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

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| In the Matter of<br>Amendment of Part 101 of the Commission's Rules to Facilitate the Use of Microwave for Wireless Backhaul and Other Uses and to Provide Additional Flexibility to Broadcast Auxiliary Service and Operational Fixed Microwave Licensees | ) | WT Docket No. 10-153 |
| Petition for Rulemaking filed by Fixed Wireless Communications Coalition to Amend Part 101 of the Commission's Rules to Authorize 60 and 80 MHz Channels in Certain Bands for Broadband Communications | ) | RM-11602 |

**COMMENTS OF CLEARWIRE CORPORATION TO SECOND FUTHER NOTICE OF PROPOSED RULEMAKING AND SECOND NOTICE OF INQUIRY**

Clearwire Corporation ("Clearwire") hereby respectfully submits these comments in the above-captioned proceedings. Clearwire commends the Commission for the actions taken in its Second Report and Order. These actions will increase efficient and flexible use of microwave frequencies for backhaul. Additionally, resolution of the questions posed in the Second Further Notice of Proposed Rulemaking and Second Notice of Inquiry ("Second Notice") will assist the Commission in continuing these advancements in wireless backhaul. As the nation's first 4G mobile wireless broadband provider, Clearwire agrees with the Commission's determination that access to cost-efficient and effective backhaul solutions is critical to the deployment of 4G mobile broadband networks across America.[1]

[1] In the Matter of Amendment of Part 101 of the Commission's Rules to Facilitate the Use of Microwave for Wireless Backhaul and Other Uses and to Provide Additional Flexibility to Broadcast Auxiliary Service and Operational Fixed Microwave Licenses, *Second Report and Order, Second Further Notice of Proposed Rulemaking,*

## I. BACKGROUND

Clearwire operates open, Internet-Protocol ("IP") 4G wireless broadband networks in markets across the United States and Europe. These networks provide communities with high-speed residential and mobile Internet and interconnected voice over Internet protocol ("VoIP") services. It is the leader in WiMAX 4G, currently the leading 4G standard in the world. Clearwire has also announced a capacity-rich TDD-LTE deployment that is designed to provide wholesale LTE capacity beginning in the first half of 2013 in dense urban markets where it is needed most. Clearwire is targeting high demand "hot zones" in 31 major urban centers such as New York City, San Francisco, Los Angeles, Chicago, and Seattle where demand for 4G mobile broadband is high and the need for deep capacity resources is most acute.

Clearwire's 4G network now reaches 134 million people in the U.S. and covers over 70 of the top U.S. markets. Clearwire currently serves approximately 11 million total subscribers consisting of 1.3 million retail subscribers and 9.6 million wholesale subscribers. Clearwire currently markets its 4G service through its own brand called CLEAR® as well as through its 4G wholesale relationships, including Sprint, NetZero, FreedomPop and others.

As the nation's first, greenfield 4G wireless broadband provider, Clearwire was able to develop and deploy a backhaul strategy specifically designed for the demands of 4G mobile broadband. A key component of that strategy is the use of cost-effective microwave backhaul that is simple to install and manage, yet delivers the capacity and reliability needed for the explosive demand of broadband customers. Clearwire designed its microwave backhaul network around the following key requirements:

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*Second Notice of Inquiry, Order on Reconsideration, and Memorandum Opinion and Order,* WT Docket No. 10-153, RM-11602 (rel. Aug. 3, 2012) ("Second Notice").

- Packet-based, all-IP solution to ensure greater efficiency and compatibility with next-generation applications and services;
- High capacity and scalability;
- Low latency supporting real-time applications, including voice and video over IP;
- Rapid deployment; and
- Carrier-grade reliability utilizing advanced ring architecture.

