

**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

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SUMMARY

Microsoft Corporation (“Microsoft”) submits these comments in response to the Notice of Proposed Rulemaking (“NPRM”) in the above-referenced proceeding in which the Commission proposes rules for mobile radio services in four millimeter wave bands suitable for future fifth generation (5G) wireless services.¹ Microsoft agrees that the Commission’s overall framework will enable flexibility in the uses and technologies that might be deployed in these bands, while protecting incumbent services. We applaud that the Commission’s proposed service rules examine various licensing mechanisms including licensed, unlicensed and shared spectrum use.

In particular, we appreciate that the Commission is proposing to expand the current 60 GHz band (57-64 GHz) to higher frequencies and make the spectrum available for Part 15 unlicensed operations under harmonized rules to the greatest extent possible. Microsoft believes that the 60 GHz band should be extended to 72.5 GHz rather than 71.0 GHz to make the most efficient use of the spectrum, given the IEEE standard for channel size and ITU-R recommended channel plan. Additionally, the Commission should allow indoor Part 15 unlicensed operations between 72.5 GHz and 76 GHz as it will not conflict with the lightly-licensed outdoor use.

Microsoft believes the Commission should partition its proposed 27.5-28.35 GHz band into two sub-bands. The first sub-band, covering 27.5-28.0 GHz, should be for Part 15 unlicensed operations. The second sub-band, covering 28.0-28.35 GHz, should be along the lines of the Commission’s proposal. The 500 MHz of contiguous unlicensed spectrum will allow for an ecosystem to form quickly as there is a potential large and diverse set of users that could be able to utilize this spectrum for both indoor and outdoor use.

¹ 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 (released October 23, 2015) (“NPRM”).

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I. INTRODUCTION

The breathtaking growth in mobile broadband data usage is projected to continue into the foreseeable future. In recent years, the U.S. Congress and the Commission have taken several affirmative steps to address this growth through repurposing and making more efficient use of spectrum. These actions include the Spectrum Act², the AWS-3 auction³, the upcoming Incentive Auction⁴, revising the technical rules for operating unlicensed devices in the 600 MHz band⁵ and the U-NII-1 band⁶, and implementing an innovative three-tier-of-access flexible framework for spectrum sharing in the 3.5 GHz band⁷. The Commission recognizes that meeting the seemingly insatiable demand for spectrum requires an “all of the above” approach -- that it make additional spectrum available on a licensed, unlicensed and a shared basis.

Microsoft commends the Commission for promoting a flexible regulatory environment for the next generation, the fifth generation (5G), of wireless services that is predicted to be ready for widespread commercial use in the 2020 timeframe. Although not yet defined, 5G capability is expected to provide much higher speeds, lower latency, and greater spectral efficiency than existing fourth generation (4G) wireless capability. Microsoft sees 5G networks developing on two paths, the first more of an evolutionary path of existing 4G services and the second,

² See Title VI of the Middle Class Tax Relief and Job Creation Act of 2012 (Pub. L. 112-96).

³ See http://wireless.fcc.gov/auctions/default.htm?job=auction_summary&id=97

⁴ See <https://www.fcc.gov/wireless-telecommunications/auctions/about-auctions/incentive-auctions/general/incentive-auctions>

⁵ See In the Matter of Amendment of Part 15 of the Commission’s Rules for Unlicensed Operations in the Television Bands, Repurposed 600 MHz Band, 600 MHz Guard Bands and Duplex Gap, and Channel 37, *et al.*, ET Docket No. 14-165, *et al.*, *Report and Order*, 30 FCC Rcd 9551 (released Aug. 11, 2015).

⁶ See In the Matter of Revision of Part 15 of the Commission’s Rules to Permit Unlicensed National Information Infrastructure (U-NII) Devices in the 5 GHz Band, ET Docket No. 13-49, *First Report and Order*, 29 FCC Rcd 4127 (released April 1, 2014).

⁷ See In the Matter of Amendment of the Commission’s Rules with Regard to Commercial Operations in the 3550-3650 MHz Band, GN Docket No. 12-354, *Report and Order and Second Further Notice of Proposed Rulemaking*, (released Apr. 21, 2015).

revolutionary new system capabilities that will serve as a distinct break with the prior generation. Microsoft sees significant opportunities for the use of unlicensed and shared spectrum to meet these 5G capabilities.

