Parametric Analysis of Modified Modulation Techniques for AWGN and Rayleigh Channel Models

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ABSTRACT-In this paper, the parametric analysis of different wireless channels is evaluated and discussed. The techniques established under this work are BPSK and QPSK modified prototypes for better performance of the system. The major objective of the work highlights in obtaining SNR and BER parameters for both the highlighted techniques. Quantitative approach and comparative analysis are discussed for both AWGN and Rayleigh channels. For high SNR values, it is found that the BER value obtained in AWGN channel is better when compared to Rayleigh channel.

Keywords *-BPSK, QPSK, OFDM, PAPR, BER, SNR, AWGN, Rayleigh channel*

1. INTRODUCTION

Orthogonal frequency division multiplexing (OFDM) is one of the most powerful multiplexing in which the sub channels cover without meddling used in a constructive telecommunication framework. Each subchannel would be influenced by just a little piece of the channel trademark, which could be approximated by consistent adequacy and stage [1].Several standards such as digital video/audio broadcasting, IEEE 802.11a WLAN and IEEE 802.16a WMAN adopts OFDM technique as it is capable of converting the frequency selective channel into a parallel collection of frequency flat sub channels [2-3]. Besides maintaining the orthogonality of the time domain waveforms with the subcarriers having a minimum separation of frequency, it is found that the spectrum signal corresponding to different subcarriers overlap in the frequency.

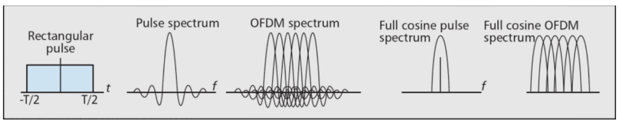

Fig 1: Rectangular pulse in different spectrums

OFDM is considered for maintaining high bandwidth connections to the users with high speeds and the multiple signal components as denoted in Fig1. Recent development in the MIMO techniques promises a significant contribution in the OFDM system performance [4]. Especially the broad band OFDM systems with high efficient bandwidths are intended for wireless LAN/MAN environments [5]. Li et al discussed the channel estimation for OFDM can exploit time and frequency correlation of the channel parameters [6]. This paper mainly focuses on the analysis of the Signal to Noise ratio (SNR) and the Bit Error rate (BER) of the different modulation techniques as focused on two modulation techniques i.e., Binary Phase Shift Keying (BPSK) and Quadrature Phase Shift Keying (QPSK). Numerical calculations for SNR and the corresponding BER values are calculated and these values are compared with the simulated values generated using MATLAB tool. Elaborate discussion and comparative analysis of both AWGN and Rayleigh fading channels are also evaluated in this paper.

2. DESIGN ANALYSIS

The orthogonality between the subcarriers and subbands are denoted by the below mentioned equations. The multicarrier modulated transmitted signal s(t) is represented as [7]

$$s(t) = \sum_{i=-\infty}^{+\infty} \sum_{k=1}^{N_{SC}} C_{ki} S_k (t - iT_S) \tag{1}$$

$$s_k(t) = \prod(t) e^{j2\prod f_k t} \tag{2}$$

$$\prod(t) = \begin{cases} 1, (0 <= t <= T_S) \\ 0, (t <= 0, t > T_S) \end{cases} \tag{3}$$

Where C_{ki} is the i^{th} information symbol at the k^{th} subcarrier, $S_k(t)$ is the waveform for the k_{th} subcarrier, N_{sc} is the number of subcarriers, f_k is the frequency of the subcarrier, and T_S is the symbol period, t is the pulse shaping function. The optimum detector for each subcarrier could use a filter that matches the subcarrier waveform, or a correlator matched with the subcarrier.

