



# Broadband Wireless Access Backhaul

## High Capacity, Integrated Wireless Packet Backhaul

### Introduction

Service providers around the world, employing Broadband Wireless Access (BWA) technologies such as WiMAX, have established sound business models, delivering universally-available, high-capacity wireless data services – and generating revenues of over \$3 billion USD in 2009.

Many broadband wireless operators have reaped the benefits of building their service portfolio and their networks from scratch, offering significantly higher capacities than traditional mobile data service providers, whose networks were built primarily for voice traffic.

BWA requires a flat, all-IP/Ethernet backhaul solution that supports extremely high volumes of traffic, while ensuring carrier-grade quality for premium real-time services. Most BWA operators also deploy wireless technologies for the backhaul and the aggregation segments of their networks. BWA is unique in the sense that the subscribers' usage profile is very similar to that of fixed-line broadband users. As a result, the BWA access network is expected to match the performance of xDSL/DOCSIS/GPON services, while the backhaul network is required to provide capacities comparable to available fiber-based solutions

This paper discusses the backhaul challenges of BWA operators, and shows how Ceragon's FibeAir® line of backhaul products can be used to meet their demand for a cost-efficient backhaul solution that helps turn revenues into profits.

### The Challenge: Designing BWA Backhaul Networks that Generate Profits

Designing BWA backhaul networks is a lot about capacity, but not just capacity.

BWA backhaul means designing solutions that offer high capacity, low latency, and support for an all-IP architecture. They must provide comprehensive support for today's wireless broadband traffic service coverage, yet must provide the necessary scale for national coverage, and must meet even more demanding requirements in the near and long term. Let's take a closer look at some of these challenges:



**Increased Capacity.** Backhaul to a single tail site should easily scale to 100 Mbps and beyond. While many current WiMAX based deployments were designed with non-blocking architectures, the longer-term BWA vision requires the use of statistical multiplexing and advanced QoS to offset the exponential increase in demand for backhaul capacity. Efficient microwave and transport capabilities are needed to ensure that base stations, no matter how remote, will always be accessible.

**Space and Infrastructure.** WiMAX and wireless broadband operators need to quickly achieve profitability while dealing with multiple constraints, such as limited footprint, fiber point-of-presence (PoP), availability of powering, cabinet deployment, and real estate costs. These constraints require a portfolio of solutions to help build a complete network in a cost-efficient manner.

**Power and Air Conditioning.** Challenger operators and rural service providers, faced with the need to reduce OPEX and their carbon footprint, are considering the means to reduce the level of air conditioning use and power consumption for radio and networking elements. Modern transport devices may also be able to monitor environmental conditions and adapt their power consumption accordingly.

**Service Scalability.** As broadband services evolve – both in terms of services and capacity – forecasting the future utilization level of every wireless link becomes impossible. In order to deal with this uncertainty, it is worthwhile to deploy flexible, packet-based gear that scales up to 500 Mbps on a single carrier, and that can integrate multiple carriers to support 1 Gbps and more with Carrier Ethernet rings.

**Availability.** In order to achieve carrier-class availability levels, special attention must be paid to network robustness. Backhaul resilience should be enhanced using redundant paths and protection schemes.

**Low Latency.** In order to achieve true high capacity and guarantee satisfactory subscriber Quality of Experience (QoE), low end-to-end delay levels are required for BWA in general and 10 milliseconds or less for WiMAX and TD-LTE networks in particular. Service providers must therefore choose transmission equipment that supports extremely low latency.

**Preservation of Legacy Services.** For some BWA operators, there is also a need for a migration path to all-IP networking. Operators that offer legacy E1/DS1 services to business customers, or mobile services based on CDMA, GSM, and iDEN technologies, require smooth migration solutions that allow them to maintain profitable legacy or 2G services, while offering new 4G services to their subscriber base.



Other important considerations include:

- **Transmission Costs.** Decreasing revenue-per-bit from mobile data applications requires that service providers reduce wireless transmission costs accordingly.
- **Management tools.** Scaling a wireless backhaul network from a few links to dozens or thousands, requires the right management tools to assist throughout the entire project lifecycle. The management system should offer quick and easy provisioning, effective fault management, and trouble-free system upgrades.
- **Support for LTE Architectures.** Many BWA operators consider LTE to be either their evolution path technology, or a complementary technology. LTE-based transport systems should be able to support S1 and X2 interfaces in the future.
- **Synchronization.** In BWA, the main synchronization source is usually GPS-based as in CDMA/EV-DO or WiMAX. However, there are scenarios in which backhaul networks must provide low-cost, end-to-end synchronization – in order to support legacy 2G/3G services, indoor base stations, or other 4G technologies such as LTE.

