



WiMAX: The Backhaul Perspective

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This white paper addresses the intrinsic benefits of wireless WiMAX backhaul, presenting operators with a cost-effective solution to introduce high-capacity for WiMAX broadband networks. How can operators rise to the challenge and deliver the high capacities required for WiMAX-based services? How can this be achieved without significant roll-out stage investments in infrastructure? And when decreasing total cost of ownership is key in building a viable, profitable solution, how can operators grow the backhaul with a limited subscriber base, enhance their services, and increase revenues?

Introduction

Today's successful WiMAX deployments are based on cost-optimized backhaul design. With the global WiMAX market still evolving and changing, WiMAX has emerged as the solution of choice for regional or challenger operators. To date, market trials and various deployments worldwide have proven that WiMAX is in fact moving towards larger-scale operations by several operators.

At the roll-out stage, WiMAX operators cope with heavy investments in infrastructure, and an emerging subscriber base. Faced with this challenge, operators must make critical business decisions. The ultimate challenge is to decrease operators' total cost of ownership, a key factor in building and maintaining a viable and profitable business. While much emphasis is placed on lowering access equipment costs, the impact of backhaul is often overlooked. Incorporating high-capacity backhaul with Ethernet radio that covers all deployment scenarios will enable operators to lower costs without compromising on service quality or performance.

WiMAX is all about affordable personal broadband. The premise of WiMAX backhaul is offering operators the same affordable capacity at the base station site. This can be achieved by providing a microwave segment for WiMAX backhaul that delivers three significant highs – high power, high capacity, and is highly available.

WiMAX: Evolution or Revolution?

Market Trends

In 2007, WiMAX made a tremendous market impact with optimistic and reassuring industry-wide announcements. By the end of 2008, it was clear that WiMAX would not become the next mobile technology, as LTE was clearly taking the lead as the technology of choice for mobile operators. In retrospect, this was not necessarily all bad for the WiMAX industry.

WiMAX is now synonymous with broadband wireless. WiMAX is an important, highly visible part of the evolving fixed/portable broadband field. The fundamentals for continued growth remain sound. Broadband is becoming a necessity for many residential and business subscribers worldwide. Although DSL and cable are poised to remain the dominant

technologies for access in urban and developed areas, wireless access technologies such as WiMAX, are already becoming reliable and cost effective complements or alternatives to providing voice and broadband services.

Infonetics research suggests that in 2008, the number of fixed and mobile WiMAX subscribers reached 3.9 million, an increase of 120% from 2007.

Apart from aiming as the next generation air interface technology for mobile operators, WiMAX is also perceived as a cost-effective DSL replacement service. While CPEs are not as low cost, WiMAX offers the flexibility of being wireless, eliminates the need to trench cables, gain access to central offices, and therefore generate faster ROI, WiMAX plays into lucrative service niches achieving higher ARPU (Average Revenue Per User) compared to fixed service providers as they tend to serve where no operators has gone before. The WiMAX value proposition has anything but diminished. The effects of standardization will drive increased unit demand, and commoditized IC/SoCs will help drive the price equation, stimulate increased awareness and market driven demand, and provide increased supply stability and compatibility.

Deployment Trends

With 519 deployments in 146 countries (WiMAX Forum, December 2009), it is safe to assume that WiMAX is here to stay. There are numerous business models and opportunities that make WiMAX an attractive service platform for personal broadband services.

In developing countries, representing most of the worldwide population, the potential for WiMAX growth is most pronounced. In rural areas, governments at all levels are driving the growth of wireless broadband through continued frequency allocation and subsidies to make the rural business case more attractive in order to reduce the digital divide.

Operators are now exploring the challenge of growing broadband ARPU. There will not be a single solution: faster speeds and VoIP will work for some; rich content and or Internet TV services for others. There will be a growth in commercial bundles driven by telcos' responses to cable operators' triple play services or by cable operators complementing their Nomadic/Mobile service portfolio. WiMAX's expected evolution with IEEE802.16m technology will enable true triple-play services. It is also expected that VoIP services will continue to show growth and acceleration in subscriber bases in both consumer and enterprise segments.

