

**Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554**

In the Matter of)	
)	
Use of Spectrum Bands Above 24 GHz For Mobile Radio Services)	GN Docket No. 14-177
)	
Establishing a More Flexible Framework to Facilitate Satellite Operations in the 27.5-28.35 GHz and 37.5-40 GHz Bands)	IB Docket No. 15-256
)	
Petition for Rulemaking of the Fixed Wireless Communications Coalition to Create Service Rules for the 42-43.5 GHz Band)	RM-11664
)	
Amendment of Parts 1, 22, 24, 27, 74, 80, 90, 95, and 101 To Establish Uniform License Renewal, Discontinuance of Operation, and Geographic Partitioning and Spectrum Disaggregation Rules and Policies for Certain Wireless Radio Services)	WT Docket No. 10-112
)	
Allocation and Designation of Spectrum for Fixed-Satellite Services in the 37.5-38.5 GHz, 40.5-41.5 GHz and 48.2-50.2 GHz Frequency Bands; Allocation of Spectrum to Upgrade Fixed and Mobile Allocations in the 40.5-42.5 GHz Frequency Band; Allocation of Spectrum in the 46.9-47.0 GHz Frequency Band for Wireless Services; and Allocation of Spectrum in the 37.0-38.0 GHz and 40.0-40.5 GHz for Government Operations)	IB Docket No. 97-95

REPLY COMMENTS OF STRAIGHT PATH COMMUNICATIONS INC.

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REPLY COMMENTS OF STRAIGHT PATH COMMUNICATIONS INC.

I. INTRODUCTION AND SUMMARY

Straight Path Communications Inc. (“Straight Path”) submits these reply comments in response to the comments submitted by other parties on the Notice of Proposed Rulemaking

(“*NPRM*”) issued by the Federal Communications Commission (“Commission” or “FCC”) in the above-referenced proceedings.^{1/}

The record developed to date supports the Commission taking the following actions:

- Adopt rules governing the four millimeter wave (“mmWave”) bands identified in the *NPRM*.
- Extend flexible use rights to existing 28 GHz and 39 GHz licensees without overlay rights to third parties.
- Reject a county-based licensing scheme for licensed mmWave services.
- Create larger license blocks at 39 GHz, in part through a pre-auction license swap.
- Reject unlicensed or shared use of licensed mmWave bands.
- Allow satellite operators access to the 28 GHz band, but only through auction or secondary markets.
- Limit satellite operations in the 39 GHz band.
- Adopt flexible performance rules, but reject a “use-it-or-share-it” requirement.
- Increase the base station Effective Isotropic Radiated Power (“EIRP”) limit to 72 dBm/100 MHz (75 dBm/100 MHz in rural areas).
- Adopt a different power limit of up to 53 dBm EIRP for usage scenarios such as fixed customer premise equipment for gigabit broadband to homes and enterprises, and relay stations on high speed trains.
- Incorporate established industry standards as exposure limits.

Adoption of flexible use rules in the mmWave bands will be an important step in the development and deployment of 5G mobile broadband technologies and services. Straight Path appreciates the Commission’s efforts and urges it to authorize mobile operations in the mmWave bands without delay.

^{1/} See *Use of Spectrum Bands Above 24 GHz For Mobile Radio Services, et al.*, Notice of Proposed Rulemaking, 30 FCC Rcd. 11878 (2015) (“*NPRM*”); see also Notice of Inquiry, 29 FCC Rcd. 13020 (2014).

II. THE COMMISSION SHOULD FOCUS ON ENABLING 5G MOBILE BROADBAND SERVICES IN THE FOUR BANDS IDENTIFIED IN THIS PROCEEDING

As Straight Path noted in its initial comments, the Commission should authorize mobile broadband operations in the four mmWave bands specified in the *NPRM*—namely, the 28 GHz, 37 GHz, 39 GHz, and 64–71 GHz bands.^{2/} Numerous commenters representing a wide variety of interests agree.^{3/} Although Straight Path is sympathetic to the requests of other commenters who encourage the Commission to study or reserve even more spectrum for 5G operations,^{4/} the Commission should not lose focus at this critical stage of promoting 5G technology. While the Commission may wish to consider providing additional spectrum for 5G uses in the future, it

^{2/} See Comments of Straight Path Communications Inc., GN Docket No. 14-177, *et al.*, at 2 (filed Jan. 27, 2016) (“Straight Path Comments”).

^{3/} See, e.g., Comment of Intel Corporation, GN Docket No. 14-177, *et al.*, at 1–3 (filed Jan. 26, 2016) (“Intel Comments”); Comments of Qualcomm Incorporated, GN Docket No. 14-177, *et al.*, at 2 (filed Jan. 27, 2016) (“Qualcomm Comments”); Comments of Samsung Electronics America, Inc. and Samsung Research America, GN Docket No. 14-177, *et al.*, at 3, 10–11 (filed Jan. 26, 2016) (“Samsung Comments”); Comments of Nokia, GN Docket No. 14-177, *et al.*, at 2–3 (filed Jan. 27, 2016) (“Nokia Comments”); Comments of Huawei Technologies, Inc. (USA) and Huawei Technologies Co., Ltd., GN Docket No. 14-177, *et al.*, at 4–8 (filed Jan. 28, 2016) (“Huawei Comments”); Comments of Verizon, GN Docket No. 14-177, *et al.*, at 2–4, 13 (filed Jan. 28, 2016) (“Verizon Comments”); Comments of the Consumer Technology Association f/k/a the Consumer Electronics Association, GN Docket No. 14-177, *et al.*, at 2–3 (filed Jan. 27, 2016) (“CTA Comments”); Comments of Facebook, Inc., GN Docket No. 14-177, *et al.*, at 2 (filed Jan. 26, 2016) (“Facebook Comments”); see also, e.g., Comments of EchoStar Satellite Operating Corporation, Hughes Network Systems, LLC, and Alta Wireless, Inc., GN Docket No. 14-177, *et al.*, at 3 (filed Jan. 27, 2016) (“EchoStar Comments”).

^{4/} See, e.g., Comments of the National Cable & Telecommunications Association, GN Docket No. 14-177, *et al.*, at 18 (filed Jan. 28, 2016) (“NCTA Comments”); Comments of AT&T, GN Docket No. 14-177, *et al.*, at 2–3 (filed Jan. 28, 2016) (“AT&T Comments”); Comments of CTIA, GN Docket No. 14-177, *et al.*, at 2–3, 8–11 (filed Jan. 28, 2016) (“CTIA Comments”); Comments of T-Mobile USA, Inc., GN Docket No. 14-177, *et al.*, at 4 (filed Jan. 27, 2016) (“T-Mobile Comments”); Comments of the Telecommunications Industry Association, GN Docket No. 14-177, *et al.*, at 5–6 (filed Jan. 28, 2016) (“TIA Comments”); Comments of 4G Americas, GN Docket No. 14-177, *et al.*, at 16 (filed Jan. 26, 2016) (“4G Americas Comments”); Comments of XO Communications, LLC, GN Docket No. 14-177, *et al.*, at 3 (filed Jan. 28, 2016) (“XO Comments”); Comments of FiberTower Spectrum Holdings, LLC, GN Docket No. 14-177, *et al.*, at 2 (filed Jan. 27, 2016) (“FiberTower Comments”); Comments of Mobile Future, GN Docket No. 14-177, *et al.*, at 9 (filed Jan. 27, 2016) (“Mobile Future Comments”); Comments of Ericsson, GN Docket No. 14-177, *et al.*, at 24–26 (filed Jan. 26, 2016) (“Ericsson Comments”); Comments of the High Tech Spectrum Coalition, GN Docket No. 14-177, at 4 (filed Jan. 28, 2016) (“HTSC Comments”).

should direct its immediate efforts to these four particular bands, which offer the most promise for rapid deployment of 5G mobile broadband technologies and services. Once the Commission adopts rules governing those bands, it should promptly consider the need for additional spectrum for 5G.

III. THE COMMISSION SHOULD MAKE SPECTRUM AVAILABLE FOR BOTH LICENSED AND UNLICENSED MOBILE OPERATIONS IN THE MMWAVE BANDS

A. The Commission Should Issue Exclusive Geographic Area Licenses Based on Large Geographic Service Areas, Extend Mobile Service Rights to Incumbents in the 28 GHz Band and the 39 GHz Band, and Implement a Band Plan with a Minimum Channel Bandwidth of 400 Megahertz

i. Exclusive Geographic Area Licenses for Incumbent Licensees in the 28 GHz and 39 GHz Bands

The record demonstrates commenters’ overwhelming support for the FCC’s proposal to extend flexible use rights to existing licensees in the 28 GHz and 39 GHz bands and to auction licenses in areas with no geographic area incumbent.^{5/} Existing licensees in the Upper Flexible Microwave Use Service (“UMFUS”) bands have already paid for the right to use that spectrum with the reasonable expectation that the Commission may allow mobile service use in the future.^{6/} As CTIA points out, “[g]ranting existing incumbents flexible fixed and mobile rights is

^{5/} See, e.g., T-Mobile Comments at 9 (“The Commission should adopt its proposal to authorize existing 28 GHz and 39 GHz licensees for mobile use.”); Verizon Comments at 2 (“The Commission should promptly adopt its plan to allow existing 28 GHz and 39 GHz licensees to use their licenses for mobile services, and to auction the spectrum in those bands not currently licensed.”); CTIA Comments at 14; Mobile Future Comments at 10; AT&T Comments at 3–4; XO Comments at 14; CTA Comments at 10; TIA Comments at 15–16; Samsung Comments at 3; Ericsson Comments at 5–6; Intel Comments at 2–3; Qualcomm Comments at 7; Comments of Cisco Systems Inc., GN Docket No. 14-177, *et al.*, at 5 (filed Jan. 28, 2016) (“Cisco Comments”); Comments of PCIA – The Wireless Infrastructure Association, GN Docket No. 14-177, *et al.*, at 8–9 (filed Jan. 26, 2016); Comments of the Information Technology Industry Council, GN Docket No. 14-177, *et al.*, at 4–5 (filed Jan. 27, 2016) (“ITI Comments”).

