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An Analysis of Design and Implementation of Physical Layer in Mobile Wimax

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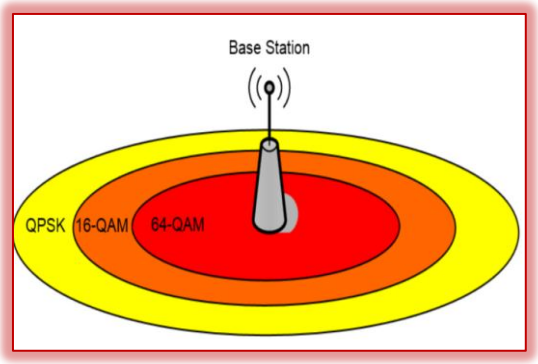
ABSTRACT

Orthogonal Frequency Division Multiplexing (OFDM) scheme with Adaptive Modulation and Coding rates at the physical layer of Worldwide Interoperability for Microwave Access (WiMAX) network is analysed for providing Quality of Service(QoS). To evaluate the QoS metrics such as throughput and delay through the simulation in Network Simulator (NS2). Institute of Electrical and Electronics Engineers (IEEE) forum developed the standard WiMAX for broadband access. In WiMAX 802.16d and 802.16e standards are used for nomadic & mobility respectively. WiMAX can be considered as an early version of the next generation mobile wireless system. The physical layer (PHY) is the lowest layer of the Open System Interconnection (OSI) model. Physical layer coordinates the functions required to transmit a bit stream over a communication channel. The advanced PHY features include OFDM with Adaptive Modulation and Coding (AMC) techniques. AMC is an effective mechanism to maximize throughput in a time varying channel. The combinations of various modulation and code rates provides a fine resolution of data rates.

Keywords: Throughput, Nomadic, Mobility, Data rates.

1. INTRODUCTION

The acronym for WiMAX is Worldwide Interoperability for Microwave Access. It is an IEEE 802.16 standard based technology responsible for bringing the broadband Wireless Access (BWA) to the world as an alternative to wired broadband. WiMAX can be classified into Fixed WiMAX and Mobile WiMAX. Fixed WiMAX is based upon Line Of Sight (LOS) conditions in the frequency range of 10-66GHz whereas Mobile WiMAX is based upon Non Line Of Sight (NLOS) condition that works in 2-11GHz frequency range. The IEEE 802.16e air interface standard is basically based on technology namely, orthogonal frequency-division multiplexing (OFDM), that has been regarded as an efficient way to combat the Inter-Symbol Interference (ISI) for its performance over frequency selective channels.



Adaptive Modulation and Coding Scheme

The standard has also been extended for use in below 11 GHz frequency bands along with initially supported 10-66 GHz bands. Frequency band 2-11 GHz are licenced exempted, additionally physical functionality supports have

been introduced to operate in near LOS and NLOS environment. The standard promises to provide data rates up to 120 Mbps. The abundant availability of bandwidth is also another reason to operate in this frequency range.

WiMAX supports a variety of modulation and coding schemes as shown in Fig1.2: and allows for the scheme to change on a burst-by-burst basis per link, depending on channel conditions. Using the channel quality feedback indicator, the mobile can provide the base station with feedback on the downlink channel quality. For uplink, the base station can estimate the channel quality, based on the received signal quality.

2. MATERIALS AND STUDY

IEEE 802.16 PHY Layer:

The IEEE 802.16 standard supports multiple physical specifications due to its modular nature. The first version of the standard only supported single carrier modulation. Since that time, OFDM and scalable OFDMA have been included to operate in NLOS environment and to provide mobility. The standard has also been extended for use in below 11 GHz frequency bands along with initially supported 10-66 GHz bands.

