

SPRINT NEXTEL,
WITH PARTNERS
INTEL, SAMSUNG,
AND MOTOROLA,
WILL DRIVE MOBILE
WIMAX FLAVOR IN
US BROADBAND
DEPLOYMENT.

Both notebook-PC users and consumers carrying increasingly powerful smartphones or connected PDAs love wireless-data services. A clear gap exists, however, between relatively short-range wireless-LAN or Wi-Fi (Wireless Fidelity) networks and the wireless WANs that cellular carriers deploy. The cellular networks will never offer the bandwidth of Wi-Fi, and Wi-Fi won't scale to cover entire metropolitan areas. Mobile WiMax (Worldwide Interoperability for Microwave Access) technology, which complies with the IEEE 802.16e specification, can fill the gap—at least from a technology perspective (see **sidebars** “Mobile WiMax and the WiMax Forum” and “Fixed or mobile?”). Less certain is whether WiMax can achieve ubiquity across regions such as North America or even the world. Moreover, everyone from IC vendors to cellular carriers have a different view of WiMax's role both today and as the wireless world moves toward 4G networks.

WIMAX GAINS IN MOBILE-BROADBAND GAME,

BY MAURY WRIGHT • EDITOR IN CHIEF



BUT 4G lurks

Generally speaking, WiMax could achieve anything from spot success to nearly the reach of cellular networks. Presumably, it will offer mobile users a minimum of 1-Mbps services and perhaps 10-Mbps or even greater data rates. Today, WiMax or prestandard WiMax-like networks are serving in developing regions that often lack a wired network. In other instances, WiMax technology competes with cable and DSL (digital-subscriber-line) services. For instance, Clearwire is aggressively building what it terms a WiMax-class network in the United States. Founded by cellular pioneer Craig McCaw, Clearwire is in more than 30 US markets with more than 200,000 subscribers and is in all probability preparing for an IPO (initial public offering). The company matches DSL and cable prices and offers a service with 1.5-Mbps download speeds.

AT A GLANCE

WiMax will bridge the gap between Wi-Fi and 3G services, providing near the speed of the former and near the reach of the latter.

Proponents see WiMax as an open-standard wireless service unencumbered by subsidies and service contracts.

Integrated Wi-Fi and WiMax chip sets for notebooks will ensure that consumers don't have to choose between WiMax and 3G.

The main obstacle to portable WiMax devices may be the power that the silicon consumes, and the power amplifier may prove especially problematic.

Sprint Nextel, meanwhile, is planning to rapidly roll out WiMax across the United States. The combined Sprint

Nextel owns a 2.5-GHz frequency spectrum that the company claims will cover 85% of the households in the top 100 US markets. The company states that it will deploy a network delivering 2- to 4-Mbps rates that potentially could reach 100 million people by the end of 2008. But in the United States, Sprint is uniquely positioned with a widely available spectrum that it can use in a rapid buildup.

WHAT EXACTLY IS 4G?

Sprint's broad plans and Korea's decision to broadly deploy WiMax raise the question of whether WiMax has now become the leading technology candidate for 4G networks—becoming the successor to 3G cellular networks. Indeed, Sprint, Intel, Samsung, and Motorola have used the 4G label in press releases about their partnership and deployment plans. But executives are quick to avoid that term. "I don't want to be the first person who puts a definition on 4G," says Atish Gude, senior vice president of mobile-broadband operations at Sprint Nextel.

Joe Nardone, general manager of Intel WiMax Solutions, agrees, saying, "I hate the description of WiMax as 4G." With the money that Intel has spent backing WiMax, you would think that the company would welcome the 4G moniker and the early lead that WiMax appears to have over other potential 4G technologies. But the 4G label brings with it political, logistical, and technical issues.

Like 2G, 2.5G, and 3G before it, 4G implies an evolution of previous-generation services. A 3G phone will still support older networks, and you might have trouble even finding a 3G connection today in North America. Moreover, the two primary 3G networks have evolved in the CDMA (code-division-multiple-access) and GSM (Global System for Mobile-communications) camps, in each case layered on the 2G frequency bands and the progression of modulation schemes that each side developed. Mobile WiMax is in a significantly different band and uses OFDM (orthogonal-frequency-division-multiplexing) technology.

Some definitions of 4G embrace a dramatic departure from earlier cellular technologies. Peruse Wikipedia's definition of 4G, and you will find objectives such as 100-Mbps data rates and maximum spec-

MOBILE WIMAX AND THE WIMAX FORUM



WiMax (Worldwide Interoperability for Microwave Access) is the name that the industry

generally gives to technologies that the IEEE 802.16 standards group defines. The 802.16d standard defines a broadband-wireless scheme for subscribers in fixed locations. The newer 802.16e standard supports mobile-system subscribers. Both standards are broad and full of implementation options. The WiMax Forum is shepherding the technologies to market. The forum has carved out subsets of requirements the standards define to develop profiles such as the WiMax Forum Mobile System Profile. The WiMax Forum also develops conformity tests and certifies conforming products.

