

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

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

**PETITION FOR RECONSIDERATION OF
CAMBIUM NETWORKS, LTD.**

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Summary

Cambium Networks, Ltd. (“Cambium”), by counsel and pursuant to Section 1.429 of the rules of the Federal Communications Commission (“FCC”), asks the FCC to reconsider the “unwanted emissions” limit (“OOBE limit”) adopted in the First R&O in this proceeding as applied to certification of devices, particularly in the U-NII-3 band at 5.725-5.850 GHz. Cambium does not seek reconsideration for any action in the *First R&O* other than this rule change.

The *First R&O* replaced the Section 15.247 OOBE limit with the much more restrictive limit of Section 15.407, which if applied to all unlicensed devices operating in the 5.725-5.850 MHz band would severely burden -- indeed virtually eliminate -- network deployments of longer-range wireless links for services such as broadband access and backhaul. The rule change imposes significant new costs on manufacturers of such devices to comply with the new standard and on wireless Internet service providers who use this equipment to deploy service.

Since Cambium began selling equipment to the WISP community eleven years ago,¹ to enable that community to deliver high-speed internet service to rural America, Cambium has sold approximately 500,000 units to WISPs that meet the OOBE standard of Section 15.247 and operate in the U-NII-3 band. These units are providing service to approximately one million rural American users.

Indeed, the Commission must promote, not harm, the widespread deployment of advanced broadband services in rural areas, consistent with stated policy objectives and with statutory directives. This *First R&O*'s change to the OOBE standard would undercut such objectives by making the spectrum at 5.725 GHz-5.850 GHz unusable for long-range deployments, particularly in rural areas where fixed wireless operations are essential to the delivery of advanced broadband. While the FCC cites to administrative convenience and protection of TDWR stations as justification for the more restrictive limit, the record does not support such bases. Any administrative convenience for governing U-NII-3 by the same OOBE standard as in other U-NII bands is no justification for cutting off millions of rural residents from the Internet. Separately, there is no evidence in the record of lawful operations under the OOBE limits in Section 15.247 resulting in any cases of harmful interference to adjacent-band users.²

Separately, the proposed OOBE limit would add prohibitive cost increases to equipment, requiring new filters to be integrated into the products and dramatically raising equipment cost to WISPs. The sharper limit will reduce bandwidth from 20 MHz to 5 MHz and the shared bitrate by a factor of four, thus eviscerating the unit's performance. Alternatively transmit power would have to be reduced, thereby reducing the range by 75%. In addition, most of the rest of the world continues to use an OOBE standard for U-NII-3 WISP equipment equivalent to that in Section 15.247, so requiring WISP equipment in the United States to meet a vastly different OOBE

¹ This includes the period when Cambium was a part of Motorola Solutions. Cambium has been an independent company for three years.

² The past usage to serve rural residents has been entirely in the U-NII-3 band. However, the U-NII-1 band is as far removed spectrally from the TDWR band as is the U-NII-3 band. Accordingly, there is no real likelihood of harmful interference if the less restrictive OOBE limit is also made the standard for the U-NII-1 band. Indeed, without such a corresponding change, the U-NII-1 band will not be available for WISP operations.

standard will require the development of special equipment for the U.S. market, and the costs could not be spread across other world markets.

Parties in the record expressing support for more restrictive emissions limits don't use the band for long-range communications links in rural areas. Such parties may stand to gain if WISPs are barred from using the 5 GHz band for such services. Other parties focus on the impact of the emissions limit restriction on indoor, short-range services like Wi-Fi or WLAN, rather than the more robust wide-area services that can be provided with Cambium equipment.

Incumbent services will continue to have protection from harmful interference by U-NII devices without eliminating the Section 15.247 emissions limit. Every instance of harmful interference cited by the Commission in the *First R&O* arose from unlawful modifications of certified equipment at the end-user level, not from the lawful use of equipment certified under Section 15.247. The closest edge of the U-NII-3 band is 75 MHz removed from the edge of the TDWR band, and almost all TDWR stations are in or near major metro areas, far removed from most rural WISP operations. As a result, the record reflects no cases of harmful interference from lawful WISP transmissions using Section 15.247-certified equipment, and in fact, the FCC has decided to grandfather deployed equipment for the life of the transmitters.

Even if the stricter emissions limit is retained, the FCC should expand the short time frames for implementing the new rules and grandfather existing product models indefinitely. The FCC has sharply underestimated the development cycle and time to market for this type of equipment, where new product development generally takes several years. Accordingly, Cambium requests that the one-year and two-year deadlines be extended to three years respecting equipment not yet certified, and that the two-year deadline be eliminated for all product models that have already been certified under the old regime. Extending the deadlines for equipment yet to be developed will allow all manufacturers a reasonable amount of time to address the daunting design issues associated with meeting the new requirements. Permanently grandfathering already-certified models is justified, due to the 100% absence of any harmful interference from past lawful operations using such units.

For the foregoing reasons, Cambium respectfully requests that the Commission reconsider its decision in the *First R&O* to apply a more restrictive OOB limit to devices certified to operate in the U-NII bands (especially U-NII-3) and to retain the Section 15.247 GHz OOB standard for those longer-range communications links which form the backbone of wireless ISP service to rural households.

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**PETITION FOR RECONSIDERATION OF
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Cambium Networks, Ltd. ("Cambium"), by counsel and pursuant to Section 1.429 of the rules of the Federal Communications Commission ("FCC"), seeks reconsideration of certain actions taken in the First Report and Order in the above-captioned proceeding.¹ Cambium asks the FCC to reconsider the "unwanted emissions" limit ("OOBE limit") adopted in the *First R&O* as applied to certification of devices in the U-NII bands, particularly the U-NII-3 band at 5.725-5.850 GHz. Previously, the OOBE limit within the U-NII-3 band was the one found in Section 15.247 of the Rules. The *First R&O* replaced the Section 15.247 OOBE limit with the much more restrictive limit of Section 15.407, and also imposed this more restrictive limit for any newly-authorized activities in the U-NII-1 band.²

As discussed herein, applying the Section 15.407 OOBE limit to all unlicensed devices operating in the 5.725-5.850 MHz band would severely burden -- indeed virtually eliminate -- network deployments of longer-range wireless links for services such as broadband access and backhaul. The rule change imposes significant new costs on manufacturers of such devices to

¹ *Revision of Part 15 of the Commission's Rules to Permit Unlicensed National Information Infrastructure (U-NII) Devices in the 5 GHz Band*, First Report and Order, ET Docket No. 13-49 (rel. April 1, 2014) ("*First R&O*").