^{6/} See, e.g., Straight Path Comments at 16; CTIA Comments at 14–15; XO Comments at 10–11; EchoStar Comments at 14–15; *see also Rulemaking to Amend Parts 1, 2, 21, and 25 of the Commission’s Rules to Redesignate the 27.5-29.5 GHz Frequency Band, to Reallocate the 29.5-30.0 GHz Frequency Band, to Establish Rules and Policies for Local Multipoint Distribution Service and for Fixed Satellite Services; Petitions for Reconsideration of the Denial of Applications for Waiver of the Commission’s*

particularly appropriate in light of the fact that the Commission contemplated such rights when these initial licenses were auctioned, but the technology did not yet exist to permit such operations.”^{7/} Many other commenters recognize that awarding flexible use rights to incumbents would also promote efficient use of the spectrum, minimize transaction costs, and facilitate rapid deployment of 5G services in the mmWave bands.^{8/}

Similarly, Straight Path agrees with the vast majority of commenters who oppose the auction of overlay rights.^{9/} According to the Telecommunications Industry Association (“TIA”), an overlay license “is an invitation to disaster because of the close coordination that is necessarily required for fixed and mobile services to coexist in the same area on a co-channel basis.”^{10/} Likewise, Verizon states that the assignment of overlay rights “would overcomplicate

Common Carrier Point-to-Point Microwave Radio Service Rules; Suite 12 Group Petition for Pioneer Preference, Second Report and Order, Order on Reconsideration, and Fifth Notice of Proposed Rulemaking, 12 FCC Rcd. 12545, ¶ 207 (1997) (“[W]e know of no reason why we would not allow mobile operations if they are proposed and we obtain a record in support of such an allocation. We believe this would be consistent with our goal of providing LMDS licensees with maximum flexibility in designing their systems.”); Amendment of the Commission’s Rules Regarding the 37.0-38.6 GHz and 38.6-40.0 GHz Bands; Implementation of Section 309(j) of the Communications Act – Competitive Bidding, 37.0-38.6 GHz and 38.6-40.0 GHz, Report and Order and Second Notice of Proposed Rulemaking, 12 FCC Rcd. 18600, ¶¶ 23–25 (1997) (permitting implementation of mobile operations in the 39 GHz band).

^{7/} CTIA Comments at 14–15.

^{8/} See, e.g., 4G Americas Comments at 3–4 (authorizing existing fixed licensees to provide mobile service in the 28 GHz and 39 GHz bands “provides for expeditious development, implementation, and deployment of 5G systems in line with mobile industry expectations and similar activities worldwide.”); T-Mobile Comments at 9 (granting flexible use rights to existing licensees “is the most efficient and effective means of putting this spectrum into use for the benefit of consumers.”); Intel Comments at 3 (granting flexible use rights to existing licensees “is the most streamlined and expeditious means for completing this rulemaking and for bringing the 28 GHz band to market for mobile services.”); EchoStar Comments at 14–15.

^{9/} See, e.g., T-Mobile Comments at 9; Verizon Comments at 6; 4G Americas at 4; XO Comments at 17–18; Comments of Skyriver Communications, Inc., GN Docket No. 14-177, *et al.*, at 5 (filed Jan. 27, 2016) (“Skyriver Comments”); EchoStar Comments at 15; TIA Comments at 15–16; Nokia Comments at 15–16; Huawei Comments at 11; Intel Comments at 4.

^{10/} TIA Comments at 16; see also Nokia Comments at 15–16 (“An overlay auction could result in interference issues among existing and new licensees using the same spectrum block in a given location,” which could “needlessly delay the deployment of 5G as more complex use cases emerge that will require

deployment by creating uncertainty for holders of the overlay licenses about their interference rights and obligations vis-à-vis point-to-point and point-to-multipoint operations undertaken under the original licenses,” and it “would also undercut the expectations of the existing licensees, and would constitute a time-consuming and administratively complex project for the Commission to design, monitor, and enforce.”^{11/} Fixed and mobile services can coexist in the UMFUS bands if a *single licensee* is permitted to self-coordinate and harmonize its operations. Conversely, the introduction of a mobile licensee overlaying the existing fixed service license would create unworkable interference scenarios and impede the deployment and provision of innovative 5G mobile broadband services.

ii. *The Commission Should Use Existing Geographic License Areas for the 28 GHz and 39 GHz Bands Instead of the Proposed County-Based License Scheme*

Commenters in this proceeding almost unanimously oppose the Commission’s proposed county-based licensing scheme for the 28 GHz and 39 GHz bands.^{12/} As Straight Path previously noted, county-sized license areas will potentially reduce the utility of mmWave

5G deployment sooner rather than later.”); Intel Comments at 4 (an overlay auction would “present more challenging interference coordination between different co-channel entities, whereas a grant of mobile rights to the holder of fixed terrestrial rights would internalize that process, resulting in more manageable, efficient, and self-coordinated licenses.”); Skyriver Comments at 5 (“As the *NPRM* correctly notes, affording incumbents flexibility to provide either or both types of service alleviates ‘concerns about compatibility between fixed and mobile uses because a single licensee will be able to coordinate fixed and mobile operations while avoiding interference.’”) (quoting *NPRM* at ¶ 43); EchoStar Comments at 15 (“[S]plitting mobile and fixed rights would create complicated sharing and interference issues between the services” in the 28 GHz band).

^{11/} Verizon Comments at 6 (internal citations omitted); *see also* Intel Comments at 9 (“A direct grant of flexibility to provide both mobile and fixed operations is consistent with past Commission decisions, alleviates coordination and interference concerns compared to fixed and mobile services provided by different co-channel entities, and has been the implied outcome by the Commission dating back many years.”).

^{12/} *See, e.g.,* Straight Path Comments at 17–22; XO Comments at 20–21; Skyriver Comments at 7–11; AT&T Comments at 17–19; T-Mobile Comments at 9–10; Verizon Comments at 10–12; 4G Americas Comments at 6–8; Mobile Future Comments at 13; CTA Comments at 11; TIA Comments at 22; Ericsson Comments at 9–11; Nokia Comments at 18–19; Intel Comments at 2–4, 8; Qualcomm Comments at 7; Cisco Comments at 11–12; Comments of the Fixed Wireless Communications Coalition, GN Docket No. 14-177, *et al.*, at 4–5 (filed Jan. 27, 2016) (“FWCC Comments”).

spectrum by creating unnecessary co-channel geographic area borders, at which power levels would need to be reduced, or at which operations would require coordination with co-channel licensees.^{13/} There is a strong consensus that the proposed county-based approach would result in coordination concerns and create substantial administrative burdens on both the Commission and UMFUS licensees.^{14/} 4G Americas states that “county-based licenses would require extensive operator coordination to minimize interference issues,” and that “the Commission should minimize administrative burdens and encourage providers to invest in [mmWave] spectrum during this nascent development stage of 5G services by adopting geographic licensing areas that are larger than the proposed county-based scheme.”^{15/} Similarly, AT&T warns that “a county-based licensing approach would require extensive and burdensome interference coordination efforts as licensees would be forced to coordinate across numerous neighboring counties,” whereas larger geographic licensing units “would reduce interference coordination burdens by allowing operators to focus such efforts along the perimeters of larger service areas.”^{16/}

^{13/} See Straight Path Comments at 18–19; Letter from Davidi Jonas, President and CEO, Straight Path Communications Inc. to Marlene H. Dortch, Secretary, Federal Communications Commission, GN Docket No. 14-177, at 2 (Feb. 16, 2016).

^{14/} See, e.g., XO Comments at 20 (“With county-based licensing, there would likely be onerous border coordination scenarios in many areas, given that county borders often cut through densely populated areas”); AT&T Comments at 17–19 (“Aside from coordination obstacles, a county-based licensing regime comes with significant administrative burdens. Verifying buildout, for example, is a challenging and time-consuming endeavor when over 3,000 counties are under review.”); T-Mobile Comments at 10 (“[C]reating county licenses will increase administrative burdens on licensees and the Commission – particularly if the Commission imposes performance requirements on a county basis for a licensee with hundreds of such authorizations.”); Skyriver Comments at 1 (“The Balkanization that would result from using counties for geographic licensing would impose additional costs and regulatory burdens on licensees.”).

