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

In the Matter of	)	
	)	
Use of Spectrum Bands Above 24 GHz For Mobile Radio Services	)	GN Docket No. 14-177
	)	
Establishing a More Flexible Framework to Facilitate Satellite Operations in the 27.5-28.35 GHz and 37.5-40 GHz Bands	)	IB Docket No. 15-256
	)	
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 MICROSOFT CORPORATION

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I. INTRODUCTION AND SUMMARY

The Commission has put forward proposed technical rules for the millimeter wave (mmW) bands to create a flexible spectrum policy that ensures wide access to spectrum, balancing the interest of multiple current and potential users and uses, and encouraging wireless innovation. In keeping with this spirit of the Spectrum Frontier, Microsoft Corporation ("Microsoft") submits these reply comments to address the comments submitted in the above-referenced proceeding,[1] which, taken as a whole, underscore the need for a flexible framework that helps usher in the age of fifth generation (5G) wireless services by expanding unlicensed use in the 60 GHz, 70 GHz, and 28 GHz bands.

The comments reflect broad agreement that additional unlicensed spectrum in the 60 GHz band is needed to keep pace with surging demand for broadband data. Several commenters agree with Microsoft that the upper boundary for unlicensed use should be extended to 72.5 GHz, which would create four additional WiGig channels, leading to far better utilization of the extended 60 GHz band spectrum than extension just to 66 GHz (creating just one new channel) or even to 71 GHz (which would create just three). FCC leadership on this issue is needed to guide equipment manufacturers and ultimately drive global harmonization efforts.

Several commenters agree that the Commission should permit devices with integrated 60 GHz radios to operate on board aircraft. The analyses put forward indicate that the use of such devices pose minimal risks to radio astronomy (RAS) and other licensed services. CORF acknowledges that its "assumptions in this analysis are somewhat tentative."

[1] Unless otherwise noted, all citations to comments herein are to initial comments filed in In the Matter of Use of Spectrum Bands Above 24 GHz For Mobile Radio Services et al, GN Docket No. 14-177 (January 2016).

A number of commenters also share Microsoft's view that the 72.5-76.0 GHz band should be opened to greater use, including an express recognition that sharing this band between indoor and outdoor applications is practical. These comments are consistent with Microsoft's view that allowing unlicensed indoor use of the 72.5-76.0 GHz band will maximize its utility without interfering with RAS or fixed satellite service operations, and without requiring new sharing mechanisms (e.g., a registration database).

Finally, the comments show strong support for making the 28 GHz band available for mobile use. Microsoft proposes that 500 MHz of the band be set aside for unlicensed use so that the large blocks of spectrum can be accessed by a wide variety of potential users in every domestic market. A TV white spaces-like database can protect incumbent licensees. For the remaining 350 MHz, Microsoft supports the Commission's proposal with the one exception that there should be no delay in when licensees are subject to a use-it-or-share-it regime.

II. 60 GHz BAND

A. Additional Unlicensed Spectrum in the 60 GHz is Needed to Meet the Growing Demand

The record shows broad agreement that additional unlicensed spectrum capacity in the 60 GHz band is required to keep up in the growth in broadband demand.[2] A majority of mobile

[2] Comments of Qualcomm, at 5 (recognizing that "wide channels available in these higher [above 24 GHz] millimeter wave spectrum bands will be needed to support growing traffic demands"; Comments of the Consumer Technology Association f/k/a/ The Consumer Electronics Association, at 8 ("unlicensed spectrum is a hotbed for innovation and integral in addressing the spectrum crunch"); Comments of the National Cable & Telecommunications Association ("a contiguous band of unlicensed spectrum from 57-71 GHz would promote the expansion of existing unlicensed operations and the development of new and innovative unlicensed applications"); Comments of Dynamic Spectrum Alliance ("Comments of DSA"), at 2 (noting that harmonization of rules for the 64-71 GHz and 54-64 GHz bands "benefits the industry and consumers by creating efficiencies and economies of scale"); Comments of Google, Inc., at 6-7 (explaining that "harmonized rules for the frequencies between 57 and 71 GHz will allow economies of scale and other efficiencies, thereby facilitating rapid and widespread deployment of unlicensed devices"); Comments of IEEE 802, at 4 ("extension of the 60 GHz band as a positive change to the Commission's rules, and recommends that the Commission proceed with extending the band to cover 57 to 71 GHz

traffic is now video traffic,[3] which is growing faster than all other types, such that 75 percent of all mobile traffic will be video by 2020.[4] The majority of video traffic is offloaded to Wi-Fi, explaining in large part why more broadband data now travels over unlicensed spectrum than licensed LTE spectrum.[5] The large channel sizes in the 60 GHz band are particularly well-suited to meeting the demand for video that is driving the overall need for more capacity, as commenters have recognized.[6] The larger channel sizes of the 60 GHz band allow for near-instantaneous download of video that could only be streamed given the smaller channel sizes in the existing 2.4 and 5 GHz bands.

