

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of)	
)	
Spectrum Horizons)	ET Docket No. 18-21
)	
James Edwin Whedbee Petition for)	RM-11795
Rulemaking to Allow Unlicensed Operation)	
in the 95-1,000 GHz Band)	

COMMENTS OF THE mmWAVE COALITION

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ATTACHMENT: Members and Principals of the mmWave Coalition

SUMMARY

The mmWave Coalition (“mmWC”), a group of innovative companies united in the objective of removing regulatory barriers to technologies and using frequencies ranging from 95 GHz to 275 GHz, supports the initiation of this proceeding to permit use of spectrum above 95 GHz and offers suggestions to make above-95 GHz spectrum more accessible and useful for innovative services and technologies. Among mmWC’s suggestions are the following:

- The Commission should consider developing rules that would accommodate both point-to-point and point-to-multipoint systems that would allow for innovative and affordable broadband service. While the licensing provisions for fixed point-to-point operations outlined in the Notice of Proposed Rulemaking (“NPRM”) is one possibility, mmWC encourages the Commission also to explore other options that would allow licensees to register operations in an area around a fixed location instead of requiring registration of individual links as required by the existing 70/80/90 GHz rules.
- mmWC urges the Commission to allow fixed operations in a large contiguous block of spectrum (on the order of a tens of GHz or more blocks) and to use this proceeding to establish performance-based criteria that would protect vital incumbent and future passive users of the spectrum while allowing responsible spectrum sharing. By creating such a large contiguous block of spectrum, as opposed to the highly balkanized bands proposed in the NPRM, the Commission can unleash the full potential of the above-95 GHz spectrum while still protecting the present passive allocations.
- While there may be little present interest in using the above-95 GHz spectrum for mobile services, mmWC urges the Commission to make clear that the Part 101 or the proposed Part 5 rules for above-95 GHz fixed services do not preclude the eventual use of these spectrum bands for shared fixed and mobile use under appropriate service rules for responsible sharing among all existing allocations.
- mmWC supports the relaxation of certain requirements in the proposed “Spectrum Horizons Experimental Radio Licenses” rules such as loosening the restrictions on marketing equipment, allowing experimental licenses across the

entire 95 GHz-3 THz range, allowing a broad scope for experimental licenses, and the proposed ten-year license term. In addition, in order to prevent situations in which federal government agencies effectively veto promising new technologies based on overly cautious approaches to spectrum management, mmWC urges NTIA to require Interdepartment Radio Advisory Committee participants to show, within a reasonable timeframe, that the proposed experimental license actually will have an adverse impact on the operations of federal systems. Similarly, mmWC urges the Commission to modify Section 5.83(b) of the rules so that experimental licenses cannot be “subject to cancellation at any time without notice or hearing” without a procedural safeguard to protect experimental licensees who invest significant sums of money in developing technologies under an experimental license.

- mmWC urges the Commission to extend existing RF safety limits on an interim basis, which are currently specified up to 100 GHz, to frequencies above 100 GHz (up to the highest frequency authorized) – even if such limits are later modified in a separate proceeding. Not specifying any RF safety limit will lead to regulatory uncertainty during deployments of new above-95 GHz services and technologies, whereas specifying even an interim limit would be better than no limit for the purposes of encouraging investment in and reducing litigation risk for new technologies developed for use in the above-95 GHz spectrum.
- mmWC urges the Commission to establish regulatory certainty for ISM operations in the above-95 GHz frequencies to encourage capital formation for both developers of new innovative ISM equipment and manufacturers who use the technology in their manufacturing processes. The current approach of OET evaluating equipment that uses the above-95 GHz frequencies on a case-by-case basis does not provide the regulatory certainty needed for investment in the development of new ISM technologies such as Terahertz Spectroscopy.

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COMMENTS OF the mmWAVE COALITION

The mmWave Coalition (“mmWC” or the “Coalition”)¹ hereby files these Comments in response to the Notice of Proposed Rulemaking² (“Notice” or “NPRM”) in the above-captioned proceeding. The Coalition commends the Commission for initiating this proceeding to permit use of spectrum above 95 GHz and offers suggestions to make above-95 GHz spectrum more accessible and useful for innovative services and technologies.