Supported Band of Frequency:

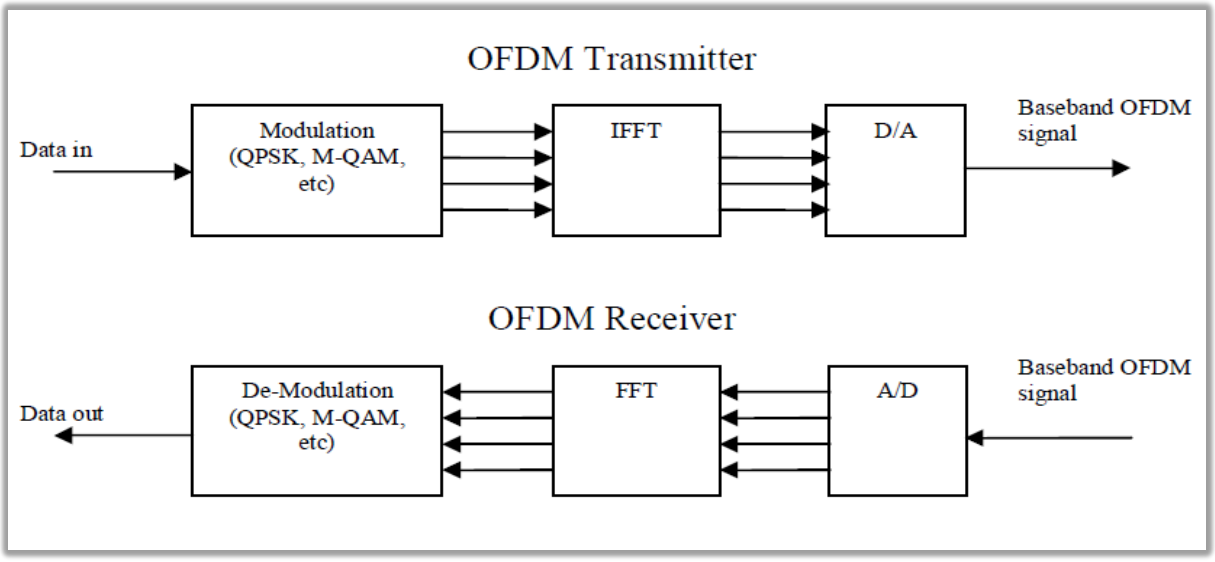
The IEEE 802.16 supported licensed and unlicensed bands of interest are as follows:

10-66GHz licensed band:

In this frequency band, due to shorter wave length, line of sight operation is required and as a result the effect of multipath propagation is neglected. The standard promises to provide data rates up to 120 Mb/s in this frequency band. The abundant availability of bandwidth is also another reason to operate in this frequency range.

2-11GHz licensed and licensed exempt:

In this frequency bands, both licensed and licensed exempt bands are address. Additional physical functionality supports have been introduced to operate in Near LOS and NLOS environment and to mitigate the effect of multipath propagation. IEEE 802.16 PHY interface variants: The standard has assigned a unique name to each physical interface. They have been described below along with their supported features in brief



Basic OFDM Transmitter &Receiver

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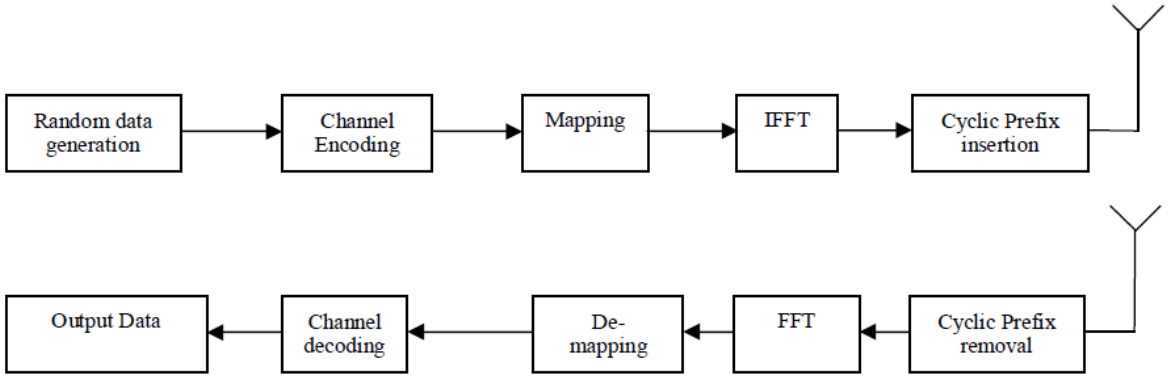
At the receiver side, The FFT blocks performs the reverse process on the received signal and bring it back to frequency domain .The block diagram in Figure 3.2 depicts the switch between frequency domain and time domain in an OFDM system.