B. Extending the 60 GHz band to 72.5 GHz Would Provide Needed Data Capacity

As recognized by Microsoft and other commenters, extending the current 60 GHz band to 72.5 GHz would provide much-needed additional capacity to keep up with the projected growth in broadband data.[7] Extending the current 60 GHz unlicensed band to 71 GHz, as proposed by the Commission, would provide only three unlicensed channels compliant with IEEE 802.11ad standard and the Wi-Fi Alliance's WiGig certification, the former of which specifies a channel bandwidth of 2.16 GHz, leaving 800 MHz of otherwise usable spectrum to lie fallow. Extending

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under the same Part 15 general provisions that allow operation in the currently authorized 60 GHz band"); Comments of Wi-Fi Alliance at 5 ("Extending Part 15 operations to the 64-71 GHz band would … greatly enhance the capacity of next-generation WiGig technologies"); Comments of Open Technology Institute at New America and Public Knowledge at 7 ("OTI & PK strongly support the Commission's proposal to extend the Part 15 operations currently permitted in the 57-64 GHz band to the adjacent 64-71 GHz band immediately above."); Comments of ViaSat, at 21-22 (noting that unlicensed use under Part 15 would "facilitate higher speeds and faster throughput for next-generation Wi-Fi and Wi-Gig networks").

[3] Cisco VNI Survey, at 2.

[4] Cisco VNI Survey, at 3.

[5] Between 60% and 80% of mobile device data is carried by Wi-Fi networks. Mobidia, "Network Usage Insights: Average Data Usage for LTE, 3G and Wi-Fi of Wireless Subscribers in the USA, Q3 2014" (Nov. 2014); OTI & PK Comments at 8-9 (noting that the European Commission projects an 80% rate of Wi-Fi offloading by end of 2016).

[6] See Comments of Qualcomm, at 11, 14 (recognizing that "wide channels available in these higher millimeter wave spectrum bands will be needed to support growing traffic demands," and specifically noting the utility of the 60 GHz band for streaming Ultra HD video)

[7] Comments of Open Technology Institute at New America and Public Knowledge at 7 ("OTI & PK . . . further recommend that the Commission consider extending harmonized unlicensed access up to 72.5 GHz."); Comments of the Information Technology Industry Council, at 7 (urging that "the Commission should look closely at extending the 64-71 GHz band to include 71-72.5 GHz.").

the upper boundary for unlicensed use from 64 GHz band to 72.5 GHz, rather than 71 GHz, would provide an additional unlicensed WiGig channel,[8] resulting in four new 2.16 GHz channels. Combined with the three existing channels in the 57-64 GHz range, this would provide seven non-overlapping channels – facilitating optimal utilization of the extended 60 GHz band spectrum.

Extending the current unlicensed band only to 66 GHz – as proposed by some wireless carriers and network equipment makers – would provide just one additional WiGig channel. This would be insufficient to meet the projected demand for unlicensed use. Mobile network operators currently utilize unlicensed spectrum in both the 2.4 and 5 GHz spectrum bands. Microsoft is not aware of any regulatory barriers that would prevent licensed operators from using the additional unlicensed channels in the 60 GHz as part of their own heterogeneous networks and using appropriate technical mechanisms to ensure fair coexistence with other users. If the 66 to 71 GHz segment of the band is reserved for licensed operations, the benefits of an extended 60 GHz band will be largely lost as only one additional channel will be added and the public interest will not be best served.

C. Extending Unlicensed Use to 72.5 GHz Demonstrates Continued U.S. Leadership in Spectrum Management

Extending the existing unlicensed 60 GHz band further than 71 GHz – up to 72.5 GHz – would reinforce the Commission's continued leadership in spectrum management, particularly its recognition of the need to make available both additional licensed *and* unlicensed spectrum for broadband use. The WRC-15 decision to study the 66-76 GHz band for potential IMT-2020 identification does not preclude eventual harmonization on unlicensed use. On the contrary, other countries are likely to consider a further extension of the 60 GHz band if the FCC moves

[8] Comments of the Information Technology Industry Council, at 7 ("Expanding the current 64-71GHz band to 72.5 GHz may allow an additional channel to fit in that band and make better use of the top of the 64-71 GHz band.").

forward, leading to global harmonization of the additional channels. With additional software drivers, the same radio front-end used for producing WiGig channels between 57-64 GHz could be used to extend the range to 72.5 GHz. The Commission's action will also provide needed guidance for equipment manufacturers, which will further drive eventual harmonization and the economies of scale that lead to lower costs for consumers. The Commission has a unique opportunity to create seven contiguous WiGig channels, with new channels that – thanks to reduced oxygen attenuation in spectrum above 64 GHz – are suitable for a flexible range of uses.