¹ The mmWave Coalition is a group of innovative companies united in the objective of removing regulatory barriers to technologies and using frequencies ranging from 95 GHz to 275 GHz. The Coalition does not limit itself to supporting any particular use or technology but rather it is working to create a regulatory structure for these frequencies that would encompass all technologies and all possible uses, limited only by the constraints of physics, innovation, and the imagination. Members and principals of the Coalition are listed in an Attachment to these Comments. For more information, please visit <http://mmwavecoalition.org/>.

² *Spectrum Horizons; James Whedbee Petition for Rulemaking to Allow Unlicensed Operation in the 95-1000 GHz Band*, ET Docket No. 18-21, RM-11795, Notice of Proposed Rulemaking and Order, FCC 18-17 (rel. Feb. 28, 2018) (“NPRM”).

I. INTRODUCTION

As Commission recognizes, the shorter wavelengths of frequencies above 95 GHz are well suited for particular technologies and that the combination of narrow antenna beams with modest antenna sizes and high total propagation loss (*i.e.*, normal free space loss plus gaseous absorption loss) in the above-95 GHz frequencies would make these frequencies well suited for flexible use without requiring complex sharing arrangements.³

Adopting service rules for use of these frequencies will provide certainty and spur investment in and development of new technologies, products, and services. Indeed, past examples of the development of “frontier” spectrum suggest that appropriate service rules can boost development of technologies that were not even contemplated at the time the rules were adopted as technology advances and as demand for a wide variety of wireless services and technologies continues to grow exponentially. However, regulatory certainty is required before these new technologies can be expected to flourish. Indeed, the *Notice* references several examples of technologies and services being developed overseas where a combination of national and regional (*e.g.*, European Union) funding of research and development and more supportive regulatory environments have led to investment and capital formation for technologies using frequencies above 95 GHz with little to no regulatory risk.⁴ mmWC

³ *Id.* at 14, ¶ 25.

⁴ *Id.* at 9-10, ¶¶ 12-15.

urges the Commission to proceed expeditiously to allow the United States to be on par with these overseas developments.

The above-95 GHz spectrum is promising for a variety of new technologies and uses, including, as the Commission recognizes in the *Notice*, the development of 5G and other wireless technologies. As the demand for spectrum grows, these frequencies can be used for a variety of applications, including fixed wireless access to replace or complement fiber to the home, wireless backhaul, mobile broadband, sensing, industrial automation, and high capacity wireless links for IoT links and AR/VR. Some other examples of current and potential future developments in this spectrum include:

- Nokia is working with NTT DoCoMo to develop 5G New Radio (5G NR) enhancements at 90 GHz.⁵ The technology, which the two companies demonstrated recently during the Brooklyn 5G Summit, uses a Nokia Bell Labs-developed compact millimeter wave phased-array antenna system scalable up to 256-elements using an RFIC solution to enable multi-gigabit per second speeds. The recent test demonstrated how using the new 5G NR technology at mmWave frequencies can provide greater bandwidth while handling the necessary network management with a large number of antenna beams.
- Several small companies, including RaySecur, have developed equipment that uses mmWave spectroscopy and imaging. Examples of devices range from mail scanners to industrial metrology apparatus to remote detection of weapons and explosives.
- Virginia Diodes has recently worked with NYU Wireless on 140 GHz transmit and receive RF front ends. The group at NYU Wireless has incorporated these RF front ends into their channel sounding system and will be conducting measurements in the field in the near future.

⁵ Monica Allevan, *Nokia, DoCoMo to Demonstrate 5G NR at 90 GHz During Brooklyn 5G Summit*, at <https://www.fiercewireless.com/wireless/nokia-docomo-to-demo-5g-nr-at-90-ghz-during-brooklyn-5g-summit>.

