



# LTE-Ready Mobile Backhaul

## Risk-free Backhaul Network Migration from 2G to 3G & LTE

### Introduction

Service providers around the world continue to upgrade their networks to accommodate the rapidly growing number of mobile broadband subscribers, as well as increased per-subscriber bandwidth requirements.

2G networks are widely deployed around the globe, supporting 4 billion subscribers, with close to 3 million base stations and more than 2 million cell sites. Today's mobile backhaul networks are still dominated by TDM-based infrastructure, ranging from E1/DS1 microwave links to high-capacity SDH-SONET networks. However, emerging next-generation mobile networks, utilizing HSPA, EV-DO, WiMAX, and LTE for high-speed data/voice services, signify a shift to all-IP network infrastructure. The challenge of LTE-ready mobile backhauling is to provide an evolution path for mobile technology and the delivery of faster data speeds and new services. To benefit from LTE-ready systems, operators will need to learn the technology and its impact on their networks, applications and service offerings.

New-generation networks will require IP/Ethernet based backhaul infrastructure that supports extremely high traffic volumes, while ensuring carrier-grade quality for premium real-time services. No less importantly, such a migration requires service providers to maintain support for existing (and proven) TDM transport networks, while gradually transitioning the bulk of communication to their next-generation packet-based networks

This paper discusses these and other migration issues, and shows how Ceragon's FibeAir® line of mobile backhaul products can be used to meet the challenge of readying their backhaul networks for LTE technology.



*FibeAir IP-10 offers risk-free migration, providing complete 3G and 4G backhauling solutions*



## The Challenge: Designing LTE-Ready Mobile Backhaul Networks

Designing LTE-ready backhaul networks is not just about upgrading transport capacity.

LTE-ready 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 2G and 3G traffic, yet must provide an easy migration path to LTE. Let's take a closer look at some of these challenges:

**Preservation of Legacy Services.** The migration path to all-IP networking is potentially expensive, and is filled with unknowns – including the number of mobile data subscribers, the bandwidth demand growth rate, and the location of bandwidth bottlenecks in the network. Service providers need migration solutions that allow them to maintain profitable 2G and 3G services, while allowing them to quickly adopt and offer new 4G services to their client base.

Over 90% of wireless sites will be reused during the 2G/3G transition to LTE. Clearly, transition does not mean "replacement", and the three technologies will have to coexist over the long term. This situation will force transport networks to adapt to the varied requirements that arise during the different stages of wireless technology evolution.

**Increased Capacity.** Backhaul to a single tail site should easily scale to 100 Mbps and beyond. Statistical multiplexing and QoS should be employed 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.

**Service Scalability.** As mobile networks 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, all-in-one transport devices that can support at least 16 T1/E1 ports and TDM cross-connect functionality, as well as packet-based traffic levels of 400-500 Mbps with Carrier Ethernet capabilities.

**Space and Infrastructure.** Mobile operators need to quickly reach 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 issues require a portfolio of solutions to help build a complete network in a cost-efficient manner.

*The Challenge:  
Designing mobile  
backhaul networks  
that generate  
profits*



**Power and Air Conditioning.** Whether it is due to rural service requirements, lack of urban power availability in emerging countries, the need to reduce OPEX, or environmentally-aware business practices, carriers are considering the means to reduce the level of air conditioning use and power consumption for radio and networking elements. Modern transport equipment may also be able to monitor environmental conditions and adapt its power consumption accordingly.

**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.

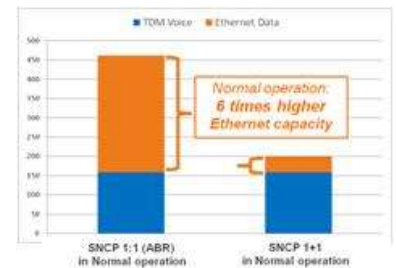
**Low Latency.** 3G and newer applications require end-to-end delay levels of 10-30 milliseconds in order to guarantee satisfactory subscriber Quality of Experience (QoE). Service providers must therefore choose transmission equipment that supports extremely low latency.

Other important considerations include:

- **Transmission Costs.** Decreasing revenue-per-bit from mobile data applications requires that service providers reduce wireless transmission costs.
- **Support for LTE Architectures.** Systems must support flat IP architectures that will support S1 and X2 interfaces.
- **Synchronization.** Backhaul networks must provide low-cost, end-to-end synchronization as required by 2G/3G services, as well as by tomorrow’s 4G services, such as LTE FDD or TD-LTE, in order to ensure optimal subscriber QoE.

### The FibeAir LTE-Ready Mobile 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 operators. FibeAir offers risk-free migration, providing complete 3G and 4G backhauling solutions, while maintaining vital support for profitable TDM and ATM-based services.



*Protected ABR doubles the capacity of a Native<sup>2</sup> deployment, while effectively enabling a 6-fold Ethernet*