Portable devices are becoming consumers' primary means for accessing information and communications technology (ICT) services. Most broadband use occurs indoors and consumers are increasingly accessing broadband nomadically (over Wi-Fi) – in close proximity to a fixed broadband connection. Consequently, Microsoft delivers its cloud-based services to our customers' portable devices over a mix of licensed and unlicensed spectrum and will increasingly do so into the future. Continuing to provide our customers accessing our cloud-based services over portable devices with the high quality of service they expect for a great consumer experience will require access to spectrum that can be used to provide 5G capabilities. This is why Microsoft supports making more licensed and unlicensed spectrum available through any number of means, including dynamic spectrum sharing, in order to keep up with the demand for more data intensive services as well as the increasing number of connected devices that form the Internet of Things.

The evolutionary vision of 5G consists of heterogeneous networks of small cells providing network operator(s) with the additional capacity, scalability, and density as required to handle peak data rates. At the higher millimeter wave frequencies envisioned, there will be much denser networks in high demand areas. Carrier aggregation will also factor in with respect to increasing network capacity. Over time, there is no reason to believe carrier aggregation will not be applied to the millimeter wave bands. Our vision for the more revolutionary path includes much more intelligence at the edge of the network and leveraging technologies such as Network Function Virtualization. Fundamentally, having sufficient spectrum available is an essential

condition, but not the only condition to having 5G networks with revolutionary system capabilities.

At stake is U.S. leadership in core segments the 5G ecosystem. These segments may include system components such as millimeter wave radio chips and antennas, network software, and applications and on-line services. There is a first mover advantage of having early deployment of 5G networks domestically. For example, it will enable the U.S. private sector, public sector, not-for-profit sector, and academia to develop cutting edge applications and services leveraging the 5G capability as soon as such networks become available. These new 5G applications and services can be exported online into global markets as other countries' networks are upgraded with the capability. Having regulatory certainty for the millimeter wave bands that have been identified for 5G services in the U.S. will help to stimulate investment across the ecosystem.

The Commission's actions with its Spectrum Frontiers proceeding are timely in light of the actions resulting from the recently completed WRC-15 conference. The WRC-15 selected several millimeter wave bands to examine over its next study period for possible identification as globally harmonized bands for IMT-2020 (5G) at the WRC-19 conference. The spectrum bands selected are: 24.25-27.5 GHz, 31.8-33.4 GHz, 37-43.5 GHz, 45.5-50.2 GHz, 50.4-52.6 GHz, 66-76 GHz, and 81-86 GHz. Most, but not all, of these bands, are allocated for mobile services. Some of these bands will also be studied concurrently as potential bands for other services.

Microsoft was disappointed that WRC-15 decided not to study the 27.5-29.5 GHz frequency range for potential IMT-2020 identification and did decide to study the 66-76 GHz range for IMT-2020 identification, which imply licensing of the spectrum. Based on the record

developed by the Commission in the Spectrum Frontiers NOI⁸ and the ITU report examining the potential of frequencies above 6 GHz for IMT-2020,⁹ Microsoft believes the 28 GHz band holds much promise for delivering the type of services envisioned for 5G. We also see the range 66-76 GHz, which already has a mobile allocation, as more appropriately considered for unlicensed operations. The Commission identified the 28 GHz band as one suitable for mobile service and proposed extending the unlicensed 57-64 GHz band to 71 GHz prior to WRC-15. Microsoft hopes that that decisions made at WRC-15 do not cause the Commission to change course with respect to these two bands addressed in the NPRM.

The Commission's flexible Part 15 rules have lowered the barriers to entry for innovators seeking to develop new communications services and devices. These innovations include Wireless Local Area Networks (WLANs), Wireless Personal Area Networks (WPANs), and the Internet of Things. When consumers think of WLANs, they use the term Wi-Fi.¹⁰ Wi-Fi is ubiquitous. Wi-Fi is affordable. Wi-Fi networks are easy to set up. According to the Wi-Fi Alliance, roughly two and one half billion Wi-Fi devices were sold last year and there are over five billion Wi-Fi devices in operation worldwide.¹¹ Wi-Fi has proven to be the most popular way to deliver connectivity to end-users in the spectrum below 6 GHz, and there is every reason to believe that the majority of internet traffic above 6 GHz will also be delivered to consumers with technologies that make use of unlicensed bands. Products utilizing WiGig¹² are just coming

⁸ 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 Inquiry, 29 FCC Rcd 13020 (released October 17, 2014); 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, 30 FCC Rcd 11878 (released October 17, 2014).

⁹ *Technical feasibility of IMT in bands above 6 GHz*, Report ITU-R M.2376-0, Radiocommunication Sector of the International Telecommunication Union (July 2015).

¹⁰ Wi-Fi is a trademark of the Wi-Fi Alliance.

