

**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 Operation)	IB Docket No. 97-95

REPLY COMMENTS OF T-MOBILE USA, INC.

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October 31, 2016

TABLE OF CONTENTS

I. INTRODUCTION AND SUMMARY2

II. ADDITIONAL SPECTRUM IS REQUIRED FOR LICENSED SERVICES.....3

 A. The Commission Should Make the Target Bands Available for Licensed Services
 Now3

 B. The Commission Should Consider Making Additional Spectrum – Not Specified in
 the *FNPRM* – Available for Licensed Terrestrial Mobile Use10

 C. The Commission Should Regard with Skepticism Satellite Industry Claims of
 Insufficient Capacity12

III. TERRESTRIAL SPECTRUM SHOULD BE LICENSED ON AN EXCLUSIVE,
NON-SHARED BASIS14

 A. The Commission Should Limit Shared Use of Millimeter Wave Spectrum by Satellite
 Users14

 B. The Commission Should Reject Sharing Approaches Such as an SAS or Use-It-or-
 Share-It.....20

IV. THE RECORD SUPPORTS DESIGNATING THE BANDS IDENTIFIED BY THE
COMMISSION FOR EXCLUSIVE TERRESTRIAL USE.....23

V. THERE IS BROAD AGREEMENT ON TERMS OF CARRIER USE OF SPECTRUM29

VI. CONCLUSION.....33

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REPLY COMMENTS OF T-MOBILE USA, INC.

T-Mobile USA, Inc. (“T-Mobile”)^{1/} submits these reply comments in response to the comments of other parties on the Further Notice of Proposed Rulemaking (“*FNPRM*”)^{2/} in the

^{1/} T-Mobile USA, Inc. is a wholly-owned subsidiary of T-Mobile US, Inc., a publicly traded company.

above-referenced proceedings, in which the Commission seeks comment on (i) making an additional 17.7 gigahertz of spectrum in the bands above 24 GHz available for the deployment of fifth generation (“5G”) mobile wireless technologies, and (ii) various refinements to the rules adopted in the *Report and Order*.^{3/}

I. INTRODUCTION AND SUMMARY

T-Mobile commends the Commission’s efforts in this proceeding to make additional millimeter wave spectrum available for licensed mobile use, so that carriers are able to meet the rapidly growing demands on terrestrial wireless networks caused by skyrocketing use of communications applications. While intended to boost U.S. 5G leadership, the *Report and Order* was heavily weighted in favor of making unlicensed spectrum available at the expense of licensed use that has been a critical driver of technology investment, innovation, and competition. While unlicensed spectrum plays an important role in providing access to broadband, tilting the scales in favor of unlicensed spectrum will undermine the rollout of 5G services and harm the ability of the U.S. to compete globally. Accordingly, and as the comments demonstrate, the Commission should now adopt rules that will make spectrum available on an exclusive, licensed basis in order to foster the greatest investment and innovation in these

^{2/} *Use of Spectrum Bands Above 24 GHz For Mobile Radio Services; Establishing a More Flexible Framework to Facilitate Satellite Operations in the 27.5-28.35 GHz and 37.5-40 GHz Bands; Petition for Rulemaking of the Fixed Wireless Communications Coalition to Create Service Rules for the 42-43.5 GHz Band; Petition for Rulemaking of the Fixed Wireless Communications Coalition to Create Service Rules for the 42-43.5 GHz Band; 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*, Report and Order and Further Notice of Proposed Rulemaking, FCC 16-89 (rel. July 14, 2016) (subparts referred to respectively as the “*Report and Order*” and the “*FNPRM*”).

^{3/} *Id.*

additional millimeter wave bands. Consistent with T-Mobile’s comments, others supported the Commission taking the following actions:

- Making all bands specified in the *FNPRM* available for licensed terrestrial mobile use.
- Considering making additional Local Multipoint Distribution Service (“LMDS”) spectrum and the 40-42 GHz band available for terrestrial mobile use.
- Licensing the target bands on an exclusive basis where possible, and rejecting use of untested sharing approaches such as a spectrum access system (“SAS”) or use-it-or-share-it in *any* Upper Microwave Flexible Use Service (“UMFUS”) bands.
- Rejecting additional satellite sharing where there are little to no satellite operations today.
- Rejecting proposals to increase satellite Power Flux Density (“PFD”) limits in the 37.5-40 GHz band and maintaining the prohibition on satellite user equipment in this band.
- Issuing licenses covering 200 megahertz blocks except where smaller sizes are necessary to promote competition.
- Licensing all target bands in the *FNPRM* on a Partial Economic Area (“PEA”) basis.
- Refraining from adopting additional performance metrics.
- Imposing a spectrum aggregation limit across the bands allocated through the *FNPRM*, and reconsidering imposing in-band limits.
- Refraining from adopting digital identification requirements.

II. ADDITIONAL SPECTRUM IS REQUIRED FOR LICENSED SERVICES

Comments filed in response to the *FNPRM* make it clear that the Commission should (1) make the bands targeted in the *FNPRM* available for licensed services now; (2) consider making additional spectrum available for licensed terrestrial mobile use; and (3) regard with skepticism satellite industry claims of insufficient capacity.

A. The Commission Should Make the Target Bands Available for Licensed Services Now

As T-Mobile has detailed, consumers’ growing use of data-intensive applications such as video and Internet access is creating mounting demand for mobile network capacity^{4/} – demand

^{4/} See CISCO, CISCO VISUAL NETWORKING INDEX: GLOBAL MOBILE DATA TRAFFIC FORECAST UPDATE, 2015–2020 WHITE PAPER, at 26 (2016), <http://www.cisco.com/c/en/us/solutions/collateral/>

that will outpace available spectrum.^{5/} Therefore, identifying new spectrum for the provision of mobile services is vitally important for U.S. consumers and our Nation’s economy. Moreover, it is essential that this spectrum be made available on a licensed basis. Massive investment by wireless carriers in licensed spectrum has made America the world’s wireless industry leader. In 2015 alone, U.S. wireless carriers invested approximately \$32 billion in their networks.^{6/} This was not an anomaly. Indeed, since 2010, U.S. wireless carriers have invested nearly \$177 billion in their networks,^{7/} a figure which does not include tens of billions in carrier expenditures on spectrum auctioned by the Commission.^{8/}

Carriers’ capital investment also serves as a catalyst for wireless innovation. Sustained capital expenditures facilitate the creation of networks capable of supporting greater speeds and functionalities, which, in turn, results in the introduction of new, more powerful and sophisticated devices. These new devices encourage the development of new applications and content used by consumers and businesses, driving the mobile ecosystem into new areas, including health care, education, farming, intelligent transportation, fleet management, mobile commerce, safety and security, small business efficiency, and more. In fact, licensed spectrum is a critical driver of the Nation’s economy. Spectrum licensed to U.S. wireless carriers generates

service-provider/visual-networking-index-vni/mobile-white-paper-c11-520862.pdf (“Because mobile video content has much higher bit rates than other mobile content types, mobile video will generate much of the mobile traffic growth through 2020.”).

^{5/} See *Why Spectrum is Important to You*, CTIA, <http://www.ctia.org/your-wireless-life/how-wireless-works/why-spectrum-is-important-to-you> (last visited Oct. 12, 2016).

^{6/} See *Americans’ Data Usage More Than Doubled in 2015*, CTIA (May 23, 2016), <http://www.ctia.org/resource-library/press-releases/archive/americans-data-usage-more-than-doubled-in-2015>.

^{7/} See *id.*

^{8/} For instance, there were \$41.3 billion in net bids made in the AWS-3 auction alone. See *Advanced Wireless Services (AWS-3) Fact Sheet*, FCC (last accessed Oct. 27, 2016) http://wireless.fcc.gov/auctions/default.htm?job=auction_factsheet&id=97.

more than \$400 billion annually in economic activity and wireless technologies further enable other sectors of the economy.^{9/} For instance, American entrepreneurs capture 91% of the world’s mobile app downloads.^{10/} Mobile entertainment generated an estimated \$9 billion in revenues in 2014, and it has been estimated that the U.S. telehealth market will grow from \$240 million in 2013 to \$1.9 billion by 2018.^{11/}

Moreover, investment in licensed spectrum has led to ubiquitous access to broadband services and transformed American daily life – changing everything from the way we work to the way we relax. Notably, as of February 2016, 198.9 million people in the United States owned smartphones,^{12/} and smartphones currently comprise at least 77% of the traffic on wireless networks.^{13/} Americans access the Internet on mobile devices more often than on computers,^{14/} and the number of American adults who rely solely on their smartphones for Internet access at home is increasing – as of 2015, 13% of adults were “smartphone-only,” with no home broadband subscription.^{15/} Indeed, 99.6% of Americans now have access to a 4G Long

^{9/} See Coleman Bazelon and Giulia McHenry, *Mobile Broadband Spectrum: A Vital Resource for the U.S. Economy*, THE BRATTLE GROUP, 2 (May 11, 2015) (“Brattle Group Report”), http://www.ctia.org/docs/default-source/default-document-library/brattle_spectrum_051115.pdf.