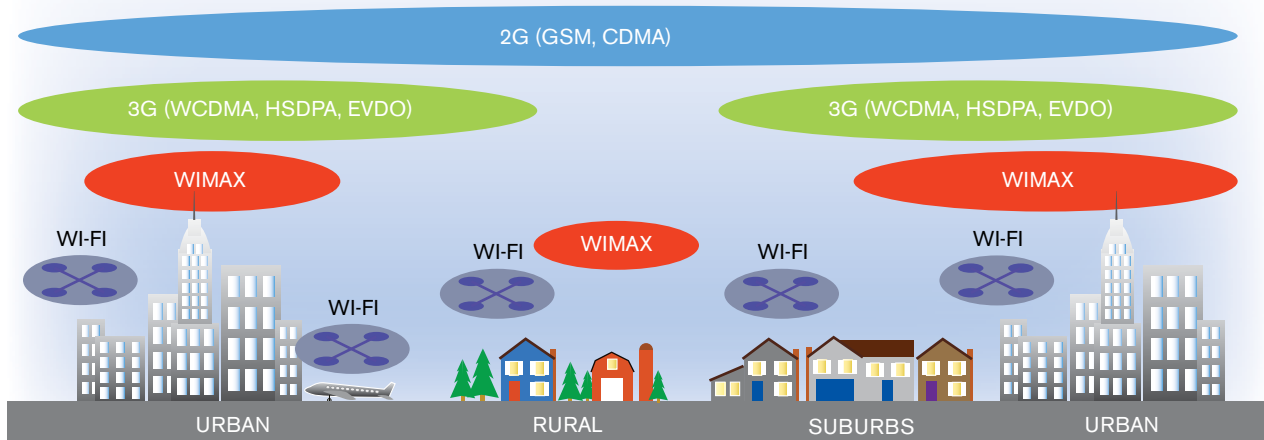
Developers of the fixed-WiMax flavor based it on OFDM (orthogonal-frequency-division-multiplexing) technology, which the industry generally recognizes for delivering maximum spectral efficiency (Reference A). Mobile WiMax uses a newer OFDMA (orthogonal-frequency-division-multiple-access) modulation scheme that includes MIMO (multiple-input-multiple-out-

put) technology. The mobile flavor offers greater immunity to multipath interference and includes methods for adapting changing channel conditions—a necessity in a mobile-system market. Mobile WiMax also includes the session management to hand off mobile-system users from one cell to another.

As in many areas, specmanship rules in wireless-WAN technologies. Many believe that Mobile WiMax is capable of 70-Mbps bidirectional data rates. The rate, however, depends on factors such as range and the wireless channel. Moreover, the standard allows service providers to trade off range and capacity or bandwidth. Early on, Mobile WiMax will typically deliver around 10-Mbps rates, and even that speed depends on the number of users in a cell. Sprint Nextel has stated that users on its network will get 2- to 4-Mbps rates.

REFERENCE

Wright, Maury, "WiMax wireless broadband: Fixed-flavor questions abound, mobile lurks," *EDN*, March 31, 2005, pg 44, www.edn.com/article/CA512128.



Differing perspectives have Mobile WiMax serving as the 4G successor to today's 3G cellular networks or as a symbiotic technology to cellular systems, with deployment across metropolitan areas but not along roadways between cities.

tral efficiency. Qualcomm has been a dissenting voice, but most experts agree that OFDM is requisite to achieving maximum spectral efficiency, specifically in bits per second per hertz. Moreover, Wikipedia clearly defines 4G as an IP (Internet Protocol) network, with features such as QOS (quality of service) that would support a pure VOIP (voice-over-IP) method for carrying voice traffic.

GOODBYE SUBSIDIES

The business model just may be the biggest issue in labeling WiMax as a 4G technology in the United States. The key WiMax semiconductor suppliers, such as Intel, Wavesat, and Fu-

jitsu in the baseband or SOC (system-on-chip) market, and Analog Devices and SiGe Semiconductor in the radio market, have presented the technology since day one as an open standard. Executives from all of the companies can recite a party line of subscribers buying WiMax devices from their local retailer with no tether to a specific service provider. Even Sprint is emphatic that, with WiMax, it will not go the subsidy-and-service-contract route that prevails in the cellular business.

On WiMax devices, Sprint's Gude states, "We don't want to be the people that control those devices." Gude claims that the subsidy model ultimately

adds to the overall cost of a technology.

