–40 GHz bands. The simulations and analyses by commenters indicate that this power level will be sufficient to provide the expected range and data rates. In addition, the power level is consistent with the Commission's rules for part 15 devices in the 57–64 GHz band that have been in place since 1995. The Commission is also encouraged by the strong support for this power limit, especially from commenters who indicate that they will manufacture equipment for these bands.

¹⁰ See Federal Communications Commission, Office of Engineering and Technology, Laboratory Division, *Emissions Testing of Transmitters with Multiple Outputs in the Same Band* (October 31, 2013) and *MIMO with Cross-Polarized Antenna* (October 25, 2011) (<https://apps.fcc.gov/kdb/GetAttachment.html?id=B0ZQjTBTVsn3P3wZ2WdqhQ%3D%3D> and <https://apps.fcc.gov/kdb/GetAttachment.html?id=i%2BFrza%2B2Hh0pf9nHJHJGHw%3D%3D>). The Commission notes that OET has developed a substantial body of additional guidance that is available via public notices, frequently asked questions (FAQ's), and specific process guidance that is compiled in our online Knowledge Database (KDB). Equipment authorization topics that relate to new services and devices authorized by the Commission are often addressed in the KDB. This includes, for example, simple answers to questions, guidance on how to file for authorization of new types of devices, and guidance on how to conduct rule compliance testing. The staff guidance provided in the KDB is intended to assist the public in following Commission requirements. The guidance is not binding on the Commission and will not preclude the Commission from making a different decision in any matter that comes to its attention for resolution.

167. The Commission notes that UMFUS devices will be expected to comply with the Commission's rules regarding radiofrequency radiation exposure in addition to complying with the 43 dBm EIRP limit the Commission adopted. These radiofrequency radiation exposure rules specify more stringent exposure limits for devices that are designed to be used within 20 centimeters of the user's body. The Commission recognizes that such devices may have to limit their transmit power below the 43 dBm limit to meet exposure limits.

c. Transportable Stations

168. The Commission agrees with the majority of commenters that there is a need for an additional class of transportable stations requiring a maximum allowable power limit higher than the 43 dBm adopted for mobile user equipment stations. Higher power for such devices will increase range, enable higher data rates and provide for better coverage throughout buildings, which will allow consumers flexibility in installation locations to provide service where needed. These devices could be used to provide residential broadband service, which as the simulation results provided by Nokia illustrate will benefit from a higher transmit power than the Commission is allowing for mobile stations. The Commission adopted a 55 dBm EIRP maximum power limit for this for this class of equipment, which the Commission shall refer to as transportable stations. This 55 dBm limit represents a consensus that has been endorsed by commenters who have expressed an intention to manufacture UMFUS equipment. The Commission notes that in adopting this higher power limit for transportable stations that such devices will be expected to comply with the Commission's rules regarding radiofrequency exposure.

169. No commenter has proposed a definition of transportable devices for purposes of the Commission's rules. However, the terminology that most commenters have used suggests that such devices will be stationary while operating. Therefore, the Commission shall define a transportable device as transmitting equipment that is not intended to be used while in motion, but rather at stationary locations. The Commission believes this definition is appropriate because it will exclude portable devices that are meant to be carried by people while operating such as mobile phones or smart phones from transmitting at the higher power level. One commenter has suggested that these transportable devices could be built into

vehicles, which implies that they should be permitted to operate while in motion. The Commission has chosen not to expand the Commission's definition to include devices in moving vehicles because such devices in general will not need to transmit signals that penetrate walls and therefore will not require more power than mobile devices.

d. Terrestrial Aggregate Interference Concerns to FSS Satellite Receivers in 28 GHz

170. The analyses, provided by commenters, leads us to conclude that specific technical limits on UMFUS stations are not necessary at this time to address aggregate interference. As discussed in more detail below, the information in the record shows a wide disparity between assumptions and illustrates that much work must be done to accurately model mmW systems and the effects that these systems might have on co-channel satellite receivers. As a result, the Commission does not want to unduly restrict the development and growth of UMFUS unless the Commission has adequate evidence that actual harm will occur. The Commission does not believe the record demonstrates that there is a risk of interference to satellites from aggregate interference caused by UMFUS stations. Consequently, the Commission will not adopt a limit on aggregate skyward interference from 28 GHz band UMFUS stations or require that UMFUS stations employ specific techniques to reduce skyward emissions. The Commission observes that features such as antenna downtilt, suppression of sidelobes and adaptive power control will occur naturally because they are inherent characteristics of anticipated 5G technologies.

171. The analyses provided by the satellite operators are based on very conservative assumptions and provide for a worst case scenario regarding aggregate interference from future terrestrial networks. For example, the satellite analyses appear to assume terrestrial devices will continuously operate at maximum power levels and do not account for the fact that many UMFUS deployments will occur indoors. Most of the satellite analyses assume all terrestrial devices will be line of sight to the satellites with the exception of the analysis submitted jointly by the Satellite Operators, which assumes only a 9.6 dB attenuation for a 90% non-line of sight scenario. These analyses also assume a -12.2 dB interference criteria, which the Joint Filers point out has been under past review in language reflected in a

Conference Preparatory Meeting report to WRC-15. The Joint Filers also note that some system parameters provided by Satellite Industry Association (SIA), such as satellite noise and receive beam gain, are based on the most sensitive projections about future, planned satellite network deployments, not necessarily satellite networks that currently exist.

172. While the Joint Filer's simulation results are not based on as conservative assumptions as the satellite operators, they vividly illustrate how the assumptions made can lead to vastly different conclusions. Assumptions such as the antenna pattern of the UMFUS devices, how many of the devices are line of sight to the satellites, the characteristics of the satellites, and the satellite interference criteria clearly can make an enormous difference in the number of devices that may transmit without interference occurring. Given that mmW technology is just being developed and the deployment scenarios of these devices are uncertain, many of these assumptions are speculative at this point and any conclusions that can be drawn from analyses or simulations at this point are necessarily tentative. The Commission also observes that no information has been submitted into the record as to how terrestrial licensees would demonstrate compliance with a limit on aggregate energy at each satellite or each point in the sky. While the Commission concludes that the various studies submitted by the parties do not support establishment of an aggregate interference limit or adoption of specific technical requirements to reduce skyward emissions, they do indicate the need for additional study on the effect of aggregate interference on satellite receivers. The Commission expects that the parties will continue to study this issue and inform the Commission of the outcome. The Commission will revisit this issue if additional information comes to the Commission's attention suggesting that regulatory requirements are necessary.

3. Out-of-Band Emission Limits

a. Use of Conductive Emission Limits

173. One of the implications of requiring an EIRP metric for the OOBE limit is that a transmitter has to meet the limit along the maximum EIRP direction. This makes meeting the radiative OOBE limit particularly challenging, as recognized by the commenters. In the mmW band, transmitters require higher gain antennas to compensate for significantly higher propagation losses and

consequently the antennas will, in general, have much smaller beamwidth, as compared to other lower band mobile systems. As a result, OOBE of mmW transmitters have highly directive characteristics, concentrating the transmission power along a narrow beam in the direction of maximum EIRP. Furthermore, because the beam is narrow and because a transmitter needs to track the relative movement of its intended receiver in order to maintain the communication link, the OOBE of the mmW transmitter should be spatially averaged over the path of the receiver to reflect the spatially transient nature of the transmitter OOBE. In this regard, Qualcomm states that, "based on its simulations to date, the average interference from a mobile and a base-station/small cell with a steerable/selectable array is very different and variable when compared to a fixed link. With mobile operations, the interference impact differs from fixed links due to the dynamic nature of the array, for it points in different directions as mobile users move and are served." The Commission believes these features of the mmW spectrum make the OOBE limit in the maximum EIRP direction less significant and a spatially averaged OOBE limit more appropriate. One way to spatially average OOBE of a transmitter is to determine its out of band TRP or by extension of its out of band conductive power.¹¹ To set forth a more suitable OOBE metric that reflects the aforementioned features of mmW band, the Commission should express the OOBE limit as an equivalent conductive limit. An equivalent conductive limit is consistent with the OOBE rule for other mobile systems.

174. Compliance with a conductive OOBE limit in the mobile mmW systems will be the same as other mobile systems where access to the antenna RF port(s) is available. Where access to the RF port(s) is not available, a somewhat more complicated process is necessary. For each frequency (or band), an emission measurement of the DUT must be performed along the direction of the maximum EIRP. The EIRP measurement value is then adjusted for the antenna gain along the same direction as the measured EIRP and at the same frequency (or band) to obtain a conductive OOBE power of the device. This process needs to be performed for

¹¹ TRP of a transmitter is closely related to its' conductive power. In fact, TRP is product of antenna radiation efficiency, e_r , and conductive power P ($TRP = e_r P$ and depending on antenna efficiency TRP can be virtually the same as the conductive power P). See W.L. Stutzman and Gary A. Thiele, *Antenna Theory and Design*, 2013, equations 13-40 and 2-155.

both polarization and, the respective conductive OOBE power summed, to obtain the total conductive OOBE power of the device. To obtain the antenna gain, licenses should use a validated antenna pattern computation, manufacturer supplied antenna pattern, or any other approach acceptable to the Commission as may be described in OET's KDB publications. The Commission recognizes that under certain circumstances the DUT antenna may interact with its supporting structure sufficiently enough that the interaction may require consideration through simulation or by an additional measurement step. One way to identify such circumstances may be through the antenna pattern validation step. Other means of identifying and considering such circumstances may be described in OET's KDB publications.

175. With respect to TRP, TRP measurement requires EIRP measurement of the device under test around spherical surface of the device for both polarizations, and as a result it can be time consuming and difficult. A reverberation chamber is deemed to be one of the most practical means of TRP measurement. However, as noted by Straight Path, TRP measurement in a reverberation chamber requires conducted power measurement of power amplifiers. Straight Path further argues that given that in many cases 5G transceiver power amplifiers and antennas may be integrated on a single printed circuit board, it is unclear how conducted measurement can be achieved for transceivers. Moreover, even if access to RF ports were to be made available, a conductive measurement would be far easier and economical to perform than TRP, as no over the air measurement would be required for conductive measurement. However, given that a number of commenters have requested TRP as a metric for OOBE, and given that TRP is a spatial averaging method, the Commission will allow TRP as the alternate metric for compliance. As there are no TRP measurement procedures currently defined, new measurement procedures will be developed through the FCC Laboratory's KDB process.

176. In the *NPRM* the Commission proposed a radiated OOBE limit that requires licensees to attenuate their unwanted radiated emission power below the transmission power (P) by a factor of at least $43 + 10\log_{10}(P)$ per MHz (or an absolute power of -13 dBm/MHz) for any emissions on frequencies outside the licensee's authorized spectrum. This radiated OOBE limit is consistent with the conductive OOBE

limit that the Commission has generally required for other mobile systems. In addition, a number of commenters state that using TRP as a metric the proposed OOBE attenuation factor or absolute power of -13 dBm/MHz would be feasible. For these reasons the Commission has set the OOBE limit for both conductive metric and TRP metric to -13 dBm/MHz. This may be used as a basis for developing further requirements that relate to transmitter performance by industry standard organizations. This limit applies to base stations, transportable, and mobile stations.

177. With respect to dBr radiated emission mask, the mask is significantly more relaxed than the -13 dBm/MHz absolute limit that a number of commenters support. In addition, the Commission finds that the equivalent conductive limit (or alternatively TRP) is the appropriate metric for OOBE in this band. For these reasons, the Commission declines to adopt the dBr radiated emission mask that Qualcomm proposes.

b. Licensed Block Edge Region

178. The Commission agrees with Ericsson, and some of the other commenters that a bandwidth-dependent unwanted emission requirement at the first megahertz adjacent to the licensed block discriminates against broadband systems. However, a bandwidth-independent unwanted emission requirement at the channel edge may not be sufficient for very large bandwidth channels, or may not be spectrally efficient for narrowband channels. As it is difficult at this nascent stage of mmW development to anticipate the future channel configuration of this technology, the Commission is relaxing the emission requirement at the channel edge dependent on channel bandwidth, so as to provide for the greatest latitude for channel configuration. For the first 10 percent of the channel bandwidth from the edge of the licensed block, the Commission requires an emission level of -5 dBm/MHz. Beyond the first 10 percent of the channel bandwidth, the Commission requires an emission level of -13 dBm/MHz. These requirements exceed Intel's request over the first 10 percent of the channel bandwidth immediately outside and adjacent to the licensee's frequency block. The permissible out of band power under these emission limits are higher than Nokia and Sprint recommendations over the first 10 percent of the channel bandwidth, but lower than Samsung's recommendations. Overall, the

Commission believes these requirements balance the various comments on record.

4. Interference Protection and Coordination

a. Coordination and Field Strength Limits at Market Borders

i Base/Mobile Operations

179. The Commission agrees with the majority of commenters that some criteria is necessary at market boundaries to manage interference and coordination between adjacent area licensees. The Commission also believes that given the wide channel bandwidths and diversity of potential applications that might be deployed in these bands, any criteria that the Commission adopts should include a scaling factor for the bandwidth. Therefore, the Commission will adopt a PFD limit/MHz that base operations must meet at the licensee's market boundary, absent a mutual agreement between adjacent market licensees to exceed that value.

180. The Commission continues to believe that the 47dBuV/m field strength value that the Commission proposed in the *NPRM* is an appropriate basis on which to set a PFD limit for the mmW bands. This is the same limit that has been successfully used in the PCS, AWS, and BRS bands. However, the Commission notes that a field strength of 47dBuV/m results in a very conservative absolute power limit because field strength does not take into consideration the bandwidth and frequency components. Therefore, the Commission believes it is appropriate to convert a 47dBuV/m field strength to a PFD limit in terms of dBm/m²/MHz for the mmW bands. Looking again at the AWS, PCS, and BRS bands, the Commission notes that the equivalent PFD based on a 47dBuV/m field strength is within the range of -76 to -81 dBm/m²/MHz depending on what bandwidth is assumed. The Commission observes that these values bound the -77.6 dBm/m²/MHz PFD limit proposed by the joint filers. The Commission also recognizes that these values are higher than the -86 dBm/m²/MHz PFD proposed by Straight Path and the -90.3 dBm/m²/MHz PFD proposed by Intel. However, the Commission notes that Straight Path assumed an interference criteria of -10 dB I/N. In recent rulemakings the Commission has assumed an interference criteria of 0 dB I/N. Adjusting Straight Path's proposed limit to provide a 0dB I/N as opposed to a -10 dB I/N yields a market boundary limit of -76 dBm/m²/MHz. The Commission also notes that Intel's

proposed PFD was based on worst case assumptions about the receive antenna gain, citing that the base station would have a gain of 29.1 dB in the direction of the interfering source. The Commission believes that this assumption is overly conservative. For example, the joint filers stated that a lower antenna gain is typically computed in the simulation towards the earth station since the receive beam is pointed in the direction of the transmitting UE, and it is statistically unlikely to coincide with the direction towards the earth station. Thus, on balance, the Commission believes that adopting a -77.6 dBm/m²/MHz PFD limit as suggested by the joint filers, will protect terrestrial facilities in adjacent market areas from interference in a variety of different terrestrial to terrestrial use cases as well as the earth station to terrestrial scenario. Therefore, the Commission will adopt a market border PFD limit of -77.6 dBm/m²/MHz measured at 1.5 meters above ground. The Commission emphasizes that this level is intended to be a coordination trigger and that adjacent licensees are free to coordinate mutually agreed upon limits that exceed this value along their common market boundaries. The Commission will also reserve the right to revisit the market border PFD limit in the future if it becomes necessary as technology and services develop in these bands.

ii. Fixed Point-to-Point Operations

181. The Commission agrees with Skyriver that a field strength limit would not be appropriate for fixed point-to-point operations because it would require large power reductions by fixed service providers. The Commission will retain the existing part 101 technical rules for traditional fixed point-to-point links. As such, the Commission believes that it is also appropriate to retain the existing requirement that fixed point-to-point operations within 16 kilometers (in the 38.6–40 GHz band) or 20 kilometers (in the 27.5–28.35 GHz band) of a licensee's market boundary must coordinate with co-channel licensees in adjacent market areas. With respect to Sprint's suggestion that the Commission impose a coordination requirement for adjacent channel licensees; in light of the OBE limits that the Commission adopted, the Commission does not believe that any additional coordination requirement is necessary for adjacent channel operation.¹² The Commission seeks

comment on further refining these coordination requirements in the *FNPRM*.

b. Canadian and Mexican Borders

182. In the *NPRM*, the Commission proposed to adopt a rule for the 27.5–28.35 GHz, 37–38.6 GHz, and 38.6–40 GHz bands similar to § 101.147(r)(13), 101.509(d), or 27.57 of the Commission's rules which provide that fixed and mobile operations are subject to existing and future international agreements with Mexico and Canada. The Commission noted that there are existing arrangements for fixed operations in the 27.5–28.35 GHz and 38.6–40.0 GHz bands between the United States and Canada. The Commission also noted that mmW operations must not cause harmful interference across any of the Commission's international borders. No parties filed comments with respect to this proposal.

