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WiMAX (Worldwide Interoperability for Microwave Access) Technology : An Introductory Review

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ABSTRACT

WiMAX stands for Worldwide Interoperability for Microwave Access. WiMAX technology enables abundant delivery of wireless broadband service for fixed and mobile users. WiMAX can be used for long distance wireless communication with higher data rates. It can be used as an alternative broadband.
Keywords: Broadband, IEEE standard 802.16, P2MP, Portable WiMAX, QoS, Wireless MAN

I. INTRODUCTION

WiMAX technology enables abundant delivery of wireless broadband service for fixed and mobile users which is also called list mile access. The fixed version of WiMAX operates with a TDM (Time Division Multiplexing) data stream on the downlink and TDMA (Time Division Multiple Access) on the uplink communications with a centralized scheduler controlling access.

It can be used as an alternative broadband rather than using cable and DSL[2]. WiMAX is a connection-oriented wide area network. It can potentially provide broadband access to remote places. It can use point-to-multipoint (P2MP) architecture.

Standards of WiMAX

IEEE 802.16 is a series of Wireless Broadband standards written by the Institute of Electrical and Electronics Engineers (IEEE)[4]. The IEEE 802.16 group was formed in 1998 to develop wireless broadband. The group's initial focus was the development of a line- of- sight (LOS)-based point-to-multipoint wireless broadband system for operation in the 10 GHz -66GHz millimeter wave band. The following Table 1.shows the IEEE 802.16 standard IEEE 802.16[5]:

STANDARD NO.	COMMENTS
802.16	Now withdrawn. This is the basic 802.16 standard that was released in 2001. It provided for basic high data links at frequencies between 11 and 60 GHz.
802.16a	Now withdrawn. This amendment addressed certain spectrum issues and enabled the standard to be used at frequencies below the 11 GHz minimum of the original standard.
802.16b	Now withdrawn. It increased the spectrum that was specified to include frequencies between 5 and 6 GHz while also providing for Quality of Service aspects.
802.16c	Now withdrawn. This amendment to 802.16 provided a system profile for operating between 10 and 66 GHz and provided more details for operations within this range. The aim was to enable greater levels of

	interoperability.
802.16d (802.16-2004)	This amendment was also known as 802.16-2004 in view of the fact that it was released in 2004. It was a major revision of the 802.16 standard and upon its release, all previous documents were withdrawn. The standard / amendment provided a number of fixes and improvements to 802.16a including the use of 256 carrier OFDM. Profiles for compliance testing are also provided, and the standard was aligned with the ETSI HiperMAN standard to allow for global deployment. The standard only addressed fixed operation.
802.16e (802.16-2005)	This standard, also known as 802.16-2005 in view of its release date, provided for nomadic and mobile use. With lower data rates of 15 Mbps against to 70 Mbps of 802.16d, it enabled full nomadic and mobile use including handover.
802.16f	Management information base
802.16g	Management plane procedures and services
802.16h	Improved coexistence mechanisms for license-exempt operation
802.16j	Multi-hop relay specification
802.16k	802.16 bridging
802.16m	Advanced air interface. This amendment is looking toth e future and it is anticipated it will provide data rates of 100 Mbps for mobile applications and 1 Gbps for fixed applications. It will allow cellular, macro and micro cell coverage, with currently there are no restrictions on the RF bandwidth although it is expected to be 20 MHz or more.

The IEEE 802.16 is specifically designed for flexibility on allowing the BS and MS implementations. It operates on MAC layer and physical layer. It does not define all upper layer signaling or network architecture and protocols. WiMAX was established in 2001 and its goal is to enable conformity and inter-operability of SSs and BSs based on IEEE 802.16. Since June 2008, the WiMAX Forum has been working on a new version of the Mobile WiMAX, called Release 1.5, based on the latest IEEE 802.16-2009 standard. This release is aimed at enabling mobile WiMAX in new spectrum bands, including those for FDD operation, addressing the most recent MAC improvements, and introducing advanced network capabilities [1].

System Mode

IEEE 802.16 supports two modes of operation: PTP and PMP.

Point-to-point (PTP)

The PTP link refers to a dedicated link that connects only two nodes: BS and subscriber terminal. It utilizes resources in an inefficient way and substantially causes high operation costs. It is usually only used to serve high-value customers who need extremely high bandwidth, such as business high-rises, video postproduction houses, or scientific research organizations. In these cases, a single connection contains all the available bandwidth to generate high throughput. A highly directional and high-gain antenna is also necessary to minimize interference and maximize security.

