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Modelling and Performances Analysis of WiMAX/IEEE 802.16 Wireless MAN OFDM Physical Downlink

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***Abstract*— The Recently world wireless communication systems are involved in every part of life. Worldwide Interoperability for Microwave Access (WiMAX) is OFDM-based technology that supports point to multi-point broadband wireless access for the next generation radio access. Main application (fixed and mobile) of WiMAX today is for MAN/WAN base stations and link stations. That WiMAX te chnology is the upcoming wireless system which uses IEEE standard 802.16. By using this technology it can overcome the limitations of the existing wireless communication like short coverage area, lack of security and low data.**

Also WiMAX technology offers a great deal of data rate with a great coverage area, recently the diamond on broadband is increase and wireless also because it is easy to install for provider of serves and for customer, and WiMAX offer wireless broadband with reasonable price.

This paper aims to investigate and simulate a WiMAX/IEEE 802.16 Wireless MAN OFDM Physical Downlink system. The investigation part includes a how WiMAX does it work , WiMAX technology Standard, and comparison of WiMAX with other wireless technologies. Also include advantages and disadvantages of WiMAX technology and their applications

The simulation results achieved for Varying multipath fading channel with AWGN into three cases such as for a channel is no fading, frequency selective fading and frequency flat fading. That results are include include the measured spectrum of the transmitted signal, spectrum of the signal at the channel output, constellation diagrams of both the signal after the modulation and the received signal prior to demodulation . Also measured SNR in each case.

***Keywords*—** WiMAX, Channel, Fading, OFDM and wireless communication**.**

I. Introduction

The Worldwide Interoperability for Microwave Access (WiMAX), is a telecommunications technology proposed at providing wireless data over long distances in a different ways, from point-to-point links to full mobile cellular type access . The Overview of WiMAX technology is illustrated in figure 1 , that technology is a wireless digital communications technique that is intended for wireless .This technology can provide broadband access up to 50 km (30 miles) for fixed stations, and in the range of 5 to 15 km (3 - 10 miles) for mobile stations.

WiMAX is a standards-based technology enabling the delivery of last mile wireless broadband access as an option to wired broadband like cable and digital subscriber line (DSL). WiMAX provides fixed, traveling, and moveable. Almost immediately, mobile wireless broadband connectivity without the require for directs line-of-sight (LOS) with a base station. For a typical cell radius operation of 3 to 10 kilometers, WiMAX debate specialized systems can be expected to deliver capacity of up to 40 Mbps per channel, for fixed and moveable access applications.

Alot of companies are closely examining WiMAX for the last mile connectivity at high data rates. The resulting competition may bring lower pricing for both home and business customers or bring broadband access to places where it has been inexpensively unavailable. Prior to WiMAX, a lot of operators have been using proprietary fixed wireless technologies for broadband services. The bandwidth and reach of WiMAX make it suitable for some potential applications such as connecting Wi-Fi hotspots with each other and to other parts of the Internet, providing a wireless alternative to cable and DSL for last mile broadband access, also providing high-speed data and telecommunications services, providing a diverse source of Internet connectivity as part of a business continuity plan and providing nomadic connectivity.

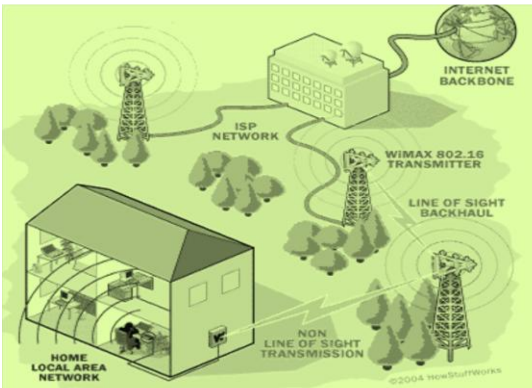

Fig 1. WiMAX Technology Overview

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II HOW DOES WIMAX WORK?

WiMAX utilizes radio microwave technology to provide wireless internet service to computers and other devices that are equipped with WiMAX compatible chips for example personal digital assistants, cell phones, …etc. It works more or less like cellular network technology, due to WiMAX technology also involves the use of a base station to establish a wireless data communication link just as in the same way it is needed in cellular networks like global system for mobile communication (GSM) and universal mobile telecommunication system (UMTS). The theoretical range of WiMAX is up to 50Km's (30 miles) and obtains data rates up to 75 Mbps, although at very long range that is greater than 50Km's the throughput is closer to the 1.5 Mbps. WiMAX operates same as wireless -fidelity (Wi-Fi) but with two very convincing differences as compared to Wi-Fi, these are data rate and data range. The typical WiMAX scenario engages a base station normally mounted on top of the building or at some high placeswhere it can provide optimum coverage and a WiMAX receiver that can be in any form like for e.g a chip installed in laptops or customer premises equipment (CPE) or home personal computer's just similar to Wi-Fi chip.

