



4G Ahead!

A new world of enterprise
mobile broadband.



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4G Ahead!

A NEW WORLD OF ENTERPRISE MOBILE BROADBAND

Abstract

This white paper defines 4G, examines the two leading 4G technologies, and discusses their various features, benefits and the progress of each technology to date. It concludes with a recommendation for companies considering future 4G deployments, and iPass' position.

Introduction

Mobile broadband use continues to grow. According to industry analyst firm Infonetics, cellular mobile broadband subscribers are forecast to grow at a 104 percent compound annual growth rate from 2007 to 2011. Businesses and individuals are putting mobile broadband technologies to work and realizing the productivity and convenience benefits of always-available broadband access.

While people still primarily use their mobile devices for voice, texting and e-mail, the emergence of applications such as audio and video download and streaming, virtual collaboration and Web 2.0 applications will continue to increase demand for faster and more responsive mobile broadband. Enter fourth-generation (4G) technology.

What Is 4G?

4G is high-speed wireless connectivity that enables a real-time multimedia experience. It allows mobile users to not just send and receive emails, but to deal with large file transfers, view high-resolution streaming multimedia or have a high-quality interactive video experience. While there is no formal 4G definition in the market, the competing 4G technologies each include:

- **IP-based architecture:** 4G at its most basic level is defined as an all-IP, high-speed, low-latency, flat-architecture network. The network will enable fast, cost-efficient access to the Internet and enterprise applications.
- **Packet-switched data:** Like existing 3G networks, 4G radio access networks will be optimized for packet-switched data as opposed to circuit-switched voice.
- **OFDMA signaling:** To enable higher speeds and more users per cell, the 4G air interface will be based on orthogonal frequency-division multiple access (OFDMA), which makes more efficient use of the wireless spectrum than older technologies (improved spectral efficiency).
- **MIMO antennas:** 4G radios will make use of multiple input, multiple output (MIMO) technology. MIMO-equipped cell sites send information simultaneously over two or more antennas to improve reception, reduce interference and increase effective throughput.
- **Open access:** The price/performance improvements of 4G should lead to the expansion of broadband to a wider variety of devices beyond laptops and smartphones, which will lead to market pressure on network providers to open their networks to any compatible device rather than a select few as is true today.



Enterprise Benefits of 4G

- **Higher speed:** 4G technologies are expected to offer speeds of at least 70 Mbps in each direction, which is at least four times faster than the peak rates of the newest HSPA-based GSM networks and 50 times the speed of prevalent CDMA 3G networks such as those using EV-DO Rev A.
- **Lower latency:** In a flat, all-IP architecture, the initial data packet connection should be in the 50-millisecond (ms) range with approximately 5 ms of one-way latency—an order of magnitude better than 3G networks. Low latency makes 4G ideal for “mobilizing” real-time applications such as VoIP, video streaming and tele-presence.
- **Lower price per bit:** Due to their architecture and the spectral efficiency of OFDMA, 4G networks promise a substantially lower cost-per-bit than 3G systems.
- **Indoors to outdoors:** The promise of 4G to serve as a fixed-line replacement for DSL or cable is spawning the development of indoor femtocells and picocells, which give users high throughput indoors and can transfer them to the wide-area 4G network when they leave the building.

What New Applications Does 4G Help Mobilize?

4G will allow enterprises to extend to mobile workers those applications that were previously restricted to the LAN. It will also allow for brand-new mobile-only applications.

VoIP and Unified Communications

To date, use of mobile VoIP has been driven by end users with internet telephony accounts (e.g. Skype) who have wanted to avoid international long-distance and cellular roaming charges by using a Wi-Fi hotspot or hotel Ethernet link. 4G changes the game by providing sufficient network performance for a mobile device to act as a fully enabled company telephone over a wide-area network. Its functionality could include a corporate phone number; transparent support for PBX features; and integration with voice mail, email and corporate blogs, social networks and other emerging aspects of a unified communications system.