## The FibeAir BWA Backhaul Solution

The FibeAir IP-10 family of microwave backhauling products was designed by Ceragon in order to address the requirements of forward-thinking mobile and wireless broadband operators. FibeAir IP-10 offers the highest possible capacities at the lowest overall cost, providing complete BWA backhauling solutions, including integrated networking, while operating in any climate or geographical terrain.

This section details how Ceragon's FibeAir IP-10 is especially well suited for backhaul network deployment in support of high-capacity wireless broadband services.

**High-Capacity Microwave Links.** The FibeAir IP-10 microwave backhauling platform covers the entire licensed frequency spectrum – from 6 GHz to 38 GHz, and offers a wide range of capacities – from 10 Mbps to 500 Mbps (full duplex) over a single radio carrier, using a single RF unit. FibeAir's enhanced compression techniques allow carriers to achieve capacities of 500 Mbps on a single carrier, and of up to 1 Gbps using XPIC (Cross Polarization Interference Cancellation).

**Service Scalability.** While continued growth in the demand for broadband service bandwidth is considered a given, it is nonetheless difficult for carriers to predict the rate of growth, the type of traffic, and where the next backhaul bottleneck will be. Ceragon's FibeAir IP-10



platform helps carriers overcome these challenges with its unique Ethernet-based nodal solution that enables carriers to cost-effectively scale their backhaul networks as they grow. The platform's modular nature allows for easy topology upgrades. For example, any tail site can be seamlessly upgraded to become a chain, tree, or ring site, fully leveraging the installed equipment base. Statistical multiplexing techniques, based on a carrier-selected oversubscription factor, are used to enhance scalability while achieving cost savings in the aggregation network

**Space and Power Efficiency.** In order to help reduce indoor footprint and save on scarce cabinet space, Ceragon developed the FibeAir Outdoor Enclosure. The Outdoor Enclosure is designed to house the entire wireless backhaul networking system, including its carrier-grade Ethernet switch and power supply. Ceragon's Outdoor Enclosure speeds deployments cycles and saves on CAPEX and OPEX, offering the following benefits:

- **Small form factor.** The Outdoor Enclosure's compact size reduces the cost of leasing or purchasing rack space.
- **No additional footprint.** Its versatile deployment capabilities result in zero additional footprint at the central office or in a communications room.
- **Quick roll-out.** The Outdoor Enclosure ensures speedy introduction of new microwave links in greenfield areas – at solar-powered sites, and at repeater sites adjacent to highways.
- **Low installation costs.** One-man installation and shorter cabling reduce installation costs.
- **Environment-friendly.** Greener deployments, saving on powering and air-conditioning costs.

**High Availability.** Ceragon's FibeAir platform offers optimized spectrum utilization and link availability, employing a highly-efficient Adaptive Coding Modulation (ACM) capability that supports 8 modulation levels and errorless and hitless transition. The ACM feature is enhanced by a power-adaptive mechanism and exceptionally high system gain, improving link and network availability, supporting longer links, and allowing the carrier to employ smaller, less expensive antennas. An advanced QoS engine allows the platform to adjust itself, allocating capacity in favor of high-priority traffic, and reducing the possibility of a total service outage. Ceragon's ring coordinated operation can be enhanced with QoS mechanisms to ensure that only pre-defined, low-priority traffic is dropped, in failure conditions.