183. Consistent with the Commission's rules for other services, the Commission adopted a rule that the 27.5–28.35 GHz, 37–38.6 GHz, and 38.6–40 GHz bands are subject to existing and future agreements with Mexico and Canada.

5. Operability

184. The Commission adopted its proposal to require operability across each millimeter wave band for mobile and transportable equipment. The Commission continues believe that interoperability delivers important benefits to consumers. While there is significant opposition in the record to an interoperability requirement, no commenter offered specific reasons why the type of operability proposed in the *NPRM* would be either technically infeasible or harmful as a policy matter in these bands. In addition, much of the opposition in the record appears to be based on an interpretation of an interoperability requirement that the Commission did not propose. The Commission therefore concludes that the benefit to consumers outweighs the burden to manufacturers in this regard.

185. Specifically, the Commission requires that any mobile or transportable device designed to operate within the 28 GHz band (27.5 GHz–28.35 GHz) be capable of operating at all frequencies within the 28 GHz band, on each air interface it uses to operate in the 28 GHz band, and similarly that a

contain some information on leased links there is no requirement for licensees to report all fixed point-to-point links operating under their geographic licenses. Therefore the ULS database is an incomplete record of the existing point-to-point links.

device operating in the 37 or 39 GHz bands be capable of operating at all frequencies within those bands (37 GHz–40 GHz). For example, a device that uses an LTE air interface to operate in a lower frequency band, and a future 5G air interface to operate in the 28 GHz band, would be compliant with this requirement if it could operate on frequencies from 27.5 GHz to 28.35 GHz using the 5G air interface.

186. For the purposes of this requirement, for the 37 GHz and 39 GHz bands, a device operating in either band must be capable of operating across the entirety of both bands, from 37 GHz to 40 GHz (including the 37–37.6 MHz lower block). This requirement will increase the market for equipment in these bands, and allow both smaller and larger service providers to benefit from economies of scale and increased equipment availability. Mandating operability will also facilitate shared use of the 37 GHz band by ensuring that a wide variety of equipment is available by both Federal agencies and non-Federal SALs.

187. The Commission emphasizes that it will not mandate compatibility of each device with all possible air interfaces to be used in these bands, as some commenters interpreted. Rather, the Commission will mandate that *with each air interface* used by a particular device in a millimeter wave band, that device must be capable of operating across the entire band. The Commission does not adopt any requirement that a device must be capable of utilizing any particular standard, technology, or air interface. Additionally, while the Commission does not require operability of base or fixed equipment, it is its expectation that licensees will work in good faith through the standards setting process to develop standards, as technically feasible, that support the operation of base and fixed equipment across each band.

6. Technical Rules for Part 15 Operation Within the 64–71 GHz Band

188. The Commission is adopting requirements for unlicensed operations in the 64–71 GHz band that are based on the technical standards used for the 57–64 GHz band under § 15.255 of the Commission's rules. Part 15 of the Commission's regulations permits the operation of radio frequency (RF) devices without an individual license from the Commission or the need for frequency coordination. The technical standards contained in part 15 are designed to ensure that there is a low probability that such devices will cause harmful interference to other users of the radio spectrum. Except for operating

¹² The Commission also notes that Sprint's assumption that ULS contains current station information is not entirely correct. While ULS does

on-board aircraft or satellites, and in mobile field disturbance sensor applications, any type of unlicensed operation is permitted within the 57–64 GHz band under § 15.255 of the Commission's rules.¹³

189. *Suitability of the Existing Rules in Section 15.255 to the 64–71 GHz Band.* In the *NPRM*, the Commission proposed to apply the existing rules in § 15.255 to the 64–71 GHz band with some adjustments, and sought comments on certain aspects of the rules to further the growth and development of devices without increasing the potential for harmful interference to authorized users in the bands. Proponents of unlicensed operations unanimously support the proposal to extend the technical rules in § 15.255 to cover the entire 57–71 GHz band. Google argues that harmonized rules for the frequencies between 57 and 71 GHz will allow economies of scale and other efficiencies, thereby facilitating rapid and widespread deployment of unlicensed devices; the Wi-Fi Alliance confirms that extending part 15 rules to the 64–71 GHz band would greatly enhance the capacity of next-generation WiGig technologies.” The Commission finds that the existing technical rules in the 57–64 GHz band can successfully apply to the proposed 64–71 GHz adjacent band, with certain adjustments, as the Commission examines the pertinent rules in detail below.

a. Operation On-Board Aircraft

190. The Commission is reluctant to allow 60 GHz unlicensed operations on-board aircraft in the 57–71 GHz band at the present time. In the *NPRM*, the Commission did not propose to permit unlicensed operations on-board aircraft but sought to start the discussion to compile a comprehensive record on this subject. The Commission noted, there are substantial technical disagreements between the passive services licensees and the WiGig industry 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. The Commission further observes that even among the WiGig industry advocates, there is technical disagreement. For example, ZII, a wireless inflight

entertainment services and products provider, opposes on-board aircraft operation of WiGig devices in the 64–71 GHz band at the present time due to its findings of potential harmful interference to passive services above 63 GHz despite its financial interest in providing these services. Conversely, the Wi-Fi Alliance's analysis found no harmful interference to EESS and RAS in the entire 57–71 GHz spectrum. The Commission also finds that the studies and technical analyses submitted in the record are not persuasive for several reasons. First, the CEPT ECC and ITU reports do not address the 60 GHz band, but cover lower frequencies. Second, the various link budget analyses from the industry (e.g., from ZII and Wi-Fi Alliance) do not show a technical consensus, at least for a portion of the proposed 57–71 GHz band, and cast doubt on the validity of certain assumptions used to derive these link budgets. Third, since the collaboration effort between the WiGig industry and NTIA/NSF/JPL (Jet Propulsion Laboratory) has not yet resolved many issues, as indicated by NRAO, a decision on the Commission's part at this time could prejudice the outcome of that work. Finally, the Commission notes that 60 GHz transmitters in mobile devices are only just beginning to be marketed, and the impact of their deployment in real-world scenarios will require time to be assessed adequately. Further, the technology will continue to evolve to address signal propagation challenges in the mmW spectrum such that analyses of WiGig transmissions on-board aircraft could change substantially once the Commission has wide deployments.

191. The Commission finds that further technical analyses and data are necessary before lifting the present operation restriction because the record so far did not reflect a clear perspective of the types of WiGig applications envisioned on-board aircraft, the priority/order of their planned introduction, etc., to provide an adequate assessment of their associated potential harmful interference profile as the Commission elaborates further in the *FNPRM* to seek additional information on this topic, *infra*. Specifically, the Commission requests sharing studies and data demonstrating that 60 GHz transmitters could operate on-board aircraft without causing harmful interference to passive sensor services in various types of inflight applications and on various types of aircraft.

192. Finally, the Commission finds that as long as the Commission does not permit 60 GHz operations on-board

aircraft, the airlines (who control the aircraft) would not install access points operating at 60 GHz on airplanes to provide entertainment/broadband services to WiGig user devices. Without the presence of 60 GHz access points, the potential for widespread airborne WiGig transmissions is removed. The Commission also expects manufacturers/host integrators of WiGig transmitters that are incorporated into mobile devices, such as laptops, to provide instructions to end users regarding the prohibition of operating such transmitters' on-board aircraft, in compliance with the Commission's rules as part of the equipment authorization process. Consequently, end users will be aware of this rule to avoid device-to-device transmissions. Based on the above, the Commission is extending the restriction on on-board aircraft operation in § 15.255(a)(1) to cover the entire 57–71 GHz band.

b. Field Disturbance Sensor Operation

193. The Commission is reluctant at this time to lift the restriction on mobile field disturbance applications in the 60 GHz spectrum. At this time, the Commission does not have sufficient information about the operation of these mobile field disturbance sensors in this spectrum to allow general operation of all mobile field disturbance sensors. However, the Commission finds that the narrow application of mobile radars in short-range devices for interactive motion sensing, such as that described in Google's Project Soli,—where a radar is used to detect hand gestures very close to a device to control the device without touching it—could be allowed without causing harmful interference to other authorized users. As a first cautious step, the Commission will not permit these devices to operate at the same power levels as 60 GHz communications devices in this spectrum, as Google requests, but will allow these short-range devices to operate at the same low power levels as those permitted in existing *fixed* field disturbance sensors (i.e., 10 dBm peak EIRP and –10 dBm peak transmitter conducted output power, approximately 30 dB below the allowable power levels of WiGig communications devices). These power levels will ensure that the mobile radars will operate at very short distances—such as using hand gestures to control a watch, a smartphone's or tablet's screen—which will minimize their harmful interference potential. As the Commission acquires more experience with these devices, the Commission may consider allowing them higher power levels in the future. Accordingly, the Commission is

¹³ A field disturbance sensor is defined as “a device that establishes a radio frequency field in its vicinity and detects changes in that field resulting from the movement of persons or objects within its range.” 47 CFR 15.3(l). Examples of unlicensed field disturbance sensors include radars operating under 47 CFR 15.252 or 15.256; and perimeter protection systems operating under 47 CFR 15.209(g) or 15.229.

amending § 15.255 to permit the operation of short-range devices for interactive motion sensing at 10 dBm peak EIRP and -10 dBm peak transmitter conducted output power over the entire 57–71 GHz band.

194. With respect to fixed field disturbance sensors, the Commission finds that these devices can continue to operate under the technical rules in § 15.255, as they have successfully done over the years, and that these rules may be extended to the 64–71 GHz band without increasing the potential for harmful interference to communication devices in the band. This would result in their wider usage in wireless factory automation processes in manufacturing facilities, such as those mentioned by Boeing. Accordingly, the Commission is amending § 15.255 to allow the operation of fixed field disturbance sensors over the entire 57–71 GHz band at the existing power limits permitted in the 57–64 GHz band (*i.e.*, 10 dBm peak EIRP and -10 dBm peak transmitter conducted output power).

c. Emission Limits

195. The Commission declines to increase the EIRP limits for low-power networking indoor and outdoor 60 GHz transmitters by a factor of 10 as requested by commenters. The Commission notes that the existing generous average and peak EIRP limits were adopted based on the very high oxygen attenuation in the 57–64 GHz band, which would ensure that unlicensed transmitters operating in this band do not cause harmful interference to other authorized services. The Commission further notes that the Commission proposed the same emission limits for the 64–71 GHz band, despite the fact that this band does not exhibit the same atmospheric attenuation characteristics, which would enable equipment operating in the proposed 64–71 GHz band at the same emission levels to effectively provide longer range and higher data throughput. The Commission finds that keeping the same emission limits in the absence of high oxygen attenuation in the 64–71 GHz band effectively provides an increase in power. No additional increase is necessary at this time and the Commission is amending the EIRP limits for 60 GHz transmitters in § 15.255 to apply across the 57–71 GHz band.

d. Spurious Emissions

196. The Commission observes that since the Commission first adopted part 15 rules for unlicensed operation in the 57–64 GHz band in the 1995–2000 time frame, 60 GHz unlicensed transmitters

have been operating without causing harmful interference to RAS by their harmonic signals. This indicates that the Commission's spurious emission limits in § 15.255 for transmitters operating in the existing 57–64 GHz band are adequate for protecting these passive services. Thus, the Commission is concerned with the potential effect of the harmonics of fundamental signals in the proposed 64–71 GHz band. The Commission observes at the outset that the existing spurious emission limit in § 15.255, at 90 pW/cm², is extremely low as compared to the spurious limit adopted for other unlicensed transmitters operating in comparative spectrum, such as the 76–77 GHz, which, at 600 pW/cm², is more than 6 times higher than the spurious limit in § 15.255.

197. While acknowledging that attenuation effects due to oxygen become much less pronounced in the 64–71 GHz band as compared to the 57–64 GHz band, the Commission finds that interference to RAS stations is unlikely for the following reasons. First, RAS receivers discriminate against off-axis signals, are generally located in rural and remote areas, and radio astronomy observatories typically have control over access to a distance of one kilometer from the telescopes to provide protection from interference caused by uncontrolled radio frequency interference (RFI) sources. Second, the severe propagation losses of RF signals in the 64–71 GHz band, their ability to be blocked easily by terrain and obstacles, and the typically directional emissions of transmitters at these frequencies limit any potential for interference from fundamental emissions to a short distance (*e.g.*, 100–200 meters). Third, 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. Based on all these factors, the Commission finds that spurious and harmonic emissions of 57–71 GHz unlicensed transmitters at the very low limit of 90 pW/cm² in § 15.255 would not cause harmful interference to RAS operations. Accordingly, the Commission is amending the spurious emission rule in § 15.255 to apply across the 57–71 GHz band.

e. Publicly-Accessible Coordination Channel

198. Section 15.255(d) sets aside a publicly-accessible coordination channel in the 57.00–57.05 GHz band, in which only spurious emissions and

emissions related to coordination techniques regarding interference management between diverse, non-interoperable, transmitters are permitted. The Commission observed in the *NPRM* that with recent technological advances and industry standardization, co-existence between 60 GHz devices is better resolved by voluntary standards than by a coordination channel requirement in the rules, and proposed to remove this requirement. Commenters unanimously agree with the Commission's assessment and support the elimination of this requirement to free a 50-megahertz swath of spectrum for communications usage. Accordingly, the Commission is removing the requirement for a publicly-accessible coordination channel from § 15.255.

f. Conducted Transmitter Output Power

199. Section 15.255(e) limits the peak transmitter conducted output power of 57–64 GHz unlicensed devices to 500 mW (*i.e.*, 27 dBm) for transmitters with an emission bandwidth of at least 100 MHz, and is reduced for systems that employ narrower bandwidths.