Enterprise IPTV

Industry analyst firm IDC estimates that enterprise video use will grow at a compound annual growth rate of nearly 50 percent over the next five years. Video has the chance to blossom as a business communications media in an era where every employee has some experience using a webcam or video camera.

In a 4G world, where bandwidth and latency are removed as issues, video content can for the first time be economically delivered to mobile devices.

Tele-presence/Virtual Collaboration

Tele-presence solutions attempt to create the richness of a physical face-to-face meeting over a telecommunications network. They help businesses lower travel expenses and increase communications velocity by allowing for instantaneous virtual meetings.



According to a *Harvard Business Review* study of project management best practices in Global 500 enterprises, face-to-face meetings and interaction in the workplace are declining rapidly, being replaced by e-mail, tele-conferences and fixed video conferences. But current virtual collaboration methods are limited by the lack of a ubiquitous mobile video component.

4G promises a world where high-quality video meetings can take place on demand, regardless of where the participants are located or whether they are in motion (e.g. in a taxi). Since tele-presence is a two-way application, upload performance is just as important as download speeds. Historically, 3G technologies were designed primarily for downlink performance, which is fine for broadcasting from a central point but not for high-speed peer-to-peer communications.

Specific 4G Technologies

Two technologies comprise the anticipated fourth-generation of mobile wireless technology:

- **Worldwide Interoperability for Microwave Access (WiMAX)** is based on the IEEE 802.16 family of standards and delivers wireless broadband data at up to 70 Mbps in each direction. This technology is already standardized and in use in more than 300 networks. In the U.S., it is backed by a consortium of companies that include Intel, Motorola, Google, Sprint Nextel and major cable operators. A major performance upgrade to the standard known as 802.16m is due out in 2010.
- **Long Term Evolution (LTE)** is an extension to two key 3G technologies, the Global System for Mobile Communications (GSM) and Universal Mobile Telecommunications Systems (UMTS). . LTE is being backed by leading telecommunications companies that include AT&T, Verizon, Vodafone, T-Mobile, NTT DOCOMO. While LTE is not yet standardized, tests with pre-standard equipment have delivered peak speeds of over 100 Mbps. Industry analysts expect the first commercial availability to occur in 2010.

Meet WiMAX

WiMAX is a standards-based technology capable of delivering high-speed wireless broadband access based on an all-IP architecture designed to increase scalability, lower costs and reduce network complexity. Mobile WiMAX hits a sweet spot in today's market by offering exponentially greater range and throughput than Wi-Fi and superior performance than 3G.

WiMAX is based on IEEE standards and enables the delivery of fixed and mobile wireless broadband services. The 802.16d-2004 standard forms the foundation for WiMAX, delivering 70 Mbps at up to 30 miles. The 802.16e-2005 standard updates WiMAX with key mobility features such as cell handoff capabilities, MIMO support and VoIP Quality of Service.

Clearwire: Jumpstarting WiMAX

On May 8, 2008, Sprint Nextel and Clearwire announced a plan—backed by other industry heavyweights—to deliver nationwide fixed and mobile WiMAX to the U.S. To achieve this, the two companies are merging their spectrum and network assets, which comprise some 190 MHz of bandwidth in the 2.5 GHz spectrum—or about 80 percent of the total available in that band.

Other industry-leading companies are committed to helping this venture succeed and have invested more than US\$3.2 billion so far:



- **Intel** has invested US\$1 billion in Clearwire and is working to integrate Wi-Fi and WiMAX into its Centrino 2 chip, which will be embedded in new PCs, notebooks, handhelds and various consumer electronics starting this fall.
- **Google** is developing a mobile Internet portal and search engine. WiMAX provides an avenue for convenient high-speed Internet access to Google's applications, services and Android phone.
- **Comcast, Time Warner Cable and Bright House Networks** are large U.S. cable TV and Internet companies that intend to use WiMAX as a path to selling mobile voice and data services to their large customer base.