"Without the subsidy model, the economics of a low-cost data service works," says Intel's Nardone. Moreover, he claims, WiMax users may not even need a service contract. Presumably, users could buy service on an ad hoc or even one-time basis. Gude and Nardone agree that the one-to-one relationship between a device and a service contract won't exist with WiMax.

Without question, Sprint Nextel and its partners Intel, Motorola, Samsung, and, lately, Nokia, are making a bold move with WiMax. It's almost unprecedented for a service provider to announce adoption of such a new technology in one year, roll out initial service in the next, and broadly deploy it in the following. Intel certainly appreciates the high-profile partner given its investment in WiMax. Still, you have to wonder about all of the individual motives coming into play and how the deployment unfolds.

We'll probably never know whether Sprint and Nextel consummated their merger in large part because of some strategic vision on the potential future of WiMax. Or were the WiMax proponents just lucky that Sprint Nextel needed a broadband-wireless technology that perhaps was more attractive from a royalty perspective than other alternatives? More than one prognosticator has opined that WiMax would have died in the United States without the Sprint commitment.

Sprint Nextel had to roll some sort of wireless-data service. As a condition of the merger, Sprint Nextel faced a mandate from the FCC (Federal Communications Commission) to provide

FIXED OR MOBILE?

Ironically, much of the deployment of Mobile WiMax (Worldwide Interoperability for Microwave Access) will serve fixed-system clients. Clearwire focuses on such subscribers, and a desktop modem will be among the first WiMax offerings from Sprint. So, why does the world appear to be coalescing around the mobile flavor? The mobile flavor is more complex than the fixed and therefore presumably more expensive due to a more complex modulation scheme and the requirement to hand off connections from cell to cell. Why won't there be a market for lower cost fixed-system-only implementations?

According to Joe Nardone, general manager of Intel WiMax Solutions,

there just won't be enough fixed-only demand to get volumes up and prices down. A single standard will generate economy of scale across the market.

It's also worth noting that, although 802.16e is more complex than 802.16d, the mobile profile that the WiMax Forum specifies is very much a subset of 802.16e. For example, the forum profile specifies only a TDD (time-division-duplex) scheme, in which both base station and client share the same channel for bidirectional communications. The 802.16e spec allows both TDD and FDD (frequency-division duplex), which uses a pair of channels, to carry data in each direction. The mobile profile also specifies relatively few options in frequency bands relative to the broad IEEE specs.

data services using its broad 2.5-GHz-spectrum licenses by 2009. Nextel was known to have tested OFDM-based technology from Flarion, which Qualcomm acquired in mid-2005.

You won't find executives willing to go on the record to make such a statement, but Sprint Nextel almost assuredly wanted to escape the clutches of the Qualcomm intellectual-property vault. WiMax may have been the only choice Sprint had to meet the FCC mandate or lose those 2.5-GHz licenses. The WiMax move may also give Sprint Nextel leverage in negotiating the use of Qualcomm technology in the 3G market. You can also bet that Qualcomm will claim some intellectual-property rights in the WiMax world. The WiMax Forum has some intellectual-property data on its Web site, but the situation is far from settled concerning who might owe whom once broad deployment starts.

IF MOVING FROM WI-FI TO WIMAX IS AS EASY AS INTEL CLAIMS, YOU WOULD EXPECT THE OTHER WI-FI CHIP MAKERS TO PLAY.

How will Sprint initially deploy WiMax? Sprint's Gude says that the company will start with data cards for notebook PCs and with desktop modems, despite the fact that the technology is, by definition, mobile. The stated goal of reaching 100 million potential users means that Sprint will cover entire metropolitan areas. It will use 3G base-station and antenna locations to collocate WiMax support. But Sprint won't deploy WiMax along, say, freeways between cities, in the way it plans to fully build 3G coverage.

The plan for desktop modems puts Sprint in direct competition with DSL and cable operators. "Sprint could use this [plan] as a push into the home market," says Tom Gratzek, WiMax technical-business director at Analog Devices.

Sprint's Gude disagrees, however. "The target is taking the Internet mobile," he says.

Intel's interest is most assuredly mobile clients—first and foremost, notebook-PC users. "3G is a great start," says

Intel's Nardone. "But it's nowhere near making the Internet mobile." On 3G-data services today, he adds, "It's just such a small penetration."

INTEGRATING WI-FI AND WIMAX

So, Intel sees a big gap between Wi-Fi and 3G but, as Nardone further notes, does not want to force users to choose between WiMax and 3G, because WiMax won't have the breadth of 3G coverage. What's the problem with three radios rather than two? Cost is always a factor, but these radios are integrated into notebook PCs using Mini PCI cards, and notebooks typically have two Mini PCI slots. So, Intel is moving to integrate Wi-Fi and WiMax into a single chip set and hopes to ultimately equip every notebook with that chip set.