- National Science Foundation’s Platform for Advanced Wireless Research program recently funded a research center termed COSMOS in New York City.⁶ One of the areas of interest is mmWave communication. Though currently the focus is on 5G mmWave frequencies, as the center matures, there is ample opportunity to prototype and demonstrate radios for fixed and mobile above 95 GHz.
- Azbil, a leader in Industrial Control and Building Automation, is researching mmWave and terahertz technology for non-invasive sensing and wireless connectivity in a diverse set of applications and market segments of Industrial Internet of Things (IIoT), factory automation, process control, robotics, agriculture, aife science, and oil & gas.
- GLOBALFOUNDRIES has developed and will continue developing silicon-based technologies for diverse mmWave applications using frequencies ranging from 24GHz to well beyond 100GHz. Applications include satellite communication, 5G user equipment and infrastructure, WiGig, mmWave radar, sensing, etc.

II. THE COMMISSION SHOULD CREATE LARGE CONTIGUOUS BLOCKS OF SPECTRUM TO FACILITATE WIRELESS SERVICES THAT COMPLEMENT FIBER DEPLOYMENT

The Coalition commends the Commission for focusing on the importance of permitting flexible wireless services in the above 95 GHz spectrum and, in particular, proposing to permit licensed fixed point-to-point operations in the portions of the 95 GHz to 275 GHz band. The Commission should also consider developing rules that would accommodate both point-to-point and point-to-multipoint systems that would allow for innovative and affordable broadband service. While the licensing provisions for 70/80/90GHz is one possibility, we encourage the Commission also to explore other options that would “allow licensees to register operations in an area around a fixed location instead of requiring registration of individual links as required by the 70/80/90

⁶ Powering Advances in Wireless Connectivity for the Future, National Science Foundation News Release 18-025, April 9, 2018, *available at* https://www.nsf.gov/news/news_summ.jsp?cntn_id=245045.

GHz rules[.]”⁷ The Coalition believes it is premature to settle exclusively on fixed point-to-point rules based on the 70/80/90 GHz rules for all of the bands being considered and that providing more flexibility would enable more diverse deployments such as on lamp posts and similar structures instead of being limited to towers, building rooftops, hills, etc.

The Coalition also supports the Commission’s proposal to permit higher transmitted power limits than in the 70/80/90 GHz frequencies and, in particular, supports a limit of 75 dBm/100 MHz EIRP as recently established in the Part 30 rules.⁸ While there may be little present interest in using the above-95 GHz spectrum for mobile services, mmWC urges the Commission to make clear that the Part 101 or the proposed Part 5 rules for above-95 GHz fixed services do not preclude the eventual use of these spectrum bands for shared fixed and mobile use under appropriate service rules for responsible sharing with fixed users.⁹

In addition, the Commission misses an important opportunity to make available large contiguous blocks of spectrum that would greatly benefit fixed point-to-point deployment. As the Commission explained in the *Notice*, the above-95 GHz spectrum can be used to provide very-high-speed fixed wireless links, which can be used for “disaster recovery operations, temporary replacement for a damaged optical network,

⁷ *NPRM* at ¶ 17, ¶ 32, ¶ 38.

⁸ *Id.* at 18, ¶ 34.

⁹ For example, once technological advances made mobile use of the Upper Microwave frequencies feasible, the Part 30 rules permitted flexible use of those frequencies.

or wireless backhaul in locations where installation of a fiber optic line is difficult.”¹⁰

Such “wireless fiber” links could be a key enabler of high-speed broadband services in rural areas or in areas affected by natural disasters such as hurricanes or tornados, earthquakes, wildfires, etc.

However, the frequencies proposed in the NPRM for fixed point-to-point operations are highly balkanized due to both the presence of passive allocations¹¹ and the present provisions of Allocation Table footnote US246, which states that “[n]o station shall be authorized” in various passive bands above 95 GHz. While the “no stations” provision may be reasonable in lower bands where antenna directionality is limited, path loss is less than at higher frequencies due to little or no absorptive loss, and other factors exist such as the presence of intermittent “anomalous propagation”, the outright prohibition of transmitters in a wide variety of blocks of spectrum has never been justified from a public interest standpoint. Presently, US246 would prevent the true benefits of above 95 GHz spectrum for many key point-to-point broadband and cellular backhaul operations from being realized. In order to unleash the full potential of the above-95 GHz spectrum, while protecting passive allocations, mmWC urges the Commission to allow fixed operations in a large contiguous block of spectrum (on the order of a tens of GHz or more blocks) and use this proceeding to establish

¹⁰ *Id.* at 9, ¶ 13.

