

Bit Error Rate of Mobile Wimax (Phy) Under Different Communication Channels and Modulation Technique

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Abstract—*Mobile Wimax is a broadband wireless solution that enables the convergence of mobile and fixed broadband network, through a common wide area broadband radio access technology and flexible network architecture. The Performance of mobile Wimax under varying channel is one of the interesting research interests. Most of the most existing systems, based on performance and evaluation under channel condition are limited to AWGN, ITU etc in mobile Wimax. In this paper the performance of mobile Wimax (PHY layer) under SUI channel models in addition to different data rates and modulation techniques were analyzed. The simulation covers important performance parameters like Bit Error Rate and Signal to Noise Ratio.*

Keywords—*Wimax, BER, SNR, BPSK, OFDMA*

I. INTRODUCTION

IEEE802.16e is a global broadband wireless access standard capable of delivering high data rates to fixed users as well as portable and mobile ones over long distance [1]. In mobile Wimax air interface adopts orthogonal frequency division multiple access (OFDMA) for improved multi-path performance in non-line-of sight (NLOS) environment. Mobile Wimax extends the OFDM PHY layer to support terminal mobility and multiple-access. The resulting technology is Scalable OFDMA. Data streams to and from individual users are multiplexed to groups of sub channel on the downlink and uplink. By adopting Scalable PHY architecture, mobile Wimax is able to support a wide range of bandwidths.

The performance of the WiMAX (Worldwide Interoperability for Microwave Access) can be evaluated by using the Stanford University Interim (SUI) channel models which has a set of six channels for terrain types [3]. With different data rates, coding schemes and modulation techniques.

The mobile WiMAX standard builds on the principles of OFDM by adopting a Scalable OFDMA-based PHY layer (SOFDMA) [4]. SOFDMA supports a wide range of operating bandwidths to flexibly address the need for various spectrum allocation and application requirements.

The simulation done in the paper covers important performance such as Bit Error Rate and Signal to Noise Ratio.

II. WIMAX PHYSICAL LAYER

This project deals with the performances of Bit Error Rate and Signal to Noise Ratio in mobile WiMAX physical layer. The block diagram of the physical layer of mobile WiMAX diagram is given in Figure 1. The transferring of data or receiving the data is done through the physical layer of WiMAX. So the uplink and the downlink of the message were done on the physical layer of WiMAX. There are three levels in the physical layer of mobile WiMAX physical layer are

- Bit level processing
- OFDM symbol level processing
- Digital IF processing

Each levels of physical layer of WiMAX consist of certain processes for transferring the data at uplink region and receiving of data at downlink region consists of encoder, decoder, symbol mapper and randomizer etc., Every processes were done in order to improve the performance of the mobility condition of mobile wimax. In this paper the performance was analyzed by the signal to noise ratio and the bit error rate