The Rural Perspective

Governments have realized how great the disparity is between the provision of broadband services in metropolitan areas and in rural areas. This normally leaves the rural area at a considerable disadvantage, both technologically and commercially. Rural broadband initiatives are on the rise across the globe, with every government facing the same challenges of density in populated areas and the lack of efficient and reliable services in rural areas.

Apart from proving it is possible to build affordable, yet profitable broadband services based on WiMAX, this technology also emerges to be one of the beneficiaries of global stimulus plans. While HSPA lacks the capacity and is associated with the spectrum used by mobile operators on a national scale, WiMAX is here to suffice the need of developed countries to ignite their economy, while dealing with increasing digital divides.

Undoubtedly, it is rural areas that are driving the next wave of telecom growth. To effectively serve the masses ranked at the lower end of the financial spectrum and make a profit, a dedicated, tailored strategy is critical. To achieve true rural connectivity, we need to acknowledge and work with the realities of rural connectivity today. We must find the right technology to meet rural requirements, achieve low ARPU by defining the right cost model, and ensure fast ROI with low financial risks.

WiMAX Backhaul (Who Needs It and Why?): Various Business Models

In reality, WiMAX operators use mainly microwave radios for their backhaul networks.. It is important to understand precisely how and why WiMAX operators use Ethernet Microwave radios to cater to WiMAX's flat, all-IP architecture, enabling successful business growth.

Business Services

The demand for business broadband is soaring, as service providers must deploy gigabit Ethernet backhaul to support high bandwidth WiMAX services, all of which must support a WiMAX network to an appropriate capacity. Where a private DS1/E1 (1.54/2.048 Mbps) was once thought to be a business luxury, multiple megabits, if not gigabits for Internet connectivity, are now mandatory in even the least technical of businesses. WiMAX service for any business district will require gigabit capacities to support 40 Mbps per sector WiMAX radios.

Residential Services

The next generation of residential services will require great deals of IP bandwidth. Service providers planning nationwide rollouts are currently shopping for and testing wireless backhaul solutions. What makes WiMAX so exciting is the broad range of residential applications it makes possible but not limited to broadband Internet access as a DSL/DOCSIS substitute, Voice Over Internet Protocol (VoIP) as a legacy telephone substitute, Internet Protocol Television (IPTV) as cable/Satellite TV substitute or as backhaul for Wi-Fi hotspots or microcell sites.

Smart Metering

Smart metering is a relatively new trend in utilities (power, gas, and water) where an advanced meter identifies consumption and communicates back to the local utility headquarters for monitoring and billing purposes. When applied by power utilities in conjunction with a smart grid concept, smart metering may also address energy independence, global warming, and emergency resilience challenges, by better managing consumers and business consumption on a national level.

WiMAX is perceived as major tool required in building backhaul for meters. The first successful smart metering project was in Australia by SP AusNet, the regional power utility in Victoria. WiMAX was deemed highly effective, as it enabled high-capacity data service for NLOS devices in urban areas in a spectrum that is not captured by mobile operators. While utility companies enjoy large fiber facilities in their covered regions, new WiMAX base stations cannot be covered by fiber alone. In this scenario, high-capacity PtP microwave becomes a

viable choice, as it allows rapid deployment for base stations not served by fiber, or serves as an alternate path in protection schemes to increase availability.

Network Deployment Strategies

Backhaul Options

The debate on the number of options available for a backhaul network, are out of the scope of this white paper. However, it is important to understand that due to the relatively high-capacity requirements implied by the mobile WiMAX standards as specified by the WiMAX Forum's TWG (Technical Working Group) and NWG Networking Working Group, there are two feasible options -Fiber and PtP Microwave. (For more information and a comparison of the differences and similarities between these two popular media types, please refer to Ceragon's white papers entitled "Rural Broadband", and "Fiber vs. Microwave").

In urban areas, based on the assumption that erecting a tower is not required, the business case for microwave is made above a few hundred meters (yards). In rural areas, however, this option becomes attractive after a few kilometers (2.5km /1.6 miles, including the cost of erecting a tower). Finally, in distances beyond 5km (3 miles), the case for fiber diminishes quickly, even if operators assume up-selling capacity opportunities.

