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# A Survey on Evolution, Architecture and Applications of Wi-Max

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### **Abstract:**

WiMAX is an emerging new technology that offers opportunities to telecom operators for enhanced broadband coverage and service offering. The broadband wireless Technologies is based on IEEE 802.16. It is known as Worldwide Interoperability for Microwave Access(WiMAX). The WiMax Forum describes WiMAX as" a standards-based technology enabling the delivery of few-mile wireless broadband access as an alternative to cable and DSL". The main goal/purpose of this technology is to deliver wireless communications with quality of service in a secured environment. The main objectives of this paper are to gain knowledge about the WiMAX technology, its security and application. This paper will cover the applications and characteristics of emerging wireless technologies: Wireless Local Area Networks (WiFi-802.11n), Wireless Personal Area Networks (ZigBee) and Wireless Metropolitan Area Networks (WiMAX).

### **Keywords:**

Wi-MAX, ZigBee, Security, Wi-Fi.

### **1. INTRODUCTION:**

Today's broadband Internet connections are limited to wired infrastructure using digital subscriber line (DSL), T1 or cable-modem based connection. However, these wired infrastructures are considerably more costly and time- consuming to deploy than a wireless connection. Worldwide Interoperability for Microwave Access, is a telecommunications technology that provides for the wireless data transmission using a various of transmission modes, from point-to-point links to full mobile cellular-type access. WiMAX is one of the nascent and hottest broadband wireless technologies around today.

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The technology is based on the IEEE 802.16 standard (also called Wireless MAN). The name "Wimax" was created by the Wimax Forum, which was formed in June 2001 to promote conformity and interoperability of the standard. WiMAX systems are expected to deliver broadband access services to residential and enterprise users in an economical way. WiMAX would operate or work similar to Wi-Fi, [8] but at higher speeds over larger distances and for a greater number of customers. WiMAX can provide service even in areas that are most difficult for wired infrastructure to reach and the capability to overcome the physical limitations of traditional wired infrastructure. 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.

Wimax is a wireless digital communications system, also known as IEEE 802.16, which is intended for wireless "metropolitan area networks". Wimax can provide broadband wireless access up to 30 miles for fixed stations, and upto 10 miles for mobile stations. The IEEE 802.16 standard defines the technical features of the communications protocol. This paper presents an overview survey of emerging wireless technologies – 802.11n, 802.15.4 and 802.16 [2]. In this paper first we study architecture and resolution of Wi-Max and in third section discussed about types of WiMAX. In fourth section we will discuss the comparison of Wi-Fi,ZigBee And Wi-Max followed by conclusion.

# 2. ARCHITECTURE AND EVOLUTION OF Wi-MAX

## 2.1 ARCHITECTURE OF Wi-MAX

The key feature of WiMAX networks is that the security layer is built into the protocol stack instead of



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being added on later. The messages for authentication and key exchange are defined as part of the medium access control (MAC) layer. The MAC layer performs encryption based on the keys negotiated during the key exchange phase [1].



Figure 1: Wi-MAX Architecture

Basically WiMAX Layer Architecture consists of two layers. They are

- 1) Physical layer
- 2) Data link Layer

## **Physical layer:**

The IEEE 802.16 physical layer protocols include multiple specifications, defined through several amendments and revisions, each appropriate for a particular frequency range and application. The IEEE 802.16 compliant devices include mobile stations or base stations.

- It is responsible for receiving MAC frame.
- In this we used OFDMA (orthogonal frequency division multiplexing technique).
- It supports both full duplex and half duplex transmission.
- It uses TDD and FDD techniques.

# Data link Layer:

The data link layer of IEEE 802.16 standard comprises three sub-layers

- I. MAC CS (convergence sub layer)
- II. MAC CPS (common part sub layer)
- III. Security sub layer

## Medium Access Control Service Specific Convergence Sub layer (MAC CS):

The service-specific convergence sub-layer (CS) provides any transformation or mapping of network-layer data packets into MAC SDUs.

