

Recent Trends of Wireless: WiMAX

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ABSTRACT

We are presenting here the new technology for accessing the internet through fast wireless means, naming WiMAX. Traditional methods (Wi-Fi, 3G) & need of WiMAX is also discussed along with its components, types, features, standards, workings and some problems. There are a lot of advantages of enhancement technology i.e. WiMAX to access internet fast over traditional internet accessing methods like DSL, cable modem, WiFi etc. but there are also some misconceptions related to WiMAX. Our topic shows how WiMAX is better than rest & why it's getting more importance for users. This project will investigate the performance of VoIP over WiMAX and Wi-Fi based wireless networks, compared to a baseline wired Ethernet network, to determine how the user calling experience is affected and whether mobile VoIP communication is feasible

Keywords: IEEE.802.16, WiMAX, security, CDMA, CMAS, DSL , CSN

I. INTRODUCTION

WiMAX is a latest wireless technology for accessing the internet with the high quality speed. It is also known for Forth Generation or simply says 4G technology. WiMAX stands for World-Wide Interoperability for Microwave access. 4G is the key to empower more potency to MAN and can access Internet fast to the widest used of devices including notebook PCs, handsets, smart-phones (Personal Digital Assistant which has mobile phone functionality) and consumer electronics such as gaming devices, cameras, camcorders, music players, and more. The technology provide up to 70MB/Sec without the need of cables. The technology is based on IEEE.802.16 standard. It is believed that WiMAX will replace DSL & cable Modem option for accessing internet. Although WiMAX is quite similar to Wi-Fi but WiMAX can support large no. of users, with high bandwidth over large distances with_low-cost, open networks and is the first all IP mobile Internet solution enabling efficient, Quality of service and scalable networks for data, video, and voice. WiMAX is intended for wireless "Metropolitan Area Networks". [1][2]

II. TRADITIONAL TECHNOLOGY TO ACCESS INTERNET

➤ DSL Modem

Digital subscriber line (DSL) technology transmits data over phone lines without interfering with voice service. The DSL line connects to your phone jack and the USB line or Ethernet to your computer.

➤ Cable Modem

A cable modem allows the user to get high-speed Internet from their cable provider, though in times of heavy usage with many connected users, performance might be significantly slower.

➤ T1 or T3 Line

The phone company has brought a fiber optic line into your office (T1 line might also come in on copper). [10]

Other two major options for accessing the internet are:

- WiFi access
- Dial-up access

What if there was a new technology that would provide:

- The high speed of broadband service
- Wireless rather than wired, so it would be a very less expensive than cable or DSL
- Much easier to extend to suburban and rural areas
- Broad coverage like the cell phone network instead of small WiFi hotspots[6][7]

III. WHAT IS WiMAX CAPABLE OF?

WiMAX is capable of up to 70 megabits per second, which is however split between multiple businesses and consumers. WiMAX has two sets of bands:

- *Licensed (2-11GHz)*

Licensed spectrum comes at a potentially high price, but it is well worth it, especially when the service offering requires high quality of service. The greatest advantage of having licensed spectrum is that the licensee has exclusive use of the spectrum. It is protected from outside interference while competitors can only enter the market if they also own or lease spectrum.

- *Unlicensed (10-66GHz)*

Unlicensed spectrum comes at a potentially high price; the barrier to entry is low, thus making it easier for a potential operator to begin offering services using the spectrum. In some instances, this can be advantageous for obvious reasons. Unfortunately, there are also several disadvantages relating to the Interference, Increased Competition, Limited power and Availability. [3][4]

IV. WiMAX NETWORK ARCHITECTURE

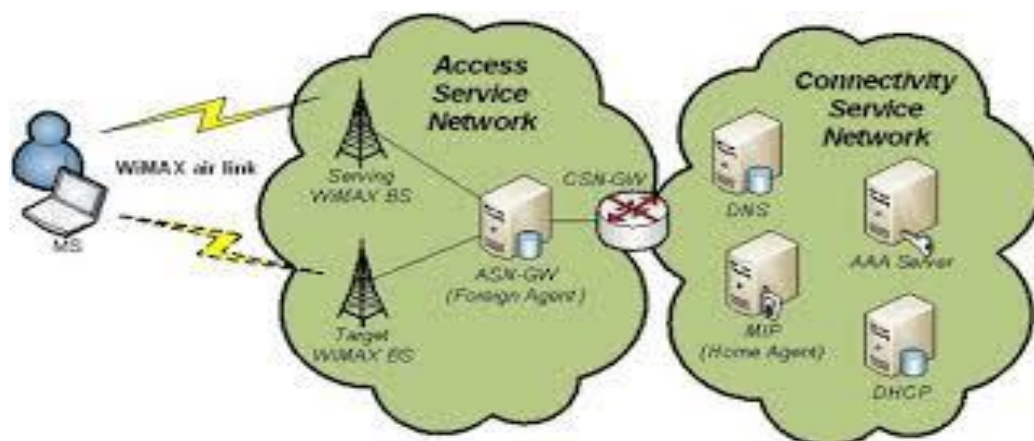


Figure 1: ASN/CSN



Figure 2. WiMAX network architecture

The overall network may be logically divided into three parts:

- Mobile Stations (MS) used by the end user to access the network.
- The access service network (ASN), which comprises one or more base stations and one or more ASN gateways that form the radio access network at the edge.
- Connectivity service network (CSN), which provides IP connectivity and all the IP core network functions.
- Base station (BS): The BS is responsible for providing the air interface to the MS. Access service network gateway (ASN-GW): The ASN gateway typically acts as a layer 2 traffic aggregation point within an ASN Connectivity service network (CSN): The CSN provides connectivity to the Internet, ASP, other public networks, and corporate networks. Figure1. shows some of the more important functional entities.

The WiMAX architecture framework allows for the flexible decomposition and/or combination of functional entities when building the physical entities. For example, the ASN may be decomposed into Base Station Transceivers (BST), Base Station Controllers (BSC), and an ASNGW analogous to the GSM model of BTS, BSC, and Serving GPRS Support Node (SGSN).[4]

V. WiMAX TECHNOLOGY COMPARISON vs Wi-Fi

WiMAX can distribute Wi-Fi from a 30 mile radius around a signal tower (providing you have line of sight).WiMAX can also be distributed via mobile WiMAX stations which have smaller coverage but higher levels of compatibility. As the Table1: [6][3]

Factors	WiMAX (802.16a)	Wi-Fi (802.11b)	Wi-Fi (802.11a/g)
Primary application	Broadband and wireless access	Wireless LAN	Wireless LAN
Frequency band	Licensed/unlicensed 2G to 11 GHz	2.4 GHz ISM	2.4 GHz ISM (g) 5GHz 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
FEC	Convolution Code Reed-Solomon	None	Convolution Code
Encryption	Mandatory-3DES Optional-AES	Optional-RC4 (AES in 802.11i)	Optional-RC4 (AES in 802.11i)
Access Protocol	Request/Grant	CSMA/CA	CSMA/CA
Mobility	Mobile WiMAX (802.16e)	In development	In development
Mesh	Yes	Vendor Proprietary	Vendor Proprietary

Table1. Technology Comparison

VI. HARDWARE PLATFORM FOR WiMAX IMPLEMENTATION

Designers of WiMAX systems need to meet a number of critical requirements such as processing speed, flexibility and time-to-market, and it is these stringent requirements that ultimately drive the choice of the hardware platform. Some of the major challenges are further described below.

➤ *Implementation Challenges*

➤ *Processing speed*

Broadband wireless systems such as WiMAX have throughput and data rate requirements that are significantly higher than those in cellular systems such as WCDMA and cdma2000. In order to be able to support such high data rates, the underlying hardware platform must have significant processing capabilities. In addition, several advanced signal processing techniques such as Turbo coding/decoding, and front end functions such as FFT/IFFT, beam forming, MIMO, CFR and DPD are very computationally intensive and require several billion multiply and accumulate (MAC) operations per second.

➤ *Flexibility*

WiMAX is a relatively new market and is currently going through the initial development and deployment process. 802.16Rev d has just been standardized while the 802.16e mobile version is still in the works. Under this current scenario, having hardware flexibility/reprogram ability in the end WiMAX compliant product is very important. This ensures that in-field programmability is possible, alleviating the risks posed by constantly evolving standards.

➤ *Time to Market*

Because WiMAX is an emerging technology, time-to-market is a key differentiator for OEMs looking for early success in gaining market share. This has a direct effect on the development cycle and choice of hardware platform, with designers requiring easy-to-use development tools, software, boards, and off-the-shelf IP and reference designs in order to accelerate the system design.

➤ *Cost Reduction Path*

Another important requirement to keep in mind while choosing the hardware platform is the availability of a long term cost reduction path. The evolving WiMAX standard/market is expected to stabilize after the initial uncertainty surrounding it, leading to a situation where cost of the final product becomes much more important than retaining flexibility. A hardware platform that has such a clear cost reduction path and enables a seamless flexibility/cost tradeoff is the need of the hour.