Mobile WiMAX Progress to Date

- According to Gartner, "The WiMAX Forum estimates there are over 305 commercial [WiMAX] networks in 118 countries."¹ Some 120 of those networks are mobile.²
- In South Korea, Korea Telecom already offers Wireless Broadband (WiBro)—a mobile subset of WiMAX—and has deployed the service across 25 percent of the country, garnering 100,000 subscribers.
- In Taiwan, M-Taiwan is a large-scale plan to blanket the entire country with mobile WiMAX. Service is expected to become available in 2009.
- Clearwire intends to launch mobile WiMAX in the Baltimore/Washington D.C. and Chicago markets in the fall of 2008, followed by additional markets in 2009.³

Getting to Know LTE

LTE is Release 8 of the Third Generation Partnership Project (3GPP) and updates networks from 3G to 4G technology. LTE specifies a new, OFDMA-based air interface, which will require operators to deploy new base stations with higher-bandwidth backhubs. New end-user devices will also be required to take advantage of the new technology. LTE operates in a number of frequency ranges including the 700 MHz range, which was recently auctioned to carriers in the U.S.

The LTE standard reached the functional freeze milestone in March 2008 with official ratification expected in December 2008. LTE test equipment has been shipping from several vendors since early 2008. Motorola demonstrated a working system at Mobile World Congress 2008.

GSM operators around the world are adopting LTE, such as Verizon and AT&T in the U.S.; France Telecom, T-Mobile and Vodafone in Europe; and NTT DOCOMO and China Mobile in Asia. Along with WiMAX, LTE has been formally endorsed by the CDMA Group, with Verizon, the largest CDMA provider, announcing plans to adopt the technology.

LTE's Progress So Far

LTE is three years behind mobile WiMAX in terms of standardization; however, vendors in the U.S., Europe and China have already begun testing pre-standard LTE equipment. An early test by Nokia in Berlin achieved system peak throughput of 173 Mbps while NTT DOCOMO's Super3G (which included some proprietary antenna technology) recently delivered 250 Mbps in a test setting.

Commercial availability for LTE is forecast for 2010, and a complete conversion to LTE will take several years, as carriers start with dense urban areas and then expand into suburban and rural areas.

Unique Advantages of Each 4G Technology

While they have similar goals—providing the next evolution of mobile broadband connectivity—each of the two 4G technologies maintains unique competitive advantages over the other:

WiMAX's Competitive Advantages

- **Time to market:** There are already over 100 mobile WiMAX networks operational, and an ecosystem of networking equipment is available. In contrast, the LTE specification will not be ratified until fall of 2008, and no provider has set a firm date for commercial availability.
- **Support for fixed and mobile use:** WiMAX is a single worldwide standard for both fixed and mobile deployments, allowing operators a quicker rollout based on the expectation of multiple revenue streams to cover their deployment costs.
- **Integrated Wi-Fi/WiMAX chipsets:** Intel will be shipping Centrino 2 chipsets this fall, resulting in pre-integrated notebooks and handhelds that can switch between WiMAX and Wi-Fi networks. Intel's Centrino effort in 2003 was considered central to the subsequent growth in public Wi-Fi. A market seeded with tens of millions of WiMAX-ready devices would give operators confidence in seeing early and sizable revenues from their new networks.
- **Lower deployment costs for new entrants:** Since LTE is really a set of added capabilities to existing 3G systems, it is prohibitively expensive for new entrants to build an LTE network from scratch. New mobile providers such as cable companies and fixed-line carriers will probably choose WiMAX in order to get to market with a reasonable investment.
- **Open system:** WiMAX is based on open standards that allow for an ecosystem of chip, device, equipment and service providers to develop organically, much in the same way the PC, Ethernet and Wi-Fi industries evolved. The innovation such a system can deliver will be set against the huge resources and installed base of the world's incumbent mobile operators.