^{10/} See *The Next Generation of Wireless: 5G Leadership in the U.S.*, CTIA, at 1 (Feb. 9, 2016), http://www.ctia.org/docs/default-source/default-document-library/5g_white-paper-web.pdf.

^{11/} See Brattle Group Report at 2.

^{12/} See *comScore Reports February 2016 U.S. Smartphone Subscriber Market Share*, COMSCORE (Apr. 6, 2016), <http://www.comscore.com/Insights/Rankings/comScore-Reports-February-2016-US-Smartphone-Subscriber-Market-Share>.

^{13/} See *INFOGRAPHIC: Smartphones Comprise 77 Percent of Traffic on Wireless Networks*, CTIA (Jun. 26, 2015), <http://www.ctia.org/resource-library/facts-and-infographics/archive/infographic-smartphones-comprise-77-percent-of-traffic-on-wireless-networks>.

^{14/} See *KPCB Internet Trends 2015*, KPCB (May 27, 2015), <http://www.kpcb.com/file/kpcb-internet-trends-2015>.

^{15/} See John Horrigan and Maeve Duggan, *Home Broadband 2015*, PEW RESEARCH CENTER (Dec. 21, 2015), <http://www.pewinternet.org/2015/12/21/1-home-broadband-adoption-modest-decline-from-2013-to-2015/>.

Term Evolution (“LTE”) network, which means nearly every American can access mobile broadband at speeds up to tens of Mbs a second^{16/} – and the number of 4G connections is expected to grow 3-fold between 2015 to 2020.^{17/}

Maintaining our Nation’s position of leadership in the wireless industry and addressing consumers’ evolving demands requires ensuring that wireless providers have access to a significant and predictable supply of spectrum. Spectrum is the most important resource for wireless networks, and thus making additional exclusively licensed spectrum available is essential for continued promotion of competition, innovation, and investment. As T-Mobile noted in its comments, of the 10.85 gigahertz of millimeter wave spectrum made available in the *Report and Order*, only 3.25 gigahertz will be licensed on an exclusive basis and, of that, only a limited amount will be auctioned because of the existence of incumbent licensees in the spectrum.^{18/} Moreover, the Commission made all of that spectrum subject to sharing with satellite licensees, creating a potential degradation of terrestrial services, as outlined further below. As AT&T notes, “there are, especially in the wake of the recent Spectrum Frontiers *Report & Order*, sufficient assets available for unlicensed experimentation, and the FCC should not preclude the benefits of licensed use by prematurely adding to an already significant unlicensed spectrum pool.”^{19/} Accordingly, it is critical that the Commission make millimeter wave spectrum available for exclusively licensed use without these impediments.

^{16/} See *The Next Generation of Wireless: 5G Leadership in the U.S.*, CTIA, at 1 (Feb. 9, 2016), http://www.ctia.org/docs/default-source/default-document-library/5g_white-paper-web.pdf.

^{17/} See *VNI Mobile Forecast Highlights, 2015-2020*, CISCO (last accessed Oct. 27, 2016) http://www.cisco.com/c/dam/assets/sol/sp/vni/forecast_highlights_mobile/index.html.

^{18/} Comments of T-Mobile USA, Inc., GN Dkt. No. 14-177, *et al.*, at 2-3 (filed Sept. 30, 2016) (“T-Mobile Comments”).

^{19/} Comments of AT&T, GN Dkt. No. 14-177, *et al.*, at 11 (filed Sept. 30, 2016) (“AT&T Comments”).

Parties in this proceeding agree that the Commission should make additional millimeter wave spectrum available for licensed services now. As 5G Americas notes, “[v]arious industry studies demonstrate that much more spectrum will be needed to realize the promise of 5G” and thus, 5G Americas agrees that the Commission should “repurpose[e] each and every band currently being considered for flexible use in the captioned proceedings, and . . . allocate[e] each of the bands solely for licensed use.”^{20/} AT&T similarly urges the Commission to “continue its momentum and act expeditiously to allocate additional spectrum for 5G networks and services[.]”^{21/} AT&T further stresses that the spectrum should be exclusively licensed, as “[e]xclusive use licensing is a key way to give investors the confidence to proceed with investing in deployment of 5G networks” and because “in the wake of the recent Spectrum Frontiers Report & Order, [there are] sufficient assets available for unlicensed experimentation[.]”^{22/} Samsung also “applauds the Commission’s efforts to unleash additional [millimeter wave] spectrum for 5G networks and services”^{23/} and states that exclusive licensing of the additional target bands “will encourage investment, provide certainty to users of the band, and foster deployment of 5G services.”^{24/}

^{20/} Comments of 5G Americas, GN Dkt. No. 14-177, *et al.*, at 5 (filed Sept. 30, 2016) (“5G Americas Comments”).

^{21/} AT&T Comments at 2.

^{22/} *Id.* at 11.

^{23/} Comments of Samsung Electronics America Inc. and Samsung Research America, GN Dkt. No. 14-177, *et al.*, at 3 (filed Sept. 30, 2016) (“Samsung Comments”).

^{24/} *Id.* at 2; *see also* Comments of Verizon, GN Dkt. No. 14-177, *et al.*, at 3 (filed Sept. 30, 2016) (“Verizon Comments”) (“[The Commission] should open up the 24 GHz, 32 GHz, and 42 GHz bands to mobile use under traditional licensing models known to promote investment and innovation.”); Comments of Nokia, GN Dkt. No. 14-177, *et al.*, at 7-8 (filed Sept. 30, 2016) (“Nokia Comments”) (supporting licensing of the 24 GHz, 32 GHz, 42 GHz, 47 GHz, and 50 GHz bands); Comments of the Telecommunications Industry Association, GN Dkt. No. 14-177, *et al.*, at Summary (filed Sept. 30, 2016) (“TIA Comments”) (“[A]dditional UMFUS bands should be licensed in a combination of 200 MHz, 400 MHz, and 800 MHz blocks.”); Comments of Qualcomm Incorporated, GN Dkt. No. 14-177, *et al.*, at 5-6 (filed Sept. 30, 2016) (“Qualcomm Comments”) (“Qualcomm encourages the FCC to adopt its proposal to provide flexible use exclusive licenses for the following spectrum bands that also are candidate bands

As the above demonstrates, Inmarsat is wrong to suggest there is no “urgency” to making additional spectrum available.^{25/} And contrary to the claims of the satellite industry, it is not premature to adopt rules for these bands.^{26/} The regulatory and administrative lead time between Commission action allocating spectrum for licensed mobile terrestrial use, auction of the allocated spectrum, and the spectrum being deployed – despite carriers’ aggressive efforts to build networks – is significant. In order to meet the well-established need for additional capacity, the Commission should take steps now to make additional millimeter wave spectrum available for licensed use so that carriers can integrate spectrum into their networks when those regulatory and administrative processes are complete. Waiting for networks to be overcrowded before acting to provide additional capacity is short-sighted and contrary to the public interest. Taking steps now to meet developing needs is both consistent with international trends^{27/} and Congressional recognition of the need to create a pipeline for additional capacity.^{28/}

for IMT-2020: 24.25- 24.45 GHz and 24.75-25.25 GHz, 31.8-33.4 GHz, 42-42.5 GHz, 47.2-50.2 GHz, 50.4-52.6 GHz, 71-76 GHz, and 81-86 GHz.”).

^{25/} Comments of Inmarsat, Inc., GN Dkt. No. 14-177, *et al.*, at 9 (filed Sept. 30, 2016) (“Inmarsat Comments”).

^{26/} *See, e.g.*, Comments of Global VSAT Forum, GN Dkt. No. 14-177, *et al.*, at 7 (filed Sept. 30, 2016) (“Global VSAT Forum Comments”) (arguing that the Commission should not adopt rules for the 70, 80, and 90 GHz bands at this time as “the technology does not exist today for the satellite or mobile terrestrial industries to begin making firm plans in these bands”); Comments of the Satellite Industry Association, GN Dkt. No. 14-177, *et al.*, at iv (filed Oct. 3, 2016) (“SIA Comments”) (arguing that the “Commission need not, and should not, attempt to definitively address [the 70, 80, and above 90 GHz] bands at this time”).

^{27/} *See, e.g.*, WORLD RADIOCOMMUNICATION CONFERENCE (WRC-15), PROVISIONAL FINAL ACTS, at 424-26 (2015), http://www.itu.int/dms_pub/itu-r/opb/act/R-ACT-WRC.11-2015-PDF-E.pdf (identifying the bands in the *FNPRM* as candidate bands for IMT-2020 and “recognizing . . . that there is a lead time between the allocation of frequency bands by world radiocommunication conferences and the deployment of systems in those bands, and that timely availability of wide and contiguous blocks of spectrum is therefore important to support the development of IMT”).