The Case for Ethernet

Combining wireless Ethernet over microwave is ideal for WiMAX backhaul. Apart from its inherent scalability features, Ethernet enables network operators to build "flatter", more cost-efficient network topologies. Ethernet backhaul can be used either by mapping Ethernet over a TDM connection (PDH/SONET/SDH), or by employing native-Ethernet solutions. The advantage of native-Ethernet is that packets are not mapped into fixed length frames, such as SONET/SDH virtual containers or PDH frames. Instead, packet traffic is enabled using the smallest possible overhead and with an optimal frame size for each throughput and modulation scheme. At the same time, Ethernet can also support ultra-high data rates, exceeding TDM-based solutions' capacity in all wireless channel bandwidths.

WiMAX Backhaul -A Look Inside

Early WiMAX deployments were about fixed wireless access, replacing Point-to-Multi-Point as the cost-effective solution for residential and relatively low capacity business services. Later, with the evolution of WiMAX towards IEEE 802.16e-2005, the market perception was about a viable alternative for mobile operators introducing mobile broadband services to the market, especially those using CDMA2000 technology in their networks. Following this line of thought, backhaul considerations looked very similar, just with higher capacities and more focus on all-IP network architecture from day one. Eventually, only few mobile operators introduced WiMAX as their next generation radio access technology, maintaining WiMAX's niche position.

Following are some of the major differences that impact both the business models and the selection of backhaul concept and equipment:

	WiMAX Backhaul	Mobile Backhaul
Business		
Business model	Mostly challengers	Incumbent or associated with one
Facilities	Mostly facility less	Both
Coverage	Mostly regional	Global
Likely to perform up front investments	Not likely	Not likely, but usually share risk with fixed operations
Technology		
High capacity	Now – central theme	Later, risk free and evolutionary as possible
Packet oriented	From day one	Migration strategy
Legacy support	Not likely	Yes... and revenue generating

Backhaul Requirements

When engineering a backhaul network to support a WiMAX network, the service provider should consider the following elements in backhaul planning: range and throughput demands of the market, security, quality of service (QoS), interference mitigation, frequency reuse, rain fade, SLA, and availability.

The selection of backhaul solutions, similar to the WiMAX platforms they support, should be driven by the business plan. That is, selecting the appropriate platform for the market served. Wireless backhaul solutions are ideal for supporting WiMAX networks – no other wireless solution can approach these platforms in terms of range and throughput. These solutions also have advantages over fiber optic cables in terms of cost and time to market.

Design Concept: What's backhaul got to do with it?

WiMAX backhaul is the transport link between a Base Station (BS) and the WiMAX Access Service Network Gateway (ASN-GW) which carries WiMAX R6 interface packet data. Backhaul is generally defined as the network components which connect client/subscriber access sections of networks with their core switching and management section. It transports considerable traffic from a service provider's POP (Point-of-Presence) to the rest of the network, and essentially acts as the "glue" that pieces all of the network elements together. This enables the network to effortlessly deliver seamless and transparent broadband communications to its subscribers with high reliability and availability.