LTE's Competitive Advantages

- **3G compatibility:** LTE is the logical evolution of GSM—and GSM carriers dominate today's mobile world. 3GPP Release 8 requirements include seamless handoff to 3G cells.
- **Speed:** Once delivered, LTE should deliver much higher download speeds than the current WiMAX standard. This speed advantage will only be captured if the bandwidth of the base station backhaul is upgraded beyond the T1/E1 speeds that currently dominate. Also, this performance lead may be short-lived, as the IEEE 802.16m standard, due to be ratified in 2010, is targeting 1 Gbps peak throughput and requires WiMAX compatibility.
- **Lower deployment costs for incumbent mobile operators:** Besides leveraging a mobile operator's existing 3G infrastructure, LTE uses lower frequency bands than WiMAX, resulting in greater range and more users covered per base station.
- **Better in-building penetration:** The lower frequencies used by LTE penetrate buildings better than the frequencies in which WiMAX networks operate, which may make the use of femtocells necessary to deliver high-speed WiMAX indoors.

WiMAX vs. LTE

	Mobile WiMAX	LTE
Specification	IEEE 802.16e (2005)	3GPP Release 8 (due 12/2008)
Commercial availability	Today	2010 (estimate)
Peak throughput	70 Mbps download and 70 Mbps upload	Specifies up to 326 Mbps download and 84 Mbps upload
Downlink technology	OFDM	OFDM
Uplink technology	OFDM	SC-FDMA
Frequency	2.3, 2.5, and 3.5 GHz	Various: 700 MHz – 2.5 GHz
Quality of Service (QoS)	Yes	Yes

So Which Standard Will Win Out?

It is unlikely that one technology will win outright in the global marketplace, and predictions of long-term market share vary widely. iPass believes that mobile WiMAX and LTE will each succeed, dominating different regions and competing vibrantly in some as well.

Because LTE is a natural evolution of GSM, it will eventually replace 3G technologies in those areas of the world where operators have a large and lucrative user base—primarily in Europe. The endorsement of the CDMA Group also means that other CDMA-based operators (in the Americas and Asia) may follow Verizon's lead in adopting LTE.

WiMAX, on the other hand, has great potential in developing markets where there is little or no mobile data infrastructure to leverage. Likewise, WiMAX is attractive for those who live and work in rural or hard-to-reach areas, where providers haven't yet deployed 3G, cable, DSL or fiber. For instance, AT&T, an LTE adopter, has announced it will use WiMAX to provide fixed services in rural locations. Also, cable operators who have millions of subscribers and substantial bandwidth in place will look to WiMAX as a way to deliver additional services to their customers without having to build a 3G infrastructure.

Beyond the Current Battle

Beyond LTE and WiMAX, there is the battle over the 802.16m standard, for which the IEEE has requested technology proposals. The 3GPP is working on an LTE Advanced specification while the WiMAX Forum has a WiMAX II proposal. The goal of the standard is to deliver 100 Mbps to users in motion and 1 Gbps to stationary users, along with backwards-compatibility to the 802.16e (mobile WiMAX) standard. There is hope that this effort may lead to the unification of LTE and WiMAX into a single standard, but it is still too early to tell.



Planning an Enterprise Mobility Strategy for a 4G World

4G will usher in an era of pervasive mobility that will change the way people interact with one another while they are on the move. What should IT leaders do today in anticipation of the 4G technology shift? While companies may not deploy 4G on a broad basis until 2009 or 2010, now is the time for them to create their 4G mobility strategy to allow adequate runway for solution development, testing, and deployment.

