Bit Error Rate for M- DPSK on Rayleigh Channel

Ashutosh Kumar Rai[1] Prof. B.S. Rai[2]
[1]Research Scholar [2]Head of Department
[1,2]Department of Electronics and Communication Engineering
[1,2]MMM University of Technology, Gorakhpur, Uttar Pradesh

Abstract— This paper investigated the performance of M-*ary* DPSK on Rayleigh Channel on the basis of Bit Error Rate (BER). BER is calculated by using simulation of system model consisting of source, modulator, channel and demodulator on MATLAB platform.

***Key words**:* M-DPSK, BER and Rayleigh Channel

I. INTRODUCTION

With the rapid development of wireless communications it has become a challenge to achieve higher date rate and high spectrum efficiency and also to meet future demands which is becoming higher and higher day by day due to population growth.

In order to fulfil the requirements of the high spectrum efficiency and system capacity in the wireless communications, appropriate modulation schemes should be adopted, e.g., differential phase shift keying used for 40 Gbit/s speed, differential quadrature phase shift keying (DQPSK) used in military Link-11 and differential 8 phase shift keying (D8PSK) used in VHF data link (VDL) mode 2 [1]. Wireless communication suffer the multipath fading resulting from the reflection, scattering, diffraction, and shadowing effects together with a direct line-of-sight (LOS) path, but also possess their own characteristics, such as the

Doppler shift due to variation in position of receiver [2]. Due to the difficulties as well as the cost and complexity associated with carrier phase recovery, differential modulation schemes, which do not require a coherent phase reference at the receiver, are highly preferred.

II. DPSK AND RAYLEIGH CHANNEL.

DPSK is non-coherent form of phase shift keying which avoids the need for a coherent reference signal at the receiver [13].

Although only the direct wave is desired, several distinguishable paths between the transmitter and receiver do exist. These are typically due to reflections. These paths cause several waves to arrive at the receiver at slightly different times and produce fading. The interference between a direct wave and a reflected wave is called multi-path fading.

When there is no single line-of-sight path between the transmitter and the receiver, the received signal amplitude is modelled as a Rayleigh random variable.

Its probability density function (pdf) is given by [13]

$$P(r) = \frac{r}{\sigma^2} \exp\left(-\frac{r^2}{2\sigma^2}\right) \qquad 0 \le r \le \infty$$

Where $2\sigma^2$ = average energy of the received signal

III. BIT ERROR RATE

$$\text{BER} = \frac{Number\ of\ bits\ in\ error}{Total\ number\ of\ bits\ transmitted}$$

IV. SYSTEM MODEL

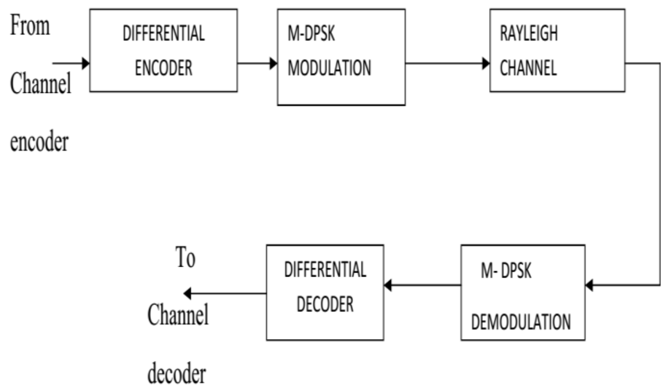

Fig. 1: System structure of M- DPSK

The system model with differential phase shift keying modulation schemes is shown in Fig. 1. Referring to this figure, input bits from channel encoder are passed through the differential encoder for the differential non-coherent modulation schemes. The resultant symbols are mapped to the relevant constellation and sent to the Rayleigh channel. On the contrary, at the receiver side, the received signals from the Rayleigh channel are sent to AWGN channel for varying SNR (E_b/N_o), when performing simulation on MATLAB platform. Then the output symbols are demodulated and differential decoded. The Rayleigh channel models have already been investigated in many studies. The Rayleigh channel models are characterized by Doppler shift, discrete path delay vector and average path gain vector. This paper mainly concentrates on the performance evaluation of differential modulation scheme influenced by Doppler shift and varying value of M-*ary* from 8 to 62 i.e. 8, 16, 32 and 64.

