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The WiMax Evolution – Features, Architecture, Applications and Comparative analysis

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Abstract WiMax (Worldwide Interoperability for Microwave Access) is a remote broadband innovation, which bolsters point to multi-point (PMP) broadband remote access.. Orthogonal Frequency Division Multiplexing or OFDM is a modulation format that is being used for many of the latest wireless and telecommunications standards including Wimax. OFDM technique has increased the speed as it carries multiple carriers, each carrying more than one data bits based on modulation techniques (QPSK, 16QAM). The IEEE remote standard has a scope of up to 30 miles, and can convey broadband at around 75 megabits for each second. This is hypothetically, 20 times speedier than an economically accessible remote broadband. This augmentation accommodates non-observable pathway access in low recurrence groups like 2 - 11 GHz. These groups are once in a while unlicensed. This additionally helps the greatest separation from 31 to 50 miles and backings PMP (point to multipoint) and work advances.

Index Terms— Wimax, PMP, IEEE 802.16, QoS

I. INTRODUCTION

The name "Wimax" was made by the Wimax Forum, which was framed in June 2001 to advance similarity and interoperability of the standard. The discussion portrays Wimax as "a measures based innovation empowering the conveyance of last mile remote broadband access as an other option to link and DSL [1]. Wimax is a remote advanced correspondences framework, otherwise called IEEE 802.16, which is planned for remote "metropolitan territory systems". Wimax can give broadband remote access (BWA) up to 30 miles (50 km) for settled stations, and 3 - 10 miles (5 - 15 km) for versatile stations.

The first form of WiMax, known as 802.16, concentrated on conveying scope in the 10 to 66 GHz band. A more up to date form, 802.16a, covers the 2 to 11 GHz range. 802.16 and 802.16a both characterize a solitary transporter tweak conspire for observable pathway connects over 10 GHz. Moreover, they characterize two kinds of OFDM for non-viewable pathway connects underneath 11 GHz and Time Division Duplex (TDD) and Frequency Division Duplex (FDD) Medium Access Control conventions. The standard does not characterize particular nature of administration (QOS) and planning calculations, leaving space for adaptability among merchant executions[2].

Dissimilar to 802.11, WiMax was outlined particularly for organization in open air conditions. This shows itself in a few ways. For one, WiMax has arrangements at the physical layer for advancing image rate. This makes it hearty within the sight of expanded defer spread, which is pervasive outside. Also, WiMax does not utilize conflict based MAC convention, for example, CSMA. Thus, it can convey more dependable QOS and per-customer data transmission assignments, which can wind up basic crosswise over longer separations. WiMax is expected to support mobile wireless technology too, wireless transmissions directly to mobile end users. WiMax changes the last mile problem for broadband. The WiMAX group of guidelines (802.16) focus on two kinds of utilization models a settled WiMAX usage model and a mobile WiMAX usage model. The fundamental component that separates these frameworks is the ground speed at which the frameworks are intended to oversee. In view of portability, wireless access systems are intended to work moving with no interruption of administration.

Fixed WiMAX

Broadband service and consumer usage of fixed WiMAX access is expected to reflect that of fixed wire-line service, with many of the standards-based requirements being confined to the air interface. Because communications takes place via wireless links from WiMAX Customer Premise Equipment (WiMAX CPE) to a remote Non Line-of-sight (NLOS) WiMAX base station, requirements for link security are greater than those needed for a wireless

service. The security mechanisms within the IEEE 802.16 standards are sufficient for fixed WiMAX access service.

Mobile WiMAXs

The 802.16a extension, refined in January 2003, uses a lower frequency of 2 to 11 GHz, enabling NLOS connections. The latest 802.16e task group is capitalizing on the new capabilities this provides by working on developing a specification to enable mobile WiMAX clients. These clients will be able to hand off between WiMAX base stations, enabling users to roam between service areas[3].