¹¹ The Commission seeks comment on adopting rules to permit fixed point-to-point operations in the 95-100 GHz, 102-109.5 GHz, 111.8-114.25 GHz, 122.25-123 GHz, 130-134 GHz, 141-148.5 GHz, 151.5-158.5 GHz, 174.5-174.8 GHz, 231.5-232 GHz, and 240-241 GHz bands. *Id.* at 16, ¶ 31. The Commission also seeks comment on applying such rules to several other frequency bands above 95 GHz that are currently allocated for FSS or MSS, including 158.5-164 GHz, 167-174.5 GHz, 191.8-200 GHz, 209-226 GHz, 232-235 GHz, 238-240 GHz, and 252-275 GHz. *Id.* at 20, ¶ 39.

performance-based criteria that would protect vital incumbent and future passive users of the spectrum while allowing responsible spectrum sharing. It is recognized that protection of passive systems is essential and that in a very small fraction of the country passive bands use may not be practical due to nearby radio astronomy facilities. Nevertheless, given the technical characteristics discussed above such as narrow antenna beams and large free space propagation loss, licensed services in the above-95 GHz spectrum should be able to protect passive users with appropriate technical and geographic limits.¹²

In order to do so, the Commission should work with NTIA to eliminate US246's flat ban on stations transmitting in the affected frequencies and, instead simply require stations transmitting in such frequencies to protect passive systems from interference. For example, above 95 GHz, a revised US246 might replace the total prohibition with a requirement that any service rules adopted must be based on meeting the international passive systems protection requirements stated in Recommendation ITU-R RA.1272¹³

¹² In parallel deliberations for WRC-19 on the use of 275-450 GHz, it has become clear that proponents of passive use have justified the "no station" policy on an assumption of antenna sidelobes from terrestrial users being given by the model in Recommendation ITU-R F.1245-2 (03/2012). See Recommendation ITU-R F.1245-2, *Mathematical Model of Average and Related Radiation Patterns For Line-Of-Sight Point-To-Point Fixed Wireless System Antennas For Use In Certain Coordination Studies and Interference Assessment In The Frequency Range From 1 GHz To About 70 GHz*, available at https://www.itu.int/dms_pubrec/itu-r/rec/f/R-REC-F.1245-2-201203-I!!PDF-E.pdf. But this model is limited to frequencies in the range of 1-70 GHz and does not consider antennas types such as dielectric lenses that are practical at the frequencies of interest in this proceeding.

¹³ Recommendation ITU-R RA.1272, *Protection of Radio Astronomy Measurements Above 60 GHz From Ground Based Interference*.

and Recommendation ITU-R RS.2017¹⁴. In effect, this would replace a total prohibition based on analyses at lower frequencies with a performance-based goal using well-documented international standards for protection of vital passive services. Doing so would result in transparency for the criteria used and would enable market access for new technologies that meet these performance criteria, which in turn would facilitate private capital formation for development of such new, innovative technologies.

While this would require additional discussions with NTIA, this is an inter-agency coordination matter rather than a technical one. Given the technical characteristics of the above-95 GHz spectrum discussed above such as narrow antenna beams and large free space propagation loss, sharing of fixed operations with existing passive uses should be possible in most parts of the country.

III. mmWC SUPPORTS THE PROPOSED EXPERIMENTAL LICENSE RULES BUT SUGGESTS ADDITIONAL PROCEDURAL SAFEGUARDS TO ENSURE GREATER REGULATORY CLARITY

The Coalition applauds the Commission for proposing modifications to the existing experimental license rules to encourage greater innovation in the above-95 GHz spectrum than the current rules would allow.¹⁵ The Coalition supports the relaxation of certain requirements in the proposed “Spectrum Horizons Experimental Radio Licenses” rules such as loosening the restrictions on marketing equipment,¹⁶ allowing

¹⁴ Recommendation ITU-R RS.2017, *Performance and Interference Criteria for Satellite Passive Remote Sensing*.

¹⁵ NPRM at 31-35, ¶¶ 70-81.

