



# Broadband Wireless: The New Era in Communications

---

Intel in  
Communications



## Contents

---

<b>Summary/Abstract</b>	<b>2</b>
<b>The Road to Wireless</b>	<b>3</b>
<b>What is Broadband Wireless?</b>	<b>3</b>
<b>The Mobility Goal: Always Best-Connected</b>	<b>4</b>
<b>Enabling the Revolution</b>	<b>4</b>
Technology Leadership	5
Wireless Silicon	5
<b>Success Metrics</b>	<b>6</b>
<b>Conclusion</b>	<b>6</b>

---

### Summary/Abstract

There's no doubt the world is going wireless – faster and more broadly than anyone might have expected. In this visionary paper, Intel demonstrates this new reality and predicts that billions of people will gain high-speed Internet access – wirelessly – within the next decade.

The premise for this vision is clear: all high-speed wireless technologies (3G, Wi-Fi\*, WiMAX and Ultra-Wideband) will coexist, working in tandem to meet service provider and customer needs for truly mobile computing and communications across the globe. No single technology will become dominant or ubiquitous – they all meet unique user requirements in a wirelessly connected world. In fact, the most robust wireless solutions will use a combination of technologies to enable increased mobility and eventually seamless roaming.

Intel wholeheartedly embraces the march to wireless, and is enabling the revolution through industry leadership, technology development, and new silicon products. From Intel® Centrino™ mobile technology to WiMAX technology to Intel PXA processors, you'll find Intel at the forefront of the broadband wireless revolution. Read the complete paper to learn more.

## The Road to Wireless

The transition to wireless really started during the Internet revolution. What began as an exchange mechanism for electronic data has sparked worldwide demand for anytime/anywhere computing and communications.

The advent of Wi-Fi technology and hotspots is only beginning to meet this need. Offering portable Internet access, hotspots provide connections to users *within a limited range of an access point*. Although hotspots extend the reach of the Internet, they still tether users at a fixed location. Meanwhile, many users want mobile access – the ability to retain their high-bandwidth Internet connection even as they freely move about their lives.

It's this demand for mobility that will continue to fuel convergence and transform the communications industry. To that end, Intel and other industry leaders are developing new wireless standards that will expand and extend the reach of wireless networks across the globe. Meanwhile, carriers have slowed expansion of the fiber network in anticipation of new wireless technologies. And engineers are focusing new development on the products and services that will enable broadband wireless communications on a wide scale.

In fact, so much momentum is being generated around wireless communications that Intel Executive Sean Maloney has defined the next decade as the "Broadband Wireless Era." He predicts that broadband wireless presents the most viable opportunity to improve communications for the 1 billion people that currently enjoy Internet access and to newly connect the next 5 billion users.

## What Is Broadband Wireless?

So what is "broadband wireless" anyway? Intel defines it as a continuum of co-existing, overlapping technologies that enable wireless high-speed communications. Wi-Fi, WiMAX, 3G and Ultra-Wideband (UWB) technologies each are necessary to form the global wireless infrastructure needed to deliver high-speed communications and Internet access worldwide.

While Wi-Fi is ideal for isolated "islands" of connectivity, WiMAX and 3G are needed for long distance wireless "canopies." Meanwhile, WiMAX and 3G are both required because their optimum platforms differ: WiMAX works best for computing platforms, such as laptops, while 3G is best for mobile devices like PDAs and cell phones. UWB offers very short range connectivity, perfect for the home entertainment environment or wireless USB. In short, each technology is important for different reasons. (See corresponding chart and technology sidebar.)

"It's not a case of one technology becoming universal, or one technology replacing another," explains Sean Maloney, Executive Vice President and General Manager, Intel Communications Group. "All of the wireless networks will get built out for different usages, with some overlap at the edges. But most importantly, the technologies will co-exist, creating more robust solutions that will enable a lot of new and exciting possibilities."

In essence, the term "broadband wireless" encompasses the full range of wireless technologies and applications – both fixed and mobile.

