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

In the Matter of	)	
	)	
Revision of Part 15 of the Commission's	)	ET Docket No. 13-49
Rules To Permit Unlicensed National	)	
Information Infrastructure (U-NII)	)	
Devices in the 5 GHz Band	)	

REPLY COMMENTS OF
MIMOSA NETWORKS, INC.

Mimosa Networks, Inc. ("Mimosa"), by its attorneys, hereby submits its Reply Comments in response to the Comments filed August 14, 2014 in the above-captioned proceeding. The Comments were filed in response to the Petitions for Reconsideration seeking modification of the highly restrictive out-of-band emissions ("OOBE") limits adopted for Unlicensed National Information Infrastructure ("U-NII") devices operating in the 5.15-5.25 GHz (U-NII-1) band and the 5.725-5.850 GHz (U-NII-3) band.[1] For the reasons set forth in its Petition and in these Reply Comments, Mimosa respectfully requests that the Commission revise its rules to adopt Mimosa's proposal to increase the OOBE limit by the amount in dB that the directional gain of the antenna exceeds 6 dBi. Mimosa provides a comprehensive technical analysis demonstrating that adoption of its proposal will ensure that there is no harmful interference to users of adjacent bands,

[1] *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 (2014) ("*First Report and Order*" or "*Order*"). A summary of the *Order* and notice of the final rules adopted in the *Order* was published in the Federal Register on May 1, 2014. *Unlicensed National Information Infrastructure (U-NII) Devices in the 5 GHz Band*, 47 C.F.R. Parts 2 and 15, ET Docket No. 13-49, FCC 14-30, 79 Fed. Reg. 24569 (May 1, 2014).

while preserving the ability of fixed wireless users to utilize the bands for long-distance links that are critical to the provision of unsubsidized broadband service to rural Americans.

I. BACKGROUND AND INTRODUCTION

The *First Report and Order* imposed stringent OOBE limits on fixed point-to-point operations and devices in the U-NII-1 and U-NII-3 bands. Petitions for Partial Reconsideration of the stringent OOBE limits were filed on June 2, 2014 by Mimosa, Cambium Networks, Ltd. ("Cambium"), the Wireless Internet Service Providers Association ("WISPA"), and JAB Wireless, Inc. (collectively, "Petitioners"), a mix of vendors to, and operators of, wireless broadband Internet providers primarily serving rural areas.[2] Petitioners argued that the restrictive OOBE limits would have the unintended consequence of disrupting efforts to bring fixed wireless broadband services to unserved and underserved communities throughout rural America.[3] Petitioners further argued that the restrictive OOBE limits were unnecessary to prevent interference to adjacent bands, and that developing and deploying equipment in compliance with the strict OOBE limits would be costly, unmanageable and impractical. Mimosa and Cambium both submitted tech-

[2] Petitions for Partial Reconsideration were also filed by the Association of Global Automakers and EchoStar Technologies L.L.C. Mimosa's Reply Comments do not address those Petitions. A Petition for Partial Reconsideration was also filed by Motorola Solutions, Inc. ("MSI"), seeking an extension of the grandfathering and transition periods. In its Comments, MSI clarified its position to state that, in the first instance, it favored restoration of the less restrictive OOBE limits. MSI Comments at 2 – 3 ("Although [MSI] initially sought grandfathering of devices previously certified under Section 15.247 and an extended transition period for compliance with the new rules, the alternative of reconsidering the substantive OOBE limit altogether would be a more effective solution ….")

[3] This consequence would be contrary to the Commission's statutory mandate to make "available . . . to all the people of the United States . . . a rapid, efficient, Nation-wide, and world-wide wire and radio communication service with adequate facilities at reasonable charges." Section 1 of the Act, 47 U.S.C. § 151.

nical analyses demonstrating the engineering and economic challenges of complying with the restrictive OOBE limits.[4] Mimosa urged the FCC to amend the OOBE limits of Section 15.407 to scale with antenna gain in the U-NII-1 and U-NII-3 bands.