VII. FEATURES OF WiMAX

- Range: 30-mile (50-km) radius from base station.
- Data Rates: Higher
- Speed : 70 megabits per second
- Frequency bands: 2 to 11 GHz and 10 to 66 GHz (licensed and unlicensed bands)
- Cost: Installation cost is high.
- QoS: Excellent Quality Of service management

VIII. WiMAX STANDARDS

- Technically, WiMAX supports 802.16 specifications and will continue to developments as the specifications evolve, but other standards have also been produced based on the 802.16 specification. [9][10]

	802.16	802.16a	802.16e
Spectrum	10-66 GHz	2-11 GHz	<6 GHz
Configuration	Line of Sight	Non-Line of Sight	Non-Line of Sight
Bit Rate	32 to 132 Mbps (28 MHz Channel)	≤ 70 or 100 Mbps (20 MHz Channel)	Up to 15 Mbps
Modulation	QPSK,16-QAM,64-QAM	256 Sub-Carrier OFDM using QPSK,16-QAM,64-QAM	Same as 802.16a
Mobility	Fixed	Fixed	≤75 MPH
Channel Bandwidth	20,25,28 MHz	Selectable 1.25 to 20 MHz	5 MHz
Typical Cell Radius	1-3 miles	3-5 miles	1-3 miles
Completed	Dec,2001	Jan,2003	Mid of 2005

Table2. WiMAX Standards

IX. DRAWBACKS OF WiMAX

➤ Authentication Problem

Each Subscriber Station (SS) must have a X.509 certificate that will exclusively recognize the subscriber.

➤ Encryption Problem in WiMAX

➤ Management frames are not encrypted, permitting an attacker to collect data about subscribers in the area and other potentially sensitive network characteristics.

I Availability Problem in WiMAX

An attacker can use legacy management frames to forcibly disconnect legitimate stations. This is similar to the de-authenticate flood attacks used against 802.11 networks. [3][4]

X. THREATS TO WiMAX

➤ ***Denial of Service Attacks on WiMAX***

By triggering unnecessary state transitions that overload the base station with signal processing.

➤ ***Jamming and Packet Scrambling***

This type of attacks that WiMAX can most affect WiMAX's physical layer. Signals in the lower frequencies that cross or are in close proximity to the WiMAX antenna can produce second and third harmonic waves that interfere and can overload the WiMAX signal. For example: if we take 790MHz signal, we will find a second harmonic, although not as strong $2 \times 790 = 1580\text{MHz}$ and for third harmonic it is $3 \times 790 = 2370\text{MHz}$ which is much weaker.

➤ ***Threat of Identity Theft in WiMAX***

It includes reprogramming of a device with the hardware address of another device. The address can be stolen over the air by interrupting management messages.

➤ ***Threat of Water Torture in WiMAX***

In which an attacker Black Hat Threat to WiMAX: By the awful people thinking about cracking into the network or the computer system for their own financial benefit or mental satisfaction. [7][9]

XI. WiMAX SECURITY FUNCTIONS

➤ ***Support for Privacy***

User data is encrypted using cryptographic schemes of proven robustness to provide privacy.

➤ ***Authentication***

Terminal devices come with built-in X.509 digital certificates that contain their public key and MAC address.

➤ ***Flexible Key Management Protocol***

The Privacy and Key Management Protocol Version 2 (PKMv2) is used for transmitting keying material securely from the base station to the mobile station. PKM are also used to periodically reauthorize and refreshing the keys.

➤ ***Protection of Control Messages***

By using message digest schemes, such as Advance Encryption Standard (AES) based Cipher-based Message Authentication Code (CMAS) or Message Digest 5 based HMAC (Hash-based Message Authentication).

➤ ***Support for Fast Handover***

By use pre-authentication & a three-way handshake scheme is supported to optimize the re-authentication mechanisms. [5]

Common misconception is that the WiMAX can offer 70 Mbps in range of 70 miles (113 kilometers) with moving stations. In practice situation is a very different. It is true only in ideal circumstances with only one recipient.

With line-of-site (optical visibility), you could have speed of 10 Mbps at 10 kilometers.

