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Comparative Evaluation of Different Digital Modulation Schemes on AWGN, LOS and Non-LOS Fading Channels Based on BER Performance.

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ABSTRACT
In this paper, Comparative Evaluation of Different Digital Modulation Schemes on AWGN, LOS and Non-LOS Fading Channels Based on BER Performance has been achieved. Digital modulation schemes such as Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK), Phase Shift Keying (PSK), Differential Phase shift Keying (DPSK) and Quadrature Amplitude Modulation (QAM) play fundamental roles in the performance of all digital communication systems. In this paper, the evaluation of three different digital modulation schemes i.e. 16-QAM, 64-QAM and 16-DPSK are compared based on Bit Error Rate (BER) performed on Additive White Gaussian Noise (AWGN), Line of Sight (Rician) and Non Line of Sight (Rayleigh) Fading Channels to identify a suitable digital modulation scheme. The data modulation and data rate were considered to analyze the performance i.e. Bit Error Rate (BER) vs. Signal Noise ratio (SNR).The entire process was modeled in the MATLAB/SIMULINK environment. Based on simulation results, it is observed that among the three digital modulation schemes, 16-QAM showed better performance as compared to 64-QAM and 16- DPSK.

Keywords : ASK, AWGN, DPSK, FSK, PSK, QAM, BER, SNR

I. INTRODUCTION

Wireless communication is one of the most active areas of technology development and has become an ever-more important and prominent part of everyday life. Simulation of wireless channels accurately is very important for the design and performance evaluation of wireless communication systems and components. It is important to evaluate the performance of wireless devices by considering the transmission characteristics, wireless channel parameters and device structure. The performance of data transmission over models. The results show the effects of various modulation schemes on the BER operating in AWGN channel and Rayleigh and Rician fading channels. The performance of the different modulation is also analyzed. This paper presents a comparative BER performance of different modulation schemes which are theoretically analyzed to identify the one with best performance.

II. OVERVIEW OF THE DIFFERENT FADING CHANNEL MODELS

Fading is one of the most detrimental effects in wireless system. It refers to the distortion that a carrier-modulated telecommunication signal experiences over certain propagation media. Fading is due to multipath propagation and it is sometimes referred to as multipath induced fading. The effects of multipath include constructive and destructive interference, and phase shifting of the signal. This distortion of signals caused by multipath is known as fading. In real world environment, the radio propagation effects combine together and multipath is generated by these fading channels. Due to multiple signal propagation paths, multiple signals will be received by receiver and the actual received signal level is the vector sum of the all signals. In multipath, some signals aid the direct path and some others subtract. The effects of multipath include constructive and destructive interference, and phase shifting of the signal.

There are many models that describe the phenomenon of small scale fading. Out of these models, Rayleigh fading, Rician fading and AWGN models are most widely used.

Rayleigh Fading Channel

Rayleigh fading occurs primarily due to the multilink reception. Rayleigh fading is a statistical model for the effect of a propagation environment on a radio signal i.e.

wireless channels is well captured by observing their BER, which is a function of SNR [1][2] at the receiver. In wireless channels, several models have been proposed and investigated to calculate SNR. Several probability distributed functions are available to model a time-variant parameter i.e. channel gain. The three important and frequently used distributions models are AWGN, Rayleigh and Rician models.

The main goal in the design of digital communication system is to achieve least probability of error and effective utilization of channel bandwidth. In case of digital modulation systems, there are two performance criteria of interest [3]. They are the probability of error relative to the symbol or bit errors and the outage probability defined as the probability that the instant signal to noise ratio falls below a given threshold. In this paper the theoretical bit error rate performance of different digital modulation schemes are compared for the selection of different modulation scheme. Simulations were performed to study the bit error rate (BER) versus signal to noise ratio (SNR) of the designed

Rician Fading Channel

Rician Fading is a part of Rayleigh fading with the introductionof a strong line of sight path in the Rayleigh fading environment. Rician fading is worthy for satellite communications and is acceptable for some urban scenarios. Rician fading is a type of small-scale fading because the probability of deep fades is less than that in the Rayleigh-fading case [5].