200. The Commission declines to remove this requirement. The reason for limiting the peak transmitter conducted output power while allowing very high EIRP limits (in this case, 40 dBm (10W) average/43 dBm (20W) peak) for an unlicensed transmitter is to ensure that the transmitter antenna beamwidth is kept sufficiently narrow to avoid causing harmful interference to other users in the band and to minimize the risk of RF exposure to humans. Accordingly, the Commission denies NCTA's request and amend the peak transmitter conducted output power requirement in § 15.255 to apply across the 57–71 GHz band.

g. Frequency Stability

201. Section 15.255(f) requires that fundamental emissions be contained within the 57–64 GHz frequency band during all conditions of operation; and that equipment be able to operate over the temperature range -20 to +50 degrees Celsius with an input voltage variation of 85% to 115% of rated input voltage. In the *NPRM*, the Commission proposed to apply the same requirements to transmitters operating in the 64–71 GHz band. No party objects to this proposal. Accordingly, the Commission is amending § 15.255 to apply across the 57–71 GHz band.

h. Co-Location of Separately-Authorized Transmitters

202. Section 15.255(h) allows group installation of transmitters that have

been tested separately for compliance with the rules and received separate equipment authorizations, as long as no transmitter in the group is equipped with external phase-locking inputs that permit beam-forming arrays to be realized. In the *NPRM*, the Commission indicated that this requirement seeks to prevent the possibility of producing a high-power coherent beam from discrete transmitters that have not been tested for compliance together. This could lead to non-compliance with the emission limits but it does not preclude the use of advanced antenna technologies with beam-forming arrays in any transmitter, as long as the emissions in any array configuration comply with the emission and RF exposure limits. The Commission proposed to apply the same requirement to equipment operating in the 64–71 GHz band. No party objects to this proposal. Accordingly, the Commission is amending § 15.255 to apply across the 57–71 GHz band.

7. Equipment Authorization

203. The OET was delegated authority by the Commission to administer the equipment authorization program for RF devices under part 2 of its rules. All RF devices subject to equipment authorization must comply with the Commission's rules prior to importation or marketing, by being tested for compliance with the applicable technical requirements, using measurement procedures that either follow guidance issued by OET through its KDB publications, or have been found to be acceptable to the Commission in accordance with § 2.947 of the rules.

a. Measurement Techniques

204. In the *NPRM*, the Commission recognized that there are some unique technical challenges specific to demonstrating compliance for the purpose of equipment authorization of millimeter wave devices. The Commission sought comments on a variety of challenges involved with measurements of in-band, out-of-band and spurious emissions. As discussed, *supra*, a number of parties discuss the measurement challenges concerning emission limit metrics. For example, certain parties oppose using EIRP as the metric for measuring OOB limits, proposing instead a different metric using TRP, claiming consistency with recent academic research for multiple-input, multiple-output (MIMO) antenna arrays. However, TRP is not presently part of the Commission's measurement procedure guidance for devices using MIMO antennas. Commenters recommend that the Commission

continue to provide guidance on acceptable new measurement procedures via OET's KDB publications. Commenters also recognize that 5G technology is in the early stages of equipment design and development so it is difficult at this point in time to identify all of the potential compliance and measurement challenges.

205. The Commission finds that the mmW technology will continue to evolve to address various technical challenges in this spectrum (with respect to propagation, interference protection, modulation techniques, transmission security, etc.), and pending new measurement equipment availability to cover the entire mmW spectrum that the Commission is making available for the next generation of wireless services herein, mmW measurement procedures are best developed by OET with the participation of interested parties. The Commission expects that OET will provide guidance on various acceptable measurement techniques for mmW devices through its KDB publications as products are developed.

b. RF Exposure Compliance

206. (RF) exposure compliance is an ongoing requirement for all transmitters authorized by the Commission. In the *NPRM*, the Commission proposed to similarly require compliance with the Commission's general RF exposure limits in §§ 1.1307(b), 2.1091 and 2.1093 of the rules for equipment operating in the UMFUS. While the Commission sought comment on this proposal alongside some of the other relevant technical challenges unique to compliance demonstration for devices envisaged to be operating under the UMFUS, the Commission acknowledged in the *NPRM* that any issues raised involving the present exposure limits themselves would be considered in the context of the Commission's separate proceeding on this particular issue.

207. With respect to the rules specific to UMFUS in part 30 of the Commission's rules, the Commission adopts the paragraph the Commission proposed in the *NPRM* that requires compliance with the Commission's general RF exposure limits in §§ 1.1307(b), 2.1091 and 2.1093 of the rules. The comments from industry advocate adopting alternative exposure limits, which the Commission continues to view as beyond the scope of this proceeding, and that will be considered in a separate proceeding. The Commission is not changing its fundamental exposure limits at this time in light of the devices to be expected under the UMFUS rules. More

specifically, the Commission is not modifying its specified SAR values as a primary exposure limit between 100 kHz and 6 GHz, and the Commission will continue to use the specified MPE power density limit as a primary exposure limit above 6 GHz.

208. The Commission recognizes that there is a discontinuity at 6 GHz resulting from the fact that the Commission's rules do not specify a spatial averaging area (an area over which to average power density) or a spatial peak power density above 6 GHz that is consistent with the Commission's localized (over 1 gram) specific absorption rate (SAR) below 6 GHz. At lower frequencies for sources at least 20 cm from the body, spatial averaging over the entire body has been acceptable. However, both IEEE and International Commission on Non-Ionizing Radiation Protection (ICNIRP) have recognized that at higher frequencies spatial averaging areas need to be smaller. Of these specifications, the smaller and more conservative area is by ICNIRP, which has specified a spatial averaging area of 20 cm² above 10 GHz. While the Commission notes this as an apparently reasonable requirement the Commission is not suggesting any particular changes to the Commission's evaluation procedures at this time. The Commission will separately consider the broader questions of the RF exposure limits and how they should be applied in the Commission's RF *Inquiry*. In the meantime, as the Commission acknowledged in the *NPRM*, specific guidance on evaluating devices operating in this service will be issued by OET, and it is consistent with the Commission's existing discussions on spatial averaging to further clarify guidance on an area over which to average power density in the Commission's KDB publications through that process. Finally, the Commission acknowledges the variations between standards pointed out by the MMF and encourage further efforts on the specific issue of localized millimeter wave exposure by the standards setting bodies and the broader research community.

H. Other Allocation Issues

209. The Commission deletes the broadcasting and broadcasting-satellite service allocations from the 42 GHz band to better protect the radio astronomy observations of the 42.5–43.5 GHz band from out-of-band emissions. Further, the ubiquitous nature of the BSS and the broadcasting service would likely interfere with ubiquitous mobile deployment in similar ways to a ubiquitous fixed service deployment. As

previously noted, the BSS also poses an interference risk to adjacent RAS services. Nevertheless, the BSS will still retain 1.5 gigahertz of spectrum in the 40.5–42 GHz band for its future operations.

210. The Commission also declines to adopt its proposal to allocate the 42 GHz band for FSS downlink operations. Given the Commission's decision to grant FSS enhanced access to the 37.5–40 GHz band, and the fact that FSS has access to the 40.5–42 GHz band, the Commission find there is less reason to further expand FSS operations to the 42 GHz band. The Commission believes there is value in potentially having an UMFUS band available for exclusive terrestrial use, and the Commission addresses this issue in the companion *FNPRM*.

II. Procedural Matters

Final Regulatory Flexibility Analysis

211. As required by the Regulatory Flexibility Act of 1980, as amended (RFA), the Commission incorporated an 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 *NPRM*. No comments were filed addressing the IRFA. Because the Commission amends the rules in this Report and Order, the Commission has included this Final Regulatory Flexibility Analysis (FRFA) which conforms to the RFA.

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

212. In the attached *Report and Order*, the Commission increases the Nation's supply of spectrum for mobile broadband by adopting rules for fixed and mobile services in the 27.5–28.35 GHz band (28 GHz band), the 38.6–40 GHz band (39 GHz band), and the 37–38.6 GHz band (37 GHz band). The Commission also authorizes unlicensed operation pursuant to part 15 of its rules in the 64–71 GHz band. These bands are known collectively as the “mmW bands.”

213. 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.

214. In the 28 GHz, 39 GHz, and 37 GHz bands, the Commission creates a new radio service in a new rule part that will authorize fixed and mobile services—the part 30 Upper Microwave Flexible Use Service. 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.

215. The service rules the Commission adopted make additional spectrum available for flexible use. In creating service rules for these bands, which include technical rules to protect against harmful interference, licensing rules to establish geographic license areas and spectrum block sizes, and performance requirements to promote robust buildout, the Commission advances toward enabling rapid and efficient deployment. The Commission does so by providing flexible service, technical, assignment, and licensing rules for this spectrum, except where special provisions are necessary to facilitate shared use with other co-primary users.

216. For the 28 GHz 37 GHz, and 39 GHz bands, the Commission proposes to assign licenses by competitive bidding using counties as the area for geographic area licensing in the 28 GHz band and in a portion of 37 GHz band (37–37.6 GHz). The Commission will award PEA-based licenses by competitive bidding for the 39 GHz and the upper portion of the 37 GHz band (37.6–38.6 GHz). In the 37–37.6 GHz band, the Commission has created a 600 MHz shared access space with rule-based, non-interfering Shared Access Licenses (SALs) which will share the band with Federal fixed and mobile operations. SAL licensees are not guaranteed spectrum access or

interference protection from individual licensees. The Commission believes this system at 37 GHz will create an innovative shared space that can be used by a wide variety of Federal and non-Federal users, by new entrants and by established operators—and small businesses in particular—to experiment with new technologies in the mmW space and innovate.

217. At the same time, because the 28 GHz, 39 GHz, and 37 GHz bands are shared with satellite services, the Commission has taken steps to facilitate sharing with satellite uses in ways that are consistent with fixed and mobile use of the bands. Specifically, the Commission concludes the Commission will authorize a limited number of satellite earth stations to operate on a co-primary basis—one in each county for the 28 GHz band and one in each PEA in the 37.5–40 GHz band—on a first-come, first-served basis. In the 28 GHz band the Commission will grandfather pre-existing satellite earth stations in any county into a local interference zone with the right to operate under the terms of their existing authorizations. These FSS earth stations must comply with certain enumerated conditions to obtain an authorization for their specific locations, including coordinating their operations with any existing mmW licensees to ensure non-interference between the services. Additional earth stations can be located if the FSS operator acquires a part 30 license, reaches a contractual agreement with the part 30 licensee, or agrees to operate on a secondary basis.

218. Overall, the new provisions the Commission is 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 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.

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

219. No comments were filed in direct response to the IRFA.

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

220. 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. The Chief Counsel did not file any comments in response to the proposed rules in this proceeding.

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

221. 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. 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.

222. *Small Businesses, Small Organizations, and Small Governmental Jurisdictions.* The Commission’s action may, over time, affect small entities that are not easily categorized at present. The Commission therefore describes here, at the outset, three comprehensive, statutory small entity size standards. First, nationwide, there are a total of approximately 28.2 million businesses, 99.7 percent of which are small, according to the SBA. In addition, a “small organization” is generally “any not-for-profit enterprise which is independently owned and operated and is not dominant in its field.” Nationwide, as of 2007, there were approximately 1,621,315 small organizations. Finally, the term “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.” Census Bureau data for 2011 indicate that there were 89,476 local governmental jurisdictions in the United States. The Commission estimates that, of this total, as many as 88,506 entities may qualify as “small

governmental jurisdictions.” Thus, the Commission estimates that most governmental jurisdictions are small.

223. *Wireless Telecommunications Carriers (except satellite).* The appropriate size standard under SBA rules is for the category Wireless Telecommunications Carriers. Under that size standard, such a business is small if it has 1,500 or fewer employees. Census Bureau data for 2012, show that there were 967 firms in this category 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. Thus under this category and the associated small business size standard, the Commission estimates that the majority of wireless telecommunications carriers (except satellite) are small entities that may be affected by the Commission’s action.

224. *Fixed Microwave Services.* Microwave services include common carrier, private-operational fixed, and broadcast auxiliary radio services. They also include the Local Multipoint Distribution Service (LMDS), the Digital Electronic Message Service (DEMS), the 39 GHz Service (39 GHz), the 24 GHz Service, and the Millimeter Wave Service where licensees can choose between common carrier and non-common carrier status. At present, there are approximately 61,970 common carrier fixed licensees, 62,909 private and public safety operational-fixed licensees, 20,349 broadcast auxiliary radio licensees, 412 LMDS licenses, 35 DEMS licenses, 870 39 GHz licenses, and five 24 GHz licenses, and 408 Millimeter Wave licenses in the microwave services. The Commission has not yet defined a small business with respect to microwave services. For purposes of the FRFA, the Commission will use the SBA’s definition applicable to Wireless Telecommunications Carriers (except satellite)—*i.e.*, an entity with no more than 1,500 persons is considered small. Under that size standard, such a business is small if it has 1,500 or fewer employees. Census Bureau data for 2012, show that there were 967 firms in this category 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. Thus under this category and the associated small business size standard, the Commission estimates that the majority of wireless telecommunications carriers (except satellite) are small entities that may be affected by the Commission’s proposed action. The Commission notes that the number of firms does not necessarily track the number of licensees. The Commission estimates that virtually all

of the Fixed Microwave licensees (excluding broadcast auxiliary licensees) would qualify as small entities under the SBA definition.

225. *Satellite Telecommunications and All Other Telecommunications.* Two economic census categories address the satellite industry. The first category has a small business size standard of \$32.5 million or less in average annual receipts, under SBA rules. The second also has a size standard of \$32.5 million or less in annual receipts.

226. The category of Satellite Telecommunications “comprises establishments 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.” Census Bureau data for 2012 show that 333 Satellite Telecommunications firms operated for that entire year. Of this total, 275 firms had annual receipts of under \$10 million, and 58 firms had receipts of \$10 million to \$24,999,999. Consequently, the Commission estimates that the majority of Satellite Telecommunications firms are small entities that might be affected by the Commission’s action.

227. The second category, *i.e.*, “All Other Telecommunications,” comprises “establishments primarily engaged in providing specialized telecommunications services, such as satellite tracking, communications telemetry, and radar station operation. 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. Establishments providing Internet services or voice over Internet protocol (VoIP) services via client-supplied telecommunications connections are also included in this industry.” For this category, Census Bureau data for 2012 show that there were a total of 1442 firms that operated for the entire year. Of this total, 1400 firms had annual receipts of under \$25 million, and 42 firms had annual receipts of \$25 million to \$49,999,999. Consequently, the Commission estimates that the majority of All Other Telecommunications firms are small entities that might be affected by the Commission’s action.

228. *Radio and Television Broadcasting and Wireless Communications Equipment*

Manufacturing. The proposed rules relating to part 15 operation pertain to manufacturers of unlicensed communications devices. The Census Bureau defines this category as follows: "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." The SBA has developed a small business size standard for firms in this category, which is: All such firms having 750 or fewer employees. According to Census Bureau data for 2007, there were a total of 939 establishments in this category that operated for part or all of the entire year. Of this total, 784 had less than 500 employees and 155 had more than 100 employees. Thus, under this size standard, the majority of firms can be considered small.