II. SUMMARY OF COMMENTS FILED

The comments filed unanimously support, with only one exception, either restoration of the less restrictive OOBE limits set forth in Section 15.407 or amendment thereto. Comments in support were filed by a broad array of vendors, operators, trade associations and individuals. Participants in the wireless broadband Internet industry, including WISPA, MSI, FreeWave Technologies, Inc., and scores of wireless Internet service provider ("WISP") operators, unanimously supported restoration of less restrictive OOBE limits. The Fixed Wireless Communications Coalition, representing a broad array of companies, associations and individuals interested in fixed service, the Utilities Telecom Council, representing utilities and other critical infrastructure industries, and TechAmerica, the public sector and public policy division of the Computing Technology Industry Association ("CompTIA") representing information technology and communications industry companies, all supported restoration of the less restrictive OOBE limits. In fact, of the scores of comments addressing the OOBE limits, only Cisco Systems, Inc. opposed grant of the Petitions to restore the less restrictive OOBE limits.

[4] Mimosa Petition, Appendix A, Mustafa Rangwala, *Engineering Analysis of Out-of-Band Emissions Requirements Adopted by the FCC in the U-NII Devices First Report and Order*. *See also* Cambium Petition, Declaration of Nigel King and Appendix A, Analysis of the Impact of Tightened OOBE on Representative WISP Deployment.

III. CISCO'S COMMENTS FAIL TO PROVIDE ANY TECHNICAL OR ENGINEERING ANALYSIS TO SUPPORT RETENTION OF THE MORE RESTRICTIVE OOBE LIMITS

In opposing the restoration of the less restrictive OOBE limits, Cisco blames the WISP community for (1) illegally modifying U-NII-3 equipment to operate in the U-NII-2C band and thereby creating interference to Terminal Doppler Weather Radar ("TDWR") operations,[5] and (2) failing to compromise its own self-interest so as to maximize shared use of the band.[6] Mimosa sharply disagrees with Cisco's broad-brush smear of the entire WISP industry, but will leave any further rebuttal to the representatives of that industry. Cisco also mischaracterizes the Petitioners, and their supporters, as "a handful of outliers".[7] In fact, the Comments overwhelmingly demonstrate that it is Cisco that is the outlier in this proceeding.

Most importantly, Cisco fails to provide any technical or engineering analysis to support the need for the more restrictive OOBE limits to ensure against harmful interference. Likewise, and again without any support, Cisco speciously argues that compliance with the more restrictive OOBE limits can be achieved, at a reasonable cost, with filtering.[8] For example, Cisco boldly concludes – without providing any evidence – that "the Commission can reasonably expect that compliance (by employing better filters) will be far less expensive, and with far less (if any) reduction in tuning range, than today's doom and gloom projections."[9]

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[5] *See e.g.* Cisco Comments at 3 ("Many of the interference problems addressed by the [*First Report and Order*] stem directly from the propensity of some WISPs to illegally modify U-NII-3 equipment to operate in other bands ….").

[6] Id. at 2.

[7] Id.

[8] Id. at 12 – 13.

[9] Id. at 12.

By contrast, Mimosa provides a comprehensive technical analysis demonstrating that adoption of Mimosa's proposal will ensure that there is no harmful interference to users of adjacent bands, while preserving the ability of fixed wireless users to utilize the bands for long-distance links that are critical to the provision of unsubsidized broadband service to rural Americans. Mimosa also demonstrates that filters are not a viable means to comply with the more restrictive OOBE limits.

IV. ADOPTION OF MIMOSA'S PROPOSAL WILL EFFECTIVELY PROTECT ADJACENT BAND USERS FROM HARMFUL INTERFERENCE

The fundamental flaw of applying the more stringent OOBE requirements in Section 15.407 is that they are specified as an absolute EIRP value, measuring peak radiation and not taking into account total integrated radiation across a sphere. Expressed in this way, the new limits in fact penalize high gain antennas in a manner that destroys their efficacy. Mimosa proposes instead that peak emissions limits be scaled for high gain antennas (gain higher than 6 dBi) which, by design, narrowly radiate peak emissions in the direction of the antenna's main beam. Mimosa's proposal ensures that peak radiation is subjected to an equivalent emissions limit as would exist for a radio with an omnidirectional antenna – without the need to perform an integrated radiation measurement.