The Rician fading model [3] is similar to the Rayleigh fading model, except that in Rician fading, a strong dominant component is present. This dominant component is a stationary (non-fading) signal and is commonly known as the LOS (Line of Sight Component)[12]

Additive White Gaussian Noise Channel

An Additive White Gaussian Noise (AWGN) channel adds White Gaussian noise to the signal when it is passed through the channel. In the case of white Gaussian noise the values at any pair of times are identically distributed and statistically independent on each other.

AWGN channel is not associated with either fading or any other system parameters. It is just the noise that is added to the OFDM modulated signal when it is travelling through the channel. Additive white Gaussian noise (AWGN) is commonly used to transmit signal while signals travel from the channel and simulate background noise of channel.

it models the effect of the environment spreading to a larger area on a radio signal. It is a reasonable model for troposphere and ionospheres signal propagation as well as the effect of heavily built-up urban environments on radio signals. Rayleigh fading is most applicable when there is no line of sight between the transmitter and receiver. It is frequently used to model the statistics of signals transmitted through radio channels such as cellular radio.

wavelength of the propagating wave, then reflection will occurred. Actually we know that if the plane wave isincident on a perfect dielectric, part of the energy is transmitted and part of the energy is reflected back into the medium. If the medium is a perfect conductor, all the energy is reflected back. Reflections occur from the surface of the earth and from buildings and walls. In practice, not only metallic materials cause reflections, but dielectrics also cause this phenomenon. Reflection mainly occurs from the earth surface and from the buildings and walls.

Diffraction: Diffraction is a phenomenon which will occur when a wave strikes with an obstacle. The sharp irregularities (edges) of a surface between transmitter and receiver and obstructs the radio path then diffraction will occurred. The bending waves around the obstacle, even when a Line of Sight does not exist between transmitter and receiver the secondary waves will be spread over the space. Diffraction looks like a reflection at high frequencies, depending on the amplitude, phase and polarization of the incident wave and geometry of the object at the point of diffraction. Diffraction helps to measure the coherence

Scattering: If beam of light illuminate rough surface some of the light is removed from the beam and redistribution in all direction. This angular redistribution is called scattering. The wave travels through the medium consists of smaller dimension objects compared to the wavelength and having larger volumes of obstacles per unit volume, this leads to scattering. Due to rough surfaces, small objects and irregularities in the channel, scattered waves are produced. In practice, in mobile communications, electrical poles and street signs etc. induces scattering [9] in communication.

Fading on the basis of effect of multilink

Large scale fading is defined as the fading which depends upon the location with respect to objects or it shows clearly in case of the short distance of the transmitter or the receiver. A continuous variation in the phase and amplitude occurs when a signal moves from a distance in the order of wavelength or it can also say that the small scale fading refer to the changes occur in the position of the transmitter and receiver in order of

Fading

Fading refers to the disturbance or distortion, when a signal is experienced over any propagation media. Fading is also defined as the signal loss which is caused either in phase or amplitude due to the some changes in the channel response. In wireless communication, a multilink propagation is sometimes referred as multilink fading. In order to know about the fading, first we have the knowledge about the multilink. As we know about that in wireless communication the multilink phenomenon can give the result into the radio signal by taking it into two or more path at the receiver side. Fading channel is defined as, during signal transmission, the communication channel which goes through the various fading phenomenon [3]. By using multipath signal, the multiple signals will be calculated by the vector sum of the entire signal.

Causes of Fading

Fading is caused by different physical phenomenon: Doppler shift, reflection, diffraction and scattering.

Doppler shift: This is the phenomenon which occurs when wave energy like sound or radio waves travels from two objects, the wavelength can seem to be changed if one or both of them are moving. For the body in motion, with the variation of distance between transmitter and receiver, the received frequency of a transmitter differs from the sent frequency, which comes up with a Doppler shift [6]. This effect is more pronounced for the variation of sound between a moving source and a stationary observer.

