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Performance Analysis Of UWB-OFDM Using Different Modulation Schemes Over The Hybrid Flat Fating Channel

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ABSTRACT

This paper presents the simulation based analysis of UWB-OFDM using Different Modulation Schemes over the Hybrid Flat Fating Channel. Different modulation techniques such as BPSK, QPSK-16-QAM, and 64-QAM are used by considering different multipath channels (AWGN, Rayleigh and Rician).Simulation results obtained are compared with the proposed hybrid combination of Rayleigh, Rician and AWGN to observe a realistic multipath faded environment. These cases are based on no fading and flat Rayleigh-fading, multiple-diversity reception Rayleigh-fading, and flat Rician-fading. The simulation is used to determine both signal to noise ratio and bit error rate.In M-QAM as the value of M increases the performance of the system improves in terms of low bit error rate for different modulation techniques.

I. INTRODUCTION

Orthogonal Frequency Division Multiplexing is a multi carrier transmitter. In this single data is transmitted through a number of lower data rate subcarriers. Here UWB-OFDM is used where the bandwidth is split into man narrow sub channels, which are transmitted in parallel. The technology which is used here is based on a parallel data transmission scheme that reduces the effect of multi path fading and reduces the use of complex equalizers. The UWB-OFDM is to divide a relatively high rate data stream to more than one lower rate data streams. After the division they are transmitted through a number of subcarriers in same time. The figure 1 shows a simple UWB-OFDM system. The system consist of the IFFT (Inverse Fast Fourier Transform) following that Cyclic Prefix (CP) has been introduced which is also termed as guard intervals to prevent the interference between two overlapping channels [1]. The signal is transmitted through a wireless channel, and that is based on high frequency. On the receiver side the Cyclic Prefix removal has been carried out and then FFT (Fast Fourier Transform) is performed to regain the original signal [2].

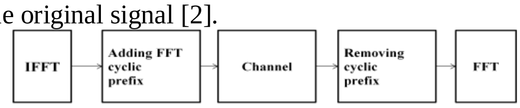

Fig 1: UWB-OFDM System

A channel is a medium, which transfer data or information from transmitter to receiver. In this paper several channels have been modeled and used, so let us see a brief introduction about these channels. **AWGN**, the function of Additive White Gaussian Noise is to add white Gaussian noise to a real or complex input signal. If the input signal is real, the block adds real Gaussian noise and produces a real output signal. On the other hand if the input signal is complex, then it will add complex Gaussian noise and generates a complex output signal. In this channel model the only impairment to communication is a linear addition of wideband or white noise with a constant spectral density and a Gaussian distribution of amplitude [3]. It generates simple and tractable mathematical models. Those models are useful for gaining insight into the underlying behavior of a system.

The next one is **Rayleigh** channel is a statistical model. It assumes the magnitude of a signal. This model is used for the effect of a propagation environment on a radio signal, such as that used by wireless devices. So we can say that it is a useful model of real-world phenomena in wireless communications. These phenomena include multipath scattering effects, time dispersion, and Doppler shifts that arise from relative motion between the transmitter and receiver [4]. Another channel simulated here is **Rician** channel it is a stochastic model. It is used for radio propagation anomaly caused by partial cancellation of a radio signal by itself, the signal arrives at the receiver by several different paths (hence exhibiting multipath interference), and at least one of the paths is changing (lengthening or shortening) [5][6]. It brings fading in channels that are also very realistic phenomena in wireless communication environments. These phenomena include multipath scattering effects, time dispersion, and Doppler shifts that arise from relative motion between the transmitter and receiver. The function of Rayleigh channel is to implements a baseband multipath Rayleigh fading propagation channel. The Rayleigh channel block accepts only frame based on complex signals at its input. If the input is sample based, the use of frame conversion block is necessary to reformate the signal. The input signal only accepts discrete sample time greater than 0. The working of

Rician channel block is quite similar to the Rayleigh channel but the parameters used are different.

Rest of the paper is organized as follows: A brief literature review and related research work on the technology comes under Section II .Section III gives the multipath channel modeling, leading the discussion to the development of the channel models in section IV with results and discussions. A brief conclusion has been presented in section V.