^{28/} *See* SPECTRUM PIPELINE ACT OF 2015, Public Law No. 114-74 (2015) (requiring the FCC to reallocate and auction 30 megahertz of spectrum identified by the Secretary of Commerce for reallocation

T-Mobile, for its part, is putting its spectrum to full use and acquiring more in the secondary market, demonstrated by the fact that, within the space of three years, the footprint for T-Mobile's 4G LTE network has gone from covering zero to covering approximately 312 million Americans, carrying 55% more data per customer than Verizon.^{29/} T-Mobile will also be deploying wireless services using its AWS-3 spectrum licenses by the end of the year to help keep up with ever-increasing consumer demand.^{30/} But more exclusively licensed spectrum will be needed to meet consumers' exploding demand for mobile broadband and to deploy the next generation of wireless technologies. The Commission should therefore provide carriers with the certainty necessary for investment and development of innovative 5G technologies and create rules for licensing additional millimeter wave bands now.

Nor should the Commission, as some parties suggest,^{31/} delay this proceeding to await direction from the International Telecommunication Union ("ITU"). Satellite interests continue to use the international process as a mechanism to delay designation of spectrum for terrestrial use, by demanding study of multiple spectrum bands for satellite broadband services that are less

from Federal use to non-Federal use, shared use, or a combination and to submit reports to Congress identifying and additional 100 megahertz of spectrum for potential future use).

^{29/} See T-Mobile News Release, *LTE Advanced is so 2014. We're already on to the next big thing. Verizon is now 50% faster ... and still slower than T-Mobile!* (Sept. 6, 2016), <https://newsroom.t-mobile.com/news-and-blogs/lte-advanced.htm> ("T-Mobile September News Release") (also noting that T-Mobile "now has near parity with the once dominant Verizon coverage, reaching 99.7% of the consumers Verizon does").

^{30/} See T-Mobile News Release, *T-Mobile Opens LG V20 Pre-Sale with Awesome Deals and is First to Light Up AWS-3 Spectrum* (Oct. 17, 2016), <https://newsroom.t-mobile.com/news-and-blogs/lg-v20-pre-sale.htm>; see also Mike Dano, *T-Mobile to Start AWS-3 Spectrum Buildouts Later This Year, Ahead of AT&T*, FIERCEWIRELESS (Aug. 8, 2016), <http://www.fiercewireless.com/wireless/t-mobile-to-start-aws-3-spectrum-buildouts-later-year-ahead-at-t>.

^{31/} See, e.g., Comments of EchoStar Satellite Operating Corporation and Hughes Network Systems, LLC, GN Dkt. No. 14-177, *et al.*, at p (filed Sept. 30, 2016) ("EchoStar Comments") (arguing that the Commission should refrain from making decisions on the 51.4-52.4 GHz band because the ITU-R is conducting studies pursuant to Resolution 162 (WRC-15) regarding the creation of a new co-primary allocation to the FSS in the band).

efficient and effective at providing services than terrestrial systems, which is contrary to the public interest.^{32/} The Commission must address the domestic requirement for additional wireless capacity and should demonstrate global leadership in making spectrum available for these services. As CTIA notes, “data usage in the U.S. far surpasses usage internationally” and “the transition to 5G networks and services will only accelerate this growth.”^{33/} It further states that “[e]nsuring that spectrum allocation and deployment keep pace with growing consumer demands will be critical in maintaining the United States’ position as the world’s foremost wireless leader.”^{34/} As it did in the *Report and Order*, the Commission must act in the best interest of U.S. consumers and move forward expeditiously.

B. The Commission Should Consider Making Additional Spectrum – Not Specified in the *FNPRM* – Available for Licensed Terrestrial Mobile Use

The record supports T-Mobile’s suggestion that other bands beyond those included in the *FNPRM* should be part of this proceeding for allocation to exclusive-use licensed services. Numerous parties urge the Commission to supplement the 28 GHz spectrum repurposed in the *Report and Order* with other segments of the LMDS band,^{35/} and parties also agree with T-Mobile that the Commission should consider allowing terrestrial use of the 40-42 GHz band.^{36/}

^{32/} See, e.g. *FCC Seeks Comment on the Recommendations Approved by the World Radiocommunication Conference Advisory Committee*, Public Notice, DA 16-1216 (rel. Oct. 25, 2016).

^{33/} Comments of CTIA, GN Dkt. No. 14-177, *et al.*, at 5 (filed Sept. 30, 2016) (“CTIA Comments”).

^{34/} *Id.* at 6.

^{35/} See, e.g., Verizon Comments at 4-5; Comments of Straight Path Communications Inc., GN Dkt. No. 14-177, *et al.*, at 3-5 (filed Sept. 30, 2016) (“Straight Path Comments”); Comments of Nextlink Wireless LLC, GN Dkt. No. 14-177, *et al.*, at 3-17 (filed Sept. 30, 2016) (“Nextlink Wireless Comments”).

^{36/} See, e.g., CTIA Comments at 13 (“[T]he Commission should consider reallocating the entire 40-42.5 GHz band for mobile uses rather than focusing solely on the 42-42.5 GHz band.”); Comments of Ericsson, GN Dkt. No. 14-177, *et al.*, at 11 (filed Sept. 30, 2016) (“Ericsson Comments”) (“Ericsson also recommends expanding the 42.0–42.5 GHz band, to include the 40.0–42.0 GHz band and the 42.5–43.5 GHz band for a 3.5-GHz-wide band spanning 40.0–43.5 GHz[.]”); Comments of Huawei Technologies,

Moreover, while making additional exclusively licensed spectrum available in the bands above 24 GHz is important, commenters correctly recognize that the Commission also “should not lose sight of the paramount importance of mid- and low-band spectrum” and “should continue to identify all opportunities for freeing spectrum below 24 GHz for mobile services.”^{37/} As the Commission has recognized, spectrum in different bands has very different characteristics that impact the coverage, capacity, and service potential of the spectrum.^{38/} For instance, the Commission determined that spectrum below 1 GHz has “distinct propagation advantages for network deployment over long distances, while also reaching deep into buildings and urban canyons.”^{39/} The Commission has also recognized that carriers need a balance of spectrum resources to compete.^{40/} Thus, while the Commission should designate additional millimeter wave spectrum for terrestrial use – both as specified in the *FNPRM* and otherwise – it should also not ignore the need to make additional low and mid-band spectrum available.

Inc. (USA) and Huawei Technologies Co., Ltd., GN Dkt. No. 14-177, *et al.*, at 6 (filed Sept. 30, 2016) (“Huawei Comments”) (“Huawei would recommend, however, for the proposed 42 GHz band that the Commission extend the applicable frequency bands from 42-42.5 GHz to 40-42.5 GHz band for UMFUS.”); Straight Path Comments at 5-6 (“Straight Path . . . urges the Commission to authorize mobile operations in the 40-42 GHz band.”).

^{37/} CTIA Comments at 3; *see also* AT&T Comments at 4 (“To fully realize the potential for 5G, these networks will require multi-band implementation with a mix of low-, mid-, and high-band capacity. Thus, while AT&T commends the FCC’s efforts with respect to mmW spectrum, it should not lose sight of the need to continue to allocate more spectrum below 6 GHz.”); Comments of MVDDS 5G Coalition, GN Dkt. No. 14-177, *et al.*, at ii (filed Sept. 30, 2016) (“Several bands in the 6-24 GHz range—the so-called centimeter wave bands—are as well suited as, and in some respects better suited than, the bands under consideration by the Commission for use for 5G.”).

^{38/} *See, e.g., Policies Regarding Mobile Spectrum Holdings*, Report and Order, 29 FCC Rcd. 6133, ¶283 (2014) (“*Mobile Holdings Order*”) (noting that “certain frequencies possess distinct characteristics for the provision of mobile wireless services”) (internal citations omitted).

^{39/} *See id.* ¶ 3.

^{40/} *See id.* ¶ 63 (stating that “a mix of spectrum holdings provides distinct advantages to providers’ ability to compete in the marketplace”).

C. The Commission Should Regard with Skepticism Satellite Industry Claims of Insufficient Capacity

In contrast, the Commission should be skeptical of competing satellite industry claims of need for additional capacity.^{41/} These claims are unsubstantiated and contradicted by the limited use of spectrum already allocated for satellite operations. Only now, when spectrum is under consideration for mobile terrestrial broadband use, has the satellite industry discovered a “need” for capacity to offer satellite broadband service. The need is unsupported and, to the contrary, years of lack of interest in current satellite bands – such as the 40-42 GHz – demonstrate that there really is no demand for this service.^{42/} As CTIA correctly emphasized in its opposition to Boeing’s Petition for Rulemaking,^{43/} “[t]he Fixed-Satellite Service already has extensive spectrum allocations (more than five times the spectrum available for licensed terrestrial mobile services) and has made no technical showing to demonstrate why the currently allotted spectrum is insufficient to deliver satellite service.”^{44/} Moreover, as the recently filed Fixed Wireless Communications Coalition Petition for Rulemaking shows, satellite operators are not even using the capacity for which they are licensed – they coordinate operations for “full-band, full-arc”

^{41/} See, e.g., Global VSAT Forum Comments at 7-8 (“Satellite has been serving customers in the mmW bands for years, and is in the process of rapidly expanding both its capacity and its speeds.”); Inmarsat Comments at 4 (stating that satellite operators “are investing heavily in developing and deploying future systems that will bring even more capacity and innovation to the market”); SIA Comments at 4 (“[S]atellite operators must have sufficient protected access to greenfield spectrum bands in millimeter wave (‘mmW’) spectrum that enable higher speeds and more intensive broadband capabilities.”).