V. RESULT AND ANALYSIS

Below Table 1 shows BER value of M- DPSK where M varies as 8, 16, 32 and 64. Then comparative analysis is shown between theoretical results and simulated result. Graph is also shown between BER performance of 8, 16, 32 and 64- DPSK.

SNR (dB)	8- DPSK	16- DPSK	32- DPSK	64- DPSK
0	0.2881	0.3232	0.3445	0.3615
1	0.2513	0.2906	0.3261	0.3533
2	0.2265	0.2685	0.3075	0.3379
3	0.2023	0.2468	0.2833	0.3221
4	0.1791	0.2253	0.265	0.3064
5	0.157	0.2044	0.2467	0.288
6	0.1363	0.1825	0.2264	0.2723
7	0.1161	0.1648	0.2067	0.2565
8	0.0988	0.145	0.1914	0.2386
9	0.0691	0.1276	0.1724	0.2232

Table 1: BER v/s SNR table for M- DPSK

A. Parameters Specifications

1) Rayleigh Channel

Discrete path delay vector = [0 2e-6]

Average path gain vector (dB) = [0 -3]

Doppler shift = 40 Hz

2) AWGN

E_b/N_0 = [0 9]

No. of bits/ symbol = 8, 16, 32 and 64

Fig. 2, Fig. 3, Fig. 4, Fig. 5 and Fig. 6 shows the simulated result implemented on MATLAB platform.