² Compare 47 C.F.R. §15.247 with 47 C.F.R. §15.407. The difference in required attenuation of unwanted emissions imposed by these two sections is as much as 50 dB.

comply with the new standard. These costs will be passed on to wireless Internet service providers (“WISPs”) who are the users of this equipment to deploy, and are so significant that they jeopardize the continued use of this spectrum to deliver service to rural households. In those rural areas where fixed wireless architecture is the only viable access solution, the rule change would make broadband deployment *effectively impossible*. The only countervailing “benefit” is the Commission’s administrative convenience in having the same OOB limit for the U-NII-3 band as for the other U-NII bands (bands which are not used to deliver the internet to these rural households). Accordingly, Cambium urges the Commission to reconsider the aspects of the *First R&O* described herein.

Background

Description of Cambium and Its Interest

Cambium is a leading global provider of wireless broadband solutions. Headquartered just outside Chicago, IL, the company also has research and development centers in the United Kingdom and in India. Cambium has an extensive portfolio of wireless broadband point-to-point (“PTP”) and point-to-multipoint (“PMP”) platforms, and its customers include a variety of WISPs, other internet service providers (“ISPs”), governmental and military agencies, oil, gas and utility companies, and public safety networks. Cambium has more than 4,000,000 access and backhaul radios deployed in more than 150 countries.³

Since Cambium began selling equipment to the WISP community eleven years ago,⁴ to enable that community to deliver high-speed internet service to rural America, Cambium has sold approximately 500,000 units to WISPs that meet the OOB standard of Section 15.247 and

³ See <http://www.cambiumnetworks.com/company> (visited May 20, 2014).

⁴ This includes the period when Cambium was a part of Motorola Solutions. Cambium has been an independent company for three years.

operate in the U-NII-3 band. These units are providing service to approximately one million rural American users.⁵ Cambium is a market leader in U.S. sales of high-power, longer-range PTP and PMP equipment that rural WISPs use to deliver service to rural households.

In this proceeding, the Commission has modified policies and rules to better promote the use of the 5 GHz band for unlicensed broadband devices. More specifically, the First Report and Order: 1) relaxed the power limits and removed the outdoor use restriction for devices operating in the 5.15-5.25 MHz (U-NII-1) band; 2) imposed new authentication and security requirements for all unlicensed devices to prevent unauthorized software changes; 3) detailed new compliance measurement procedures for devices operating in the 5.25-5.35 GHz and 5.47-5.725 GHz bands to better protect Federal Terminal Doppler Weather Radar⁶ and other radar systems; and 4) consolidated its rules to impose a uniform regulatory framework for devices operating 5.725 – 5.850 MHz band. To be clear, Cambium has no issues and does not seek reconsideration for any action other than the significant new restrictions on OOB in the 5.725 – 5.850 MHz band, and application of those restrictive OOB limits in the newly-authorized outdoor use of the U-NII-1 band.

Cambium filed Comments in this proceeding, which Comments urged the Commission not to apply the OOB limits from Section 15.407 in the U-NII-3 band (or by implication for point to point usage in the U-NII-1 band) and predicted a material harm to rural residents, especially if the proposed change within the U-NII-3 band was implemented. Cambium explained below that “incumbent systems in the U-NII 2C band are more likely to be affected by the wanted radiation from unlicensed devices in the same band than from unwanted out of band

⁵ See Declaration of Nigel King, Cambium Chief Technology Officer, attached hereto (“King Declaration”), ¶3.

⁶ Terminal Doppler Weather Radar (“TDWR”) units operate at 5.6-5.65 GHz.

radiation from devices in the U-NII 3 band”,⁷ meaning that there may be solid policy reasons to treat the two U-NII bands differently from the standpoint of OOB. Cambium went on to explain, *id.*:

addition of a limit in EIRP for fixed point-to-point applications will hamper useful deployment of longer links in hard-to-reach rural areas. Non-line-of-sight (NLOS) links can be operated in the 5.7 GHz band using polarization diversity, in cost-effective deployments where a licensed band link would require one or more repeaters. We encourage the Commission to permit the continued use of higher gain antennas without an output power penalty in areas where interference is unlikely to be a problem.

As Cambium summarized: “the benefits of changing the emission limits are unproven.” *Id.*

Cambium has thirteen product lines which would be adversely affected by the change from the Section 15.247 OOB standard to the Section 15.407 OOB standard. Since, as discussed herein, the OOB limits change results in the virtual elimination of WISPs and their subscribers as a viable market for Cambium’s equipment due to the prohibitive cost increase involved, Cambium stands to lose millions of dollars in revenue. Therefore, Cambium has standing to seek reconsideration.

Discussion

I. The Commission Should Promote, Not Harm, the Diffusion of Advanced Broadband Services in Rural Areas.

Promoting rural broadband deployment is a critical policy objective for both the Congress and the Commission. The Commission has a statutory mandate to “encourage the deployment on a reasonable and timely basis of advanced telecommunications capability to all Americans...”⁸ The Commission’s National Broadband Plan articulated the importance of fixed

⁷ Cambium Comments, p.4.

⁸ 47 U.S.C. §1302(a). “Advanced telecommunications capability” is defined to include “broadband telecommunications capability.” *Id.* § 1302(d)(1). By statute, the FCC is charged with making “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.” 47 U.S.C. §151.

and mobile broadband to drive economic growth, job creation, education, health care, homeland security and other goals.⁹ The Communications Act of 1934, as amended, 47 U.S.C. 151 *et seq.* (“Act”), provides that “[a]ccess to advanced telecommunications and information services should be provided in *all* regions of the Nation”¹⁰ and that consumers in rural, insular and high-cost areas should have access to “advanced telecommunications and information services ... that are reasonably comparable to those services provided in urban areas.”¹¹ Cambium has built a business around serving the needs of broadband providers, particularly WISPs, who seek to deploy advanced services to rural areas.