At the present, there are two steps that make up the whole communication model in WiMAX. These steps are summarized in the following points:

• Data transmission from WiMAX receiver (CPE or WiMAX Chips) to the WiMAX base station (BS).

• Data transmission from BS to backbone internet.

Transmission data between two towers can be through a microwave transmission media link and WiMAX base station can also be connected to the internet protocol (IP) backbone network using a wired connection as represented in figure 2 . Communication between WiMAX BS and subscriber can be point to multipoint where as communication between two WiMAX BSs could be in form of point to point LOS.

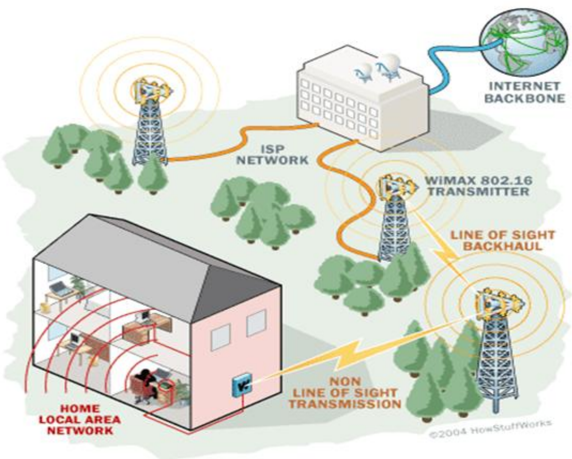

Fig 2 . WiMAX operation

III **WiMAX TECHNOLOGY STANDAES**

It is important to note that the IEEE 802.16 standard and WiMAX focus almost exclusively on the digital aspects of wireless communication, in particular at the transmitter side. The receiver implementation is unspecified; each equipment manufacturer is welcome to develop efficient proprietary receiver algorithms. Aside from agreeing on a carrier frequency and transmit spectrum mask, few requirements are placed on the RF units. The standard is interested primarily in the digital transmitter because the receiver must understand what the transmitter did in order to make sense of the received signal but not vice versa.

The IEEE 802.16 standard (also known as the air interface for fixed broadband wireless access (FBWA systems or IEEE WMAN air interface) is the first version of 802.16 family standards (published in April 2002). It specifies fixed broadband wireless systems operating in the 10–66 GHz licensed spectrum, which is expensive but there is less interference at the high-frequency band and more bandwidth is available. Because radio waves in this band are too short to penetrate buildings, the 802.16 standard is only used for line-of-sight (LOS) connections. Compared to non-line-of-sight (NLOS) connections, LOS links are not so flexible but are stronger and more stable against transmission error. IEEE 802.16 is interoperable with other wireless networks, such as cellular systems and wireless local area networks (WLANs).

IEEE 802.16-2004 is a wireless access technology standard optimized for fixed and nomadic access, which was published in October 2004. It is a combined and improved version of IEEE 802.16, 802.16a, and 802.16c (these three standards are replaced by 802.16-2004 now) in which both the 10–66GHz and 2–11GHz frequency bands are specified and the bandwidth can be as narrow as 1.25 MHz IEEE 802.16-2004 is designed for fixed BWA-systems to support multiple services. The goal of this standard is to enable global deployment of innovative, low-cost, and interoperable multivendor BWA-products; increase the capacity of competition of BWA-systems against their wired counterparts; and facilitate global commercialization of BWA products. IEEE 802.16-2004 does not add any new models in addition to those covered by IEEE 802.16 and 802.16a. Its main features also remain the same. The main comparison between IEEE 802.16 standards are represented in table 1.

IV COMPARISON OF WIMAX WITH OTHER WIRELESS TECHNOLOGIES

WiMAX technology is not the only solution for delivering broadband wireless services. Many proprietary solutions are already in the market. The 3rd generation cellular systems and IEEE 802.11-based Wi-Fi systems are also playing a very important role in un-tether access of Internet throughout the world.