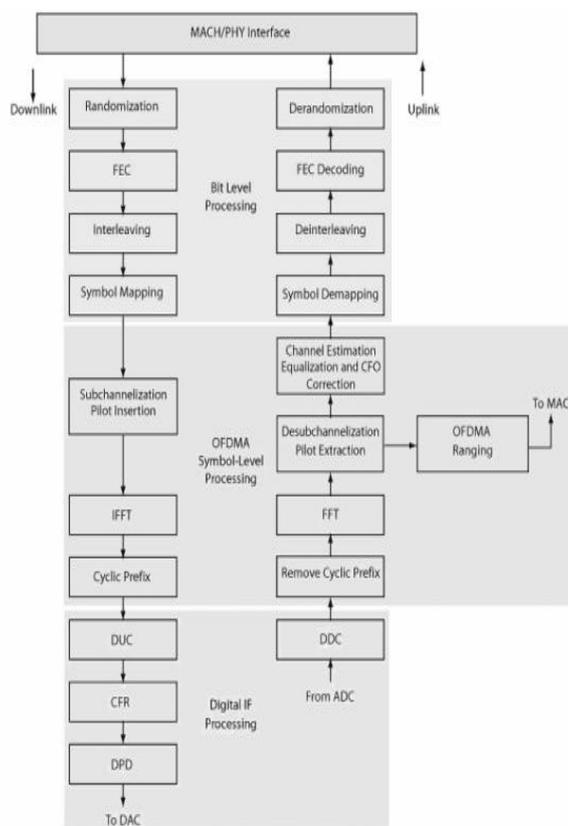


Figure: 1. Block Diagram of Wimax Physical Layer

Table.1 Parameter of mobile wimax physical layer

Parameter	Value			
FFT size	128	512	1024	2048
Channel Bandwidth(MHz)	1.25	5	10	20
Subcarrier Frequency spacing (KHz)	10.94			
Useful Symbol Period	91.4			
Guard Time	1/32,1/8,1/6,1/4			

III. CHANNEL

The medium between the transmitting antenna and the receiving antenna is said to be the channel. The profile of received signal can be obtained from that of the transmitted signal, if we have a model of the medium between the two. The model of the medium is called channel model.

$$Y(f) = X(f) H(f) + n(f)$$

Where,

- Y (f) ->output signal
- H (f) ->channel response
- X (f) ->input signal

A. Stanford University Interim (SUI) Channel Models:

It is a set of six channel models representing three terrain types and a variety of Doppler spreads, delay spread and mainly the line-of-sight/non-line-of-site conditions that are typical of the continental. The terrain type A, B, C is same as those defined in Erceg model [10]. The multipath fading is modeled as a tapped delay line with 3 taps with non-uniform delays. The gain associated with each tap is characterized by a Rician Distribution and the maximum Doppler frequency.

In a multipath environment, the received power r has a Rician distribution, whose Pdf is given by:

$$Pdf(r) = r/\sigma^2 e^{-(r/2\sigma^2)} \quad 0 \leq r \leq \infty$$

A is zero if there is no LOS component and the pdf of the power becomes

$$Pdf(r) = r/\sigma^2 e^{-[frac{2+A^2\sigma^2]}{2\sigma^2}r} I_0(rA/\sigma^2) \quad 0 \leq r \leq \infty$$

This is also known as Raleigh distribution.

The ratio $K=A^2/(2\sigma^2)$ in the Rician case represents the ratio of LOS component to NLOS component and is called the "K-Factor" or "Rician Factor."

The general structure for the SUI channel model is as shown below in figure. This structure is for Multiple Input Multiple Output (MIMO) channels and includes other configurations like Single Input Single Output (SISO) and Single Input Multiple Output (SIMO) as subsets.

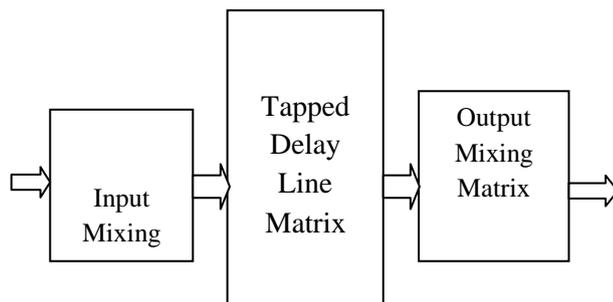


Figure 2.SUI Channel Model

Power Distribution For each tap a set of complex zero-mean Gaussian distributed numbers is generated with a variance of 0.5 for the real and imaginary part, so that the total average power of this distribution is 1. This yields a normalized Rayleigh distribution (equivalent to Rice with $K=0$) for the magnitude of the complex coefficients. If a Rician distribution ($K>0$ implied) is needed, a constant path component m is added to the Rayleigh set of coefficients. The ratio of powers between this constant part and the Rayleigh (variable) part is specified by the K-factor. For this general case, we show how to distribute the power correctly by first stating the total power P of each tap:

$$P = |m|^2 + \sigma^2$$

Where m is the complex constant and σ^2 the variance of the complex Gaussian set. Second, the ratio of powers is $K = |m|^2/\sigma^2$.