^{42/} See Straight Path Comments at 6-7 (“Notably, there are currently no FSS operations in the 40-42 GHz band. Allowing flexible use operations throughout the 40-42.5 GHz band would allow terrestrial providers to make use of spectrum that is currently lying fallow.”)

^{43/} The Boeing Company Petition for Rulemaking, RM-11773 (filed June 22, 2016) (“Petition”).

^{44/} CTIA Opposition to Petition for Rulemaking, RM-11773, at 2-4 (filed Oct. 17, 2016) (noting that “there is approximately 3.85 gigahertz of terrestrial mobile spectrum available nationwide— less than one-fifth of the spectrum than is available for FSS nationally”) (“CTIA Opposition”).

operations when it is not required.^{45/} In contrast, the need for additional mobile terrestrial broadband spectrum is well documented.

As T-Mobile pointed out in its recent filing on Boeing’s Petition, reserving a substantial amount of spectrum for satellite operations is inefficient, since providing broadband services by satellite will be impactful to an important, but very limited segment of the population^{46/} – a fact which satellite interests themselves acknowledge.^{47/} The number of consumers that can be served with terrestrial operations, however, is vastly greater.^{48/} Given the rate at which consumer demand is increasing, it is not in the public interest to make additional spectrum available for fixed satellite service (“FSS”) use to serve a limited market segment in a way that forecloses the spectrum’s broader potential deployment. While T-Mobile addresses satellite requests to use particular bands below, it generally urges the Commission to consider the needs of satellite systems relative to those of terrestrial wireless providers.

^{45/} Fixed Wireless Communications Coalition Petition for Rulemaking (filed Oct. 11, 2016).

^{46/} Comments of T-Mobile USA Inc., RM-11773, at 7 (filed Oct. 17, 2016) (“T-Mobile Boeing Petition Comments”).

^{47/} See Petition at 7-8 (“Although 96 percent of those living in urban areas of the United States have access to broadband Internet with speeds at least 25 MB down/3 MB up, 39 percent of those in rural areas – more than 23 million people – do not. On Tribal Lands . . . more than 1.5 million people – lack access.”).

^{48/} See Straight Path Communications Inc. *Ex Parte*, GN Dkt. No. 14-177, at 4-5 (filed July 7, 2016) (“A survey from the NTCA – The Rural Broadband Association found that among the ‘more than 128 rural telecom and cable companies’ that were surveyed by the NTCA, ‘satellite was cited by less than a fraction of 1 percent of respondents’ as the technology for broadband services.”). At the end of 2015, satellite broadband subscribership was approximately 1.8 million *globally*, with most of these subscribers in the U.S. See *State of the Satellite Industry Report*, Satellite Industry Association, at 12 (July 2016), <http://www.sia.org/wp-content/uploads/2016/06/SSIR16-Pdf-Copy-for-Website-Compressed.pdf>. The number of mobile broadband subscriptions *in the U.S. alone*, however, was estimated to be approximately 375.5 million. See *Broadband Portal, Total Fixed and Wireless Broadband Subscriptions by Country*, Organisation for Economic Co-operation and Development (Aug. 2016) (data available in a downloadable chart), www.oecd.org/sti/broadband/oecdbroadbandportal.htm.

III. TERRESTRIAL SPECTRUM SHOULD BE LICENSED ON AN EXCLUSIVE, NON-SHARED BASIS

The *FNPRM* and this proceeding remain appropriately focused on licensed terrestrial operations, which will be able to deliver innovative 5G services to the greatest number of American consumers. Accordingly, the Commission should limit shared use of the spectrum by satellite operators and reject sharing approaches such as an SAS or use-it-or-share-it. As noted above, only through exclusively licensed spectrum will the Commission effectively promote the growth of 5G services in the millimeter wave bands.

A. The Commission Should Limit Shared Use of Millimeter Wave Spectrum by Satellite Users

Any Satellite Use of Terrestrial Spectrum is Degrading. T-Mobile recognizes the need to protect existing operations and potentially permit expansion where there are existing satellite operators, as the Commission did at 28 GHz in the *Report and Order*. However, where there are no satellite operations today, the Commission should not create shared bands. Doing so will limit the utility of the spectrum for terrestrial services. Terrestrial mobile broadband relies on service ubiquity. Any shared use of mobile terrestrial broadband spectrum will compromise that ubiquity, either by creating exclusion zones (in the case of spectrum used for satellite earth-to-space transmissions) where service will be unavailable or by creating (with increased PFD limits on spectrum used for satellite space-to-earth transmission) compromised coverage areas or degraded service levels such as a decrease in throughput speeds. Both results will make millimeter wave spectrum less attractive for terrestrial wireless broadband and threaten the economics that will make it viable. It is one thing to protect existing satellite operations; it is another to unnecessarily create impediments to terrestrial services where none exist today to serve unsubstantiated needs. The comments of satellite entities demonstrate the point by arguing

for limitations on terrestrial use of the spectrum^{49/} – while satellite interests claim they can co-exist, it is only on terms detrimental to terrestrial operations.^{50/}

Satellite Industry Analysis of Potential Interference from Space-to-Earth

Transmissions Is Flawed. As T-Mobile’s comments in response to the *FNPRM* demonstrated, the Boeing analysis, which requests an increase in the PFD limits in the 37.5-40 GHz band for space-to-earth transmissions, is flawed.^{51/} Straight Path previously provided a detailed link budget analysis for various interference scenarios between FSS and 5G services in this band, and its comments reiterate that, at the current PFD limit, FSS downlink (space-to-earth) already causes non-negligible impairment to 5G base stations and mobile station receivers.^{52/} FiberTower also found the Boeing analysis insufficient, arguing that any proposed changes to

^{49/} See, e.g., Global VSAT Forum Comments at 5 (“The V-band spectrum requirements for broadband satellite systems mean that some of the spectrum sharing proposals raised in the *Further Notice* would not be viable as applied to satellite end user terminals in portions of the 47 GHz band. One option would be for UMFUS terminals to operate on an opportunistic basis, listening for and avoiding FSS transmissions and enjoying full use of the band at locations and times when FSS end user operations were minimal. GVF believes that through these or other sharing strategies, the 47 and 50 GHz bands can be made available for both satellite operations and future UMFUS users.”); SIA Comments at 9 (arguing that “certain spectrum in the V-band is critical to the future growth of satellite services and should be designated as core FSS spectrum bands where UMFUS should not operate”); Comments of ViaSat, Inc., GN Dkt. No. 14-177, *et al.*, at 5 (filed Sept. 30, 2016) (“ViaSat Comments”) (“In particular, the *Further Notice* proposes to authorize wireless services in the 48.2-50.2 GHz band segment, which currently is designated exclusively for FSS uplink operations. The proposed rules for wireless services in this band segment would significantly limit broad deployment of satellite user terminals, as well as individually-licensed earth stations.”).

^{50/} See, e.g., Straight Path Comments at 14 (“Increasing the PFD limit [in the 39 GHz band] further will more severely impact the 5G user experience and the economic prospect of providing 5G services to the American public.”); Comments of FiberTower Spectrum Holdings, LLC, GN Dkt. No. 14-177, *et al.*, at 4-5 (filed Sept. 30, 2016) (“FiberTower Comments”) (“The ultra-low latency requirements and the relative brittleness of digital signals in the mmW bands, combined with the need to densely deploy terrestrial mmW services for both backhaul and broadband access, leave no room for increased satellite power levels or increased satellite earth stations/terminals outside of the existing rule structure [in the 39 GHz band]. . . . In fact, UMFUS operations may require more robust protections from FSS interference than those currently in place.”).

^{51/} T-Mobile Comments at 29.

^{52/} Straight Path Comments at 16.

PFD limits should undergo trials that are (1) reviewable by Fixed Service, UMFUS, and FSS operators and licensees and (2) based on accurate, current assumptions on Fixed Service system characteristics.^{53/}

The impact of changes to the PFD level on UMFUS deployments should not only be considered for one satellite, but also for multiple satellites serving the same geographic location using the same spectrum. As Boeing states in its comments, “[e]fficient spectrum sharing techniques, such as satellite diversity, permit multiple satellites (potentially operated by unaffiliated operators) to use the same spectrum to serve the same location and avoid interference into each other by directing beams to and from satellites at different points in the sky.”^{54/} To determine the potential impact of such co-frequency operations on UMFUS receivers in the 37/39 GHz bands, Boeing calculates the aggregate equivalent PFD (“ePFD”) of multiple satellites on UMFUS systems. Regardless of the propriety of Boeing’s methodology, it incorrectly concludes that the aggregate impact of multiple co-frequency satellites on UMFUS receivers is minimal.