As the Commission notes, delivery of broadband service to rural areas is difficult:

We recognize that rural America poses particular challenges for the deployment of next generation communications services. By definition, rural areas are geographically dispersed, with lower population density. Often they are in areas with geological and topographical challenges; in addition, some rural areas experience particularly extreme seasonal and meteorological conditions. For various reasons, rural areas have lower broadband adoption rates than urban areas. For instance, rural areas have a higher percentage of elderly residents, who tend to have lower broadband adoption. Since the 1960’s, when poverty rates were first officially recorded, rural areas have been home to a disproportionate number of low-income Americans. In 2012, 17.7 percent of the population, or about 8.5 million people, living in nonmetropolitan (nonmetro) areas were poor as compared to a poverty rate of 14.5 percent in metro areas. And this gap between nonmetro and metro poverty rates has widened in recent years, from 2.4 percentage points in 2011 to 3.2 percentage points in 2012. All of these factors, taken together, can make the economics of building out broadband-capable infrastructure in rural areas more challenging.¹²

⁹ See National Broadband Plan, Federal Communications Commission, Executive Summary at xi.

¹⁰ *Id.* §254(c)(1).

¹¹ *Id.* at §254(b)(3).

¹² *Technology Transitions, AT&T Petition to Launch a Proceeding Concerning the TDM-to-IP Transition; Connect America Fund; Structure and Practices of the Video Relay Service Program; Telecommunications Relay Services and Speech-to-Speech Services for Individuals with Hearing and Speech Disabilities, Numbering Policies for Modern Communications*, Order, Report and Order and Further Notice of Proposed Rulemaking, Report and Order, Order and Further Notice of Proposed Rulemaking, Proposal for Ongoing Data Initiative, GN Docket No. 13-5, *et al.*, FCC 14-5 (2014) (“*FNPRM*”) at ¶88 (footnotes omitted).

Cambium has taken up this challenge. Cambium’s vision is to “connect the unconnected,” with an intensive focus on delivering broadband to rural Americans.

Unfortunately, the Commission's decision to tighten the emissions limit for the U-NII-3 band undercuts its statutory obligation to promote the provision of advanced broadband services in rural areas. As described below, this rule change would make the spectrum at 5.725 GHz-5.850 GHz unusable for long-range deployments, particularly in rural areas where fixed wireless operations are essential to the delivery of advanced broadband.

If there were a legitimate countervailing public interest at stake, it might make sense for this Commission to hamstring delivery of high-speed internet services to rural America. But there is no such countervailing public interest here. The only rationales mentioned by the Commission were: a) administrative convenience in having the U-NII-3 band governed by the same OOB standard that applies in other U-NII bands; and b) prevention of harmful interference to adjacent channel operations, primarily TDWR stations. Standing alone, administrative convenience is no justification for cutting off over a million rural residents from the internet. As to harmful interference, there was no evidence in the record of this proceeding (and Cambium is unaware of any evidence even outside the record), of lawful operations under the OOB limits in Section 15.247 having even once resulted in a case of harmful interference to adjacent band users, TDWR or otherwise.

II. The FCC Should Retain the Existing Out-of-Band Emissions Limits in Section 15.247 for Devices Certified in the 5.725-5.850 GHz (U-NII-3) Band.

Cambium and other manufacturers develop and market equipment that makes efficient use of the U-NII-3 band for long-range communication in rural areas. Such areas are costly to serve due to terrain, low population density, distance from metropolitan areas and other issues. To date, the 5.725-5.850 GHz band and the Section 15.247 technical rules have enabled Cambium and others to develop equipment that enables cost-effective deployments of long-range communications links in rural areas, both PTP and PMP. WISPs and others can provide

broadband access in these areas because of the availability of these long-distance equipment products. The U-NII-3 band solutions are superior to licensed operations at higher frequencies, which generally operate over more limited distances than 5 GHz connections due to attenuation, rain fade and other technical considerations. *See King Declaration, ¶4.*

A. Changing the OOB Limit Adds Prohibitive Cost Increases

In the *First R&O*, at ¶119, the FCC decided to:

adopt our proposal to apply the more restrictive unwanted emissions limits in Section 15.407 for the combined new rule, rather than the more lenient unwanted emissions limit currently in Section 15.247. This decision is consistent with our decision to apply the 15.407 out-of-band emission levels in the U-NII-2 bands and having a single limit for devices that operate in any U-NII band will provide clarity and simplicity, while providing appropriate protection to incumbent services.

Unfortunately, the Commission failed to provide “protection to incumbent services”, with respect to the rural WISP market and its rural subscribers.

Using current product designs, meeting the much more restrictive Part 15.407 emissions limit will require using a filter for each piece of WISP equipment, which would have to be integrated into each product. *See King Declaration, ¶5.* Depending on the current MSRP of a product, each piece of equipment will cost rural WISPs up to four times what that same piece of equipment costs today. *Id.* Those price increases are as follows:

WISP Product	Current MSRP to WISP	New MSRP to WISP w/ Add'l. Filtering
Point-to-Point	\$2,615	\$3,215
PMP Low Cost (Access Point)	\$500	\$700
PMP Low Cost (Subscriber Station)	\$99	\$399
PMP Medium Cost (Access Point)	\$2,895	\$3,095
PMP Medium Cost (Subscriber Station)	\$249	\$549

Importantly, the two largest-volume pieces of equipment are the Subscriber Stations; there are generally twenty Subscriber Stations for each associated Access Point in a WISP network. And to clarify, the table above reflects the prices paid to the manufacturer by the WISP, which is less than the price the WISP must charge the rural subscriber in order to achieve a return on the WISP's own investment.

Even if adding filters to each product maintained the product's effectiveness and performance capabilities (and, as discussed in Part II.B *infra*, such is not the case), these huge price increases, by themselves, will eliminate 5 GHz fixed wireless as a viable method of delivering service to these rural residents.

B. Changing the OOB Limit Will Eviscerate Product Performance

While the FCC states that “unwanted emission can be reduced without affecting the utility of the device,”¹³ this is simply not the case. Even assuming, *arguendo*, that the equipment price increases detailed, *supra*, did not exist, adding the filter to each unit will reduce the channel size from 20 MHz to 5 MHz, reducing the shared bitrate by a factor of four and thus eviscerating the unit's performance. Reducing the channel size from 20 MHz to 5 MHz means so much less throughput as to eliminate WISPs' ability to deliver advanced services such as distance learning, tele-medicine or VoIP.

The only alternative to reducing bandwidth is to reduce the transmit power by 12 dB (and thus one-fourth the prior range in terms of distance). Reducing the range by 75% means sixteen base stations where today one base station suffices.¹⁴

¹³ *First R&O, supra*, at ¶114.