Table 2: Terrain type and Doppler spread for SUI channel model

Channel	Terrain Type	Doppler spread	Spread	LOS
SUI-1	C	Low	Low	High
SUI-2	C	Low	Low	High
SUI-3	B	Low	Low	Low
SUI-4	B	High	Moderate	Low
SUI-5	A	Low	High	Low
SUI-6	A	High	High	High

In the SUI channel model, parameter for the SUI 1 and SUI 2 channel model has been tabulated in 3 and 4 respectively for the reference. BER performance is evaluated in this channel models. Depending on the performance parameter for the SUI channel, the performances of wimax physical layer are evaluated through the performance graph.

Table 3 SUI -1 Channel Model				
	Tap 1	Tap 2	Tap 3	Units
Delay	0	0.4	0.9	μ s
Power(omni antenna)	0	-15	-20	db
90% K-factor(omni)	4	0	0	
75% K-factor(omni)	20	0	0	
Power(30 ⁰ antenna)	0	-21	-32	db
90% k-factor(30 ⁰)	16	0	0	
75% K-factor(30 ⁰)	72	0	0	
Doppler	0.4	0.3	0.5	Hz
Antenna correlation= $\rho=0.7$		Terrain Type : C		
Gain Reduction Factor:GRF=0db		Omni antenna : $\tau_{RMS}=0.111 \mu$ s		
Normalization Factor:		Overall K: K=3.3 (90%)		
$F_{omni}=-0.1771$ db		K=10.4 (75%)		
$F_{30^0}=-0.0371$ db		30 ⁰ antenna: $\tau_{RMS}=0.042 \mu$ s		
		Overall K: K=14.0(90%)		
		K=44.2(75%)		

Table 4 SUI -2 Channel Model				
	Tap 1	Tap 2	Tap 3	Units
Delay	0	0.4	1.1	μ s
Power(omni antenna)	0	-12	-15	db
90% K-factor(omni)	2	0	0	
75% K-factor(omni)	11	0	0	
Power(30 ⁰ antenna)	0	-18	-27	db
90% k-factor(30 ⁰)	0	0	0	
75% K-factor(30 ⁰)	36	0	0	
Doppler	0.2	0.15	0.25	Hz
Antenna correlation: $\rho=0.5$		Terrain Type : C		
Gain Reduction Factor:GRF=2db		Omni antenna : $\tau_{RMS}=0.202 \mu$ s		
Normalization Factor:		Overall K: K=1.6 (90%)		
$F_{omni}=-0.3930$ db		K=5.1 (75%)		
$F_{30^0}=-0.0768$ db		30 ⁰ antenna: $\tau_{RMS}=0.069 \mu$ s		
		Overall K: K=6.9(90%)		
		K=21.8(75%)		

For a 30⁰ antenna beam width, 2.3 times smaller RMS delay spread is used when compared to an omnidirectional antenna RMS delay spread. Consequently, the 2nd tap power is attenuated additional 6 dB and the 3rd tap power is attenuated additional 12 dB (effect of antenna pattern, delays remain the same). The simulation results for all the six channels are evaluated. The above experiments are done using the simulation in Matlab communication tool box.

IV. SIMULATION RESULTS

The output for the performance of mobile WiMAX was estimated by the BER and the SNR plot using the MATLAB coding with BPSK modulation. The bandwidth used in the experiment was 3.5 MHz

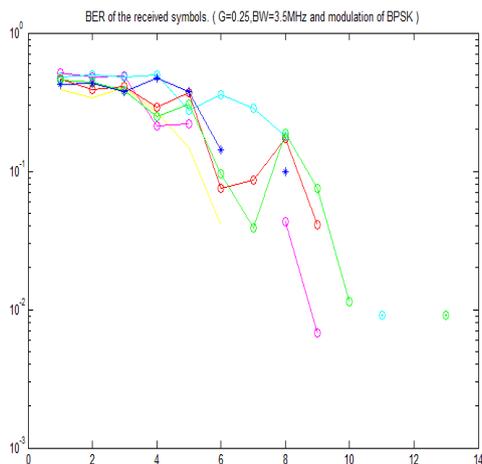


Figure3. BER curve for BPSK modulation

The output for the performance of mobile WiMAX was estimated by the Bit Error Rate and the Signal to Noise Ratio plot using the MATLAB coding with Quadrature Phase Shift Keying modulation technique is given below in figure 4.