3. BLOCK DIAGRAM



4. SOFTWARE REQUIREMENTS

Available bandwidth: The bandwidth limit will play a significant role in the selection of number of subcarriers. Large amount of bandwidth will allow obtaining a large number of sub-carriers with reasonable CP length. Required bit rate: The system should be able to provide the data rate required for the specific purpose.

Tolerable delay spread: A user environment specific maximum tolerable delay spread should be known beforehand in determining the CP length. Max T Tg T Multipath components TX Sampling start 25. Doppler values: The effect of Doppler shift due to user movement should be taken into account.

Number of subcarriers: We stated earlier that the selection of large number of subcarriers will help to combat multipath effects. But, at the same time, this will increase the synchronization complexity at the receiver side. FEC coding: A suitable selection of FEC coding will make sure the robustness of the channel to the random errors.

5. OPERATION TECHNIQUE

The idea of OFDM comes from Multi Carrier Modulation (MCM) transmission technique. The principle of MCM describes the division of input bit stream into several parallel bit streams and then they are used to modulate several sub carriers as shown in Figure 3.1. Each subcarrier is separated by a guard band to ensure that they do not overlap with each other. In the receiver side, band pass filters are used to separate the spectrum of individual subcarriers.

Depending on the channel coherence time, this reduces or completely eliminates the risk of Inter Symbol Interference (ISI), which is a common phenomenon in multipath channel environment with short symbol duration. The use of Cyclic Prefix (CP) in OFDM symbol can reduce the effect of ISI even more, but it also introduces a loss in SNR and data rate.

5.1 OFDM System Implementation

The principle of OFDM was already around in the 50's and 60's as an efficient MCM technique. But, the system implementation was delayed due to technological difficulties like digital implementation of FFT/IFFT, which were not possible to solve on that time. In 1965, Cooley and Turkey presented the algorithm for FFT calculation and later its efficient implementation on chip makes the OFDM into application. At the transmitter side, an OFDM system treats the source symbols as though they are in the frequency domain. These symbols are feed to an IFFT block which brings the signal into the time domain. If the N numbers of subcarriers are chosen for the system, the basic functions for the IFFT are N orthogonal sinusoids of distinct frequency and IFFT receive N symbols at a time. Each of N complex valued input symbols determines both the amplitude and phase of the sinusoid for that subcarrier.

5.2 Robust Error Control Mechanism:

Forward Error Correction (FEC) is done on two phases through the outer Reed Solomon (RS) code and inner Convolutional code (CC). The RS coder corrects burst error at the byte level. It is particularly useful for OFDM links in the presence of multipath propagation. The CC corrects independent bit errors. The puncturing functionality in CC made the concatenated codes rate compatible as per specification. The support of Turbo coding is left as an optional feature to increase the coverage and/or capacity with the expense of increased decoding latency and complexity.

6. RESULT

We analysed the OFDM scheme with Adaptive modulation and coding rates at the physical layer of WiMAX. We also analysed the packet delivery ratio and delay using different modulation techniques. We compared the existing simulation result with our simulation results, it shows that packet delivery ratio has improved.

7. CONCLUSION

In this project, we have performed a performance study of rate allocation in a WiMAX network using Adaptive Modulation and Coding techniques. We analysed pdf under various system parameters values. The technique of rate control used in this paper depends on the transmission rate. By simulation results, we analysed that the proposed scheme attains an improved pdf and a reduced delay. This project has been extended to get the QoS in MAC layer in a secured manner.

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