2.1 BER Performance Analysis in AWGN Channel

A received data affected by Gaussian noise and error will generated while recollecting original data. If data length is too long then total number of error will increase. To reduce this error, one way is increase SNR or Eb/No of the signal. Simulation result for evaluation on BER vs. SNR when the number of data is considered as 10,000 as discussed in the next section. In this simulation, the BERs are obtained by varying the values of Eb/No in the range of 1 to 10. The iteration is done 1000 times where the total number of data transmitted is 10000. From simulation result it is found that if an Eb/N0 value varies BER probability will decrease and total no. of error also decrease. As the SNR values increase & number of iterations up to 10th or more, the maximum amount of noise will minimize.

The quantitative BER expressions for M-ary QAM signaling in AWGN channel [8] is given by

$$P_e = \frac{2(M-1)}{M\, log_2 M} Q\left(\sqrt{\frac{6E_b}{N_0}\frac{log_2 M}{M^2-1}}\right) \tag{4}$$

2.2 BER Performance Analysis in Rayleigh Channel

In this channel received data is affected by the Doppler shift and multipath fading effect. This effect creates error while receiving data and BER performance will be reduce at receiver. Simulation result for evaluation on BER verses SNR with constellation diagram, when the number of data is 10,000 and the values of Eb/No in the range of 1 to 10. If the selected SNR value 30 or more than 30, four symbols are generated on constellation diagram and total errors at receiver also decreases when compared to SNR value 10. However, the energy required for each bit in symbol is more due to higher SNR values.

The analytical BER expression for M-ary QAM signaling in Rayleigh channel [9] is given as:

$$P_e = \frac{M-1}{M\, log_2 M}\left(1 - \sqrt{\frac{3\gamma log_2 M/(M^2-1)}{3\gamma log_2 M/(M^2-1)+1}}\right) \tag{5}$$

3. RESULTS AND DISCUSSION

3.1 BPSK with AWGN channel

Table1 shows the theoretical and practical values of BPSK modulation technique in AWGN channel by varying the SNR value i.e., Eb/No the respective BER values are generated and plotted using MATLAB tool. From the above value, the comparison of theoretical and practical values of BPSK in AWGN channel. The graph has been generated using MATLAB as represented in Fig2.

Table 1. SNR Vs BER of BPSK using AWGN channel Theoretical and Practical values

Modulation Technique	Theoretical		Practical	
	SNR(dB)	BER	SNR(dB)	BER
BPSK (AWGN)	2	0.0375	2	0.0950
	4	0.0125	4	0.0600
	6	0.002	6	0.024
	8	0	8	0.011
	10	0	10	0

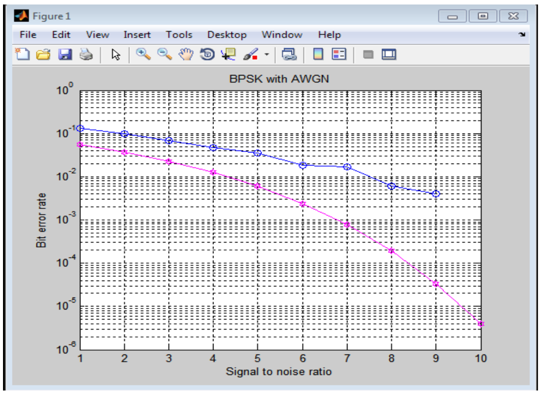

Fig 2: BER Vs SNR of BPSK with AWGN Channel

From the table it can be seen that for the respective SNR, Low BER value is obtained. For the high value of SNR i.e., 8dB and 10dB the BER is zero.

3.2 QPSK with AWGN channel

Table 2 show the theoretical and practical values of QPSK modulation technique in AWGN channel by varying the SNR value i.e., Eb/No the respective BER values are generated and plotted using MATLAB tool. From the above values, the comparison of theoretical and practical values of QPSK in AWGN channel is evaluated. The response for the same has been generated using MATLAB as represented in the Fig3.

From the table it can be seen that for the respective SNR, Low BER value is obtained and is almost zero.