5. Description of Projected Reporting, Recordkeeping, and Other Compliance Requirements

229. The projected reporting, recordkeeping, and other compliance requirements proposed in the *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.

230. Any 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. Upper Microwave Flexible Use Service applicants that must submit long-form license applications must do so through ULS using Form 601, FCC Ownership Disclosure Information for the Wireless Telecommunications Services using FCC Form 602, and other appropriate forms.

231. Licensees in the Upper Microwave Flexible Use Service will be subject to performance requirements based on a series of metrics, tailored to

each type of service a licensee may offer. Accordingly, mobile services will be required to provide service to 40 percent of the population of their license area by the end of their initial license terms. Geographic area licensees providing Fixed Service in the 28 GHz, 37 GHz and 39 GHz will be required to construct and operate at least 15 links per million persons in the population. Satellite operators will be able to meet their build-out requirement by deploying an operational earth station in the license area that provides service. Licensees deploying a mix of such services will be able to choose which performance metric—or combination thereof—they desire to meet. Performance will be assessed on a license area basis, regardless of license area size. For the 28 GHz band, licenses will terminate automatically if a licensee fails to meet the applicable performance requirements. For geographic area licenses in the 37 and 39 GHz bands, licensees will have the option of partitioning their licenses on a county basis to come into compliance with the relevant performance metric. Licensees 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, to both facilitate sharing with other authorized services and to enable accurate assessment of their performance. Incumbent licensees will be granted time to transition to these new performance requirements. FSS operators will have to coordinate their operations with any existing mmW licensees to ensure non-interference between the services.

232. New licensees will also be required, within three years after receiving their licenses but no later than six months prior to deployment, to file with the Commission a security statement signed by a senior licensee executive with personal knowledge of the licensee's security plans and practice, which must include, at a minimum, the following elements: (1) A high-level, general description of the licensee's security approach designed to safeguard the planned network's confidentiality, integrity, and availability with respect to communications from: A device to the licensee's network; one element of the licensee's network to another element on the licensee's network; the licensee's network to another network; and device to device (with respect to telephone voice and messaging services); (2) a high-level, general description of the

licensee's approach to assessing and mitigating cyber risk induced by the presence of multiple participants in the band. This should include the high level approach taken toward ensuring consumer network confidentiality, integrity, and availability security principles, which are to be protected in each of the following use cases: Communications between a wireless device and the licensee's network; communications within and between each licensee's network; communications between mobile devices that are under end-to-end control of the licensee; and communications between mobile devices that are not under the end-to-end control of the licensee; (3) a high-level description of relevant cybersecurity standards and practices to be employed, whether industry-recognized or related to some other identifiable approach; (4) a description of the extent to which the licensee participates with standards bodies or industry-led organizations pursuing the development or maintenance of emerging security standards and/or best practices; (5) the high-level identification of any other approaches to security, unique to the services and devices the licensee intends to offer and deploy; and (6) plans to incorporate relevant outputs from Information Sharing and Analysis Organizations (ISAOs) as elements of the licensee's security architecture. Plans should include comment on machine-to-machine threat information sharing.

233. All of the filing, recordkeeping and reporting requirements associated with the demands described above, including professional, accounting, engineering or survey services used in meeting these requirements will be the same for large and small businesses that intend to utilize these new UMFUS licenses, but as described below, several steps have been taken that will alleviate burdens on small businesses in particular.

6. Steps Taken To Minimize Significant Economic Impact on Small Entities, and Significant Alternatives Considered

234. The RFA requires an agency to describe any significant alternative 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.

235. As noted above, the various construction and performance requirements and their associated showings will be the same for large and small businesses that license the Upper Microwave Flexible Use Service bands. To the extent the same cost of complying with these burdens is 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 the Commission's service and technical rules and coordination requirements are necessary for the furtherance of the Commission's goals of protecting the public while also providing interference free services. Large and small businesses must therefore comply with these rules and requirements, but the Commission has taken steps to alleviate the burden on small businesses that seek to comply with these requirements, as discussed below.

236. The *Report and Order* provides that in the 28 GHz, 37 GHz and 39 GHz bands, mmW licensees 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 licensees were limited to only 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. In addition, licensees will be able to make a showing based on a combination of fixed and mobile service, simplifying this process for all licensees including small businesses. The Commission has also extended the existing renewal deadlines for incumbent licensees in the 28 and 39 GHz bands, giving these licensees, including small businesses in these bands, additional time until 2024 to meet the performance requirements pertaining to their current licenses.

237. Furthermore, the license areas chosen in the *Report and Order* should provide spectrum access opportunities for smaller carriers by giving them access to less densely populated areas that match their footprints. For example, the *Report and Order* transitions the 28 GHz band from being licensed on the BTA basis to a much smaller license area—counties. Similarly, the Commission transitions the 39 GHz band from being licensed via Economic Areas (“EAs”) to the smaller Partial Economic Areas (“PEAs”). The

Commission also uses PEAs for the 37 GHz band, which will be newly licensed. The Commission abandons its proposed “hybrid licensing scheme” in the 37 GHz band and has instead opted to use geographic area licensing with PEAs in the upper 37.6–38.6 GHz portion with county-based licensing in the lower band (37.0–37.6 GHz). Finally, the Commission has created an unlicensed space in the 64–71 GHz band. However, the *Report and Order* also permits partitioning and disaggregation by licensees in the mmW bands. While PEAs and counties are small enough to 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 and county license areas are equivalent for small and large businesses. The 400 MHz shared space the Commission has created in the lower 37 GHz band (37.0–37.6 GHz) should also provide ease-of-entry and plenty of space for opportunistic and innovative uses that could be developed by small businesses. These rules should enable providers, or any entities large or small providing service in the mmW bands, to more easily adjust their spectrum holdings and build their networks pursuant to individual business plans. The Commission believes this should result in small businesses having an easier time acquiring or accessing spectrum.

238. Licensees may also adjust their geographic coverage through auction in those areas where the Commission is permitting geographic area auctions or through the secondary markets. The *Report and Order* concludes it will auction licenses in the mmW bands in conformity with the general competitive bidding rules set forth in part 1, subpart Q, of the Commission's rules, and substantially consistent with the competitive bidding procedures that have been employed in previous auctions. The procedures the Commission has adopted contain provisions to assist small entities in competitive bidding. The Commission will employ the part 1 rules governing competitive bidding design, designated entity preferences, unjust enrichment, application and payment procedures, reporting requirements, and the prohibition on certain communications between auction applicants. Furthermore, qualifying “small businesses”—those with gross revenues for the preceding three years not exceeding \$55 million—will be

provided with a bidding credit of 15 percent, and “very small businesses”—those with average annual gross revenues for the preceding three years not exceeding \$20 million—with a bidding credit of 25 percent. Providing small businesses and very small businesses with bidding credits will provide an economic benefit to small entities by making it easier for small entities to acquire spectrum or access to spectrum in these bands.

239. Furthermore, the *Report and Order* provides for licensing of this spectrum under market-oriented rules. This includes applying the Commission's secondary market policies and rules to all transactions involving the use of mmW bands, which will provide greater predictability and regulatory parity with bands licensed for mobile broadband service. These rules should make it easier for mmW providers to enter secondary market arrangements involving use of their spectrum. The secondary market rules apply equally to all entities, whether small or large. As a result, the Commission believes that this will provide an economic benefit to small entities by making it easier for entities, whether large or small, to enter into secondary market arrangements for mmW spectrum.

240. The *Report and Order* also adopts an operability requirement such that any device designed to operate within the 37 GHz and 39 GHz bands (37–40 GHz) must be capable of operating on all frequencies within those bands. This operability requirement will ensure that devices developed for the geographic area licensed portion of the band will also operate in the innovation shared space, making it easier for smaller businesses with fewer resources to find equipment that can operate across multiple bands. The technical rules in the *Report and Order* will also allow licensees of the mmW spectrum to operate while protecting licensees in nearby spectrum from harmful interference, some of whom may be small entities.

241. Finally, the proposals to facilitate satellite service in the 28 GHz and 37.5–40 GHz bands should also assist small satellite businesses.

7. Federal Rules That May Duplicate, Overlap, or Conflict With the Proposed Rules

242. None.

J. Ordering Clauses

243. Accordingly, *it is ordered*, pursuant to Sections 1, 2, 3, 4, 5, 7, 10, 201, 225, 227, 301, 302, 302a, 303, 304, 307, 309, 310, 316, 319, 332, and 336 of

the Communications Act of 1934, 47 U.S.C. 151, 152, 153, 154, 155, 157, 160, 201, 225, 227, 301, 302, 302a, 303, 304, 307, 309, 310, 316, 319, 332, 336, Section 706 of the Telecommunications Act of 1996, as amended, 47 U.S.C. 1302, and § 1.411 of the Commission's Rules, 47 CFR 1.411, that this *Report and Order and Further Notice of Proposed Rulemaking* is hereby adopted.

244. *It is further ordered* pursuant to section 4(i) of the Communications Act of 1934, 47 U.S.C. 154(i), that the Commission's Consumer and Governmental Affairs Bureau, Reference Information Center, shall send a copy of this *Report and Order and Further Notice of Proposed Rulemaking*, including the Final and Initial Regulatory Flexibility Analysis, to the Chief Counsel for Advocacy of the Small Business Administration.

245. *It is further ordered* that the petition for rulemaking filed by the Fixed Wireless Communications Coalition (RM-11664) is denied with respect to the 42-42.5 GHz band.

246. *It is further ordered* that the Commission shall send a copy of this *Report and Order and Further Notice of Proposed Rulemaking* to Congress and the Government Accountability Office pursuant to the Congressional Review Act, see 5 U.S.C. 801(a)(1)(A).

List of Subjects in 47 CFR Parts 1, 2, 15, 25, 30 and 101

Communications common carriers, Communications equipment, Reporting and recordkeeping requirements.

Federal Communications Commission.

Marlene H. Dortch,
Secretary.

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 is revised 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 1.907 is amended by revising the definitions for “Wireless Radio Services” and “Wireless Telecommunications Services” to read as follows:

§ 1.907 Definitions.

* * * * *

Wireless Radio Services. All radio services authorized in parts 13, 20, 22, 24, 26, 27, 30, 74, 80, 87, 90, 95, 96, 97 and 101 of this chapter, whether commercial or private in nature.

Wireless Telecommunications Services. Wireless Radio Services,

whether fixed or mobile, that meet the definition of “telecommunications service” as defined by 47 U.S.C. 153, as amended, and are therefore subject to regulation on a common carrier basis. Wireless Telecommunications Services include all radio services authorized by parts 20, 22, 24, 26, 27, and 30 of this chapter. In addition, Wireless Telecommunications Services include Public Coast Stations authorized by part 80 of this chapter, Commercial Mobile Radio Services authorized by part 90 of this chapter, common carrier fixed microwave services, Local Television Transmission Service (LTTS), Local Multipoint Distribution Service (LMDS), and Digital Electronic Message Service (DEMS), authorized by part 101 of this chapter, and Citizens Broadband Radio Services authorized by part 96 of this chapter.

■ 3. Section 1.1307 is amended by adding an entry for “Upper Microwave Flexible Use Service (part 30)” above the entry for “Radio Broadcast Services (part 73)” in Table 1 in paragraph (b)(1) and revising paragraph (b)(2)(i) to read as follows:

§ 1.1307 Actions that may have a significant environmental effect, for which Environmental Assessments (EAs) must be prepared.

* * * * *

(b) * * *

(1) * * *

TABLE 1—TRANSMITTERS, FACILITIES AND OPERATIONS SUBJECT TO ROUTINE ENVIRONMENTAL EVALUATION

Service (title 47 CFR rule part)	Evaluation required if:
* * * * *	* * * * *
Upper Microwave Flexible Use Service (part 30).	Non-building-mounted antennas: Height above ground level to lowest point of antenna <10 m and power >1640 W EIRP. Antennas are mounted on buildings.
* * * * *	* * * * *

(2)(i) Mobile and portable transmitting devices that operate in the Commercial Mobile Radio Services pursuant to part 20 of this chapter; the Cellular Radiotelephone Service pursuant to part 22 of this chapter; the Personal Communications Services (PCS) pursuant to part 24 of this chapter; the Satellite Communications Services pursuant to part 25 of this chapter; the Miscellaneous Wireless Communications Services pursuant to part 27 of this chapter; the Upper Microwave Flexible Use Service pursuant to part 30 of this chapter; the Maritime Services (ship earth stations only) pursuant to part 80 of this chapter;

the Specialized Mobile Radio Service, the 4.9 GHz Band Service, or the 3650 MHz Wireless Broadband Service pursuant to part 90 of this chapter; the Wireless Medical Telemetry Service (WMTS), or the Medical Device Radiocommunication Service (MedRadio) pursuant to part 95 of this chapter; or the Citizens Broadband Radio Service pursuant to part 96 of this chapter are subject to routine environmental evaluation for RF exposure prior to equipment authorization or use, as specified in §§ 2.1091 and 2.1093 of this chapter.

* * * * *

■ 4. Section 1.9001 is amended by revising paragraph (a) to read as follows:

§ 1.9001 Purpose and scope.

(a) The purpose of part 1, subpart X is to implement policies and rules pertaining to spectrum leasing arrangements between licensees in the services identified in this subpart and spectrum lessees. This subpart also implements policies for private commons arrangements. These policies and rules also implicate other Commission rule parts, including parts 1, 2, 20, 22, 24, 25, 27, 30, 80, 90, 95,

and 101 of title 47, chapter I of the Code of Federal Regulations.

* * * * *

■ 5. Section 1.9005 is amended by revising paragraphs (hh) through (kk) and adding paragraph (ll) to read as follows:

§ 1.9005 Included services.

* * * * *

(hh) The Multipoint Video Distribution and Data Service (part 101 of this chapter);

(ii) The 700 MHz Guard Bands Service (part 27 of this chapter);

(jj) The ATC of a Mobile Satellite Service (part 25 of this chapter);

(kk) The 600 MHz band (part 27 of this chapter); and

(ll) The Upper Microwave Flexible Use Service (part 30 of this chapter).

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

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

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

■ 7. Section 2.106 is amended as follows:

■ a. Pages 55, 57, 58, and 61 are revised.

■ b. In the list of United States (US) Footnotes, footnote US151 is added.

■ c. In the list of Non-Federal Government (NG) Footnotes, footnote NG63 is added.

The revisions and additions read as follows:

§ 2.106 Table of Frequency Allocations.