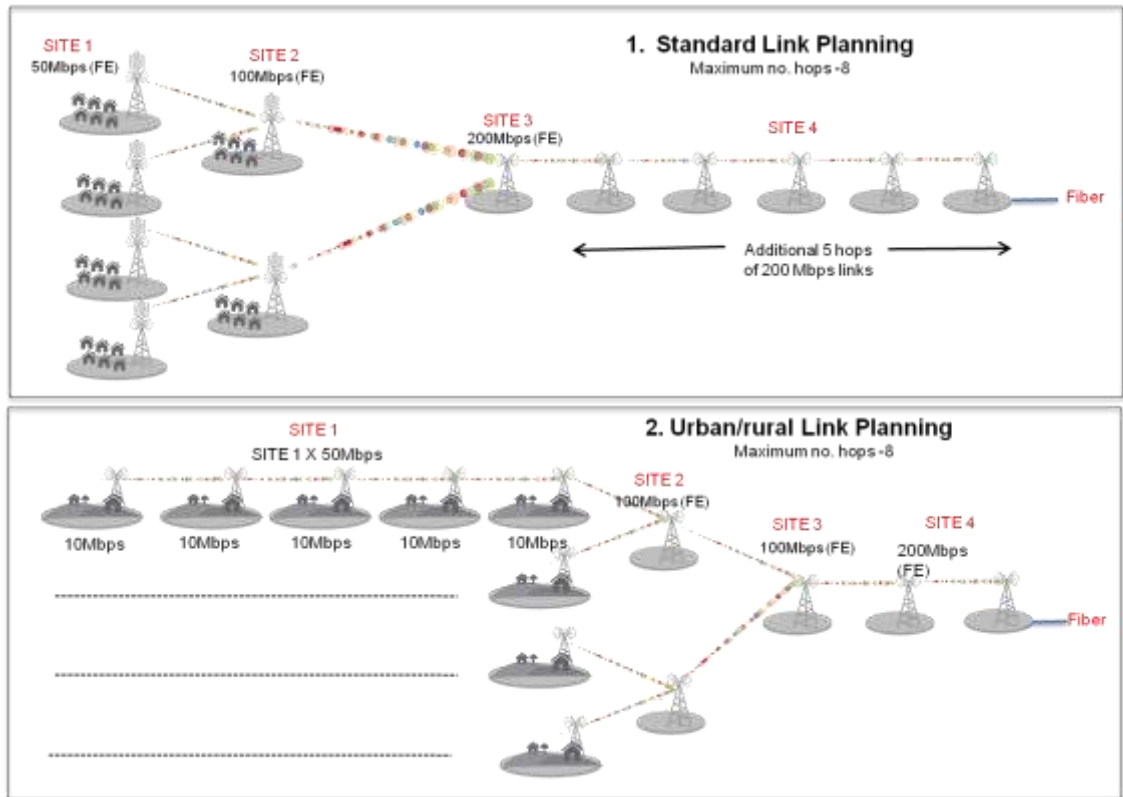


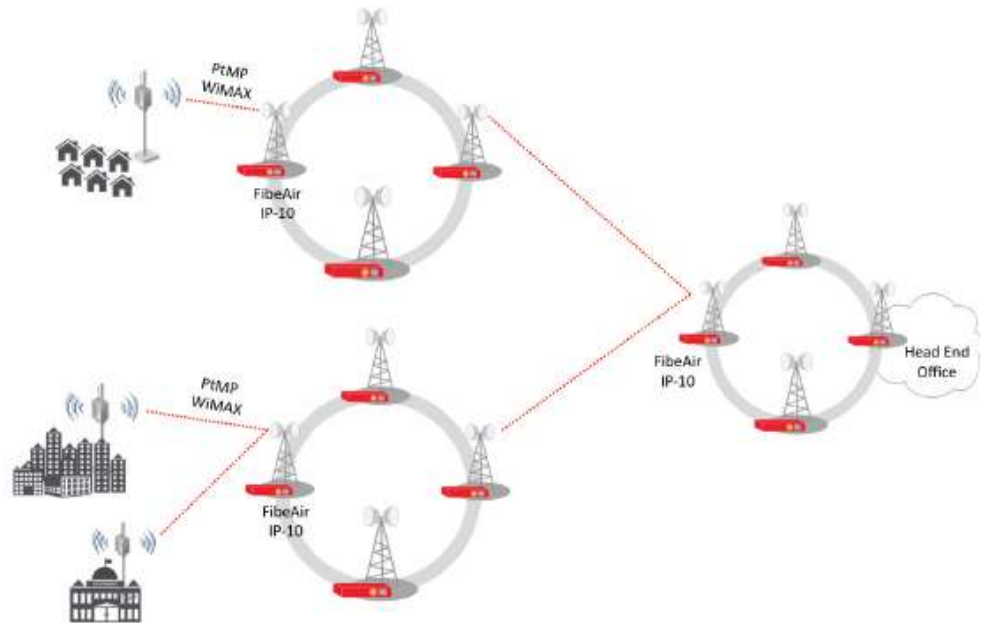
Figure 1: BWA Backhaul Deployment – Long, Low Latency Radio Chains

**Reduced Latency.** In order to reduce packet-traffic latency, meet bandwidth requirements, and ensure acceptable levels of subscriber Quality of Experience (QoE), FibeAir uses a latency-optimized radio design employing sophisticated QoS capabilities, guaranteeing bandwidth at any base station, even in a long radio chain.