Bandwidth is shared among users in a given radio sector. If there are many users in one sector, they will have lower speed. Users could have 2, 4, 6, 8, or 10 Mbps of the shared bandwidth. [5][8]



XII. WiMAX – THE

FUTURE WORK

In future, we may have just one device – a laptop, palmtop or WiMAX/GSM phone connected at work, home, on holiday and on the highway. Today's mobile devices are intended primarily for voice calls, and they are supplemented with a very small stream of data communications. Tomorrow's pocket device, by contrast, will be a small multimedia centre which can handle huge streams of data and video, including TV. Because WiMAX has been designed to move large amounts of data, we can assume that prices will change, too. Users won't have to pay per data unit. Instead they will pay a fixed monthly fee which allows them to download and upload unlimited amounts of data. Voice calls will be just one service among many. GSM companies see WiMAX as a technology which complements 3G, but the fact is that VoIP (Voice over Internet Protocol) is already nibbling away at the market share of traditional phone operators. This is a factor which must not be overlooked. Perhaps it is not all that far-fetched to think that WiMAX operators will soon be competing with traditional mobile operators.

XIII. APPLICATIONS OF WiMAX

➤ *Residential or Home and Broadband Internet Access*

Internet provided by WiMAX base station towers can be well utilized within the rural areas where DSL and Cable internet facilities are not available. Using WiMAX internet technology brings reliability to the customers as it being the wireless in nature there are no apparent mediums required to use it. WiMAX base station will simply connect to customer premises device and that will be all. Deploying WiMAX technology is very useful for developing countries where setup and reliability of Land line telecommunication infrastructure is poor.

➤ *Medium and small size business*

The WiMAX Wireless broadband Access (WBA) can be very well suited to provide the reliability and can meet the needs of small to medium scale business especially in low density area, whereas this may not work at its full potential in the area of high density. It has spectral limitation issues. There is a possibility that bandwidth may not be sufficient enough to provide access to large clients in high density area. This could bring the cost way up.

➤ *Backhaul networks for cellular base stations*

Backhaul networks for cellular base stations can be provided by bypassing the PSTN networks, Public Switched Telephone Network. This cost effective alternative can be achieved by cellular services by looking into Wireless

backhaul. Strong WiMAX technology can be preferable choice for backhaul for enterprises such as hotspots and point to point backhaul access solutions

➤ **Wi-Fi Hotspots**

This can allow users to access internet remotely by roaming outside office and homes. There are several Hotspots and WiMAX backhauls which are providing wireless solutions to wireless networks.

XIV.CONCLUSION

This project presenting the new technology for accessing the internet through fast wireless means naming WiMAX. It is high speed 4G technologies. WiMAX stations have smaller coverage but higher levels compatibility. Its range is 50km radius from base station.

Due to the best features of WiMAX there are some limitations like encryption and availability problems. In future we hope WiMAX operators will soon be competing with traditional mobile phones.

REFERENCES

- [1] "Air Interface for Fixed Broadband Wireless Access Systems," IEEE STD 802.16 – 2004, October, 2004.
- [2] "Air Interface for Fixed and Mobile Broadband Wireless Access Systems," IEEE P802.16e/D12, February, 2005.
- [3] Hassan Yagoobi, "Scalable OFDMA Physical Layer in IEEE 802.16 WirelessMAN", Intel Technology Journal, Vol 08, August 2004.
- [4] "WiMAX End-to-End Network Systems Architecture - Stage 2: Architecture Tenets, Reference Model and Reference Points," WiMAX Forum, December, 2005.
- [5] L.J. Cimini, "Analysis and Simulation of a Digital Mobile Channel Using Orthogonal Frequency Division Multiplexing," IEEE Trans. Comm., vol. COM-33, no. 7, pp 665-675, June 1985.
- [6] Richard Van Nee and Ramjee Prasad, "OFDM for Wireless Multimedia Communications," Artech House, 2000.
- [7] W. Xiao and R. Ratasuk, "Analysis of Hybrid ARQ with Link Adaptation", Proceedings of the Annual Allerton Conference on Communications, Control, and Computing, pp. 1618-1619, Oct 2002.
- [8] G. Nair, J. Chou, T. Madejski, K. Perycz, P. Putzolu and J. Sydir "IEEE 802.16 Medium Access Control and Service Provisioning", Intel Technology Journal, vol 08, August 2004.
- [9] F. Wang, A. Ghosh, R. Love, K. Stewart et.al., "IEEE 802.16e System Performance-Analysis and Simulation Results", Proc. of PIMRC, Berlin, Germany, Sept. 2005.
- [10] W. Hruday and Lj. Trajkovic, "Streaming video content over IEEE 802.16/WiMAX broadband access," *OPNETWORK 2008*, Washington, DC, Aug. 2008.
- [11] Kostas, T.J, et al., "Real-time voice over packet-switched networks," *Network, IEEE*, vol. 12, no. 1, pp. 18-27, Jan/Feb 1998.