Today, Clearwire operates the largest wireless backhaul network in the United States and uses microwave backhaul for more than 90 percent of its cell sites. It has employed microwave to break what the company calls internally the "backhaul bottleneck." Traditional TDM backhaul can account for more than 30 percent of a wireless carrier's operating expense, is notoriously slow to deploy and is not well suited for the high-capacity demands of 4G. For example, Clearwire's WiMAX network is carrying significantly higher payloads than 2G/3G networks (approximately 30-60 Mbps per site) that would require more than 20 T1s per site using a traditional TDM backhaul solution. As a result, Clearwire estimates that by relying on microwave, its backhaul deployment costs are approximately 50 percent less—both in terms of capital expenditure and time—relative to traditional cellular implementations.[2]

Clearwire's backhaul network architecture departs radically from the "hub and spoke" or "tree and branch" designs that were typical before the advent of 4G. Clearwire relies on a ring topology that provides 99.999 percent network availability by providing redundant link diversity from every cell site location. The chief benefit of the ring topology is network redundancy and

[2] Traditional 2G/3G wireless carriers had little choice but to build their existing and expansive backhaul networks on TDM circuits since the sophisticated microwave technology employed by Clearwire was not available until recently. These TDM-based networks were built on a wholly different architecture from Clearwire's network and cannot be quickly or easily retrofitted with Ethernet microwave mesh. Consequently, Clearwire's construction of a greenfield microwave backhaul system should not be cited as a solution for the deep dysfunction that permeates the special access marketplace. Clearwire fully supports efforts by the "No Choke Points" Coalition and others seeking reform.

reliability. Any single microwave radio failure on any ring causes traffic to be diverted around the failure with no service interruption to the customer. Ring network topologies, however, require a minimum of two antennas, one in each ring direction, and if a site is a connection point for an outbound ring, one other antenna is required at that site. In general, Clearwire plans and deploys three (3) microwave antennas at each site.

While there is a wide range of microwave frequencies that can be deployed within Clearwire's backhaul network, the most commonly utilized microwave bands within the system are licensed 11 GHz links with 40 MHz channels, and 18 and 23 GHz links with 50 MHz channels. Clearwire also uses a substantial amount of unlicensed spectrum at 5.4 and 5.8 GHz in partially blocked line-of-site (nLOS) applications and high interference environments. Clearwire uses a multi-layered ring topology that is both redundant and scalable to accommodate increases in capacity demand and links its microwave aggregation points with dark fiber transport that is also connected by redundant pathways.

## II. DISCUSSION OF SECOND FNPRM

### A. Clearwire Supports the Proposal to Permit the Use of Smaller Antennas in the 13 GHz Band

Clearwire's Ethernet backhaul network is primarily composed of 11, 18, and 23 GHz microwave radios. Clearwire currently does not deploy, nor does it have any immediate plans to incorporate, 13 GHz microwave radios into its microwave backhaul network. However, Clearwire applauds the Commission's efforts to consider rule changes that would promote the use of 13 GHz as a microwave backhaul option. These efforts, as currently proposed, would make 13 GHz spectrum more attractive as a deployment option and would help to alleviate growing congestion in the 11, 18, and 23 GHz bands in major markets.

Specifically, Clearwire supports Comsearch's proposed use of smaller 2 foot antennas at 13 GHz.[3] This proposed rule change would significantly shorten the time required to negotiate microwave antenna leases, meet zoning requirements, and obtain zoning approvals, thus reducing overall processing time. The proposal would also reduce deployment costs by significantly reducing equipment costs (antenna, antenna mounting equipment, stealth materials, etc.) through use of a smaller antenna. As with the current 11, 18 and 23 GHz spectrum, Clearwire supports the frequency coordination process and rigor it brings in identifying and eliminating potential interference between coordinated paths/links. Under the proposed rule changes that would allow 2 foot antennas at 13 GHz, and the continued application of the frequency coordination process, Clearwire believes that the smaller 13 GHz antennas would not adversely affect other users and would result in efficient, cost-effective use of the band.