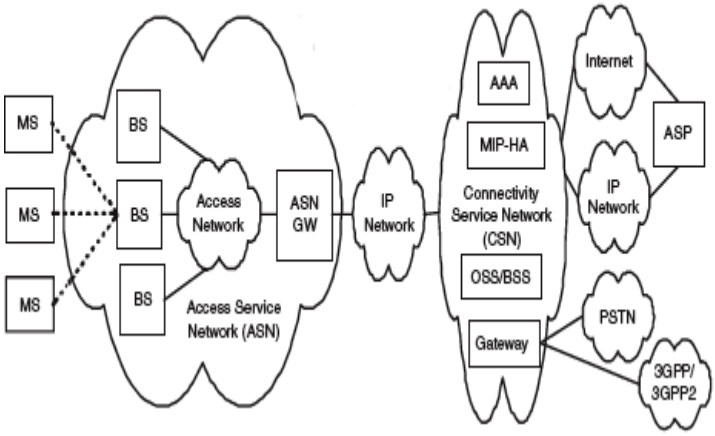
II. WIMAX ARCHITECTURE

The IEEE 802.16e-2005 standard gives the air interface to WiMAX, however does not characterize the full end-to-end WiMAX network. The WiMAX Forum's Network Working Group (NWG) is in charge of building up the end-to-end arrange necessities, architecture, and protocols for WiMAX, using IEEE 802.16e-2005 as the air interface.

The WiMAX architecture developed by the WiMAX form supports is a unified network architecture to support fixed, nomadic and mobile operation. The WiMAX network architecture is based upon an all-IP model.
The WiMAX network architecture comprises three major elements or areas.

- ***Remote or Mobile stations:*** These are the user equipments that may be mobile or fixed and may be located in the premises of the user.
- ***Access Service Network, ASN :*** This is the area of the WiMAX network that forms the radio access network at the edge and it comprises one or more base stations and one or more ASN gateways.
- ***Connectivity Service Network, CSN:*** This part of the WiMAX network provides the IP connectivity and all the IP core network functions. It is what may be termed the core network in cellular parlance.

IP-Based WiMAX Network Architecture



The overall WiMAX network comprises a number of different entities that make up the different major areas described above. These include the following entities:

- ***Subscriber Station, SS / Mobile Station, MS :*** The Subscriber station, SS may often be referred to as the Customer Premises Equipment, CPE. These take a variety of forms and these may be termed "indoor CPE" or "outdoor CPE" - the terminology is self-explanatory. The outdoor CPE has the advantage that it provides better performance as a result of the better position of the antenna, whereas the indoor CPE can be installed by the user. Mobile Stations may also be used. These are often in the form of a dongle for a laptop, etc.
- ***Base Station, BS:*** The base-station forms an essential element of the WiMAX network. It is responsible for providing the air interface to the subscriber and mobile stations. It provides additional functionality in terms of micro-mobility management functions, such as handoff triggering and tunnel establishment, radio resource management, QoS policy enforcement, traffic classification, DHCP (Dynamic Host Control Protocol) proxy, key management, session management, and multicast group management.
- ***ASN Gateway, ASN-GW:*** The ASN gateway within the WiMAX network architecture typically acts as a layer 2 traffic aggregation point within the overall ASN.
  The ASN-GW may also provide additional functions that include: intra-ASN location

management and paging, radio resource management and admission control, caching of subscriber profiles and encryption keys. The ASN-GW may also include the AAA client functionality(see below), establishment and management of mobility tunnel with base stations, QoS and policy enforcement, foreign agent functionality for mobile IP, and routing to the selected CSN.

- ***Home Agent, HA:*** The Home Agent within the WiMAX network is located within the CSN. With Mobile-IP forming a key element within WiMAX technology, the Home Agent works in conjunction with a "Foreign Agent", such as the ASN Gateway, to provide an efficient end-to-end Mobile IP solution. The Home Agent serves as an anchor point for subscribers, providing secure roaming with QOS capabilities.
- ***Authentication, Authorisation and Accounting Server, AAA:*** As with any communications or wireless system requiring subscription services, an Authentication, Authorisation and Accounting server is used. This is included within the CSN.