Technology	Standard	Usage	Throughput	Range	Frequency
■ UWB	802.15.3a	WPAN	110-480 Mbps	Up to 30 feet	7.5 Ghz
■ Wi-Fi*	802.11a	WLAN	Up to 54 Mbps	Up to 300 feet	5 Ghz
■ Wi-Fi	802.11b	WLAN	Up to 11 Mbps	Up to 300 feet	2.4 Ghz
■ Wi-Fi	802.11g	WLAN	Up to 54 Mbps	Up to 300 feet	2.4 Ghz
■ WiMAX	802.16d	WMAN	Up to 75 Mbps (20 Mhz BW)	Typical 4-6 miles	Sub 11 Ghz
■ WiMAX	802.16e	Mobile WMAN	Up to 30 Mbps (10 Mhz BW)	Typical 1-3 miles	2-6 Ghz
■ WCDMA/UMTS	3G	WWAN	Up to 2 Mbps (Up to 10 Mbps with HSDPA technology)	Typical 1-5 miles	1800, 1900, 2100 Mhz
■ CDMA2000 1 x EV-DO	3G	WWAN	Up to 2.4 Mbps (typical 300-600 Kbps)	Typical 1-5 miles	400, 800, 900, 1700, 1800, 1900, 2100 Mhz
■ Edge	2.5G	WWAN	Up to 348 Kbps	Typical 1-5 miles	1900 Mhz

Technology	Description
■ Wi-Fi	<p>Short for wireless fidelity, Wi-Fi technologies include the approved IEEE 802.11a, b and g specifications, as well as the yet-to-be-ratified 802.11n specification. Wi-Fi is the first high-speed wireless technology to enjoy broad deployment, most notably in hotspots around the world – including homes and offices, and increasingly cafes, hotels, and airports. Wi-Fi hotspots became popular almost immediately and have been applauded by road warriors for their ability to improve productivity. Wi-Fi is limited, however, by its range: high-speed connectivity is possible only as long as a user remains within range of the wireless access point, which is optimum within 300 feet.</p> <p>Wi-Fi was one of the earliest high-speed wireless data technologies and now benefits from a broad availability of supporting products and technologies. Intel Centrino mobile technology optimizes performance in mobile data platforms, helping users get the most from the expanding Wi-Fi infrastructure. Some of the newest platforms even support multiple Wi-Fi standards (e.g. 802.11a, b and/or g) for compatibility among several wireless networks.</p>
■ WiMAX	<p>WiMAX is an emerging technology that will deliver last mile broadband connectivity in a larger geographic area than Wi-Fi, enabling T1 type service to business customers and cable/DSL-equivalent access to residential users. Providing canopies of coverage anywhere from one to six miles wide (depending on multiple variables), WiMAX will enable greater mobility for high-speed data applications. With such range and high throughput, WiMAX is capable of delivering backhaul for carrier infrastructure, enterprise campuses and Wi-Fi hotspots.</p> <p>WiMAX will be deployed in three phases. Phase one will see WiMAX technology using the IEEE 802.16d specification deployed via outdoor antennas that target known subscribers in a fixed location. Phase two will roll out indoor antennas, broadening the appeal of WiMAX technology to carriers seeking simplified installation at user sites. Phase three will launch the IEEE 802.16e specification, in which WiMAX-Certified* hardware will be available in portable solutions for users who want to roam within a service area, enabling more persistent connectivity akin to Wi-Fi capabilities today.</p>
■ 3G	<p>3G is an ITU specification for high-speed wireless communications. This worldwide wireless connection is compatible with GSM, TDMA, and CDMA. Next-generation 3G cellular services will provide a long-range wireless access canopy for voice and data. Carriers worldwide are now in the process of deploying 3G network infrastructure across urban, suburban and highly trafficked rural areas.</p> <p>Next-generation 3G cellular services will create broad-range coverage for data access across wide geographic areas, providing the greatest mobility for voice communications and Internet connectivity. 3G services will enable highly mobile users with laptops and other wireless data devices to bridge the gap between higher bandwidth WiMAX hot zones and Wi-Fi hotspots.</p> <p>New devices optimized for 3G communications are beginning to reach the marketplace. Such devices include cell phones that can also provide interactive video conferencing, as well as PDAs that can provide full-playback DVD services. 3G technologies are designed to provide the greatest mobility and are intended for devices whose primary function is voice services with additional data applications as a complement to those services.</p>
■ UWB	<p>Ultra-Wideband (UWB) is a future wireless personal area network (WPAN) technology capable of high throughput (up to 400Mbps) at very short range (less than 30 feet). UWB will likely be utilized to enable wireless USB access for connecting computer peripherals to a PC and multiple components in the consumer electronics stack – e.g. home theater equipment. UWB has the throughput capability to simultaneously distribute multiple high definition video streams.</p> <p>Intel engineers are working with a variety of industry leaders to develop a standard UWB radio platform. Made up of two core layers – the UWB radio layer and the convergence layer – the UWB platform will serve as the underlying transport mechanism for different applications that would operate on top of the single radio, such as wireless universal serial bus (USB), IEEE 1394, the next generation of Bluetooth* and Universal Plug and Play*.</p>