^{15/} 4G Americas Comments at 8–9; see also, e.g., TIA Comments at 22 (“Ultimately, county-by-county licensing would hinder investment in the UMFUS bands and chill innovation.”).

^{16/} AT&T Comments at 18–19.

Straight Path agrees with numerous commenters who recommend that the Commission maintain its current geographic license areas for the LMDS and 39 GHz bands—specifically, Basic Trading Areas (“BTAs”) in the 28 GHz band and Economic Areas (“EAs”) in the 39 GHz band.^{17/} For example, Ericsson recommends the FCC employ BTAs and EAs in the 28 GHz and 39 GHz bands because “[u]se of larger-sized geographic areas will facilitate frequency coordination among licensees, both new entrant and incumbent alike, while a move to county-based licensing would dramatically increase the need for frequency coordination among all licensees.”^{18/} Qualcomm also notes that “[l]arger geographic areas, such as BTAs and EAs, provide investment certainty that new mobile licensees need to innovate, develop, and deploy new 5G capabilities in these new mobile bands.”^{19/}

Only a few commenters support small geographic area licenses in part because they believe that mmWave spectrum will be used only for small-cell applications.^{20/} As Straight Path has previously noted, however, the key value proposition for mmWave 5G will be wide-area mobile broadband service. The Commission should not make small-cell or hot spot applications

^{17/} See, e.g., Straight Path Comments at 17–22; Skyriver Comments at 1, 7–11 (“Larger areas like BTAs and EAs afford licensees greater economies of scale than smaller geographic service areas, promote deployments in rural areas that would not be served if subject to county-based performance requirements, and minimize the operational and economic costs of interference coordination with neighboring licensees.”); Cisco Comments at 11 (“Cisco suspects that counties . . . are too small a geographic area to promote the most efficient and effective deployment in the band, and urges the Commission to retain the use of Basic Trading Areas for 28 GHz and Economic Areas for 39 GHz.”); XO Comments at 20–21; TIA Comments at 22; Ericsson Comments at 9–10; FWCC Comments at 5; Intel Comments at 2–4, 8; Qualcomm Comments at 7; Mobile Future Comments at 13; 4G Americas Comments at 6–8; Verizon Comments at 10–12.

^{18/} Ericsson Comments at 9–10.

^{19/} Qualcomm Comments at 7; see also CTA Comments at 11 (“Rather than break apart the licenses by counties and impose potentially high transaction costs on companies for reconstituting the once larger licenses, preserving the current geographic blocks would efficiently divide and encourage swift deployment of new services in these bands.”).

^{20/} See FiberTower Comments at 3, 8; Comments of Open Technology Institute and New America and Public Knowledge, GN Docket No. 14-177, *et al.* at 12 (filed Jan. 28, 2016) (“OTI/Public Knowledge Comments”).

the *de facto* use case by creating small license areas. Instead, it should adopt rules that preserve licensees' ability to provide wide-area mobile broadband service. Moreover, many of the planned 5G use cases other than mobile service would also benefit from larger geographic license areas.^{21/} For example, fixed broadband services, small cell backhaul, and high altitude platform services, will easily achieve transmission ranges well beyond one kilometer and possibly tens of kilometers—much larger than the radius of typical 4G cells today. The Commission's goal of enabling a multitude of services in the 28 GHz and 39 GHz bands would be frustrated by a county-based license scheme. Straight Path therefore reiterates its request that the Commission abandon its proposed county-based license scheme in favor of larger geographic license areas such as BTAs and EAs, which have proven to be successful for 3G and 4G cellular systems.

iii. *The Commission Should Implement a Band Plan with Larger Frequency Blocks in the 39 GHz Band and Adopt Straight Path's "Spectrum Swap" Proposal*

Straight Path encouraged the Commission to adopt a band plan with wider channelization for the 39 GHz band.^{22/} Other parties in this proceeding almost unanimously agree and request the Commission to issue 39 GHz licenses covering more spectrum than the current 50-megahertz-wide channels. Many commenters—including AT&T, CTIA, 4G Americas, the Consumer Technology Association ("CTA"), TIA, Samsung, Ericsson, Nokia, and Qualcomm—

^{21/} See Straight Path Comments at 8–14; see also, e.g., AT&T Comments at 17–19 (stating that “many of the planned 5G use cases would benefit from large licensing tracts covering densely populated areas,” and advising that “The Commission’s approach to geographic licensing areas should be consistent with the broad territorial reach of 5G services and use cases.”). While FiberTower supports the Commission’s proposal to provide county-sized UMFUS licenses to incumbent licensees, it also acknowledges that 5G mobile service radii “may sometimes cover miles instead of meters.” See FiberTower Comments at 10–11 (stating that “reach studies’ routinely issued by fixed service manufacturers show that significant capacity can sometimes be distributed over many miles in certain markets at, or below, 39 GHz.”).

^{22/} See Straight Path Comments at 22–27.

recommend band plans with channel blocks of 200 megahertz or more in the 39 GHz band.^{23/} AT&T states that “[t]he need for large channel bandwidth is driven by 5G’s technical requirements and the anticipated explosion in mobile traffic,” and ultra-wide channels of at least 200 megahertz are required because “[n]etwork densification gains and advances in spectral efficiency alone will not be sufficient to deliver ultra-high throughputs and accommodate projected demand increases[.]”^{24/} CTIA points out that the Commission itself has acknowledged that “the critical element of the millimeter wave spectrum is the ability to have access to large blocks of contiguous spectrum,” and it notes that the existing fragmented band plan for the 39 GHz band would inhibit incumbent licensees and new entrants from taking full advantage of the spectrum.^{25/} 4G Americas also recommends a minimum block size of 200 megahertz. It states: “Coupled with industry’s plans for 5G requirements for high reliability and availability and low

^{23/} See CTA Comments at 12 (recommending wide blocks of at least 200 megahertz of unpaired spectrum in the 37 GHz and 39 GHz bands to encourage deployments in these bands); Samsung Comments at 13–14 (recommending 200 megahertz building blocks in the 37 GHz and 39 GHz bands, and noting that use of the existing channelization at 39 GHz “would inhibit the ability of license holders to effectively use the spectrum in the most efficient manner as well as make interoperability with the 37 GHz band difficult.”); Ericsson Comments at 8–9 (recommending 15 exclusively-licensed 200 megahertz blocks, which should be unpaired because TDD is likely to be the technology selected at this frequency); Nokia Comments at 22–23 (stating that “400 MHz blocks would provide the right balance between the number of operators in the 28 GHz, 37 GHz and 39 GHz bands and the possibility to meet the 5G data rates without having to make the systems more complex than needed.”); Qualcomm Comments at 11 (noting that the UMFUS bands “have very wide channel bandwidths that can support compelling mobile service throughputs,” and that “Qualcomm believes that it is very important to provide wide contiguous blocks of spectrum that are at least 200 MHz wide.”); AT&T Comments at 12–14; CTIA Comments at 21–22; 4G Americas Comments at 15; TIA Comments at 29–30.

^{24/} AT&T Comments at 9–10.

^{25/} See CTIA Comments at 21–22 (citing *NPRM* at ¶ 20); see also TIA Comments at 29–30 (“The *NPRM* acknowledges the broad consensus among participants in this proceeding that at [mmWave] frequencies, wide bands are preferable to accommodate the range of services being contemplated. While some spectrum fragmentation can be overcome through the use of carrier aggregation technologies, those technologies do not yet provide the same level of spectrum efficiency as is achieved when wide blocks of contiguous spectrum are used.”) (citing *NPRM* at ¶¶ 116-18).

energy consumption for devices, a 200 MHz channelization scheme will provide for efficient use of spectrum, consistent with the Commission’s goals.”^{26/}

While a new band plan based on 200 megahertz channels is a significant step forward from the legacy 50 megahertz x 50 megahertz plan, a minimum of 400 megahertz will be needed to enable a gigabit mobile broadband experience in wide area deployment. A 200 megahertz band plan may still cause spectrum fragmentation and force operators to aggregate non-contiguous channels to enable gigabit mobile broadband services, which will significantly increase the cost of both infrastructure equipment and mobile devices. Instead, the Commission should adopt Straight Path’s three-channel band plan for the 39 GHz band with a minimum channel bandwidth of 400 megahertz.^{27/}

XO Communications claims that wider channelization could jeopardize its existing FDD links in the band.^{28/} FiberTower supports “maintaining the existing 39 GHz channel plan, as long as innovation-friendly flexibility is allowed.”^{29/} Specifically, FiberTower recommends the Commission: (i) allow licensees to exchange licenses with other licensees within a market in order to achieve larger (or smaller) contiguously held spectrum as needed, and (ii) allow licensees to operate frequency division duplexing (“FDD”) or time division duplexing (“TDD”) within a channel or a subset of a channel.^{30/} The Commission’s current band plan is based on FDD technology. The broad consensus among commenters (including XO), however, is that

^{26/} 4G Americas Comments at 14–15.

