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A Review on Existing OFDM Scheme

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Abstract—Abstract: OFDM is an Orthogonal Frequency Division Multiplexing. It is a multiplexing technique based on parallel transmission. OFDM is used in many of the present day wireless communication techniques. It is a digital modulation scheme and is used for encoding the digital data on multiple carrier frequencies. Each subcarrier is modulated using different modulation techniques. In this paper, I presented a survey on the existing OFDM scheme. OFDM is adopted by various standards. IEEE 802.16e, WIMAX, is the upcoming wireless system that offers high speed voice, video and data service at the customer end. By using WIMAX Technology, the limitation of short coverage area, lack of security and low data rate can be overcome. The bit error rate (BER) is the parameter of consideration in. Through this paper, the parameters related to wireless transmission have been discussed.

Keywords— OFDM, Wireless Communication, Modulation, Wireless Standards, WiMAX, BER.

I. INTRODUCTION

In wireless communication, to meet the increased traffic demands the high rate transmission techniques are adopted in the present scenario**.** The wireless technology has overpowered almost every application over the conventional wired transmission techniques. Many wireless and wired networks have been defined under IEEE. The technology that is used for high data rates is OFDM i.e. Orthogonal Frequency Division Multiplexing. OFDM is the most widely used modulation technique nowadays and is being implemented in many applications like WLAN, WiMAX, etc. it is better than Code division multiplexing because it uses the concept of multiple carrier frequencies. The data is being carried by the subcarriers and each subcarrier is differently modulated using conventional modulation techniques like binary phase shift keying, quadrature phase shift keying and quadrature amplitude modulation. Different modulation techniques are used for different purposes. If the data is to be sent at the low rate then the BPSK and QPSK can be used. If the data is to b transmitted at high rate then higher modulation techniques are preferred which include the M-ary PSK and M-QAM. The IEEE WIMAX/802.16 is discussed in this paper as it is the upcoming wireless technology. WiMAX is a promising technology for broadband wireless metropolitan area networks (WMANs) as it can provide high data rates extended coverage for fixed and mobile users, network scalability, security& support of quality of services [2].

II. TERMS USED

A. Wireless Communication

Wireless communication is defined as the transfer of voice, data or any kind of information from transmitter to the receiver via a wireless medium between the two. There are many wireless communication systems based on various methods and technologies. Wireless communication is process of transmission of information over a distance without help of wires, cables or any other forms of electrical conductors.

B. IEEE Wireless Standards

There are number of wireless standards that are based on the OFDM technique. These wireless standards are defined under the IEEE standards.

TABLE I
COMPARISON CHART OF ALL WIRELESS IEEE STANDARDS

Standard	Frequency in Giga Hertz	Data Rate in Mega Bits per Second(Mbps)	Range	Modulation & Coding	Type
802.11a [7]	5GHz	54 Mbps	120m	BPSK,QPSK, 16QAM, 64QAM,OFDM	LAN(Local Area Network)
802.11b [7]	2.4GHz	11Mbps	140m	DBPSK,DQPSK,CCK ,DSSS	LAN

802.11g [7]	2.4GHz	54Mbps	140m	DBPSK,DQPSK,16QAM,64QAM, OFDM	LAN
802.11n [7]	2.4/5GHz	(Max. data rate from 54 Mbps to 600 Mbps) 248Mbps	250m	OFDM	LAN
802.11ac [7]	5GHz	-	-	OFDM	LAN
802.11ad [7]	2.4/6/60 GHz	Upto 6.75Gbps	-	OFDM	LAN
802.11af [7]	UHF/VHF (Ultra High Frequency/ Very High Frequency)	26.7 Mbps for 6,7 MHz channel and 35.6 MHz for 8MHz channel(Using 1 spatial stream) 426.7Mbps in 6,7 MHz channel and 568.9 Mbps for 8MHz channel(Using 4 spatial streams)	5Km	OFDM	LAN
802.15.1	2.4GHz	3Mbps	Depends on class: Class C =1m, Class B =10m, Class C = 100m	8DPSK, DQPSK, GFSK, pi/4 DQPSK, AFM	PAN (Personal Area Network)
802.15.4	868/915 MHz, 2.4GHz	40Kbps,250Kbps	10m	DSSS, FHSS, BPSK,ASK,OQPSK	PAN/ ZigBee
802.15.6	1THz	>1Gbps	10m	-	BAN (Body Area Network)
802.16 (2004)	2-11GHz	75 Mbps	10Km	OFDM	Fixed WiMAX
802.16e (2005)	2-6GHz	30 Mbps	3.5Km	OFDM	Mobile WiMAX
802.20 [9]	< 3.5GHz	80 Mbps	Several Kms	OFDM	MBWA (Mobile Broadband Wireless Access)
802.22	UHF/VHF	For one TV channel, 19 Mbps at a 30 Km distance	100 Km	OFDMA	WRAN (Wireless Regional Area Network)

