ON IMPORTANCE OF BIT ERROR RATE IN WIRELESS COMMUNICATION

RAJESH GOEL
Head, Department of ECE,
Ambala College of Engineering and Applied Research, P.O. Sambalkha, Ambala-133101-India
ecedept2003@yahoo.com

MUKESH SINGLA
Lecturer,Vaish College of Engg,
Rohtak -Haryana-124001-India
mukesh27singla@yahoo.co.in

DR. PAWAN KUMAR BANSAL
Principal,
Malout Institute of Management and Information Technology, Malout- Punjab-152107-India
pkbmimit@yahoo.com

ABSTRACT

This "Letter" compares the six PSK based digital transmission schemes PSK, QPSK, OQPSK, MSK, GMSK, and QAM[1,2,3]. The comparison proposes that Bit Error Rate is the fundamental parameter to access the quality of any digital transmission .By describing the basic existing configurations [2,3] and the characteristics of their transmitters and receivers, through MATLAB; we have evaluated them by computer simulation. By comparison, it is observed that different modulation techniques struggles neck to neck for getting low BER ,but still with the slight change in BER the quality changes many folds(fig-2). If these PSK techniques are used in designing the wireless transmitter, then BER further increases due to system complexity. Therefore there is a requirement of designing the new applications/transmission system having the basis as PSK modulation, so that BER atleast remains constant, if not decreases.

Keywords: Bit Error Rate, PSK, QPSK, OQPSK, MSK, GMSK, and QAM

1 INTRODUCTION

Coding and modulation provide the means of mapping information into waveforms such that the receiver (with an appropriate demodulator and decoder) can recover the information in a reliable manner. The common model for a communication system is with a Rayleigh fading channel. In this model, a user transmits information by sending one of M possible waveforms in a given time, period T, with a given amount of energy. The received signal is the sum of the transmitted signal and several distinct multipath signals(noise occupying all frequencies). There is a fundamental tradeoff between the energy efficiency of a communication system and the bandwidth efficiency. This fundamental tradeoff is shown in Fig.1. In this figure the possible normalized rate of transmission (measured in bits per second per Hz) is shown as a function of the received signal-to-noise ratio E_b/N_0 for arbitrarily reliable communication. Here, E_b is the amount of energy received per information bit while N_0 is the power spectral density of the noise. The curves labeled AWGN(Fig-1) [2] place no restrictions on the type of transmitted waveform except that the average energy must be constrained so that the received signal energy per bit is E_b. The curve labeled BPSK(fig-2) restricts the modulation (but not the coding) to binary phase shift keying. The curve labeled QPSK(fig-2) is for quaternary phase shift keying and the 8-PSK curve is for 8-ary phase shift keying. Clearly at low rates and low E_b/N_0 there is virtually no loss in using QPSK modulation with the best coding compared to the best modulation and coding. While these curves shows the best possible transmission rate for a given energy, no restrictions are placed on the amount of delay incurred and on the complexity of implementation. It has been the goal of communication researchers and engineers to achieve performance close to the fundamental limits with small complexity and delay.

2 COMPARISON OF DIGITAL MODULATIONTECHNIQUES

For a wireless communications system, the Rayleigh fading channel/environment is much common. In a wireless communication system the transmitted signal typically propagates over several distinct paths before reaching the receiving antenna. Depending on the relative phases of the received signal the multiple signals could interfere in a destructive manner or in a constructive manner. The result of the multiple paths is that the received signal amplitude is sometimes attenuated severely when the signals from different paths cancel destructively, while sometimes the signal amplitude becomes relatively large because of constructive interference. The nature of the interference is, in general, time varying and frequency dependent. This is generally called time and frequency selective fading.

The received signal varies more quickly as the vehicle speed increases. In the original analog cellular systems, in order to compensate for the multipath fading, the transmitter increases or decreases the amount of transmitted power. As with the Additive White Gaussian Noise Channel, there are fundamental limits on the rate of transmission for a given average received energy-to-noise ratio (E_b/N_0). In the simplest model the received signal energy is modeled as a Rayleigh distributed random variable[1], independent from symbol to symbol. With this assumption the transmissions rates possible, as a function of the average received signal-to-noise ratio, are shown in Fig 1. The gray curves as shown represent the performance possible in an additive white Gaussian noise channel while the dark curves represent the performance with Rayleigh fading. The assumption in this figure is that the channel bandwidth is very narrow and so the result of fading is to only change the amplitude of the signal and not distort the signal in any other way. This is clearly not valid for many communication systems (especially wide bandwidth systems like direct-sequence CDMA).