Reflection: When a propagating electromagnetic wave falls on object which has generated large dimensions wave length, when compared to information are known as modulating signals. The

carrier frequency is greater than the modulating frequency. Also the receiver recreates the original message signal from the transmitted signal after propagation through the channel. This process of recreating the original signal is known as demodulation [8].

Good bit error rate performance, less power consumption and good spectral efficiency are the properties of modulation techniques. The BER, or quality of the digital link, is calculated from the number of bits received in error divided by the number of bits transmitted.

BER= (Bits in Error) / (Total bits received).

In digital transmission, the number of bit errors is the number of received bits of a data stream over a communication channel that has been altered due to wavelength [9]. These changes are very small.

Fading on the basis of the Doppler spread effect

Slow fading occurs when the minimum time required for t
channel is large to change its magnitude from its previous
relative to the delay behavior of the channel. Slow fading c
also be formed by shadowing. In shadowing, when large
buildings or hills create problem for the path of the main s
of the transmitter and receiver, the received power is obtai
shadowing can be modeled by using log -distance path los
log-normal distribution. The minimum time required for th
channel is to change its magnitude from its previous value
relative to the delay behavior of the channel is known as F
fading

III. Design Approach

Modulation may be defined as the process by which some characteristic of a signal called carrier is varied in accordance with the instantaneous value of another signal called modulating signal. The designed model used in this work is shown in Fig.1.

16-Differential Phase Shift Keying

In 16-DPSK, change in phase of the carrier wave takes place. In DPSK high state contains only one and half cycle. Differential Shift Keying is a modulation technique that codes information by using the phase difference between two neighboring symbols. In the transmitter, each symbol is modulated relative to the previous symbol and modulating signal. In the transmitter side, each symbol is modulated with respect to the previous one, for BPSK 0 represents no change and 1 represents 180 degrees out of phase. In the receiver side, the current value can be demodulated by taking previous value as a reference. In DPSK, the transmitter, each symbol is modulated relative to the phase of the immediately preceding signal element and the data being transmitted but here we talk about the 16-DPSK modulating technique to analyse Bit error rate (BER.) and Signal noise ratio (SNR) [10][11].

V. SIMULATION RESULTS

In this section, the evaluation of three digital modulation schemes i.e. 16-QAM, 64-QAM and 16-DPSK is performed on Additive White Gaussian Noise (AWGN), Line of Sight (Rician) and Non Line of Sight (Rayleigh) Fading Channels. The results are plotted in terms of bit error rate. It is necessary to explore what happens to the signal as it travels from the transmitter to the receiver. Then it is very easy to understand the concepts in wireless communications. As explained earlier, one of the important aspects of the path between the transmitter and receiver is the occurrence of fading. MATLAB

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noise, interference, distortion or bit synchronization errors. The BER is the number of bit errors divided by the total number of transferred bits during a particular time interval. BER is a unit less performance measure, often expressed as a percentage

Digital modulation schemes transform digital signals into waveform that are compatible with the nature of the communications channel. One category uses a constant amplitude carrier and the other carries the information in phase or frequency variations (FSK, PSK). A major transition from the simple amplitude modulation (AM) and frequency modulation (FM) to digital techniques such as: Quadrature Phase Shift Keying (QPSK), Frequency Shift Keying (FSK), Minimum Shift Keying (MSK) and Quadrate Amplitude Modulation (QAM). The analysis based on the DPSK and QAM will give the idea which helps for the application development in the market [9].

1. **16-Quadrature Amplitude Modulation**

It is the encoding of the carrier wave by variation of the amplitude of both carrier wave and a quadrature carrier of the amplitude that is 90^o out of phase with the main carrier with respect to the two signals. The amplitude and the phase of the carrier wave are simultaneously changed according to the information that has to transmit. In 16-QAM, there are four values of I and four values of Q, this gives the total of 16 possible states for the signal. Since $16 = 2^4$, four bits per symbol can be sent. This consists of two bits for I and Q each. The symbol rate is one fourth of the bit rate. The 16-QAM modulation produces a spectrally efficient transmission. This modulation is more efficient than BPSK, QPSK or 8PSK [12].