Next, we provide a few planning recommendations for consideration:

- **Need mobile video or VoIP?** Since video, VoIP and tele-presence are key new capabilities enabled by 4G, CIOs must assess how these apply to their business and IT strategy, and how the importance of each changes as they become available to mobile workers.
- **Understand users' mobility patterns:** Many companies don't understand how their mobile users get work done. While data from telecoms vendors can be helpful in determining when, where, and how usage occurs, these should be supplemented with market research in the form of online surveys and telephone or face-to-face focus groups. Key questions should include how usage changes by department and role, which users are fixed versus in motion, whether their usage locations are urban, rural, or mixed, what applications are used, how much bandwidth each segment is likely to consume, and what is the maximum allowable latency. This data should be used to create a user profiles for which technologies, applications and policies can be developed.
- **Think globally:** As we've discussed, WiMAX and LTE will evolve differently across geographies and we cannot count on the current fragmentation in 3G between GSM and CDMA to be resolved in the near-term. Companies will have to decide between standardizing on a single technology at the risk of disenfranchising some users versus taking on added complexity of multiple standards.
- **Look for complementary applications:** 4G speeds provide the opportunity of using it to replace landlines in applications such as branch office networking, tele-working, business continuity/disaster recovery, remote telemetry and security monitoring. In addition, there may be multimedia e-commerce applications for a company's mobile-savvy consumers or business buyers that lead to revenue opportunities for your company.
- **Get hands on:** One should conduct hands-on testing of both WiMAX and LTE to get a feel for real-world performance and issues, as well as trial existing 3G services to establish a benchmark for these new services, as some of a company's needs may be met by existing technology.
- **Make a map:** Work with candidate vendors to determine a preliminary roadmap for service delivery. Factors for rollout timing include a projection of network deployments and subscription costs, the evolution of mobile computing platforms likely to be enabled by these high speeds, and the business impact of various applications on different employee types.
- **Plan conservatively:** Optimistic forecasts from telecoms vendors on time to deploy, performance and costs should be appropriately hedged, and then companies should trial, learn and adjust their roadmaps to face the real-world outcomes. Initial experiences with a pilot program will allow making early (and thus less expensive) adjustments to plans.
- **Don't get locked into a single solution:** Operators are prone to push the technology in

which they have made their investments and recommend it as the answer to all customer needs. Companies should take a strategic, independent approach and consider a complete portfolio of technologies and make sure that they have a clear understanding of a vendor's plans to open their networks to the broad set of devices that 4G will enable.

Conclusion

4G technologies have the potential to create industry-wide innovation and significant enterprise value. At iPass, we believe these wireless broadband technologies combined with increased provider competition for roaming users will create a world of more open and affordable access.

A long-time leader in enterprise mobility, iPass prides itself on being technology-agnostic. As we have blended together dial-up, Wi-Fi, Ethernet and multiple 3G technologies into a unified fabric, we intend to support both WiMAX and LTE as well. We are uniquely positioned to quickly add these to our global virtual network in an enterprise-ready fashion that can be easily managed by the enterprise. Our software-based platform gives us the flexibility to embrace any network or device type and add substantial value by helping customers take control of their increasing mobile diversity.

About iPass

iPass unifies mobility management for global enterprises. Our services combine worldwide remote and mobile broadband access with comprehensive management control over connectivity, devices and costs. iPass customers benefit from a single global solution that easily integrates with existing systems, simplifies IT management and reduces overall connectivity expenses. More than 3,500 enterprises and more than 400 Global 2000 companies rely on award-winning iPass services.

The company has been recognized as a leader in Mobile Device Management by IDC in 2007. iPass is headquartered in Redwood Shores, California, with offices in North America, Europe and Asia.

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¹ Phillip Redman. *First WiMAX World Congress Draws Global Support But Challenges Remain*. Gartner Research. July 11, 2008.

² Paul Taylor. *Battle Lines Are Drawn for the Future of 4G*. FT.com. February 13, 2008.

³ Jacqueline Emigh. *Clearwire Launches New WiMAX Beta in Portland, Oregon*. BetaNews. July 10, 2008.