In any case, there is no consensus among commenters that the FCC should defer to the WRC-15 outcome with respect to the 66-71 GHz spectrum range. In fact, Microsoft observed a gross inconsistency among a subset of commenters who on one hand vigorously applaud the Commission's actions to propose technical rules for the 28 GHz band even in the face of WRC-15's decision to not study the 28 GHz band for potential IMT-2020 identification, but on the other hand want the Commission to obediently follow the WRC-15's recommendation to study the spectrum range 66-71 GHz for potential IMT-2020 identification.[9] The Commission appropriately released its Spectrum Frontiers NPRM prior to the beginning of WRC-15. It provided guidance on the Commission's domestic priority in having a balance of licensed and unlicensed spectrum in the millimeter wave bands and reflected the pivotal role of unlicensed spectrum in providing broadband connectivity and capacity.

D. The Commission Should Allow Use of Devices with 60 GHz Radios on Aircraft

As recognized by other commenters, the Commission should permit devices with 60 GHz radios to operate on board aircraft.[10] There is broad agreement that 60 GHz radios will be

[9] *See*, *e.g.*, Comments of Cisco Systems, Inc., at 4; Comments of 4G Americas, at 16; Comments of Avanti Communications Group PLC, at 2, 8.
[10] *See*, *e.g.*, Comments of Wi-Fi Alliance, at 7-8, Comments of Boeing, at 13-14, Comments of Dynamic Spectrum Alliance, at 3.

integral to future portable devices and that these devices will be carried aboard transport aircraft.[11]

The record demonstrates that these devices pose minimal risk to radio astronomy due to the combination of the nature of the devices, the high frequencies involved, and the characteristics of aircraft. For example, Boeing explains that both ITU studies *and* internal testing are consistent with the conclusion that "modern aircraft can be expected to provide 35 dB of fuselage attenuation, which includes 10 dB of attenuation to in cabin signals above 1 GHz even under worst-case viewing angles, and up to 45 dB of attenuation for other viewing angles and non-cabin or other highly shielded areas."[12] Indeed, Boeing explains that the fuselage's "high degree of shielding" has the effect of "substantially reducing or *effectively eliminating* emissions from low-power devices used within the aircraft cabin."[13]

The National Radio Astronomy Observatory (NRAO) operates three radio astronomy facilities and mentions a fourth (Kitt Peak) that it established but no longer operates. NRAO's primary concern is in regards to signals generated at the harmonic frequencies of the extended 60 GHz band.[14] There should be general agreement that the signal strengths at these harmonic frequencies are considerably *weaker* signals than those of the fundamental frequencies. The question is whether the received signals, if any, after all the losses and the geometries involved, are above the threshold that will cause a degradation to RAS operations. Boeing's comments show that NRAO's concerns about these low-power harmonics are speculative and somewhat misplaced because as Boeing explains, "[t]he low power of onboard wireless communications

[11] *See*, T. S. Rappaport, et al., "State of the Art in 60 GHz Integrated Circuits and Systems for Wireless Communications," Proceedings of IEEE, Aug. 2011, pp. 1396-1430, filed as Attachment 3 to Comments of NYU Wireless, Notice of Inquiry (January 15, 2015); see also https://www.qualcomm.com/news/releases/2016/01/05/qualcomm-80211ad-products-lead-way-multi-band-wi-fi-ecosystem.
[12] Comments of Boeing, at 13.
[13] Comments of Boeing, at 13 (emphasis added).
[14] Comments of NRAO, at 5.

devices, combined with the substantial attenuation of the aircraft skin and free space losses provide a high degree of assurance that use of the extended 60 GHz band on aircraft would be *imperceptible* to the handful of terrestrial-based radio astronomy stations."[15]

NRAO also says that "transmissions must also not be directed at a radio astronomy station within line of sight over some portion of the 60 GHz band as well."[16] For the isolated locations NRAO cites, it is not evident when such a line-of-sight case from aircraft to the ground-based receiver would occur. In any case, as explained below, the beam forming aspect of WiGig transmitters makes it unlikely that energy will escape the aircraft at all.