¹¹ See <http://www.wi-fi.org/news-events/newsroom/total-wi-fi-device-shipments-to-surpass-ten-billion-this-month>

¹² See <http://www.wi-fi.org/discover-wi-fi/wigig-certified>

on to the market. WiGig products certified by the Wi-Fi Alliance operate over unlicensed spectrum in the 60 GHz band and deliver multi-gigabit speeds, low latency, and security-protected connectivity between nearby devices.

Several studies have been done that examine the economic value enabled by innovation in unlicensed spectrum.¹³ Microsoft's comments in the Spectrum Frontiers NPRM are focused on increasing the amount of unlicensed and shared spectrum available to provide 5G capability.

II. EXTENDING THE CURRENT 60 GHz BAND

The Commission should extend the current 60 GHz band to 72.5 GHz, thereby allocating additional spectrum for unlicensed Part 15 use and thus enabling greater unlicensed broadband capacity. Additionally, the Commission should allow unlicensed devices to operate on transport aircraft across the entire expanded 60 GHz band. Finally, the 50 MHz channel at 57.00 GHz, originally set aside exclusively for coordination of non-interoperable devices, should be eliminated as technological advancement has supplanted its need.

A. The Commission Should Extend the Current 57-64 GHz Band for Unlicensed Devices to 72.5 GHz to Make Most Efficient Use of the Spectrum

Given the expected high demand for large capacity broadband channels where there are dense deployments of Wi-Gig networks, Microsoft recommends that the Commission extend the

¹³ See e.g., Raul Katz, *Assessment of the Future Economic Value of Unlicensed Spectrum in the United States*, Telecom Advisory Services, LLC (August 2014), available at <http://www.wififorward.org/wp-content/uploads/2014/01/Katz-Future-Value-Unlicensed-Spectrum-final-version-1.pdf>; Richard Thanki, *The Economic Significance of Licence-Exempt Spectrum to the Future of the Internet* (June 2012), available at <http://www.wirelessinnovationalliance.org/index.cfm?objectid=DC8708C0-D1D2-11E1-96E9000C296BA163>.

upper boundary of the 60 GHz Band to 72.50 GHz. The actual band edge is 72.36 GHz. In this way, seven non-overlapping channels can operate in the extended 60 GHz Band and spectrum utilization can be maximized.

Currently, three non-overlapping channels can operate in the 7 GHz-wide 60 GHz band. IEEE Standard 802.11ad-2012 and IEEE Standard 802.15.3c-2009 defines a channel bandwidth of 2.16 GHz for Wireless Local Area Networks (WLANs)¹⁴ and Wireless Personal Area Networks (WPANs)¹⁵ respectively. The sum of the bandwidth of the three non-overlapping channels is 6.48 GHz. Even with a nominal lower guard band, a significant amount of spectrum in the band is not being utilized.

The International Telecommunication Union (ITU) classifies both WLANs and WPANs envisioned for the 60 GHz band as Multiple Gigabit Wireless Systems (MGWS) radio networks. In Europe, the 60 GHz band consists of frequencies between 57-66 GHz. ITU-R M.2003.1 recommends the center frequencies of channels for 60 GHz multiple gigabit wireless systems to be at 58.32, 60.48, 62.64, and 64.80 GHz, asserting that “[i]t is important that MGWS standards employ the same channelization in order to promote better coexistence.”¹⁶

Global harmonization of spectrum use in the 60 GHz band is an important policy objective as it provides many benefits, including lower cost network equipment and user devices

¹⁴ IEEE Standard for Information Technology – Telecommunications and Information Exchange Between Systems – Local and Metropolitan Area Networks – Specific Requirements – Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications – Amendment 3: Enhancements for Very High Throughput in the 60 GHz Band, December 2012.

¹⁵ IEEE Standard for Information Technology – Telecommunications and Information Exchange Between Systems – Local and Metropolitan Area Networks – Specific Requirements – Part 15.3: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications for High Rate Wireless Personal Area Networks (WPANs) – Amendment 2: Millimeter-wave based Alternative Physical Layer Extension.

¹⁶ Recommendation ITU-R M.2003-1, *Multiple Gigabit Wireless Systems in frequencies around 60 GHz*, ITU-R Radiocommunication Sector of ITU, January 2015.

through increasing economies of scale. An internationally agreed upon channelization scheme within the 60 GHz band is an important component of global harmonization.