II. RELATED RESEARCH WORK

In this paper two fading modes are compared those are the Flat fading and No fading. Fading refers to fluctuations in the amplitude of a received signal that occur owing to propagation related interference [7]. Multipath fading is a significant problem in communications. This multipath propagation is caused by reflection and the scattering of radio waves lead to a situation in which transmitted signals arrive phase shifted over paths of different lengths at the receiver and are superimposed there[8]. The interference can cause strengthen, distort or even eliminate the received signal. In a fading channel, signals experience fades (i.e., they fluctuate in their strength). Fading is divided into two types. The first one is the small-scale fading and the other one is the large-scale fading. In this paper we will see the comparison in small scale fading environment. Small scale fading is again divided into two parts that are based on multipath time delay spread and other based on Doppler Spread[9][10]. Small scale fading includes flat fading that occurs due to multipath time delay spread. Flat fading refers to the amplitude of the received signal changes with time. Fading takes place when symbol period of the transmitted signal is much larger than the delay spread of the channel. Because of that, deep fade may occurs and the only way to overcome this problem is to increase the transmit power. In flat fading the bandwidth of signal is lesser than bandwidth of channel. When the signal power drops significantly, the channel is said to be in a fade. This gives rise to high bit error rates (BER).

III. Multipath Channel Modelling

In UWB-OFDM model the multipath channel block is divided into three models. Here we use two fading modes are also used that are Flat fading and No fading.

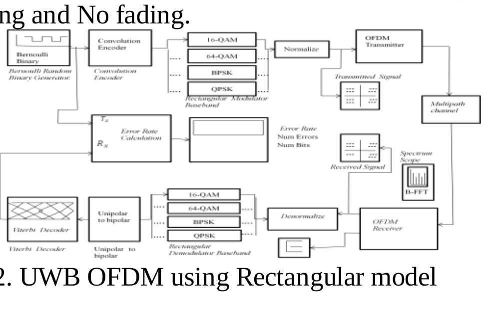

Fig2. UWB OFDM using Rectangular model

This model mainly depends on two parts i.e. UWB-OFDM transmitter and UWB-OFDM receiver, but there are other blocks which are need to be discussed as shown in figure 2. The descriptions of all blocks are as follows.

UWB-OFDM Transmitter: The first block in the model is Bernoulli Random Binary Generator. It is used to generate random binary numbers using a Bernoulli distribution. The Bernoulli distribution with parameter p produces zero with probability p and one with probability 1-p. In this the frame based output is selected.. The next block is Convolutional Encoder. It is used to encode a sequence of binary input vectors to produce a sequence of binary output vectors. The block can process multiple symbols at a time. The next block is Rectangular Modulator Baseband. In this block we will use different modulation techniques like BPSK modulation, QPSK modulation, 16-QAM and 64-QAM. The next block is Normalize block, which normalizes the filter numerator coefficients for a quantized filter to have values between -1 and 1. Next block presents a Transmitted signal block that samples per symbol is set to be 1 and offset is 0. The next block is UWB-OFDM transmitter, first PN sequence generator is attached followed by a Unipolar to bipolar convertor. The Matrix Concatenation block is also used in which the numbers of inputs is selected to be 11 and mode is selected to be Multidimensional array. After that Zero padding for UWB-OFDM is worn and then Inverse Fast Fourier Transform (IFFT) block is used. Cyclic prefix block is attached owing to the well-known Inter symbol and Inter carrier interference problem in UWB-OFDM. Next block is Multipath channel. After that Spectrum Scope is attached, the function of Spectrum Scope block is to computes and displays the Periodogram of the input. The input can be either sample-based or frame-based vector or a frame-based matrix.

UWB-OFDM Receiver: In Receiver part the received signal is passed through Remove Cyclic Prefix block and then forwarded to Fast Fourier Transform (FFT). After the frame conversion, zero padding is removed and pilots channel is removed and then output is achieved. In the received signal the same value is selected as the transmitted signal. Next block is Denormalize; the function of the block is the inverse of Normalize block. The function of Rectangular Demodulator Baseband is to demodulate a signal that was modulated using different modulation techniques which are used in modulation block with a constellation on a rectangular lattice. The next block is Viterbi Decoder that decodes input symbols to produce binary output symbols. The last block attached is of Error Rate Calculation block that compares input data from a transmitter with input data from a receiver. It calculates the error rate as a running statistic, by dividing the total number of unequal pairs of data elements by the total number of input data elements from one source.

A. (Rayleigh + AWGN Channel) Model-1:

In this model the inside structure of multipath channel can be seen. Here the model consists of two Rayleigh channels that are attached to AWGN channel as shown in figure 3.