Table (1) The main comparison between IEEE 802.16 standards

standard	802.16	802.16-a	802.16e-d or 802.16-2004	802.16-e or 802.16e-2005
Frequency range	10-66GHz	2-11GHz	2-11GHz 10-66GHz	2-6GHz
Channel conditions	LOS only	NON LOS	NON LOS	NON LOS
Channel BW	20, 25, and 28 MHz	1.25-28 MHz	1.25-28 MHz	1.25-20 MHz
Modulation scheme	BPSK, QPSK, 16QAM, and 64QAM	OFDM, BPSK, QPSK, 16QAM, and 64QAM	OFDM, BPSK, QPSK, 16QAM, and 64QAM	OFDM, BPSK, QPSK, 16QAM, and 64QAM
Network architecture supported	PTP, PMP	PTP, PMP, mesh	PTP, PMP, mesh	PTP, PMP, mesh
Bit Rate	32-134 MHz	Up to 75 MHz	Up to 75 MHz	Up to 15 MHz
Mobility	Fixed	Fixed	Fixed	Pedestrian mobility regional roaming, maximum mobility support 125km/h
Typical cell radius	1-3 miles	Maximum rage in 30 miles, on basis of antenna height, antenna gain, and transmit power	Maximum rage in 30 miles, on basis of antenna height, antenna gain, and transmit power	1-3 miles
Applications	Replacement of E1/T1 services for enterprises, backhaul for hot spots, residential broadband access, small office/home office (SOHO)	Alternative to E1/T1, DSL, cable backhaul for cellular and Wi-Fi, VoIP, Internet connections	802.16 plus 802.16a applications	802.16-2004 applications plus fixed VoIP, QoS based applications, and enterprise network

V . MODELING AND SIMULATION OF WIMAX /1EEE 802.16 WIRELESS MAN OFDM PHYSICAL DOWNLINK

In this section a model of WiMAX/IEEE 802.16 Wireless MAN OFDM Physical Downlink is designed and implemented using Matlab with Simulink V.2012a as shown in figure (3).

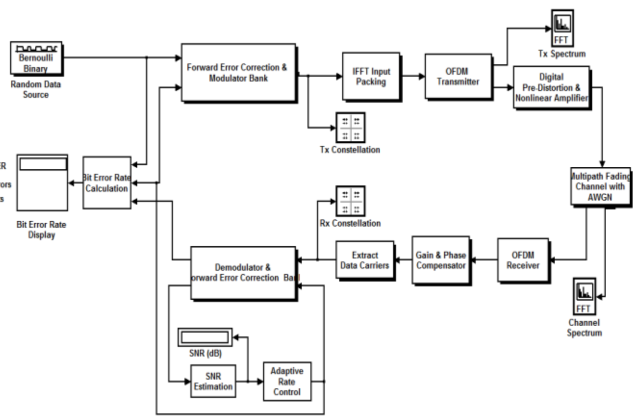

Fig.3 n Simulation Model of WiMAX/IEEE 802.16 Wireless MAN OFDM Physical Downlink).

Established the number of OFDM symbols to be constant for all data bursts generated. As a result, for any given profile, the frame duration in Simulink remains the same. Within the downlink frame. The library file in Matlab has blocks which cover this functionality. Assume perfect synchronization between the transmitter and receiver. As a consequence, they only use a short preamble for every downlink burst .Estimate the channel at the receiver using only the inserted preambles and not the pilot subcarriers. It can vary the state of the nonlinearity and the digital pre-distortion via the Amplifier nonlinearity and Digital pre-distortion parameters..
Also in this model it vary multipath fading channel with AWGN into three schemes no fading, frequency selective fading and frequency flat fading so all of them can variance (in SNR well the receiver performs with different fading characteristics. After setting the parameters of WiMAX/IEEE 802.16 wireless MAN OFDM physical downlink Model. Several testes are carried when multipath fading channel with AWGN varying as clarified in the following points:

- **No Fading**

After the multipath fading channel with AWGN set as no fading then simulate WiMAX/IEEE 802.16 model, after that windows come up automatically to display the simulation results which represented the spectrum of the transmitted signal, spectrum of the signal at the channel output , constellation diagram of the signal after the modulation and constellation diagram of the received signal prior to demodulation using scatter plots as illustrated in figure (4).

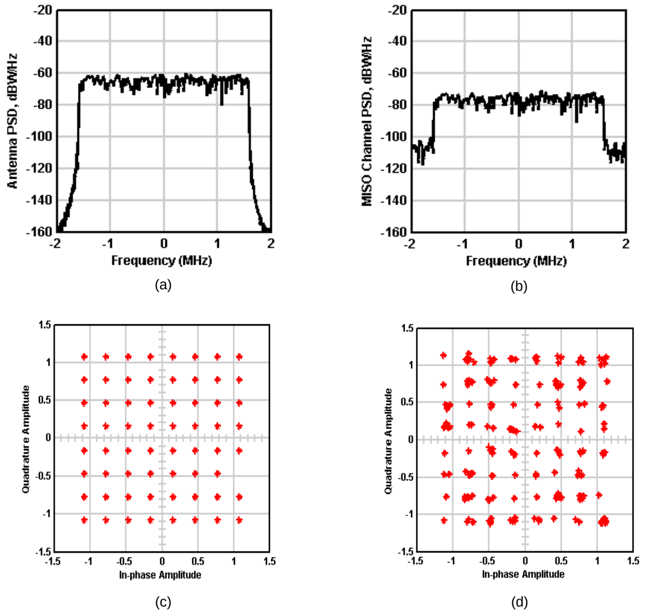

Fig. 4 Simulation results when no fading channel is used
(a) Spectrum of the transmitted signal
(b) Spectrum of the signal at the channel output
(c) Constellation diagram of the signal after the modulation
(d) Constellation diagram of the received signal prior to demodulation