* * * * *

BILLING CODE 6712-01-P

Table of Frequency Allocations			27-34.7 GHz (SHF/EHF)		Page 55
International Table			United States Table		FCC Rule Part(s)
Region 1 Table	Region 2 Table	Region 3 Table	Federal Table	Non-Federal Table	
27-27.5 FIXED INTER-SATELLITE 5.536 MOBILE	27-27.5 FIXED FIXED-SATELLITE (Earth-to-space) INTER-SATELLITE 5.536 5.537 MOBILE		27-27.5 FIXED INTER-SATELLITE 5.536 MOBILE	27-27.5 Inter-satellite 5.536	RF Devices (15)
27.5-28.5 FIXED 5.537A FIXED-SATELLITE (Earth-to-space) 5.484A 5.516B 5.539 MOBILE			27.5-30	27.5-29.5 FIXED FIXED-SATELLITE (Earth-to-space) MOBILE	RF Devices (15) Satellite Communications (25) Upper Microwave Flexible Use (30) Fixed Microwave (101)
5.538 5.540 28.5-29.1 FIXED FIXED-SATELLITE (Earth-to-space) 5.484A 5.516B 5.523A 5.539 MOBILE Earth exploration-satellite (Earth-to-space) 5.541					
5.540 29.1-29.5 FIXED FIXED-SATELLITE (Earth-to-space) 5.516B 5.523C 5.523E 5.535A 5.539 5.541A MOBILE Earth exploration-satellite (Earth-to-space) 5.541					
5.540 29.5-29.9 FIXED-SATELLITE (Earth-to-space) 5.484A 5.516B 5.539 Earth exploration-satellite (Earth-to-space) 5.541 Mobile-satellite (Earth-to-space)	29.5-29.9 FIXED-SATELLITE (Earth-to-space) 5.484A 5.516B 5.539 MOBILE-SATELLITE (Earth-to-space) Earth exploration-satellite (Earth-to-space) 5.541	29.5-29.9 FIXED-SATELLITE (Earth-to-space) 5.484A 5.516B 5.539 Earth exploration-satellite (Earth-to-space) 5.541 Mobile-satellite (Earth-to-space)		29.5-30 FIXED-SATELLITE (Earth-to-space) MOBILE-SATELLITE (Earth-to-space)	Satellite Communications (25)
5.540 5.542 29.9-30 FIXED-SATELLITE (Earth-to-space) 5.484A 5.516B 5.539 MOBILE-SATELLITE (Earth-to-space) Earth exploration-satellite (Earth-to-space) 5.541 5.543					
5.525 5.526 5.527 5.538 5.540 5.542				5.525 5.526 5.527 5.529 5.543	
30-31 FIXED-SATELLITE (Earth-to-space) 5.338A MOBILE-SATELLITE (Earth-to-space) Standard frequency and time signal-satellite (space-to-Earth)			30-31 FIXED-SATELLITE (Earth-to-space) MOBILE-SATELLITE (Earth-to-space) Standard frequency and time signal-satellite (space-to-Earth)	30-31 Standard frequency and time signal-satellite (space-to-Earth)	
5.542			G117		

Table of Frequency Allocations			34.7-46.9 GHz (EHF)		Page 57
International Table			United States Table		FCC Rule Part(s)
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34.7-35.2 RADIOLOCATION Space research 5.550 5.549			34.7-35.5 RADIOLOCATION	34.7-35.5 Radiolocation	Private Land Mobile (90)
35.2-35.5 METEOROLOGICAL AIDS RADIOLOCATION 5.549			US360 G117	US360	
35.5-36 METEOROLOGICAL AIDS EARTH EXPLORATION-SATELLITE (active) RADIOLOCATION SPACE RESEARCH (active) 5.549 5.549A			35.5-36 EARTH EXPLORATION-SATELLITE (active) RADIOLOCATION SPACE RESEARCH (active) US360 G117	35.5-36 Earth exploration-satellite (active) Radiolocation Space research (active) US360	
36-37 EARTH EXPLORATION-SATELLITE (passive) FIXED MOBILE SPACE RESEARCH (passive) 5.149 5.550A			36-37 EARTH EXPLORATION-SATELLITE (passive) FIXED MOBILE SPACE RESEARCH (passive) US342 US550A		
37-37.5 FIXED MOBILE except aeronautical mobile SPACE RESEARCH (space-to-Earth) 5.547			37-38 FIXED MOBILE SPACE RESEARCH (space-to-Earth)	37-37.5 FIXED MOBILE	Upper Microwave Flexible Use (30)
37.5-38 FIXED FIXED-SATELLITE (space-to-Earth) MOBILE except aeronautical mobile SPACE RESEARCH (space-to-Earth) Earth exploration-satellite (space-to-Earth) 5.547			US151	US151	
38-39.5 FIXED FIXED-SATELLITE (space-to-Earth) MOBILE Earth exploration-satellite (space-to-Earth) 5.547			38-38.6 FIXED MOBILE 38.6-39.5	38-39.5 FIXED FIXED-SATELLITE (space-to-Earth) NG63 MOBILE NG175	Satellite Communications (25) Upper Microwave Flexible Use (30)
39.5-40 FIXED FIXED-SATELLITE (space-to-Earth) 5.516B MOBILE MOBILE-SATELLITE (space-to-Earth) Earth exploration-satellite (space-to-Earth) 5.547			39.5-40 FIXED-SATELLITE (space-to-Earth) MOBILE-SATELLITE (space-to-Earth) US382 G117	39.5-40 FIXED FIXED-SATELLITE (space-to-Earth) NG63 MOBILE NG175 US382	

40-40.5 EARTH EXPLORATION-SATELLITE (Earth-to-space) FIXED FIXED-SATELLITE (space-to-Earth) 5.516B MOBILE MOBILE-SATELLITE (space-to-Earth) SPACE RESEARCH (Earth-to-space) Earth exploration-satellite (space-to-Earth)			40-40.5 EARTH EXPLORATION-SATELLITE (Earth-to-space) FIXED-SATELLITE (space-to-Earth) MOBILE-SATELLITE (space-to-Earth) SPACE RESEARCH (Earth-to-space) Earth exploration-satellite (space-to-Earth) G117	40-40.5 FIXED-SATELLITE (space-to-Earth) MOBILE-SATELLITE (space-to-Earth)	Satellite Communications (25)
40.5-41 FIXED FIXED-SATELLITE (space-to-Earth) BROADCASTING BROADCASTING-SATELLITE Mobile	40.5-41 FIXED FIXED-SATELLITE (space-to-Earth) 5.516B BROADCASTING BROADCASTING-SATELLITE Mobile Mobile-satellite (space-to-Earth)	40.5-41 FIXED FIXED-SATELLITE (space-to-Earth) BROADCASTING BROADCASTING-SATELLITE Mobile	40.5-41 FIXED-SATELLITE (space-to-Earth) Mobile-satellite (space-to-Earth)	40.5-41 FIXED-SATELLITE (space-to-Earth) BROADCASTING BROADCASTING-SATELLITE Fixed Mobile Mobile-satellite (space-to-Earth)	
5.547	5.547	5.547	US211 G117	US211	
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43.5-47 MOBILE 5.553 MOBILE-SATELLITE RADIONAVIGATION RADIONAVIGATION-SATELLITE			43.5-45.5 FIXED-SATELLITE (Earth-to-space) MOBILE-SATELLITE (Earth-to-space) G117	43.5-45.5	
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Region 1 Table	Region 2 Table	Region 3 Table	Federal Table	Non-Federal Table	
59-59.3 EARTH EXPLORATION-SATELLITE (passive) FIXED INTER-SATELLITE 5.556A MOBILE 5.558 RADIOLOCATION 5.559 SPACE RESEARCH (passive)			59-59.3 EARTH EXPLORATION-SATELLITE (passive) FIXED INTER-SATELLITE 5.556A MOBILE 5.558 RADIOLOCATION 5.559 SPACE RESEARCH (passive) US353	59-59.3 EARTH EXPLORATION-SATELLITE (passive) FIXED MOBILE 5.558 RADIOLOCATION 5.559 SPACE RESEARCH (passive) US353	RF Devices (15)
59.3-64 FIXED INTER-SATELLITE MOBILE 5.558 RADIOLOCATION 5.559			59.3-64 FIXED INTER-SATELLITE MOBILE 5.558 RADIOLOCATION 5.559 5.138 US353	59.3-64 FIXED MOBILE 5.558 RADIOLOCATION 5.559 5.138 US353	RF Devices (15) ISM Equipment (18)
64-65 FIXED INTER-SATELLITE MOBILE except aeronautical mobile 5.547 5.556			64-65 FIXED INTER-SATELLITE MOBILE except aeronautical mobile	64-65 FIXED MOBILE except aeronautical mobile	RF Devices (15)
65-66 EARTH EXPLORATION-SATELLITE FIXED INTER-SATELLITE MOBILE except aeronautical mobile SPACE RESEARCH 5.547			65-66 EARTH EXPLORATION-SATELLITE FIXED MOBILE except aeronautical mobile SPACE RESEARCH	65-66 EARTH EXPLORATION-SATELLITE FIXED INTER-SATELLITE MOBILE except aeronautical mobile SPACE RESEARCH	RF Devices (15) Satellite Communications (25)
66-71 INTER-SATELLITE MOBILE 5.553 5.558 MOBILE-SATELLITE RADIONAVIGATION RADIONAVIGATION-SATELLITE 5.554			66-71 MOBILE 5.553 5.558 MOBILE-SATELLITE RADIONAVIGATION RADIONAVIGATION-SATELLITE 5.554	66-71 INTER-SATELLITE MOBILE 5.553 5.558 MOBILE-SATELLITE RADIONAVIGATION RADIONAVIGATION-SATELLITE 5.554	
71-74 FIXED FIXED-SATELLITE (space-to-Earth) MOBILE MOBILE-SATELLITE (space-to-Earth)			71-74 FIXED FIXED-SATELLITE (space-to-Earth) MOBILE MOBILE-SATELLITE (space-to-Earth) US389		Fixed Microwave (101)
74-76 FIXED FIXED-SATELLITE (space-to-Earth) MOBILE BROADCASTING BROADCASTING-SATELLITE Space research (space-to-Earth) 5.561			74-76 FIXED FIXED-SATELLITE (space-to-Earth) MOBILE Space research (space-to-Earth) US389	74-76 FIXED FIXED-SATELLITE (space-to-Earth) MOBILE BROADCASTING BROADCASTING-SATELLITE Space research (space-to-Earth) US389	RF Devices (15) Fixed Microwave (101)

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United States (US) Footnotes

* * * * *

US151 In the band 37–38 GHz, stations in the fixed and mobile services shall not cause harmful interference to Federal earth stations in the space research service (space-to-Earth) at the following sites: Goldstone, CA; Socorro, NM; and White Sands, NM. Applications for non-Federal use of this band shall be coordinated with NTIA in accordance with 47 CFR 30.205.

* * * * *

Non-Federal Government (NG)

Footnotes

* * * * *

NG63 In the band 37.5–40 GHz, earth station operations in the fixed-satellite service (space-to-Earth) shall not claim protection from stations in the fixed and mobile services, except where individually licensed earth stations are authorized pursuant to 47 CFR 25.136.

* * * * *

■ 8. Section 2.1091 is amended by revising paragraph (c)(1) introductory text to read as follows:

§ 2.1091 Radiofrequency radiation exposure evaluation: mobile devices.

* * * * *

(c)(1) Mobile devices that operate in the Commercial Mobile Radio Services pursuant to part 20 of this chapter; the Cellular Radiotelephone Service pursuant to part 22 of this chapter; the Personal Communications Services pursuant to part 24 of this chapter; the Satellite Communications Services pursuant to part 25 of this chapter; the Miscellaneous Wireless Communications Services pursuant to part 27 of this chapter; the Upper Microwave Flexible Use Service pursuant to part 30 of this chapter; the Maritime Services (ship earth station devices only) pursuant to part 80 of this chapter; the Specialized Mobile Radio Service, and the 3650 MHz Wireless Broadband Service pursuant to part 90 of this chapter; and the Citizens Broadband Radio Service pursuant to part 96 of this chapter are subject to routine environmental evaluation for RF exposure prior to equipment authorization or use if:

* * * * *

■ 9. Section 2.1093 is amended by revising paragraph (c)(1) to read as follows:

§ 2.1093 Radiofrequency radiation exposure evaluation: portable devices.

* * * * *

(c)(1) Portable devices that operate in the Cellular Radiotelephone Service pursuant to part 22 of this chapter; the Personal Communications Service (PCS) pursuant to part 24 of this chapter; the Satellite Communications Services pursuant to part 25 of this chapter; the Miscellaneous Wireless Communications Services pursuant to part 27 of this chapter; the Upper Microwave Flexible Use Service pursuant to part 30 of this chapter; the Maritime Services (ship earth station devices only) pursuant to part 80 of this chapter; the Specialized Mobile Radio Service, the 4.9 GHz Band Service, and the 3650 MHz Wireless Broadband Service pursuant to part 90 of this chapter; the Wireless Medical Telemetry Service (WMTS) and the Medical Device Radiocommunication Service (MedRadio), pursuant to subparts H and I of part 95 of this chapter, respectively, unlicensed personal communication service, unlicensed NII devices and millimeter wave devices authorized under §§ 15.253(f), 15.255(g), 15.257(g), 15.319(i), and 15.407(f) of this chapter; and the Citizens Broadband Radio Service pursuant to part 96 of this chapter are subject to routine environmental evaluation for RF exposure prior to equipment authorization or use.

PART 15—RADIO FREQUENCY DEVICES

■ 10. The authority citation for part 15 continues to read as follows:

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

■ 11. Section 15.255 is amended by revising the section heading, paragraphs (a)(2), (b), and (c)(1); removing paragraph (d); redesignating paragraphs (e) through (h) as paragraphs (d) through (g); revising newly redesignated paragraph (d)(2); and adding new paragraph (h) to read as follows:

§ 15.255 Operation within the band 57–71 GHz.

(a) * * *

(2) Field disturbance sensors, including vehicle radar systems, unless the field disturbance sensors are employed for fixed operation, or used as short-range devices for interactive motion sensing. For the purposes of this section, the reference to fixed operation includes field disturbance sensors installed in fixed equipment, even if the sensor itself moves within the equipment.

(b) Within the 57–71 GHz band, emission levels shall not exceed the

following equivalent isotropically radiated power (EIRP):

(1) Products other than fixed field disturbance sensors and short-range devices for interactive motion sensing shall comply with one of the following emission limits, as measured during the transmit interval:

(i) The average power of any emission shall not exceed 40 dBm and the peak power of any emission shall not exceed 43 dBm; or

(ii) For fixed point-to-point transmitters located outdoors, the average power of any emission shall not exceed 82 dBm, and shall be reduced by 2 dB for every dB that the antenna gain is less than 51 dBi. The peak power of any emission shall not exceed 85 dBm, and shall be reduced by 2 dB for every dB that the antenna gain is less than 51 dBi.

(A) The provisions in this paragraph for reducing transmit power based on antenna gain shall not require that the power levels be reduced below the limits specified in paragraph (b)(1)(i) of this section.

(B) The provisions of § 15.204(c)(2) and (4) that permit the use of different antennas of the same type and of equal or less directional gain do not apply to intentional radiator systems operating under this provision. In lieu thereof, intentional radiator systems shall be certified using the specific antenna(s) with which the system will be marketed and operated. Compliance testing shall be performed using the highest gain and the lowest gain antennas for which certification is sought and with the intentional radiator operated at its maximum available output power level. The responsible party, as defined in § 2.909 of this chapter, shall supply a list of acceptable antennas with the application for certification.

(2) For fixed field disturbance sensors that occupy 500 MHz or less of bandwidth and that are contained wholly within the frequency band 61.0–61.5 GHz, the average power of any emission, measured during the transmit interval, shall not exceed 40 dBm, and the peak power of any emission shall not exceed 43 dBm. In addition, the average power of any emission outside of the 61.0–61.5 GHz band, measured during the transmit interval, but still within the 57–71 GHz band, shall not exceed 10 dBm, and the peak power of any emission shall not exceed 13 dBm.