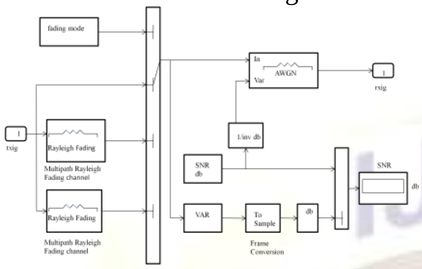

Fig3. Structural design of model-1

B. (Rician + AWGN Channel) Model-2:

In this model two Rician channels are attached to AWGN channel instead of Rayleigh channel as shown in figure 4.

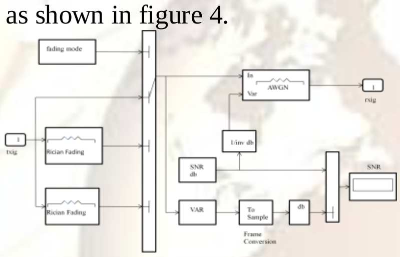

Fig4. Structural design of model-2

C. (Rayleigh + Rician + AWGN Channel) Model-3:

In this model combination of the channels are used that is the Rayleigh and Rician channels both are combined and then forwarded to AWGN channel as presented in figure 5.

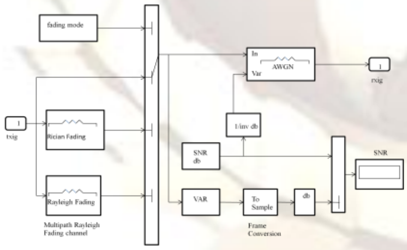

Fig5. Structural design of model-3

IV. SIMULATION RESULTS AND DISCUSSIONS

A. (Rayleigh + AWGN Channel) Model-1:

1. **For BPSK:** In figure 6 we will see the difference of Received Signal in Flat and No Fading model by using BPSK technique. The first figure shows the result of Received signal in Flat fading mode and the second describes the Received signal in No fading mode using model-1.

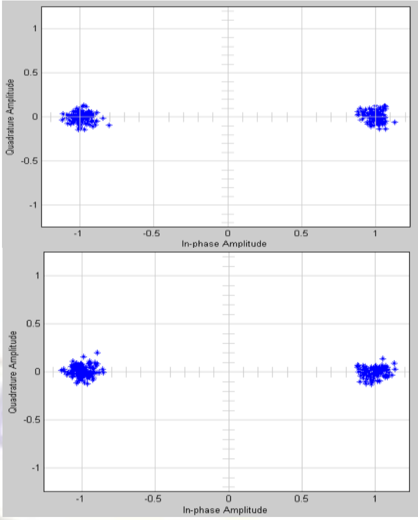

Fig6. Received Signals of Model 1 in Flat and No Fading of a BPSK

2. For QPSK: The difference of Received Signal in Flat and No Fading model by using QPSK technique is shown in figure 8. The first figure shows the result of Received signal in Flat fading mode and the second describes the Received signal in No fading mode using model-1.

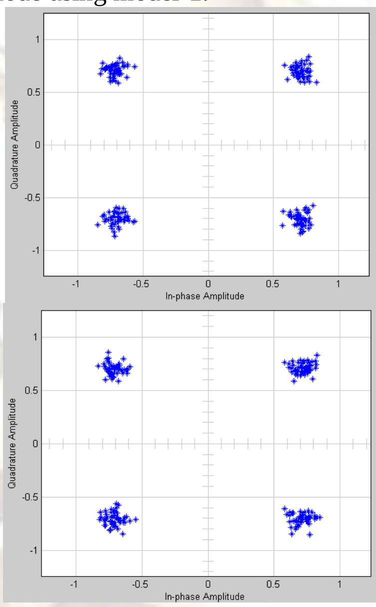

Fig7. Received Signals of Model 1 in Flat and No Fading of a QPSK

3.For 16-QAM: Here figure 8 we will give the difference of Received Signal in Flat and No Fading model by using 16-QAM technique. The first figure shows the result of Received signal in Flat fading mode and the second describes the Received signal in No fading mode using model-1

