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Wi-Fi or Wi-MAX?: A Comparitive Study

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Abstract

Wireless technology and networking are becoming one of the major areas of research today because of its ubiquitous applications. This paper gives an overview of the technologies-Wi-fi and WiMAX, on how they work and their respective problems as well as applications. It provides a technical analysis and a detailed comparison between IEEE 802.11(Wi-fi) and IEEE 802.16(WiMAX). This paper even evaluates the Quality of Service (QoS) in Wi-fi compared with WiMAX along with many other parameters and in conclusion provides the better of the two.

Keywords— Wi-Fi, WiMAX, QoS

Introduction

Wireless networks refer to any type of computer network that is not connected by cables of any kind. It is an important method by which homes, telecommunication networks and businesses avoid the cost of introducing cables or as a connection between various equipment locations. With the help of many communication engineers IEEE has developed various wireless standards, out of which this paper will talk about 802.11(Wi-fi) and 802.16(WiMAX), which are each deployed to fulfill certain criteria and hence they tend to complement each other.

OVERVIEW OF WI-FI AND WIMAX

Wi-Fi Networks

Wi-Fi stands for “wireless fidelity”. Wi-Fi is the technology which appeared early in the wireless arena. Wi-fi is based on the IEEE 802.11 wireless local area network (WLAN) specification. It was developed for close range devices like laptops and PCs for homes and office environments. Recently though it has found use in televisions, digital cameras and even DVD players. But the access of Wi-Fi is limited to only a specific area and its establishment is limited to some restricted place.

Wi-Fi is not a technical term though. Routers that incorporate a subscriber modem or cable modem set up a Wi-Fi access point to which consumer electronic devices are connected. The region which is covered by more than one access point forms a hotspot. Hotspots can range from a single room to thousands of square feet. Wi-Fi also allows connectivity in the wireless ad-hoc mode which enables devices to connect directly with each other. There are various Wi-Fi standards which use Radio Technologies to transmit and receive and data at high speed, which are IEEE 802.11a, IEEE 802.11b and 802.11g. Different devices use these different frequency bands so as to not interfere with each other and create distortion. However these devices cannot communicate with each other, for example 802.11a mobile cannot communicate with 802.11g mobile.

The working of a Wi-Fi network is the same as that of a walkie-talkie. A Wi-Fi hotspot is created by installing an access point to an internet connection. An access point acts as a base station. When Wi-Fi enabled device encounters a hotspot the device can then connect to that network wirelessly. A single access point can support up to 30 users and can function within a range of 100 – 150 feet indoors and up to 300 feet outdoors. Many access points can be connected to each other via Ethernet cables to create a single large network. This has fairly high power battery consumption as compared to Bluetooth and ZigBee module.

Standard	802.11b	802.11a	802.11g
Range	100-150 feet indoors	27-75 feet indoors	100-150 feet indoors
Frequency	2.4GHZ	5GHZ	2.4GHZ
Speed	11 Mbps	54Mbps	54Mbps

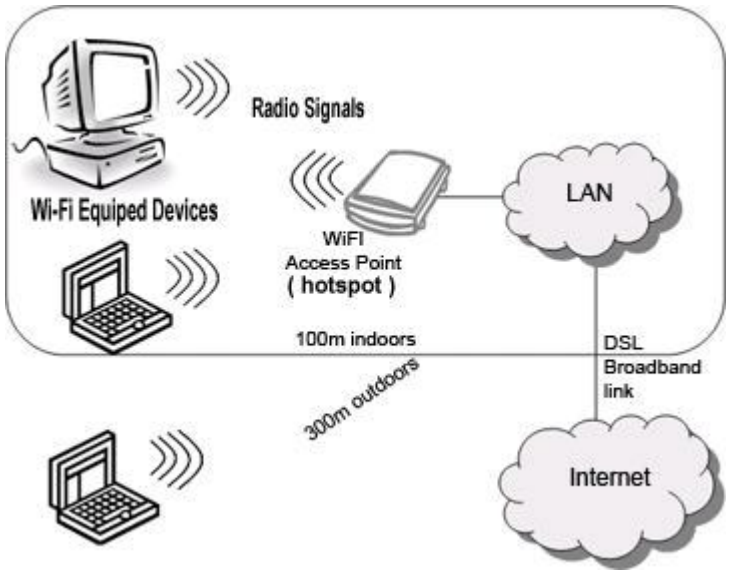

FIG I.A. WI-FI NETWORK

WiMAX Networks

WiMAX (Worldwide Interoperability for Microwave Access) is a telecommunications protocol that provides fixed and mobile Internet access. The WiMAX produces up to 40 Mbit/s using the IEEE 802.16m and also the release in maximum speed is up to 1 Gbit/s. The name "WiMAX" was created by the WiMAX Forum. The forum describes WiMAX as "a standards-based technology enabling the delivery of last mile wireless broadband access as an alternative to cable and DSL".