The OOBE limits for U-NII-3 are currently set at -17 dBm/MHz EIRP at band edge and -27 dBm/MHz EIRP starting 10 MHz from band edge. Similarly, the OOBE limits for U-NII-1 are currently set at -27 dBm/MHz EIRP at band edge. These OOBE limits unfairly – and unnecessarily – penalize high gain systems employing a directional antenna, since the peak emissions from such antennas exist solely in a narrow solid angle (on the order of 10° or less) within the antenna's main beam. In fact, a well-designed high gain antenna will have very low

side lobes, generally on the order of 30 dB lower than the main beam.[10] Thus, adopting Mimosa's proposal to scale the maximum allowable OOBE by antenna gain would actually result in lower off-axis emissions, and thereby further reduce the risk of harmful interference to devices.

Exhibit A illustrates a 25 dBi high gain antenna (the dotted line approximates the antenna radiation pattern) in a point-to-point link, transmitting 30 dBm of conducted output power. This link meets the FCC's more restrictive Part 15.247 U-NII-3 requirements for conducted power and antenna gain. Applying Mimosa's proposed emissions requirements, the transmitter could radiate up to -8 dBm/MHz EIRP of emissions within the main beam of the antenna, but in a very narrow volume of space directed only towards its link partner. The off-axis emissions from this transmitter would be much lower than -8 dBm/MHz EIRP. Assuming a nominal 30 dB side lobe rejection, this system would radiate only -38 dBm/MHz EIRP emissions to any nearby 5 GHz system, shown in the illustration as a potential TDWR site. Thus, the risk of interference under Mimosa's proposal would be even lower than that emitted from an omnidirectional radiator complying with the current -27 dBm/MHz EIRP limit. Exhibit B compares the radiation patterns of a high gain directional antenna and an omnidirectional antenna.

[10] See e.g. Jirous antenna JRC-24, a 23 dBi parabolic dish with 8° beam width and side lobes under 30 db. http://en.jirous.com/antenna-5ghz/jrc-24.

V. FILTERING IS NOT A VIABLE TECHNICAL SOLUTION TO MEET THE MORE RESTRICTIVE OOBE REQUIREMENTS

Cisco asserts, without providing any empirical data, that better filtering can be employed to comply with the more restrictive OOBE limits. Cisco is incorrect, as shown by the following technical discussion. Using the previously stated link example, a radio could employ a 25 dBi directional antenna, transmitting 30 dBm conducted power with a 10 dB peak-to-average ratio (standard for high spectral efficiency OFDM modulation) over an 80 MHz channel bandwidth (as per the latest 802.11ac specification). In order to meet the stringent -27 dBm/MHz EIRP limit, this radio would be subjected to a spectral mask of 73 dBc. As demonstrated in Mimosa's Petition, the standard spectral mask performance of today's high-linearity power amplifiers is on the order of 45 dBc. Thus, an extra 30 dB rejection would be required from a narrow-band filtering solution. Exhibit C shows a spectral diagram of this configuration, where the 80 MHz channel is centered as a best case in the middle of the 125 MHz U-NII-3 band.

Exhibit C illustrates that, in order to comply with the more restrictive OOBE limits, a filter would have to meet all of the following requirements: (i) 80 MHz of bandwidth at a center frequency of 5785.5 MHz, translating to an unrealizable filter Q[11] of 72, (ii) a 1 dB/MHz rejection slope to meet the 30 dB filter rejection by 10 MHz from the band edge at 5715 MHz, and (iii) an extremely low insertion loss such that the filter does not disturb the pass band performance of the channel. Unfortunately, no such commercially available filter exists.

[11] Q is a measure of filter "sharpness", often calculated as the ratio of the pass band and the center frequency of the desired filter. Q above 50 is extremely challenging to realize, especially at microwave frequencies such as 5 GHz.

To further demonstrate, the required performance of the filter can be compared to the performance of a commercially available filter from a high quality vendor such as TriQuint Semiconductor (part number 880639). This particular filter offers a bandwidth of 145 MHz and a stop band rejection slope of approximately 0.3 dB/MHz, falling short of the requirements by a factor of three. The TriQuint filter is a large size resonant cavity filter (3.3 x 1.6 mm^2) that also suffers from 3 dB of insertion loss which would degrade radio transmit power. Other commercially available filters are also wholly inadequate.[12] Even in the best case scenario of centering the channel within the band and giving up the rest of the band as unusable, no filtering solution currently exists that would allow the use of the band for high throughput long distance backhaul applications. Attempting to fit channels closer to the band edge, or using the 100 MHz U-NII-1 spectrum is equally impractical, thus blocking out large swaths of otherwise usable spectrum.

