

# Recent Standards Activity: 802.16 WirelessMAN™, 802.15 WPAN and ZigBee

One of the most often heard questions in wireless business is, "What's next?" Among the emerging applications with potential for large markets are various short range wireless systems and city-wide wireless access systems. For these application families to reach their potential, a unified set of standards is needed to assure that products manufactured by the various companies are compatible with one another.

We will focus on three specific standards groups: the IEEE 802.15 Wireless Personal Area Network (WPAN) group, the IEEE 802.16 Metropolitan Area Network (WirelessMAN) group and the ZigBee Alliance. Each of these standards groups have active standards development committees, and their recent activities are the subject of this report.

## IEEE 802.16 WirelessMAN and WiMAX

The IEEE 802.16 WirelessMAN™ air interface represents the standards effort for wireless broadband Internet access. Initially created to address point-to-multipoint communications in the 28-32 GHz range, the 802.16 group is now working on systems operating as low as 2 GHz. The first standard, covering frequencies from 10 to 66 GHz, was completed in October 2001 and published in April 2002.

Wireless point-to-multipoint services have several key performance issues that are addressed in the standards. These systems operate as base stations with many individual end-user sites. To maintain the desired quality of service, the modulation and coding must maintain high data rates, allow for both downstream and upstream communications, and accommodate variations in system loading, as well as variation in upstream/downstream traffic ratios.

In addition, operation in the tens of GHz range requires line-of-sight communications. The biggest disadvantage is "in the clear" location of base station and user terminal antennas. The main advantage is that single-carrier modulation can be used.

The WirelessMAN standards are now being enhanced as WiMAX (Worldwide Interoperability for Microwave Access). The WiMAX suite of air interface standards will address portable and mobile broadband wireless access, in addition to the fixed systems of WirelessMAN. With bandwidth of up to 75 Mbps, WiMAX uses licensed and unlicensed frequency bands between 2 and 66 GHz.

802.16e, an update to the IEEE standard document, is scheduled for an update in 2005, with the draft completed in the first quarter, followed by committee voting. This version will add additional mobility support.

The next revision 802.16f, is in process in the Network Management (NetMan) Task Group. This work is intended to improve multi-hop functionality, with WiMAX user terminals able to function as repeaters in a mesh network scenario to extend the reach of the network to areas inaccessible to fixed base stations. In part, this is intended to deal with the expected interoperation with cellular and hot spot technologies. 802.16g is intended to deal with efficient handover and improved quality of service.

As indicated by the ongoing work noted above, the initial fixed systems of 802.16 were quickly superseded by proposals to improve network reach and mobility. In addition to mesh network support, coverage can be improved by using frequencies in the lowest part of the available spectrum, as low as 2 GHz. At these frequencies, signal paths are less strict in their line-of-sight requirements. Mobility is being addressed with multicarrier transmission standards (OFDM) that are capable of reliable communications with moving users.

WiMAX and WirelessMAN are generating considerable interest in two areas: as lower-cost alternatives to DSL or cable modem access and as an urban wireless access network operating in a city's main business district and other business centers. The latter application is usually intended to work in conjunction with 802.11 WiFi hot spots and with 3G cellular high-speed data capabilities.

## IEEE 802.15 WPAN Standard

Originally, the IEEE 802.15 group was the Bluetooth™ group, but it has evolved to include other short-range Wireless Personal Area Network (WPAN) systems. The initial version, 802.15.1, was adapted from the Bluetooth specification and is fully compatible with Bluetooth 1.1.

As it is now described by the IEEE, “The IEEE 802.15 Working Group proposes two general categories of 802.15, called TG4 (low rate) and TG3 (high rate). The TG4 version provides data speeds of 20 Kbps or 250 Kbps. The TG3 version supports data speeds ranging from 11 Mbps to 55 Mbps. Additional features include the use of up to 254 network devices, dynamic device addressing, support for devices in which latency is critical, full handshaking, security provisions, and power management. There will be 16 channels in the 2.4-GHz band, 10 channels in the 915-MHz band, and one channel in the 868-MHz band.”

The 802.15.3 Standard for high data rate services, which continues to be reviewed and enhanced, includes the following features and goals:

- Data rates of 11, 22, 33, 44 and 55 Mbps.
- Quality of Service (QoS) isochronous protocol
- Ad hoc peer-to-peer networking
- Security
- Low power consumption
- Low cost

The higher data rate of this standard is designed to meet the requirements of portable consumer imaging and multimedia applications.

The IEEE 802.15 Task Group 5 is studying mesh networking, determining the necessary mechanisms that must be present in the PHY and MAC layers of WPANs to enable mesh networking, in both full mesh and partial mesh topologies. Mesh networks are useful for extending network coverage without increasing transmit power or receive sensitivity, enhancing reliability with redundant routing, easy network configuration and, ultimately, longer device battery life due to fewer retransmissions.

The IEEE 802.15.3 Study Group 3c, formed in March 2004, is developing a millimeter-wave-based alternative physical layer (PHY) for the existing 802.15.3 WPAN Standard 802.15.3-2003. This mm-Wave WPAN will operate in a band that includes the 57-64 GHz unlicensed band. The millimeter-wave WPAN will allow very high data rate applications such as high-speed internet access, streaming content download (video on demand, HDTV, home theater, etc.), real time streaming and wireless data bus for cable replacement. Optional data rates in excess of 2 Gbps are to be provided.

## ZigBee™ Low Cost, Low Data Rate System

In December 2004, the ZigBee Alliance ratified the first ZigBee specification, a major step toward making these systems a reality. ZigBee is an extremely power efficient, cost-effective, low data rate system for monitoring, control and sensing. ZigBee Alliance members can proceed with final development of products and participate in interoperability testing with other member companies. The organization currently has 124 members.

ZigBee is an extension to the IEEE 802.15.4 low data rate standard, adding security, networking and application software to the base standard. Initial applications include industrial and building control and sensors, including HVAC systems, environmental monitoring, security systems, materials handling and manufacturing workflow. The principle advantage is simple system reconfigurability, since nothing is hard-wired. This simplicity extends to both the retrofitting of existing systems and the installation of new systems.

Future applications include home automation where low data is sufficient, such as temperature sensors for environmental controls and medical or security alarm monitoring. Many sensor applications are well-suited for ZigBee, including water level, refrigeration temperature, power quality (brownout) and others. As a data-based system, remote monitoring is simple via any type of wired or wireless access.

802.15.4 and ZigBee products are intended for the lowest possible power consumption, perhaps years of operation from one or two battery cells. This is a key requirement for areas with difficult access.

The next ZigBee Alliance meeting is scheduled for February 28 through March 4, 2005 in San Francisco. See the organization's web site for information: [www.zigbee.org](http://www.zigbee.org)

## The Impact of Standards

Proprietary systems and protocols certainly exist and have been successful in many cases. In general, however, they are limited to systems from a sole provider, intended for a specific task that does not require interoperability with other equipment from other vendors.

Standards provide an assurance of interoperability among products from different vendors, which is a necessity for systems that will be widely implemented in a variety of configurations. Independent standards organizations such as the IEEE provide the means for developing the necessary standards, while industry-specific groups such as the ZigBee Alliance provide a central clearing house for technical matters like interoperability and for business development discussions, as well.