**Cost Reduction.** The unmatched versatility of Ceragon’s multi-service backhaul transport device, used at base stations and at traffic-intensive hub sites, makes it an excellent choice for deployment in WiMAX backhaul networks. Ceragon’s highly efficient QoS and ACM capabilities increase operator per-channel bandwidth capacity by up to 60%. Its integrated Ethernet capabilities support Ethernet protection, Ethernet OA&M (CFM), and service management, saving on additional equipment or the need for third-party network management tools. With its wide range of radio configurations and installation schemes, the FibeAir IP-10 is well suited for any type of deployment – all-outdoor on an urban roof top, traditional tower-mounted split indoor/outdoor, or rural with an all-indoor trunk setup. Easily scalable to enable simple, cost-efficient future upgrades, the FibeAir platform can dramatically reduce operator CAPEX and OPEX.



**Network Management System (NMS).** FibeAir IP-10 comes with a fast, optimized provisioning mechanism, easy and accurate fault management and root cause analysis tools, and a user-friendly, intuitive end-to-end service maintenance module, streamlining the operation of BWA wireless backhaul networks, large or small.



*Figure 2: WiMAX Backhaul Deployment – Integrated Native Ethernet Rings*

**Seamless Support for Legacy Services.** For BWA operators offering legacy services (TDM access services, or 2G GSM or CDMA mobile networks) headed for eventual phase-out, support for legacy technologies are of critical importance. The FibeAir IP-10 incorporates Ceragon’s unique, field-proven Native2, a hybrid TDM-to-packet migration approach that allows for the forwarding of TDM and packet-based traffic over microwave links – “natively”, without using expensive encapsulation methods. Integrating cross-connect capabilities for TDM traffic, as well as a powerful Carrier Ethernet switch, the FibeAir IP-10 provides carriers with the tools needed to maintain revenue-generating 2G services, while accomplishing a smooth transition to true all packet broadband wireless access.

The system efficiently handles TDM at the E1/DS1 level, supporting up to 84 E1/DS1s with full SNCP 1+1 support. In addition, Ceragon allows carriers to maintain legacy services while potentially doubling Ethernet transport capacity with its innovative SNCP 1:1-based solution, known as ABR (Adaptive Bandwidth Recovery).



For these cases, Ceragon's FibeAir product line provides a complete portfolio of synchronization tools to support the migration of mobile networks from 2G all the way to 4G. The FibeAir IP-10 offers optional TDM support for delivery of E1/DS1 clock references – even in an all-packet environment. For native packet synchronization, FibeAir IP-10 provides support for Sync Ethernet as well as IEEE 1588v2 delivery.

### FibeAir IP-10 Fits any Deployment Scenario

The FibeAir IP-10 can be integrated seamlessly in any WiMAX deployment scenario. The solution's extended granularity allows it to be deployed in any site – from tail, chain, and aggregation site, to traffic intensive hub-sites – using a single system design.

A survey of some in-the-field FibeAir IP-10 WiMAX backhaul deployment scenarios appear in the following table.