IV. CONCLUSION

For the reasons discussed in its Petition and in these Reply Comments, Mimosa respectfully requests the Commission to partially reconsider the *First Report and Order* and to revise its rules to adopt Mimosa's proposal to increase the OOBE limit by the amount in dB that the directional gain of the antenna exceeds 6 dBi. Mimosa's proposal represents a compromise that will allow high gain outdoor systems to continue to provide connectivity over long distances, while

[12] *See* L-com BPF5800A, http://www.l-com.com/bandpass-filter-rf-splitter-58-ghz-ultra-high-q-4-pole-outdoor-bandpass-filter-full-band. *See also* Q Microwave 5.8 GHz Filter Product Line, http://www.qmicrowave.com/q_images/5.8GHz_Product_Line.pdf.

further reducing the risk of interference from lower gain systems employing omnidirectional antennas.

Respectfully submitted,

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September 2, 2014

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EXHIBIT A

High gain antenna utilized in point-to-point link

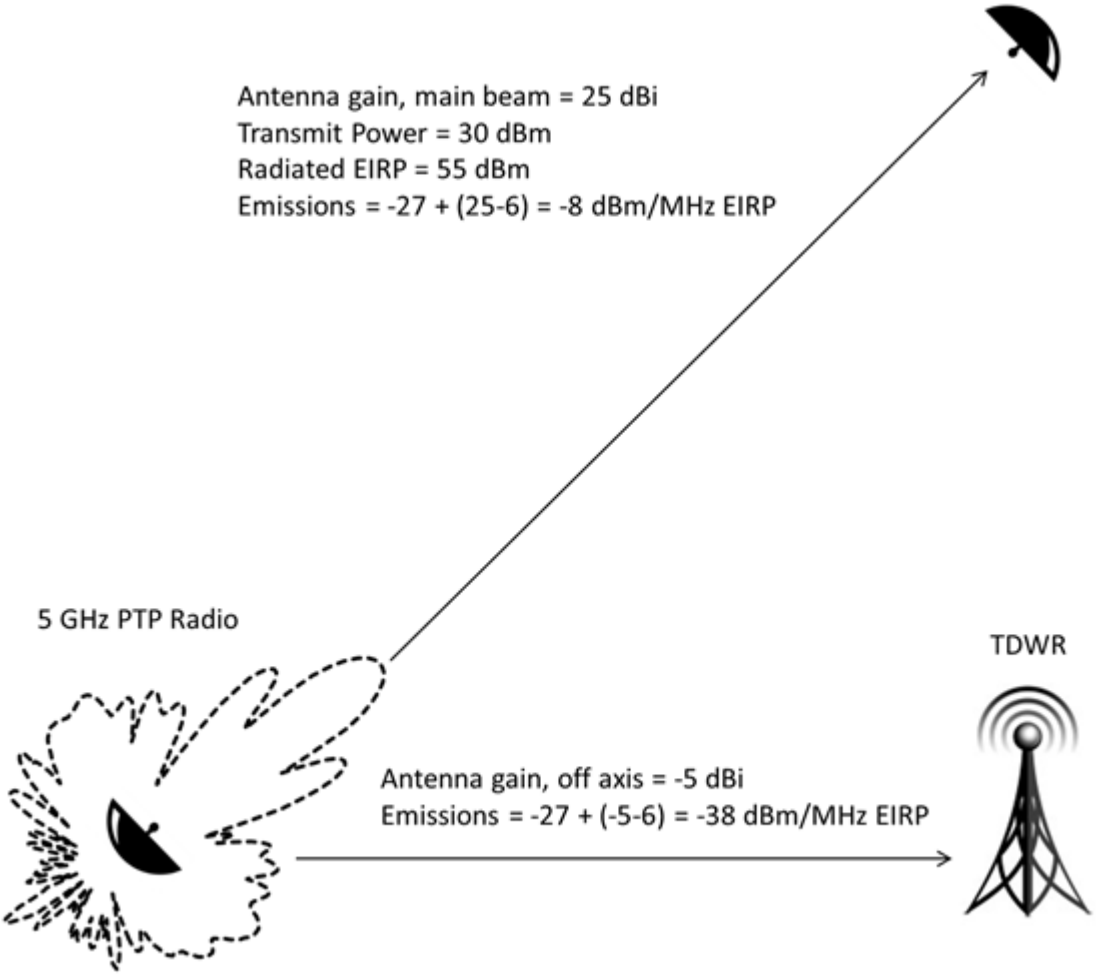

EXHIBIT B

Comparison of radiation patterns of directional and omnidirectional antenna

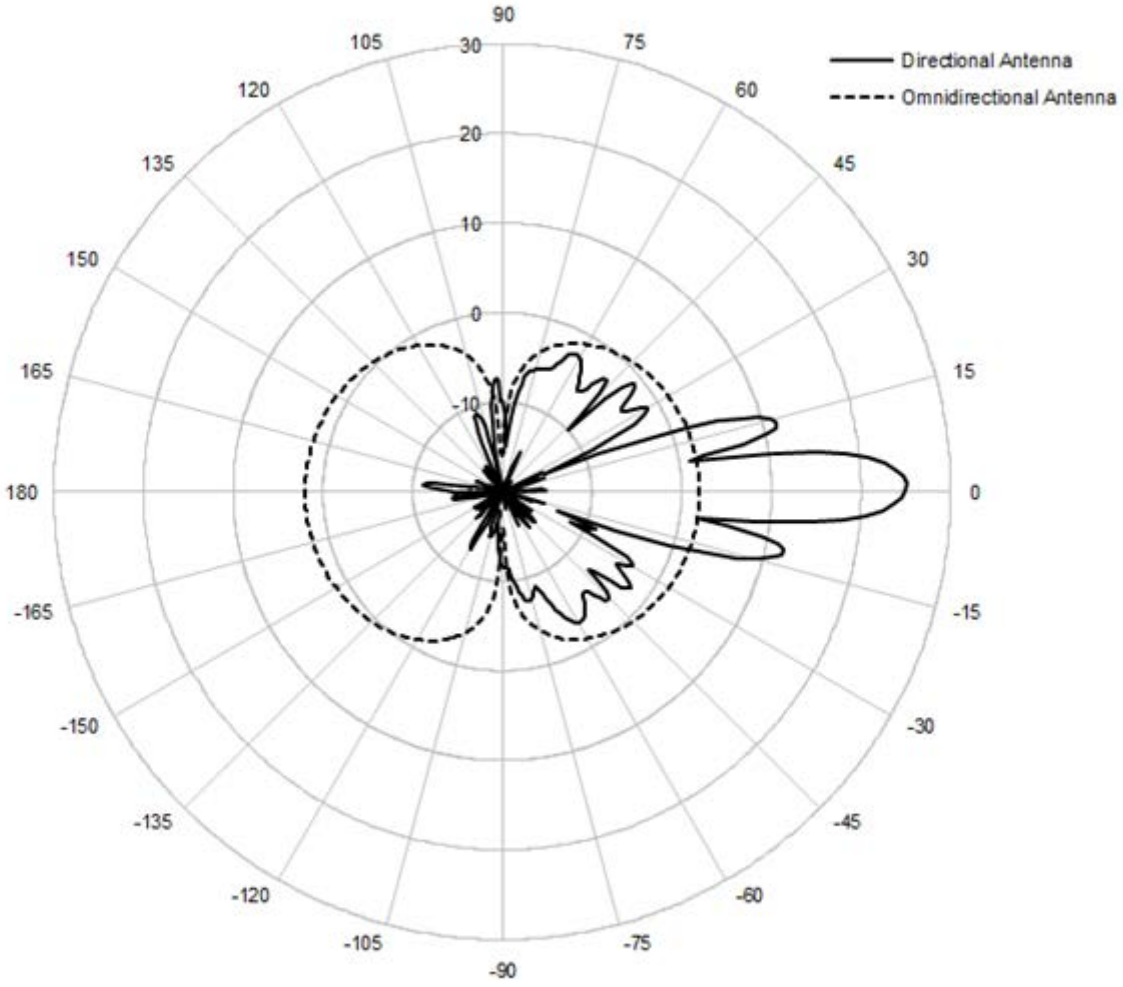

EXHIBIT C

Filter spectral requirements