### B. Clearwire Supports Intermediate Antenna Upgrade Proposal in the 11 GHz Band

Clearwire strongly supports Wireless Strategies, Inc.'s ("WSI") proposal to allow 11 GHz licensees and applicants to resolve interference issues by upgrading from one Category B antenna to another Category B antenna with better performance characteristics.[4] Clearwire's internal metrics for its backhaul network include high service availability using a cascaded ring topology with at least 95% microwave backhaul. To meet that standard, Clearwire had to design and deploy 11 GHz links to account for long path lengths and propagation characteristics in different markets across the nation. As with all of its 11, 18, and 23 GHz microwave radio deployments, antenna diameter was the single most significant contributing factor to siting issues, influencing Clearwire's ability to: (1) successfully negotiate microwave antenna space

[3] Second Notice at ¶ 64 (*citing* Comments of Comsearch at 4).
[4] Reply Comments of Wireless Strategies, Inc. ("WSI Comments") (filed Oct. 5, 2011) at 2.

rent and obtain leases; (2) meet the topology guideline of three microwave antennas per site (required to support its cascaded ring topology); (3) reduce the cost of disguising (known as "stealthing") antenna enclosures/mounts on rooftop sites; (4) obtain zoning approvals and meet zoning friendly antenna requirements; and (5) reduce structural loads and the cost of any structural modifications that would otherwise be required to support a 3 foot, or larger, antenna on monopoles or other tower structures.

In 2006, when Clearwire initiated its accelerated 4G network deployments in markets across the country, 3-foot Category A antennas were the smallest diameter antennas allowed at 11 GHz. Consequently, to meet siting requirements, Clearwire often had to separate what would otherwise have been a long path length 11 GHz link (>3 miles, 750 mbps, >99.995% link availability) into two shorter path lengths at 18 or 23 GHz so that it could use 2 foot Category A antennas on each path. The use of these microwave repeater sites significantly increased deployment and equipment costs and the time to market for these sites. When the Commission approved the use of smaller 2 foot Category B antennas at 11 GHz, Clearwire updated its technical design rules and began to deploy long path 11 GHz length links. Today, 11 GHz links comprise about 23% of Clearwire's nationwide microwave backhaul network, with over 50% of those links deployed using a 2 foot Category B antenna on one or both link ends. The net effect has been to allow Clearwire to quickly and cost effectively deploy its microwave backhaul network and provide 4G service in major markets across the nation.

To date, Clearwire has not been the cause of, nor the subject of, any 11 GHz interference complaints on any of its 11 GHz links deployed with 2 foot Category B antennas. Clearwire attributes this to the clarity and completeness of the Commission's rules and the rigor of the frequency coordination process. Despite the lack of complaints, however, Clearwire supports the

establishment of clearly defined rules, and frequency coordination processes and guidelines that would allow Clearwire to mitigate an 11 GHz Category B interference issue with another Category B antenna with better performance characteristics. Such a rule would allow Clearwire to effectively address an interference complaint while staying within its original leasing and zoning entitlements. Using another 11 GHz Category B antenna would also allow Clearwire to stay with its current network topology and not have to resort to either a larger diameter Category A antenna or at worst, deploy a microwave repeater site, using shorter path length 18 or 23 GHz radios with 2 foot Category A antennas to mitigate interference issues. Clearwire concurs with WSI's claim that its proposed change "would allow designers and users of FS microwave to minimize the cost and make it easier to comply with local zoning and homeowner association rules and ensure that the sue of antennas not meeting Category A requirements does not increase the potential for harmful interference."[5]

## III. DISCUSSION OF SECOND NOTICE OF INQUIRY

### A. Clearwire Encourages a Comprehensive Review of the Commission's Antenna Standards

Clearwire believes that the Commission should undertake a comprehensive review of its antenna standards. Clearwire recommends the European Telecommunications Standards Institute ("ETSI") standards as a useful benchmark as the Commission considers amendments to its rules. Clearwire believes that there are no unique factors (economic, environmental, service, or regulatory) in US markets that would justify different standards from those established by ETSI. Mobile broadband customers in the U.S. demand the same high availability, low cost, high capacity/high throughput 4G services and devices as customers across the globe. Aligning U.S. and ETSI operating rules and standards would significantly enhance service provider

[5] Second Notice at ¶ 71, (*citing* WSI Comments at 2).

deployments while driving down operational costs by creating a global equipment ecosystem that supports multiple 4G networks worldwide.