If the Commission extends the current 60 GHz band to 71 GHz, based on the ITU-R M.2003.1 channelization recommendation, there would be a total of 6 non-overlapping channels that can operate in the extended 60 GHz band. The upper edge of the highest frequency channel would be at 70.20 GHz. As a result, several hundred megahertz of spectrum will be left fallow. In order to make the most efficient use of the spectrum in the band, and consistent with a globally harmonized channel plan, the Commission should extend the top of the 60 GHz band to 72.5 GHz.

B. The Commission Should Remove the Publicly-Accessible Coordination Channel

The publicly-accessible coordination channel has out-lived its original purpose of coordinating amongst non-interoperable unlicensed devices operating in the 60 GHz band. Advances in technology and the establishment of a well-functioning industry consensus standards process for unlicensed device coexistence over the past decade has lessened the need for the Commission to intercede directly in such matters as it once did. As such, the coordination channel is no longer necessary and should be removed.

In December 1995, when the Commission opened the 59-64 GHz region of the spectrum for unlicensed devices, it stated that “the 59-64 GHz band offers the greatest potential for

allowing the development of short-range wireless radio systems with communications capabilities approaching those now achievable only with coaxial and optical fiber cable.”¹⁷

Several commenters in the proceeding recommended the Commission: (1) undertake the establishment of a spectrum etiquette to protect against interference between unlicensed devices operating in the band; and (2) direct industry to form a working group to design and demonstrate for the Commission such a spectrum etiquette for unlicensed use in the millimeter wave band.¹⁸

What can be inferred is that without some means for diverse (*i.e.* non-interoperable) unlicensed transmitters to coexist fairly, there would be a market failure -- in this case the market for such short-range devices would be delayed or not developed at all. At the time, scheduling was assumed to be the preferred method of coordinating transmissions. The private sector had yet to agree upon many of the sharing mechanisms that we take for granted today, and uncoordinated contention based protocols were still in the early stages. The base version of the IEEE 802.11 standard for local area networks was not released until 1997 and the Wi-Fi Alliance, an organization that certifies the interoperability of wireless networking technologies that use listen-before-talk, was founded in 1999.

While the Commission expressed reluctance to take such action over concerns it could restrict the development of new technology, it acknowledged that a few years prior, it had required a spectrum etiquette for Personal Communications Service (PCS) devices “to ensure that the spectrum is used more effectively and efficiently.”¹⁹

¹⁷ In the Matter of Amendment of Parts 2, 15, and 97 of the Commission’s Rules to Permit Use of Radio Frequencies Above 40 MHz for New Radio Applications, ET Docket No. 94-124, *First Report and Order and Second Notice of Proposed Rulemaking*, FCC 95-499, 11 FCC Rcd 4481, 4488, at ¶ 14 (released December 15, 1995).

¹⁸ *Ibid.*

¹⁸ *Ibid.*, at ¶ 63, 11 FCC Rcd at 4508.

¹⁹ *Ibid.*, at ¶ 64, 11 FCC Rcd at 4508.

The Commission delayed implementation of its 59-64 GHz rules for one year to give industry an opportunity to agree on a spectrum etiquette standard. In the FNPRM it asked for comments on the need for a spectrum etiquette standard to prevent interference among unlicensed devices operating between 59 and 64 GHz similar to what was implemented for PCS under Part 15 of its rules and for specific proposals.²⁰

In order to address sharing concerns, in December 1996, the Millimeter Wave Communications Working Group (MWCWG) submitted its spectrum etiquette proposal²¹ to the Commission. Among other things, the MWCWG recommended that the Commission preserve 50 MHz of spectrum, from 59.00 to 59.05 GHz, exclusively for the development and establishment of a coordination channel to reduce interference between non-interoperable transmitters. The MWCWG admittedly acknowledged that neither the working group nor any of its members had developed a specific coordination approach to that point. The idea was for entities interested in developing a coordination channel to use the 50 MHz under an experimental license as a sandbox. Once there was an industry-consensus standard for device coordination, the Commission would be petitioned to permit operations consistent with the standard²² and allow for the channel to become publicly accessible.

The following August, the Commission issued a NPRM on the spectrum etiquette proposal filed by the MWCWG.²³ Concurrently, the Commission decided to allow for interim operation of unlicensed devices between 59-64 GHz while the NPRM process was underway out

²⁰ *Ibid.*

²¹ *Report and Recommendation of the Millimeter Wave Communications Working Group to the Federal Communications Commission*, December 13, 1996.