In particular, Boeing’s ePFD analysis uses the antenna models referenced in the 3rd Generation Partnership Project (“3GPP”) Channel Modeling Report.^{55/} The models discussed in that report are intended for evaluation of the performance of 3GPP physical layer techniques using the above-6 GHz channel model(s) in a terrestrial mobile wireless network. They will not necessarily be what the industry may eventually implement in the UMFUS receive terminals

^{53/} FiberTower Comments at 4.

^{54/} Comments of The Boeing Company, GN Dkt. No. 14-177, *et al.*, at 28 (filed Sept. 30, 2016) (“Boeing Comments”).

^{55/} *Study on Channel Model for Frequency Spectrum Above 6 GHz (Release 14)*, 3GPP TR 38.900 V1.0.0 (2016-06), 3RD GENERATION PARTNERSHIP PROJECT, Section 7.3 - Antenna modelling (June 2016) (“Channel Modeling Report”).

and/or what would be used in UMFUS mobile deployments. For example, UMFUS mobile user equipment (“UE”) needs to be capable of receiving not only the main beam, but also the reflected beams in order to maintain the link to the base station in case the main beam is blocked by natural or man-made obstructions. In addition, UMFUS systems may follow a so-called “cell-less” concept and the UE would not necessarily be associated with a single base station. As a result, the UE could be in communication with multiple access points simultaneously or need to be ready to switch access points at any time. To satisfy these requirements, the UE antenna needs to be designed in such a way that enables the UE to receive signals from different directions simultaneously in both the horizontal and vertical planes. Some early prototype concepts consider embedding multiple antenna arrays at different UE corners and/or sides.

In contrast, the UE antenna model used in Boeing’s analysis consists of one antenna array placed possibly on one side or one corner of the UE. Using the UE model discussed above, *i.e.*, with multiple arrays on different UE sides/corners, the total number of satellites in the field of view of these antenna arrays which would impact the UE reception would be many more and the resulting ePFD on the UE quite different than what is presented in the Boeing analysis.

And, once satellite downlink operations are initiated under a particular set of operational parameters, it will be impossible to reverse any regulatory decisions that infringe on mobile terrestrial operations. In order to protect terrestrial operations from satellite downlink operations, the Commission must reject satellite sharing requests or at least be certain of the appropriate PFD limit for satellite downlink operations in order not to degrade mobile terrestrial services, making the provision of terrestrial services in a shared band infeasible.

Further Studies Show that the Effect of Satellite Earth Stations May Be Understated. In its comments, Nokia demonstrated that in the 28 GHz band even the adopted

PFD limits of $-77.6 \text{ dBm/m}^2/\text{MHz}$ may harm terrestrial operations because permitted satellite earth stations will cause harmful interference to terrestrial 5G base stations.^{56/} Nokia's measurements show that: (1) the measured levels were higher – typically 20-30 dB above the adopted limits; (2) the PFD levels measured in the vertical plane were typically 1-2 dB higher than the horizontal; (3) the measured levels to the sides and rear of sites were higher than expected; (4) there was no roll-off as a function of the azimuth angle as the Satellite Industry Association argued there would be; and (5) there were equal levels of PFD at all angles – about a 10 dB reduction as compared to the 0 degree measurement. The Commission may wish to revisit the limits applicable to the 28 GHz band in particular, but further analyze the “spillover effect” that Nokia demonstrated from satellite earth stations as it considers permitting earth stations in spectrum designated for terrestrial use. For purposes of the *FNPRM*, the Nokia analysis demonstrates that the Commission must re-examine the premises behind satellite uplink/terrestrial sharing before potentially compromising terrestrial use of millimeter wave bands. The Commission should not, therefore, permit satellite earth station use of terrestrial spectrum or should at least postpone adoption of rules governing satellite uplink/terrestrial sharing until this question is more fully addressed.

Proposed Uplink Operations Would Dramatically Reduce Spectrum for Terrestrial Services. Boeing proposes that the Commission allocate the 47.2-50.2 GHz and 50.4-52.4 GHz bands as uplink spectrum for gateways used to serve the forward links to end user terminals, 3 gigahertz of which – 47.2-50.2 GHz – would be available for ubiquitously deployed transmitting

^{56/} Nokia Comments at 16-19; *see also* Nokia *Ex Parte*, GN Dkt. No. 14-177, *et al.* (filed Oct. 20, 2016) (“Nokia *Ex Parte*”).

end user terminals.^{57/} Nearly 22 gigahertz of spectrum is currently available for FSS use between 3 and 80 GHz,^{58/} and as discussed above, there is no demonstrated need for additional capacity for satellite broadband service. In contrast, there is only 3.25 gigahertz of spectrum available for licensed, terrestrial mobile use above 24 GHz, despite clear, growing need for terrestrial mobile capacity. Boeing’s proposal for use of the 47.2-50.2 GHz and 50.4-52.4 GHz bands, however, would make the majority of this spectrum unavailable for terrestrial operations. Co-equal sharing would simply not be possible in the 47.2-50.2 GHz band if the Commission allows the proposed ubiquitous deployment of end user devices – a fact that Boeing admits^{59/} – and as a result, there would be no meaningful terrestrial use of the 47.2-50.2 GHz band. By removing 3 gigahertz of critical spectrum from terrestrial use, Boeing’s proposal would therefore significantly negatively impact terrestrial operations across the entire 47.2-52.4 GHz band.

Potential Sharing Analyses Are Premature. As demonstrated above, any assertions by the satellite industry that it can successfully share with terrestrial services miss a fundamental point about 5G: it is still evolving. Therefore, satellite industry analyses that show protection to 5G are necessarily premature. In addition to the early stage of engineering analyses, the Commission must take into consideration the nascent stage of 5G operations. Even if satellite services protect the current vision for 5G, that will lock in technologies contemplated today and lock out those that have not yet been developed – freezing innovation. In order to best allow 5G operations to flourish, satellite operations should not be permitted in spectrum dedicated for terrestrial operations at all.

^{57/} See Boeing Comments at 9.

^{58/} See CTIA Opposition at 3.

^{59/} See Boeing Comments at 16 (“Boeing’s transmitting end user terminals will not be able to share uplink spectrum with UMFUS systems that are widely deployed, at least not on a co-primary basis, or in outdoor locations.”).

B. The Commission Should Reject Sharing Approaches Such as an SAS or Use-It-or-Share-It

SAS. Other proposed sharing techniques are also misguided and, as noted above, will limit the amount of spectrum designated for exclusive geographic licensing. An SAS is untested, overly complicated and unnecessary, a point highlighted by the scattered, limited support in the record.^{60/} In contrast, the record contains widespread opposition to the SAS approach both for use in licensed and unlicensed spectrum. As AT&T correctly notes, “[w]hile the SAS concept has been portrayed as a technological enabler, the reality is that the model is still untested, and there are already significant issues coming to the fore as industry struggles with SAS implementation for the 3.5 GHz band.”^{61/} The Competitive Carriers Association (“CCA”) states that use of an SAS in the millimeter wave bands “raises substantial uncertainty for CCA members, enough to deter investment and hamper innovative testing of mmW bands and sharing systems.”^{62/} Other carriers and industry groups raise similar concerns.^{63/}

Nor is opposition to an SAS limited to carriers, who generally opposed SAS techniques to permit access to licensed spectrum. Users of unlicensed spectrum also expressed opposition.

^{60/} See, e.g. Comments of Aeronet Global Communications, GN Dkt. No. 14-177, *et al.* (filed Sept. 30, 2016); Comments of Public Knowledge and the Open Technology Institute at New America, GN Dkt. No. 14-177, *et al.* (filed Sept. 30, 2016) (“Public Knowledge and the Open Technology Institute at New America Comments”); Comments of Federated Wireless, Inc., GN Dkt. No. 14-177, *et al.* (filed Sept. 30, 2016) (a company that creates dynamic spectrum database technologies); Comments of Dynamic Spectrum Alliance, GN Dkt. No. 14-177, *et al.* (filed Sept. 30, 2016) (“Dynamic Spectrum Alliance Comments”).

^{61/} AT&T Comments at 11.

^{62/} Comments of Competitive Carriers Association, GN Dkt. No. 14-177, *et al.*, at 5-6 (filed Sept. 30, 2016) (“CCA Comments”).

^{63/} See also 5G Americas Comments at 7-10 (arguing that the SAS “concept is new, unproven and complex” and should not be applied in the 37-37.6 GHz band or 70/80 GHz bands); Comments of Mobile Future, GN Dkt. No. 14-177, *et al.*, at 3 (filed Sept. 30, 2016) (“Mobile Future Comments”) (“Commission should . . . [d]ecline to extend the 3.5 GHz three-tiered sharing regime to the 70 GHz and 80 GHz bands; [d]ecline to use the untested Spectrum Access System (‘SAS’) model for frequency coordination in the 37 GHz Band.”).