When digital data is transmitted, like +1 or –1 by using radio waves, the best way is to modulate carrier signals with frequency f_c in accordance with the information of digital information data. The meaning of "modulate" is to vary the peculiar component that is included in the carrier signal wave. The waveform of the carrier signal is written as follows:

$$S(t) = A \cos \{ 2\pi f_c t + \theta(t)\} \quad (1)$$

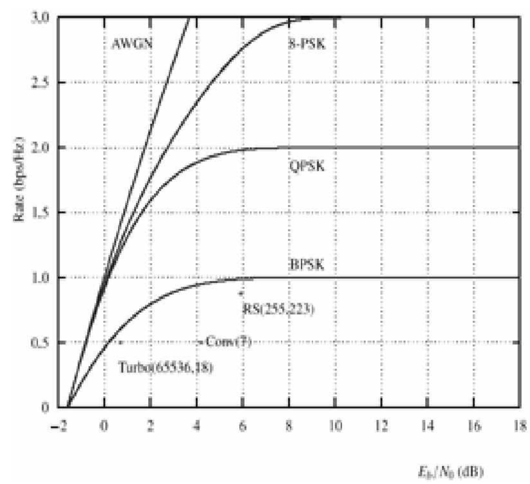

Figure 1: Possible transmission rates versus signal-to-noise ratios for an additive white Gaussian noise channel

Where A, f_c, and $\theta(t)$ and are the amplitude, center frequency, and time-variant phase of the carrier wave signal, respectively. In (1), there are three peculiar components by which users can change the value. These three are amplitude, frequency, and phase, and if the amplitude of (1) is changed in accordance with the digital information data, it is called the AM modulation scheme. Moreover, if the frequency of (1) is changed with information digital data, then the modulation scheme is called FM. Finally, if the phase of (1) is changed in accordance with the digital information data, the modulation scheme is called PM or PSK.

This "Letter" focuses on existing PSK-based digital communication [2,3] and explains existing QPSK to increase the transmission rate with high-frequency utilization efficiency in comparison with BPSK. QPSK has several problems regarding its shared bandwidth from the viewpoint of the development of the prototype. To solve these problems many researchers have introduced three modulation schemes: OQPSK, MSK, and GMSK. Moreover, to realize broadband data transmission in the limited bandwidth, existing QAM technique is being used. For performance analysis BER must be chosen as BER can be evaluated by changing the following parameters (i.e;BER is a superset of following sets)

a) Receiver noise level

b) Level of received signal

c) Fading environment

d) Level of interference signals

3 CONCLUSION

This "Letter" describes six existing PSK-based digital transmission schemes: BPSK, QPSK, OQPSK, MSK, GMSK, and QAM. These modulation schemes are the basis of all wireless transmission schemes. The comparison table 1, shows the BER performance of different sequence in Rayleigh fading environments. In the receiver, the received signal is fed into the digital demodulator and down converted to base band digital data. For conversion, the method where the received signal on the carrier frequency band is converted to the IF band, and then converted to the base band is popular. Then, on the baseband, the level of amplitude, frequency, or phase is detected for the AM, FM, and PM schemes, respectively, and finally the transmitted digital data is recovered.

The BER is a important parameter in mobile communication for quality measurement of recovered data. These PSK schemes are the basis of every digital modulation and transmission scheme. The comparison given in figure 2 shows the BER of each modulation scheme. By comparison, it is observed that different modulation techniques struggles neck to neck for getting low BER ,but still with the slight change in BER the quality changes many folds. If these PSK techniques are used in designing the wireless transmitter then BER further increases due to system complexity. Therefore there is a requirement of designing the new applications/transmission system having the basis as PSK modulation, so that BER atleast remains constant, if not decreases.

.

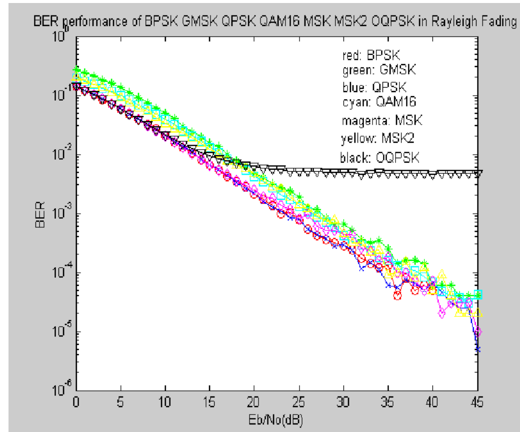

Fig-2-BER performance of various PSK-based digital modulation scheme under Rayleigh fading environment.

4 REFERENCES

[1] Prasad, R., Universal Wireless Personal Communications,Norwood,MA:Artech House,1996

[2] Proakis,J.G., Digital Communications, 3rd ed., New York: McGraw-Hill,1995.

[3] Sampei, s., Applications of Digital Wireless Technologies to Global Wireless Communications, Upper Saddle River,NJ : Prentice Hall,1997.

.