²² *Ibid.*, at 9

²³ In the Matter of Amendment of Parts 2, 15, and 97 of the Commission's Rules to Permit Use of Radio Frequencies Above 40 MHz for New Radio Applications, ET Docket No. 94-124, *Memorandum Opinion and Order and Fourth Notice of Proposed Rulemaking*, FCC 97-267, 12 FCC Rcd 12212, 12221-12222 ¶ 26 (released August 14, 1997).

of concern that the additional delay “would be detrimental to the introduction of new products and services.”²⁴ Nevertheless, the Commission required that any equipment approved in the interim comply with the proposed spectrum etiquette and was clear to prospective manufacturers and operators that there was a risk that any spectrum etiquette adopted by the Commission could differ significantly from the proposal.²⁵

Almost a year later, the Commission incorporated the MWCGW’s recommendations into its rules for the 59-64 GHz band, including the establishment of a coordination channel.²⁶ It held that “the adopted spectrum etiquette provides the best plan to maximize the number of users and minimize the potential for interference in the 59-64 GHz band.”²⁷

The Commission extended spectrum etiquette down to 57 GHz when it expanded the unlicensed band to 57-64 GHz in the year 2000.²⁸ Correspondingly, the coordination channel was shifted downward (57.00 to 57.05 GHz).²⁹ With the development of the IEEE 802.11ad and IEEE 802.15.3 standards, and the Wi-Fi Alliance ‘Wi-Gig’ certification program, there no longer appears to be a need to retain the 50 MHz as a coordination channel. For this reason alone, Microsoft recommends that the Commission remove the publicly-accessible coordination channel.

²⁴ *Ibid.*, at ¶ 12, 12 FCC Rcd at 12213.

²⁵ *Ibid.*

²⁶ In the Matter of Amendment of Parts 2, 15, and 97 of the Commission’s Rules to Permit Use of Radio Frequencies Above 40 MHz for New Radio Applications, ET Docket No. 94-124, *Third Report and Order*, FCC 98-150, 13 FCC Rcd 15074, 15074 ¶ 11 (released July 15, 1998).

²⁷ *Ibid.*

²⁸ In the Matter of Amendment of Part 2 of the Commission’s Rules to Allocate Additional Spectrum to the Inter-Satellite, Fixed, and Mobile Services and to Permit Unlicensed Devices to Use Certain Segments in the 50.2-50.4 GHz and 51.4-71.0 GHz Bands, ET Docket No. 99-261, *Report and Order*, FCC 00-442, 15 FCC Rcd 25264, 25280 ¶ 39 (released December 20, 2000).

²⁹ *Ibid.*, at 39.

C. The Commission Should Allow Unlicensed Devices to Operate in Transport Aircraft Across the Entire Extended 60 GHz Band

Inside the controlled environment of a transport aircraft, the risk of harmful interference to Radio Astronomy Service (RAS) operations at the limited number of domestic and international RAS sites from unlicensed emissions in the 64-72.5 GHz range can be managed and minimized. As such, the Commission should allow Part 15 unlicensed operations aboard aircraft. The same rationale also holds true for the 57-64 GHz band. Here, when combined with the much higher oxygen absorption, Microsoft believes that 60 GHz devices can also operate in aircraft between 57 and 64 GHz without causing harmful interference to terrestrial RAS operations. Thus, the Commission should reconsider allowing unlicensed 60 GHz devices to operate onboard aircraft in the 57-64 GHz range. In this way, the Commission's rules can be harmonized across the entire extended 60 GHz band.

The Commission's rules prohibit the use of equipment operating in the frequency range of 57-64 GHz on aircraft to protect Radio Astronomy Service (RAS) operations.³⁰ The concern appears to be more about interference from emissions at the second harmonic (114-128 GHz), third harmonic (171-192 GHz) and fourth harmonic (228-256 GHz) frequencies than the fundamental frequency range. Harmonics and any spurious emissions are typically much lower in power than the fundamental frequency. Nevertheless, if the emission is strong enough, it can interfere with RAS observations of spectral lines arising from various isotopes of the carbon monoxide (CO) molecule. And even though the resonant frequencies of the CO spectral lines are narrow in frequency, the Doppler Effect causes these lines to be observed over a range of frequencies.

³⁰ 47 C.F.R. § 15.255(a) (2016).

The U.S. agreed to protect several passive radio astronomy service (RAS) bands from emissions of specific strengths when it adopted ITU-R 5.340 in 2004.³¹ These include the bands identified in the NPRM where the second harmonic (and spurious) emissions would fall within the 114.25-116.0 GHz and 109.5-111.8 GHz passive bands; where the third harmonic (and spurious) emissions would fall within the 182-185 GHz and 164-167 GHz passive bands; and where the fourth harmonic (and spurious) emissions would be in the passive band (226-231.5 GHz). It is important to note, though, that the Commissions affirmed that its current standard on harmonic and spurious emissions only applies up to 200 GHz.³²

Air passengers increasingly expect to have broadband connectivity when they fly. Microsoft sees 60 GHz band WLAN and WPAN use cases aboard aircraft. These include one or more access points beaming a high-bandwidth 60 GHz signal directly to the seat back as part of an in-flight entertainment system, one or more access points beaming a high-bandwidth 60 GHz signal directly to consumer devices, and 60 GHz enabled devices communicating directly with one another. The expectation, though, is that the vast majority of the data traffic will be in one direction -- downloaded from the aircraft to the seat back or the mobile device.