NCTA states that with regard to the 70/80 GHz bands, the proposed three-tiered SAS approach is “more complex than required to accomplish the Commission’s goal of freeing up spectrum for shared mobile use while ensuring that incumbent users are protected.”^{64/} Wi-Fi Alliance similarly notes that “device-based contention would be difficult to introduce” in the 70/80 GHz band, and also argues that the “Commission should not encumber the [37 GHz] band with complicated access mechanisms.”^{65/}

With regard to the lower 37 GHz band in particular, designated in the *Report and Order* for unlicensed use and about which the Commission specifically sought comments regarding sharing, several parties have proposed additional alternative approaches.^{66/} Based on the lack of consensus on an appropriate sharing mechanism, the Commission should refrain from adopting a sharing framework for the lower 37 GHz band and instead, as T-Mobile has suggested, allow industry to develop mechanisms for sharing based on the use cases that stakeholders expect to be developed. Industry-led techniques, and not an SAS or other third party mechanisms, should also be employed for any other unlicensed millimeter wave bands.

Use-it-or-Share-It. The record also reflects little support for use-it-or-share-it in the 37 GHz band in particular or throughout the millimeter wave bands.^{67/} The Commission should not take this approach with regard to any of the millimeter wave bands allocated for licensed

^{64/} Comments of NCTA - The Internet & Television Association, GN Dkt. No. 14-177, *et al.*, at 8 (filed Sept. 30, 2016) (“NCTA Comments”).

^{65/} Comments of Wi-Fi Alliance, GN Dkt. No. 14-177, *et al.*, at 8 (filed Sept. 30, 2016) (“Wi-Fi Alliance Comments”).

^{66/} *See, e.g.*, Wi-Fi Alliance Comments at 8 (arguing that the lower 37 GHz band should be completely unlicensed); 5G Americas Comments at 10 (“[A]greed procedures for Federal and non-Federal users in cleared AWS spectrum is a more useful model, and has been proven in the marketplace.”).

^{67/} *See* Public Knowledge and the Open Technology Institute at New America Comments at 17; SIA Comments at 16-18; Comments of O3b Limited, GN Dkt. No. 14-177, *et al.*, at 4 (filed Sept. 30, 2016) (“O3b Comments”); Inmarsat Comments at 20.

terrestrial mobile use; doing so will undermine the benefits of allocating spectrum for exclusive, geographic area licenses. As CTIA states, it is premature to adopt a use-it-or-share it framework in the millimeter wave bands, as “many questions remain about how the millimeter wave bands will ultimately be put to use. . . . Implementing a ‘use it or share it’ mandate would wreak havoc on the millimeter wave bands, thwarting the Commission’s central goal of facilitating the transition to 5G. It would create uncertainty, undermine investment, and stifle innovation.”^{68/} CCA correctly points out that “resource-sensitive competitive carriers cannot justify purchasing a mmW spectrum license if doubt lingers as to whether the equipment necessary to sufficiently ‘use’ that band can be procured.”^{69/} The Telecommunications Industry Association further warns that “imposing use-or-share requirements at this early stage would impose substantial costs on device manufacturers and licensees and could harm development of the millimeter-wave technology ecosystem.”^{70/} Use-it-or-share-it is particularly problematic if the spectrum would be shared with satellite interests. The challenges in sharing with unlicensed terrestrial users – (1) the likelihood that licensees will be unable to actually displace sharers when they wish to use their licensed spectrum; (2) the greater uncertainty; and (3) that the approach may inhibit licensees’ ability to dynamically reconfigure their networks – will only be exacerbated if the spectrum is shared with satellite operators.

^{68/} CTIA Comments at 19; *see also* Mobile Future Comments (“Adopting a use-or-share requirement would needlessly limit licensees’ flexibility to examine different uses and technologies, and could imperil development of innovative 5G technologies in the bands.”).

^{69/} CCA Comments at 6.

^{70/} TIA Comments at Summary; *see also* Ericsson Comments at 19 (“Sharing between mobile uses and incumbents should be the primary focus, before further actions are taken in these bands that adds additional complexity and risks jeopardizing the investment necessary to open these bands at this time. As a result, Ericsson cautions against premature consideration of sharing mechanisms that may discourage development of the Spectrum Frontiers, including ‘use-or-share’ requirements and dynamic sharing, and instead urges the Commission to rely on frequency coordination.”).

IV. THE RECORD SUPPORTS DESIGNATING THE BANDS IDENTIFIED BY THE COMMISSION FOR EXCLUSIVE TERRESTRIAL USE

The record supports allocation of the *FNPRM* target bands for exclusive terrestrial use, and the Commission should act expeditiously to make this spectrum available for the deployment of terrestrial 5G services. T-Mobile addresses each target band specifically below.

24 GHz Bands. There is broad support for Commission’s proposal^{71/} to add a mobile allocation to the 24.25-24.45 and 24.75-25.25 GHz segments of the 24 GHz band, a fixed allocation to 24.75-25.05 GHz and to authorize both mobile and fixed operations in those segments under the new Part 30 rules.^{72/} The Commission should not, as the Satellite Industry Association proposes, only allow UMFUS operations and other terrestrial uses on a secondary basis.^{73/} As is explained above, exclusive, licensed spectrum is necessary for robust investment and innovation in the millimeter wave bands. The Commission should not hamstring deployment of 5G services by allowing continued satellite access to spectrum the industry has barely put to use. The Commission should also reject suggestions from Microsoft, Google, Public Knowledge, and the Open Technology Institute at New America to implement an SAS sharing mechanism in the 24 GHz bands.^{74/} As discussed above, use of the untested SAS approach will create deep uncertainty, reducing investment and hindering deployment of services that can best be provided through spectrum exclusively licensed on a geographic area basis.

^{71/} See *FNPRM*, ¶ 383.

^{72/} See, e.g., AT&T Comments at 9; Verizon Comments at 3; CTIA Comments at 10; 5G Americas Comments at 4; FiberTower Comments at 2-3; Qualcomm Comments at 5-7; Comments of National Spectrum Management Association Comments, GN Dkt. No. 14-177, *et al.*, at 2 (filed Sept. 29, 2016).

^{73/} See SIA Comments at 8.

^{74/} See Comments of Microsoft Corporation, GN Dkt. No. 14-177, *et al.*, at 12-13 (filed Sept. 30, 2016) (“Microsoft Comments”); Public Knowledge and the Open Technology Institute at New America Comments at 15; Comments of Google Inc. and Google Fiber Inc., GN Dkt. No. 14-177, *et al.*, at 8-12 (filed Sept. 30, 2016).

32 GHz Band. The record also supports adding primary non-Federal fixed and mobile service allocations to the 32 GHz band under the new Part 30 rules.^{75/} Contrary to Echodyne’s claim, shared use between 5G and radionavigation is not “improbable.”^{76/} Rather, commenters agree with T-Mobile that protection of existing co-channel and adjacent channel operations is possible.^{77/} Moreover, as TIA correctly notes, “[c]urrently, there are no non-Federal licensees in the band despite an existing allocation for non-Federal radionavigation service from 32.3-33.4 GHz. While the Commission should certainly proceed cautiously in crafting service rules, hypothesized developments in radionavigation[.]” such as those discussed by Echodyne, “cannot be a basis for blocking action entirely.”^{78/}

In addition, the adjacent band radioastronomy service (“RAS”) can be protected through exclusion zones. CORF agrees that fixed services can protect RAS “with proper coordination”, although it does not address use of exclusion zones for mobile services.^{79/} However, as T-Mobile previously explained, based on the small number of and known remote fixed locations of RAS sites, providing protection through geographic separation, considering terrain characteristics and other network implementation capabilities, offers the most effective means of maximizing spectrum access in the 31.3-31.8 GHz band. Therefore, direct discussions with RAS operators

^{75/} See *FNPRM*, ¶ 389; AT&T Comments at 9; Verizon Comments at 3; CTIA Comments at 10; 5G Americas Comments at 4; TIA Comments at 9-10; Qualcomm Comments at 7.

^{76/} Comments of Echodyne Corp., GN Dkt. No. 14-177, *et al.*, at 5 (filed Sept. 30, 2016) (“Echodyne Comments”).

^{77/} See, e.g., NCTA Comments at 14 (“The sophisticated mitigation techniques that exist today, or those currently under development, could serve as a starting point for addressing coexistence between new 32 GHz mobile licensees and incumbent users.”); Ericsson Comments at 10-11 (recommending consideration of the 23 GHz band for mobile use even though “the 32 GHz band is directly adjacent to the passive services below 31.8 GHz, which may present implementation design challenges and may require a guard band at 31.8 GHz that would limit the available bandwidth”).

^{78/} TIA Comments at 9.

^{79/} Comments of CORF-National Academy of Sciences, GN Dkt. No. 14-177, *et al.*, at 7-8 (filed Sept. 29, 2016) (“CORF Comments”).

regarding the specific sites should be pursued to determine exclusion or coordination zones.^{80/}

The Commission should not protect federal radar operations via an SAS, as is suggested by NCTA and Federated Wireless,^{81/} for the same reasons it should not adopt an SAS approach in any millimeter wave band.

