



SMALL-CELL BACKHAUL: FIBER CAN'T BE EVERYWHERE, BUT CAMBIUM CAN

Cambium NLOS, High-Capacity Wireless Is Your Answer to LTE Small-Cell Backhaul.

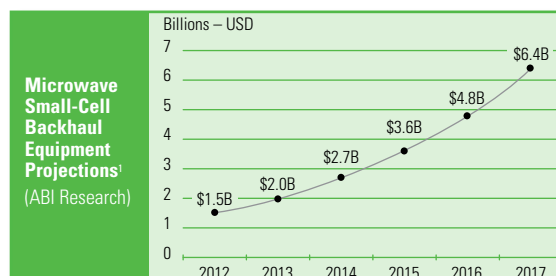
As the demand for everywhere mobility has continued to skyrocket, carriers and mobile network operators are under increasing pressure to relieve their overburdened networks. Despite the migration to 3G, 4G, LTE and WiMAX, the proliferation of cellular devices and applications requires network operators to take additional steps that will increase capacity and coverage. As a result, virtually all network operators are employing small cells to increase capacity in urban areas and provide coverage where gaps exist.

BACKHAUL DECISIONS

Most carriers are focused on deployment plans in which the majority of small cells will be backhauled using fiber or copper. While physical connectivity works in the majority of cases, total coverage requires backhaul that can connect where fiber and copper are not available, where fiber may be cost prohibitive as may occur when spanning long distances, or where time-to-deploy is excessive.

In such cases, wireless technology provides the ability to rapidly deploy reliable small-cell backhaul solutions. However, carriers need to select a small-cell backhaul system that will deliver carrier-grade connectivity and overcome physical obstacles and interference.

Formerly part of Motorola Solutions, Cambium Networks' Wireless Broadband solutions deliver reliable, high-performance connectivity in some of the most challenging environments on earth. So, we can help you design the right backhaul solution for your multi-technology, small-cell network such as UMTS, HSPA, and LTE.



Many large service providers have benefited from our NLOS and interference problem-solving technology, including:

- AT&T
- Bell Mobility
- BTiNet
- China Mobile
- Clearwire
- Sprint
- Telus
- Verizon

¹ RCR Wireless, U.S., Sept. 2012

SMALL-CELL TERMINOLOGY

“Small cell” is the collective term used to describe several different types of cells, including femtocells, picocells, microcells, metrocells, and ruralcells. While this list should not be considered as all-inclusive, it is intended as a guideline to the types of small cells referenced in this brief.

FEMTOCELLS, 4G AND LTE DOMINATE

Collectively small cells are projected to comprise nearly 90% of all base stations by 2016², with femtocell deployments anticipated to garner the lion’s share of the small-cell market.

At the 2012 Mobile World Congress, Informa Telecom & Media indicated that small cells are set to grow from 3 million in 2012 to 62 million units by the end of 2016 – a 2000% increase – with 4G and LTE small cells expected to account for the major portion of this growth. During this period of rapid growth, small-cell technology will continue to evolve, and the small-cell vendor landscape is likely to change drastically.

In a report on small-cell backhaul³, more than 1.8 million small-cell wireless backhaul unit shipments are projected to occur during 2016.

KEY BACKHAUL ISSUES

While small cells are seen as the answer to a range of capacity and coverage issues, significant challenges remain in deploying small cells. According to industry experts, backhaul is one of the greatest challenges you face as a network operator, and there is no single solution that will handle every situation. Because small cells are deployed in a wide variety of indoor and outdoor, urban and rural environments, you need backhaul solutions that have the technology to overcome a wide variety of deployment problems.

Our Cambium Point-to-Point (PTP) and Point-to-Multipoint (PMP) wireless backhaul solutions are engineered to overcome even the most severe connectivity challenges. In fact, our systems often provide reliable, high-performance communications where comparable systems cannot make a connection.