There are a number of reasons why Microsoft believes unlicensed 60 GHz devices will be able to operate aboard aircraft without causing harmful interference to RAS operations. First, an aircraft is an enclosed and regulated environment where the network operating parameters and topology will be controlled. The cabin is pressurized. Additionally, there are lots of objects

³¹ In the Matter of Amendment of Part 2 of the Commission's Rules to Realign the 76-81 GHz Band and the Frequency Range Above 95 GHz Consistent with International Allocation Changes, ET Docket No. 03-102, *et al.*, *Report and Order*, FCC 04-20, 19 FCC Rcd 3212 (released February 12, 2004).

³² In the Matter of Revision of Part 15 of the Commission's Rules Regarding Operation in the 57-64 GHz Band, ET Docket No. 07-113, *et al.*, *Report and Order*, FCC 13-112, 28 FCC Rcd 12517, 12533 ¶ 40 (released August 9, 2013) (noting that "the difference in atmospheric attenuation between 200 GHz and 231.5 GHz is not significant enough to affect the acceptable level of emissions from both spurious and harmonic emissions ensured by operation of our existing rules.").

within the close confines of the aircraft cabin to block, scatter, and absorb 60 GHz transmissions (and harmonics) before they could exit the aircraft. Any remaining emissions must travel through a two pane acrylic window with an abrasive-resistant coating such as some representative models manufactured by GKN Aerospace³³ at an angle not only to exit the moving aircraft but one that allows the emission to be collected by a radio telescope some distance away. Additionally, there will always be a percentage of passenger window shades that are drawn.

Further, with the large channels in the 60 GHz band, communications (video downloads) that might have to have been otherwise streamed at 2.4 or 5 GHz will appear to be transmitted almost instantaneously – little blips. With respect to WPAN device-to-device communications at 60 GHz, the data transmission will most likely occur when the devices are resting on the seat back table. Again the wide channel bandwidth should allow these types of communications to occur very quickly. It may be worth exploring, though, whether portable devices operating in the 60 GHz band should incorporate transmit power control so that the communication can be completed at the lowest possible power level.

Keep in mind that there are a finite number of terrestrial RAS stations both in the U.S. and globally.³⁴ RAS stations are terrestrial and RAS receivers discriminate against off-axis signals.³⁵ The ground speed of transport aircraft at altitude is several hundred miles per hour. The free space path loss (FSPL) in dB = $20\log(F)+20\log(d)-147.55$ where F is the signal frequency in

³³

http://www.gkn.com/aerospace/media/resources/Brochures/GKN_Aerospace_Boeing_737_Product_Data_Sheet.pdf
http://www.gkn.com/aerospace/media/resources/Brochures/GKN_Aerospace_Boeing_757-767-777_Product_Data_Sheet.pdf

³⁴ http://sites.nationalacademies.org/BPA/BPA_059065

³⁵ *Ibid.*

Hertz and d is the distance from the transmitter in meters.³⁶ There is significant path loss at the frequencies between 64 and 72.5 GHz for the distances between and aircraft and a RAS receiver.

As the Commission pointed out in its First Report and Order, “[i]f future filings indicate a need for use of these devices on aircraft and demonstrate how such devices can be designed to avoid potential interference to radio astronomy operations, then we may ultimately allow such use.”³⁷ The Commission correctly realizes in the NPRM that we have reached the time where there is a need for use of such devices on transport aircraft.³⁸

III. 28 GHz BAND (27.50 – 28.35 GHz)

Microsoft proposes that the Commission immediately make available the frequency range 27.5 – 28.0 GHz for unlicensed use, and allocate the remaining 350 MHz along the lines proposed in its NPRM. Unlicensed operations between 27.5-28.0 GHz potentially will allow for a continuum of channel characteristics that fall in between the 5 GHz and 60 GHz bands. Similar to the 5 GHz band, operations at 28 GHz allow for outdoor-to-indoor access. One consequence outcome of the introduction of unlicensed LTE technologies into the 5 GHz band is that the larger bonded channels sizes envisioned under the IEEE 802.1ac standard may not be able to be implemented reliably in areas of dense deployments. Industry continues to need larger channel bandwidth unlicensed spectrum that is capable of bridging consumers to high bitrate fixed infrastructure, such as fiber optic cable, outdoor-to-indoor, and through one-wall applications.

