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**Intel in
Communications**

Accelerating Wireless Broadband

Sparking New Competition in Broadband Through the IEEE* 802.16 WirelessMAN Specification

Broadband has been a long time coming, and for most people it's still not here yet. At the close of 2002, just 46 million subscribers worldwide had broadband (In-Stat/MDR*). In the U.S., only 17 percent of households were connected. What's the holdup?

Apparently, the problem isn't demand. It's supply. People can't or don't connect with DSL or cable because:

- They're out of reach of DSL services (too far from the central office)

- They're not part of the residential cable infrastructure (a problem for many businesses)

- They think it's too expensive (both getting connected and the monthly service fee)

More competition could help. Something new to drive down costs and enable homes and businesses to connect quickly and painlessly. The solution? Broadband wireless access.

"We feel that 802.16 holds the promise to provide a viable third pipe, a wireless alternative to cable and DSL." (Margaret LaBrecque)

Through a series of phone interviews with WiMAX* president Margaret LaBrecque (Director of Industry Programs for Intel's Broadband Wireless Division) and Intel engineer DJ Johnston, (802.16 member and chair of the IEEE* 802 Handoff Study Group), we got the inside scoop on how 802.16 and WiMAX* will standardize and promote this crucial competitor to DSL and cable.

Closing the Gap with Broadband Wireless Access

The new IEEE* 802.16 standard defines the Wireless MAN (metropolitan area network) air interface specification. This broadband wireless access standard supplies the missing link for the last mile connection in wireless metropolitan area networks. It figures to be a strong competitor to either of its wired counterparts (cable and DSL) because it's simpler to implement, scalable and more flexible.

With 802.16, businesses and residences have a new, faster way to add broadband service. A corresponding acceleration in the deployment of 802.11 hotspots throughout metropolitan areas should also follow. Why? Because in the cases where it's difficult to get wired service (DSL or cable), you'll be able to connect wirelessly instead. Even when DSL is available, sometimes it takes too long to get service from the local telephone company.

Example of an 802.16-style base station on the Prudential* Tower in Boston.

Faster-to-deploy wireless service will be possible through 802.16 compliant equipment that enables access over a broad section of a metropolitan area.

The Importance of 802.16 in Driving Down Costs

Broadband wireless access isn't new. According to Margaret, there are 2,400 wireless ISPs in the United States serving over 6,000 markets. The problem is they use expensive, proprietary equipment that's not interoperable with equipment from other vendors. Lack of standards has limited the usefulness of the technology and made it hard for broadband wireless access providers to be competitive and profitable.

Margaret LaBrecque is the Director of Industry Programs for Intel's Broadband Wireless Division. At Intel since 1994, she has been involved with the development of Intel platforms to support high speed connectivity delivered via datacasting, Ethernet, cable modem and wireless. She was recently elected President of WiMAX* Forum, the World Interoperability for Microwave Access forum which advocates the IEEE* Standard 802.16 WirelessMAN global specification

What 802.16 will do is provide definitive standards for a carrier-class solution that can scale to support thousands of users with a single base station and provide differentiated service levels. For instance, a single base station sector can provide enough data rate to simultaneously support more than 60 businesses with T1-type connectivity and hundreds of homes with DSL-type connectivity.

By enabling standards-based products with fewer variants and larger volume production, 802.16 will drive the cost of equipment down. Having standardized equipment will also encourage competition, making it possible to buy from many sources. For areas poorly served by a wired infrastructure, such as many developing countries, 802.16 will be very important both for its ease of implementation and low cost.

Enabling Cellular-Style Roaming

The original 802.16 standard operates in the 10–66GHz frequency band and requires line of sight towers. An 802.16a extension, ratified in January, uses the lower frequency of 2–11GHz enabling non-line of sight connections. This constitutes a major breakthrough in broadband wireless access because no longer do you have to have line-of-sight between your transmission point and the receiving antenna. With 802.16a, operations will be able to connect more customers to a single tower and substantially reduce service cost.

"With 802.11, if you move out of a building, you're going to lose your connection. With 802.16e, you are going to have the kind of connectivity you have with a cell phone." (DJ Johnston)

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The 802.16e task group is capitalizing on the new capabilities this provides by working on developing a specification to enable mobile 802.16 clients. These clients will be able to hand off between 802.16 base stations, just as cell phones do

Mesh Networking in 802.16

A newly formed group within 802.16, the Mesh Ad Hoc committee, might help improve the coverage of base stations even more. Mesh networking allows data to hop from point to point, circumventing obstacles such as hills. A small amount of meshing can bring a large improvement in the coverage of a single base station. If this group's proposal is accepted, they could become Task Force F and develop an 802.16f standard.