42 GHz Band. The Commission should adopt its proposal to authorize fixed and mobile operations in the 42 GHz band under the Part 30 rules, subject to protections for adjacent-band RAS operations.^{82/} The record shows strong support for UMFUS use in the 42 GHz band,^{83/} and in addition, numerous parties urge the Commission to consider combining the 42 GHz band with the 40-42 GHz band to create a larger block of spectrum for UMFUS use.^{84/} Contrary to CORF's contentions, and as T-Mobile previously detailed,^{85/} because RAS operates at known fixed remote locations, the Commission could establish exclusion or coordination zones to avoid interference to those RAS locations. Given that the sites are remote, exclusion or coordination zones will not likely impact wireless industry efforts to reach most of the U.S. population.

^{80/} See T-Mobile Comments at 12-13; *see also* Ericsson Comments at 10-11 (“[T]he use of guard bands in [the 32 GHz] band or others considered in the *FNPRM* should only be considered if other mitigation techniques are not applicable.”).

^{81/} See NCTA Comments at 14; Federated Wireless Comments at 20-21.

^{82/} See *FNPRM*, ¶ 403.

^{83/} See, e.g., AT&T Comments at 9; Verizon Comments at 3; CTIA Comments at 10-13; 5G Americas Comments at 4; Ericsson Comments at 11; Huawei Comments at 6; Straight Path Comments at 5-6.

^{84/} See, e.g., CTIA Comments at 13 (“[T]he Commission should consider reallocating the entire 40-42.5 GHz band for mobile uses rather than focusing solely on the 42-42.5 GHz band.”); Ericsson Comments at 11 (“Ericsson also recommends expanding the 42.0–42.5 GHz band, to include the 40.0–42.0 GHz band and the 42.5–43.5 GHz band for a 3.5-GHz-wide band spanning 40.0–43.5 GHz[.]”); Huawei Comments at 6 (“Huawei would recommend, however, for the proposed 42 GHz band that the Commission extend the applicable frequency bands from 42-42.5 GHz to 40-42.5 GHz band for UMFUS.”); Straight Path Comments at 5-6 (“Straight Path . . . urges the Commission to authorize mobile operations in the 40-42 GHz band.”).

^{85/} See T-Mobile Comments at 14.

47 and 50 GHz Bands. Numerous parties expressed support for the Commission’s proposal to authorize fixed and mobile operations in the 47 and 50 GHz bands.^{86/} T-Mobile previously urged the Commission to adopt a licensing scheme consistent with the Part 30 rules established in the *Report and Order*. Other commenters agreed.^{87/} As CTIA explains, “[m]aintaining regulatory parity across the various millimeter wave bands will streamline compliance efforts and maximize spectrum efficiency.”^{88/} TIA likewise notes that “providing some commonalities in licensing and access rights across all of the UMFUS bands will help facilitate technological innovation, potentially allow devices to operate more easily in several different bands, and allow the marketplace to develop as rapidly as possible.”^{89/}

Satellite interests either oppose UMFUS in this spectrum or request that the Commission extend their primary or co-primary designation to the entire 47.2-52.2 GHz band.^{90/} As noted above, Boeing also recently filed a Petition for Rulemaking seeking the adoption of an allocation for FSS in the 50.4-51.4 GHz and 51.4-52.4 GHz bands. In the Petition, Boeing claims its planned NGSO satellite system will need access to a full five gigahertz of paired spectrum, including full access to the 40.0-42.0 GHz band, shared access to the 37.5-40.0 GHz band, and shared access to the 42.0-42.5 GHz band.

Boeing and other satellite interests have failed to make any compelling demonstration of their need for spectrum in the 47 and 50 GHz bands. As discussed above, spectrum that is already allocated to FSS has been lying fallow for years. In contrast, there is demonstrated need

^{86/} See, e.g., TIA Comments at 11-13; Qualcomm Comments at 9-11; Ericsson Comments at 12-13; CTIA Comments at 10; see also, e.g., Verizon Comments at 1; AT&T Comments at 9.

^{87/} See, e.g., CTIA Comments at 10; Verizon Comments at 3-4.

^{88/} CTIA Comments at 10.

^{89/} TIA Comments at 4-5.

^{90/} See, e.g., Inmarsat Comments at 18-19; Boeing Comments at 14-22; ViaSat Comments at 8-13.

for exclusively licensed spectrum to support 5G terrestrial operations. Moreover, Boeing's Petition is premised on the idea that the 50 GHz band would be paired with uplink spectrum in the 37.5-42.5 GHz band. As T-Mobile noted in its comments on Boeing's Petition, the *Report and Order* designated the 37.5-40 GHz band for terrestrial operations on a primary basis.^{91/} It is therefore impossible for there to be the five gigahertz of spectrum dedicated to satellite that Boeing's Petition envisions.

70/80 GHz Bands. Many commenters urge the Commission to retain the existing licensing structure for the 70/80 GHz bands.^{92/} While T-Mobile continues to propose that the Commission consider issuing geographic area licenses for mobile terrestrial operations, it agrees with the Telecommunications Industry Association, Ericsson, CTIA, and other parties who advise the Commission not to disrupt a coordination system for existing operations that is working well by attempting to establish an SAS in the bands.^{93/} Similarly, if the Commission rejects T-Mobile's recommendation to license the 70/80 GHz bands on a geographic area basis for mobile terrestrial use, it should not impose an SAS in the band for future operations.

Nevertheless, in order to rectify the imbalance between exclusively licensed millimeter wave spectrum on the one hand and shared or unlicensed millimeter spectrum on the other, T-Mobile urges the Commission to consider issuing geographic area authorizations for mobile terrestrial operations, coupled with continued use of the existing database to protect fixed operations. There is no reason that narrow beamwidth assignments in the 70/80 GHz band

^{91/} See T-Mobile Boeing Petition Comments at 8. In addition, part of the five gigahertz of paired spectrum is comprised of the band 42-42.5 GHz, which the Commission is also considering making available for terrestrial use. See also *FNPRM*, ¶ 403.

^{92/} See, e.g., CTIA Comments at 14; Mobile Future Comments at 4-5; Ericsson Comments at 14-15; TIA Comments at 14.

^{93/} CTIA Comments at 14; Mobile Future Comments at 4-5; TIA Comments at 14; Ericsson Comments at 14-15.

cannot co-exist with terrestrial operations. E-band provider Siklu Inc. explains that co-existence of fixed services in these frequencies is possible under the current regulatory regime without compromising the fixed services priority level. According to Siklu, “the high frequency and narrow beams (even after some relaxation in antenna requirements) enables efficient spectrum management by the existing database system with small adaptations.”^{94/} Nokia also studied co-existence of fixed links with 5G systems, “including a technique of shutting down 5G beams which proved to be effective in mitigating 5G-into-Fixed Link interference while keeping the performance of the 5G system acceptable.”^{95/} Moreover, as the Commission notes, operations are not widespread, but clustered in certain geographic areas.^{96/} Narrow beamwidths and the power differential between fixed and mobile operations mean that point-to-point facilities will cause interference *to* mobile terrestrial operations, not receive interference *from* them. Mobile terrestrial licensees should be permitted to assess the risk of that interference in determining whether to employ the 70/80 GHz bands.^{97/}

^{94/} Comments of Siklu Inc., GN Dkt. No. 14-177, *et al.*, at 3 (filed Sept. 28, 2016).

^{95/} Nokia *Ex Parte* at 1; *see also* Nokia Comments at 9 (“Nokia believes that sharing [in the 71-76 GHz and 81-86 GHz bands] is feasible though, and provides further analysis on sharing considerations [in an Appendix].”); Nokia Comments, Appendix 1 at 11 (“Our simulation results showed that the 5G [Access Points] into Fixed link interference is the most significant and the technique of shutting down beams was effective in suppression of 5G-to-Fixed link interference while keeping the performance of the 5G system acceptable.”).

^{96/} *See FNPRM*, ¶ 432.

^{97/} For example, potential terrestrial mobile licensees may determine, by assessing the Commission’s database, that the limited number of 70/80 GHz links in an area pose little risk to mobile terrestrial use of the spectrum.

V. THERE IS BROAD AGREEMENT ON TERMS OF CARRIER USE OF SPECTRUM

Parties in this proceeding largely agree on the terms for licensed, exclusive use of millimeter wave spectrum. T-Mobile addresses those issues below. Based on industry alignment, the Commission should adopt rules based on these consensus positions.

Block Size. Parties generally agree on a standard 200 megahertz block size in the millimeter wave bands, subject to some band-specific variations.^{98/} In setting the block sizes for specific bands, T-Mobile urges the Commission ensure that the block sizes are proportional to the amount of spectrum available, take into consideration a band’s location in the spectrum, and promote in-band competition where possible – which may result in smaller block sizes in some bands.^{99/} T-Mobile disagrees with parties suggesting the Commission should use block sizes larger than 200 megahertz in the target bands^{100/} – doing so may limit the number of potential entrants into the bands and impede competition.