On the transmitter side, the CS receives the data packets through the CS Service Access Point (SAP) and delivers MAC SDUs to the MAC Common Part Sub-layer (MAC CPS) through the MAC SAP.

# Medium Access Control Common Part Sub layer (MAC CPS):

The MAC CPS provides the core MAC functionality of system access, bandwidth allocation, connection establishment, and connection maintenance. It can receive data from the various convergence sub-layers, through the MAC SAP classified into particular MAC connections.

## Security sub layer:

The MAC also contains a separate security sub-layer providing authentication, secure key exchange, and encryption. It used two protocol for maintain security in Wi-Max

- Encryption protocol: used for encryption data packet.
- PKM protocol: used for key management and authentication technique.

# 2.2 EVOLUTION OF Wi-MAX:

The working group of IEEE 802.16 has developed some standards for WiMAX. The first standard was published in 2001 and focused on the frequency range between 10 to 66 GHz and required line-of-sight (LOS) transmission between the sender and the receiver. This reduces multipath distortion, thereby enhancing communication efficiency. Theoretically, IEEE 802.16 can provide single transmission data rates 10 to 75 Mbps on both the uplink and downlink. Service -Providers could use multiple IEEE 802.16 channels for a single transmission to provide bandwidths of up to 350 Mbps [2]. Support for portable or mobile devices is considered in IEEE 802.16e std., which is published in 2005. WiMAX networks consist of some Subscriber Stations and a central radio Base Station. In the WiMAX network, Base station is fixed in nature is connected to the public network and can handle multiple sectors simultaneously, and Subscriber station are mobile.



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In this section, we describe the development phases of IEEE 802 .16 extension from the beginning to last release. In this section we describe the development phases of IEEE 802 .16 extension from the beginning to last release of WiMAX [3].

Table	1: Evolution	of WiMax	Standard

IEEE STANDARD	YEAR	FREQUENCY BAND	SPECIFIC FEATURES	
802.16	2001	10-66GHz	The Initial version of WiMAX based on the single carrier physical layer and the burst TDM MAC layer. Use (line of sight towers) to fixed location	
802.16a	2003	2-11GHz	Operates with Non-Line of Sight. Max transmission rate is 75 Mbps.	
802.16c	2003	10-66GHz	Broadband Wireless Access. Interoperability specification.	
802.16d	2004	2-11GHz	Based on 802.16 std. With some improvement and support both TDD and FDD transmission.	
802.16e	2005	2-6GHz	Privacy sub —layer for network security and power saving mode for MS. Mobility support to 65 mph with data Transmission rate up to 15 Mbps and distance area 1-3 miles.	
802.16f	2005	2-11GHz	The 802.16f define the mesh networking and management information base. Improve the coverage area.	
802.16g 802.16h 802.16i 802.16j 802.16k 802.16k	2007- 2011	2-11GHz	Data transferrate: mobile user 100Mbps Fixed user 1 GB. Multi-hop relay specification. Advance data — interface. Management plan procedure and services, mobility at the higher level.	

#### **3. TYPES OF Wi-MAX:**

WiMAX can be differentiated/grouped into two basic standards types, fixed and portable /mobile. The WiMAX standards are continuously evolving to keep up with other standards in various advances that are being made with unique protocols.

### A. Fixed WiMAX:

WiMAX can be used for point to point communication. Fixed wireless access protocols are designed in IEEE 802.16 Standard 2004 Release. The Standard 802.16d is referred as Fixed WiMAX. Mounted antennas used at subscriber's site for data transmission. So may be referred as "Fixed Wireless" and those antennas are mounted on roof/mast, similar to a satellite television dish. The IEEE 802.16 2004 Release addresses indoor installations for safety purpose. It connects businesses and homes to high speed Internet [3]. Orthogonal Frequency Division Multiplexing (OFDM) modulation is used in Fixed WiMAX which supports subchannelization in the Uplink. OFDM breaks the wireless carrier into 256 subcarriers.

### **B. Portable/Mobile WiMAX:**

The IEEE 802.16 Standard 2004 Release also provides goals for portability. The Standards 802.16e and 802.16m supports the mobility. WiMAX has the ability to support both 3G and 4G technology.