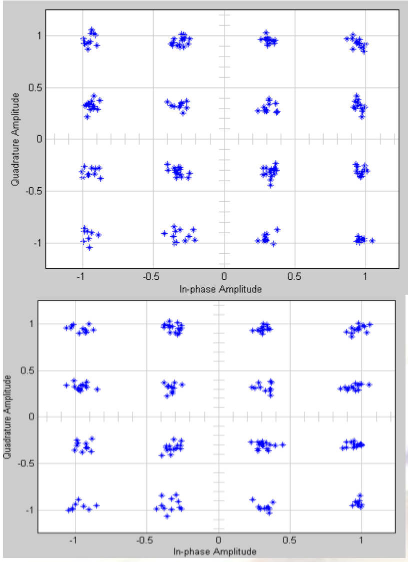

Fig8. Received Signals of Model 1 in Flat and No Fading of a 16-QAM

4. For 64-QAM :Figure 9 gives the difference of Received Signal in Flat and No Fading model by using 64-QAM technique. The first figure shows the result of Received signal in Flat fading mode and the second describes the Received signal in No fading mode using model-1.

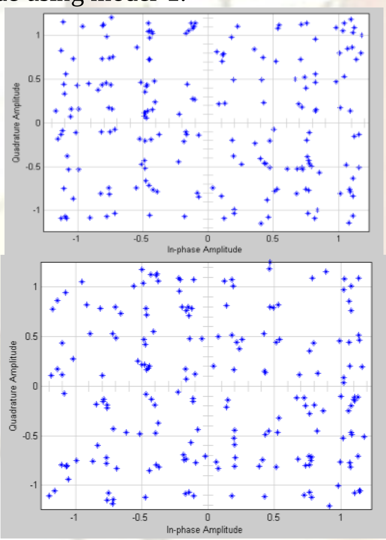

Fig9. Received Signals of Model 1 in Flat and No Fading of a 64-QAM

B. **(Rician + AWGN Channel) Model-2**

1. For BPSK: The figure 10 illustrates the difference in Received signals of Model 2. The first part of figure gives the result of Received signal in Flat fading mode and second one gives the result of Received signal in no fading mode using BPSK techniques.

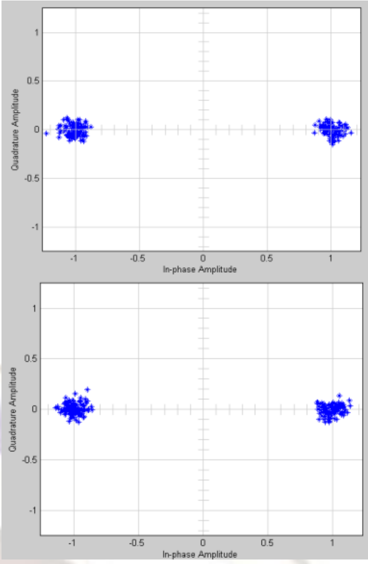

Fig10. Received Signals of Model 2 in Flat and No Fading of a BPSK

2. For QPSK: The different Received signals of Model 2 are illustrated in figure11. The first part of figure shows the result of Received signal in Flat fading mode and second part of the result shows the Received signal in no fading mode using QPSK techniques.

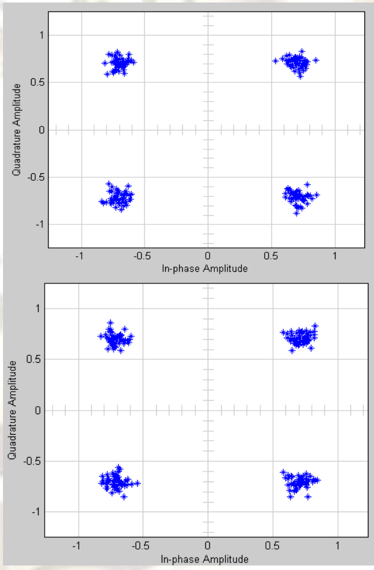

Fig11. Received Signals of Model 2 in Flat and No Fading of a QPSK

3. For 16-QAM: Here figure 12 we will give the difference of Received Signal in Flat and No Fading model by using 16-QAM technique. The first figure shows the result of Received signal in Flat fading mode and the second describes the Received signal in No fading mode using model-2.