It is a standard typically based on global interoperability including ETSI HIPERMAN, IEEE 802.16d-2004 for fixed, and 802.16e for mobile high-speed data. WiMAX is gaining popularity as a technology which delivers carrier-class, high speed wireless broadband. It has been designed in a cost effective way to deliver broadband over a large area. It is intended to handle high-quality voice, data and video services while offering a high QoS (Quality of Service).

WiMAX operates in between 10 and 66 GHz Line of Sight (LOS) at a range up to 50 km (30 miles) and 2 to 11GHz non Line-of-Sight (NLOS) typically up to 6-10 km (4-6 miles) for fixed customer premises equipment. Both the fixed and mobile standards include the licensed (2.5, 3.5, and 10.5 GHz) and unlicensed (2.4 and 5.8 GHz) frequency spectrum. However, the frequency range for the fixed standard covers 2 to 11 GHz while the mobile standard covers below 6 GHz. Depending on the frequency band, it can be Frequency Division Duplex (FDD) or Time Division Duplex (TDD) configuration. The data rates for the fixed standard will support up to 75 Mbps per subscriber in 20 MHz of spectrum, but typical data rates will be 20 to 30 Mbps.

With the large coverage range and high data transmission rate WiMAX open the door of the technology to a variety of applications. WiMAX can be used as a backbone for IEEE 802.11 hotspots for connecting to the global world, as well as a subscriber can connect WiMAX enabled mobile devices such as providing a DSL or T1/E1 service for a business customer to a relatively remote location or outer suburbs can take several months and the cost associated with it is very high. With the help of WiMAX, a service provider can provide that service in a short time and in a very cost effective way.

A WiMAX network is generated when a user sends data from a subscriber device to a base station then that base station broadcast the wireless signal into channel which is called uplink and base station transmit the same or another user is called downlink. The base station of WiMAX has higher broadcasting power, antennas and enhanced additional algorithms. When the signal transmits from user to WiMAX base station or base to user the wireless channel faces many attenuation such as fraction, reflection, refraction, wall obstruction etc. OFDMA that prohibit interfering which can be multiplexed also makes possible power prioritization for various sub carriers according to the link quality. WiMAX is providing quality of service (QoS) which enables high quality of data like VoIP or TV broadcasts. WiMAX technology support various protocol such as VLAN, ATM, IPv4, Ethernet etc.

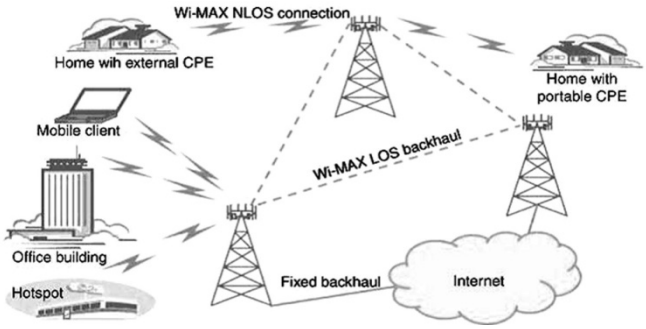

FIG I.B. WI-MAX NETWORK

COMPARISON BETWEEN WI-FI AND WIMAX

MOBILITY

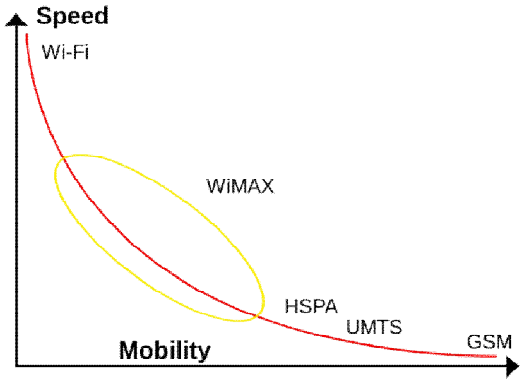

FIG III.A. MOBILITY VS SPEED

The mobility of a network is based on networking points. It works as the short-range wireless networking, such as to network PCs within the building. The following graph represents comparison of the speed and mobility of the network.

RADIO TECHNOLOGY

WiMAX differs from Wi-Fi in the radio technology sector. The IEEE 802.11 WLAN standards describe four radio link interfaces that operate mainly in unlicensed radio band having range from 2.4 G to 5 GHz. The lower frequency bands support Non-line-of-sight (NLOS) for that reason customer unit need not be aligned with base station. Wi-Fi mainly operates in unlicensed frequency bands, but WiMAX can operate in both licensed and unlicensed spectrum.

EFFICIENCY

Maximum channel bandwidth for Wi-Fi is 25 MHz for IEEE 802.11b and 20 MHz for either IEEE 802.11a or g networks. The maximum bit rates it's providing is 54 Mbps.

Wi-Fi has latency in the range of 50 ms hence little bit higher latency. In WiMAX, the channel bandwidths are in the range of 1.25 MHz to 20 MHz. Basically there has been lots of confusion regarding the actual bit rate of a WiMAX channel. But many articles give a range in of 70 M or 100 Mbps, basically exact transmission rate depends on the assigned bandwidth of the channel. WiMAX have latency in between the range of 25 to 40 ms, which is quite a considerable range.