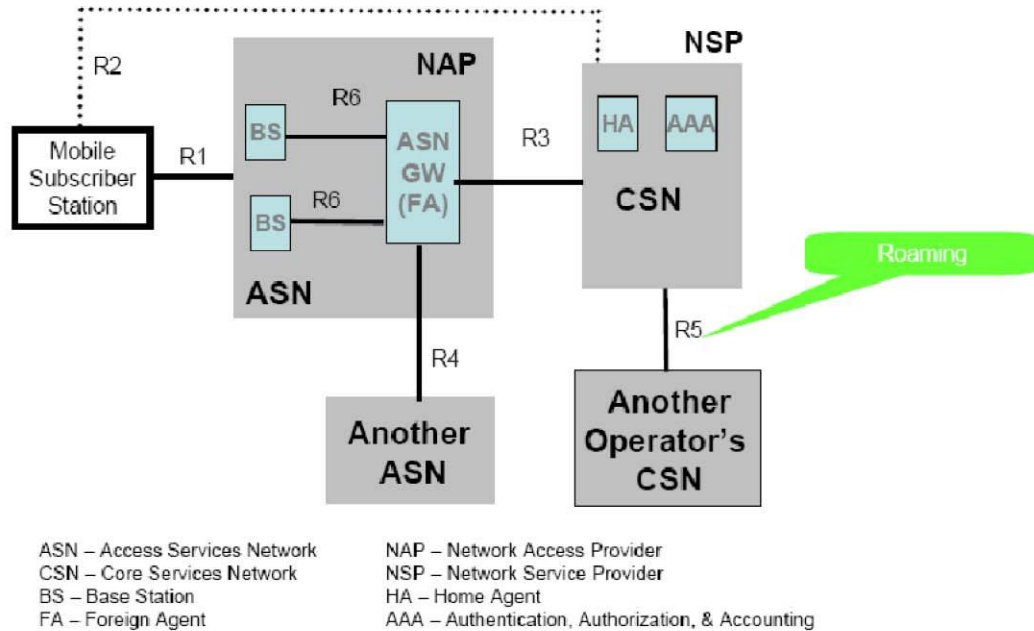


Figure 1: Network Reference Model (Source: Intel)

For service providers who select WiMAX as their underlying technology, high-capacity backhaul is essential for ensuring continuous delivery of rich media service across high-speed data networks. If the backhaul and its components are not cost-effective, resilient, scalable, and able to supply sufficient capacity, then a providers' entire network can be seriously compromised – resulting in significant customer churn.

Operational Aspects - Components of WiMAX Backhaul Architecture

The backhaul of the network is recognized as a major enabler of network performance. In order to deliver the expected bandwidth requirements of WiMAX, the backhaul is critical, must be high capacity, and a rich media services enabler. The following section presents the most critical requirements that must be addressed by any effective WiMAX backhaul architecture:

Upgradability

WiMAX operators are often challengers, and therefore are susceptible to high investment before the demand is ever realized. Ideally, a WiMAX operator would like to receive high-capacity-ready equipment with an extensive software license portfolio to enable increased capacity and functionality to cope with the growing service take rate.

Quality of Service (QoS)

WiMAX carries the promise of a multi-service environment carried over high-capacity wireless platforms, enabling personal broadband - anywhere. By applying QoS techniques, operators can provide comparatively higher SLA to high revenue-generating services.

Latency

WiMAX networks, as any high-capacity wireless technology, sets stringent round trip latency and jitter budgets. While 2G voice services could tolerate a few hundred of milliseconds of delay and even more if operated in satellite mode, then 3G had reduced the delay budget to 30msec. LTE sets the bar even higher with around 10msec figure for round trip latency. WiMAX is somewhere in between 3G and WiMAX. This means that the number of hops between the WiMAX base stations and the ASN-GW should be reduced to between 8 to 12 hops, depending on the links capacity and type.