### B. Clearwire Supports Proposals that Would Encourage Non-Parabolic Antennas

Clearwire understands that the FCC rules in do not mandate, or limit, microwave deployments to parabolic antenna geometries at 11, 18, or 23 GHz. The objective of Clearwire's original comments[6] to the Commission's First Notice of Proposed Rulemaking ("First Notice")[7] was to foster the discussion and definition of new standards that would encourage the development of zoning friendly, low cost, high performance microwave antennas at 11, 18, and 23 GHz, whatever the geometry.

Clearwire's experience in deploying its nationwide microwave backhaul network has shown that the most significant factor in terms of cost and time-to-market has been antenna selection and installation. In Clearwire's microwave backhaul network, vertical polarization is the primary orientation. However, to mitigate congestion and/or potential interference with other licensees/applicants, Clearwire coordinated links/paths on horizontal polarization. In addition, to increase physical link/path capacity, 2+0 radio configurations behind a single antenna were deployed. In these high-capacity link configurations, a single antenna with an OMT radio mount has one radio operating on vertical polarization and one radio operating on horizontal polarization. This 2+0 radio configuration provides a physical doubling of the link/path capacity that can be supported by a single antenna. Clearwire has deployed all of its 11, 18, and 23 GHz

[6] Comments of Clearwire Corporation at 8.

[7] In the Matter of Amendment of Part 101 of the Commission's Rules to Facilitate the Use of Microwave for Wireless Backhaul and Other Uses and to Provide Additional Flexibility to Broadcast Auxiliary Service and Operational Fixed Microwave Licenses, *Report and Order, Further Notice of Proposed Rulemaking and Memorandum Opinion and Order*, WT Docket No. 10-153, WT Docket No. 09-106 (rel. Aug. 9, 2011) ("*First Notice*").

microwave backhaul network links/paths using parabolic (directional) antennas for the simple reason that it's the only antenna geometry currently available at those frequencies.

Antennas in and of themselves do not add power to a signal; they simply redirect the energy they receive from the transmitter at the opposite end of the link. By redirecting this energy, the antenna provides more energy in one direction, and less energy in all other directions. As the gain of a parabolic antenna increases, the angle of radiation usually decreases, providing greater path length under the given environmental conditions (rain zone), but with a reduced coverage angle. Parabolic antennas have a very narrow RF energy path, which increases the deployment costs in initially aligning the antennas, and then in keeping them aligned during weather events (wind, rain, snow). Under the deployment scenarios discussed above, as parabolic antenna diameters increase, so do the capital costs of deploying them, and the operational costs of keeping them in alignment, and performing at full capacity.

The fast-growing demand for high-speed, reliable 4G services drives Clearwire to continually advocate for and deploy new microwave backhaul technologies that can provide effective and efficient ways to increase both coverage and capacity at lower capital and operating costs. New antenna designs, supported by operating rules and standards specified by antenna design experts, with frequency coordination services provided by coordinators like Comsearch, and deployed by 4G service providers like Clearwire, will need to be accommodated under the Commission's rules. Clearwire urges the Commission to continue to be mindful as it has been in this proceeding of both the development speed and breadth of adoption of new antenna technologies that are critical components to supporting the increasing challenges of 4G deployments and initiate a review of its standards to accommodate these advancements.

## IV. CONCLUSION

For the foregoing reasons, Clearwire largely supports the Commission's proposals to promote the efficient use of spectrum for backhaul and for providing more flexible use of microwave frequencies for backhaul. Additionally, Clearwire hopes that the Commission will periodically review of its antenna standards as technology advancements occur in order to continue to facilitate the deployment of high speed broadband.

Respectfully submitted,

By: /s/ Cathleen A. Massey

Cathleen A. Massey
Vice President, Regulatory Affairs
& Public Policy
Christiaan Segura
Regulatory Counsel
Clearwire Corporation
1250 I Street, N.W.
Suite 901
Washington, D.C. 20005
(202) 351-5033

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