Point-to-multipoint (PMP)

The PMP topology, where a group of subscriber terminals are connected to a BS separately (shown in Figure), is a better choice for users who do not need to use the entire bandwidth. Under PMP topology, sectoral antennas with highly directional parabolic dishes (each dish refers to a sector) are used for frequency reuse. The available bandwidth now is shared between a group of users, and the cost for each subscriber is reduced.

The IEEE 802.16 standard with specific revisions addresses two usage models:

- Fixed (IEEE 802.16d)
- Portable (IEEE 802.16e)

Fixed (IEEE 802.16d)

Fixed WiMAX is the 802.16d standards or as it is sometimes called 802.16-2004. Its product profile utilizes the OFDM 256-FFT (Fast Fourier Transform) system profile, which is just different enough from its sister standard of Mobile WiMAX (802.16e) that the two are incompatible. Interestingly, both standards support both protocols within the technology protocol as well as the one chosen for Mobile WiMAX and the Korean WiBro/Mobile WiMAX standard. If the Forum had elected to use an OFDMA version in Fixed WiMAX, it would have been far easier to provide an upgrade path. This particular disconnect likely points to the emerging understanding of the marketplace power of WiMAX. More importantly, it indicates the power of the Korean WiBro/Mobile WiMAX persuasion, which heavily influenced the use of OFDMA in the Mobile Standard. The Fixed WiMAX 802.16-2004 standard supports both time division duplex (TD) and frequency division duplex (FDD) services---the latter of which is far more popular with mobile wireless providers than the newer TDD approach. At this point, Fixed WiMAX 802.16d systems are widely deployed in both Europe and Asia, but it is clear that for many vendors the adoption of the Mobile WiMAX 802.16e is the option of choice. Having said this, the opening of the US 3.65 GHz spectrum range has opened up a 802.16d opportunity in the US as vendors adapt existing 3.5 GHz systems (and mostly Fixed WiMAX based built for International use) radio systems to use in this band.

Portable (IEEE 802.16e)

The true Mobile WiMAX standard of 802.16e is divergent from Fixed WiMAX. It attracted a significant number of Forum members towards an opportunity to substantively challenge existing 3G technology purveyors. While clearly based on the same OFDM base technology adopted in 802.16-2004, the 802.16e version is designed to deliver service across many more sub-channels than the OFDM 256-FFT. It is important to note that both standards support single carrier, OFDM 256-FFT and at least OFDMA 1K-FFT. The 802.16e standard adds OFDMA 2K-FFT, 512-FFT and 128-FFT capability. Sub-channelization facilitates access at varying distance by providing operators the capability to dynamically reduce the number of channels while increasing the gain of signal to each channel in order to reach customers farther away. The reverse is also possible. For example, when a user gets closer to a cell site, the number of channels will increase and the modulation can also change to increase bandwidth. At longer ranges, modulations like QPSK (which offer robust links but lower bandwidth) can give way at shorter ranges to 64 QAM(which are more sensitive links, but offer much higher bandwidth) for example. Each subscriber is linked to a number of subchannels that obviate multi-path interference. The upshot is that cells should be much less sensitive to overload and cell size shrinkage during the load than before. Ideally, customers at any range should receive solid QOS without drops that 3G technology may experience. Here is an in-depth Q&A on OFDMA. The 802.16e version of WiMAX also incorporates support for multiple-input-multiple-output (MIMO) antenna technology as well as Beam forming and Advanced Antenna Systems (AAS), which are all "smart" antenna technologies that significantly improve gain of WiMAX systems as well as throughput. The 802.16e standard is being utilized primarily in licensed spectrum for pure mobile applications. Many firms have elected to develop the 802.16e standard exclusively for both fixed and mobile versions. The 802.16e version of WiMAX is the closest comparable technology to the emerging LTE mobile wireless standard. Or rather, it is more proper to say that LTE is the most comparable to Mobile WiMAX in terms of capabilities as well as technology. The two competing technologies are really very much alike technically.