(3) For fixed field disturbance sensors other than those operating under the provisions of paragraph (b)(2) of this section, and short-range devices for interactive motion sensing, the peak transmitter conducted output power

shall not exceed - 10 dBm and the peak EIRP level shall not exceed 10 dBm.

(4) The peak power shall be measured with an RF detector that has a detection bandwidth that encompasses the 57-71 GHz band and has a video bandwidth of at least 10 MHz. The average emission levels shall be measured over the actual time period during which transmission occurs.

(c) * * *

(1) The power density of any emissions outside the 57-71 GHz band shall consist solely of spurious emissions.

* * * * *

(d) * * *

(2) Peak transmitter conducted output power shall be measured with an RF detector that has a detection bandwidth that encompasses the 57-71 GHz band and that has a video bandwidth of at least 10 MHz.

* * * * *

(h) Measurement procedures that have been found to be acceptable to the Commission in accordance with § 2.947 of this chapter may be used to demonstrate compliance.

PART 25—SATELLITE COMMUNICATIONS

■ 12. 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, 319, 332, 605, and 721, unless otherwise noted.

■ 13. Add § 25.136 to read as follows:

§ 25.136 Earth Stations in the 27.5-28.35 GHz and 37.5-40 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 earth station in the 27.5-28.35 GHz band that meets one of the criteria listed below may operate consistent with the terms of its authorization 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/m²/MHz;

(2) The FSS earth station was authorized prior to July 14, 2016; or

(3) The application for the FSS earth station was filed prior to July 14, 2016 and has been subsequently granted; 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 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 0.1 percent of the population of the county within which the earth station is located;

(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/m²/MHz does not contain any major event venue, arterial street, interstate or U.S. highway, 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/m²/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.

(b) Applications for earth stations in the 37.5-40 GHz band shall provide an exhibit describing the zone within which the earth station will require protection from transmissions of Upper Microwave Flexible Use Service licensees. For purposes of this rule, the protection zone shall consist of the area where UMFUS licensees may not locate facilities without the consent of the earth station licensee. The earth station applicant shall demonstrate in its application, using reasonable engineering methods, that the requested protection zone is necessary in order to protect its proposed earth station.

(c) The protection zone (as defined in paragraph (b) of this section) shall comply with the following criteria. The applicant shall 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 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 0.1 percent of the population of the Partial Economic Area within which the earth station is located;

(3) The protection zone does not contain any major event venue, arterial street, interstate or U.S. highway, urban mass transit route, passenger railroad, or cruise ship port; and

(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 chapter.

(d) If an earth station applicant or licensee in the 27.5-28.35 GHz or 37.5-40 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.

■ 14. Section 25.202 is amended by revising footnotes 1 and 7 to the table in paragraph (a)(1) to read as follows:

§ 25.202 Frequencies, frequency tolerance, and emission limits.

(a) * * *

(1) * * *

¹ Use of this band by the Fixed-Satellite Service is limited to individually licensed earth stations. Satellite earth station facilities in this band may not be ubiquitously deployed and may not be used to serve individual consumers.

* * * * *

⁷ The Fixed-Satellite Service is secondary to the Upper Microwave Flexible Use Service authorized pursuant to 47 CFR part 30, except for FSS operations associated with earth stations authorized pursuant to 47 CFR 25.136.

* * * * *

■ 15. Part 30 is added to read as follows:

PART 30—UPPER MICROWAVE FLEXIBLE USE SERVICE

Subpart A—General

- Sec.
- 30.1 Creation of upper microwave flexible use service.
- 30.2 Definitions.
- 30.3 Eligibility.
- 30.4 Frequencies.
- 30.5 Service areas.
- 30.6 Permissible communications.
- 30.7 37–37.6 GHz Band—Shared coordinated service.
- 30.8 5G Provider cybersecurity statement requirements.

Subpart B—Applications and Licenses

- 30.101 Initial authorizations.
- 30.102 Transition of existing local multipoint distribution service and 39 GHz licenses.
- 30.103 License term.
- 30.104 Construction requirements.
- 30.105 Geographic partitioning and spectrum disaggregation.
- 30.106 Discontinuance of service.

Subpart C—Technical Standards

- 30.201 Equipment authorization.
- 30.202 Power limits.
- 30.203 Emission limits.
- 30.204 Field strength limits.
- 30.205 Federal coordination requirements.
- 30.206 International coordination.
- 30.207 Radio frequency (RF) safety.
- 30.208 Operability.
- 30.209 Duplexing.

Subpart D—Competitive Bidding Procedures

- 30.301 Upper Microwave Flexible Use Service subject to competitive bidding.
- 30.302 Designated entities and bidding credits.

Subpart E—Special Provisions for Fixed Point-to-Point, Fixed Point-to-Multipoint Hub Stations, and Fixed Point-to-Multipoint User Stations

- 30.401 Permissible service.
- 30.402 Frequency tolerance.
- 30.403 Bandwidth.
- 30.404 Emission limits.
- 30.405 Transmitter power limitations.
- 30.406 Directional antennas.
- 30.407 Antenna polarization.

Authority: 47 U.S.C. 151, 152, 153, 154, 301, 303, 304, 307, 309, 310, 316, 332, 1302.

Subpart A—General

§ 30.1 Creation of upper microwave flexible use service, scope and authority.

As of December 14, 2016, Local Multipoint Distribution Service licenses

for the 27.5–28.35 GHz band, and licenses issued in the 38.6–40 GHz band under part 101 of this chapter shall be reassigned to the Upper Microwave Flexible Use Service. Local Multipoint Distribution Service licenses in bands other than 27.5–28.35 GHz shall remain in that service and shall be governed by the part 101 of this chapter applicable to that service.

§ 30.2 Definitions.

The following definitions apply to this part:

Authorized bandwidth. The maximum width of the band of frequencies permitted to be used by a station. This is normally considered to be the necessary or occupied bandwidth, whichever is greater. (See § 2.202 of this chapter).

Authorized frequency. The frequency, or frequency range, assigned to a station by the Commission and specified in the instrument of authorization.

Fixed satellite earth station. An earth station intended to be used at a specified fixed point.

Local Area Operations. Operations confined to physical facility boundaries, such as a factory.

Point-to-Multipoint Hub Station. A fixed point-to-multipoint radio station that provides one-way or two-way communication with fixed Point-to-Multipoint Service User Stations.

Point-to-Multipoint Service. A fixed point-to-multipoint radio service consisting of point-to-multipoint hub stations that communicate with fixed point-to-multipoint user stations.

Point-to-Multipoint User Station. A fixed radio station located at users' premises, lying within the coverage area of a Point-to-Multipoint Hub station, using a directional antenna to receive one-way communications from or providing two-way communications with a fixed Point-to-Multipoint Hub Station.

Point-to-point station. A station that transmits a highly directional signal from a fixed transmitter location to a fixed receive location.

Portable device. Transmitters designed to be used within 20 centimeters of the body of the user.

Prior coordination. A bilateral process conducted prior to filing applications which includes the distribution of the

technical parameters of a proposed radio system to potentially affected parties for their evaluation and timely response.

Secondary operations. Radio communications which may not cause interference to operations authorized on a primary basis and which are not protected from interference from these primary operations

Transportable station. Transmitting equipment that is not intended to be used while in motion, but rather at stationary locations.

Universal Licensing System. The Universal Licensing System (ULS) is the consolidated database, application filing system, and processing system for all Wireless Radio Services. ULS supports electronic filing of all applications and related documents by applicants and licensees in the Wireless Radio Services, and provides public access to licensing information.

§ 30.3 Eligibility.

Any entity who meets the technical, financial, character, and citizenship qualifications that the Commission may require in accordance with such Act, other than those precluded by section 310 of the Communications Act of 1934, as amended, 47 U.S.C. 310, is eligible to hold a license under this part.

§ 30.4 Frequencies.

The following frequencies are available for assignment in the Upper Microwave Flexible Use Service:

(a) 27.5 GHz—28.35 GHz band—27.5–27.925 GHz and 27.925–28.35 GHz.

(b) 38.6–40 GHz band:

(1) New channel plan:

Channel No.	Frequency band limits (MHz)
1	38,600–38,800
2	38,800–39,000
3	39,000–39,200
4	39,200–39,400
5	39,400–39,600
6	39,600–39,800
7	39,800–40,000

(2) Pending transition to the new channel plan, existing 39 GHz licensees licensed under part 101 of this chapter may continue operating on the following channel plan:

Channel group A		Channel group B	
Channel No.	Frequency band limits (MHz)	Channel No.	Frequency band limits (MHz)
1–A	38,600–38,650	1–B	39,300–39,350
2–A	38,650–38,700	2–B	39,350–39,400
3–A	38,700–38,750	3–B	39,400–39,450
4–A	38,750–38,800	4–B	39,450–39,500

Channel group A		Channel group B	
Channel No.	Frequency band limits (MHz)	Channel No.	Frequency band limits (MHz)
5-A	38,800–38,850	5-B	39,500–39,550
6-A	38,850–38,900	6-B	39,550–39,600
7-A	38,900–38,950	7-B	39,600–39,650
8-A	38,950–39,000	8-B	39,650–39,700
9-A	39,000–39,050	9-B	39,700–39,750
10-A	39,050–39,100	10-B	39,750–39,800
11-A	39,100–39,150	11-B	39,800–39,850
12-A	39,150–39,200	12-B	39,850–39,900
13-A	39,200–39,250	13-B	39,900–39,950
14-A	39,250–39,300	14-B	39,950–40,000

(c) 37–38.6 GHz band: 37,600–37,800 MHz; 37,800–38,000 MHz; 38,000–38,200 MHz; 38,200–38,400 MHz, and 38,400–38,600 MHz. The 37,000–37,600 MHz band segment shall be available on a site-specific, coordinated shared basis with eligible Federal entities.

§ 30.5 Service areas.

(a) Except as noted in paragraphs (b) and (c) of this section, and except for the shared 37–37.6 GHz band, the service areas for the Upper Microwave Flexible Use Service are Partial Economic Areas.

(b) For the 27.5–28.35 GHz band, the service areas shall be counties.

(c) Common Carrier Fixed Point-to-Point Microwave Stations licensed in the 38.6–40 GHz bands licensed with Rectangular Service Areas shall maintain their Rectangular Service Area as defined in their authorization. The frequencies associated with Rectangular Service Area authorizations that have expired, cancelled, or otherwise been recovered by the Commission will automatically revert to the applicable county licensee.

(d) In the 37.5–40 GHz band, Upper Microwave Flexible Use Service licensees shall not place facilities within the protection zone of Fixed-Satellite Service earth stations authorized pursuant to § 25.136 of this chapter, absent consent from the Fixed-Satellite Service earth station licensee.

§ 30.6 Permissible communications.

(a) A licensee in the frequency bands specified in § 30.4 may provide any services for which its frequency bands are allocated, as set forth in the non-Federal Government column of the Table of Frequency Allocations in § 2.106 of this chapter (column 5).

(b) Fixed-Satellite Service shall be provided in a manner consistent with part 25 of this chapter.

§ 30.7 37–37.6 GHz Band—Shared coordinated service.

(a) The 37–37.6 GHz band will be available for site-based registrations on

a coordinated basis with co-equal eligible Federal entities.

(b) Any non-Federal entity meeting the eligibility requirements of § 30.3 may operate equipment that complies with the technical rules of this part pursuant to a Shared Access License.

(c) Licensees in the 37–37.6 GHz band must register their individual base stations and access points prior to placing them in operation.

§ 30.8 5G Provider cybersecurity statement requirements.

(a) *Statement.* Each Upper Microwave Flexible Use Service licensee is required to submit to the Commission a Statement describing its network security plans and related information, which shall be signed by a senior executive within the licensee’s organization with personal knowledge of the security plans and practices within the licensee’s organization. The Statement must contain, at a minimum, the following elements:

(1) *Security approach.* A high-level, general description of the licensee’s approach designed to safeguard the planned network’s confidentiality, integrity, and availability, with respect to communications from:

- (i) A device to the licensee’s network;
- (ii) One element of the licensee’s network to another element on the licensee’s network;
- (iii) The licensee’s network to another network; and
- (iv) Device to device (with respect to telephone voice and messaging services).

(2) *Cybersecurity coordination.* A high-level, general description of the licensee’s anticipated approach to assessing and mitigating cyber risk induced by the presence of multiple participants in the band. This should include the high level approach taken toward ensuring consumer network confidentiality, integrity, and availability security principles, are to be protected in each of the following use cases: communications between a

wireless device and the licensee’s network; communications within and between each licensee’s network; communications between mobile devices that are under end-to-end control of the licensee; and communications between mobile devices that are not under the end-to-end control of the licensee;

(3) *Cybersecurity standards and best practices.* A high-level description of relevant cybersecurity standards and practices to be employed, whether industry-recognized or related to some other identifiable approach;

(4) *Participation with standards bodies, industry-led organizations.* A description of the extent to which the licensee participates with standards bodies or industry-led organizations pursuing the development or maintenance of emerging security standards and/or best practices;

(5) *Other security approaches.* The high-level identification of any other approaches to security, unique to the services and devices the licensee intends to offer and deploy; and

(6) *Plans with Information Sharing and Analysis Organizations.* Plans to incorporate relevant outputs from Information Sharing and Analysis Organizations (ISAOs) as elements of the licensee’s security architecture. Plans should include comment on machine-to-machine threat information sharing, and any use of anticipated standards for ISAO-based information sharing.

(b) *Timing.* Each Upper Microwave Flexible Use Service licensee shall submit this *Statement* to the Commission within three years after grant of the license, but no later than six months prior to deployment.

(c) *Definitions.* The following definitions apply to this section:

Availability. The accessibility and usability of a network upon demand.

Confidentiality. The protection of data from unauthorized access and disclosure, both while at rest and in transit.

Integrity. The protection against the unauthorized modification or destruction of information.

Subpart B—Applications and Licenses

§ 30.101 Initial authorizations.

Except with respect to in the 37–37.6 GHz band, an applicant must file a single application for an initial authorization for all markets won and frequency blocks desired. Initial authorizations shall be granted in accordance with § 30.4. Applications for individual sites are not required and will not be accepted, except where required for environmental assessments, in accordance with §§ 1.1301 through 1.1319 of this chapter.

§ 30.102 Transition of existing local multipoint distribution service and 39 GHz licenses.

Local Multipoint Distribution Service licenses in the 27.5–28.35 GHz band issued on a Basic Trading Area basis shall be disaggregated into county-based licenses and 39 GHz licenses issued on an Economic Area basis shall be disaggregated into Partial Economic Area-based licenses on December 14, 2016. For each county in the Basic Trading Area or Partial Economic Area in the Economic Area which is part of the original license, the licensee shall receive a separate license. If there is a co-channel Rectangular Service Area licensee within the service area of a 39 GHz Economic Area licensee, the disaggregated license shall not authorize operation with the service area of the Rectangular Service Area license.

§ 30.103 License term.

Initial authorizations will have a term not to exceed ten years from the date of initial issuance or renewal.

§ 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.

(b) Showings that rely on a combination of multiple types of service will be evaluated on a case-by-case basis.

