

WiMax/IEEE 802.16 Wireless Broadband Access Nears Deployment

WiMax, the implementation of the IEEE 802.16 standards, has been touted as the “next big thing” in wireless technology, gaining recent attention by financial analysts and the media. The interest in WiMax has increased as the technology approaches its first major deployments.

Development of WiMax

The search for a broadband wireless delivery system began several years ago with two actions by Congress and the FCC: The NII (National Information Infrastructure) bands in the 5 to 6 GHz range and the creation of LMDS (Local Multipoint Distribution Service) around 30 GHz. These new services were intended to be used for wireless delivery of Internet access and other broadband services as both an alternative to DSL and cable modem, and as a new service to areas where a wired infrastructure was difficult to install or was not economically feasible.

LMDS got the greatest attention by investors because the bandwidth was sufficient to offer entertainment services in competition with CATV systems as well as Internet access. Companies like Teligent, NextLink and Winstar were started and got lots of publicity about their efforts to create a new wireless broadband marketplace. Their failure to achieve the stated goals was both a discouragement to the investment community and a reason for the engineering community to re-think how the technology should work.

As the story of these early ventures was playing out, a new standards effort was begun: IEEE 802.16, which soon became known as WirelessMAN (Metropolitan Area Network). The 802.16 committee began exploring more than just LMDS; its efforts were expanded to cover potential licensed and unlicensed services from 2 to 66 GHz. Later, its scope was increased further, adding mobile services to the original fixed service approach. WirelessMAN is meant to provide a more usable approach to wireless broadband, a better fit to the manner in which customers are expected to use it.

In parallel with the IEEE 802.16 standards activity, the WiMax Forum, an industry consortium, was established in 2001. The WiMax Forum has the stated purpose “to facilitate the deployment of broadband wireless networks based on the IEEE 802.16 standard by helping to ensure the compatibility and interoperability of broad-

band wireless access equipment.” This effort is similar to the WiFi consortium that coordinates component and equipment development for IEEE 802.11 wireless LAN. WiMax Forum has more than 250 members, with new members continually being added.

WiMax Forum is complementary to the standards activities. The IEEE committees simply create the operating standards. WiMax Forum has the purpose of providing voluntary coordination among companies to assure that each company’s equipment will operate properly with other companies’ equipment. For a market to develop, equipment operation must be reliable, and an independent means of assuring interoperability is essential. Equipment that has been verified through a WiMax Forum laboratory will be designated “WiMAX Forum Certified™” to provide assurance to the consumer.

Technical Overview

Briefly, WiMax uses OFDM (Orthogonal Frequency Division Multiplexing), a multicarrier technique that allows broadband transmission in a mobile environment with fewer multipath effects than a single signal with broad bandwidth modulation.

WiMax is an international undertaking. IEEE and ETSI have accelerated their standards-making in response to market demand. The nomadic standard (802.16-2004) was published in July 2004 to consolidate previously published base standards and amendments. The mobile standard (802.16e) has reached a final draft, incorporating scalable signal modulation modes (SOFDMA) for the mobility standard, Netman 802.21. An Ad Hoc group has been tasked to enable roaming across networks (PAR), and the European ETSI HIPERMAN standard has been harmonized with 802.16-2004 OFDM.

Standards work has been divided into two frequency ranges, 2 to 11 GHz and 10 to 66 GHz. The reason for the division is the nature of signal propagation. Above 10 GHz, signals travel in a strictly line-of-sight manner. The transmitter and receiver must, quite literally, see each other. Precipitation and vegetation create significant attenuation. Below about 10 GHz, transmission paths can be maintained with some deviation from line-of-sight. Refraction and diffraction can bend a signal around corners, and the penetration of buildings is better than higher frequencies.

At the higher microwave frequencies, multipath effects are greater, due to the shorter wavelengths. This makes mobile operation more difficult to implement, although OFDM modulation helps mitigate the problem. An advantage to the higher frequencies is wider allowed bandwidths. As was envisioned for early LMDS, the greater capacity is sufficient for CATV-style entertainment distribution. This level of service is not possible using the narrower bandwidths of 2 to 11 GHz WiMax systems.

WiMax Business Planning

Any new service must be viable from an economic standpoint. Given the failure of early LMDS efforts, as well as other highly-touted wired and wireless communications systems, it is appropriate to examine the way WiMax is being developed.

Marketplace positioning—Primarily, WiMax is envisioned as the link between WiFi wireless LAN and wide area networks (Internet, telephone system and entertainment programming sources). It is also seen as a way to extend broadband services to areas where CATV is not built out and where the telephone network will not support DSL. Assuming that equipment costs are competitive, WiMax is expected to have lower initial construction costs than competing services in these areas.

WiMax is not limited to this fixed wireless approach. Standards for mobile service have been a high priority for the 802.16 committee. It is expected that as WiMax evolves, it will provide service directly to portable and mobile computing equipment with bandwidth that exceeds what is possible with 802.11 WLAN.

Municipal wireless networks—The 802.16 committee chose the term WirelessMAN to identify the service's application as a Metropolitan Area Network. Taking this definition to heart, several municipalities in the US have begun development of wireless access systems that will use WiMax as the backbone distribution network and WiFi as the short-range connection to individual users.

There is significant controversy surrounding some of these systems, since some are intended to be municipal utilities. Such a utility would compete with commercial telephone, cable and Internet companies. In most cases, the city's justification is a combination of necessary economic development and speed of development—moving ahead rapidly on new technology because of the difficult private investment climate presently being experienced in telecommunications.