¹⁶ *Id.* at 32-33, ¶¶ 72-75.

experimental licenses across the entire 95 GHz-3 THz range,¹⁷ allowing a broad scope for experimental licenses,¹⁸ and the proposed ten-year license term.¹⁹ The proposed ten-year license term, along with other proposed rules designed to provide experimental licensees with greater flexibility in developing and marketing services, will help licensees attract capital to develop and implement new innovative technologies and services.

Based on prior experience, however, the primary obstacle to experimental license applications is the overly cautious approach of federal users participating in the Interdepartment Radio Advisory Committee (“IRAC”) process. This approach effectively gives a government agency the ability to veto an experimental application regardless of whether there is any potential for real-world interference to government spectrum users. The Coalition urges NTIA to require IRAC participants to show, within a reasonable timeframe, that the proposed experimental license actually will have an adverse impact on the operations of federal systems. This approach would be consistent with Memorandum of Understanding between the FCC and NTIA, under which the two agencies committed to “ensure that the spectrum is used for its highest and best purpose whether by the private sector, state and local government, or Federal agencies”

¹⁷ *Id.* at 33, ¶ 77.

¹⁸ *Id.* at 33-34, ¶ 78.

¹⁹ *Id.* at 34, ¶ 79.

and are required to work together to “promote efficient use of spectrum consistent with both the economic interests and national security of the nation.”²⁰

Similarly, mmWC urges the Commission to modify the current provision of Section 5.83(b) of the rules that states that experimental licenses are “subject to cancellation at any time without notice or hearing” as it applies to Spectrum Horizons Experimental Radio Licenses. While experimental licenses will no doubt remain “experimental” without the expectations of regular FCC licenses, there should nevertheless be a procedural safeguard to protect experimental licensees who invest significant sums of money in developing technologies under an experimental license. Specifically, the cancellation provisions in Section 5.83 should only apply in cases of actual interference with some safeguards to allow appeal of interference determinations. While experimental licenses above 95 GHz will not have the “expectation of renewal” of all non-experimental licenses, facilitating capital formation for new technology requires some measure of certainty. As noted above, a 10-year term for Spectrum Horizons Experimental Radio Licenses will facilitate capital formation for new innovative technologies. However, allowing such licenses to be terminated at any time for any reason without hearing or notice will undo the benefits of the greater certainty provided by the Commission’s proposed experimental license rules. Accordingly, mmWC urges the Commission to ensure that terminating a Spectrum

²⁰ *Memorandum of Understanding Between the Federal Communications Commission and the National Telecommunications and Information Administration*, Section III, Jan. 31, 2003, available at https://www.ntia.doc.gov/files/ntia/publications/fcctiamou_01312003.pdf.

Horizons Experimental Radio License before its term be subject to procedural safeguards and limited only to actual interference cases.

IV. THE COMMISSION SHOULD EXTEND RF SAFETY LIMITS ABOVE 100 GHZ TO DECREASE REGULATORY UNCERTAINTY

The Commission proposes deferring the issue of RF safety limits until the it considers such limits in a separate, ongoing *RF Inquiry* proceeding.²¹ However, mmWC urges the Commission to extend existing RF safety limits on an interim basis, which are currently specified up to 100 GHz, to frequencies above 100 GHz (up to the highest frequency authorized in this proceeding) – even if such limits are later modified in a separate proceeding. Not specifying any RF safety limit will lead to regulatory uncertainty during deployments of new above-95 GHz services and technologies because operators and manufacturers will not be able to point to compliance with an applicable FCC RF safety limit when faced with zoning/permitting issues from local governments or in litigation over possible health impacts of such systems. All other FCC licensees can point to numerical standards for RF exposure as a line of defense in such cases. The absence of a numerical standard here is a regulatory risk for users of these bands. Even a conservative limit would be better than no limit for the purposes of encouraging investment in and reducing litigation risk for new technologies developed for use in the above-95 GHz spectrum.

²¹ *NPRM* at 35, ¶ 82 & nn. 195-197 (proposing to defer changes to its RF exposure rules pending consideration of such issues in the *RF Inquiry* proceeding, ET Docket Nos. 13-84, 03-137.