^{27/} See Straight Path Comments at 25 (proposing that the FCC divide the 39 GHz band into three channels with 400 megahertz, 500 megahertz, and 500 megahertz for each channel).

^{28/} See XO Comments at 23–24.

^{29/} See FiberTower Comments at 6 (internal citations omitted).

^{30/} See *id.*

TDD will likely be the preferred duplex scheme for 5G operations,^{31/} and the FCC’s proposed adoption of flexible duplexing rules that permit UMFUS licensees to use either TDD or FDD technology should be adequate to address XO’s concerns.^{32/} Moreover, the Commission does not propose to disturb existing licensees’ spectrum assignments; the new band plan would apply only to licenses that the Commission issues at auction. So, all incumbents, including XO and FiberTower, would be permitted to retain their current 50 megahertz x 50 megahertz licenses.

While Straight Path does not propose a mandatory reallocation of incumbent spectrum to conform to a new band plan, it recommended that the Commission conduct a voluntary, pre-auction exchange between licensees and the Commission, which would give licensees contiguous spectrum and create more valuable contiguous channel blocks for the Commission to auction.^{33/} Commenters support this proposal. Skyriver agrees that a voluntary pre-auction spectrum swap: (i) will enable incumbents to better service the market because “service providers that utilize TDD will be able to more efficiently utilize their 39 GHz spectrum if it is in a single contiguous block;” and (ii) “can result in more contiguous spectrum for the Commission to license through upcoming auctions, increasing the value of the spectrum to be auctioned and facilitating the rapid introduction of advanced service offerings.”^{34/} Nokia and Intel also support the proposal to allow incumbent 39 GHz licensees to voluntarily exchange licenses with other

^{31/} See, e.g., Straight Path Comments at 23–24, 40; XO Comments at 24–25 (“TDD will better suit the expected asymmetrical nature of mobile data usage and future 5G use cases.”); Skyriver Comments at 16–17 (“[W]e anticipate that the majority of users will opt for TDD technology. Our experience has been that customer traffic tends to be both asymmetric and bursty, and TDD technology affords the flexibility to maximize data speeds in a spectrally efficient manner.”); Cisco Comments at 9–10 (stating that TDD is likely to be the predominant technology for mobile use of the mmWave bands and requesting that the Commission “facilitate use of either [TDD or FDD] technology by making the spectrum available in unpaired blocks.”).

^{32/} See *NPRM* at ¶¶ 268–270.

^{33/} See Straight Path Comments at 25–27; see also Nokia Comments at 24; Skyriver Comments at 16–17.

^{34/} Skyriver Comments at 17.

licensees prior to auction.”^{35/} Notably, Intel correctly observes that “[e]ven if some incumbents choose not to participate in repacking, there is still value in allowing willing incumbents to elect partial repacking of the band.”^{36/} Allowing a pre-auction swap is also consistent with the creation of a new band plan with large frequency blocks. That band plan will serve as a guide during the pre-auction exchange and a fundamental reference toward which operators will be able to align their spectrum holdings over time via the spectrum auction and secondary market transactions.

B. The Commission Should Not Permit Unlicensed Use in the 28 GHz or 39 GHz Bands

Straight Path strongly disagrees with commenters who argue that spectrum in the 28 GHz and 39 GHz bands should be allocated for partially unlicensed or shared use between licensed and unlicensed systems.^{37/} Not a single hertz of mmWave has been allocated for exclusive licensed use to support the tried-and-true business model of cellular industry based on exclusively licensed spectrum. Without the 28 GHz and 39 GHz bands, there is no viable path for the cellular industry to upgrade the Nation’s mobile broadband networks to Gbps with wide-area coverage.

Many of the arguments in favor of making the 28 GHz and 39 GHz bands available for unlicensed or shared use are based on misconceptions about mmWave spectrum—specifically, the belief that the “propagation and atmospheric absorption characteristics [of bands above 24 GHz] result in shorter range communications . . . [and] provide greater opportunity for frequency

^{35/} See Nokia Comments at 24; Intel Comments at 12.

^{36/} Intel Comments at 12.

^{37/} See OTI/Public Knowledge Comments at 9–10; NCTA Comments at 9–13; Comments of Google Inc., GN Docket No. 14-177, *et al.*, at 1–4 (filed Jan. 28, 2016); Comments of Microsoft Corporation, GN Docket No. 14-177, *et al.*, at 14–18 (filed Jan. 27, 2016); Comments of Federated Wireless, Inc., GN Docket No. 14-177, *et al.*, at 14–20 (filed Jan. 27, 2016) (“Federated Wireless Comments”).

reuse without interference.”^{38/} As Straight Path has explained, mmWave 5G technologies will be capable of providing wide-area Gbps mobile broadband service, a strong and unique value proposition that will fundamentally upgrade the Nation’s broadband infrastructure. With sub-6 GHz spectrum becoming increasingly scarce and expensive, mmWave 5G is the only practical way for the Nation to realize this quantum leap in mobile broadband, both technologically and economically. Allowing unlicensed or shared use in these two bands will discourage operators and vendors when investment in this nascent and yet promising technology is needed the most. It will effectively preclude a wide area Gbps mobile broadband network deployment—losing much of the value of 5G—and result in the use of these two bands in the same way that the 57–71 GHz band will be used. However, with a large amount of unlicensed spectrum potentially available in the 57–71 GHz band (with up to 14 gigahertz of spectrum for unlicensed use), additional unlicensed or shared use in the 28 GHz and 39 GHz bands (with a total of only 2.25 gigahertz of spectrum) is unnecessary.

Certain proponents of shared use envision that the Commission can employ a Spectrum Access System (“SAS”) to facilitate use of the 28 GHz and 39 GHz bands between licensed and unlicensed users.^{39/} But an SAS that the Commission has designated for management of the 3.5 GHz band^{40/} is still not in use and remains unproven. In fact, almost a year after the Commission adopted rules incorporating SAS management of spectrum, the Commission just last month

^{38/} *NPRM* at ¶ 215; *see also, e.g.*, Federated Wireless Comments at 20.

^{39/} *See, e.g.*, OTI/Public Knowledge Comments at 11–14, 19–21, 25–26, Federated Wireless Comments at 7–20; Huawei Comments at 16–17.

^{40/} *See NPRM* at ¶ 150 (citing *Amendment of the Commission's Rules with Regard to Commercial Operations in the 3550-3650 MHz Band*, Report and Order and Second Further Notice of Proposed Rulemaking, 30 FCC Rcd. 3959 (2015)).

opened the proposal window for prospective SAS administrators.^{41/} Others agree with Straight Path’s skepticism. Intel remarks that “[u]nless and until the sharing (SAS) concept proposed in the 3.5 GHz band is proven technically and operationally under a broad range of user and usage conditions, and also proven for scalability to other bands, it should be considered an unproven experimental concept.”^{42/} CTIA also “opposes the use of a SAS for the 28 GHz spectrum band when it has yet to be tested and operated in intensively used spectrum.”^{43/}

IV. THE COMMISSION SHOULD BE CAUTIOUS WHEN PERMITTING MOBILE AND SATELLITE SERVICES IN THE SAME BAND

A. FSS Providers Have No Reasonable Expectation for Co-Primary Status in the 28 GHz Band, and there is No Basis to Preclude Mobile Services from the Band

Several operators of Fixed Satellite Service (“FSS”) systems oppose the authorization of mobile services in the mmWave bands. But claims by FSS providers regarding their need for access to the spectrum and investment in the mmWave bands are overstated. For example, the Satellite Industry Association (“SIA”) claims that “[w]hile FSS operators have planned for and reasonably expected to share the 28 GHz band, they have made decisions to invest in this spectrum in reliance on the current band plan and sharing environment.”^{44/} SIA also alleges that the allocation for FSS operations in the 28 GHz band is in fact already co-primary because “FSS

^{41/} See Wireless Telecommunications Bureau, *Wireless Telecommunications Bureau and Office of Engineering and Technology Establish Procedure and Deadline for Filing Spectrum Access System (SAS) Administrator(s) and Environmental Sensing Capability (ESC) Operator(s) Applications*, Public Notice, DA 15-1426 (Dec. 16, 2015) (establishing a filing window of January 15, 2016, through April 15, 2016, for the “first wave” of proposals from prospective SAS Administrators).

^{42/} Intel Comments at 22.

^{43/} CTIA Comments at 31–32. See also, e.g., T-Mobile Comments at 16–17 (“SAS remains an untested concept. While there are rules that permit its use in the 3.5 GHz band, there are no current SAS or similar database-driven operations.”); Samsung Comments at 22–23 (opposing increased sharing via an SAS system between FSS and terrestrial operations in the 28 GHz band because the SAS concept has not yet been deployed and demonstrated to be viable in the 3.5 GHz band).