³⁶In the Matter of Revision of Part 15 of the Commission’s Rules Regarding Operation in the 57-64 GHz Band, ET Docket No. 07-113, *Report and Order*, FCC 13-112, 28 FCC Rcd 12517, 12533 n. 103 (released August 9, 2013).

³⁷ In the Matter of Amendment of Parts 2, 15, and 97 of the Commission's Rules to Permit Use of Radio Frequencies Above 40 GHz for New Radio Applications, *et al.*, ET Docket No. 94-124, *et al.*, *First Report and Order and Second Notice of Proposed Rule Making*, FCC 95-499, 11 FCC Rcd 4481, 4496-4497 ¶ 35 (released December 15, 1995).

³⁸ *NPRM*, 30 FCC Rcd at 11966 ¶ 304.

Microsoft proposes that the Commission allocate 500 MHz between 27.50 and 28.00 GHz for unlicensed use in order to address this need. Details, including channel size, should be developed through the appropriate standards bodies.

In 1993, the Commission allocated two LMDS licenses in each of the nation's 493 Basic Trading Areas (BTAs) – an “A block” and a “B block”.³⁹ The “A Block” consists of three 27.50-28.35 GHz (A1), 29.10-29.25 GHz (A2), and 31.075-31.225 GHz (A3) sub-bands. The “B Block” consists of the 31.00-31.075 GHz (B1) and 31.225-31.300 GHz (B2) sub-bands.⁴⁰ There are 986 LMDS license areas consisting of 493 “A Block” and 493 “B Block” licenses.⁴¹ There is one licensee in each A and B license area. There is the opportunity, though, for a licensee to partition, disaggregate, and lease spectrum in the band under the rules.⁴² According to the Commission, as of October 2014 there were a combined 416 LMDS licenses, which cover about 75 percent of the U.S. population.⁴³ Short of going license by license, it was not readily available how many of these active licenses are for the A block. It appears though that there are between a half dozen and a dozen entities that control the bulk of LMDS licenses across BTAs. The majority of LMDS licenses are up for renewal in 2018, with the balance requiring renewal the following year.

As proposed by the Commission, the “28 GHz Band” is the A1 block. Nationally, the block consists of a patchwork of licensed and no-longer licensed BTAs. Some of the individual

³⁹ In the Matters of Rulemaking to Amend Part 1 and Part 21 of the Commission's Rules to Redesignate the 27.5 - 29.5 GHz Frequency Band and To Establish Rules and Policies For Local Multipoint Distribution Services, et al., CC Docket 92-297, *Notice of Proposed Rulemaking, Order, Tentative Decision and Order on Reconsideration*, FCC 92-538, 8 FCC Rcd No. 2 ¶ 20 (released January 8, 1993); 47 C.F.R. § 101.1007 (2016).

⁴⁰ 47 C.F.R. § 101.1005 (2016).

⁴¹ 47 C.F.R. § 101.1007 (2016)

⁴² 47 C.F.R. 101.1111

⁴³ See In the Matter of Use of Spectrum Bands Above 24 GHz For Mobile Radio Services, et al., *Notice of Inquiry*, GN Docket No. 14-177, et al., 29 FCC Rcd 13020 ¶ 52 (released October 17, 2014).

BTA licenses have been partitioned, disaggregated, or leased. These subdivisions may or may not fall neatly along county lines. The Commission's proposal calls for license holders to provide both fixed LMDS and mobile service throughout their now multi-county licensing area. It is still to be determined how many current LMDS license holders either have an interest or are in a position to provide both fixed and mobile services given the potential new service requirements and resulting investments required.

Broadly speaking, for the economics of 28 GHz mobile ecosystem to work in the U.S., there needs to be a national market. As it stands, it does not appear that any MNO has a national footprint in the A1 block of the 28 GHz LMDS band. In principle this can change by MNOs acquiring access to spectrum through the secondary market and the Commission re-auctioning licenses for counties where there is no current licensee. The Commission will have to take steps to ensure that competition is preserved. There is the real possibility that one or two entities can shut out all other entities from obtaining access to 28 GHz spectrum in major metropolitan areas.