C. OFDM

OFDM is a multiplexing technique that is useful in wireless transmission of data. OFDM system is use for high speed applications. The OFDM-related technique has been invented over 40 years ago. OFDM for wireless communications has intensively been an active research area in the past 10 years [4]. In orthogonal frequency-division multiplexing (OFDM), the entire channel is divided into many narrow-band sub-channels, which are transmitted in parallel to maintain high-data- rate transmission and, at the same time, to increase the symbol duration to combat ISI [4]. Due to its advantages, OFDM is the modulation technique of choice that is being adopted nowadays. OFDM uses various modulation techniques on its sub channels to carry the data. This makes it a flexible modulation technique. OFDM is used in both wired as well as wireless applications. Wireless standard include IEEE 802.11 a/g/n, IEEE 802.15.3a (UWB), IEEE 802.16 d/e, IEEE 802.20 (MWBA), etc. Many techniques are employed on OFDM based systems so that the efficiency of the system can be increased. One key principle of OFDM is that since low symbol rate modulation schemes suffer less from intersymbol interference caused by multipath propagation, it is advantageous to transmit a number of low- rate streams in parallel instead of a single high-rate stream [7]. The duration of each symbol being long, it is feasible to insert a guard interval between the OFDM symbols, thus eliminating the intersymbol interference. Cyclic prefix and guard interval are used to reduce the problem of Intersymbol Interference but if there is no CP or guard interval, or its length is not long enough, the delay spread of wireless channels will cause both Interbit Interference and Interchannel Interference.

Modulation and demodulations of signal is done with the help of IFFT/FFT controller respectively. To further improve the performance of OFDM systems, link adaptation, including adapting transmission power or data rate of each sub-channel, has extensively been investigated [4]. The performance of an OFDM based system depends upon the number of bits transmitted efficiently. To study the performance of an OFDM system, the BER is calculated and analysed. If BER is less the system performance is good. Multi-band Orthogonal Frequency Division Multiplexing (MB-OFDM) is a suitable solution for implementation of high speed data transmission in ultra wide band spectrum by dividing it into various bands [5]. OFDM has high spectral efficiency as compared to other double sideband modulation schemes; spread spectrum etc .The main problem in OFDM is high peak-to-average power ratio (PAPR). It is one of the major shortcomings in OFDM systems, as it causes nonlinearity distortion in the transmitter, thus degrading the performance of the system significantly. High PAPR causes clipping of the OFDM signal by the High power amplifier (HPA) and in the HPA output producing nonlinearity. This non-linearity distortion will result in-band distortion and out-of-band radiation [1]. Many techniques have been developed to reduce the high PAPR effect in OFDM systems. To overcome PAPR effects for OFDM signals, there are a number of proposed PAPR reduction techniques such as amplitude clipping, clipping and peak windowing, coding, Selective Mapping Technique (SLM), partial transmit sequence (PTS), tone reservation (TR), tone injection (TI) [1]. Linear block coding based PAPR reduction technique has also been proposed. Here the application of the Hamming coding technique results in significant reduction in the PAPR values.