¹⁴ See King Declaration, ¶7. Cutting the radius of a circle to ¼ of its prior length results in a circumference covering only one-sixteenth the area previously within the circumference. Appendix A to the King Declaration is a depiction illustrating, for four typical rural sectors of one representative WISP in Colorado, how many of its current subscribers would never have received broadband service, or would have received second-class internet connections incapable of reliable provision of distance learning, tele-medicine or VoIP functions.

Nor is exiting the 5 GHz band a viable alternative. The 5 GHz band offers wider options than lower frequency alternatives such as the 900 MHz, 2.4 GHz and 3.50 GHz bands. The 5 GHz band also offers better propagation characteristics and can therefore be deployed at lower costs than higher frequency bands such as 26 GHz, where rain and obstructions can severely impact performance. These advantages combine to render the 5 GHz band as uniquely well suited for wireless broadband delivery in rural markets.

C. Designing New, Compliant Products Is Not Feasible

Cambium has thirteen product lines which would be adversely affected by the change from the Section 15.247 OOB standard to the Section 15.407 OOB standard. Cambium's expected cost, per production line, is over three million dollars, to design new products that would somehow: a) meet the OOB limit of Section 15.407; b) maintain adequate throughput to deliver quality broadband service to the rural customer; c) be deliverable at reasonable cost to WISPs so that their business models remain viable; and d) obtain new equipment certifications for these new designs.¹⁵ Those manufacturers which claim to be able to "adapt" to the OOB limit of Section 15.407 are making low-power, short-range equipment for the entirely distinct WLAN market, not for the WISP market and not for rural America.

Among other problems, except for portions of Europe, the rest of the world continues to use an OOB standard for U-NII-3 band WISP equipment equivalent to that found in Section 15.247. Requiring WISP equipment in the United States to meet a vastly different OOB standard means that the special equipment to be developed will be solely for use in the United

¹⁵ King Declaration, ¶10. As Mr. King explains, the development cost per product line is an estimate, which optimistically assumes that such equipment can be designed at all if the engineers can imagine some sort of radically different design approach that would solve the problems. At this time, neither Cambium nor any other manufacturer has an idea where to start, given the limitations of the available components.

States, with no ability to spread the development costs across the rest of the world's markets.¹⁶ This will also render any such hypothetical new Section 15.407 products too expensive to enable a viable rural service business model.

In summary, the Commission's move to stricter emissions limit leaves every manufacturer supplying the rural WISPs (including Cambium) with an impossible dilemma. There is no protection afforded to incumbent WISP service to rural America, and changing the OOB limit will eviscerate the utility of the current generation of devices, with no reasonable "fix" being foreseeable. Therefore, the FCC should preserve the ability of equipment manufacturers to obtain certification using Section 15.247, at least for outdoor-use devices used to bring the internet to rural America.

III. Parties Expressing Support for More Restrictive Emissions Limits Don't Use the Band for Long-Range Communications Links in Rural Areas

The FCC states that the record "shows broad support for adopting the tighter unwanted-emissions limits of Section 15.407" and identifies certain commenters as supporters of this position.¹⁷ These parties who support the tighter OOB standard either stand to gain if WISPs are barred from using the 5 GHz band to provide internet service to rural households, or at minimum are indifferent to whether rural Americans receive broadband service. Those commenters are either: a) manufacturers of wireless LAN and Wi-Fi equipment (or their associations);¹⁸ b) users of wireless LAN or Wi-Fi networks (or their associations);¹⁹ or c) those who use wire/fiber/cable to provide internet service, in competition with WISPs.²⁰

¹⁶ See King Declaration, ¶6. Because most foreign markets with a significant demand for fixed wireless as a broadband solution (*i.e.*, where this type of equipment is sold in volume) are outside Europe, effectively the U.S. will be separate from the rest of the world's markets.

¹⁷ *First R&O* at n. 178.

¹⁸ See, e.g., Wi-Fi Alliance, Motorola Solutions, IEEE 802 LMSC, Cisco, Ericsson, GlobalStar, TIA, Motorola Mobility and Ruckus Wireless.

¹⁹ See, e.g., Wi-Fi Alliance and TIA.

²⁰ See, e.g., NCTA, Comcast.

Certain parties, and particularly the Wi-Fi Alliance and TIA, focus on the impact of the emissions limit restriction on indoor, short range services like Wi-Fi rather than the more robust, wide-area services that can be provided using Cambium equipment. While Cisco states that “manufacturers have proven themselves readily capable of complying with the tighter limits set forth in Section 15.407(b)(4) without adversely impacting device performance or materially increasing costs,”²¹ this statement does not apply to long-range equipment serving rural households, a market Cisco does not serve.

Cisco, the Wi-Fi Alliance and similar parties are seeking to support the implementation of 802.11ac, which apparently requires two 80 MHz swathes of contiguous spectrum. By obtaining the shared use of TDWR spectrum for low-power, short-range Wi-Fi and WLAN operations, they have, in the *First R&O*, achieved their objective, and Cambium has no objection to that outcome. But the ability of Wi-Fi and WLAN manufacturers to make viable equipment that complies with the OOB limit of Section 15.407 is irrelevant to the issue of whether the totally separate WISP industry, operating in a different spectrum band (5.725-5.85 GHz) can possibly do so.

It may well be that the Commission staff mistakenly believed that supporters of 802.11ac were speaking for an entirely distinct industry (*i.e.*, the providers of higher-power, long-range PTP and PMP equipment with which WISPs serve rural Americans), but in fact the Wi-Fi proponents are not involved in bringing broadband to rural America and could not speak for that totally separate industry.²²

²¹ Comments of Cisco Systems, Inc. at 47.

²² At this stage, Cambium is primarily focused on continuing to apply the OOB standard of Section 15.247 in the U-NII-3 band, where it has been heavily relied upon to bring service to millions of rural residents. But Cambium and the rest of the WISP industry would like to use of the U-NII-1 band to serve rural residents, and believe that a relaxation of 15.407 within U-NII-1 for fixed point to point operation would be sound policy and would not result in harmful interference.