Other cities have opted for a model similar to CATV, awarding one or more franchises for a metropolitan wireless network. Controversy has arisen in some cities over tax incentives and franchise terms that have been seen as showing preference over competing service providers.

SOHO (Small Office/Home Office)—Despite the above target market positions, initial WiMax operations will certainly include head-to-head competition with existing DSL, cable modem and leased-line services to small business and home office customers. This marketing effort is expected to be focused where those services are limited or, because of market size, are not priced as

competitively as in large metropolitan areas. New marketing approaches may include bundling fixed service with mobile/portable “hot spot” access.

Market analysis—WiMax operators will face several classic business competition and cost issues. First, the market with the most potential users (urban areas) also has the greatest competition. If WiMax proves to be easy to implement, a fractional market share may be sufficient to support the service.

As distance from population centers increases, the issues change from competition to market size. Suburban areas have many computer and cell phone users, but fewer business users. The cell size of a WiMax network may be larger (and lower cost), but will have limits due to terrain and site availability.

Rural areas may have high demand for WiMax broadband services, but the number of potential customers will vary considerably, depending on the nature of the community. Some rural areas may present problems for high-capacity backhaul if the telecommunications infrastructure is limited.

Perhaps the most attractive market will be in “far suburban” areas. Population density and cost of real estate has driven many successful people further away from city centers. This lifestyle is supported by telecommuting, which requires high-speed Internet access that can be provided by WiMax. The number of communities with a significant population that fit this model may be limited, but is expected to grow.

Integration With Other Telecommunications

As wired and wireless telecommunications continues to grow in importance for both personal and business users, the appropriate place for each type of service needs to be examined. The following services are all part of the consumer's current set of telecommunication choices:

- Wired telephone (PSTN)
 - Dial-up Internet access
 - DSL Internet access
- Wireless phone (cellular/PCS)
 - 2.5G/3G broadband services
- CATV entertainment
 - Cable modem Internet access
- WiFi WLAN
- Wireline broadband (T-1)
- VoIP using broadband services

Developing systems include WiMax, Ultra Wideband (UWB), Broadband over Power Line (BPL), expansion of 3G (and beyond) service availability and fiber-to-home.

The role of WiMax as a basic broadband access medium has already been discussed, but there are a number of marketplace uncertainties, even without WiMax in the mix. The biggest of these is how 3G wireless services will compete with, or complement, WiFi “hot spot” wireless access, particularly as metropolitan WiMax/WiFi networks are implemented. It is not known whether consumers will gravitate toward a single mobile broadband service, or use “phone-centric” 3G for certain functions,

and “computer-centric” WiFi for another set of uses. A few analysts see the possibility that 3G will be used mostly by individuals and WiFi by business customers, but for many people those roles overlap.

After much media attention, BPL is developing very slowly, and will have lower capacity than WiMax as an alternative broadband delivery service. Also, the ability of BPL to mitigate interference to other users of the short-wave and lower-VHF spectrum has not been established. Both BPL and WiMax are being promoted, in part, as viable options for broadband access in rural and semi-rural areas with no cable or DSL service.

The larger question is whether the marketplace will become more fragmented as new services are implemented, or whether some services will gain some degree of domination.

WiMax Development Process

How will a WiMax network be implemented? The first deployments are expected to use both the unlicensed spectrum at 5.8 GHz and licensed bands at 2.5 GHz (US, Canada, Latin America) or 3.5 GHz (Europe, Asia, Latin America). The 5.8 GHz unlicensed band has more spectrum available (125 MHz vs. 22.5 MHz at 2.5 GHz, in the US), but allows much lower power than the licensed bands. The number of unlicensed users is unregulated, and is coordinated by the operating standards. Licensed users will be protected from interference, as with all licensed services. However, licenses will be awarded by auction and will represent a sizeable investment in major markets. Unlicensed spectrum does not have this cost.

The WiMax Forum anticipates that licensed spectrum will be used in metropolitan areas, where the increased cost is offset by the exclusivity of a license and the larger customer base. Unlicensed spectrum will see greatest use in suburban and rural areas where interference is expected to be lower. The larger capacity (bandwidth) requires fewer base stations, which should make deployment less costly in an area with fewer potential customers.

The process will begin with an analysis of the cus-

tomers base—number and the distribution of locations. Next is an analysis of the physical environment—terrain and buildings. With this information, the number of base stations can be calculated, along with their necessary locations. This process is for fixed access deployment. Early mobile access to WiMax will likely be limited to those places where existing base stations provide service in an opportunistic manner, with some augmentation by additional base stations where high density of users warrants the investment.

Cell-based network engineering is well-established, so the marketing process may be more important than the technical process. Attracting customers to a new service will be a significant challenge in those areas where WiMax has the least advantage over competing broadband services.

High Expectations

Although the telecommunications business community is not booming at this time, expectations for WiMax are high. WiMax appears to be a viable wireless broadband network, after several highly-publicized failures. Through the IEEE 802.16 committee, the standards behind WiMax have been more carefully crafted than earlier attempts at wireless broadband. In addition, the WiMax Forum has provided a means of coordinating efforts among service providers, base station and customer equipment developers, chip makers and marketing personnel.

The most significant issues causing concern are marketplace matters: Are there enough consumers who need the capabilities of WiMax? Will WiMax work with WiFi as expected? Will equipment and other startup costs meet the goals required to support deployment and ongoing operations?

Of course, these are the same questions for which all new technologies must find answers. Although stated with caution, many analysts believe WiMax will become the primary wireless broadband system—the wireless alternative to wire, coax or fiber broadband systems.

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