(c) If a licensee in this service is also a Fixed-Satellite Service licensee and uses the spectrum covered under its UMFUS license in connection with a satellite earth station, it can demonstrate compliance with the requirements of this section by demonstrating that the earth station in question is in service, operational, and using the spectrum associated with the license. This provision can only be used to demonstrate compliance for the county in which the earth station is located.

(d) 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 within the license area to a level where the licensee's buildout would meet one of the applicable performance metrics.

(e) Existing 28 GHz and 39 GHz licensees shall be required to make a showing pursuant to this rule by June 1, 2024.

§ 30.105 Geographic partitioning and spectrum disaggregation.

(a) Parties seeking approval for partitioning and disaggregation shall request from the Commission an authorization for partial assignment of a license pursuant to § 1.948 of this chapter. Upper Microwave Flexible Use Service licensees may apply to partition their licensed geographic service area or disaggregate their licensed spectrum at any time following the grant of their licenses.

(b) *Technical standards*—(1) *Partitioning.* In the case of partitioning, applicants and licensees must file FCC Form 603 pursuant to § 1.948 of this chapter and list the partitioned service area on a schedule to the application. The geographic coordinates must be specified in degrees, minutes, and seconds to the nearest second of latitude and longitude and must be based upon the 1983 North American Datum (NAD83).

(2) Spectrum may be disaggregated in any amount.

(3) The Commission will consider requests for partial assignment of licenses that propose combinations of partitioning and disaggregation.

(4) For purposes of partitioning and disaggregation, part 30 systems must be

designed so as not to exceed the signal level specified for the particular spectrum block in § 30.204 at the licensee's service area boundary, unless the affected adjacent service area licensees have agreed to a different signal level.

(c) *License term.* The license term for a partitioned license area and for disaggregated spectrum shall be the remainder of the original licensee's license term as provided for in § 30.103.

(d)(1) Parties to partitioning agreements must satisfy the construction requirements set forth in § 30.104 by the partitioner and partitionee each certifying that it will independently meet the construction requirement for its respective partitioned license area. If the partitioner or partitionee fails to meet the construction requirement for its respective partitioned license area, then the relevant partitioned license will automatically cancel.

(2) Parties to disaggregation agreements must satisfy the construction requirements set forth in § 30.104 by the disaggregator and disaggregatee each certifying that it will independently meet the construction requirement for its respective disaggregated license area. If the disaggregator or disaggregatee fails to meet the construction requirement for its respective disaggregated license area, then the relevant disaggregated license will automatically cancel.

§ 30.106 Discontinuance of service.

(a) An Upper Microwave Flexible Use License authorization will automatically terminate, without specific Commission action, if the licensee permanently discontinues service after the initial license term.

(b) For licensees with common carrier regulatory status, permanent discontinuance of service is defined as 180 consecutive days during which a licensee does not provide service to at least one subscriber that is not affiliated with, controlled by, or related to the licensee in the individual license area. For licensees with non-common carrier status, permanent discontinuance of service is defined as 180 consecutive days during which a licensee does not operate.

(c) A licensee that permanently discontinues service as defined in this section must notify the Commission of the discontinuance within 10 days by filing FCC Form 601 or 605 requesting license cancellation. An authorization will automatically terminate, without specific Commission action, if service is permanently discontinued as defined in this section, even if a licensee fails to

file the required form requesting license cancellation.

Subpart C—Technical Standards

§ 30.201 Equipment authorization.

(a) Except as provided under paragraph (c) of this section, each transmitter utilized for operation under this part must be of a type that has been authorized by the Commission under its certification procedure.

(b) Any manufacturer of radio transmitting equipment to be used in these services may request equipment authorization following the procedures set forth in subpart J of part 2 of this chapter. Equipment authorization for an individual transmitter may be requested by an applicant for a station authorization by following the procedures set forth in part 2 of this chapter.

(c) Unless specified otherwise, transmitters for use under the provisions of subpart E of this part for fixed point-to-point microwave and point-to-multipoint services must be a type that has been verified for compliance.

§ 30.202 Power limits.

(a) For fixed and base stations operating in connection with mobile systems, the average power of the sum of all antenna elements is limited to an equivalent isotopically radiated power (EIRP) density of +75dBm/100 MHz. For channel bandwidths less than 100 megahertz the EIRP must be reduced proportionally and linearly based on the bandwidth relative to 100 megahertz.

(b) For mobile stations, the average power of the sum of all antenna elements is limited to a maximum EIRP of +43 dBm.

(c) For transportable stations, as defined in § 30.2, the average power of

the sum of all antenna elements is limited to a maximum EIRP of +55 dBm.

(d) For fixed point-to-point and point-to-multipoint limits see § 30.405.

§ 30.203 Emission limits.

(a) The conductive power or the total radiated power of any emission outside a licensee's frequency block shall be – 13 dBm/MHz or lower. However, in the bands immediately outside and adjacent to the licensee's frequency block, having a bandwidth equal to 10 percent of the channel bandwidth, the conductive power or the total radiated power of any emission shall be – 5 dBm/MHz or lower.

(b)(1) Compliance with this provision is based on the use of measurement instrumentation employing a resolution bandwidth of 1 megahertz or greater.

(2) When measuring the emission limits, the nominal carrier frequency shall be adjusted as close to the licensee's frequency block edges as the design permits.

(3) The measurements of emission power can be expressed in peak or average values.

(c) For fixed point-to-point and point-to-multipoint limits see § 30.404.

§ 30.204 Field strength limits.

(a) *Base/mobile operations:* The predicted or measured Power Flux Density (PFD) from any Base Station operating in the 27.5–28.35 GHz band, 37–38.6 GHz band, and 38.6–40 GHz bands at any location on the geographical border of a licensee's service area shall not exceed – 76dBm/m²/MHz (measured at 1.5 meters above ground) unless the adjacent affected service area licensee(s) agree(s) to a different PFD.

(b) *Fixed point-to-point operations.* (1) Prior to operating a fixed point-to-point transmitting facility in the 27,500–

28,350 MHz band where the facilities are located within 20 kilometers of the boundary of the licensees authorized market area, the licensee must complete frequency coordination in accordance with the procedures specified in § 101.103(d)(2) of this chapter with respect to neighboring licensees that may be affected by its operations.

(2) Prior to operating a fixed point-to-point transmitting facility in the 37,000–40,000 MHz band where the facilities are located within 16 kilometers of the boundary of the licensees authorized market area, the licensee must complete frequency coordination in accordance with the procedures specified in § 101.103(d)(2) of this chapter with respect to neighboring licensees that may be affected by its operations.

§ 30.205 Federal coordination requirements.

(a) Licensees in the 37–38 GHz band located within the zones defined by the coordinates in the tables below must coordinate their operations with Federal Space Research Service (space to Earth) users of the band via the National Telecommunications and Information Administration (NTIA). All licensees operating within the zone defined by the 60 dBm/100 MHz EIRP coordinates in the tables below must coordinate all operations. Licensees operating within the area between the zones defined by the 60 dBm and 75 dBm/100 MHz EIRP coordinates in the tables below must coordinate all operations if their base station EIRP is greater than 60 dBm/100 MHz or if their antenna height exceeds 100 meters above ground level. Licensees operating outside the zones defined by the 75 dBm/100 MHz EIRP coordinates in the tables below are not required to coordinate their operations with NTIA.

TABLE 1 TO PARAGRAPH (a): GOLDSTONE, CALIFORNIA COORDINATION ZONE

60 dBm/100 MHz EIRP		75 dBm/100 MHz EIRP	
Latitude/Longitude (decimal degrees)	Latitude/Longitude (decimal degrees)	Latitude/Longitude (decimal degrees)	Latitude/Longitude (decimal degrees)
34.69217/– 115.6491	34.19524/– 117.47963	34.69217/– 115.6491	34.19524/– 117.47963
35.25746/– 115.32041	34.24586/– 117.36210	35.25746/– 115.32041	34.24586/– 117.36210
36.21257/– 117.06567	35.04648/– 117.03781	36.11221/– 116.63632	34.21748/– 117.12812
36.55967/– 117.63691	35.04788/– 117.00949	36.54731/– 117.48242	34.20370/– 116.97024
36.66297/– 118.31017	34.22940/– 117.22327	36.73049/– 118.33683	34.12196/– 116.93109
36.06074/– 118.38528	34.20370/– 116.97024	36.39126/– 118.47307	34.09498/– 116.75473
35.47015/– 118.39008	34.12196/– 116.93109	36.36891/– 118.47134	34.13603/– 116.64002
35.40865/– 118.34353	34.09498/– 116.75473	35.47015/– 118.39008	34.69217/– 115.6591
35.35986/– 117.24709	34.19642/– 116.72901	35.40865/– 118.34353	34.69217/– 115.6491
35.29539/– 117.21102	34.64906/– 116.62741	35.32048/– 117.26386	
34.67607/– 118.55412	34.44404/– 116.31486	34.63725/– 118.96736	
34.61532/– 118.36919	34.52736/– 116.27845	34.55789/– 118.36204	
34.91551/– 117.70371	34.76685/– 116.27930	34.51108/– 118.15329	
34.81257/– 117.65400	34.69217/– 115.6591	34.39220/– 118.28852	
34.37411/– 118.18385	34.69217/– 115.6491	34.38546/– 118.27460	

TABLE 1 TO PARAGRAPH (a): GOLDSTONE, CALIFORNIA COORDINATION ZONE—Continued

60 dBm/100 MHz EIRP		75 dBm/100 MHz EIRP	
Latitude/Longitude (decimal degrees)	Latitude/Longitude (decimal degrees)	Latitude/Longitude (decimal degrees)	Latitude/Longitude (decimal degrees)
34.33405/ – 117.94189	34.37524/ – 118.24191	
34.27249/ – 117.65445	34.37039/ – 118.22557	

TABLE 2 TO PARAGRAPH (a): SOCORRO, NEW MEXICO COORDINATION ZONE

60 dBm/100 MHz EIRP		75 dBm/100 MHz EIRP	
Latitude/Longitude (decimal degrees)	Latitude/Longitude (decimal degrees)	Latitude/Longitude (decimal degrees)	Latitude/Longitude (decimal degrees)
34.83816/ – 107.66828	33.44401/ – 108.67876	33.10651/ – 108.19320	
34.80070/ – 107.68759	33.57963/ – 107.79895	33.11780/ – 107.99980	
34.56506/ – 107.70233	33.84552/ – 107.60207	33.13558/ – 107.85611	
34.40826/ – 107.71489	33.85964/ – 107.51915	33.80383/ – 107.16520	
34.31013/ – 107.88349	33.86479/ – 107.17223	33.94554/ – 107.15516	
34.24067/ – 107.96059	33.94779/ – 107.15038	33.95665/ – 107.15480	
34.10278/ – 108.23166	34.11122/ – 107.18132	34.08156/ – 107.18137	
34.07442/ – 108.30646	34.15203/ – 107.39035	34.10646/ – 107.18938	
34.01447/ – 108.31694	34.29643/ – 107.51071	35.24269/ – 107.67969	
33.86740/ – 108.48706	34.83816/ – 107.66828	34.06647/ – 108.70438	
33.81660/ – 108.51052	33.35946/ – 108.68902		
33.67909/ – 108.58750	33.29430/ – 108.65004		
33.50223/ – 108.65470	33.10651/ – 108.19320		

TABLE 3 TO PARAGRAPH (a): WHITE SANDS, NEW MEXICO COORDINATION ZONE

60 dBm/100 MHz EIRP		75 dBm/100 MHz EIRP	
Latitude/Longitude (decimal degrees)	Latitude/Longitude (decimal degrees)	Latitude/Longitude (decimal degrees)	Latitude/Longitude (decimal degrees)
33.98689/ – 107.15967	31.78455/ – 106.54058	31.7494/ – 106.49132	32.88382/ – 108.16588
33.91573/ – 107.46301	32.24710/ – 106.56114	32.24524/ – 106.56507	32.76255/ – 108.05679
33.73122/ – 107.73585	32.67731/ – 106.53681	32.67731/ – 106.53681	32.56863/ – 108.43999
33.37098/ – 107.84333	32.89856/ – 106.56882	32.89856/ – 106.56882	32.48991/ – 108.50032
33.25424/ – 107.86409	33.24323/ – 106.70094	33.04880/ – 106.62309	32.39142/ – 108.48959
33.19808/ – 107.89673	33.98689/ – 107.15967	33.21824/ – 106.68992	31.63664/ – 108.40480
33.02128/ – 107.87226	33.24347/ – 106.70165	31.63466/ – 108.20921	
32.47747/ – 107.77963	34.00708/ – 107.08652	31.78374/ – 108.20798	
32.31543/ – 108.16101	34.04967/ – 107.17524	31.78322/ – 106.52825	
31.79429/ – 107.88616	33.83491/ – 107.85971	31.7494/ – 106.49132	

(b) Licensees in the 37–38.6 GHz band located within the zones defined by the coordinates in the table below must coordinate their operations with the Department of Defense via the National Telecommunications and Information Administration (NTIA).

TABLE TO PARAGRAPH (b)—COORDINATION AREAS FOR FEDERAL TERRESTRIAL SYSTEMS

Location	Agency	Coordination area (decimal degrees)
China Lake, CA	Navy	30 kilometer radius centered on latitude 35.59527 and longitude – 117.22583. 30 kilometer radius centered on latitude 35.52222 and longitude – 117.30333. 30 kilometer radius centered on latitude 35.76222 and longitude – 117.60055. 30 kilometer radius centered on latitude 35.69111 and longitude – 117.66916.
San Diego, CA	Navy	30 kilometer radius centered on latitude 32.68333 and longitude – 117.23333.
Nanakuli, HI	Navy	30 kilometer radius centered on latitude 21.38333 and longitude – 158.13333.
Fishers Island, NY	Navy	30 kilometer radius centered on latitude 41.25 and longitude – 72.01666.
Saint Croix, VI	Navy	30 kilometer radius centered on latitude 17.74722 and longitude – 64.88.
Fort Irwin, CA	Army	30 kilometer radius centered on latitude 35.26666 and longitude – 116.68333.
Fort Carson, CO	Army	30 kilometer radius centered on latitude 38.71666 and longitude – 104.65.
Fort Hood, TX	Army	30 kilometer radius centered on latitude 31.11666 and longitude – 97.76666.
Fort Bliss, TX	Army	30 kilometer radius centered on latitude 31.8075 and longitude – 106.42166.
Yuma Proving Ground, AZ	Army	30 kilometer radius centered on latitude 32.48333 and longitude – 114.33333.
Fort Huachuca, AZ	Army	30 kilometer radius centered on latitude 31.55 and longitude – 110.35.
White Sands Missile Range, NM	Army	30 kilometer radius centered on latitude 33.35 and longitude – 106.3.

TABLE TO PARAGRAPH (b)—COORDINATION AREAS FOR FEDERAL TERRESTRIAL SYSTEMS—Continued

Location	Agency	Coordination area (decimal degrees)
Moody Air Force Base, GA	Air Force	30 kilometer radius centered on latitude 30.96694 and longitude -83.185.
Hurlburt Air Force Base, FL	Air Force	30 kilometer radius centered on latitude 30.42388 and longitude -86.70694.

§ 30.206 International coordination.

Operations in the 27.5–28.35 GHz, 37–38.6, and 38.6–40 GHz bands are subject to existing and future international agreements with Canada and Mexico.