The concerns of the National Academy of Sciences' Committee on Radio Frequencies (CORF) need to be examined in the same vein as those of NRAO. CORF's analysis focuses on the Earth exploration-satellite service (EESS) use case in the 57-59.3 GHz sub-band for weather forecasting. EESS operations in the 57-59.3 GHz band provide data that contributes to weather forecasts but is not the sole source of weather forecasts. Nevertheless, weather forecasting is important and any concerns expressed require due consideration. Unfortunately, as CORF admits, its analysis is "somewhat tentative." CORF points out, "The transmission power may be less than 1 W; it is unlikely there often will be a direct [line of sight] from the transmitter to the satellite; and the WiGig devices proposed for airborne use have a standard 2 GHz of bandwidth."[17]

In fact, the use of beam forming for WiGig channels makes such a line of sight (LOS) extremely unlikely. WiGig access points on board aircraft will likely target narrow areas within the plane rather than "spraying" transmissions about the aircraft cabin. At the 60 GHz band frequencies, there will need to be a line of sight between the access point and the WiGig-capable

[15] Comments of Boeing, at 13 (emphasis added).
[16] Comments of NRAO, at 14.
[17] Comments of CORF, at 14.

device. Because energy from a transmitter is directed in a beam to the WiGig device, no energy is directed toward windows, which seems to be the source of leakage that CORF is most concerned about.[18] Transmission power will also be reduced within the aircraft cabin due to multiple reflections, scattering and absorption within the cabin, and by the fuselage. CORF's "tentative" analysis also mistakenly focuses only on 60 GHz band access points. It is worth noting that the transmission power levels for device-to-device communications in the 60 GHz band are even lower than the access point communications to WiGig capable devices, further reducing the chance that transmissions would interfere with EESS.

Report ITU-R M.2283-0 is entitled "Technical characteristics and spectrum requirements of Wireless Avionics Intra-Communications systems to support their safe operation." [19] Annex 3 of that report examines "propagation considerations" with respect to Wireless Avionics Intra-Communications systems and sets forth a model of aircraft interior-to-exterior attenuation levels that is valid at frequencies up to 18 GHz.[20] In 2012, CEPT released ECC Report 175, entitled "Co-existence study considering UWB applications inside aircraft and existing radio services in the frequency bands from 3.1 GHz to 4.8 GHz and from 6.0 GHz to 8.5 GHz."[21] Taken together, the two reports should provide the Commission confidence that aircraft interior-to-exterior attenuation at 60 GHz would be the same or even greater than that listed in Table 5 of Rep. ITU-R M.2283-0.

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[18] Comments of CORF, at 14 (CORF itself appears to recognize that its concerns about signal reflections escaping through windows could be addressed by installing RF reflective window films "at very low cost to the aircraft manufacturers.")

[19] *Technical characteristics and spectrum requirements of Wireless Avionics Intra-Communications systems to support their safe operation*, Report ITU-R M.2283-0 (Dec. 2013), *available at* http://www.itu.int/dms_pub/itu-r/opb/rep/R-REP-M.2283-2013-PDF-E.pdf.

[20] *Id*. at 51.

[21] Co-existence study considering UWB applications inside aircraft and existing radio services in the frequency bands from 3.1 GHz to 4.8 GHz and from 6.0 GHz to 8.5 GHz, ECC Report 175 (March 2012), *available at* http://www.erodocdb.dk/docs/doc98/official/pdf/ECCRep175.pdf.

III. 70 GHz BAND

A. The FCC Should Allow Indoor Use of the 72.5-76.0 GHz Band under Its Part 15 Rules

The Commission should authorize indoor operations for the frequency range 72.5-76.0 GHz under Part 15 of its rules. Few issues have been raised regarding more flexible use of this spectrum. Several commenters – Huawei, Nokia, and the Dynamic Spectrum Alliance – have described the benefits of opening this frequency segment for greater use.[22] While those commentators have not focused on indoor-only uses, they note that sharing on an unlicensed basis can be achieved without interfering with existing users, and Huawei's comments recognize that "the sharing between indoor and outdoor applications is practical due to shielding effects of buildings."[23] With the addition of software drivers, the same front-end radio can be used for unlicensed WiGig operations between 57-76 GHz allowing for a low incremental cost.