1) Advantages of OFDM:

OFDM have several attractive features which are responsible for making it more advantageous for high speed data transmission over other data transmission techniques. They are:

- Ability to cope with severe channel conditions
- Robust against ICI and fading due to multipath propagation
- Robust against narrow-band co-channel interference
- Flexibility
- High spectral efficiency as compared to other double sideband modulation schemes
- Ease of equalization
- Efficient implementation using Fast Fourier Transform (FFT)

2) Disadvantages of OFDM:

Inspite of various advantages there are various disadvantaged of OFDM systems.

- High sensitivity to Doppler shift
- Sensitive to frequency synchronization problems
- High peak-to-average-power ratio (PAPR)
- Intercarrier Interference (ICI) between the subcarriers

D. WiMAX

WiMAX stands for Worldwide Interoperability for Microwave Access. IEEE 802.16 d/e is a WiMAX standard. IEEE 802.16 d is a fixed WiMAX standard and 802.16e is a mobile WiMAX standard. WiMAX is a technology that enables anywhere, anytime access to information and applications at low cost and with a small investment. This technology can reach a theoretical 30 miles coverage radius and achieve data rates up to 75 Mbps, although at extremely long range, throughput is closer to the 1.5 Mbps performance of typical broadband services, similar to that used for wired broadband services [3]. WiMAX is an OFDM based standard. WiMAX is also called a wireless MAN standard. It is a wireless communications standard designed to provide 30 to 40 megabit-per-second data rates, with the 2011 update providing up to 1 Gbit/s for fixed stations [8]. WiMAX is based upon IEEE 802.16e-2005, approved in December 2005 and is a supplement to the IEEE 802.16-2004 standard. It has two layers: Medium Access Control layer and Physical layer. The WiMAX physical layer is based on OFDM technique. The MAC layer is to provide an interface between the physical layer and the upper transport layer [3].The IEEE 802.16e and more advanced versions, also bring multiple antenna support through MIMO. It is advantageous in terms of coverage, power consumption, self installation, frequency re-use and bandwidth efficiency. WiMAX is the most energy-efficient pre-4G technique among LTE and HSPA+ [8]. As OFDM is used in the physical layer of WiMAX, each smaller data stream is then mapped to individual data sub-carrier and modulated using Phase Shift Keying PSK) or Quadrature Amplitude Modulation (QAM) such as BPSK, QPSK, 16-QAM, 64-QAM.

Features of WiMAX [2]:

- OFDM Based physical layer
- It is cost effective
- High data rate
- Flexible architecture
- Mobility support
- It supports fixed, nomadic and mobile applications
- WIMAX MAC layer is responsible for QoS.
- WIMAX offer scalable network architecture that support user roaming indifferent networks
- WIMAX uses Advanced Encryption Standard (AES) encryption for secure transmission and for data integrity, it use data authentication mechanism. Thus, providing strong security.

E. BER

BER stands for Bit Error Rate. The BER is defined as the number of erroneous bits in a transmission channel over the total number of bits that are transmitted in a given transmission. BER is a unitless performance measure, often expressed as a percentage. It is, sometimes, used interchangeably with the probability of error. But there is a difference between the two. The probability of error (P_e) is defined as the theoretical expectation of the bit error rate for a given system. BER is an empirical record of a system's actual bit error performance. The BER is directly affected by the SNR. SNR is analogous to Eb/No. Thus BER is inversely proportional to the Eb/No. The lower the SNR, the lower is the Eb/No; the lower the Eb/No, the higher is the BER. Thus, higher the BER the slower is the effective data rate. The conclusion is that the lower the SNR, the slower the effective data rate.

BER= No. of erroneous bits / Total no. of bits sent

In a communication system, the receiver side BER may be affected by these factors: transmission channel noise, interference like InterChannel and InterSymbol Interference, distortion, bit synchronization problems, attenuation, wireless multipath fading, etc. There are methods to reduce the BER and may be improved by choosing a strong signal strength (unless this causes cross-talk and more bit errors), by applying channel coding schemes such as redundant forward error correction codes and also by choosing a slow and robust modulation scheme or line coding scheme. Lower BER means better QoS in a system. The BER value in a system should be less. The numbers of methods are being adopted to reduce the BER in a system.