## The Mobility Goal: Always Best-Connected

As computing and communications converge on broadband wireless platforms and technologies, demand will soar for true mobility. When that happens, Intel and other industry leaders must be ready to deliver the technologies, infrastructure, devices and services that enable users to stay connected through the best available technology even as they move about their lives – across the room, across the street, and across the globe.

This is the always best-connected goal, where broadband technologies such as 3G, UWB, Wi-Fi and WiMAX will work synergistically to deliver secure data with anytime, anywhere connectivity. These overlapping wireless networks will offer users choices for the best possible connection. In fact, the mobility enabled by wireless technology necessitates overlap between networks and co-existence among technologies – wired and wireless.

Intel expects broadband wireless to reach the always best-connected goal through the following scenario:

- ✓ All types of wireless networks will be deployed around the globe.
- ✓ Wi-Fi hotspots will proliferate in public places, businesses and homes.
- ✓ Homes and businesses will add UWB (when available) for the fastest distribution of high-definition content.
- ✓ First-generation WiMAX technology will be broadly deployed to provide long distance broadband connectivity for Wi-Fi hotspots, as well as cellular and enterprise backhaul.
- ✓ Later, 802.16e WiMAX connectivity will be added in densely populated areas to provide a canopy of wireless broadband data access to mobile laptop users.
- ✓ Innovations in 3G technologies will add groundbreaking data capabilities to mobile handset and handheld PC users.

The always best-connected scenario predicts that users will mix and match mobile platforms and wireless technologies to meet their unique requirements, enabling them to stay connected virtually anytime and anywhere. Some developers will likely integrate multiple wireless technologies into their mobile platforms to maximize user ability to stay connected.

It should be noted, however, that always best-connected does not mean that wired access will disappear. In fact, wired technologies will continue to be important, as it would be difficult to imagine the entire world's computing infrastructure operating

without Gigabit Ethernet. Ethernet and other wired technologies such as InfiniBand\* and Fibre Channel play a vital behind-the-scenes role in the infrastructure enabling wireless connectivity as well as providing the fastest available connection option to the mobile platform users.

## Enabling the Revolution

Fuel for the broadband wireless revolution is coming from consumers and businesses worldwide who increasingly expect to enjoy wireless computing and communications anytime, anywhere. It will require a virtual plethora of solutions – technologies, components, platforms, infrastructure and services – to meet this demand. Not since the early days of the Internet era have there been so many new revenue-generating opportunities.

It's time for the communications industry to join together and fully embrace the broadband wireless era. To that end, Intel continues to commit significant resources to the development of technologies and building blocks, the creation of an industry ecosystem, and to the promotion of end-user awareness. Intel's efforts are helping to foster the environment necessary for worldwide proliferation of broadband wireless solutions.