Important Wireless MAN IEEE 802.16 (WiMAX) Specifications:
Range - 30-mile (50-km) radius from base station
Speed - Up to 70 megabits per second
Non-Line-of-sight (NLoS) between user and base station
Frequency bands - 2 to 11 GHz and 10 to 66 GHz (licensed and unlicensed bands)
Defines both the MAC and PHY layers and allows multiple PHY-layer specifications.

III. WIMAX WORKING UNITS

In practical terms, WiMAX would operate similar to WiFi but at higher speeds, over greater distances and for a greater number of users. WiMAX could potentially erase the suburban and rural blackout areas that currently have no broadband Internet access because phone and cable companies have not yet run the necessary wires to those remote locations[4].
A WiMAX system consists of two parts:

- A **WiMAX tower**, similar in concept to a cell-phone tower - A single WiMAX tower can provide coverage to a very large area -- as big as 3,000 square miles (~8,000 square km)

Fig.1 **WiMAX tower**

- A **WiMAX receiver** - The receiver and antenna could be a small box or PCMCIA card, or they could be built into a laptop the way WiFi access is today.

Fig.2 **WiMAX receiver**

A WiMAX tower station can connect directly to the Internet using a high-bandwidth, wired connection (for example, a T3 line). It can also connect to another WiMAX tower using a line-of-sight, microwave link. This connection to a second tower (often referred to as a **backhaul**), along with the ability of a single tower to cover up to 3,000 square miles, is what allows WiMAX to provide coverage to remote rural areas.
WiMAX actually can provide two forms of wireless service:

- There is the **non-line-of-sight**, WiFi sort of service, where a small antenna on your computer connects to the tower. In this mode, WiMAX uses a **lower frequency range** -- 2 GHz to 11 GHz (similar to WiFi). Lower-wavelength transmissions are not as easily disrupted by physical obstructions -- they are better able to diffract, or bend, around obstacles.
- There is **line-of-sight** service, where a fixed dish antenna points straight at the WiMAX tower from a rooftop or pole. The line-of-sight connection is stronger and more stable, so it's able to send a lot of data with fewer errors. Line-of-sight transmissions use **higher frequencies**, with ranges reaching a possible 66 GHz. At higher frequencies, there is less interference and lots more bandwidth.

WiFi-style access will be limited to a 4-to-6 mile radius (perhaps 25 square miles or 65 square km of coverage, which is similar in range to a cell-phone zone). Through the stronger line-of-sight antennas, the WiMAX transmitting station would send data to WiMAX-enabled computers or routers set up within the transmitter's 30-mile radius (2,800 square miles or 9,300 square km of coverage). This is what allows WiMAX to achieve its maximum range.

The final step in the area network scale is the global area network (GAN). The proposal for GAN is **IEEE 802.20**. A true GAN would work a lot like today's cell phone networks, with users able to travel across the country and still have access to the network the whole time. This network would have enough bandwidth to offer Internet access comparable to cable modem service, but it would be accessible to mobile, always-connected devices like laptops or next-generation cell phones.

IV. WIMAX APPLICATIONS

At the most basic level, WiMAX supports mobile, fixed and nomadic wireless applications. A mobile application provides communication while the user is in transit. A good example is a business traveler who communicates while on a train. The Sprint Xohm service -- to be launched in spring 2008 -- will provide Internet access while moving at high speeds using WiMAX technology. It will compete with 3G technologies like EV-DO (from Verizon Wireless) and HSDPA (from AT&T).

Fixed wireless applications often provide last-mile connections in rural or underdeveloped areas that do not have Digital Subscriber Line (DSL), Hybrid Fiber-Coax (HFC), or other last-mile wired infrastructure. Enterprises can either purchase fixed WiMAX technology for use in their own private network (e.g., a point-to-point wireless connection between two buildings) or can purchase fixed WiMAX service from a wireless Internet service provider(WISP). Towerstream is an example of a WISP that provides fixed, high-speed WiMAX access for business users in many urban areas.