^{44/} Comments of the Satellite Industry Association, GN Docket No. 14-177, *et al.*, at 10 (filed Jan. 28, 2016) (“SIA Comments”).

earth stations operate on a secondary basis in the band only with respect to LMDS—not with respect to any other service permitted by the Table of Frequency Allocations.”^{45/} Similarly, O3b claims that there is a “dearth of other bands available to meet growing demand for satellite services that support the broadband economy,” and claims that “satellite operators are relying on these bands to meet near term and long term requirements.”^{46/} Likewise, Inmarsat expresses concern that the proposed rule changes will “deprive Inmarsat's satellite constellation of the spectrum it needs to provide, expand, and enhance its services,” and it claims that adoption of the rules place at risk mission-critical communications, frustrate billions of dollars of investment capital sunk into advanced satellite networks, and threaten continued innovation in satellite services in the U.S. and across the globe.^{47/}

There is little factual support for the satellite industry’s claims. Multiple gigahertz of spectrum are already allocated for FSS use, including the 40.0–42.0 GHz band and the 47.2–50.2 GHz band which have never been used. There are also no satellite operations in the 39 GHz band despite an existing satellite allocation in that band, and FSS operators have not identified any anticipated offerings for the 39 GHz band that cannot be provided over other spectrum available to satellite industry. Indeed, more than a decade has passed since the Commission adopted its “soft segmentation” band sharing arrangement to “provide certainty necessary for FSS operators to begin construction” in the 37.5–40 GHz band,^{48/} and yet—as the Commission

^{45/} *Id.* at 11–12.

^{46/} Comments of O3b Limited, GN Docket No. 14-177, *et al.*, at ii (filed Jan. 28, 2016).

^{47/} See Comments of Inmarsat Mobile Networks, Inc., GN Docket No. 14-177, *et al.*, at 1–2 (filed Jan. 28, 2016).

^{48/} See *Allocation and Designation of Spectrum for Fixed Satellite Services in the 37.5-38.5 GHz, 40.5-41.5 GHz and 48.2-50.2 GHz Frequency Bands; Allocation of Spectrum to Upgrade Fixed and Mobile Allocations in the 40.5-42.5 GHz Frequency Band; Allocation of Spectrum in the 46.9-47.0 GHz Frequency Band for Wireless Services; and Allocation of Spectrum in the 37.0-38.0 GHz and 40.0-40.5 GHz for Government Operations*, Second Report and Order, 18 FCC Rcd. 25428, ¶¶ 1–3, 23–24 (2003);

recognizes—there are currently no non-Federal FSS authorizations or pending applications in the 39 GHz band.^{49/} While there has been a rulemaking proceeding pending covering potential further changes to the use of the 39 GHz band for satellite services for more than five years,^{50/} the satellite industry has made little effort to urge the Commission to conclude that proceeding. Having made little effort—because of its limited need for the spectrum—to resolve whatever regulatory uncertainty may have existed before, the satellite industry must not now be permitted to stand in the way of allowing flexible use of this critical band. If the demand for satellite spectrum was dire, then FSS operators should have expressed that need in the other proceeding instead of now, as an impediment to the Nation taking the lead in dedicating spectrum for 5G operations.

Moreover, the Commission should not preclude mobile use in the 28 GHz band solely because of FSS operators’ secondary use of the spectrum. Satellite providers invested in their operations in the band with full knowledge of their secondary status and thus have no reasonable expectation regarding access to this spectrum. The fact that satellite operations will be secondary to mobile *and* fixed use is no reason to prevent mobile use. To the contrary, as discussed above, the Commission specifically contemplated the eventual grant of mobile rights

see also 47 C.F.R. § 25.208(r) (establishing power flux density limits for FSS space stations in the 37.5–40.0 GHz band).

^{49/} See *NPRM* at ¶¶ 38, 44 (“Unlike in 28 GHz, there are no current commercial satellite operations in the 39 GHz band Furthermore, while several commenters express interest in using V-band to provide satellite service, no commenter expresses any concrete intention to provide such service.”).

^{50/} See *Allocation and Designation of Spectrum for Fixed-Satellite Services in the 37.5-38.5 GHz, 40.5-41.5 GHz and 48.2-50.2 GHz Frequency Bands; Allocation of Spectrum to Upgrade Fixed and Mobile Allocations in the 40.5-42.5 GHz Frequency Band; Allocation of Spectrum in the 46.9-47.0 GHz Frequency Band for Wireless Services; and Allocation of Spectrum in the 37.0-38.0 GHz and 40.0-40.5 GHz for Government Operations*, Third Further Notice of Proposed Rulemaking, 25 FCC Rcd. 15663 (2010).

in the band at the time it auctioned the spectrum.^{51/} Any claim that satellite operators could not have predicted potential mobile use of the band is therefore disingenuous. Incumbent LMDS licensees in the 28 GHz band made significant investments to acquire spectrum and obtain primary status in the band. Unlike FSS providers, these incumbent licensees *do* have a reasonable expectation of priority access to this spectrum.

B. It is Feasible for FSS to Coexist with Flexible Use Services in the 28 GHz Band

The Commission proposes a market-based mechanism that would enable satellite users to obtain terrestrial licenses in the 28 GHz band, either at auction or through the secondary market, in order to achieve co-primary status.^{52/} Commenters representing a wide variety of interests support the Commission’s market-based proposal regarding satellite use at 28 GHz.^{53/} Satellite providers have generally rejected the opportunity to acquire primary status, arguing instead for the Commission to elevate individually licensed FSS earth stations in the 28 GHz band to co-primary status.^{54/} EchoStar further proposes that the Commission grandfather gateway earth stations licensed prior to auction of terrestrial licenses and supports co-primary sharing criteria for satellite and terrestrial systems deployed thereafter.^{55/} It argues that use of auction-based process and/or secondary markets will not adequately protect reasonable expectations of FSS

^{51/} See *supra* note 6.

^{52/} See *NPRM* at ¶ 33.

^{53/} See, e.g., T-Mobile Comments at 16–17 (agreeing that FSS operators may acquire primary protection in 28 GHz band only by participating in auction or through secondary market, and “[t]here is no basis for the Commission to permit current 28 GHz earth station operators—that have only secondary status today—to simply elect primary status.”); Verizon Comments at 23; CTIA Comments at 14; Mobile Future Comments at 14; XO Comments at 32–35; FiberTower Comments at 7; ITI Comments at 6; CTA Comments at 16; TIA Comments at 7–12; Samsung Comments at 20–23; Ericsson Comments at 20–22; Nokia Comments at 24–25; Cisco Comments at 5–7; Intel Comments at 5–7.

^{54/} See, e.g., SIA Comments at 18–19; EchoStar Comments at 15–22; Comments of ViaSat, Inc., GN Docket No. 14-177, *et al.*, at 14–16 (filed Jan. 28, 2016) (“ViaSat Comments”); Comments of SES Americom Comments, GN Docket No. 14-177, *et al.*, at 8–12 (filed Jan. 28, 2016).

^{55/} See EchoStar Comments at 7, 15–22.

gateway operators in 28 GHz band, and that it unnecessarily implicates the ORBIT Act, which prohibits the Commission from using competitive bidding to license spectrum used for the provision of international or global satellite communications services.^{56/}

If satellite providers wish to preserve the significant investments they claim to have made, then they should embrace the Commission’s plan. Unlike granting incumbent licensees mobile rights, satellite users have no reasonable expectation of primary operating status, and the Commission should not give that to them now. Participating in the auction or secondary markets will not implicate the ORBIT Act. As the Commission explained, it would not grant satellite rights through the auction process; rather, it would provide satellite users an opportunity to acquire spectrum for interference protection purposes.^{57/} In fact, satellite licensees would still be required to obtain an authorization under Part 25 to operate earth stations.^{58/}

In any event, there is no technical reason that satellite operators cannot continue to operate on a secondary basis. FSS operators use the 28 GHz band for uplink operations and should experience no meaningful interference from lower-powered terrestrial stations.

^{56/} See *id.* at 22–24.

^{57/} The Commission proposes that a Part 25 FSS earth station would have co-primary status if its licensee also holds the corresponding terrestrial license for the location of that earth station (i.e., by participating in a Commission auctions or by purchasing them from existing UMFUS licensees), and that “future FSS operators can obtain Upper Microwave Flexible Use licenses at auction to eliminate potential interference concerns with terrestrial operations in their areas.” See *NPRM* at ¶¶ 129–146. It emphasizes, however, that an UMFUS license would not authorize operations of the FSS Earth Stations. *Id.* at ¶ 134. “Accordingly, the fact that the Upper Microwave Flexible Use licenses would be subject to auction would not be contrary to Section 647 of the Open-market Reorganization for the Betterment of International Telecommunications Act, which states, ‘the Commission shall not have the authority to assign by competitive bidding orbital locations or spectrum used for the provision of international or global satellite communications services.’” *Id.* (citing 47 U.S.C. § 765(f)).

^{58/} See *id.* at ¶ 134 (“The licensing of earth stations would continue to be governed by our Part 25 licensing rules.”).