MAXIMUM COVERAGE RANGE

OFDM modulation has a high spectral effectiveness that why WiMAX ranges 8 km (NLOS) to 50 km (LOS). It handles many users who are widely spread out. Mesh topologies and smart antenna techniques can be used to improve the coverage. The OFDM designed for the BWA and main goal is to provide long range transmission. 802.16 is designed for high power OFDM used to maximize coverage up to tens of kilometers. In contrast, IEEE 802.11 standard have a basic CDMA and OFDM approach with a quite different vision. It required very low power consumption of energy that whys it can support very limited range of coverage. It is mainly designed for indoor use. Optimize range of this technology is around 100 meters.

SECURITY

One of the major issues that differentiate Wi-Fi & WiMAX is security. It's a major issue because it protects transmissions from eavesdropping. But security has been one of the major lacking in Wi-Fi, encryption is optional here. WiMAX is designed for public network so security is very much crucial here. So all the data that is transmitted in WiMAX network is virtually encrypted. The main encryption technique that is used here is 168-bit Digital Encryption Standard (3DES), the same encryption also used on most secure tunnel VPNs. There are also plan to include the Advanced Encryption Standard (AES) in WiMAX to maximize the security.

MOBILITY MANAGEMENT

Mobility management is supported by WiMAX. The latest IEEE 802.16e is made for Mobile WiMAX. This standard supports mobile capability with the support of hand-offs capability, mainly for users when they moved between cells. Its support data rates up to 500 kbps, equivalent to the highest speed cellular offerings. Currently mobility management is not supported by Wi-Fi. But recently IEEE has begun to development of a roaming standard for Wi-Fi. However, WLAN switch vendors like Cisco, Aruba, and Airespace have developed their own proprietary hand-off protocols.

QUALITY OF SERVICE (QoS)

Wi-Fi is based on a contention based MAC (CSMA/CA).Hence no guaranteed QoS is provided mainly it can support best offer services. The Standard does not permit for different service level for each user. There is a plan to incorporate QoS in the 802.11-e standard. In this standard two operating modes will be included to improve service for voice one is Wi-Fi Multimedia Extensions (WME) and another one is Wi-Fi Scheduled Multimedia (WSM)QoS in IEEE 802.16 is based on a request/grant protocol. Its support multiple QoS which is build in MAC. It is designed to support

different service levels such as T1/E1 for businesses and best effort to be provided to the consumer. This protocol supports delay sensitive services such as voice and video. The dynamic TDMA based technique allows the suitable support for multicast and broadcast.

	Wi-Fi(a)	Wi-Fi(b)	Wi-Fi(g)	WiMAX
Standard	802.11a	802.11b	802.11g	802.16
Frequency (GHz)	5	2.4	2.4	2.66
Speed Mbps	54	11	54	80
Range	50m	100m	100m	50km
Advantages	Speed	Low cost	Speed	Speed, Range
Disadvantages	Cost	Speed	Cost, Range	Cost
Radio technology	OFDM	Direct sequence spread spectrum	OFDM (64 - channels)	OFDM (256-channels)
Mobility	In development	In development	In development	Mobile WiMAX (802.16e)
Primary application	Wireless LAN	Wireless LAN	Wireless LAN	Broadband wireless access

APPLICATIONS

As in many fields, there is no one technology that universally provides the best fit. It all depends on the specific application. If the application is providing broadband access for mobile users, then WiMAX is the more suitable technology since it was specifically designed for this type of application.

However, if the application is providing broadband access for fixed and nomadic users in limited zones, then Wi-Fi has similar performances as WiMAX, provided that the interference level is low or can be dealt with. If the application is providing backhaul for security and surveillance cameras, then Wi-Fi is definitely the more suitable technology since in most cases only the unlicensed spectrum is available for this task.

In some applications WiMAX and Wi-Fi together can be successfully combined, to benefit from the advantages each technology has to offer. For example, Wi-Fi is used to provide the last “half a mile” access to the end user, and WiMAX is used to provide long range backhauling to the ISP’s POP. The benefits of this combination include: Cost effective backhaul, with long range, interference free, licensed WiMAX. Cost effective access, exploiting zero cost Wi-Fi clients, which already exist in laptops and many PDAs and other end user devices.

CONCLUSION

This paper has studied two emerging wireless standard technologies: Wi-Fi (IEEE 802.11), WiMAX (IEEE 802.16). A strong comparison in the performance of Wi-Fi compared with that of WiMAX is made using some important characteristics. It is shown that the problems in Wi-Fi network are overcome by the WiMAX network. Here the entire problem of the Wi-Fi network is restricted area. But the WiMAX has no restriction to work. Both of the networks are reliable networks. Compared to Wi-Fi network, WiMAX technology is more secure, reliable and flexible. Technical data was collected for both of these technologies. It was determined that WiMAX signals

form the arrival of next wave of wireless access. Limited range and data capability of Wi-Fi helps WiMAX to have a heavy marketed future.

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