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

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| In the Matter of | ) | |
| Amendment of Part 101 of the Commission's | ) | |
| Rules to Facilitate the Use of Microwave for | ) | WT Docket No. 10-153 |
| Wireless Backhaul and Other Uses and to Provide | ) | |
| Additional Flexibility to Broadcast Auxiliary | ) | |
| Service and Operational Fixed Microwave | ) | |
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| Petition for Rulemaking filed by Fixed Wireless | ) | RM-11602 |
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| 80 MHz Channels in Certain Bands for Broadband | ) | |
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# COMMENTS OF CLEARWIRE CORPORATION TO FUTHER NOTICE OF PROPOSED RULEMAKING

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**COMMENTS OF CLEARWIRE CORPORATION TO**
**FUTHER NOTICE OF PROPOSED RULEMAKING**

Clearwire Corporation ("Clearwire") hereby respectfully submits these comments in the above-captioned proceedings. Clearwire commends the Commission for initiating this further notice of proposed rulemaking to identify ways to increase efficient use of spectrum for backhaul and for providing more flexible use of microwave frequencies for 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 are 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, *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) ("*FNPRM*").

## I. SUMMARY

Clearwire supports the Commission's proposal to facilitate the deployment of smaller diameter antennas at 6, 18 and 23 GHz. The use of smaller diameter antennas, especially at 23 and 18 GHz, will significantly increase the number of candidate sites/towers that Clearwire can consider for wireless backhaul while reducing deployment costs and structural modifications. Specifically, Clearwire supports Comsearch's technical analysis and recommendations for:

- High-performance 3-foot diameter antennas in the 6 GHz band
- High performance 1-foot diameter antennas in the 18 GHz band
- High performance 8-inch diameter antennas in the 23 GHz band

Clearwire also supports the use of wider channels in the 6 and 11 GHz bands. Clearwire recommends that the Commission adopt channel bonding rules that permit carriers to bond available, cleared adjacent channels during the frequency coordination process into one wider channel. This will create more opportunities for using higher capacity backhaul links while decreasing deployment complexities and cost. Clearwire also encourages the Commission to consider similar channel bonding rules for the 18 and 23 GHz bands. The combination of the proposed smaller antenna sizes and the ability to use wider channels will greatly enhance the utility of these bands for backhaul supporting next generation, high-capacity 4G networks.

## II. 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's 4G network now reaches 130 million people in the U.S. and covers over 70 of the

top U.S. markets. Clearwire ended the first quarter of 2011 with approximately 6.15 million total subscribers consisting of 1.29 million retail subscribers and 4.86 million wholesale subscribers. Clearwire currently markets its 4G service through its own brand called CLEAR® as well as through its 4G wholesale relationships with, among others, Sprint Nextel Corporation, Comcast Corporation, Time Warner Cable Inc., Best Buy and Bright House Networks, LLC.

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:

- 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.

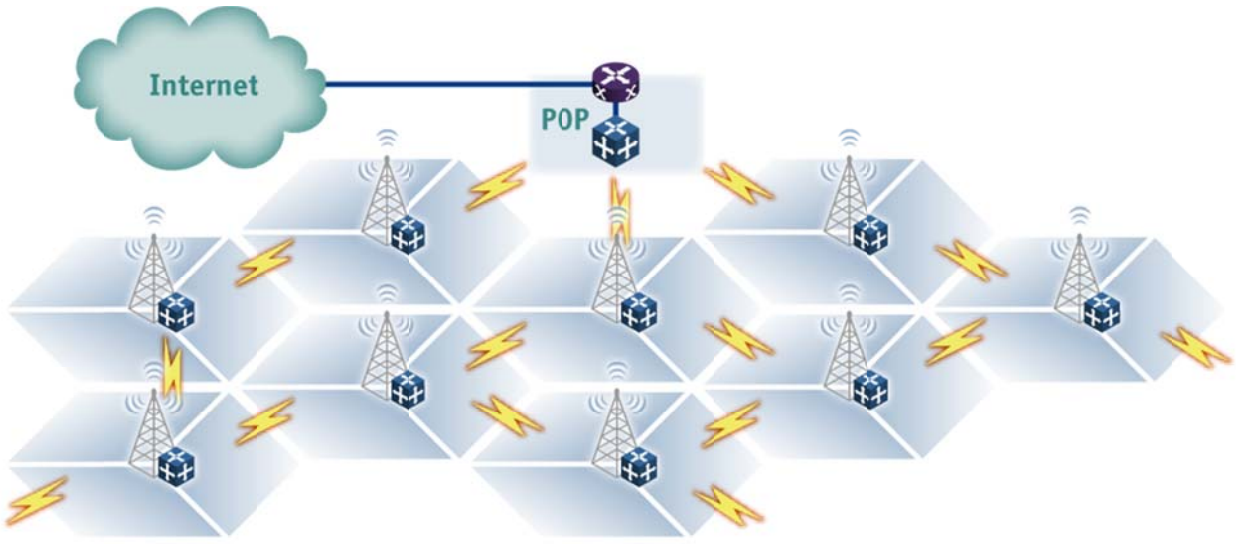
Today, Clearwire operates the largest wireless backhaul network in the United States and uses microwave backhaul for more than 90 percent of its cell sites. It has employed microwave to break what the company calls internally the "backhaul bottleneck." Traditional cellular networks rely on copper based TDM circuits at more than 80 percent of their cell sites. TDM backhaul can account for more than 30 percent of a wireless carriers' 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. In fact, the equipment needed to support an Ethernet-based microwave mesh such as Clearwire's backhaul network has only been available for a few years. Consequently, Clearwire is the first mobile broadband provider to incorporate a microwave backhaul system into its network from its inception. As shown in Figure 1 below, Clearwire relies on a ring topology that provides 99.999 percent network availability by providing redundant link diversity from every cell site location