C. The Commission Must Limit FSS Operations to Allow UMFUS to Succeed in the 39 GHz Band

In response to the Commission’s request for comment on issues relating to FSS use of the 39 GHz band,^{59/} EchoStar claims that there is “no concern that FSS operations in the 39 GHz band will cause harmful interference to fixed or mobile terrestrial systems.”^{60/} Straight Path disagrees and remains concerned that practical and technological limitations will make it difficult for mobile services and satellite downlink operations to operate in same band. Other commenters agree that the Commission should not permit FSS usage in the 39 GHz band if it would harm terrestrial UMFUS service.^{61/} CTA states that if the Commission continues to permit FSS operations in the 37.5–40 GHz bands, then “those operations should function on a secondary basis, accepting all interference from terrestrial operations.”^{62/} Ericsson also “urges the Commission not to adopt any rule changes that would disadvantage terrestrial UMFUS service.” T-Mobile states that “the Commission should retain the current rules requiring an FSS licensee to obtain a 39 GHz license in the area where an earth station will be located, or to enter into an agreement with the corresponding 39 GHz licensee, in order to deploy a gateway receive-only earth station.”^{63/}

^{59/} See *id.* at ¶¶ 160–165.

^{60/} EchoStar Comments at 27–28.

^{61/} See, e.g., T-Mobile Comments at 17–18; Ericsson Comments at 23–24; Samsung Comments at 20–23; Cisco Systems Comments at 6–7; TIA Comments at 13–14; CTA Comments at 17; see also Facebook Comments at 5 (“Facebook supports facilitating sharing between satellite operators and users of the new Upper Microwave Flexible Use service that will allow for the coexistence of satellite earth stations without harm to new mobile deployments in the millimeter wave bands.”).

^{62/} CTA Comments at 17.

^{63/} T-Mobile Comments at 17–18; see also TIA Comments at 1 (stating that FSS licensees should be permitted to continue existing operations and to add FSS user stations in the 37 GHz and 39 GHz bands on a secondary basis, and should “at their sole election, be permitted to operate solely on a secondary basis, or enter into private agreements with terrestrial licensees that provide greater flexibility, or secure terrestrial operating rights that allow them to operate without interference to or from other terrestrial users.”).

ViaSat claims that increasing the power limits for space-to-earth transmissions could allow satellite operators to use this spectrum more effectively without impacting terrestrial users.^{64/} Straight Path disagrees with this contention as well. While any satellite use of the 39 GHz band will degrade terrestrial UMFUS operations, permitting increased power to accommodate rain fade would be devastating.^{65/} First, allowing increased power levels by satellite will interfere with terrestrial operations not only in the limited areas where rain is falling, but throughout the large geographic area—potentially affecting multiple licensees and networks—covered by the satellite spot beams. Second, allowing increased power flux density (“PFD”) levels by satellite would severely impact—and potentially disrupt—many of the flexible use services that this proceeding aims to enable, including mobile services, backhaul services, and high altitude platform services.^{66/} The threat of such strong interference over a large area of the network would significantly discourage operators from investing in building a 5G network in this band, potentially negating much of the effort to enable 5G services in the spectrum. Finally, permitting increased PFD will also negatively impact FSS in this band. FSS providers must acquire a terrestrial license in order to operate a ground gateway stations in the 37–40 GHz band. In the presence of such strong potential interference over a large geographic area, terrestrial licensees will be highly discouraged to accommodate a FSS ground gateway station with a small exclusion zone in the secondary market. Instead, potentially increased PFD will likely mean FSS

^{64/} See ViaSat Comments at 19–21.

^{65/} See T-Mobile Comments at 17–18 (stating that satellite operators should not be allowed to increase their PFD limit during heavy rain); *see also* FiberTower Comments at 5–7 (recommending that space-to-earth operations must fit within known “soft-segmentation” PFD limits to avoid interfering with neighboring terrestrial operations, and any proposed changes to PFD limits should undergo publicly accessible and reviewable trials).

^{66/} See Straight Path Comments at 35 (“If the PFD limit of FSS is increased to -105 dBW/m²/MHz, with three satellites in the sky, our analysis shows that the coverage area reduction to 5G mobile services, in-band backhaul, and HAPS will be 15%, 30%, and 80%.”).

operators will be required to acquire terrestrial licenses to cover all the areas under the spot beam with increased PFD in order to operate a ground gateway station.

V. LICENSING, OPERATIONS, AND PERFORMANCE RULES

i. *Performance Requirements*

Commenters recognize that 5G use cases may require a flexible and innovative approach to performance rules in the mmWave bands.^{67/} For instance, Intel recommends that the FCC consider a performance requirement framework consisting of several elective categories, each flexibly defined, and each containing a safe harbor within its set of requirements.^{68/} Under Intel’s proposal, licensees would choose the best-fit category for the services they are deploying, subject to FCC challenge.^{69/} CTIA and others suggest that it is more appropriate to base performance metrics on usage and/or service levels than on census data, and that the metrics must be flexible, reflect the diversity of 5G applications being discussed, and account for the fact that the business models supporting small cell deployments are just beginning to emerge.^{70/} XO proposes that the FCC require only 20% population coverage for UMFUS licenses, with the possibility of revisiting this coverage requirement once 5G mobile technology has matured.^{71/}

^{67/} See Mobile Future Comments at 15 (“Traditional performance requirements are unnecessary if the Commission adopts truly flexible secondary-market policies that allow parties to enter into leasing and other arrangements without a cumbersome regulatory approval process.”); see also AT&T Comments at 22–23 (“At this early stage in the development of 5G, if the Commission believes it must adopt performance requirements, AT&T suggests that the flexibility inherent in a ‘substantial service’ approach may be appropriate—especially coupled with safe harbors recognizing the state of overall 5G progress.”).

^{68/} See Intel Comments at 23–25.

^{69/} See *id.*

^{70/} See CTIA Comments at 23–26; see also Nokia Comments at 19–20 (recommending that the FCC adopt performance metrics based on network usage and/or service levels); Cisco Comments at 12–14 (same).

^{71/} See XO Comments at 20–22.

Straight Path supports adoption of a reasonable and flexible performance framework with a variety of safe harbor options in lieu of strict performance requirements.

The Commission also seeks comment on a “use-or-share” proposal that would require licensees to make unused portions of a license area available for shared use after five years.^{72/} The vast majority of commenters representing a variety of different interests (including wireless carriers, millimeter wave providers, equipment manufacturers, technology companies, and other parties) uniformly oppose the use-or-share obligation,^{73/} which is inconsistent with flexible performance requirements and could potentially undermine other FCC objectives. For example, CTIA states that it opposes “any form” of use-or-share requirements for the UMFUS for the following reasons:

Given the nascent nature of technology available for the millimeter wave spectrum bands, it is entirely premature to require licensees – who have made considerable investments in spectrum acquisition – to share their spectrum. These licensees will require unfettered access to their licensed service area to test equipment and services. Requiring licensees to share their spectrum with other uses while deploying or expanding their networks would undermine and/or delay the provision of service.^{74/}

ATT also opposes the use-or-share proposal, which it says would “inject unnecessary complexity into the already arduous task of deploying 5G networks” and “could jeopardize the commercial viability of the UMFUS spectrum.”^{75/} AT&T rightly notes that “for licensees to invest in both the licenses and infrastructure needed to bring 5G to bear, they must have certainty that they will be able to freely and fully access their licensed spectrum without interference.”^{76/}

^{72/} See *NPRM* at ¶¶ 215–217.

^{73/} See, e.g., AT&T Comments at 20–22; Verizon Comments at 20–21; CTIA Comments at 26–27; Mobile Future Comments at 15–16; Nokia Comments at 19–20; Qualcomm Comments at 12–14; Intel Comments at 20–22; XO Comments at 29–32; HTSC Comments at 4–5.

^{74/} CTIA Comments at 26.

^{75/} AT&T Comments at 20–22.

^{76/} *Id.*

A few commenters, including Facebook, Federated Wireless, and OTI/Public Knowledge, support the proposed use-or-share obligation.^{77/} Facebook suggests that the requirement would “motivate” licensees in the mmWave bands to use the spectrum “promptly and efficiently.”^{78/} On the contrary, burdensome sharing requirements would likely complicate or delay the deployment of mmWave services and discourage investment in the bands.^{79/} Licensees have made already considerable investments in acquiring spectrum rights, and any non-licensee party seeking to use licensed spectrum should do so through secondary market mechanisms such as leases or other negotiated terms.^{80/} The marketplace provides ample motivation for licensees to make the maximum use of their spectrum as quickly as possible.

ii. *Security Issues*

The Commission seeks comment on how to ensure that effective security features are built into key design principles for all mmWave band communications devices and networks.^{81/} TIA comments that “rules addressing network security issues should be considered in a more appropriate proceeding.”^{82/} CTIA also suggests that “this proceeding is not the proper venue for consideration of security issues,” and “the Commission should defer consideration of such

^{77/} See Facebook Comments at 6–7; Federated Wireless Comments at 20; OTI/Public Knowledge Comments at 5, 20–21, 25–27.

^{78/} See Facebook Comments at 6–7.

^{79/} See, e.g., CTIA Comments at 27 (“[L]icensees will require unfettered access to their licensed service area to test equipment and services. Requiring licensees to share their spectrum with other uses while deploying or expanding their networks would undermine and/or delay the provision of service. Instead, licensees that have met the performance requirement or substantial service threshold should not be subject to any additional sharing of their licensed spectrum.”).