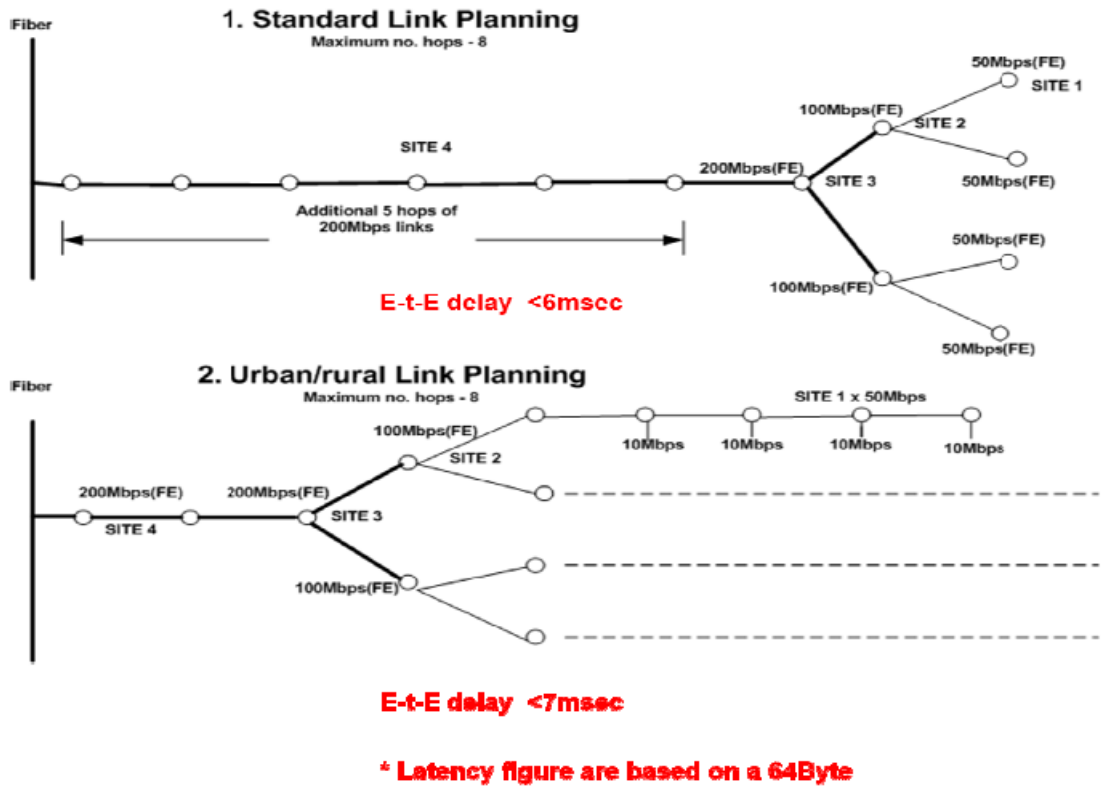


Figure 2: Expected latency as a function of hops and the available capacity

Protection

Be it smart metering applications, business services, or even urban residential services, maintaining high service availability may have a significant impact on the operator's return on investment. Deploying high availability radio equipment coupled with network protection schemes, preferably integrated, may reduce operating costs, coupled with high SLA comparable to services provided by incumbents. This may seem insignificant in urban areas, as network failure may be addressed in a matter of hours. However, the WiMAX business case is generally stronger in underserved areas, where it is also more difficult to fulfill demanding SLA requirements protected E-LAN/E-LINE service scheme or Ethernet Ring Optimized RSTP may increase availability by creating multiple protection levels at the service, network and unit level, ensuring continuous service delivery even in the unlikely event of

multiple failures. (For a detailed discussion on broadband protection services, please refer to Ceragon’s white paper entitled “Rural Broadband”).

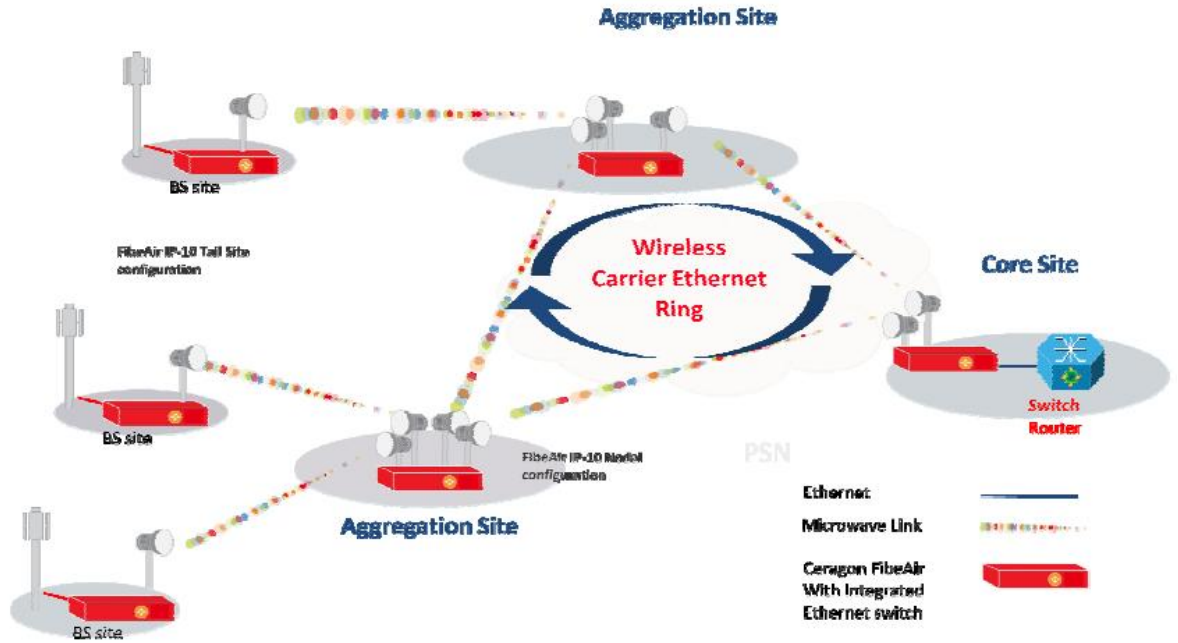


Figure 3: WiMAX Backhaul – with self-contained Ethernet aggregation and ring protection functions