### Technology Leadership

Intel is working to create an end-to-end wireless architecture that fulfills the customer experience for seamless and simple wireless connectivity. Intel will drive this result through platform integration of advanced Intel wireless communications technologies, such as seen with the integration of Intel PRO/Wireless WLAN Controllers in the Intel Centrino mobile technology platform. Intel will continue to work with a growing community of developers to develop building blocks and will deliver expertise in associated RF technologies to ensure that the always-best connected vision becomes a reality.

Intel has taken the lead in important research and development organizations, such as IEEE\*, Singapore IDA, Intel Roaming Architecture Program, IETF, 3GPP, 3GPP2, and the SDR Forum. Intel provided engineering leadership for the development of important new standards, all of which are important foundation elements for broadband wireless solutions: WiMAX, Wi-Fi, and AdvancedTCA, for example. Intel is also helping develop future technologies, such as 802.11n, 802.16e, and potential UWB specifications, such as MBOA and/or 802.16.3a.

When wireless standards are broadly adopted by the industry, time- and cost-saving benefits can be optimized throughout the supply chain. To that end, Intel is helping the industry move toward a modular platform approach to infrastructure and device development. Modular platforms enable broad design reuse, reduced spares, decreased capital expenditures, lower operating costs, and faster time to market for all suppliers. It's an approach that has already been embraced by most major manufacturers in the telecommunications industry.

### Wireless Silicon

Innovative Intel processors and chipsets are helping OEMs create new laptop, handheld and mobile phone platforms that can deliver services based on one or more wireless technologies. Other Intel silicon components are being designed for the new infrastructure equipment required for Wi-Fi and WiMAX networks. Together, these building blocks will enable significant progress in the trend to broadband wireless. These solutions will be followed by a long and comprehensive silicon roadmap to meet the needs of all segments in the broadband wireless industry.

**Intel Centrino Mobile Technology:** Now enjoying its second year of worldwide popularity and success, Intel Centrino Mobile Technology was the first silicon solution designed for mobile and wireless platforms. It remains the fastest-growing silicon technology in Intel's history, adopted by manufacturers and demanded by consumers for its ability to extend battery life and enable unwired computing.

**Intel PXA Processor Family:** The newly launched Intel PXA processor family can handle multiple forms of wireless broadband access with enough computing power to provide cell phones with full motion video conferencing capabilities and PDAs with DVD-quality video playback. They include new technologies designed to meet the multimedia, low power and security requirements of wireless handheld platforms.

In addition to higher processing power, new technologies in the Intel PXA processor family include the next-generation of stacked packaging for added flash memory, a new multimedia accelerator for 3D rendering, optimized software and reference designs that allow cell phone and PDA makers to bring Intel-based mobile devices to market faster.

**Intel PRO/Wireless WLAN Controllers:** The Intel PRO/Wireless family of networking controllers provides wireless LAN connectivity compliant with the 802.11 (Wi-Fi) wireless LAN specifications. Intel PRO/Wireless WLAN controllers are an integral part of the Intel Centrino mobile processor platform and offer the latest in WLAN

networking features. Intel will also introduce products for the 802.16 (WiMAX) wireless MAN specifications as part of the Intel PRO/Wireless family of products in late 2004.

**Infrastructure Silicon:** Intel is designing silicon that will power the full range of necessary platforms in the broadband wireless infrastructure, including access points, carrier-class base stations, PICO base stations, outdoor customer premises equipment, indoor and/or portable equipment, and mobile client platforms. Intel IXA network processors can be found in multiple Wi-Fi platforms today, while future infrastructure solutions based on the AdvancedTCA standard will be used throughout the carrier network, including Node-Bs, radio network controllers, WiMAX base stations, and more.

## The Intel® Communications Alliance

Already, more than 150 companies have aligned with Intel to deliver the global vision for broadband wireless communications. These members of the Intel Communications Alliance are developing technologies, components, and products that will provide the landing points and infrastructure for global, wireless, high-speed communications.