IV. Incumbent Services Will Continue to Have Protection from Harmful Interference by U-NII Devices Without Eliminating the Section 15.247 Emissions Limit

In the *First R&O*, the FCC stated that “using the more stringent unwanted emissions requirement will ensure that there is no increase in the potential for harmful interference from unlicensed devices operating under the new combined rule parts...”²³ But there is absolutely nothing in the record below to support that statement. As discussed below in this section, every single instance of harmful interference cited by the Commission below arose out of unlawful modifications of certified equipment at the end-user level – *not a single instance was traced to lawful use of equipment certified under Section 15.247*. And if lawful operations of Section 15.247 equipment was never the problem in the first place, *ipso facto*, prohibiting such operations prospectively is irrelevant to future harmful interference.

To repeat, the problem, as identified in the record, was unlawful equipment modifications, and in fact, in the *First R&O*, the Commission adopted several rule changes (which Cambium supports) to ensure that such unlawful equipment modifications will not be possible going forward, via a new device security requirement²⁴ as an appropriate, narrowly tailored tool to limit harmful interference to TDWR.

The *First R&O* states that “*no cases have been attributed to certified equipment operating properly in accordance with their grant of equipment operations*” – instead, the FCC found that the devices “had been illegally modified and operated at high power levels in elevated locations.”²⁵ Indeed, Cambium was unable to find, and is unaware of, any documented instance of a device operating consistent with its Section 15.247 certification causing interference to TDWRs via out-of-band emissions. Given that Cambium’s WISP customers have been operating

²³ *First R&O* at ¶114.

²⁴ *First R&O* at ¶¶47-60, 87.

²⁵ (Emphasis added.) *Id.* at ¶12.

Cambium's Section 15.247-compliant equipment in this band for over eleven years now, and that WISPs using other manufacturer equipment have been operating beginning as long as fifteen years ago, the complete absence of any reported harmful interference stemming from lawful operations is compelling evidence that no problem exists.

Given that the closest edge of the U-NII-3 band is 75 MHz removed from the edge of the TDWR band, it is no surprise that there has been a complete absence of harmful interference to TDWR installations for almost fifteen years now, despite the Section 15.247 OOB limit. Also, given that almost all TDWR stations are in or near major metro areas, far removed from most rural WISP operations, it is not surprising that there has never been a single case of harmful interference from lawful WISP transmissions using Section 15.247-certified equipment.²⁶ Stated otherwise, the chances of harmful interference moving forward, even if the Section 15.247 standard is maintained within the U-NII-3 band, are slim and none.

This argument is fully supported by the Commission's own decisions to grandfather the use of deployed equipment for the life of the transmitters and to allow the continued sale of pre-approved devices that are compliant with Section 15.247 for up to two years after the effective date of the *First R&O*.²⁷ Allowing for the continued, permanent operation of hundreds of thousands of transmitters that comply with the less restrictive out-of-band emissions does not signify a real-world interference concern.

In light of the Commission's own findings, there is no rational basis for concluding that restricting OOB limits so as to wipe out the use of the 5 GHz band to provide internet service to

²⁶Appendix B to the King Declaration is a map showing all of the TDWR stations nationwide, which illustrates this point. Moreover, as the Commission itself noted, *First R&O*, n.20, the Wireless Internet Service Providers Association ("WISPA") maintains a database of TDWR operations for the benefit of its members, to ensure avoidance of harmful interference to TDWR.

²⁷ *First R&O* at ¶134.

rural households would protect TDWR or other adjacent band users in any way. In summary, there is no countervailing public interest benefit to offset the injury to the public interest which this misguided OOB limitation has created.²⁸

V. To the Extent the Commission Retains the Stricter Emissions Limit, It Should Expand the Short Time Frames for Implementing the New Rules and Grandfather Existing Product Models Indefinitely.

The *First R&O* requires that twelve months after the effective date of the (*i.e.*, by June 2, 2015), all applications for certification of 5 GHz devices must meet the new and modified rules and that the manufacture, marketing, sale and importation into the United States of devices that do not meet the new or modified rules must cease by June 2, 2016. In its previously filed comments, Cambium argued that it is not reasonable for the Commission to expect that companies will be able to develop and bring to market a portfolio of new U-NII band products in only two years and therefore requested the Commission to allow for a longer transition period.²⁹ In the *First R&O*, although the Commission was “sympathetic to the arguments of commenters that the more restrictive unwanted emission limits for digital modulation devices may present design challenges for some manufacturers,” it nonetheless adopted its proposed two year transition period because “it is in the public interest to implement the changes as soon as possible to eliminate the potential of harmful interference to TDWRs.”³⁰

Although devices sold during this period will be grandfathered for the life of the

²⁸ Even if, arguendo, there were some minimal benefit in terms of protecting adjacent bands against harmful interference, the Commission generally establishes less stringent technical rules in rural areas where harmful interference is less likely to occur. *See, e.g.*, 47 C.F.R. §22.913 (sets higher ERP limit for transmitters in the cellular radiotelephone service in areas more than 72 km from international borders that are located in counties with population densities of 100 persons or fewer per square mile; 47 C.F.R. §90.542(a)(applies variable power limits for fixed and base stations in the 758-768/788-798 MHz bands and permits a higher combination of ERP /antenna height in counties with a population density of 100 or fewer persons); 47 C.F.R. §27.50(b)(similar approach for operations in the 746-758, 775-778 and 805-806 MHz bands).

²⁹ Cambium Comments, p.5.

³⁰ *First R&O* at ¶129.

equipment, the FCC has underestimated the development cycle and time to market for this type of equipment. In the real world, new product development (and this would be new, not incremental) generally takes several years. A business case for the proposed new equipment must be established, a development slot must be assigned, because development resources (including personnel resources) are limited, the development completed, internal testing completed, and external testing for regulatory approvals completed and submitted to regulatory authorities. Therefore, even if manufacturers begin the process now, the WISP operators will need continued access to and the right to deploy the current generation of equipment for a lengthy period.