The existing RF exposure limits up to 100 GHz limits are based on an IEEE standard that extends to 300 GHz.²² That standard has the same limits as the current FCC standard for frequencies between 100 GHz and 300 GHz. Pending resolution of the ongoing *RF Inquiry* rulemaking referenced in the *Notice*, mmWC urges the Commission to adopt an interim standard by extending the current 100 GHz RF Exposure limit to frequencies above 100 GHz.

V. THE COMMISSION SHOULD LEGITIMIZE NON-COMMUNICATIONS INDUSTRIAL, SCIENTIFIC, AND MEDICAL (ISM) USES OF ABOVE-95 GHZ SPECTRUM

The *Notice* seeks comment on whether the Commission should adopt a more certain regulatory approach with respect to Industrial, Scientific and Medical equipment operating in the above-95 GHz band.²³ The Coalition urges the Commission to establish regulatory certainty for ISM operations in the above-95 GHz frequencies to encourage capital formation for both developers of new innovative ISM equipment and manufacturers who use the technology in their manufacturing processes. The current approach of OET evaluating equipment that uses the above-95 GHz frequencies on a case-by-case basis²⁴ does not provide the regulatory certainty needed for investment in

²² American National Standards Institute (ANSI), *IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz*, ANSI/IEEE Std C95.1-1992, Sections 4.1 and 4.2. It should also be noted that the European Union RF safety standard, adopted in 1999, extends to 300 GHz. *Council Recommendation on the Limitation of Exposure of the General Public to Electromagnetic Fields (0 Hz to 300 GHz)*, 1999/519/EC, July 12, 1999, available at https://ec.europa.eu/health/sites/health/files/electromagnetic_fields/docs/emf_rec519_en.pdf.

²³ NPRM at 28, ¶ 61.

²⁴ FCC Laboratory KDB 227764 D01, *Classification of ISM Equipment*, February 1, 2018, https://apps.fcc.gov/kdb/GetAttachment.html?id=PS8dRnW5azD1bHdoKsDp4Q%3D%3D&d_esc=227764%20D01%20ISM%20equipment%20v01&tracking_number=21002.

new ISM technology development or for buyers of to invest in such expensive equipment. The case-by-case evaluation also deters the efficiencies that result from a more predictable regulatory environment including the development of components that can be used in different types of ISM equipment. One example of a new technology that would benefit from greater regulatory certainty is Terahertz Spectroscopy, which the *Notice* identifies as a technology that is well-suited for the above-95 GHz frequencies given the shorter wavelengths and that has garnered interest for these frequencies.²⁵ Terahertz Spectroscopy is used to examine materials to confirm their structural integrity and for other applications in materials science, and offers significant benefits to manufacturers of certain products by enabling real-time monitoring of structural integrity to improve manufacturing process control and product quality. This quality control makes the manufacturing more predictable and decrease product costs for the benefit of many society sectors as well as for export markets. However, the lack of regulatory clarity in the United States has deterred companies from investing in this technology domestically. This is but one example of a technology that would benefit from greater regulatory certainty for ISM devices using frequencies above 95 GHz.

VI. mmWC SUPPORTS A FLEXIBLE APPROACH TO TESTING THAT EVOLVES AS THE COMMISSION PROVIDES GUIDANCE INFORMED BY INDUSTRY INPUT

The Coalition supports the Commission’s proposed approach wherein OET will be expected to “provide guidance on appropriate measurement techniques through its

²⁵ NPRM at 10, 28, ¶¶ 14, 61.

knowledge database (“KDB”) publications as products are developed, seeking notice and comment as appropriate.”²⁶ A similar approach was used for the lower mmWave bands such as the licensed 38 and 39 GHz bands as well as the unlicensed 60 GHz band, wherein OET commenced the KDB process once the service rules were published. Coalition members are prepared to participate and provide input into this process, both before and after the KDB process is initiated, just as several companies provided input for the lower mmWave bands.

* * *

The mmWave Coalition commends the Commission for initiating this important proceeding and looks forward to working with the Commission and other interested parties to help establish rules that facilitate the introduction of innovative services and technologies in the above-95 GHz frequency bands.

Respectfully submitted,

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²⁶ *Id.* at 36, ¶ 83 (parenthetical added).

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