Indeed, Intel demonstrated a notebook with support for all three networks in December 2006 at the 3G World Congress in Hong Kong. The notebook relied on Intel's new WiMax Connection 2300 chip set, which includes a baseband that supports both Wi-Fi and WiMax and a frequency-agile radio that supports WiMax in the 2.3- to 2.7-, 3.5-, and 3.8-GHz bands. That radio should support the bands in which vendors may deploy Mobile WiMax worldwide.

Both Wi-Fi and WiMax use OFDM, making the integration possible. Moreover, the two technologies operate in similar spectrums and can even share the same antenna. Intel has not priced the new chip set. The company claims that the design is complete and plans to ship it late this year. Frankly, Intel just needs to be ready for when Sprint rolls out WiMax next year.

Ironically, the other Wi-Fi leaders, such as Atheros, Broadcom, and Marvell, haven't discussed WiMax plans. But, if moving from Wi-Fi to WiMax is as easy as Intel claims, you would expect the other Wi-Fi chip makers to play. The other key WiMax-baseband-chip vendors include Fujitsu, Sequans, Picochip, and Wavesat.

Does it sound as if WiMax now can't miss in the United States? Not so fast. There are issues ranging from affordable and low-power silicon, to whether Sprint can deliver on the network deployment, to the competition (see sidebar "Portables demand power-miserly chips" at the Web version of this article at www.edn.com/070329cs).



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For a list of industry participants or to post a comment on this article, go to www.edn.com/070329cs.

Qualcomm is quick to present an argument that evolving technology in both the GSM camp, which 3GPP (Third-Generation Partnership Project) leads, and the CDMA camp, which 3GPP2 (Third-Generation Partnership Project 2) leads, will serve mobile-broadband needs better than WiMax. Peter Carson, senior director of product management at Qualcomm CDMA Technologies, points out that 3GPP HSPA+ (high-speed-packet-access-plus) technology will soon offer downlink rates as fast as 28 Mbps. HSPA+ is an enhancement to and a combination of HSDPA (high-speed-downlink-packet access) and HSUPA (high-speed-uplink-packet access). Carson even claims that CDMA EVDO (evolution-data-optimized) Revision A will offer better data rates per channel than Mobile WiMax.

Carson claims that the evolved cellular networks will outperform WiMax, especially when you judge them on the minimum data rate they guarantee at a cell edge. He further claims that the cellular system has more efficient connection-management techniques. Finally, he points out that Mobile WiMax uses a TDD (time-division-duplex) scheme to send traffic in each direction on one channel, and cellular-data offerings all use FDD (frequency-division duplex) and a pair of channels for simultaneous upstream and downstream transmission.

No one in the WiMax camp buys Qualcomm's argument. In fact, the WiMax Forum has an in-depth comparative analysis on its Web site that presumably shows the spectral advantage of OFDM over CDMA. Even Sprint Nextel, which plans to support both technologies, claims that WiMax delivers at least a fourfold improvement in spectral efficiency, along with lower cost than CDMA technology. Of course, the cellular carriers are all doing well selling data cards for notebook PCs. Those 3G network extensions aren't yet carrying much voice traffic, but they soon will. The WiMax proponents inevitably point out that more voice capacity was still the reason behind the move to 3G technology.

The 3GPP and 3GPP2 groups are also working on longer term OFDM-based schemes—presumably for 4G—while improving 3G networks. The 3GPP group has developed LTE (long-term evolution), and the 3GPP2 has developed UMB (ultramobile broadband),

both similar in concept to Mobile WiMax. The developments are too early to gauge the potential of success.

Meanwhile, the cellular and WiMax players are set to collide. The close Sprint WiMax partners—Intel, Samsung, Motorola, and Nokia—insist that WiMax is simply a better fit than cellular technology in serving a host of new persistently connected consumer products. The group cites products such as portable game consoles and digital cameras as likely targets for WiMax connections. Qualcomm has been especially vocal about similar products and has even announced the Snapdragon chip platform to target just such technologies. Meanwhile, Motorola, Samsung, and Nokia are poised to add Mobile WiMax support into handsets, and Samsung is already selling such products in Korea.

Korea was supposed to be the early WiMax proving ground. Korean companies and the government were quick to adopt a technology that would free them from the Qualcomm royalty burden. But the early Mobile WiMax, or WiBro (wireless-broadband), news in Korea has been mediocre at best. In the past, Korea has been a consistent early adopter. Gratzek from Analog Devices speculates that the prevalence of 3G services and fiber to the home in Korea probably hurt the WiMax uptake.

Japan is next up in demonstrating the possibility of WiMax's future success. The government is preparing for a spectrum auction for wireless broadband. Intel's Nardone claims that four of the five participants are committed to WiMax technology. Still, Japan could have the same problem as Korea, given Japan's fiber-to-the-home program and enthusiastic 3G-user base. **EDN**

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