Given that the spectrum band will not be globally harmonized, whether or not the technical and operational rules facilitate the growth of a national U.S. market takes on even more significance. Again, it is not to say that it will be impossible for there to be national footprint in the 28 GHz band under the Commission's proposed framework, but it will be considerably more challenging than allowing a significant portion of the band to be used for unlicensed operations under the Commission's Part 15 Rules. The projected demand for broadband data is too great to risk having 850 MHz of spectrum either being severely underutilized or effectively locked up by a couple of MNOs.

That is why Microsoft proposes the Commission authorize 500 MHz (27.50-28.00 GHz) for unlicensed operations and allocate the remaining 350 MHz along the lines of its proposed rules. Even MNOs could take advantage of the proposed 500 MHz of unlicensed spectrum.

3GPP release 13 will allow for carrier aggregation of licensed and unlicensed spectrum in the 5 GHz band to increase network capacity.⁴⁴ All that follows is predicated on a fair sharing mechanism between Wi-Fi and unlicensed LTE technologies being agreed to and implemented. Microsoft's understanding is that 3GPP has not defined the physical (PHY) layer for frequencies above 15 GHz. Once 5G service is defined, Microsoft's expectation is that 3GPP will define the PHY layer for several millimeter wave spectrum bands that could ultimately lead to carrier aggregation between low-, medium- and high-band spectrum. 3GPP will also consider channel sizes greater than 20 MHz. The low band licensed spectrum would provide the broadband coverage and the higher band unlicensed spectrum would provide the varying degrees of broadband capacity as determined by the intelligence expected at the edge of 5G networks.

With carrier aggregation, the Commission should take another look at traditional geographic-based licensing models for the provision of true mobile and nomadic mobile service. The advantage of having the 500 MHz of spectrum unlicensed is that it could simultaneously be used by mobile operators, be used to extend the footprint of cable operators, fixed satellite operators, LMDS operators, and be used by those interested in an unlicensed first model. Such a potential diverse set of users would allow for a 28 GHz ecosystem to form faster. It would allow for greater experimentation of different services. With spectrum authorized for unlicensed use, no substantial service requirement or buildout requirements are necessary. Depending on channel

⁴⁴ See <http://www.3gpp.org/release-13>.

size, the additional broadband capacity can either be 4G or 5G compliant. Coordination across counties happens automatically.

The two things that would have to happen are the creation of technical standard(s) by appropriate standards bodies and a database that the micro/pico/femto cells must access to protect FSS earth stations operating in the 500 MHz from harmful interference.

IV. 70 GHz BAND (72.5-76 GHz)

Microsoft proposes that the Commission authorize unlicensed devices to operate indoors between the frequencies of 72.5 and 77.0 GHz. The vast majority of broadband to date is consumed indoors. Exclusive indoor use should not conflict with the current and anticipated commercial uses of the band.

V. 37 AND 39 GHz BANDS

Spectrum within these two bands is most likely to become globally harmonized for 5G services. Microsoft is very much in favor of the kind of sharing outlined in the Commission's innovative proposal for 37-38.6 GHz. We see tremendous benefit in making some spectrum available to property owners for local area networks and encourage the commission to further explore this concept. Our concern is that this particular band is unencumbered in many countries, which makes it a very good candidate for a globally harmonized band for 5G phones and tablets. Microsoft wants to ensure, given the complexity of the millimeter wave radios in end-user equipment, that the Commission prioritizes enabling the market for equipment that can be used globally.

VI. CONCLUSION

Microsoft applauds the Commission's proposal for flexible service rules in four different millimeter bands identified for their potential to provide 5G capability. Of the four bands discussed, the Commission should quickly act on its proposal to extend the 60 GHz band to higher frequencies. Extending the 60 GHz band to 72.5 GHz rather than 71 GHz will allow for one additional high-speed non-overlapping 2.16 GHz wide channel at a relatively low cost. Otherwise several hundred megahertz of spectrum will lie fallow. The remainder of the 72.5 to 76 GHz range should be allocated for indoor unlicensed use.

The Commission's proposals for the 28 GHz, 37 GHz, and 39 GHz bands are more complex given the nature of the incumbent services and current licensing mechanism. These are likely to require Further Notices of Proposed Rule Making. For example, Microsoft proposes that the 28 GHz band is sub-divided into a 500 MHz unlicensed band, and a 350 MHz band with service rules proposed by the Commission. Based on our experience with other spectrum bands, having a diverse potential set of users and a national market helps in standing up an ecosystem quickly. Our proposal for 500 MHz of spectrum for unlicensed Part 15 devices will do the same for the 28 GHz band. We look forward to working with the Commission on its flexible framework for the various millimeter wave bands to usher in 5G services.

Respectfully submitted,

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