MARKET PROJECTIONS

Small Cells:
3 million in 2012 to 62 million in 2016 – a 2000% increase

Small-Cell Wireless Backhaul:
More than 1.8 million units in 2016

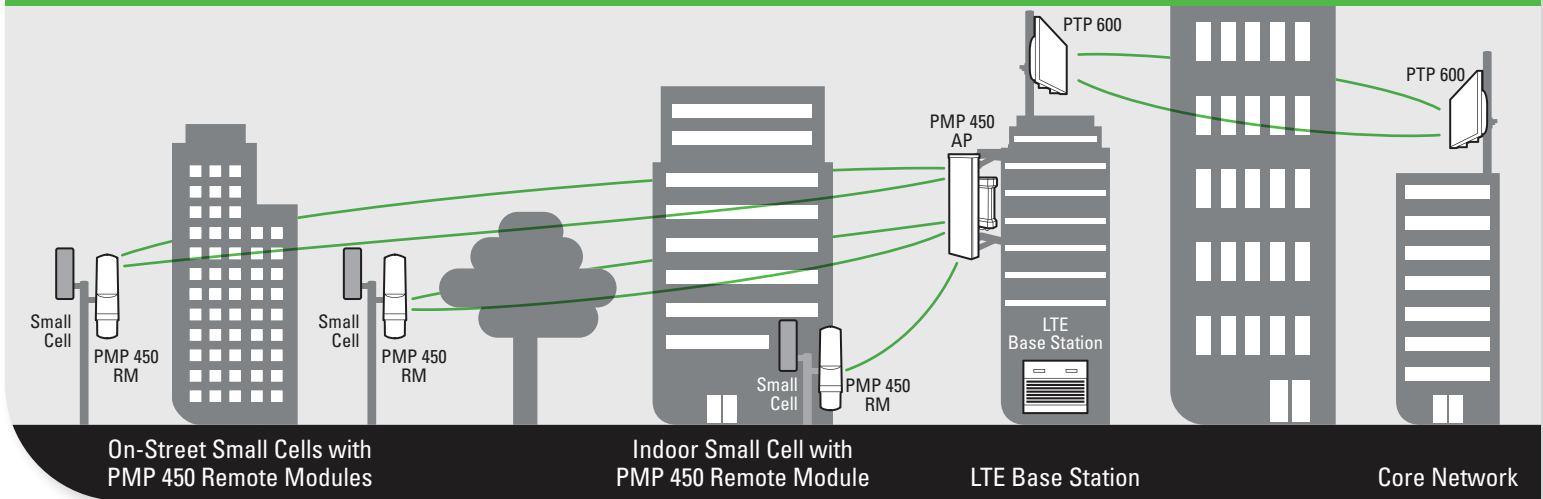
SMALL-CELL BACKHAUL CHALLENGES

Key Issues	Backhaul Requirements	Benefits
Non-line-of-sight (NLOS)	<ul style="list-style-type: none"> Overcome natural and manmade obstructions Transport data, voice, and video even where walls, building, trees, or terrain create NLOS conditions 	<ul style="list-style-type: none"> Carrier-class reliability
Interference	<ul style="list-style-type: none"> Dynamically mitigate interference where large amounts of cellular traffic exist Reduce congestion without creating a backhaul bottleneck 	<ul style="list-style-type: none"> Eliminate or greatly reduce interference
Capacity	<ul style="list-style-type: none"> Provide high throughput Increase core capacity at the macrocell and network edge 	<ul style="list-style-type: none"> Meet the demands of increasing mobile communications
Spectrum Optimization	<ul style="list-style-type: none"> Minimize multipath issues among densely packed small-cell networks Manage spectrum usage automatically Optimize spectral efficiency automatically 	<ul style="list-style-type: none"> Re-use spectrum effectively Eliminate or significantly reduce traffic congestion
Architecture	<ul style="list-style-type: none"> Flexible network architecture, including chain and ring configurations Point-to-point and point-to-multipoint topologies 	<ul style="list-style-type: none"> Support a wide variety of small-cell configurations and environments
Form Factor	<ul style="list-style-type: none"> Unobtrusive remote modules Small size and inconspicuous appearance 	<ul style="list-style-type: none"> Deploy backhaul equipment where small cells are deployed
Installation	<ul style="list-style-type: none"> Lightweight backhaul equipment that can be easily mounted on street poles, traffic lights, rooftops, and walls Fast, easy “one-touch” installation procedures 	<ul style="list-style-type: none"> One truck roll and reduced man-hours Deploy quickly with little or no site preparation
Reliability	<ul style="list-style-type: none"> Provide carrier-class performance Operate flawlessly over long periods of time without operator intervention 	<ul style="list-style-type: none"> Reduced network management man-hours
Scalability	<ul style="list-style-type: none"> Scale to meet future traffic increases 	<ul style="list-style-type: none"> Protect your backhaul investment
Durability	<ul style="list-style-type: none"> Perform reliably in severe weather conditions such as rain, sleet, snow, wind, and extreme temperatures Extended MTBF 	<ul style="list-style-type: none"> Reduce troubleshooting and maintenance man-hours Trouble-free operations over decades

² “Small cells to make up almost 90% of all base stations by 2016,” Small Cell Forum, February 2012.

³ Mobile Experts, October 2011

SMALL-CELL BACKHAUL



PAIRING SMALL CELLS WITH CAMBIUM BACKHAUL

Constructing small-cell networks requires a well thought-out backhaul solution to connect small cells to LTE base stations, Points of Presence (PoP) and, ultimately, the core network. At Cambium Networks, we understand that there is no single solution that handles every situation. So, we offer a complete portfolio of solutions that can be deployed independently or combined to address varying backhaul needs.

Our PMP 320, PMP 450, PTP 500, and PTP 600 wireless systems offer you many backhaul configuration alternatives to address the varying requirements of your small-cell deployments. As shown in the diagram, our PMP 450 solution is an excellent alternative to backhaul traffic from small cells to an LTE base station (or PoP), with a PTP 600 system backhauling traffic from the LTE base station to the core network.