E_b/N_o (Energy per bit / Noise power density)	BER						
	BPSK	GMSK	QPSK	QAM	MSK1	MSK2	OQPSK
0	1.41E-01	2.70E-01	1.40E-01	1.92E-01	1.41E-01	2.06E-01	1.40E-01
1	1.19E-01	2.41E-01	1.19E-01	1.71E-01	1.22E-01	1.80E-01	1.21E-01
2	1.02E-01	2.12E-01	1.02E-01	1.50E-01	1.03E-01	1.56E-01	1.02E-01
3	8.44E-02	1.83E-01	8.64E-02	1.32E-01	8.70E-02	1.33E-01	8.53E-02
4	7.17E-02	1.57E-01	7.17E-02	1.14E-01	7.24E-02	1.09E-01	7.09E-02
5	5.87E-02	1.34E-01	5.94E-02	9.72E-02	5.91E-02	9.10E-02	5.81E-02
6	4.74E-02	1.09E-01	4.82E-02	8.20E-02	4.86E-02	7.36E-02	4.76E-02
7	3.87E-02	9.08E-02	4.01E-02	6.93E-02	3.92E-02	6.08E-02	3.89E-02
8	3.16E-02	7.37E-02	3.17E-02	5.70E-02	2.98E-02	5.28E-02	3.16E-02
9	2.65E-02	5.99E-02	2.63E-02	4.76E-02	2.44E-02	4.16E-02	2.58E-02
10	2.04E-02	4.89E-02	2.06E-02	3.84E-02	1.99E-02	3.36E-02	2.15E-02
11	1.60E-02	3.97E-02	1.68E-02	3.11E-02	1.59E-02	2.69E-02	1.76E-02
12	1.30E-02	2.94E-02	1.33E-02	2.50E-02	1.29E-02	2.25E-02	1.49E-02
13	1.07E-02	2.41E-02	1.09E-02	2.04E-02	1.01E-02	1.85E-02	1.27E-02
14	8.00E-03	1.98E-02	8.16E-03	1.67E-02	8.39E-03	1.51E-02	1.07E-02
15	6.47E-03	1.53E-02	6.63E-03	1.29E-02	6.62E-03	1.19E-02	9.59E-03
16	5.41E-03	1.33E-02	5.51E-03	1.07E-02	5.33E-03	1.01E-02	8.35E-03
17	4.13E-03	9.82E-03	4.43E-03	8.40E-03	4.48E-03	7.80E-03	7.70E-03
18	3.44E-03	7.58E-03	3.26E-03	6.74E-03	3.58E-03	6.58E-03	6.98E-03
19	2.80E-03	6.19E-03	2.63E-03	5.30E-03	2.89E-03	5.73E-03	6.59E-03
20	2.14E-03	4.83E-03	2.24E-03	4.14E-03	2.44E-03	4.72E-03	6.23E-03
21	1.71E-03	4.05E-03	1.59E-03	3.37E-03	1.87E-03	3.53E-03	5.81E-03
22	1.37E-03	3.13E-03	1.27E-03	2.67E-03	1.82E-03	2.85E-03	5.58E-03
23	9.90E-04	2.74E-03	1.09E-03	2.05E-03	1.34E-03	2.63E-03	5.47E-03
24	1.02E-03	2.35E-03	8.35E-04	1.72E-03	1.17E-03	1.84E-03	5.12E-03
25	7.60E-04	1.87E-03	7.95E-04	1.31E-03	8.10E-04	1.40E-03	5.23E-03
26	5.40E-04	1.26E-03	5.35E-04	1.08E-03	9.70E-04	1.21E-03	5.11E-03
27	4.20E-04	1.15E-03	4.35E-04	8.58E-04	6.00E-04	8.90E-04	5.08E-03
28	3.60E-04	8.40E-04	3.65E-04	7.03E-04	5.10E-04	7.40E-04	4.97E-03
29	3.20E-04	6.50E-04	2.85E-04	5.78E-04	5.20E-04	7.70E-04	4.97E-03
30	2.80E-04	6.60E-04	2.90E-04	4.28E-04	4.30E-04	4.50E-04	4.88E-03
31	2.40E-04	5.20E-04	2.40E-04	3.33E-04	4.30E-04	3.10E-04	4.90E-03
32	1.70E-04	3.50E-04	1.15E-04	2.93E-04	2.60E-04	3.20E-04	4.52E-03
33	1.40E-04	3.20E-04	1.45E-04	2.28E-04	2.30E-04	2.20E-04	4.71E-03
34	1.20E-04	3.40E-04	1.10E-04	1.83E-04	1.60E-04	2.40E-04	4.93E-03
35	1.30E-04	2.50E-04	6.00E-05	1.58E-04	1.80E-04	9.00E-05	4.74E-03
36	4.00E-05	1.40E-04	5.50E-05	1.28E-04	1.00E-04	1.00E-04	4.82E-03
37	8.00E-05	1.60E-04	7.50E-05	1.18E-04	1.00E-04	1.50E-04	4.83E-03
38	5.00E-05	1.60E-04	6.50E-05	1.08E-04	7.00E-05	8.00E-05	4.80E-03
39	6.00E-05	1.40E-04	5.00E-05	8.25E-05	5.00E-05	1.20E-04	4.74E-03
40	5.00E-05	6.00E-05	6.50E-05	6.75E-05	7.00E-05	5.00E-05	4.61E-03

Table-1-BER performance of various PSK-based digital modulation scheme under Rayleigh fading environment