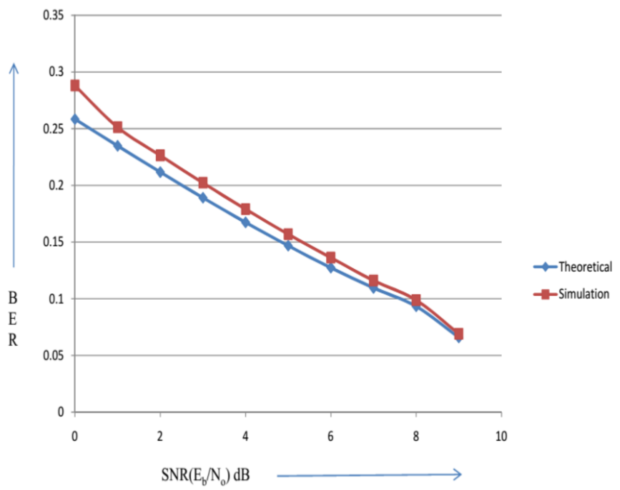

Fig. 2: BER performance of 8- DPSK in Rayleigh Channel

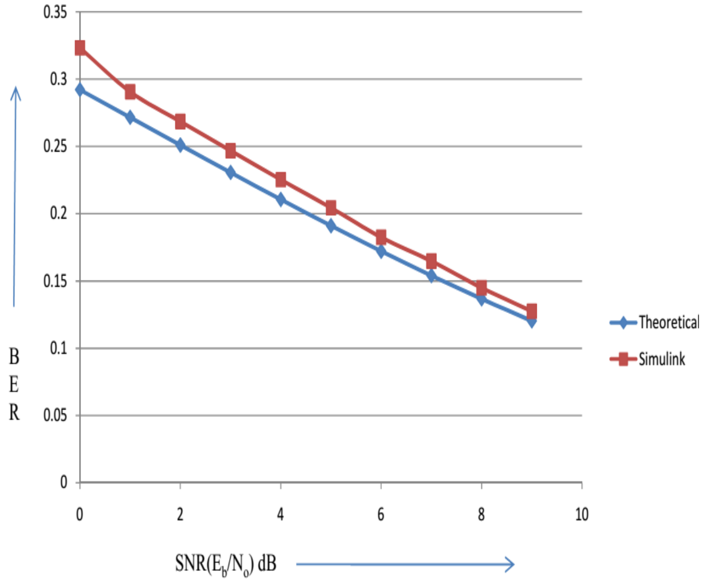

Fig. 3: BER performance of 16- DPSK in Rayleigh Channel

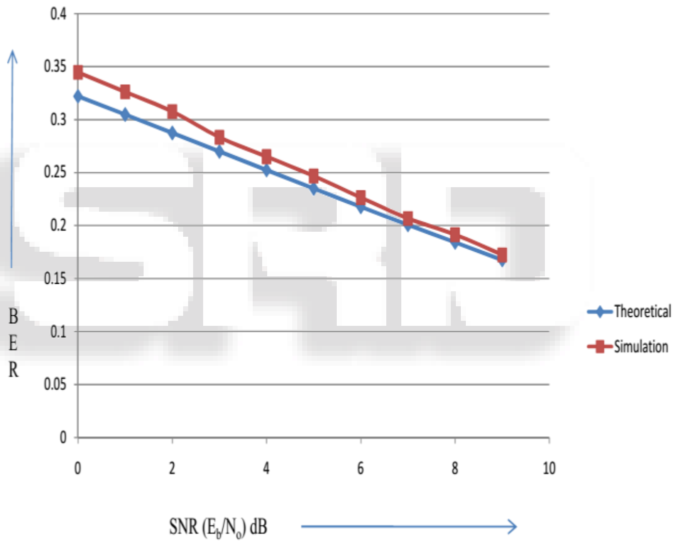

Fig. 4: BER performance of 32- DPSK in Rayleigh Channel

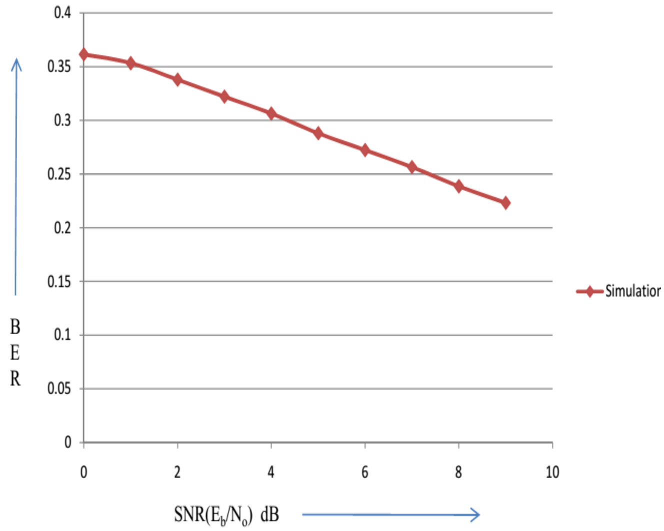

Fig. 5: BER performance of 64-DPSK in Rayleigh Channel

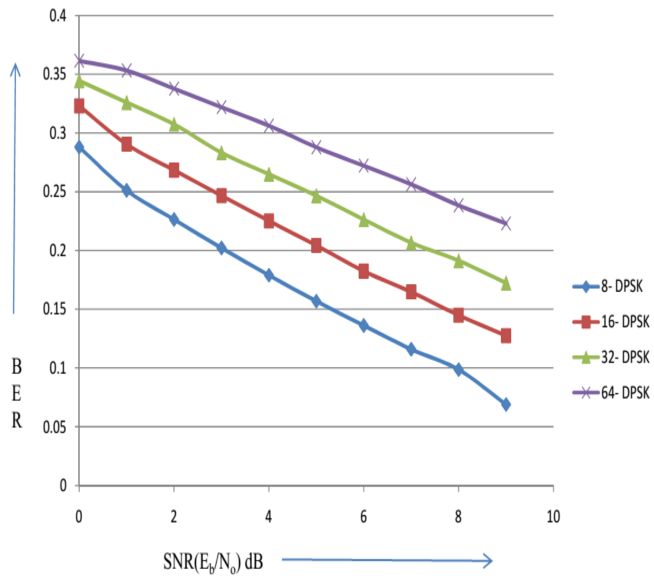

Fig. 6: Comparative BER performance of M-DPSK in Rayleigh Channel.

VI. CONCLUSION

This paper investigated the performance of M- DPSK on Rayleigh Channel and found that as the value of M increases BER increases. As the value of M increases bandwidth requirement decreases, hence there should be trade off between BER and bandwidth requirement while designing a system.

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