Case	Original Transport and Site Settings	Target Transport and Site Settings	Best practices
Greenfield national WiMAX deployment	WiMAX 802.16d or 802.16e base station with Ethernet only ranging from 10 Mbps in rural to 50 Mbps in Urban.	WiMAX 802.16.e migrating to 802.16m or even TD-LTE with 20 – 150 Mbps ready for more capacity.	FibeAir IP-10 pure packet microwave radio is configured for capacities ranging from 10 to 500 Mbps, depending on subscriber density and the services offered. In rural settings, long trees and chains can be deployed, while in dense and urban environments, integrated, RSTP-based, Ethernet ring support may be useful.
2G GSM or CDMA migration to WiMAX overlay	2G cell site with TDM- only ports. 1-2 E1s/DS1s per site. Wireless is based on TDM cross-connections where applicable, and on SNCP 1+1 protection where relevant.	2G remains on TDM while new BWA base stations (WiMAX, EV-DO, HSPA, TD-LTE...) with Ethernet support add 10-50 Mbps per site.	FibeAir IP-10 starts with TDM-only support for 2G traffic and synchronization functions, employing SNCP 1+1 and TDM XC. Ethernet ports on a packet-ready base station can begin to deliver high-capacity data services. A useful strategy is to use ABR (Adaptive bandwidth recovery based on SNCP 1:1), maintaining availability of the TDM services while doubling the capacity available for Ethernet traffic
Emerging markets urban broadband	Small scale in terms of subscribers and coverage. Access technology is based on available spectrum, and can be WiMAX, HSPA, or EV-DO. High capacity business services employ point-to-point radios. Transport segment is as integrated as possible.	Goal is the ability to seamlessly add coverage and capacity. Additional high-capacity point-to-point radios to serve the VPN requirements of large enterprises. Transport segment to gain extended functionality and capacity.	FibeAir IP-10 provides a complete all-packet solution for all transport requirements, as well as a cost-effective model for point-to-point high-capacity VPN access. FibeAir Outdoor Enclosure can be deployed on rooftops, scaling to up to 4 radios, including Ethernet switch functionality and integrated power supply. Transport capabilities include OA&M, QoS, Ring-optimized RSTP, MEF 9 and 14 certified switching, and rich Ethernet services management. For point-to-point applications, the FibeAir IP-10 provides complete demarcation functions, alleviating the need for an additional NID (Network Interface Device).

**Table 1: FibeAir IP-10 BWA Backhaul Deployment Scenarios**



**FibeAir IP-10: Clear benefits for BWA operators**

Function	Benefit
<b>Higher capacity</b>	Pay-as-you-grow software license
<b>Field-proven ACM support</b>	Higher availability and spectral efficiency
<b>Native Ethernet</b>	Increased capacity and availability
<b>Higher system gain at any modulation point</b>	Higher availability Smaller antennas Longer links
<b>Integrated switch with advanced QoS</b>	Eliminates the need for external unmanaged boxes
<b>Single platform</b>	Future proof, simplified inventory, trouble-free replacement
<b>NMS - Network Management System</b>	Fast & optimized end-to-end provisioning, efficient fault management, accurate root cause analysis
<b>Full OA&amp;M feature set</b>	Carrier-grade control on the packet radio network segment

*Table 2: FibeAir IP-10 Benefits and Features*



## Why Ceragon

Ceragon offers a broad portfolio of innovative, field-proven, high-capacity wireless backhaul solutions. Designed to enable wireless service providers – as well as private and enterprise network users – to deliver voice and premium data services, Ceragon’s solutions help to eliminate backhaul bottlenecks and significantly reduce backhaul costs while facilitating the transition to next-generation, IP-based networks.

Ceragon’s leading technology and field-proven solutions serve operators around the globe with a range of high-performance microwave radio links that enhance spectrum asset utilization, and with integrated networking functionality focused on all-packet backhaul access and aggregation ring networks. FibeAir’s spectral efficiency, combined with exceptionally high system gain, reliably delivers more bits per spectrum used, guaranteeing rapid return on investment.

The FibeAir IP-10 LTE/4G-ready, WiMAX backhaul platform is the solution of choice for mobile broadband operators. The system provides a viable and comprehensive solution for all wireless broadband backhaul requirements, and delivers superior packet architecture and performance. The FibeAir IP-10’s future-proof design offers the ultimate in deployment flexibility – from low- cost tail sites to large radio hub configurations – integrating highly-efficient Ethernet ring support.

## About Ceragon Networks

Ceragon Networks Ltd. (NASDAQ: CRNT) is the premier wireless backhaul specialist. Ceragon’s high capacity wireless backhaul solutions enable cellular operators and other wireless service providers to deliver 2G/3G and LTE/4G voice and data services that enable smart-phone applications such as Internet browsing, music and video. With unmatched technology and cost innovation, Ceragon’s advanced point-to-point microwave systems allow wireless service providers to evolve their networks from circuit-switched and hybrid concepts to all IP networks. Ceragon solutions are designed to support all wireless access technologies, delivering more capacity over longer distances under any given deployment scenario. Ceragon’s solutions are deployed by more than 230 service providers of all sizes, and hundreds of private networks in more than 130 countries. Visit Ceragon at [www.ceragon.com](http://www.ceragon.com).

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