The frequencies are well-suited for additional capacity for wireless data services and low-power enterprise applications. In addition, sharing the spectrum with indoor-only users on an unlicensed basis can be achieved without interfering with existing users. Indoor-only use will not conflict with current and anticipated users of the band for several reasons. First, non-Federal users are primarily point-to-point links that would not be affected by unlicensed indoor use. Second, although a handful of Radio Astronomy Service (RAS) facilities use this band, those sites are in relatively isolated locales, and indoor signals will not propagate very far. Therefore, it will be easy to meet their request for a 1 km minimum separation. In fact, it is likely that the RAS facility operator would be able to enforce it directly. One would expect that RAS facilities would have little difficulty in identifying any interfering site that was within the 1 km separation

[22] Comments of Huawei, at 7; Comments of Nokia, at 12; Comments of DSA, at 3 (strongly encouraging "the Commission to make it a priority to open 71-76 GHz band for Part 15 operations, provided that such use can coexist with lightly licensed operations on a non-interfering basis.").

[23] Comments of Huawei, at 21. Nokia's comments similarly recognize the feasibility of sharing between microwave backhaul and mobile broadband access in these bands. Comments of Nokia, at 14.

zone as these facilities are located in remote areas. Third, indoor-only use will not interfere with Federal fixed satellite services at military facilities.

In addition, indoor-only use will not require additional sharing mechanisms. It is envisioned that such indoor unlicensed 70 GHz devices would utilize a listen-before-talk mechanism for sharing spectrum. Thus, no registration database for point-to-point links would be necessary for the proposed indoor-only use.

IV. 28 GHz BAND

The record shows that there is broad support for the Commission's proposal to make the 28 GHz band available for services utilizing mobile 5G-like capabilities. However, steps must be taken to ensure that multiple providers will be able to access the 28 GHz band in each licensing area, be it county or Basic Trading Area (BTA), in order for the provider to have a national footprint. Therefore, the Commission should set aside 500 MHz (27.7-28.0 GHz) of the 850 MHz in the 28 GHz band A1 block for unlicensed use to ensure options for broadband connectivity in addition to 5G services. The unlicensed spectrum could be accessed directly or be part of a heterogeneous network. Coordination with satellite earth stations and fixed links can be achieved through a TV white spaces-like database.

Most Americans live in areas where there are active LMDS licenses in place. At present active A-block licensees currently cover the 50 largest BTAs by population and 70 of the 75 most populated BTAs. Because a geographic license is granted for the entire 850 MHz block, a single licensee per geographic area is authorized to use the spectrum. The Commission's proposal calls for providing each LMDS licensee the mobile rights for each county within each BTA. Review of the Commission's Universal Licensing System database and county-based population figures from the 2010 Census indicates a concentration of active LMDS licenses in

the top 75 BTAs.[24] Exhibit 1 shows the license spectrum range for each LMDS licensee and sub-licensee in the 28 GHz A-1 block for the top 75 BTAs.

If the Commission assigns current LMDS licensees mobile rights for each county within each BTA currently licensed as proposed, there is a question of how this concentration may impact future competition for mobile services in the 28 GHz band. Such concentration may also have ramifications with respect to development of the ecosystem, particularly with respect to enabled devices. As a result, Microsoft sees a need for there to be multiple national mobile network operators, cable system operators and others with access to 28 GHz spectrum across the nation's major metropolitan markets.

If, as Microsoft proposes, mobile rights for 500 MHz of the 28 GHz A1 block are reserved for unlicensed use, the availability of at least a portion of the 28 GHz band for multiple users can be assured. Within the unlicensed segment of the band, mobile operators, cable system operators and unlicensed-only service providers can make use of the 28 GHz band for a variety of mobile services and applications using appropriate mechanisms to ensure fair sharing.

The remainder of the 350 MHz (28.0-28.35 GHz) can be licensed in accordance with the Commission's proposal for flexible-use, geographic-based licenses. However, we agree with other commenters that the Commission should not wait to implement its proposal for "use it or share it".[25] Spectrum access systems (SAS) for the 28.0-28.35 GHz segment will allow greater use of the 28 GHz band – with little risk of harmful interference to existing licensees. Shared use of this portion of the band is an important measure to ensure efficient use of available spectrum and to minimize the risk of spectrum warehousing. By permitting use-it-or-share-it

[24] *See also* Comments of XO Communications, Inc., at 4 (noting that it holds 91 LMDS licenses covering 770 counties.

[25] See Comments of Open Technology Institute at New America and Public Knowledge, at 11-12 ("There is no legitimate reason to let a large geographic license area lie fallow for five years"); Comments of Federated Wireless, at 20-21.

immediately, the Commission will provide a strong positive signal to standards setting bodies, SAS providers, and equipment manufacturers.