WiMAX layer Architecture

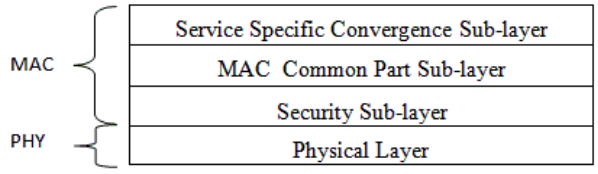

Fig. 1. Architecture of WiMAX layer

Physical layer functions are:

- Encoding /decoding of signals
- Bit transmission/reception.
- Preamble generation/removal

In the Data link layer, medium access control functions are:

- On transmission, assemble data into a frame with address and error detection fields
- On reception, disassemble frame, and perform address recognition and error detection
- Govern access to the wireless transmission medium

For the convergence layer, functions are:

- Encapsulate PDU framing of upper layers into native 802.16 MAC/PHY frames
- Map upper layer's addresses into 802.16 addresses
- Translate upper layer QoS parameters into native 802.16 MAC format
- Adapt time dependencies of upper layer traffic into equivalent MAC service.

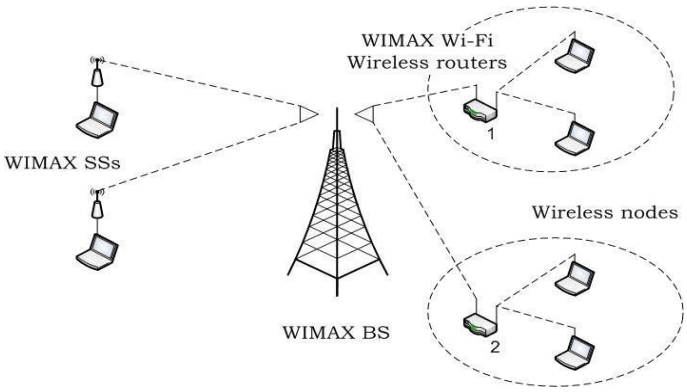

Fig. 2. WiMAX network architecture

WiMAX base station can cover at most of 3000 square miles or appx. 8000 square km. WiMAX can be your laptop with PCMCIA card inserted in it.[3]

WiMAX architecture is formed of these two stations:

· Subscriber Stations (SS) which covers a building (business or residence)

· Base station (BS) connects to public network and provides SS with first-mile access to public networks.

The communication path between SS and BS has two directions:

· Uplink (from SS to BS)

· Downlink (from BS to SS)

Quality Of Service (QoS)

Support for QoS is a fundamental part of the WiMAX MAClayer design. The QoS parameters could include traffic priority, maximum sustained traffic rate, maximum burst rate, minimum tolerable rate, scheduling type, ARQ type, maximum delay, tolerated jitter, service data unit type and size, bandwidth request mechanism to be used, transmission PDU formation rules, and so on.

There are five different quality of service [6] for WiMAX, as below:

• Unsolicited grant services (UGS): This is designed to support fixed-size data packets at a constant bit rate (CBR). Examples of applications that may use this service are T1/E1 emulation and VoIP without silence suppression. The mandatory service flow parameters that define this service are maximum sustained traffic rate, maximum latency, tolerated jitter, and request/transmission policy.

• Real-time polling services (rtPS): This service is designed to support real-time service flows, such as MPEG video, that generate variable-size data packets on a periodic basis. The mandatory service flow parameters that define this service are minimum reserved traffic rate, maximum sustained traffic rate, maximum latency, and request/transmission policy.

• Non-real-time polling service (nrtPS): This service is designed to support delay-tolerant data streams, such as an FTP, that require variable-size data grants

at a minimum guaranteed rate. The mandatory service flow parameters to define this service are minimum reserved traffic rate, maximum sustained traffic rate, traffic priority, and request/transmission policy.

- Best-effort (BE) service: This service is designed to support data streams, such as Web browsing, that do not require a minimum service-level guarantee. The mandatory service flow parameters to define this service are maximum sustained traffic rate, traffic priority, and request/transmission policy.
- Extended real-time variable rate (ERT-VR) service: This service is designed to support realtime applications, such as VoIP with silence suppression, that have variable data rates but require guaranteed data rate and delay. This service is defined only in IEEE 802.16e-2005, not in IEEE 802.16-2004. This is also referred to as extended real-time polling service (ErtPS)

II. CONCLUSION

In this paper I have presented a brief overview of WiMAX networks and WiMAX technology. WiMAX layers are also briefly discussed. This paper presents the emerging WiMAX technology review and benefits. It is expected that future work will focus on the mobility aspect and interoperability of mobile WiMAX with other wireless technologies.

III. REFERENCES

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