2. **64-Quadrature Amplitude Modulation**

64-QAM is same as of 16-QAM but in this, 64 possible combinations are given out with each symbol represents six bits ($2^6 = 64$). 64-QAM is a quite complex modulation scheme as compare to 16-QAM but it gives high efficiency. This modulating technique is mainly used for sending data downstream over a coaxial cable network. It supports up to 26-28 mbps peak transfer rates over a single 6-MHz channel [10]. But 64QAM's susceptibility to interfering signals makes

provides a simple and easy way to demonstrate how fading taking place in wireless systems. The different fading models and MATLAB based simulation approaches will now be described.

Simulink is a graphical extension to MATLAB for the modeling and simulation of systems. In Simulink, systems are drawn on screen as block diagrams. Many elements of block diagrams are available (such as transfer functions, summing junctions, etc.), as well as virtual input devices and output devices. Simulink is integrated with MATLAB and data can be easily transferred between the programs.

1. Bit Error Rate (BER) Comparison in AWGN, Rayleigh and Rician fading channels in 16-QAM Modulation

Table1 shows Comparison of BER performance of 16-QAM, on AWGN, Rayleigh and Rician fading channels.

E_b/N_o	BER in AWGN	BER in Rayleigh	BER in Rician
-5 : 0	0.1064	0.1033	0.121
0 : 5	0.0952	0.0944	0.0991
5 : 10	0.0578	0.0608	0.0401
10 : 15	0.0235	0.0275	0.001699
15 : 20	0.0078	0.01	1.8399E-07
20 : 25	0.0025	0.0025	1.4E-19

Table 2 shows Comparison of BER performance of 16-DPSK, on AWGN, Rayleigh and Rician fading channels.

E_b/N_o	BER in AWGN	BER in Rayleigh	BER in Rician
-5 : 0	0.1212	0.0946	0.0986
0 : 5	0.1102	0.101	0.1027
5 : 10	0.0787	0.0861	0.0855
10 : 15	0.0472	0.0587	0.0565
15 : 20	0.006899	0.0293	0.0259
20 : 25	2.2099E-07	0.0114	0.0092

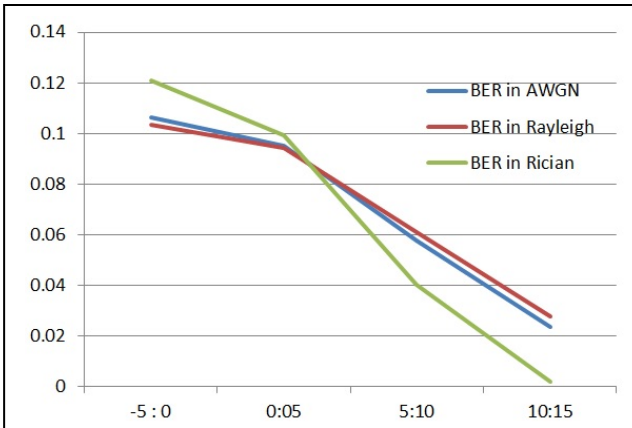
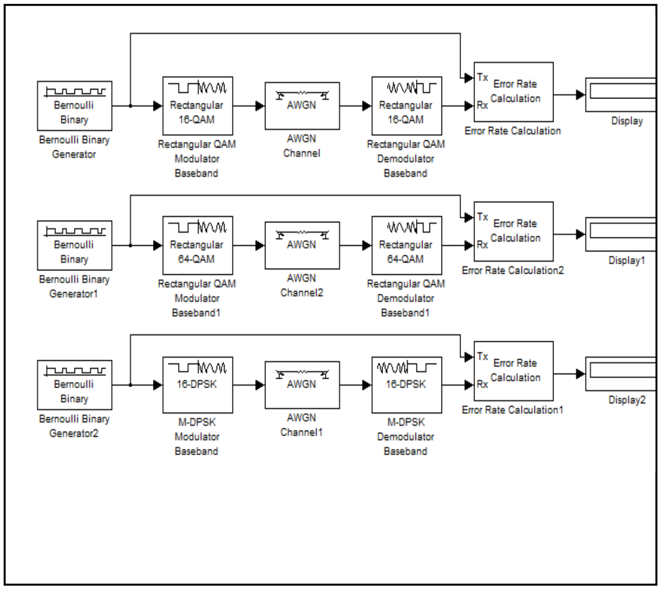


