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| Project | **IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>** |
| Title | **IEEE 802.16 WirelessMAN Backgrounder** |
| Date Submitted | **2002-3-12** |
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| Re: | [If this is a proposed revision, cite the original document.] |
| Abstract | Backgrounder on the working group to be distributed to press and analysts |
| Purpose | Overview of the standards developed or in development within IEEE 802.16 |
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# IEEE 802.16 WirelessMAN Backgrounder

**DRAFT: 3/8/01**

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## Backgrounder

### Broadband Wireless Access: An Introduction to the Technology Behind the IEEE 802.16 WirelessMAN™ Standard

Broadband wireless access (BWA) has become the best way to meet escalating business demand for rapid Internet connection and integrated data, voice, and video services. BWA can extend fiber optic networks and provide more capacity than cable networks or digital subscriber lines (DSL). One of the most compelling aspects of BWA technology is that networks can be created in just weeks by deploying a small number of base stations on buildings or poles to create high-capacity, point-to-multipoint (PMP) systems.

BWA has had limited reach so far, in part because of the unmet need for a universal standard. While providing such a standard is important for developed countries, it

is even more important for the undeveloped world where wired infrastructures are minimal.

#### The IEEE 802.16 WirelessMAN™ Standard

The Institute of Electrical and Electronic Engineers Standards Association (IEEE-SA) sought to make BWA more widely available by developing IEEE Standard 802.16, which specifies the WirelessMAN™ Air

Interface for wireless metropolitan area networks. The standard, which received final IEEE approval on Dec. 6, 2001, was created in a two-year, open-consensus process by hundreds of engineers from the world's leading operators and vendors.

IEEE 802.16 addresses the "first-mile/last-mile" connection in wireless metropolitan area networks. It focuses on the efficient use of bandwidth between 10 and 66 GHz (the 2 to 11 GHz region will be added in mid 2002) and defines a medium access control (MAC) layer that supports multiple physical layer specifications that are customized for the frequency band of use.

The 10 to 66 GHz standard supports continuously varying traffic levels at many licensed frequencies (e.g., 10.5, 25, 26, 31, 38 and 39 GHz) for two-way communications. It enables interoperability among devices, so carriers can use products from multiple vendors. The draft amendment for the 2 to 11 GHz region will support both unlicensed and licensed bands.

**Telecommunications Choices**

Business-based telecommunications encompasses many options. Major businesses often access large-capacity, high-speed fiber optic networks for broadband, converged services. Less than five percent of commercial structures worldwide are served by fiber networks, however, and extending these networks with cable is costly and time consuming.

Small businesses and home offices typically use lower-bandwidth wired networks such as cable modem networks and DSL. Cable systems are based on residential cable TV infrastructure, so they are often not a competitive in serving business subscribers. DSL is a copper-based method that typically offers 128 kbps to 2 Mbps data services. It faces many technical hurdles and is limited in both bandwidth and range.

DSL, cable, and older wireless systems tend to have low upstream bandwidth. The same is true of another option, two-way satellite transmission, which is still early in its life cycle. While invaluable in some

rural areas, it has limited application in more populous locales due to limited spectrum availability and high latency.

Early BWA networks were costly and problematical and had limited information capacity per channel. They were also inefficient in the use of spectrum. Current BWA systems offer true differentiated broadband services at minimal cost. They let thousands of users share capacity for data, voice, and video. They also are scalable: carriers can expand them as subscriber demand for bandwidth grows by adding channels or cells.

**Quality of Service (QoS) in Broadband Wireless**

BWA networks use air as the transmission medium and so are affected by temperature, humidity and obstructions such as vegetation or buildings. This makes them less predictable than networks based on copper or glass. IEEE Standard 802.16 recognizes this and includes mechanisms to make robust links for PMP BWA systems with line-of-sight, obstructed line-of-sight, and non line-of-sight transmission.

Mechanisms in the WirelessMAN MAC provide for differentiated QoS to support the different needs of different applications. For instance, voice and video require low latency but tolerate some error rate. By contrast, generic data applications cannot tolerate error, but latency is not critical. The standard accommodates voice, video, and other data transmissions by using appropriate features in the MAC layer, which is more efficient than doing so in layers of control overlaid on the MAC.

Many systems in the past decade have involved fixed modulation. Higher-order modulation in such systems offers higher data rates but requires optimal links, while lower orders of modulation are more robust but support lower data rates. The new standard supports adaptive modulation, effectively balancing different data rates and linkage quality. The modulation method may be adjusted almost instantaneously for optimum data transfer. Adaptive modulation allows efficient use of bandwidth and a broader customer base.

The standard also supports both frequency and time division duplexing (FDD and TDD). Frequency division duplexing (FDD), the legacy duplexing method, has been widely deployed in cellular telephony. It

requires two channel pairs, one for transmission and one for reception, with some frequency separation between them to mitigate self-interference.

TDD is a more efficient method in which data is sent and received in a single channel. It is especially valuable for data transmission and Internet traffic, in which the asymmetry can vary greatly over time. TDD allows efficient use of spectral resources by continuously adapting the fractions of time dedicated to uplink and downlink traffic to traffic requirements.

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