- **Frequency selective fading**

After the multipath fading channel with AWGN set as frequency selective fading then simulate WiMAX/IEEE 802.16 model, after that windows come up automatically to display the simulation results as illustrated in figure (5). That simulation results are represented the spectrum of the transmitted signal, spectrum of the signal at the channel output , constellation diagrams of the signals after and before the modulation and demodulation respectively

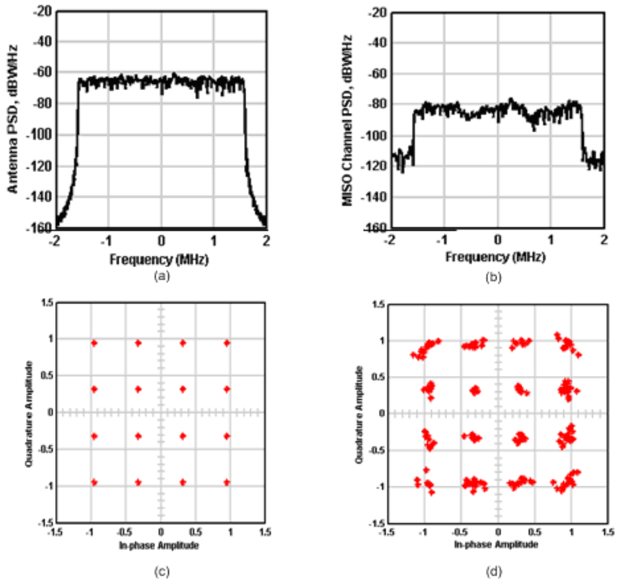

Fig. 5 Simulation results when frequency selective fading channel is used

(a) Spectrum of the transmitted signal
(b) Spectrum of the signal at the channel output
(c) Constellation diagram of the signal after the modulation
(d) Constellation diagram of the received signal prior to demodulation

- **Frequency flat fading**

After setting the multipath fading channel with AWGN as frequency flat fading then simulate the model of WiMAX/IEEE 802.16 after that windows come up automatically to display the simulation results as shown in figure (6). The achieved simulation results are demonstrated the spectrum of the transmitted signal, spectrum of the signal at the channel output , also constellation diagrams of the signals after and before the modulation and demodulation respectively.

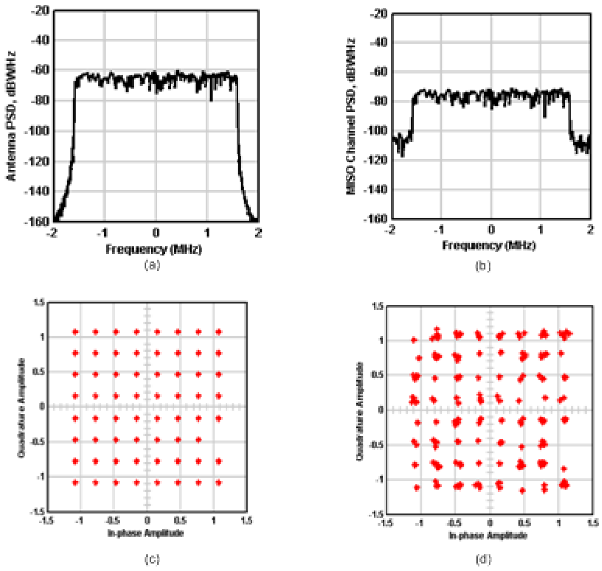

Fig. 6 Simulation results when frequency flat fading channel is used

(a) Spectrum of the transmitted signal
(b) Spectrum of the signal at the channel output
(c) Constellation diagram of the signal after the modulation
(d) Constellation diagram of the received signal prior to demodulation

VI CONCLUSION

WiMAX consider a great deal these days, as it offer a high data rate and coverage large area, so it's important to understand it's technology and investigate it's performance, with good simulation tool- like MATLAB which offer so mach tool it can implement WiMAX technology.

Referring to the achieved simulation results which represented the measured spectrum of the transmitted signal, spectrum of the signal at the channel output, constellation diagrams of both the signal after the modulation and the received signal prior to demodulation . Also measured SNR in three different channels . It observes that spectrum level of the transmitted signal is less than spectrum level of the signal at the channel output by -21.5dB. The constellation diagrams of the received signal prior to demodulation was distorted compared to the constellation diagrams of the signal after the modulation. Also the SNR was equal 21.3dB .

Finally useful simulation results are achieved and has good agreement with the expected one as well as very powerful scientific computer package are used which known as a Matlab with Simulink v.2016a.

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