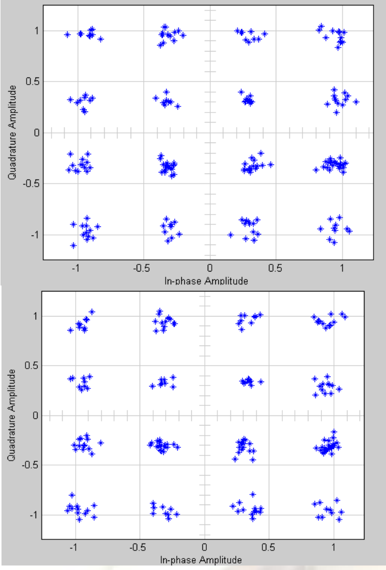

Fig12. Received Signals of Model 2 in Flat and No Fading of a 16-QAM

4. For 64-QAM: The difference of Received Signals in Flat and No Fading model by using 64-QAM technique is shown in figure 13. The first figure shows the result of Received signal in Flat fading mode and the second describes the Received signal in No fading mode using model-2.

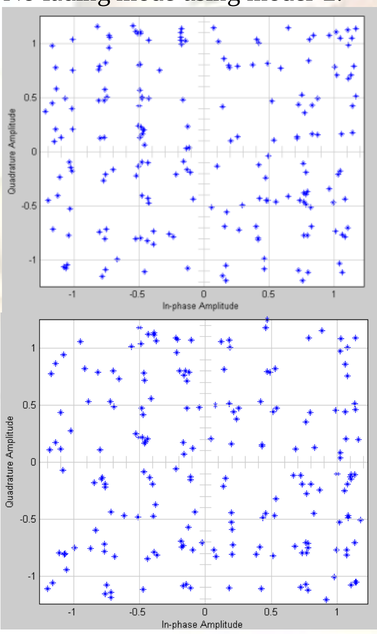

Fig13. Received Signals of Model 2 in Flat and No Fading of a 64-QAM

C. (Rayleigh + Rician + AWGN Channel) Model-3

1. For BPSK: The figure 14 presents the received signal in Flat and No fading mode. Here by using BPSK technique the received signals are obtained. The first one gives the result flat fading mode and the second one gives the result of No fading mode.

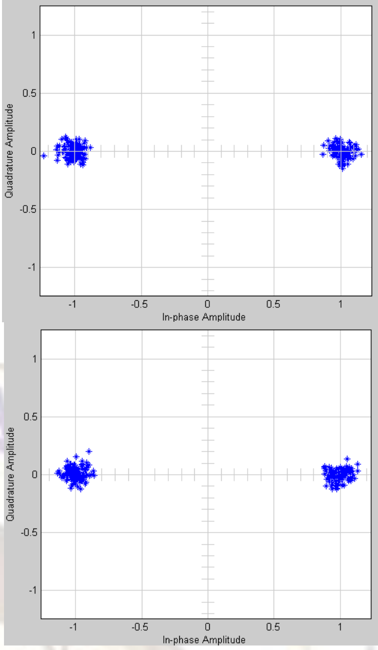

Fig14. Received Signals of Model 3 in Flat and No Fading of a BPSK

2. For QPSK: By using QPSK technique the received signals are obtained. The below figure 15 presents the received signal in Flat and No fading mode .The first one gives the result flat fading mode and the second one gives the result of No fading mode.

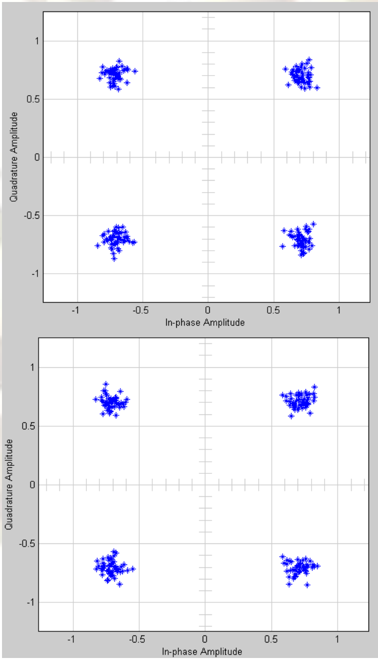

Fig15. Received Signals of Model 3 in Flat and No Fading of a QPSK

3. For16-QAM: The difference of Received Signals in Flat and No Fading model by using 16-QAM technique is shown in figure 16. The first figure shows the result of Received signal in Flat fading mode and the second describes the Received signal in No fading mode using model-3.