Accordingly, Cambium requests that the one-year and two-year deadlines be extended to three years respecting equipment not yet certified, and that the two-year deadline be eliminated for all product models that have already been certified under the old regime. Extending the deadlines for equipment yet to be developed will allow all manufacturers a reasonable amount of time to address the daunting design issues associated with meeting the new requirements. Permanently grandfathering already-certified models is justified, due to the 100% absence of any harmful interference from past operations using un-modified units.³¹

Conclusion

For the foregoing reasons, Cambium respectfully requests that the Commission reconsider its decision in the *First R&O* to apply a more restrictive OOB limit to devices certified to operate in the U-NII-3 band and to retain the Section 15.247 GHz OOB standard for those longer-range communications links which form the backbone of wireless ISP service to

³¹ As previously indicated, it is not necessary for devices operating the 5.725-5.850 GHz band to protect TDWRs through the use of the more restrictive OOB limits – the frequency separation between the two services is sufficient to ensure that the level of any unwanted emissions will be sufficiently low as to not pose any problem to weather radar facilities.

rural households. The Commission's stated advantages of "clarity and simplicity" in harmonized emissions limits do not justify virtually eliminating an entire class of service which already exists – *i.e.*, the delivery of non-government-subsidized advanced internet service to rural households via fixed wireless.

That is especially so where, as here, the Commission failed to cite (and there apparently has never been) a single instance where lawful use of the equipment under the prior OOB standard was the cause of harmful interference. The cause of the problem was unlawful use of equipment modified at the end-user level to operate differently from the manner certified for use. The remedy, which the Commission separately implemented in the *First R&O*, was to eliminate the ability of end users to engage in such unlawful conduct.

It may be in the private interest of those who use the spectrum for short-range and indoor-only Wi-Fi and wireless LAN operations to essentially restrict the 5 GHz band to their types of operation, but it is not in the public interest to do so. Rather, the Commission's statutory mandate under the Act is to promote the development of advanced broadband services to rural areas in furtherance of the FCC's universal service obligations. Only by reinstating the OOB standard of Section 15.247 for longer-range, higher-powered operations in the U-NII-3 band can the Commission protect the interests of rural households in receiving internet service.

Respectfully submitted,
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DECLARATION OF NIGEL KING

My name is Nigel King. I declare under penalty of perjury that the statements set forth in this Declaration are true, to the best of my knowledge, information and belief.

1. I am the Chief Technology Officer of Cambium Networks, Ltd. ("Cambium"). I have been involved in the field of wireless communications for over 40 years. I am the named inventor of more than twenty-five patents and hold a Bachelor of Engineering Honors Degree from Southampton University. Immediately prior to coming to Cambium, I was one of the founders and Chief Technical Officer of Orthogon Systems. Prior to that, I was employed in various engineering and technical capacities at a number of high-technology enterprises, including, among others, Motorola Solutions, Nortel Networks, Standard Telephones and Cables, and Racal.

2. I have reviewed the Petition for Reconsideration to which this Declaration is attached, and all of the facts set forth therein are true and correct. Without limiting the foregoing, I add the following.

3. Since Cambium began selling equipment to the WISP community to enable that community to deliver high-speed Internet service to rural America, 11 years ago, Cambium has sold approximately half a million units to WISPs that meet the OOB standard of Section 15.247 and operate in the U-NII-3 band, which units are providing service to approximately a million rural American residents and businesses. Cambium has 13 product lines that would be adversely affected by the change from the Section 15.247 OOB standard to the Section 15.407 OOB standard.

4. For provision of fixed wireless broadband service to retail consumers, especially in rural areas, the U-NII-3 band solutions have some good qualities which so far have proven the most popular method of supplying broadband to rural communities. There is a wider bandwidth available than lower frequencies such as 900MHz, 2.4GHz and 3.65GHz. There are better propagation characteristics and lower costs than 26GHz where rain and obstructions can be important. Rain is almost invisible to 5.8GHz.

5. If the new OOB limits take effect, each piece of equipment will need a filter. The filter has differing complexity and therefore cost depending upon the product. The table below gives my estimate of the before and after MSRPs. It is important to note that the Subscriber Stations have the greatest cost increase as a percentage. Rural deployment is dominated by Subscriber equipment cost and installation cost:

WISP Product	Current MSRP to WISP	New MSRP to WISP w/ Add'l. Filtering
Point-to-Point	\$2,615	\$3,215
PMP Low Cost (Access Point)	\$500	\$700
PMP Low Cost (Subscriber Station)	\$99	\$399

PMP Medium Cost (Access Point)	\$2,895	\$3,095
PMP Medium Cost (Subscriber Station)	\$249	\$549

In turn, this will eliminate 5 GHz fixed wireless as a viable method of delivering service to the rural residents served by these WISPs. In addition, product performance would be affected because adding the filter to each unit would reduce the bandwidth from 20 MHz to 5 MHz, reducing the shared bitrate by a factor of four and reducing throughput dramatically.

6. Except for most of Europe, the rest of the world continues to use an OOB standard for U-NII-3 band WISP equipment equivalent to that found in Section 15.247 – requiring WISP equipment in the United States to meet a vastly different OOB standard means that special equipment will have to be developed solely for use in the United States, with no ability spread the costs across the rest of the world’s markets. The relevant domestic market, rural areas, is more akin to the conditions found in Asian, Australian, African and South American countries than the urban areas where most Americans live.

7. The only alternatives to this prohibitive cost increase are to operate: a) with a reduced frequency range (and therefore so much less throughput as to eliminate the ability to deliver advanced services such as distance learning, tele-medicine or VoIP); or b) by reducing the transmit power by 12 dB, which reduces the prior range by 75% in terms of link distance, thereby requiring 16 base stations where today one base station suffices.

8. Attached hereto as Appendix A is a report analyzing typical WISP deployments in four areas in rural Colorado for one representative WISP, to assess the impact that the new, more stringent OOB limit would have had if it had been in effect prior to now. Approximately 65% of its current subscribers in these study areas would never have received broadband service, or would have received second-class internet connections incapable of reliable provision of distance learning, tele-medicine or VoIP functions, under the stricter OOB standard. The new OOB limit will result in a sharp decrease in operating power, greatly reduced capacity and a large percentage of customers who would no longer be able to receive service. The new OOB limit will render the current WISP business model non-viable for rural areas.

9. Cambium was unable to find, and is unaware of, any documented instance of a device operating consistent with its Section 15.247 certification causing interference to TDWRs via out-of-band emissions. Cambium’s WISP customers have been operating Cambium’s Section 15.247-compliant equipment in this band for over eleven years now, and WISPs using other manufacturer equipment have been operating beginning as long as 15 years ago. One reason may be that, as Appendix B demonstrates, TDWR installations are not widespread across the county and generally are located outside of rural areas. The map was created from the list of TDWR installations identified in WISPA’s online database at <http://www.wispa.org/tdwr-locations-and-frequencies> (visited May 30, 2014).