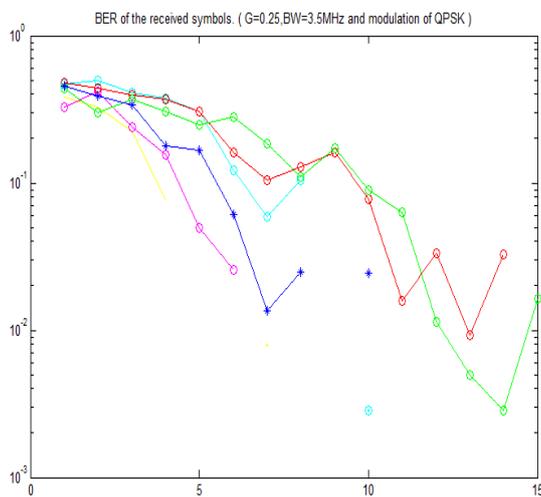


Figure 4. BER curve for QPSK modulation

The output for the performance of mobile WiMAX was estimated by the BER and the SNR plot using the MATLAB coding with 16QAM modulation. It is illustrated in the figure5.

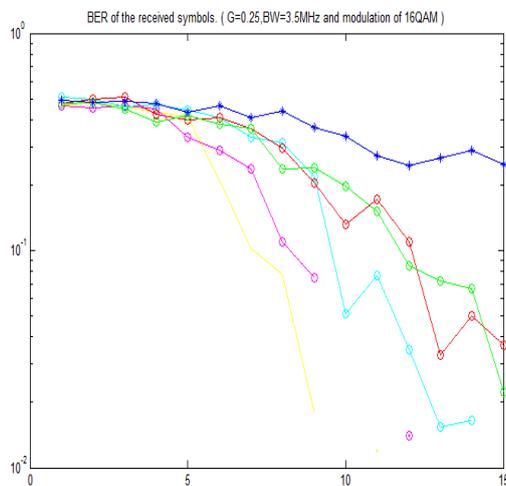


Figure5. BER curve for 16QAM modulation

The output for the performance of mobile Wimax was estimated by the BER and the SNR plot using the MATLAB coding with 64QAM modulation and graphical illustration done as in figure 6.

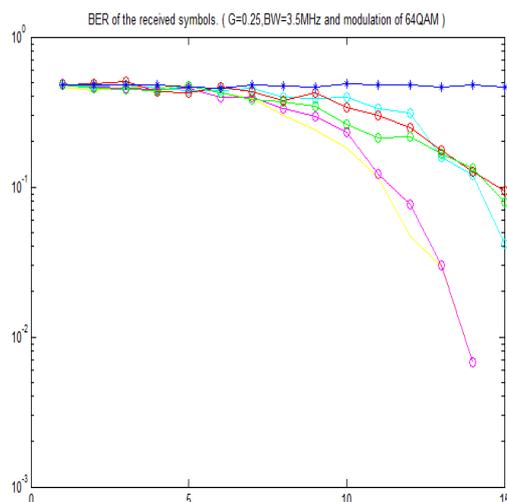


Figure6. BER curve for 64QAM modulation

V. CONCLUSION

In this paper, the performance of mobile WIMAX physical layer for OFDMA on different channel condition assisted by Mobile IP(Internet protocol) for mobility management was analyzed. The analysis demonstrated that the modulation and coding rate had a greater impact on the relative performance between the different SUI channel conditions. The performance was analyzed under SUI channel models with different modulation techniques for mobility management. It is found from the performance graphs that SUI channel 5 and 6 performs better than the conventional ones.

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