^{80/} See, e.g., Intel Comments at 20–22 (“The solution is clear: a non-licensee party interested in using a partition of a licensee’s spectrum should seek to lease the spectrum (or some other negotiated terms of use). Indeed, that is the scenario underpinning secondary market leasing, and as such, a use-it-or-share-it mandate undercuts the efficient operation of secondary markets.”); CTIA Comments at 26–27; XO Comments at 29–30.

^{81/} NPRM at ¶ 261.

^{82/} TIA Comments at 35.

matters to a broader, more holistic proceeding that can better evaluate security issues across the mobile ecosystem.”^{83/} Straight Path agrees. Security is important in network infrastructure, applications, and services. Equipment vendors, network operators, application developers, and service providers will all have business interests to provide security and protection against theft and privacy intrusion in the products and services they provide. Nevertheless, because there are so many elements in a broadband network, and a vast number of entities, applications and services are involved, it will be problematic to simply mandate a security obligation on a single entity. Consequently, Straight Path agrees with TIA and CTIA that the Commission should defer consideration of security concepts to a more appropriate proceeding.

VI. TECHNICAL RULES

A. Transmission Power Limits

Base Stations. The Commission requests comment on whether a higher transmission power limit should be considered for the in-band application where the same equipment is used for mobile service and backhaul service.^{84/} Straight Path recommended that the FCC retain the same EIRP limit for mobile services and in-band backhaul services that use the same equipment.^{85/} For backhaul services using high-gain dish antennas, Straight Path recommended that the maximum EIRP limit of 85 dBm for fixed services should apply.^{86/} Equipment manufacturers, wireless carriers, and millimeter wave providers generally support higher power

^{83/} CTIA Comments at 34.

^{84/} *NPRM* at ¶ 276.

^{85/} Straight Path Comments at 40.

^{86/} *Id.*

limits for base stations.^{87/} The performance and range of 5G systems will be further enhanced if the base station EIRP is increased. While Straight Path initially suggested that 65 dBm EIRP could be practically achieved using the circuit technology today, we also recognize that the technology may be further improved and lead to higher achievable EIRP.

A base station EIRP limit of 82 dBm/100 MHz may not be required, however. In a recent *ex parte* filing, Nokia provided simulation results to compare the performance of 5G deployments with different EIRP values (62 dBm/100 MHz versus 85 dBm regardless of bandwidth).^{88/} The simulated system performed poorly when indoor users with high penetration loss were added.^{89/} The antenna configuration assumed at user equipment was minimal (two cross-polarized omnidirectional antennas),^{90/} which will not be the typical antenna design for 5G mobile stations. In addition, although Nokia's filing did not provide all system configuration details, we suspect that the path loss for cell edge users might be overly pessimistic due to the combined effect of the non-line-of-sight ("NLOS") path loss formula and the high penetration loss assumption, together resulting in path loss for the cell edge user well beyond the 160 dB link budget that typical 5G systems would likely aim to support. Straight Path suggests a middle ground of 72 dBm/100 MHz (and 75 dBm/100 MHz in rural areas) as the base station EIRP limit. These values should be adequate even for macro cell deployment of mmWave technologies with a cell radius expanding to a few kilometers. Beyond that, if further range or

^{87/} See, e.g., TIA Comments at 32–33; Nokia Comments at 26–28; Samsung Comments at 18–19; Qualcomm Comments at 16–17; T-Mobile Comments at 19–20; Verizon Comments at 16–17; FiberTower Comments at 10–11; XO Comments at 21.

^{88/} See Letter from Jeffrey A. Marks, Government Relations, Nokia to Marlene H. Dortch, Secretary, Federal Communications Commission, GN Docket No. 14-177, *et al.* at Attachment 2, "5G Study: Simulation Results with different TX Powers & Bandwidths" (Feb. 18, 2016).

^{89/} See *id.* at Attachment 2, *10, 13.

^{90/} See *id.* at Attachment 2, *2.

throughput is desired, then vendors should resort to technical solutions such as increasing the antenna array size and gain and improving the noise figure at the mobile station.

Mobile Stations. The Commission tentatively adopts Straight Path’s recommendation for a 43 dBm maximum peak EIRP for mobile stations in the UMFUS bands.^{91/} Several commenters, including XO and Samsung, recommend a higher transmit power for mobile stations (i.e., 85 dBm).^{92/} Straight Path does not believe 85 dBm should be allowed for mobile devices, especially for devices that can be used in contact with the human body. Nokia also provided simulation results for uplink and demonstrated that the uplink throughput is poor with 43 dBm EIRP. For reasons similar to those noted above (two omnidirectional antennas at user equipment, possible path loss far exceeding 160 dB link budget), we suspect these simulation results are overly pessimistic and may not represent the performance of mmWave 5G systems with typical link budget.

Customer Premises Equipment. Samsung, Nokia, Qualcomm, and Verizon recommend that the Commission develop a power limit classification for customer premises equipment (“CPE”) that is transportable—not mobile—and would operate at a higher power than mobile equipment but lower than base stations.^{93/} Straight Path supports this proposal. These devices can enable Gbps broadband access to homes and enterprises, and possibly other deployment scenarios, such as relay stations for high speed trains in the mmWave bands. For this class of devices, Straight Path suggests an EIRP limit of 53 dBm. On one hand, 53 dBm will significantly improve the uplink throughput of the device, allowing more than 200 Mbps uplink

^{91/} *NPRM* at ¶ 279.

^{92/} *See* XO Comments at 25–27; Samsung Comments at 19.

^{93/} *See* Samsung Comments at 19; Nokia Comments at 26–28; Qualcomm Comments at 16–17; Verizon Comments at 16–17.

throughput at cell edge.^{94/} On the other hand, these devices should be generally safe because the free space loss within 1.25 meters will reduce the power density to less than 1 mW/cm² even along the direction of the peak EIRP. As an additional precaution, Straight Path recommends that these units be placed outdoors to minimize RF exposure.

B. Interoperability

The Commission seeks comment on its proposal to require that mobile equipment operating within each mmWave band be interoperable using all air interfaces that the equipment utilizes on the frequencies.^{95/} Equipment manufacturers and wireless carriers generally oppose the adoption of interoperability requirements between different technologies.^{96/} Samsung contends that such a requirement would be “too burdensome for developers who cannot be sure what technologies may be developed in these spectrum bands,”^{97/} and Huawei recommends that the Commission allow standards to develop through industry processes.^{98/} CTIA and Nokia ask for clarification of the proposed interoperability requirements.^{99/}

By way of clarification, Straight Path does not contend that it would be feasible for devices to interoperate in mmWave bands if they use different air interfaces. While Straight Path supports a requirement that devices operate across, for example, the entire 39 GHz band, there is no reason (and indeed it would be technically impractical) to impose a requirement that each

^{94/} See *infra* Appendix A, “Link Budget Analysis of 5G systems at 39 GHz in New York City, University of Texas Campus, and Rural Areas.”

^{95/} *NPRM* at ¶ 296.

^{96/} See Samsung Comments at 19–20; Qualcomm Comments at 16–17; Huawei Comments at 27–28; Ericsson Comments at 17; T-Mobile Comments at 19–20; Verizon Comments at 16–17.

^{97/} See Samsung Comments at 19–20.

^{98/} See Huawei Comments at 27–28.

^{99/} See CTIA Comments at 27–30; Nokia Comments at 29–30.

device in the band interoperate with every other, regardless of the platform used. That obligation does not exist today for mobility applications and should not exist for mmWave bands.

C. Limits on Terrestrial Emissions

The Commission asks for comment on whether a radiated emission limit of -13 dBm/MHz can be supported by 5G transmitters operating in the licensed mmWave bands, and if so, the resolution bandwidth and frequency offset that should be considered to define out-of-band emissions (“OOBE”) and spurious emissions.^{100/} Ericsson proposes that the Commission measure unwanted emissions based on Total Radiated Power (“TRP”) rather than EIRP—which it says is not suited for the advanced antenna designs that will be necessary for 5G arrays—and believes that -13 dBm/MHz would be feasible with TRP as the metric for unwanted emissions.^{101/} Straight Path agrees with Ericsson that TRP-based emission limits could be adopted if conducted power from a large number of power amplifiers can be measured. However, it remains unclear how conducted measurement can be achieved for transceivers with power amplifiers and antennas integrated on a single printed circuit board, which we expect will be one of the main form factors for 5G transceivers. For those transceivers, EIRP-based measurements are more practical. Regardless, Straight Path agrees with Ericsson on the emission limit of -13 dBm/MHz. Straight Path also supports Ericsson’s proposal of reducing the number of test points by scaling the measurement bandwidth according to frequency.^{102/}

D. Equipment Authorization

The Commission seeks comment on the factors it should take into account when developing guidance to evaluate consumer portable devices operating at frequencies above 6

^{100/} *NPRM* at ¶ 286.

^{101/} *See* Ericsson Comments at 13–17.

^{102/} *See id.* at 16.