[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.

Figure 1. Clearwire Microwave Backhaul Network




Design Criteria:

- 99.995% availability per PTP link
- Ring topology provides 99.999% network availability
- Diverse path using PBT (PBB-TE) from every site

The chief benefit of the ring topology is network redundancy and 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.

## III. DISCUSSION

### A. Clearwire Supports the Commission's Proposal to Permit the Use of Smaller Antennas in the 6, 18 and 23 GHz Bands

Clearwire supports the proposed rulemaking allowing smaller diameter antennas at 6, 18, and 23 GHz. Clearwire commends the Commission on proposing to update its rules to account for technology advancements and more sophisticated band sharing techniques, and permit the deployment of smaller diameter antennas. As the Commission notes, several parties have expressed general support for modifying antenna standards on the basis that smaller antennas are cheaper to manufacture, install and maintain.[3] In addition, smaller antennas can be deployed at a wider range of tower/site locations and reduce site acquisition costs.[4]

Clearwire agrees with many commenting parties that site acquisition and deployment are significant cost drivers in building out microwave backhaul networks. The selected backhaul network topology, for example, hub-and-spoke, ring, or mesh, drives the number of antennas to be deployed at each site. As the number of microwave backhaul antennas at a site increases based on the selected network topology, the diameter of the antennas can have a significant impact on the structural analysis and stability of the tower. Today's rules requiring larger antennas in these bands can result in deployment delays, increased deployment costs, major structural modifications to the tower, and/or decreased capacity and service availability.

As a new broadband service provider in each market it serves, Clearwire must compete with incumbent wireless carriers, local wireless services including transportation, public

[3] FNRM at § 73.
[4] *Id.*

safety, WISPS, and other wireless service providers for antenna space at suitable site and tower locations. In addition, meeting aesthetic requirements at a site, known as stealthing requirements, can limit the total amount of area available for microwave antennas. The use of smaller diameter antennas, especially at 23 and 18 GHz will significantly increase the number of candidate sites/towers carriers can use while reducing deployment costs and the need for structural modifications to the sites/towers.

Clearwire agrees that smaller antennas can be accommodated in these bands without causing harmful interference to existing users. Specifically, Clearwire endorses Comsearch's technical analysis and recommendations for:

- High-performance 3-foot diameter antennas in the 6 GHz bands
- High performance 1-foot diameter antennas in the 18 GHz bands
- High performance 8-inch diameter antennas in the 23 GHz bands

Comsearch, as a highly experienced wireless engineering and spectrum management firm, has been in the business of identifying and resolving interference concerns for decades. It has offered specific proposed standards for each of these bands that are supported by its research and experience. In its April 14, 2011 *ex parte* presentation, Comsearch submitted the beamwidth, gain, and radiation suppression requirements that would allow for smaller antennas while forcing them to have high-performance patterns.[5] Clearwire agrees that Comsearch's proposed amendments offer a reasonable trade-off between spectral efficiency and meeting the goals of lower cost, ease of installation, and less obtrusive appearance.[6]

[5] *See Ex Parte* Letter from Christopher R. Hardy, Vice President, Comsearch, to Marlene H Dortch, Secretary, FCC (filed Apr. 14, 2011).
[6] *Id*. at 1.