We disagree that SASs are unproven or too complicated to implement. Several commentators recognize that database-based systems can be used in the 28 GHz band.[26] The Commission has established rules for the operation of a SAS for the 3.5 GHz band, which is in the process of being developed for eventual launch. Arguments against application of the SAS to (part of) the 28 GHz band sound similar to those being made regarding whether the Commission should take any action regarding 5G services in the first place because the technical specifications have not yet been completed and the earliest deployment dates under discussion are several years out. Spectrum access systems can be implemented without creating a regulatory or administrative burden. The Commission notes that the information about point-to-point links is already being collected.[27] Satellite earth station operators are in a good position to combine this information with technical information about fixed satellite service facilities in order to manage exclusion zones around gateway earth stations.[28] Mobile licensees would be obligated to provide certain information to the SAS providers. The SAS represents the best technology approach to permit sharing among multiple users in the spectrum band and allow implementation of a "use it or share it" framework that encourages buildout and use of exclusive license rights.

[26] See Comments of Comsearch at 3; Comments of Federated Wireless at 18-19; Comments of ViaSat at 18-19.
[27] *See* In the Matter of Use of Spectrum Bands Above 24 GHz For Mobile Radio Services, *et al*., GN Docket No. 14-177, *et al*., *Notice of Proposed Rulemaking*, FCC-15-138, 30 FCC Rcd 11878, 11923 ¶ 152 (released October 23, 2015) ("*NPRM*").
[28] See Comments of ViaSat, at 13-14 and Exhibit 1 (noting that protection zones should be "extremely small").

V. CONCLUSION

Microsoft calls on the Commission to reaffirm its long-term vision and global leadership by defining a flexible framework for the mmW bands. Unlicensed use in the 60 GHz, 70 GHz, and 28 GHz bands should be a cornerstone of that framework. First, unlicensed use should be extended from 64 GHz all the way to 72.5 GHz allowing for a total of seven WiGig channels. Second, restrictions on using devices operating in extended 60 GHz band aboard aircraft should be lifted. Third, the 72.5-76.0 GHz band should be opened to unlicensed indoor use. Finally, 500 MHz of the 28 GHz band should be made available under the Commission's Part 15 rules, with the balance made available along the lines of the Commission's proposal, except that "use it or share it" should apply right from the start.

Microsoft again expresses its appreciation to the Commission for its commitment to flexible spectrum use, which is critical to ushering in the age of 5G, and Microsoft looks forward to working further with the Commission on these issues.

Respectfully submitted,

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Exhibit 1
LMDS A-1 Block License Spectrum Range for Active LMDS Licensees and Sub Licensees for the Largest 75 BTAs by Population Based on the 2010 U.S. Census

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BTA Rank	BTA Name	BTA No.	2010 Population	A1 Block Licensed	A1 Block LMDS License Spectrum Range
1	New York, NY	321	20,264,294	Yes	NextLink: [27.6-27.95 GHz, 28.05-28.35 GHz] (Sub band NY8) T-Mobile: [27.6-27.65 GHz, 28.05-28.01 GHz] (Sub band NY7); [27.5-27.6 GHz, 27.95-28.05 GHz] (Sub band NY9) Straight Path (application): [27.5-27.6 GHz, 27.65-28.05 GHz, 28.1-28.35 GHz] (Sub band NY6) Windstream (Sub band NY6)
2	Los Angeles, CA	262	17,895,552	Yes	NextLink*:27.64-27.95 GHz, 28.09-28.35 GHz T-Mobile: 27.5-27.64 GHz, 27.95-28.09 GHz
3	Chicago, IL	78	9,014,705	Yes	NextLink*:27.5-28.35 GHz
4	San Francisco-Oakland-San Jose, CA	404	7,620,896	Yes	Straight Path*:27.55-27.95 GHz, 28.0-28.35 GHz T-Mobile: 27.5-27.55 GHz, 27.95-28.0 GHz
5	Dallas-Ft. Worth, TX	101	6,794,511	Yes	NextLink*: 27.5-27.8 GHz, 27.9-28.25 GHz T-Mobile:27.8 -27.9 GHz, 28.25-28.35 GHz
6	Philadelphia, PA-Wilmington, DE-Trenton, NJ	346	6,488,753	Yes	NextLink*:27.5-27.8 GHz, 27.9-28.25 GHz T-Mobile: 27.8-27.9 GHz, 28.25-28.35 GHz
7	Houston, TX	196	6,298,003	Yes	NextLink: 27.5-28.35 GHz
8	Washington, DC	461	5,543,091	Yes	NextLink: 27.5-28.35 GHz
9	Atlanta, GA	24	5,450,974	Yes	NextLink: 27.6-27.95 GHz, 28.05-28.35 GHz T-Mobile: 27.5-27.6 GHz, 27.95-28.05 GHz
10	Detroit, MI	112	4,834,185	Yes	NextLink: 27.6-27.95 GHz, 28.05-28.35 GHz T-Mobile: 27.5-27.6 GHz
11	Boston, MA	51	4,552,402	Yes	NextLink: 27.6-27.95 GHz, 28.05-28.35 GHz T-Mobile: 27.5-27.6 GHz
12	Phoenix, AZ	347	4,420,079	Yes	NextLink: 27.5-27.55 GHz, 27.95-28.0 GHz, 28.092-28.242 GHz
13	Miami-Fort Lauderdale, FL	293	4,317,591	Yes	NextLink: 27.6-27.95 GHz, 28.05-28.35 GHz T-Mobile: 27.5-27.6 GHz, 27.95-28.05 GHz
14	Seattle-Tacoma, WA	413	3,650,985	Yes	NextLink*: 27.5-28.35GHz
15	Minneapolis-St. Paul, MN	298	3,606,507	Yes	NextLink: 27.5-28.35 GHz
16	San Diego, CA	402	3,095,313	Yes	NextLink: 27.5-27.55 GHz, 27.95-28.0 GHz, 28.092-28.242 GHz
17	Denver, CO	110	3,072,626	Yes	NextLink: 27.5-27.65 GHz NextLink (Application): 27.65-27.99 GHz, 28.14-28.35 GHz
18	Tampa-St. Petersburg-Clearwater, FL	440	3,050,896	Yes	NextLink: 27.6-27.95 GHz, 28.05-28.35 GHz T-Mobile: 27.5-27.6 GHz, 27.95-28.05 GHz