F. Channels

In wireless communication there are various channels that act as a medium for the effective communication between the transmitter and the receiver. There is a channel that acts as a noisy channel and other two channels are frequency selective fading channels.

1) AWGN noise:

AWGN is Additive White Gaussian Noise. It is a noise that affects the transmitted signal when it passes through the channel. It contains a uniform continuous frequency spectrum over a particular frequency band.

2) Rayleigh Fading:

This is a frequency selective fading. It is taken into account when no LOS path exists in between transmitter and receiver, but only have indirect path than the resultant signal received at the receiver will be the sum of all the reflected and scattered waves.

3) Rician Fading:

This is also a frequency selective fading channel. It occurs when there is a LOS as well as the non-LOS path in between the transmitter and receiver, i.e. the received signal comprises on both the direct and scattered multipath waves.

G. Modulation Techniques

There are number of modulation techniques used in the transmission of data over longer distances. Modulation techniques can be analog as well as digital, depending upon the type of data transmission. For digital data transmission phase shift keying like BPSK, QPSK, M-ary PSK and Quadrature amplitude modulation are used as the modulation techniques. For lower symbol rate, BPSK and QPSK are used and for higher symbol rate, the M-ary and M-QAM are used. Moreover, the studies proved that the performance of a modulated signal in AWGN is better than in fading channels. The BER is different in each modulation technique. The BER of BPSK is least and it performs better in AWGN channel. As the modulation is higher the BER is also higher. But that is not preferred.

III. CONCLUSIONS

In this paper, we have briefly described OFDM for wireless communications. The paper also shows the comparative study of all the IEEE wireless standards. The basic principle of OFDM has been explained. OFDM can be used for improving the data rate as well as high speed for cellular communication as in multi-band orthogonal frequency division multiplexing system. OFDM is robust to channel fading in wireless environment. OFDM has been chosen for several current and future communications systems all over the world in many applications. It can be used for high speed data transmission. Then, we introduced related modulation schemes. We have also summarized the wireless applications of OFDM. The Wimax standard has been explained in brief. It is not our intention and is impossible either to provide an exhaustive literature search in the area through this paper.

REFERENCES

[1] M. R. Dey and M. S. Islam "Performance Analysis of PAPR reduction for OFDM-BPSK,-QPSK and -QAM using Forward Error Correcting Code" International Conference on Electrical and Computer Engineering, December-2012, IEEE.

[2] Abdul Rehman, Tauheed Khan, Sunil Kumar Chaudhry "Study of WiMAX Physical Layer under Adaptive modulation Technique using Simulink" *International Journal of Scientific Research Engineering & Technology*, Volume 1, Issue 5, pp 005-011, ISSN 2278 – 0882, August 2012.

[3] A.Salleh, N.R. Mohamad, M.Z.A. Abd Aziz, M.H. Misran, M.A. Othman, N.M.Z. Hashim *"International Journal of Computer Science and Mobile Computing"* Vol.2, Issue. 9, September- 2013

[4] Taewon Hwang, Chenyang Yang, Gang Wu, Shaoqian Li, and Geoffrey Ye Li, "OFDM and Its Wireless Applications: A Survey*" IEEE TRANSACTIONS ON VEHICULAR TECHNOLOGY*, VOL. 58, NO. 4, MAY 2009.

[5] Miss. Priyanka Haigune, Prof. R. N. Mandavgane, Prof. M. N. Thakre "A Survey: Orthogonal Frequency Division Multiplexing" *International Journal of Innovative Research in Computer Science & Technology (IJIRCST),* ISSN: 2347-5552, Volume-2, Issue-1, January 2014.

[6] Arun Gangwar, Manushree Bhardwaj "An Overview: Peak to Average Power Ratio in OFDM system & its Effect" *International Journal of Communication and Computer Technologies,* Volume 01 – No.2, Issue: 02 September 2012.

[7] http://en.wikipedia.org/wiki/Orthogonal_frequency-division_multiplexing

[8] http://en.wikipedia.org/wiki/WiMAX

[9] http://en.wikipedia.org/wiki/IEEE_802.20