Depending on how your small-cell networks are deployed, there are many ways to configure an effective backhaul solution such as:

- Pair a PMP 450 or PMP 320 system with a PTP 500 in locations where the LTE base station is far from the core network
- Combine a PMP 450 and PTP 600 network to backhaul small cell traffic across a river or lake.
- At the network edge, use all PTP 600 systems to backhaul microcell or metrocell traffic over challenging terrain and long distances
- In short-distance hops, deploy the PMP 320 or PMP 450 from the small cells to the core network

PROBLEM-SOLVING TECHNOLOGY

Realizing the full benefits of small cells depends on the ability to configure and deploy the right backhaul system for each small cell network. Differences in site location, distances to the Point of Presence (PoP) and the macro network, the number of small cells in the network, environmental path conditions, interference potential, and applications are examples of the many variables that can present special challenges for your backhaul network.

Our high-performance PMP 320, PMP 450, PTP 500, and PTP 600 Series systems utilize a unique combination of problem-solving technologies that allow you to match needed capabilities to your specific backhaul challenges. The following information gives you an overview of those technologies and how they enable our radios to overcome the types of challenges you face.

- **Multiple-Input Multiple-Output (MIMO):** Our PMP and PTP radios radiate multiple beams from the antenna, the effect of which significantly protects against fading and increases the probability of making a successful connection. MIMO helps give you consistently reliable, high-performance communications in even the toughest environments.
- **Orthogonal Frequency Division Multiplexing (OFDM):** Our PMP 320 and PMP 450 radios employ OFDM technology to help overcome interference and NLOS issues. In our PTP 500 and PTP 600 systems, added intelligence is embedded in our OFDM implementation (*intelligent* OFDM or *i*-OFDM). *i*-OFDM not only resolves channel dispersion, achieves high spectral efficiency, and offers high resistance to frequency-selective fading, but it also offers significantly more pilot tones and sub-carriers as well as instant fade recovery.

Cambium PMP and PTP solutions give you enormous flexibility to configure the best backhaul solution for your needs.

PMP 450 DIMENSIONS



- Dynamic Spectrum Optimization:** In our PTP 500 and PTP 600 radios, channel frequencies can be set manually or dynamically. When configured as dynamic, the radios sample the band hundreds of times a second and automatically switch to the clearest channel. The time-stamped database alerts you to any interference that exists and provides statistics that help you pinpoint the channels offering the clearest data paths. In day-to-day operation, these spectrum-optimization capabilities can provide you the same benefits as having exclusive rights to a licensed channel.
- Adaptive Modulation:** Our PMP and PTP radios have powerful transmitters and receivers that can negotiate the highest mutually sustainable data rate and dynamically “upshift” and “downshift” the rate as path conditions change. So you get the maximum performance possible within the current power limits.
- GPS Synchronization:** PTP 500 and PTP 600 systems offer GPS synchronization capabilities, allowing you to deploy multiple radios on a tower or rooftop with greatly reduced self-interference. Plus, our PMP 320 and PMP 450 radios alternately transmit and receive, rather than using one channel for transmitting and a second channel for receiving. To achieve this, each Access Point (AP) provides GPS synchronization to its Remote Modules (RMs), synchronizing transmit and receive signals. When an AP is transmitting, the RMs are receiving. Conversely, when the RMs are transmitting, the AP is receiving. GPS synchronization allows you to densely

pack radios on a rooftop or tower with virtually no self-interference.

- Time Division Duplex (TDD) Synchronization:** In PTP 500 and PTP 600 radios, our TDD Synchronization capability times and synchronizes transmit and receive signals, enabling efficient frequency reuse. In addition, wayside T1/E1 transport is tightly integrated with our TDD structure, offering exceptionally low jitter and wander. This allows you to collocate multiple radios on a rooftop or tower with virtually no interference.
- Spatial Diversity:** PTP 500 and 600 systems include spatial diversity to combat ducting and multipath fading. Spatially diverse technology allows communications to travel over water, across vast expanses of open terrain, and in deep non-line-of-sight environments without signal loss.

OUR COMMITMENT

Your small-cell strategy to meet the ever-increasing demand for everywhere access clearly needs a solid backhaul strategy that you can rely on. At Cambium Networks, we are committed to providing the most innovative, dependable wireless solutions in the industry. With our PMP and PTP solutions and problem-solving technology, we can help you overcome your toughest backhaul challenges. Having successfully deployed more than 3.5 million PMP devices and more than 60,000 PTP systems worldwide, we have the experience and expertise to help you design and deploy the right backhaul solution for your small-cell network.

Let us show you how small-cell backhaul can be problem-free.

For more information on our PMP and PTP solutions, go to cambiumnetworks.com.

CAMBIUM WIRELESS BACKHAUL SOLUTIONS

Point-to-Multipoint (PMP) Solutions:

PMP 320 – 3.0, 3.65 GHz (Licensed)
PMP 450 – 5.4, 5.8 GHz (Dual Band)

Point-to-Point (PTP) Solutions:

PTP 500 – 5.4, 5.8 GHz
PTP 600 – 2.5, 4.5, 4.8, 4.9 GHz (Licensed)
PTP 600 – 5.4, 5.8, 5.9 GHz

CAMBIUM WORLDWIDE DEPLOYMENTS

> 3.5 million PMP units
> 60,000 PTP systems



www.cambiumnetworks.com