§ 30.207 Radio frequency (RF) safety.

Licensees and manufacturers are subject to the radio frequency radiation exposure requirements specified in §§ 1.1307(b), 1.1310, 2.1091, and 2.1093 of this chapter, as appropriate. Applications for equipment authorization of mobile or portable devices operating under this section must contain a statement confirming compliance with these requirements. Technical information showing the basis for this statement must be submitted to the Commission upon request.

§ 30.208 Operability.

Mobile and transportable stations that operate on any portion of frequencies within the 27.5–28.35 GHz or the 37–40 GHz bands must be capable of operating on all frequencies within those particular bands.

§ 30.209 Duplexing.

Stations authorized under this rule part may employ frequency division duplexing, time division duplexing, or any other duplexing scheme, provided that they comply with the other technical and operational requirements specified in this part.

Subpart D—Competitive Bidding Procedures

§ 30.301 Upper Microwave Flexible Use Service subject to competitive bidding.

Mutually exclusive initial applications for Upper Microwave Flexible User Service licenses are subject to competitive bidding. The general competitive bidding procedures set forth in part 1, subpart Q of this chapter will apply unless otherwise provided in this subpart.

§ 30.302 Designated entities and bidding credits.

(a) *Eligibility for small business provisions.* (1) A small business is an entity that, together with its affiliates, its controlling interests and the affiliates of its controlling interests, have average

gross revenues that are not more than \$55 million for the preceding three (3) years.

(2) A very small business is an entity that, together with its affiliates, its controlling interests and the affiliates of its controlling interests, has average gross revenues that are not more than \$20 million for the preceding three (3) years.

(b) *Bidding credits.* A winning bidder that qualifies as a small business, as defined in this section, or a consortium of small businesses may use a bidding credit of 15 percent, as specified in § 1.2110(f)(2)(i)(C) of this chapter. A winning bidder that qualifies as a very small business, as defined in this section, or a consortium of very small businesses may use a bidding credit of 25 percent, as specified in § 1.2110(f)(2)(i)(B) of this chapter.

(c) A rural service provider, as defined in § 1.2110(f)(4) of this chapter, who has not claimed a small business bidding credit may use a bidding credit of 15 percent bidding credit, as specified in § 1.2110(f)(4)(i) of this chapter.

Subpart E—Special Provisions for Fixed Point-to-Point, Fixed Point-to-Multipoint Hub Stations, and Fixed Point-to-Multipoint User Stations

§ 30.401 Permissible service.

Stations authorized under this subpart may deploy stations used solely as fixed point-to-point stations, fixed point-to-multipoint hub stations, or fixed point-to-multipoint user stations, as defined in § 30.2, subject to the technical and operational requirements specified in this subpart.

§ 30.402 Frequency tolerance.

The carrier frequency of each transmitter authorized under this subpart must be maintained within the following percentage of the reference frequency (unless otherwise specified in the instrument of station authorization the reference frequency will be deemed to be the assigned frequency):

Frequency (MHz)	Frequency tolerance (percent)
27,500 to 28,350	0.001
38,600 to 40,000	0.03

§ 30.403 Bandwidth.

(a) Stations under this subpart will be authorized any type of emission, method of modulation, and transmission characteristic, consistent with efficient use of the spectrum and good engineering practice.

(b) The maximum bandwidth authorized per frequency to stations under this subpart is set out in the table that follows.

Frequency band (MHz)	Maximum authorized bandwidth
27,500 to 28,350	850 MHz.
38,600 to 40,000	200 MHz. ¹

¹For channel block assignments in the 38,600–40,000 MHz bands when adjacent channels are aggregated, equipment is permitted to operate over the full channel block aggregation without restriction.

§ 30.404 Emission limits.

(a) The mean power of emissions must be attenuated below the mean output power of the transmitter in accordance with the following schedule:

(1) When using transmissions other than those employing digital modulation techniques:

(i) On any frequency removed from the assigned frequency by more than 50 percent up to and including 100 percent of the authorized bandwidth: At least 25 decibels;

(ii) On any frequency removed from the assigned frequency by more than 100 percent up to and including 250 percent of the authorized bandwidth: At least 35 decibels;

(iii) On any frequency removed from the assigned frequency by more than 250 percent of the authorized bandwidth: At least 43 + 10 Log₁₀ (mean output power in watts) decibels, or 80 decibels, whichever is the lesser attenuation.

(2) When using transmissions employing digital modulation techniques in situations not covered in this section:

(i) In any 1 MHz band, the center frequency of which is removed from the assigned frequency by more than 50 percent up to and including 250 percent of the authorized bandwidth: As specified by the following equation but in no event less than 11 decibels:

$A = 11 + 0.4(P - 50) + 10 \text{ Log}_{10} B$.
(Attenuation greater than 56 decibels or to an absolute power of less than -13 dBm/1MHz is not required.)

(ii) In any 1 MHz band, the center frequency of which is removed from the assigned frequency by more than 250 percent of the authorized bandwidth: At least $43 + 10 \text{ Log}_{10}$ (the mean output power in watts) decibels, or 80 decibels, whichever is the lesser attenuation. The authorized bandwidth includes the nominal radio frequency bandwidth of an individual transmitter/modulator in block-assigned bands. Equipment licensed prior to April 1, 2005 shall only be required to meet this standard in any 4 kHz band.

(iii) The emission mask in paragraph (a)(2)(i) of this section applies only to the band edge of each block of spectrum, but not to subchannels established by licensees. The value of P in the equation is the percentage removed from the carrier frequency and assumes that the carrier frequency is the center of the actual bandwidth used. The emission mask can be satisfied by locating a carrier of the subchannel sufficiently far from the channel edges so that the emission levels of the mask are satisfied. The emission mask shall use a value B (bandwidth) of 40 MHz, for all cases even in the case where a narrower subchannel is used (for instance the actual bandwidth is 10

MHz) and the mean output power used in the calculation is the sum of the output power of a fully populated channel. For block assigned channels, the out-of-band emission limits apply only outside the assigned band of operation and not within the band.

(b) [Reserved]

§ 30.405 Transmitter power limitations.

On any authorized frequency, the average power delivered to an antenna in this service must be the minimum amount of power necessary to carry out the communications desired. Application of this principle includes, but is not to be limited to, requiring a licensee who replaces one or more of its antennas with larger antennas to reduce its antenna input power by an amount appropriate to compensate for the increased primary lobe gain of the replacement antenna(s). In no event shall the average equivalent isotropically radiated power (EIRP), as referenced to an isotropic radiator, exceed the following:

MAXIMUM ALLOWABLE EIRP

Frequency band (MHz)	Fixed (dBW)
27,500–28,350 ¹	+ 55
38,600–40,000	+ 55

¹ For Point-to-multipoint user stations authorized in these bands, the EIRP shall not exceed 55 dBw or 42 dBw/MHz.

§ 30.406 Directional antennas.

(a) Unless otherwise authorized upon specific request by the applicant, each station authorized under the rules of this subpart must employ a directional antenna adjusted with the center of the major lobe of radiation in the horizontal plane directed toward the receiving station with which it communicates: *provided, however*, where a station communicates with more than one point, a multi- or omni-directional antenna may be authorized if necessary.

(b) Fixed stations (other than temporary fixed stations) must employ transmitting and receiving antennas (excluding second receiving antennas for operations such as space diversity) meeting the appropriate performance Standard A indicated in the table to this section, except that in areas not subject to frequency congestion, antennas meeting performance Standard B may be used. For frequencies with a Standard B1 and a Standard B2, in order to comply with Standard B an antenna must fully meet either Standard B1 or Standard B2. Licensees shall comply with the antenna standards table shown in this paragraph in the following manner:

- (1) With either the maximum beamwidth to 3 dB points requirement or with the minimum antenna gain requirement; and
- (2) With the minimum radiation suppression to angle requirement.

Frequency (MHz)	Category	Maximum beamwidth to 3 dB points ¹ (included angle in degrees)	Minimum antenna gain (dbi)	Minimum radiation suppression to angle in degrees from centerline of main beam in decibels						
				5° to 10°	10° to 15°	15° to 20°	20° to 30°	30° to 100°	100° to 140°	140° to 180°
38,600 to 40,000 ²	A	n/a	38	25	29	33	36	42	55	55
	B	n/a	38	20	24	28	32	35	36	36

¹ If a licensee chooses to show compliance using maximum beamwidth to 3 dB points, the beamwidth limit shall apply in both the azimuth and the elevation planes.
² Stations authorized to operate in the 38,600–40,000 MHz band may use antennas other than those meeting the Category A standard. However, the Commission may require the use of higher performance antennas where interference problems can be resolved by the use of such antennas.

§ 30.407 Antenna polarization.

In the 27,500–28,350 MHz band, system operators are permitted to use any polarization within its service area, but only vertical and/or horizontal polarization for antennas located within 20 kilometers of the outermost edge of their service area.

PART 101—FIXED MICROWAVE SERVICES

■ 16. The authority citation for part 101 continues to read as follows:

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

§ 101.17 [Removed and Reserved]

■ 17. Remove and reserve § 101.17.

§ 101.56 [Removed and Reserved]

- 18. Remove and reserve § 101.56.
- 19. Section 101.63 is amended by revising paragraph (a) to read as follows:

§ 101.63 Period of construction; certification of completion of construction.

(a) Each Station, except in Multichannel Video Distribution and Data Service, Local Multipoint Distribution Service, and the 24 GHz Service, authorized under this part must be in operation within 18 months from the initial date of grant.

* * * * *

§ 101.101 [Amended]

- 20. Section 101.101, the table, is amended by removing the entries “27,500–28,350” and “38,600–40,000.”
- 21. Section 101.103 is amended by revising paragraph (g)(1) and by removing paragraph (i) as follows:

§ 101.103 Frequency coordination procedures.

* * * * *
(g) * * *

(1) When the transmitting facilities in a Basic Trading Area (BTA) are to be operated in the bands 29,100–29,250 MHz and 31,000–31,300 MHz and the facilities are located within 20 kilometers of the boundaries of a BTA, each licensee must complete the frequency coordination process of

paragraph (d)(2) of this section with respect to neighboring BTA licensees that may be affected by its operations prior to initiating service. In addition, all licensed transmitting facilities operating in the bands 31,000–31,075 MHz and 31,225–31,300 MHz and located within 20 kilometers of neighboring facilities must complete the frequency coordination process of paragraph (d)(2) of this section with respect to such authorized operations before initiating service.

* * * * *

§ 101.107 [Amended]

■ 22. Section 101.107 is amended by removing the entry “27,500 to 28,350” from the table following paragraph (a).

■ 23. Section 101.109 is amended by removing the entries “27,500 to 28,350” and “38,600 to 40,000” in the table following paragraph (c) and revising footnote 7 to the table.

The revision reads as follows:

§ 101.109 Bandwidth.

* * * * *

(c) * * *

⁷ For channel block assignments in the 24,250–25,250 MHz band, the authorized bandwidth is equivalent to an unpaired channel block assignment or to either half of a symmetrical paired channel block assignment. When adjacent channels are aggregated, equipment is permitted to operate over the full channel block aggregation without restriction.

* * * * *

§ 101.113 [Amended]

■ 24. Section 101.113 is amended by removing the entries “27,500–28,350” and “38,600 to 40,000” in the table following paragraph (a).

§ 101.115 [Amended]

■ 25. Section 101.115 is amended by removing the entry “38,600 to 40,000” in the table following paragraph (b)(2), removing footnote 14, and redesignating footnote 15 as footnote 14.

■ 26. Section 101.147 is amended by revising the portion of paragraph (a) preceding the Notes, revising paragraph (t), and removing and reserving paragraph (v).

The revisions read as follows:

§ 101.147 Frequency assignments.

(a) Frequencies in the following bands are available for assignment for fixed microwave services.

- 928.0–929.0 MHz (28)
- 932.0–932.5 MHz (27)
- 932.5–935 MHz (17)
- 941.0–941.5 MHz (28)
- 941.5–944 MHz (17) (18)
- 952.0–960.0 MHz (28)
- 1,850–1,990 MHz (20) (22)
- 2,110–2,130 MHz (1) (3) (7) (20) (23)
- 2,130–2,150 MHz (20) (22)
- 2,160–2,180 MHz (1) (2) (20) (23)
- 2,180–2,200 MHz (20) (22)
- 2,450–2,500 MHz (12)
- 2,650–2,690 MHz
- 3,700–4,200 MHz (8) (14) (25)
- 5,925–6,425 MHz (6) (14) (25)
- 6,425–6,525 MHz (24)
- 6,525–6.875 MHz (14) (33)
- 6,875–7,125 MHz (10), (34)
- 10,550–10,680 MHz (19)
- 10,700–11,700 MHz (8) (9) (19) (25)
- 11,700–12,200 MHz (24)
- 12,200–12,700 MHz (31)
- 12,700–13,200 (22), (34)
- 13,200–13,250 MHz (4) (24) (25)
- 14,200–14,400 MHz (24)
- 17,700–18,820 MHz (5) (10) (15)
- 17,700–18,300 MHz (10) (15)
- 18,820–18,920 MHz (22)
- 18,300–18,580 MHz (5) (10) (15)
- 18,580–19,300 MHz (22) (30)
- 18,920–19,160 MHz (5) (10) (15)
- 19,160–19,260 MHz (22)
- 19,260–19,700 MHz (5) (10) (15)
- 19,300–19,700 MHz (5) (10) (15)
- 21,200–22,000 MHz (4) (11) (12) (13) (24) (25) (26)
- 22,000–23,600 MHz (4) (11) (12) (24) (25) (26)
- 24,250–25,250 MHz
- 29,100–29,250 MHz (5), (16)
- 31,000–31,300 MHz (16)
- 42,000–42,500 MHz
- 71,000–76,000 MHz (5) (17)

- 81,000–86,000 MHz (5) (17)
- 92,000–94,000 MHz (17)
- 94,100–95,000 MHz (17)

* * * * *

(t) 29,100–29,250; 31,000–31,300 MHz. These frequencies are available for LMDS systems. Each assignment will be made on a BTA service area basis, and the assigned spectrum may be subdivided as desired by the licensee.

* * * * *

§ 101.149 [Removed and Reserved]

■ 27. Remove and reserve § 101.149.

■ 28. Section 101.1005 is amended by revising paragraphs (a) and (b) to read as follows:

§ 101.1005 Frequencies available.

(a) The following frequencies are available for assignment to LMDS in two license blocks:

Block A of 300 MHz
29,100–29,250 MHz
31,075–31,225 MHz

Block B of 150 MHz
31,000–31,075 MHz
31,225–31,300 MHz

(b) In Block A licenses, the frequencies are authorized as follows:

(1) 29,100–29,250 MHz is shared on a co-primary basis with feeder links for non-geostationary orbit Mobile Satellite Service (NGSO/MSS) systems in the band and is limited to LMDS hub-to-subscriber transmissions, as provided in §§ 25.257 and 101.103(h) of this chapter.

(2) 31,075–31,225 MHz is authorized on a primary protected basis and is shared with private microwave point-to-point systems licensed prior to March 11, 1997, as provided in § 101.103(b).

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Subpart N—[Removed and Reserved]

■ 29. Remove and reserve subpart N, consisting of §§ 101.1201 through 101.1209.

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