Finally, a nomadic application is one where a user moves from location to location but communicates only while stationary. A good example is a repairman who needs high-speed network access while parked at a customer location but not while driving. The WiMAX service from Clearwire can be used for nomadic (and fixed) applications.

V. FEATURES OF WIMAX

1. Scalability

(a). The 802.16 standard supports flexible radio frequency (RF) channel bandwidths.

(b). The standard supports hundreds or even thousands of users within one RF channel [5].

(c). As the number of subscribers grows the spectrum can be reallocated with process of sectoring.

2. Quality of Service

(a). Primary purpose of QoS feature is to define transmission ordering and scheduling on the air interface

(b). These features often need to work in conjunction with mechanisms beyond the air interface in order to provide end to end QoS or to police the behaviour or SS.

3. Range

(a). Optimized for up to 50 Km.

(b). Designed to handle many users spread out over kilometres [6].

(c). Designed to tolerate greater multi-path delay spread (signal reflections) up to 10.0μ seconds

(d). PHY and MAC designed with multi-mile range in mind

4. Coverage

(a). Standard supports mesh network topology
(b). Optimized for outdoor NLOS performance
(c). Standard supports advanced antenna techniques

VI. WIMAX TECHNOLOGY

The technology is relatively new, and several vendors are coming up with the support infrastructure. Intel and Fujitsu are among the leading providers of WiMAX compliant SoC chips. The SoCs' can be used to make Customer Premise Equipment (CPE) that are used to access WBA base stations. It is expected that 802.16 compliant systems would be in place by the end of 2005.

VII. COMPARISON OF WIMAX AND WIFI

The mail distinction between WiFi and WiMAX is speed and coverage distances. WiFi has a typical bandwidth of 2MBps whereas WiMAX can have a bandwidth of up to 75MBps[7]. The coverage distances also differ to a great extent. A WiFI hotspot typically covers a few hundred feet radius (fraction of a kilometer) whereas a WiMAX can practically cover up to a distance of 10 kilometers (6 miles). One probable application of MAN is to link several WiFi networks together with WBA (Wireless Broadband Access) using WiMAX technology[8].

Feature	**WiMax (802.16a)**	**Wi-Fi (802.11b)**	**Wi-Fi (802.11a/g)**
Primary Application	Broadband Wireless Access	Wireless LAN	Wireless LAN
Frequency Band	Licensed/Unlicensed 2 G to 11 GHz	2.4 GHz ISM	2.4 GHz ISM (g) 5 GHz U-NII (a)
Channel Bandwidth	Adjustable 1.25 M to 20 MHz	25 MHz	20 MHz
Half/Full Duplex	Full	Half	Half
Radio Technology	OFDM (256-channels)	Direct Sequence Spread Spectrum	OFDM (64-channels)
Bandwidth Efficiency	<=5 bps/Hz	<=0.44 bps/Hz	<=2.7 bps/Hz
Modulation	BPSK, QPSK, 16-, 64-, 256-QAM	QPSK	BPSK, QPSK, 16-, 64-QAM
FEC	Convolutional Code Reed-Solomon	None	Convolutional Code
Encryption	Mandatory-3DES Optional- AES	Optional-RC4 (AES in 802.11i)	Optional-RC4 (AES in 802.11i)
Mobility	Mobile WiMax (802.16e)	In development	In development
Mesh	Yes	Vendor Proprietary	Vendor Proprietary
Access Protocol	Request/Grant	CSMA/CA	CSMA/CA

CONCLUSION

Wimax provides high data rates, good network range and mobility. It is used as an alternative of wired technologies such as DSL, cable, and T1/E1 links to provide broadband access to customer sites gadgets. This paper tells some features, architecture, applications and comparison of Wimax with Wifi.

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