GHz intended to be held against the head or close to the body during normal use.^{103/} Straight Path recommended that the Commission follow Maximum Permissible Exposure limits that are in line with the recommended guidelines by the International Commission on Non-Ionizing Radiation Protection (“ICNIRP”).^{104/} Qualcomm also encourages the Commission to align RF exposure assessment techniques with ICNIRP guidance and ANSI/IEEE standards,^{105/} and TIA and Nokia suggest that the Commission should consider adopting IEEE C95.1-2005, as updated by IEEE C95.1a-2010, as the applicable RF exposure standard.^{106/} Straight Path supports these proposals to adopt of industry standards for RF exposure limits, and the Commission need not develop new standards in this proceeding. The existing standards to which Qualcomm, TIA, and Nokia cite are internationally developed and accepted. To the extent that there are 5G applications that those standards do not contemplate, the Commission can evaluate other exposure standards at that time. At this time, however, there is no basis for the Commission to develop new standards for the mmWave bands.

VII. CONCLUSION

Straight Path continues to applaud the Commission’s efforts to make the United States the leader in 5G mmWave technology. The record is clear that in order to do accomplish its mission, the Commission should act quickly to grant flexible use rights to incumbent licensees in the 28 GHz and 39 GHz bands. Commenters also almost unanimously agree that the Commission should abandon its proposal to issue county-wide licenses, however, and Straight Path and other parties urge the Commission to adopt a licensing scheme that reflects existing

^{103/} *NPRM* at ¶ 323.

^{104/} *See* Straight Path Comments at 44–45.

^{105/} *See* Qualcomm Comments at 18–20.

^{106/} *See* TIA Comments at 35; Nokia Comments at 30–31.

geographic service areas in the 28 GHz and 39 GHz bands. Moreover, the record also shows broad support for a band plan with wider channelization in the 39 GHz band. Straight Path and other commenters encourage the Commission to consider potential interference scenarios and to take a cautious approach when permitting both mobile and satellite services in the same bands, and strongly oppose any increase to FSS power levels in the 39 GHz band. Finally, Straight Path echoes other commenters' support for flexible performance standards and technical rules in order to promote the development and rapid deployment of innovative 5G mobile broadband technologies and services.

Respectfully submitted,

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Appendix A

Link Budget Analysis of 5G systems at 39 GHz in New York City, University of Texas Campus, and Rural Areas

Table 1. 39 GHz 5G System Link Budget (New York City)^{107/}

5G mobile service link budget	Downlink O2O	Uplink O2O	Uplink O2O (CPE)	Downlink O2I	Uplink O2I
PA output power (dBm)	21	21	20	21	21
Number of PAs	256	8	16	256	8
Total output power (dBm)	45	30	32	45	30
Number of Tx antenna element	1024	8	64	1024	8
Tx antenna element gain (dB)	6	6	6	6	6
Antenna & feed network loss (dB)	3	2	3	3	2
Total Tx antenna array gain (dB)	33	13	21	33	13
EIRP (dBm)	78.19	43.06	53.10	78.19	43.06
Inter-Site Distance (m)	500	500	500	200	200
Path loss = $64.3 + 34\log_{10}(d)$ (dB)	147.95	147.95	147.95	134.42	134.42
Additional Loss (Penetration, blocking, etc.)	10.00	10.00	10.00	30.00	30.00
Received power (dBm)	-79.77	-114.89	-104.85	-86.24	-121.36
Bandwidth (MHz)	400	400	400	400	400
Thermal noise (dBm)	-87.98	-87.98	-87.98	-87.98	-87.98
Noise Figure (dB)	5.00	5.00	5.00	5.00	5.00
SNR (dB) per Rx antenna element	3.21	-31.91	-21.87	-3.26	-38.38
Number of Rx antenna element	8	1024	1024	8	1024
Rx antenna element gain (dB)	6	6	6	6	6
Rx antenna feed network loss (dB)	2	3	3	2	3
Total Rx antenna array gain (dB)	13	33	33	13	33
SNR after beamforming (dB)	16.24	1.19	11.23	9.77	-5.28
Implementation loss (dB)	3.00	3.00	3.00	3.00	3.00
Number of MIMO streams	1	1	1	1	1
Spectral efficiency (bit/channel use)	4.47	0.73	2.94	2.52	0.20
System overhead	40%	40%	40%	40%	40%
Duty cycle	62.50%	37.50%	37.50%	62.50%	37.50%
Throughput (Mbps)	669.85	65.75	264.28	378.73	17.99

^{107/} 160 dB link budget assumed. “O2O” stands for “outdoor-to-outdoor”. “O2I” stands for “outdoor-to-indoor”. Additional loss of 10 dB and 30 dB are assumed for O2O and O2I cases, respectively.

Table 2. 39 GHz 5G System Link Budget (University of Texas at Austin Campus)^{108/}

5G mobile service link budget	Downlink O2O	Uplink O2O	Uplink O2O (CPE)	Downlink O2I	Uplink O2I
PA output power (dBm)	21	21	20	21	21
Number of PAs	256	8	16	256	8
Total output power (dBm)	45	30	32	45	30
Number of Tx antenna element	1024	8	64	1024	8
Tx antenna element gain (dB)	6	6	6	6	6
Antenna & feed network loss (dB)	3	2	3	3	2
Total Tx antenna array gain (dB)	33	13	21	33	13
EIRP (dBm)	78.19	43.06	53.10	78.19	43.06
Inter-Site Distance (m)	3100	3100	3100	900	900
Path loss = $64.3 + 23\log_{10}(d) + 6d/1000$ (dB)	149.85	149.85	149.85	129.88	129.88
Additional loss (penetration, blocking, etc.)	10.00	10.00	10.00	30.00	30.00
Received power (dBm)	-81.67	-116.79	-106.75	-81.69	-116.82
Bandwidth (MHz)	400	400	400	400	400
Thermal noise (dBm)	-87.98	-87.98	-87.98	-87.98	-87.98
Noise Figure (dB)	5.00	5.00	5.00	5.00	5.00
SNR (dB) per Rx antenna element	1.31	-33.81	-23.77	1.29	-33.84
Number of Rx antenna element	8	1024	1024	8	1024
Rx antenna element gain (dB)	6	6	6	6	6
Rx antenna feed network loss (dB)	2	3	3	2	3
Total Rx antenna array gain (dB)	13	33	33	13	33
SNR after beamforming (dB)	14.34	-0.71	9.33	14.32	-0.73
Implementation loss (dB)	3.00	3.00	3.00	3.00	3.00
Number of MIMO streams	1	1	1	1	1
Spectral efficiency (bit/channel use)	3.87	0.51	2.41	3.86	0.51
System overhead	40%	40%	40%	40%	40%
Duty cycle	62.50%	37.50%	37.50%	62.50%	37.50%
Throughput (Mbps)	580.52	46.05	216.48	579.35	45.83

^{108/} 160 dB link budget assumed. “O2O” stands for “outdoor-to-outdoor”. “O2I” stands for “outdoor-to-indoor”. Additional loss of 10 dB and 30 dB are assumed for O2O and O2I cases, respectively.

Table 3. 39 GHz 5G System Link Budget (Rural Areas)^{109/}

5G mobile service link budget	Downlink O2O	Uplink O2O	Uplink O2O (CPE)	Downlink O2I	Uplink O2I
PA output power (dBm)	21	21	20	21	21
Number of PAs	256	8	16	256	8
Total output power (dBm)	45	30	32	45	30
Number of Tx antenna element	1024	8	64	1024	8
Tx antenna element gain (dB)	6	6	6	6	6
Antenna & feed network loss (dB)	3	2	3	3	2
Total Tx antenna array gain (dB)	33	13	21	33	13
EIRP (dBm)	78.19	43.06	53.10	78.19	43.06
Inter-Site Distance (m)	5000	5000	5000	2000	2000
Path loss = $64.3 + 20\log_{10}(d) + 6d/1000$ (dB)	150.83	150.83	150.83	132.48	132.48
Additional loss (penetration, blocking, etc.)	10.00	10.00	10.00	30.00	30.00
Received power (dBm)	-82.64	-117.77	-107.73	-84.29	-119.42
Bandwidth (MHz)	400	400	400	400	400
Thermal noise (dBm)	-87.98	-87.98	-87.98	-87.98	-87.98
Noise Figure (dB)	5.00	5.00	5.00	5.00	5.00
SNR (dB) per Rx antenna element	0.34	-34.79	-24.75	-1.31	-36.44
Number of Rx antenna element	8	1024	1024	8	1024
Rx antenna element gain (dB)	6	6	6	6	6
Rx antenna feed network loss (dB)	2	3	3	2	3
Total Rx antenna array gain (dB)	13	33	33	13	33
SNR after beamforming (dB)	13.37	-1.68	8.36	11.72	-3.33
Implementation loss (dB)	3.00	3.00	3.00	3.00	3.00
Number of MIMO streams	1	1	1	1	1
Spectral efficiency (bit/channel use)	3.57	0.42	2.15	3.08	0.30
System overhead	40%	40%	40%	40%	40%
Duty cycle	62.50%	37.50%	37.50%	62.50%	37.50%
Throughput (Mbps)	535.60	38.01	193.34	461.69	27.16

^{109/} 160 dB link budget assumed. “O2O” stands for “outdoor-to-outdoor”. “O2I” stands for “outdoor-to-indoor”. Additional loss of 10 dB and 30 dB are assumed for O2O and O2I cases, respectively.