Clearwire also renews its request that the Commission foster the development of different antenna geometries in addition to developing radio pattern envelope (RPE) standards for smaller diameter antennas using current parabolic geometries. The gain of an antenna is determined by the intended area of coverage. The gain at a given wavelength is achieved by appropriately choosing the size of the antenna. Developing different antenna geometries provides the most deployment flexibility while promoting higher performance, lower profile antennas. These next generation antennas are currently under development by several equipment manufacturers and promise to introduce an even greater array of options for deploying wireless backhaul in an efficient and cost effective manner. As these next generation antennas are introduced into the marketplace, the Commission's rules should be designed to accommodate their use.

**B. Clearwire Supports Allowing Wider Channels in the 6 and 11 GHz Bands**

Clearwire supports the Fixed Wireless Communications Coalition's ("FWCC's") proposal for allowing Fixed Service operators to combine 30 and 40 MHz channels in the 6 and 11 GHz bands. Like all wireless service providers, Clearwire is experiencing explosive growth in subscriber data usage, from streaming media, movies, gaming and social networking. Wireless service providers are faced with the increasing challenge of meeting these capacity demands through the deployment of advanced 4G networks that must be matched with enhanced backhaul capacity in the transport networks. Wider channels, specifically in the lower frequency bands where native channel width is limited will provide increased capacity on longer path length backhaul links at any given modulation rate. Clearwire, therefore, supports FWCC's proposal, but does not think it goes far enough.

For the same reasons that wider channels make sense in the 6 and 11 GHz bands, Clearwire encourages the Commission to develop rules that would allow wireless backhaul

network operators to aggregate contiguous channels for multi-gigabit operation over a single carrier in the 18 and 23 GHz bands. Channel aggregation (also referred to as "channel bonding") in the lower frequency bands of 11, 18 and 23 GHz would provide Clearwire the option of deploying single radio/single antenna, multi-gigabit capacity backhaul links on all structure types and at path lengths 3-5 times longer than that achievable with millimeter wave radios. Channel aggregation would allow wireless backhaul network operators to aggregate adjacent 40 or 50 MHz channels in the 11, 18 or 23 GHz bands, per Part 101.147, into either one 80 MHz wide channel, one 100 MHz wide channel, one 120 MHz wide channel, or one 150 MHz wide channel, subject to interference analysis and frequency coordination.

To achieve the multi-gigabit link capacities required by its ring network architecture, Clearwire has deployed over 1,190 millimeter wave links at 80 GHz. Compared to lower frequency radios, however, millimeter wave radios travel shorter distances, typically 0.5 to 1 mile, and are more vulnerable to rain fade. In addition, the inherently narrower beamwidth of millimeter wave frequencies makes millimeter wave radios more susceptible to structure twist and sway, which can cause the link to intermittently go in and out of alignment. Primarily because of the potential twist and sway effect on link availability, Clearwire limits its millimeter wave deployments to roof-top to roof-top links.

Today, Clearwire deploys 2+0 radio configurations in the 11, 18, and 23 GHz bands to achieve multi-gigabit link capacities on monopoles and other antenna structures susceptible to twist and sway and where path lengths greater than 1 mile are required. In its 2+0 radio deployments, Clearwire mounts two lower frequency radios behind a single antenna, with one radio operating independently on vertical antenna polarity and the other radio operating independently on horizontal antenna polarity. This deployment option while providing multi-

gigabit capacity, significantly increases the weight and the number of cables that run up-mast to support each microwave radio. The 2+0 radio deployments also have potentially higher deployment costs, including structural modifications to support the additional weight and number of cables, additional modem space required in the controller cabinet, and higher installation and path alignment costs. The existing Part 101 rules support wider channels, for example 80 MHz channels at 18 GHz. However, a typical 18 GHz microwave backhaul link operating in an 80 MHz channel would achieve somewhere around 640-650 mbps at 99.995% link availability, and dependent on rain zone. To provide wireless backhaul network operators more flexibility and more low cost options for deploying multi-gigabit capacity links, Clearwire encourages the Commission to develop rules to allow channel aggregation at 11, 18, and 23 GHz.

Clearwire also encourages the Commission to adjust the minimum payload requirements to account for the increased capacity that would be available with wider bandwidth channels. Payload requirements should be established to ensure that wider bandwidth channels are reserved for truly high-capacity services that will put the spectrum to its highest and best use. In that regard, Clearwire suggests that the payload requirements should not be simply additive but increased to reflect the more productive use of a wider channel plan.

## 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.

Respectfully submitted,

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