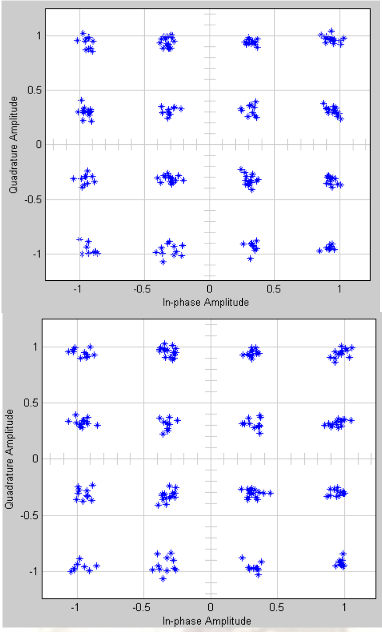

Fig16. Received Signals of Model 3 in Flat and No Fading of a 16-QAM

4. For 64-QAM: In figure 17 we will see the difference of Received Signal in Flat and No Fading model by using 64-QAM technique. The first figure shows the result of Received signal in Flat fading mode and the second describes the Received signal in No fading mode using model-3.

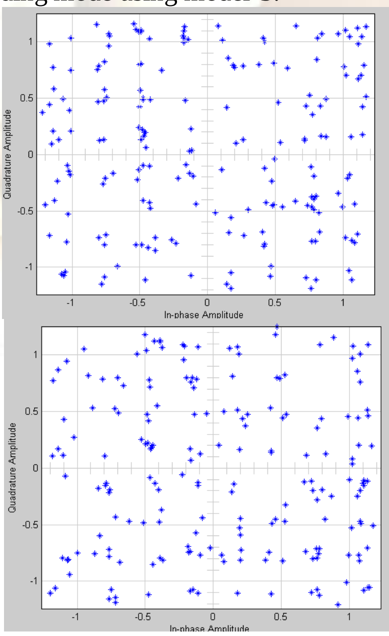

Fig17. Received Signals of Model 3 in Flat and No Fading of a 64-QAM

V. CONCLUSION:

Below tables represents the summary of all simulation results concluded with various combinations of multipath channel models for different modulation techniques.

Simulation Number	Channels	Fading Mode	Bit Error Rate	SNR
1	Rayleigh+AWGN	Flat Fading	0.4457	26.16
2	Rayleigh+AWGN	No Fading	0.4402	25.67
3	Rician+ AWGN	Flat Fading	0.4402	26.17
4	Rician+ AWGN	No Fading	0.4402	25.67
5	Rayleigh+Rician+ AWGN	Flat Fading	0.4457	26.16
6	Rayleigh+Rician+ AWGN	No Fading	0.4402	25.67

Table1: BPSK-BER & SNR for multipath channel models

Simulation Number	Channels	Fading Mode	Bit Error Rate	SNR
1	Rayleigh+AWGN	Flat Fading	0.333	26.28
2	Rayleigh+AWGN	No Fading	0.3136	25.78
3	Rician+ AWGN	Flat Fading	0.3136	26.27
4	Rician+ AWGN	No Fading	0.3136	25.78
5	Rayleigh+Rician+ AWGN	Flat Fading	0.3764	24.15
6	Rayleigh+Rician+ AWGN	No Fading	0.3764	24.09

Table2: QPSK-BER & SNR for multipath channel models

Simulation Number	Channels	Fading Mode	Bit Error Rate	SNR
1	Rayleigh+AWGN	Flat Fading	0.2722	26.68
2	Rayleigh+AWGN	No Fading	0.2505	26.16
3	Rician+ AWGN	Flat Fading	0.2508	24.47
4	Rician+ AWGN	No Fading	0.2508	24.44
5	Rayleigh+Rician+ AWGN	Flat Fading	0.2505	26.68
6	Rayleigh+Rician+ AWGN	No Fading	0.2505	26.16

Table3: 16QAM -BER & SNR for multipath channel model

Simulation Number	Channels	Fading Mode	Bit Error Rate	SNR
1	Rayleigh+AWGN	Flat Fading	0.00024	26.63
2	Rayleigh+AWGN	No Fading	0.00023	25.66
3	Rician+ AWGN	Flat Fading	0.00024	24.3
4	Rician+ AWGN	No Fading	0.00023	23.9
5	Rayleigh+Rician+ AWGN	Flat Fading	0.00024	24.3
6	Rayleigh+Rician+ AWGN	No Fading	0.00023	23.9

Table4:64QAM-BER & SNR for multipath channel models

So therefore we can say that of all the modulation techniques used simulation results shows that the performance of the system using M-QAM with M=64 outperforms the other modulation techniques in terms of low bit error rate.

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