10. Due to the new complexity of the required filtering and other issues, the relevant development cycle would be up to three years, if U-NII-3 manufacturers making devices to

deliver broadband service to rural Americans via fixed wireless are required to develop such equipment meeting the OOB limits set forth in Section 15.407. A business case for the proposed new equipment must be established, a development slot must be assigned, because development resources (including personnel resources) are limited, the development completed, internal testing completed, and external testing for regulatory approvals completed and submitted to regulatory authorities. Moreover, because such new equipment would be developed solely for the rural U.S. market and the development costs could not be spread across sales in other countries, it is unlikely that Cambium or other manufacturers would even engage in trying to develop such new products.

Executed on June 2, 2014.



Nigel King

Appendix A, Analysis re Real-World WISP Network

Appendix B, Map of TDWR Installations

APPENDIX A TO DECLARATION OF NIGEL KING

**ANALYSIS OF IMPACT OF TIGHTENED OOB
ON REPRESENTATIVE WISP DEPLOYMENT**



Cambium Networks

A study of the effect of using Part 15.407 rather than 15.247 for OOBE

JAB Deployment

N. J. R. King

May 30, 2014

Ref: PMP-0748/NJRK

Version: 0.5

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Version	Date	Change	Author
0.5	2014-05-30	Adjusted after Cambium reviews	Nigel King
0.4	2014-05-30	Improved Graphs for readability	Nigel King

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2	Deployment Concept	2	5	Conclusion	6
3	4 Typical Real-World Sectors in Colorado	3			

1 Introduction

The WISP industry is in a delicate balance. To provide service to rural customers, all aspects must work. In this document, I show the effect on an actual real world deployment in Colorado for Cambium’s WISP customer, JAB¹, of the application of

¹ JAB is the largest WISP in USA having about 175k subscribers. They concentrate their business in rural towns and villages. I asked JAB for typical deployment data.

15.407 Out of Band Emissions (OOBE) regulation relative to the current deployment which is performed under the 15.247 regulation.

The result of the application of 15.407 is to reduce the number of subscribers serviced by 65%, while the rest of the subscribers have a connection with much reduced capacity.

If section 15.407 replaces 15.247, the business fails to work. Further deployments to serve rural subscribers will not take place. This document also shows that the alternative strategy of providing filters is not economic and reduces the spectrum availability to 45MHz from 125MHz.

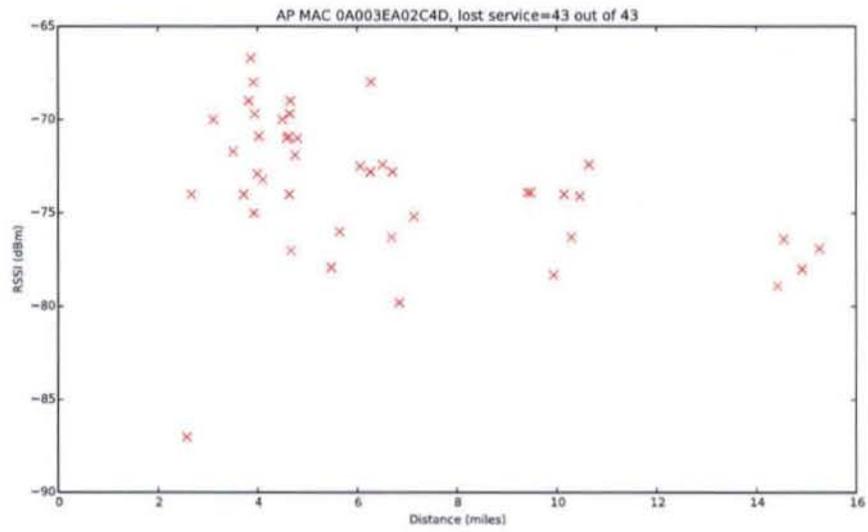
2 Deployment Concept

In order to make a cost effective deployment, JAB has used 29dBi antennas on all outstations (ie., subscriber-premises stations) of their network, while the sector antenna has a 17dBi gain. The Access Point is able to use 36dBm EIRP, while the outstations are unlimited and are able to use 48dBm EIRP, respectively. For the purposes of the 15.247 regulations, the outstations are only communicating with one Access Point and are thus considered under the Point-to-Point regulation.

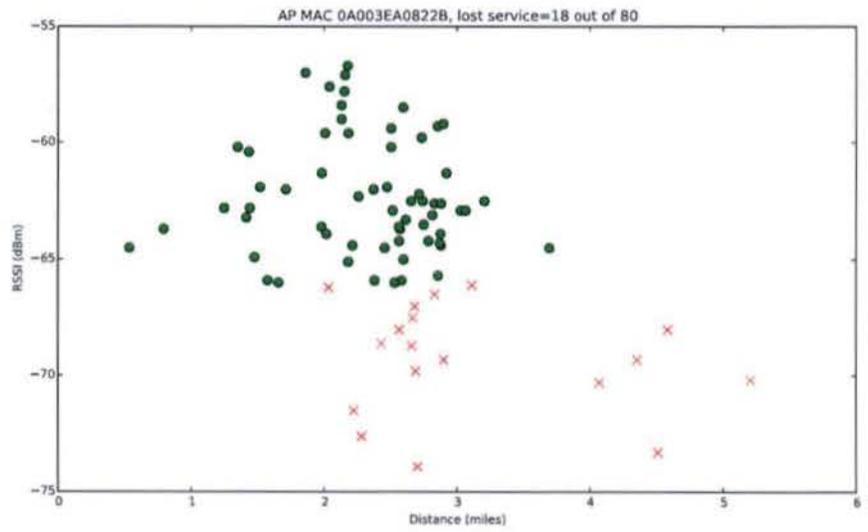
The range of one of the sectors analysed is over 16 miles. At this distance, the system is able to give the longest range subscriber a peak capacity of 17Mbps, while the shorter range subscribers have a typical capacity of about 50Mbps.

Network provision using other technologies such as Asymmetric Digital Subscriber Line (ADSL) will not provide data to a subscriber at 16 miles, partly since the route taken for the signal will not be direct and is likely to travel 25 or more miles before reaching the property (even assuming that the exchange or termination point is at the base site). At this distance the wired cost is more than \$1000 per line to install, and the throughput will be of the order of 64kbps. The technologies to deliver broadband to this type of customer are limited to satellite, where the usage costs are very high and the latency is of order 250ms reducing the usefulness for voice, video and on line gaming.