Fig 2. BER v/s SNR plot of BER performance of 16-QAM on AWGN, Rayleigh and Rician fading channels



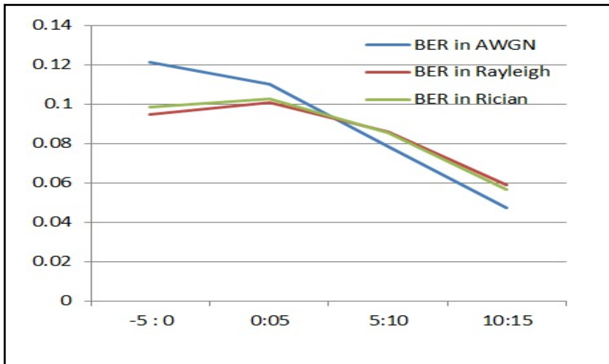


Fig3. BER v/s SNR plot of BER performance of 16-DPSK on AWGN, Rayleigh and Rician fading channels.

Table 3 shows Comparison of BER performance of 64-QAM on AWGN, Rayleigh and Rician fading channels.

E_b/N_o	BER in AWGN	BER in Rayleigh	BER in Rician
-5 : 0	0.0935	0.0905	0.1094
0 : 5	0.0948	0.0935	0.0991
5 : 10	0.0763	0.0769	0.0742
10 : 15	0.0431	0.046	0.025728
15 : 20	0.0168	0.02	0.000772
20 : 25	0.0056	0.0072	2.63E-08

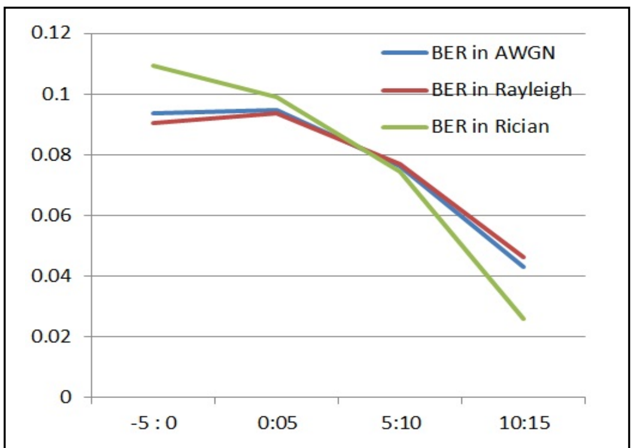


Fig 4. BER v/s SNR plot of BER performance of 64-QAM on AWGN, Rayleigh and Rician fading channels.

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It is clear from the fig.,2,3 that 16-QAM modulation technique shows better performance than 64-QAM and 16-DPSK on AWGN, Rayleigh and Rician fading channels.

VI. CONCLUSION

Digital modulation scheme choice will significantly affect the characteristics, performance and resulting physical realization of a communication system. There is no generally accepted best choice of modulation scheme, but depending on the physical characteristics of the channel, required levels of performance and target hardware trade-offs, some schemes will prove a better choice than others. In this paper, evaluation of three digital modulation schemes i.e. 16-QAM, 64-QAM and 16-DPSK in terms of Bit Error Rate (BER) is performed on Additive White Gaussian Noise (AWGN), Line of Sight (Rician) and Non Line of Sight (Rayleigh) Fading Channels. Among the three digital modulation schemes, 16-QAM is gives best performance as compared to 64-QAM and 16-DPSK on AWGN, Rician and Rayleigh fading channel.

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