Table 2. SNR Vs BER of QPSK using AWGN channel Theoretical and Practical values

Modulation Technique	Theoretical		Practical	
	SNR(dB)	BER	SNR(dB)	BER
QPSK (AWGN)	2	0.037	2	0.104
	4	0.0125	4	0.0564
	6	0.002	6	0.0211
	8	0	8	0.005
	10	0	10	0.001

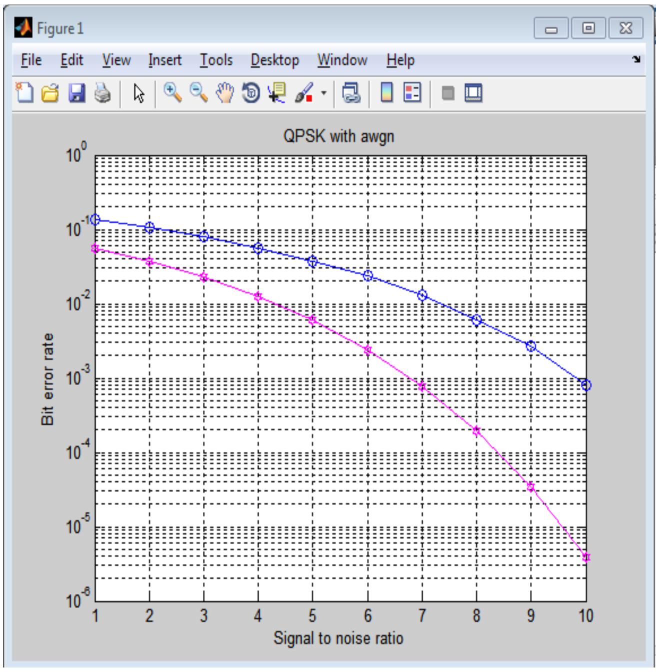

Fig 3: BER Vs SNR of QPSK with AWGN Channel

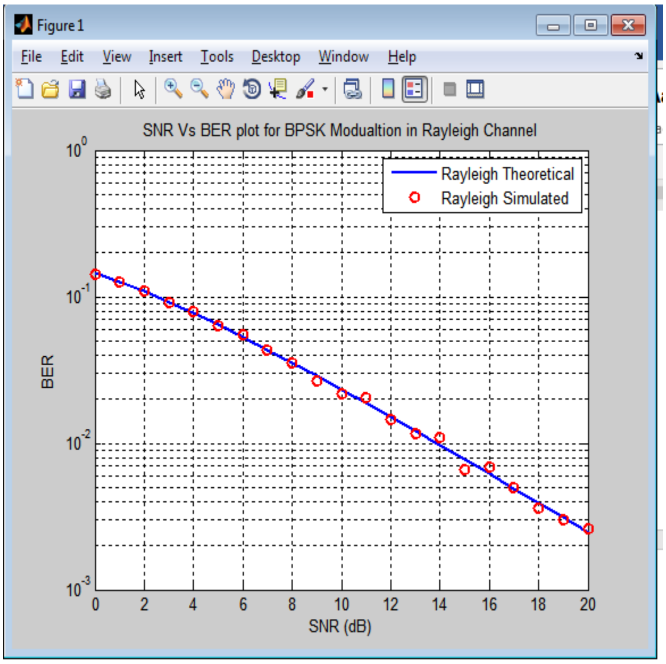

Fig 4: BER Vs SNR of BPSK with Rayleigh Channel

3.3 BPSK with Rayleigh channel

Table 3 shows the theoretical and practical values of BPSK modulation technique in Rayleigh channel by varying the SNR value i.e., Eb/No the respective BER values are generated and plotted using MATLAB tool. From the above value, the comparison of the theoretical and practical values of BPSK in Rayleigh channel. The graph has been generated using MATLAB as denoted by the Fig 4.

From the table it can be seen that for the respective SNR, Low BER value is obtained. For the high value of SNR i.e., 8dB and 10dB the BER is zero.