BTA Rank	BTA Name	BTA No.	2010 Population	A1 Block Licensed	A1 Block LMDS License Spectrum Range
19	St. Louis, MO	394	2,999,346	Yes	NextLink: 27.5-28.35 GHz
20	Cleveland-Akron, OH	84	2,937,326	Yes	First Communications: 27.5- 28.35 GHz
21	Baltimore, MD	29	2,768,468	Yes	NextLink *: 27.5-28.35 GHz
22	San Juan, PR	488	2,650,485	Yes	Lightspeed: 27.5-28.35 GHz
23	Charlotte-Gastonia, NC	74	2,592,768	Yes	NextLink: 27.5-28.35 GHz
24	Portland, OR	358	2,420,282	Yes	NextLink: 27.5-28.35 GHz
25	Pittsburgh, PA	350	2,394,971	Yes	NextLink: 27.5-28.35 GHz
26	Sacramento, CA	389	2,365,543	Yes	NextLink: 27.6-27.95 GHz, 28.05-28.35 GHz T-Mobile: 27.5-27.6 GHz, 27.95-28.05 GHz
27	Cincinnati, OH	81	2,301,251	Yes	First Communications: 27.5-28.35 GHz
28	San Antonio, TX	401	2,299,239	Yes	NextLink*: 27.5-28.35 GHz
29	Kansas City, MO	226	2,252,246	Yes	NextLink: 27.5-27.55 GHz, 27.95-28.0 GHz, 28.092-28.242 GHz
30	Orlando, FL	336	2,227,871	Yes	Straight Path: 27.5-27.6 GHz, 27.7-28.05 GHz, 28.15-28.35 GHz T-Mobile: 27.6-27.7 GHz, 28.05-28.15 GHz
31	Las Vegas, NV	245	2,201,529	Yes	NextLink: 27.5-28.35 GHz
32	Raleigh-Durham, NC	368	1,933,701	Yes	NextLink: 27.5-28.35 GHz
33	Salt Lake City-Ogden	399	1,924,555	Yes	Straight Path*: 27.5- 28.35 GHz
34	Columbus, OH	95	1,921,040	Yes	First Communications: 27.5-28.35 GHz
35	Nashville, TN	314	1,916,888	Yes	NextLink: 27.5-28.35 GHz
36	Norfolk-Virginia Beach-Newport News-Hampton, VA	324	1,894,061	Yes	Straight Path: 27.5-28.35 GHz
37	Austin, TX	27	1,805,449	Yes	NextLink: 27.5-28.35 GHz
38	Indianapolis, IN	204	1,784,131	Yes	NextLink: 27.5-28.35 GHz
39	Memphis, TN	290	1,655,032	Yes	NextLink: 27.5-28.35 GHz
40	Louisville, KY	263	1,631,400	Yes	NextLink: 27.5-28.35 GHz
41	Greensboro-Winston Salem, High Point, NC	174	1,624,722	Yes	Straight Path: 27.5-28.35 GHz
42	Jacksonville, FL	212	1,615,395	Yes	NextLink: 27.6-27.95 GHz, 28.05-28.35 GHz T-Mobile: 27.5-27.6 GHz, 27.95 GHz-28.05 GHz
43	Providence-Pawtucket, Bedford-Falls River, MA	364	1,600,852	Yes	NextLink: 27.5-27.6 GHz, 27.7-28.05 GHz, 28.15-28.35 GHz T-Mobile: 27.6-27.7 GHz
44	Oklahoma City	329	1,600,758	Yes	NextLink: 27.5-28.35 GHz
45	Knoxville, TN	232	1,458,958	Yes	NextLink: 27.5-28.35 GHz
46	Richmond-Petersburgh, VA	374	1,417,933	Yes	NextLink: 27.5-28.35 GHz
47	Birmingham, AL	44	1,399,166	Yes	NextLink: 27.5-28.35 GHz
48	West Palm Beach-Boca Raton, FL	469	1,360,130	Yes	NextLink: 27.6-27.95 GHz, 28.05-28.35 GHz T-Mobile: 27.5-27.6 GHz, 27.95-28.05 GHz
49	New Orleans, LA	320	1,292,781	Yes	Straight Path: 27.5-28.35 GHz
50	Hartford, CT	184	1,212,381	Yes	NextLink: 27.5-27.6 GHz, 27.7-28.05 GHz, 28.15-28.35 GHz
51	Milwaukee, WI	297	1,206,575	Yes	NextLink: 27.5-28.35 GHz
52	Buffalo-Niagara Falls,	60	1,177,664	Yes	NextLink: 27.5-28.35 GHz