37 GHz Lower Band Segment Channelization. As numerous parties agree, the Commission should adopt its proposal^{101/} to establish a 100 megahertz minimum channel size for

^{98/} See, e.g., CTIA Comments at 11 (“Where possible, the Commission should subdivide each of the new millimeter wave bands into wide channels of 200 megahertz blocks.”); Huawei Comments at 8 (“Huawei would prefer a base 200 MHz sub-band channel assignment across all eight of the bands.”); Samsung Comments at 6 (“First, the spectrum block size for additional spectrum bands should generally be 200 MHz, with some exceptions in constrained spectrum blocks.”); NCTA Comment at 16-17 (urging the Commission to license the 32 GHz band in 200 megahertz blocks); TIA Comments at 5-6 (“TIA urges the Commission to generally implement minimum block sizes of 200 MHz throughout the UMFUS bands.”).

^{99/} See also T-Mobile Comments at 10.

^{100/} See, e.g., AT&T Comments at 7 (arguing for 200 megahertz channels at minimum, with even larger blocks where possible); Nokia Comments at 8 (arguing that the 47 GHz band should be licensed into six blocks of 500 megahertz each and the 50 GHz band should be licensed into five blocks of 400 megahertz each with an extra 200 megahertz block); TIA Comments at 5-6 (“TIA urges the Commission to generally implement minimum block sizes of 200 MHz throughout the UMFUS bands. But . . . the Commission should also include some 400 MHz and 800 MHz blocks in appropriate bands.”).

^{101/} See FNPRM, ¶ 454.

the 37 GHz Lower Band Segment and allow aggregation up to 600 megahertz.^{102/} The Commission should reject calls to refrain from setting a minimum channel size and to instead use a coordination mechanism such as an SAS in the band.^{103/} An SAS is unsuitable in the millimeter wave bands for reasons discussed above, and a guaranteed minimum channel size designed to satisfy high-bandwidth demands will help create a market for equipment in the band.

Moreover, the Commission should revisit its decision to require operability across the entire 37-40 GHz band.^{104/} The licensed segment of the 37-40 GHz band will likely be available for use before a sharing regime is adopted for the 37 GHz Lower Band Segment. There is no reason why introduction of service using that spectrum should be delayed in order to also incorporate the adopted sharing regime for the 37 GHz Lower Band Segment into the operability protocol. Moreover, an operability requirement covering both licensed and unlicensed spectrum presumes that both segments of the band will be used to provide the same service. However, there is no evidence that this presumption is accurate. Accordingly, in adopting rules governing the 37 GHz Lower Band Segment, the Commission should clarify that the operability requirements applicable to the remainder of the 37-40 GHz band do not apply.

Performance Requirements. The record is clear that the Commission should refrain from adopting additional performance metrics at this time as it is not yet evident how technology in the millimeter wave bands will develop, and that, if anything, the Commission should only detail further non-exhaustive performance requirement safe harbors.^{105/} As T-Mobile previously

^{102/} See 5G Americas Comments at 12; TIA Comments at 6.

^{103/} See Dynamic Spectrum Alliance Comments at 5; Public Knowledge and the Open Technology Institute at New America Comments at 12.

^{104/} See *Report and Order*, ¶ 322.

^{105/} See, e.g., CCA Comments at 7; CTIA Comments at 15-18; Verizon Comments at 8; Straight Path Comments at 11; Ericsson Comments at 18.

noted, it may be appropriate, as technologies develop and performance deadlines draw nearer, for the Commission to create additional safe harbors based on developing use cases, but it believes that taking this step now is premature.^{106/} The Commission should reject calls to impose keep-what-you-use or use-it-or-share-it regimes.^{107/} As detailed above, these approaches would only serve to “create uncertainty, undermine investment, and stifle innovation”^{108/} in the millimeter wave bands.

Geographic Licensing. As T-Mobile urged previously,^{109/} and as other recognize,^{110/} the Commission should license all target bands in the *FNPRM* on a Partial Economic Area basis, consistent with the licensing of the 39 GHz band as well as other lower spectrum bands.^{111/}

Mobile Spectrum Holdings. Verizon argues that the Commission should not impose any spectrum aggregation limits on the target bands in the *FNPRM*.^{112/} Contrary to Verizon’s contention, there is a clear need for both an overall and an in-band mobile spectrum holding limit for the bands targeted by the *FNPRM*. Verizon’s argument that “[i]t would be impossible for any firm to exclude a competitor by purchasing ‘too much’ of the spectrum released early on because that competitor” will be able to bid at some future point on additional millimeter wave

^{106/} See T-Mobile Comments at 26.

^{107/} See Inmarsat Comments at 20-21; O3b Comments at 13-14; Microsoft Comments at 14.

^{108/} CTIA Comments at 19; see also Mobile Future Comments at 6 (“Adopting a use-or-share requirement would needlessly limit licensees’ flexibility to examine different uses and technologies, and could imperil development of innovative 5G technologies in the bands.”).

^{109/} See T-Mobile Comments at 26-27.

^{110/} See AT&T Comments at 13; Samsung Comments at 6.

^{111/} See *Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions*, Report and Order, 29 FCC Rcd. 6567, ¶ 71 (2014) (adopting PEAs as the service area for the 600 MHz Band licenses).

^{112/} See Verizon Comments at 7.

spectrum coming down the pipeline^{113/} assumes too much. First, if an entity is able to dominate millimeter wave band holdings “early on,” that entity will secure a significant competitive advantage, even if additional spectrum is released later. In fact, that is precisely what Verizon is in the process of achieving in its lease of the majority of the 28 GHz band spectrum from Nextlink Wireless.^{114/} Qualcomm has announced that it is developing a 5G modem for use with Verizon’s leased 28 GHz spectrum.^{115/} By acquiring rights to use the 28 GHz band now, before other spectrum is available, Verizon is solidifying its first-mover advantage by ensuring that development efforts are focused on the spectrum it controls.

Second, Verizon’s position against any aggregation limits – and by extension against in-band limits – rests on the assumption that millimeter wave spectrum is fungible, an assumption that may not be true, especially given that it is not yet clear how technical differences in millimeter wave spectrum will affect providers’ ability to satisfy different use cases. As CCA notes, “any adopted aggregation limit also must apply to the future mmW bands on an in-band basis to be sufficiently effective.”^{116/} The Commission should facilitate competition and a healthy device ecosystem by adopting both in-band and overall spectrum holding limits for the target bands.

Digital Station Identification. No party supports requiring UMFUS licensees to transmit digital station identification – agreeing that it is unnecessary – and most agree that it is

^{113/} *Id.* at 7-8.

^{114/} *See Application of Cellco Partnership d/b/a Verizon Wireless and Nextlink Wireless, LLC For Consent to Long-Term De Facto Transfer Spectrum Leasing Arrangement*, Memorandum Opinion and Order, 31 FCC Rcd. 7767 (2016).

^{115/} *See* Press Release, Qualcomm, Qualcomm Showcases 5G Leadership by Announcing its First 5G Modem Solution (Oct. 17, 2016) (“The Snapdragon X50 5G modem will initially support operation in millimeter wave (mmWave) spectrum in the 28GHz band.”).

^{116/} CCA Comments at 3.

also unnecessary for unlicensed services.^{117/} Therefore, the Commission should not require transmission of digital identification.

Minimum Bandwidth for Given BS/MS/Transportable Transmit Power Levels.

Nextlink Wireless opposes downward scaling of the maximum power limits that apply to mobile devices, arguing that 5G technology is nascent and that technology is currently being developed to support a myriad of use cases, many of which do not yet exist.^{118/} T-Mobile's comments pointed out that parts of 5G networks may require less than 100 megahertz and that, in those circumstances, a power scaling factor could be applied.^{119/} Nevertheless, T-Mobile recognizes that the power scaling issue is under consideration by 3GPP. Therefore, while T-Mobile continues to believe that there should be no minimum bandwidth for 5G devices, the question of whether power scaling is employed under those circumstances is best left to technical standards setting bodies like 3GPP. Adopting a particular scaling approach now might unnecessarily constrain the work that 3GPP is conducting in this area, and this standards setting process should be concluded before the Commission takes further action.

VI. CONCLUSION

T-Mobile applauds the Commission's continued efforts in this proceeding to make millimeter wave spectrum available to meet next generation mobile terrestrial broadband needs. Those requirements are best met through the allocation of spectrum for licensed use on an exclusive, geographic area basis. The effectiveness of the Commission's actions will be diminished if spectrum is required to be shared with satellite operators or made available through

^{117/} See, e.g., Verizon Comments at 1; Ericsson Comments at 21; Samsung Comments at 7; TIA Comments at 22.

^{118/} See Nextlink Wireless Comments at 30.

^{119/} T-Mobile Comments at 31.

an SAS. The Commission should therefore solidify its leadership role in 5G by promptly making the target bands available. In so doing, the Commission should take the steps T-Mobile proposed in its initial comments and has suggested above to encourage the greatest amount of investment and innovation in the bands.

Respectfully submitted,

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October 31, 2016