Table 3. SNR Vs BER of BPSK using Rayleigh channel Theoretical and Practical values

Modulation Technique	Theoretical		Practical	
	SNR(dB)	BER	SNR(dB)	BER
BPSK (Rayleigh)	2	0.126	2	0.131
	4	0.091	4	0.090
	6	0.064	6	0.066
	8	0.043	8	0.039
	10	0.028	10	0.027

3.4 QPSK with Rayleigh channel

Table 4 shows the theoretical and practical values of BPSK modulation technique in Rayleigh channel by varying the SNR value i.e., Eb/No the respective BER values are generated and plotted using MATLAB tool. From the above values the comparison of the theoretical and practical values of BPSK in Rayleigh channel. The graph has been generated using MATLAB and is represented in Fig 5.

From the table it can be seen that for the respective SNR, Low BER value is obtained and is almost zero.

Table 4. SNR Vs BER of QPSK using Rayleigh channel Theoretical and Practical values

Modulation Technique	Theoretical		Practical	
	SNR(dB)	BER	SNR(dB)	BER
QPSK (Rayleigh)	2	0.1084	2	0.1130
	4	0.0771	4	0.0792
	6	0.0529	6	0.0551
	8	0.0354	8	0.0339
	10	0.0232	10	0.0248

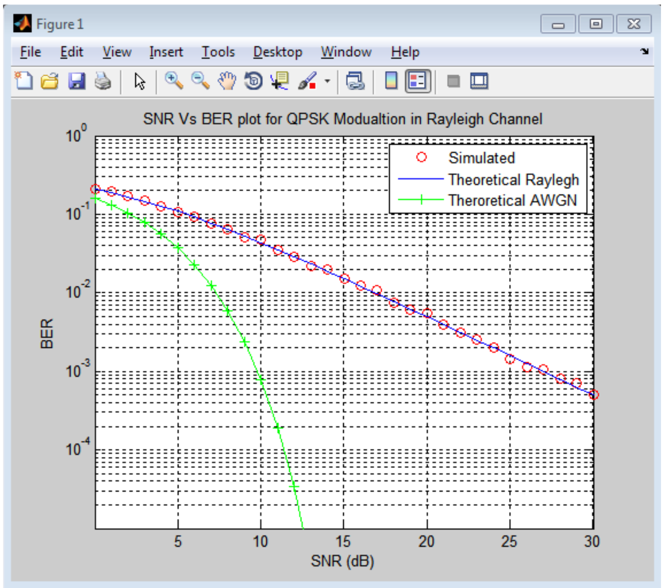

Fig 5: BER Vs SNR of QPSK with Rayleigh Channel

Simulation results shows the output wave forms of BPSK and QPSK in both the channels i.e., AWGN and Rayleigh fading channels, generated graphs using MATLAB Simulator.

Both the theoretical and practical output values are compared and tabulated below. From the above generated values, it is found that for the respective value of SNR the BER value is zero. For AWGN channel, it is found that for SNR values of 8dB and 10dB, the BER value is zero. Similarly, the same process is applicable for the QPSK modulation technique.

From both the channels AWGN and Rayleigh, BER value of AWGN channel is better when compared to Rayleigh fading channel. Mathematical and simulated evaluation of parametric is also observed in the current work.

4. CONCLUSION

The work proposed highlights the importance of evaluation of BER and SNR metrics for effectively modeling the channel design in a wireless environment. For a modified Rayleigh channel, it is found that the SNR value of 2dB and the BER value is denoted as 0.126 bps. Similarly, for a modified AWGN channel, the BER value is 0.037bps for the corresponding SNR value of 2dB. From the parametric evaluation and calculations, it is observed that for high SNR values, null value of BER is displayed. Besides, it is also found that the BER value for AWGN channel is better when compared to Rayleigh channel. Mathematical and simulated evaluation of parametric is also observed in the current work. Future work can be done by using different fading channel by considering different modulation techniques for reducing BER for the respective SNR values.

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