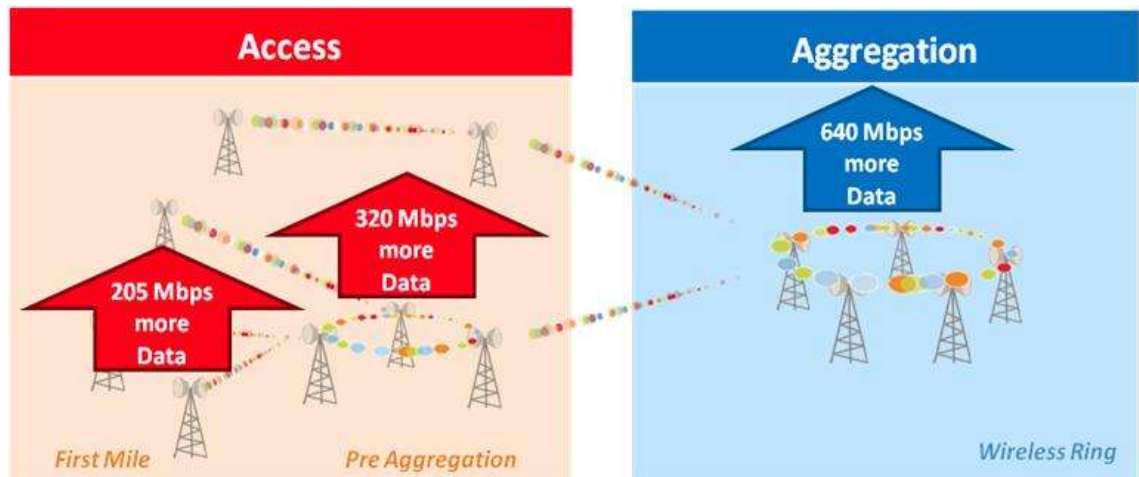


This section details how Ceragon’s FibeAir IP-10 is especially well suited for the evolution of wireless backhaul – from 2G and 3G all the way to 4G and LTE.

**Seamless Support for Legacy Services.** The FibeAir IP-10 incorporates Ceragon’s unique, field-proven Native2 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 3G and an all-IP RAN.

The system efficiently handles TDM at the E1/DS1 level, supporting up to 84 E1/DS1 channels 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 Protected-ABR (Protected Adaptive Bandwidth Recovery).

**High-Capacity Microwave Links.** The FibeAir IP-10 microwave backhauling platform covers the entire licensed frequency spectrum – from 6GHz to 38GHz, 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 allows carriers to expand capacity to 1 Gbps, using XPIC (Cross Polarization Interference Cancellation) techniques.



**Assumptions:**

1. All calculations are based on 28 MHz channels
2. Existing radio links are planned for 5x9's
3. Ethernet Traffic using a 64 Bytes

*Figure 1: Evolution from for 2G to HSPA and beyond – Native2 Rings (with Protected ABR – Adaptive Bandwidth Recovery)*



**Service Scalability.** While continued growth in the demand for mobile 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 platform helps carriers overcome these challenges with its Native2 hybrid support for TDM and Ethernet traffic flows. Native2 allows carriers to re-allocate bandwidth to either of the traffic types at any time, and will continue to operate optimally once the all-packet network is in place.

The FibeAir IP-10 is a modular, 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. Designed to house the FibeAir IP-10, the 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.

*The FibeAir Outdoor Enclosure speeds deployments cycles and saves on CAPEX and OPEX*

**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. All of these mechanisms operate natively in Ethernet, with optional support for TDM services as well.

**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 hierarchical QoS capabilities. It offers prioritized traffic handling that encourages differentiation of services, and guarantees bandwidth at crucial base stations where high levels of delay cannot be tolerated.

**Support for Flat IP Architectures.** As an LTE-ready backhauling platform, the FibeAir IP-10 supports fast, efficient set up of point-to-point connections for provisioning of LTE S1 interfaces, as well as the multipoint-to-multipoint connectivity needed to support X2 interfaces – enabling efficient transport and base-station handover.

**Synchronization.** 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. 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.

**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 LTE-ready backhaul networks. Ceragon's highly efficient QoS and ACM capabilities increase operator per-channel bandwidth capacity by up to 60%. Easily scalable to enable simple, cost-efficient future upgrades, and with easy-to-use and efficient OA&M capabilities, the FibeAir platform can dramatically reduce operator CAPEX and OPEX.

## FibeAir IP-10 Fits any Deployment Scenario

The FibeAir IP-10 can be integrated seamlessly in any deployment scenario. The solution's extended granularity allows it to be deployed in any cell 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 mobile backhaul deployment scenarios appear in the following table.

Case	Original Transport and Site Settings	Target Transport and Site Settings	Best practices
<b>2G GSM migration to 3G (HSPA) overlay</b>	2G cell site with TDM only ports.	2G remains on TDM while new HSPA NodeBs supports Ethernet traffic	FibeAir IP-10 starts with TDM forwarding only, supporting all 2G traffic and synchronization functions. Leveraging the FibeAir platform’s advanced TDM/Ethernet dual core known as <b>Native<sup>2</sup></b> , any additional traffic is forwarded over the segment allocated to Ethernet traffic. FibeAir IP-10 native Ethernet capabilities include synchronization support, enabling a complete migration to packet networking
<b>2G GSM with legacy 3G</b>	Early ATM-based 3G NodeBs with 2G TDM – utilizing multiple TDM ports	Shift to HSPA or LTE-ready NodeBs with more Ethernet capacity	Similar to the case above with few additions. FibeAir IP-10 may apply priorities on E1s/DS1s therefore may be well suited to an ACM-based network where some TDM channels receive higher priority than the rest, and some Ethernet connections receive a higher priority than the data running over TDM. FibeAir IP-10 supports the networking requirements of both the Ethernet and TDM segments, and enables a smooth migration between the two.
<b>All-packet, Greenfield, or wireless broadband overlay</b>	LTE-ready, all-IP NodeBs	LTE – all packet and flat architecture	FibeAir IP-10 was designed as an all packet radio system with the ability to deliver the highest possible capacities, given a distance and an availability goal. Whether it is a single link or a packet radio cloud, the FibeAir IP-10’s advanced OA&M features and built-in protection schemes enable operators to guarantee more bits in the air.

*Table 1: FibeAir IP-10 Mobile Backhaul Main Deployment Scenarios*



**FibeAir IP-10: Clear benefits for mobile 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>Protected Adaptive Bandwidth Recovery (ABR)</b>	Doubles capacity over a ring – up to 6 times more for data
<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 mobile 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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