The WiMAX standard 802.16e comes under the 3G classification (IMT-2000) while 802.16m is classified as a 4G technology [4]. Orthogonal Frequency Division Multiple Access (OFDMA) modulation is used in mobile WiMAX. OFDMA is similar to that of OFDM just more improved version. In this, multiple subcarriers grouped into subchannels. OFDMA improves multipath performance.

# 4. COMPARISON OF Wi-Fi, ZigBee AND Wi-MAX

Table 2: comparison of Wi-Fi and Wi-MAX

Common Name	Wi-Fi(802.11)	ZigBee(802.15)	Wi-MAX(802.16) Upto 70Mbps	
Bandwidth	11-54Mbps	20-250kbps		
Range(LOS)	100meters	10-50meters	30-50Km	
Frequency/ Spectrum	2.4GHz for 802.11b/g 5.2GHz for 802.11a	868MHz-2.4GHz	2-11 GHz for 802.16a 11-60 GHz for 802.16	
Standardization	802.11a,b and g	802.15.4	802.16, 802.16a and, 802.16REVd, 802.16e	
Mobility	Portable	Portable	Fixed(Mobile-16e)	
Network Topology	Infrastructure( Ad-hoc also possible)	Ad-hoc	Infrastructure	
Access Protocol	CSMA/CA	CSMA/CA	Request/Grant	
Applications Warless LAN, Internet		Sensor networks	MetroareaBroadband	

### **5. APPLICATIONS OF Wi-MAX**

According to the characteristics and strengths of the WiMAX technology, WiMAX applications are focused on Wireless MAN. On one hand, it can be used as a complement to wired broadband access technologies to improve the coverage and flexibility of broadband access. On the other hand, it is regarded as a Wireless MAN technology on a par with Wi-Fi. The two technologies separately serve MAN and LAN that are complementary to each other. In this solution, WiMAX is used as a supplement to wired broadband access modes for wireless access of individual broadband users and subscribers of the enterprise's network to MAN [6]. The solution can surmount physical difficulties that traditional wired systems have and be fit for downtown buildings with access problems, suburbs far from switch offices and rural areas with a sparse population and poor telecom infrastructure. It helps greatly reduce the construction investment of broadband applications in these areas. For example, exhibition centers in cities are typical application sites of the solution.



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Only one T1 access is used to meet daily demands, while WiMAX services can be just applied for a large amount of Internet and VPN access demands when there are conferences or exhibitions there. Another application of the solution is to use WiMAX as a Wireless MAN technology to directly implement wireless access for TEs. A typical application is, for example, to provide wireless terminal users with "best wireless access". Wireless terminal users realize access via IEEE 802.11 in hotspots and IEEE 802.16 in other areas of MAN except hotspots. In this way, the users can always keep wireless access in MAN. Besides, a WiMAX system can be used as a wireless loop of IEEE 802.11 access hotspots, that is to say, its SSs follow IEEE 802.11 specifications and the WiMAX technology is used to connect Wireless MAN with operator's backbone network. Accordingly, the problem of deploying IEEE 802.11 networks in areas with difficulties in building wired loops is solved [5].

### 6. CONCLUSION:

This paper has presented an overview of emerging wireless technologies. 802.11n is viewed as the most likely contender for the home network backbone. ZigBee, on the other hand, is likely to make best use of its low-power and high-speed operation in short-range equipment interconnects. 802.11n is viewed as being superior in maintaining compatibility with existing wireless LAN, while ZigBee is generally thought more likely to achieve lower levels of power consumption.

Our vision of the future is that WiMAX will enable mobile broadband at an affordable price. This will be achieved through the adoption of WiMAX by a cellular provider seeking to make a jump to this disruptive technology. WiMAX is not expected to completely eliminate the Wi-Fi technology in the near future, but will be a complement to Wi- Fi as its primary backhaul service of choice. This Paper provided quick overview of concept, technology, standard and applications for IEEE 802.16 WiMAX, evolution and various types of WiMax.

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