The Future of WiMAX Backhaul

WiMAX is a versatile technology, enabling different service providers to offer rich media and data-oriented services over wireless broadband networks. It fits the strategy of incumbent telcos, cable companies, satellite operators and broadband service providers without a wireless play to extend their services in cities and rural areas. Meanwhile, looking at the global landscape of telecom infrastructure, it is clear that wireless backhaul will support the deployment of WiMAX worldwide by improving the business case of both competitive service providers and the incumbent’s rural operations. An additional benefit of high-capacity wireless backhaul is the ability to place the WiMAX base stations according to optimal radio planning without the need to consider wireline backhaul infrastructure availability. This also improves the business case as well as the service experience

Wireless microwave backhaul provides bandwidth flexibility that the WiMAX industry has been missing. Microwave backhaul continues to thrive in places where fiber is either too expensive or is unavailable. The recent economic downturn is making PtP microwave backhaul even more attractive, as it offers a quick and cost-efficient path for new deployments and network upgrades with no compromise on performance and capacity when compared to fiber.

Conclusions

WiMAX is gaining momentum as more service providers and enterprises choose this technology for wireless access. With "always-on" ubiquitous connectivity, broadband wireless services, both mobile and nomadic, are forging ahead to become the technology of choice for service providers. These new bandwidth intensive rich media services demand high-capacity WiMAX backhaul at their base stations.

Ceragon's wireless backhaul solutions provide a field proven answer to the escalating demands of today's WiMAX networks, serving all types of access technologies, and any type of network topology. Ceragon's modular FibeAir® IP-10 product family is a high-capacity solution for wireless backhaul transport of broadband services over IP.

In their quest for modular designs and a rich set of features for cost-effective, future-proof, high-capacity backhaul connectivity, services providers will be inclined to move towards high capacity microwave solutions. They will seek out easier and more cost-effective ways to deliver WiMAX backhaul services to meet their current and future network requirements, with the promise of quick deployment, lower CAPEX/OPEX, and increased ROI.

Appendix A

Ceragon WiMAX Backhaul Offering

Ceragon has developed its FibeAir® solutions to address the escalating capacity requirements of mobile and broadband operators. The proposed deployment strategy offered by Ceragon is based on the capabilities of the FibeAir® IP-10 family of licensed point-to-point microwave radios.

The versatile FibeAir IP-10 family offers a wide capacity range of 10Mbps to 500Mbps over one radio carrier, using a single RF unit, across the entire licensed frequency spectrum – from 6GHz to 38GHz. The solution easily serves the capacity requirements of a single WiMAX base station, as well as those of traffic-intensive hub sites and leaves ample headroom for future capacity enhancements. The industry's most advanced Adaptive Coding & Modulation (ACM) helps to maximize spectrum utilization and capacity over any given bandwidth, and under changing environmental conditions.

Function	Benefit
Ceragon - Superior Radio Performance	
Higher capacity	Software license - pay-as-you-grow
True ACM support	Field proven ACM
Native Ethernet	Increased capacity and availability
Higher system gain at any modulation point	Higher availability Smaller antennas Longer links
Integrated and Managed	
Integrated switch with advanced QoS	Eliminates the need for external unmanaged boxes
Single platform	Future proof, easy to store and replace
NMS - Network Management System	End-to-End management for provisioning and alarms
Full OA&M features set	Carrier grade control on the packet radio network segment

Featuring enhanced Ethernet networking capabilities to simplify network design and maintenance, the FibeAir IP-10 family helps to reduce CAPEX and OPEX and improve overall network availability and reliability in order to support advanced services with stringent SLA. FibeAir IP-10 comes with a range of radio configurations, including high power split and all-

indoor configurations to meet any deployment challenge. In addition, there is an optional all-outdoor enclosure to cost-effectively set up new sites or to upgrade capacity in crowded sites.

ABOUT CERAGON

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