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# Performance Analysis of Rayleigh Fading Channels in Mobile Communication over AWGN Channel

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**ABSTRACT: In a mobile communication environment the channel is not time invariant and is slowly varying. This characteristic feature of the channel leads to a phenomenon called Fading. Fading channels induce rapid amplitude fluctuations in the received signal. If they are not compensated for then this will lead to serious performance degradation. In this paper simulations have been conducted to study the Bit Error Rate (BER) performance of a Rayleigh fading channel and it is compared to the BER performance of the AWGN channel.**

**Keywords:** Rayleigh fading channel, Bit Error Rate (BER), AWGN channel.

## I. INTRODUCTION

In the study of communication systems the classical additive white Gaussian noise (AWGN) channel, with statistically independent Gaussian noise samples corrupting data samples free of intersymbol interference (ISI), is the usual starting point for understanding basic performance relationships. The primary source of performance degradation is thermal noise generated in the receiver. The external interference received by the antenna is significant than thermal noise. This external interference can sometimes be characterized as having a broadband spectrum and is quantified by a parameter called antenna temperature [1, 2]. The thermal noise usually has a flat power spectral density over the signal band and a zero-mean Gaussian voltage probability density function (PDF). When modelling practical systems, the next step is the introduction of band limiting filters.

If a radio channel's propagating characteristics are not specified, one usually infers that the signal attenuation versus distance behaves as if propagation takes place over ideal free space. The model of free space treats the region between the transmit and receive antennas as being free of all objects that might absorb or reflect radio frequency (RF) energy. It also assumes that, within this region, the atmosphere behaves as a perfectly uniform and non absorbing medium. In this idealized free-space model, the attenuation of RF energy between the transmitter and receiver behaves according to an inverse-square law.

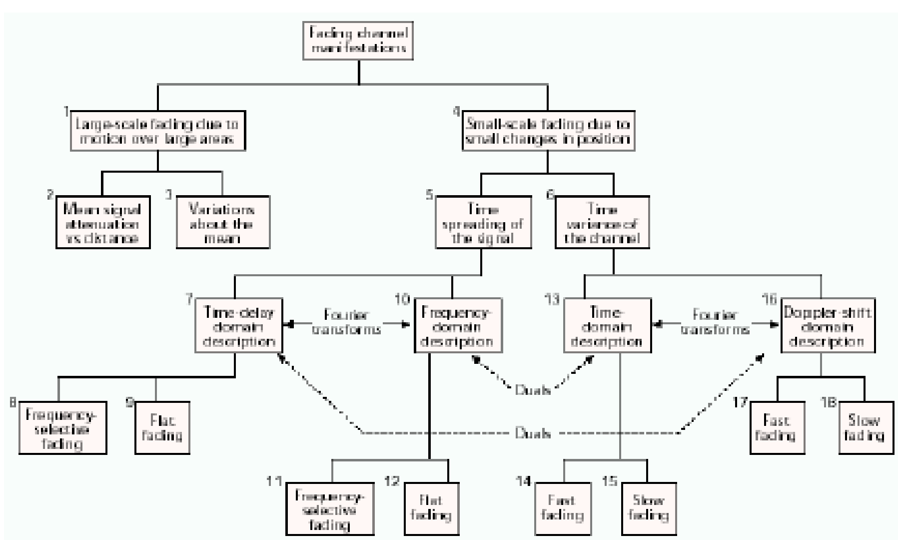


Fig: 1 Multipath fading channel

For most practical channels, where signal propagation takes place in the atmosphere and near the ground, the free space propagation model is inadequate to describe the channel and predict system performance. In a wireless mobile communication system, a signal can travel from transmitter to receiver over multiple reflective paths; this phenomenon is referred to as multipath propagation.

The effect can cause fluctuations in the received signal's amplitude, phase, and angle of arrival, giving rise to the terminology multipath fading. Another name, scintillation is used to describe the multipath fading caused by physical changes in the propagating medium, such as variations in the density of ions in the ionosphere layers that reflect high-frequency (HF) radio signals. Names, fading and scintillation refer to a signal's random fluctuations or fading due to multipath propagation. The main difference is that scintillation involves mechanisms (e.g., ions) that are much smaller than a wavelength. The end-to-end modelling and design of systems that mitigate the effects of fading are usually more challenging than those whose sole source of performance degradation is AWGN [4,5].

## II. LARGE-SCALE FADING AND SMALL-SCALE FADING

Fig. 1 represents an overview of fading channel. It starts with two types of fading effects that characterize mobile communications: large-scale and small-scale fading. Large-scale fading represents the average signal power attenuation or path loss due to motion over large areas. In Fig. 1, the large-scale fading manifestation is shown in blocks 1, 2, and 3. This phenomenon is affected by prominent terrain contours (hills, forests, billboards, clumps of buildings, etc.) between the transmitter and receiver. The receiver is often represented as being "shadowed" by such prominences. The statistics of large-scale fading provide a way of computing an estimate of path loss as a function of distance. This is described in terms of a mean-path loss and a log-normally distributed variation about the mean. Small-scale fading refers to the dramatic changes in signal amplitude and phase that can be experienced as a result of small changes in the spatial separation between a receiver and transmitter. As indicated in Fig. 1, blocks 4, 5, and 6, small-scale fading manifests itself in two mechanisms, namely, time spreading of the signal (or signal dispersion) and time-variant behaviour of the channel. For mobile radio applications, the channel is time-variant because motion between the transmitter and receiver results in propagation path changes. The rate of change of these propagation conditions accounts for the fading rapidity (rate of change of the fading impairments). Small-scale fading is also called Rayleigh fading because if the multiple reflective paths are large in number and there is no line-of-sight signal component, the envelope of the received signal is statistically described by a Rayleigh PDF [3]. When there is a dominant non fading signal component present, such as a line-of-sight propagation path, the small scale fading envelope is described by a Rician PDF [3]. A mobile radio roaming over a large area must process signals that experience both types of fading: small-scale fading superimposed on large-scale fading.