Seamless Roaming Between Networks

Another group within the IEEE* addressing roaming is the IEEE* 802 Handoff Study Group, chaired by DJ. This group is chartered to look at handoff between heterogeneous 802 networks.

The key here will be enabling the "hand-off" procedures that allow a mobile device to switch the connection from one base station to another, from one 802 network type to another (such as from 802.11b to 802.16), and even from wired to 802.11 or 802.16 connections. The goal, according to DJ, is standardizing the hand-off so devices play together nicely as they move from one network type to another.

Today, 802.11 users can move around a building or a hotspot and stay connected. Leave the building or the hotspot, they lose their connection. With 802.16e that will change. Users will be able to expect the kind of connectivity you have with a cell phone, only with data as well as voice. What's more, having a standard will allow equipment vendors to easily make 802.16 systems that interoperate with other 802.16 systems, without having to address the whole system from top to bottom. DJ foresees the day when having either 802.16e capabilities embedded in your PDA or notebook (or added through an 802.16e-enabled card) enables you to remain connected all the time within an entire metropolitan area. For example, your notebook could connect via Ethernet or 802.11 when docked and stay connected with 802.16 when roaming the city or suburbs.

DJ Johnston is an Intel engineer at the Computing and Interconnect Lab (CITL) in CTG. He currently works on the 802.16e standard for adding mobility capabilities to 802.16. He also chairs the IEEE* 802 Handoff Executive Committee Study Group that is seeking to enable devices to hand off between networks, either across administrative domains or between networks

"802.16 is very flexible. You can allocate different quality of service or delivery systems. That's very appealing to providers. If they want to sell you a megabit worth of data, then they can do that." (DJ Johnston)

Flexible and Scalable

According to Margaret, 802.16 will also provide an important advantage to new businesses or ones that move their operations frequently, such as a construction company with offices at each building site. Instead of waiting weeks for a T1 or DSL line, broadband wireless access can be quickly and easily set up at new and temporary sites.

Another 802.16 benefit is scalability. Imagine hundreds of hot spot users at a five-day conference trying to access the network. Accessing the local network would be no problem since 802.11 has plenty of bandwidth within the LAN (local area network). But what if those users want to simultaneously access the Internet, or hook up to their corporate network via VPN? The hotel might have a single T1 connection for servicing its "typical" broadband connectivity use; however, for those five days, it needs a lot more bandwidth. With broadband wireless access, it's easy to ramp up service at a location for a short period of time—something phone companies currently don't do.

of different types. DJ joined Intel in February. He previously worked at Mobilian, developing multi-standard LAN/PAN devices and becoming active in IEEE 802.11.

The Role of WiMAX*
One thing Margaret points out is the shaky start that 802.11 got because 802.11 equipment came out before there was an interoperability body in place. Back then, one vendor's 802.11 network adapter card would not work with another vendor's 802.11 access point. IEEE* does standards, but they stop there. They don't have a process for driving conformance, compliance and interoperability. Not wanting to repeat that mistake, Intel and a number of other leading communications component and equipment companies formed the non-profit corporation WiMAX Forum*.

"WiMAX* is the 802.16 equivalent to Wi-Fi* for 802.11." (Margaret LaBrecque)

This organization is charged with helping promote and certify the compatibility and interoperability of broadband wireless equipment. During the next year, WiMAX* will develop conformance test plans, select certification labs, and host interoperability events for 802.16 equipment vendors. The group will also work with the European Telecommunications Standards Institute (ETSI) to develop plans for HIPERMAN*, the European broadband wireless metropolitan area access standard.

The group's efforts should help accelerate the introduction of equipment adhering to the 802.16 standard. Margaret puts in more simply: "If we are successful, the first systems that are out of the chute that are 802.16a compliant will interoperate."

Why 802.16 Is Important to Intel
For Intel, 802.16 is part of our vision of a billion connected PCs. Margaret reminds us that Senior VP and CTO Pat Gelsinger recently pointed out that the biggest threat to Intel's core business is not competition from other silicon manufacturers, but from lack of broadband access deployment. Broadband access drives demand for more powerful computing devices, from laptops and PCs to cell phones and handhelds. Since broadband is the pipe that creates demand for rich applications that need a lot of processing power, 802.16 is an important standard for Intel to support and champion. Through WiMAX* and Intel's own broadband wireless technology efforts, the company is poised to play a big role in making a continuous broadband connection a reality for many more of us.

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Learn More

See the Intel press release on WiMAX* (www.intel.com/ca/pressroom/2003/0408.htm)

Visit the [WiMAX* Web site](www.wimaxforum.org) (www.wimaxforum.org)

Visit the) IEEE* 802.16 WirelessMAN Web site (http://wirelessman.org)