Members of the Intel Communications Alliance are aligned on two levels:

- Agree on the vision to connect the world's 5 billion unconnected via wireless technology and deliver always best-connect broadband wireless connections to the 1 billion people who already enjoy the fruits of Internet access.
- Support the architectural strategy to build silicon and platforms using industry standards and modular designs. Collaborate on sales and marketing programs to bring complete solutions (TEMs supply the solution to carriers, Intel/ICA supply building blocks) to the telecommunications supply chain, for faster deployment of new services and more satisfied customers worldwide.



A community of communications and embedded developers and solution providers

## Success Metrics

Before the Broadband Wireless Era can deliver on its promises, the entire communications industry must embrace the notion that coexisting, standards-based technologies are the right strategy. In addition, those standards must be delivered via modular, cost-effective platforms that will enable greater innovation and interoperability. As the industry works together to conform to standards, the global supply chain benefits:

- Common design criteria will allow products from multiple vendors to work together in a solution.
- Broader market enables mass production, leading to lower costs and worldwide economies of scale.
- Proliferation of mobile computing devices built on common architectures creates fast and easy opportunities to launch new services; faster time-to-profit, quicker time-to-market.
- Faster pace of innovation when multiple vendors compete for revenue opportunities.
- Greater emphasis on service capabilities and applications as vendors focus on differentiation; reduced reliance on proprietary components/designs.
- Standards compliance and interoperability will create new worldwide market segments for platforms and solutions.

## Conclusion

At the end of the Broadband Wireless Era, billions of people worldwide will be communicating wirelessly using devices and services not yet designed. Many of these people will have access to multiple technologies that will allow them choices for an always best-connected advantage.

Intel and the members of the Intel Communications Alliance are helping define the Broadband Wireless Era through innovative, wireless-optimized silicon building blocks and platforms, collaboration with other industry leaders on technology and infrastructure design, and the development of new standards.

What remains is for the entire industry to embrace the broadband wireless vision – coexisting wireless technologies and standards-based modular platforms – delivering all solutions with an eye toward high-speed global connectivity. Can you see it?

**For More Information:**

Broadband Wireless

<http://www.intel.com/netcomms/bbw>

WiMAX Broadband Access Technology

<http://www.intel.com/go/wimax>

Wi-Fi\*

<http://www.intel.com/products/mobiletechnology/prowireless.htm>

3G Infrastructure

<http://www.intel.com/go/mcp>

Intel® Centrino™ Mobile Technology

[http://www.intel.com/personal/do\\_more/wireless/going.htm](http://www.intel.com/personal/do_more/wireless/going.htm)

3G Handhelds and Handsets

<http://www.intel.com/design/pca/intro/wirelessmobility.htm>

Ultra-Wideband

<http://www.intel.com/technology/ultrawideband/>

Intel® Communications Alliance

<http://www.intel.com/design/network/ica/indx.htm>

Information in this document is provided in connection with Intel products. No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted by this document. Except as provided in Intel's Terms and Conditions of Sale such products, Intel assumes no liability whatsoever, and Intel disclaims any express or implied warranty, relating to sale and/or use of Intel products including liability or warranties relating to fitness for a particular purpose, merchantability, or infringement of any patent, copyright or other intellectual property right. Intel products are not intended for use in medical, life saving, or life-sustaining applications. Intel may make changes to specifications and product descriptions at any time, without notice.

Wireless connectivity and some features may require you to purchase additional software, services or external hardware. Network system performance, wireless performance and functionality will vary depending on your specific wireless network plan, environment, operating system, hardware and software configurations.

Intel, Centrino and the Intel logo are trademarks or registered trademarks of Intel Corporation or its subsidiaries in the United States and other countries.

\*Other names and brands may be claimed as the property of others.

Copyright © 2004 Intel Corporation. All rights reserved. 0504/QUA/RH/HG/PDF

Please Recycle 

302026-001