## III. RAYLEIGH DISTRIBUTION

This is used to describe the statistical time varying nature of the envelope of an individual multipath component. The Rayleigh distribution is given by

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

Where, σ= rms value of the received signal r2/2 = instantaneous power σ2 = local average power of the received signal before detection

## IV. BIT ERROR RATE (BER)

Bit error rate is a key parameter that is used in assessing systems that transmit digital data from one location to another. BER is applicable to radio data links, Ethernet, as well as fibre optic data systems. When data is transmitted over a data link, there is a possibility of errors being introduced into the system. If this is so, the integrity of the system may be compromised. As a result, it is necessary to assess the performance of the system, and BER provides an ideal way in which this can be achieved. BER assesses the full end to end performance of a system including the transmitter, receiver and the medium between the two. BER is defined as the rate at which errors occur in a transmission system. In simple form,

$$BER = \frac{number\ of\ bits\ in\ error}{total\ number\ of\ bits\ sent}$$

BER expression is given by Rappaport (2002) as

$$BER = \int_0^\infty P_b(E/r)P(r)\,dr$$

Where Pb(E/r) = the conditional error probability *P(r)* = the pdf of the SNR.

## V. RESULTS

The simulation of the model under study was carried out using MATLAB application package. The simulation was carried out with BPSK modulation. The following parameters and system configurations were used: Modulation: BPSK Carrier frequency: 900 MHz Bandwidth of signal: 200 ns Noise: AWGN Mobile speed: 90 km/h Fading type: Rayleigh fading

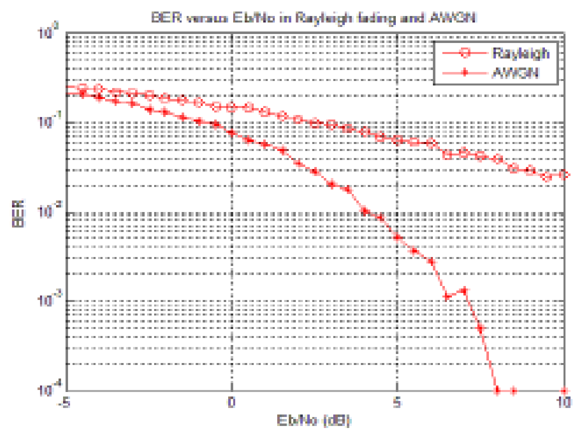


**Fig. 2.** BER in Rayleigh fading and AWGN.

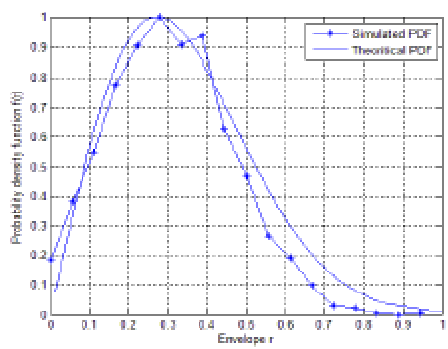


**Fig. 3.** Probability density function of Rayleigh fading channel.

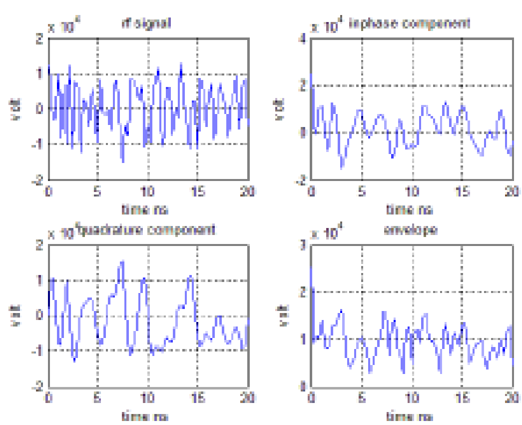


**Fig. 4.** Envelope of RF signal.

The BER performances as a function of SNR for two i.i.d paths in mobile multipath fading channel with BPSK.

Figure 2 shows the BER performance when BPSK signal was transmitted over the fast Rayleigh fading channel at a mobile speed of 90 km/h. it can be observed that at SNR of 4 dB. Fig. 3 shows the probability density function of Rayleigh fading channel. Fig 4 shows the envelope of RF signal.

## VI. CONCLUSION

In this paper, bit error rate performances for Mobile communication with BPSK transmission schemes have been evaluated with random data. Two types of fading, large-scale and small scale were described. Generation of Rayleigh faded envelope for varying number of paths are shown. BER Performance of a BPSK signal in presence of AWGN and Rayleigh Channel.

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