BTA Rank	BTA Name	BTA No.	2010 Population	A1 Block Licensed	A1 Block LMDS License Spectrum Range
	NY				
53	Rochester, NY	379	1,175,001	Yes	NextLink: 27.5-28.35 GHz
54	Grand Rapids, MI	169	1,143,970	No	------
55	Albany-Schenectady, NY	7	1,093,623	Yes	NextLink: 27.5-28.35 GHz
56	Albuquerque, NM	8	1,091,455	Yes	NextLink*:27.5-28.35 GHz
57	Fresno, CA	157	1,081,315	Yes	Straight Path: 27.5-28.35 GHz
58	Omaha, NE	332	1,077,868	Yes	NextLink: 27.5-28.35 GHz
59	Mayaguez/Aguadilla-Ponce, PR	489	1,075,304	Yes	Lightspeed: 27.5-28.35 GHz
60	Little Rock, AR	257	1,064,133	No	------
61	New Haven-Waterbury-Meriden, CT	318	1,052,404	Yes	NextLink: 27.6-27.95 GHz, 28.05-28.35 GHz T-Mobile:27.5-27.6 GHz, 27.95-28.05 GHz
62	Dayton-Springfield, OH	106	1,047,413	Yes	First Communications: 27.5-28.35 GHz
63	Greenville-Spartanburg, SC	177	1,047,071	Yes	Straight Path: 27.5-28.35 GHz
64	Tulsa, OK	448	1,035,292	Yes	NextLink: 27.5-28.35 GHz
65	Lexington, KY	252	1,013,653	Yes	NextLink: 27.5-28.35 GHz
66	Tucson, AZ	447	980,263	Yes	NextLink: 27.5-28.35 GHz
67	Honolulu, HI	192	953,207	No	-----
68	Des Moines, IA	111	897,088	Yes	NextLink: 27.5-28.35 GHz
69	Savannah, GA	410	888,213	Yes	BroadBand One of the Southeast: 27.5-28.35 GHz
70	El Paso, TX	128	870,318	Yes	NextLink*: 27.5-28.35 GHz
71	Spokane, WA	425	841,458	No	-------
72	Baton Rouge, LA	32	801,159	No	-------
73	Worcester-Fitchburg-Leominster, MA	480	798,552	Yes	NextLink: 27.5-27.6 GHz, 27.7-28.05 GHz, 28.15-28.35 GHz T-Mobile: 27.6-27.7 GHz
74	Syracuse, NY	438	791,906	Yes	NextLink: 27.5-28.35 GHz
75	Toledo, OH	444	778,230	Yes	First Communications:27.5-28.35 GHz

* Listed as “lease as a de facto transfer” in the ULS database.