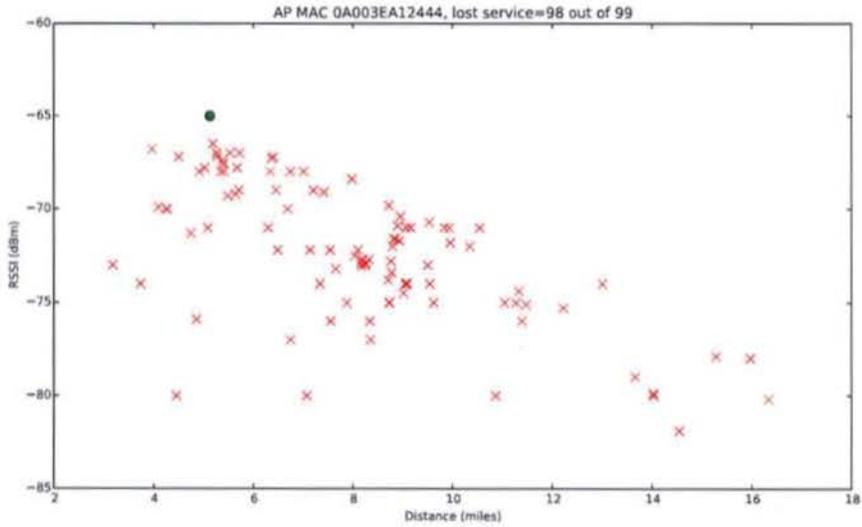
3 4 Typical Real-World Sectors in Colorado



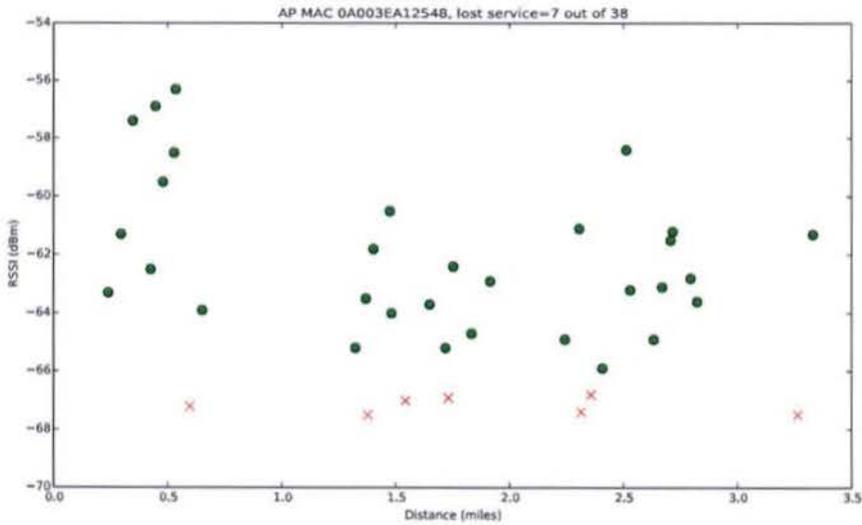
1



2



3



4

Each mark on the graphs show the signal received at the subscriber station vs the distance from the base station. The mark is an x and colored red when the consequence of 15.407 takes the signal below a useable level. Green dots are for

subscribers that continue to have service but at reduced throughput rates. Before the application of 15.407 the link is balanced with the same uplink and downlink budgets. After application of 15.407 the uplink is much the weaker, causing in many cases loss of service.

The deployment analysed herein is of 4 actual sectors in Colorado. These sectors were chosen because they are a typical rural deployment where the current business case for providing rural broadband using equipment qualified to 15.247 regulations is good. As you will see, the loss of subscribers is sufficient to cause the WISP operator to stop making a business out of wireless broadband in the 5.725 to 5.850GHz band. The real people who will suffer will be rural communities which will lose their supplier of broadband.

On the downlink, without changing the Access Point or Subscriber Module design the power will be reduced to 33dBm EIRP from 36dBm EIRP. On the uplink the EIRP is reduced to 33dBm EIRP from 48dBm. The uplink reduction dominates, causing the link budget to be reduced by $48 - 33 = 15$ dB.

Based upon a reduction of 15dB in the link budget, it is found that there is a lack of connectivity for a large percentage of subscribers.

Sector	Range (miles)	Current Subscribers	Lost Subscribers	Percentage Loss
1	16	43	43	100%
2	5	80	20	25%
3	17	99	98	99%
4	3.5	38	7	18%

Table 1 Summary results

Table 1 shows the consequence of the reduction in EIRP caused by meeting the requirements of 15.407. In total, out of 260 WISP subscribers currently provided with broadband, the number will drop to 92, a loss of 65%. The provision for those 92 would drop to sharing about 20Mbps rather than approximately 70Mbps currently shared.

4 An Alternative Strategy

In order to reduce the number of lost subscribers shown in section 3, a possible solution would be to insert large cavity filters between the Power Amplifier and the antenna. Two such filter would be needed per radio. The required attenuation of such a filter is 15dB at 5.515 and 5.860GHz. Such filters are realisable but have a

transition band of 50MHz and are expensive. The product MSRP is currently \$249 this would increase by approximately \$300 to \$549 by the addition of this filter. The product size would increase to accommodate this filter. The resulting radio would be a design specific to the USA 5.7GHz market eliminating any cost reductions through the economies of scale.

The main impact of such filtering would be to reduce the number of channels available. Since even high performance filters have a frequency range over which their filtering action takes effect, the result would be that these transition frequencies would subtract from the 5.7 GHz spectrum, dropping the bandwidth from 125 MHz to about 45 MHz. This reduced frequency range affords little opportunity for a WISP to provide adequate system performance for the customer. An additional minor problem is that the addition of filters increases the losses reducing the link budget and therefore requiring higher power amplifiers.

5 Conclusion

As has been shown, the loss of 65% of subscribers and 2/3 of the sector capacities, will dramatically reduce the business case for a WISP operator like JAB.

Filtering has been suggested as an solution, but as shown in section 4 the cost is prohibitive and the spectrum loss is also unacceptable.

APPENDIX B TO DECLARATION OF NIGEL KING

MAP OF UNITED STATES TERMINAL DOPPLER WEATHER RADAR STATIONS

Positions of TDWR Radars

