EB/N0 VS BER FOR BPSK OVER RAYLEIGH CHANNEL AND AWGN CHANNEL

The phenomenon of Rayleigh Flat fading and its simulation using Clarke's model and Young's model were discussed in the previous posts. The performance (Eb/N0 Vs BER) of BPSK modulation (with coherent detection) over Rayleigh Fading channel and its comparison over AWGN channel is discussed in this post.

We first investigate the non-coherent detection of BPSK over Rayleigh Fading channel and then we move on to the coherent detection. For both the cases, we consider a simple flat fading Rayleigh channel (modeled as a – single tap filter – with complex impulse response – h). The channel also adds AWGN noise to the signal samples after it suffers from Rayleigh Fading.

The received signal y can be represented as

$$y=hx+n$$

where n is the noise contributed by AWGN which is Gaussian distributed with zero mean and unit variance and h is the Rayleigh Fading response with zero mean and unit variance. (For a simple AWGN channel without Rayleigh Fading the received signal is represented as y=x+n).

Non-Coherent Detection:

In non-coherent detection, prior knowledge of the channel impulse response ("h" in this case) is not known at the receiver. Consider the BPSK signaling scheme with 'x=+/- a' being transmitted over such a channel as described above. This signaling scheme fails completely (in non coherent detection scheme), even in the absence of noise, since the phase of the received signal y is uniformly distributed between 0 and 2pi regardless of whether x[m]=+a or x[m]=-a is transmitted. So the non coherent detection of the BPSK signaling is not a suitable method of detection especially in a Fading environment.

Coherent Detection:

In coherent detection, the receiver has sufficient knowledge about the channel impulse response.Techniques like pilot transmissions are used to estimate the channel impulse response at the receiver, before the actual data transmission could begin. Lets consider that the channel impulse response estimate at receiver is known and is perfect & accurate.The transmitted symbols (‘x’) can be obtained from the received signal (‘y’) by the process of equalization as given below.

$$\hat{y} = y/h = hx+n/h = x+z$$

here z is still an AWGN noise except for the scaling factor 1/h. Now the detection of x can be performed in a manner similar to the detection in AWGN channels.

The input binary bits to the BPSK modulation system are detected as

$$r = \mathrm{real}(\hat{y}) = \mathrm{real}(x+z)$$

$$\hat{d}=1, \text{ if } r>0$$

$$\hat{d}=0, \text{ if } r<0$$

Theoretical BER:

The theoretical BER for BPSK modulation scheme over Rayleigh fading channel (with AWGN noise) is given by

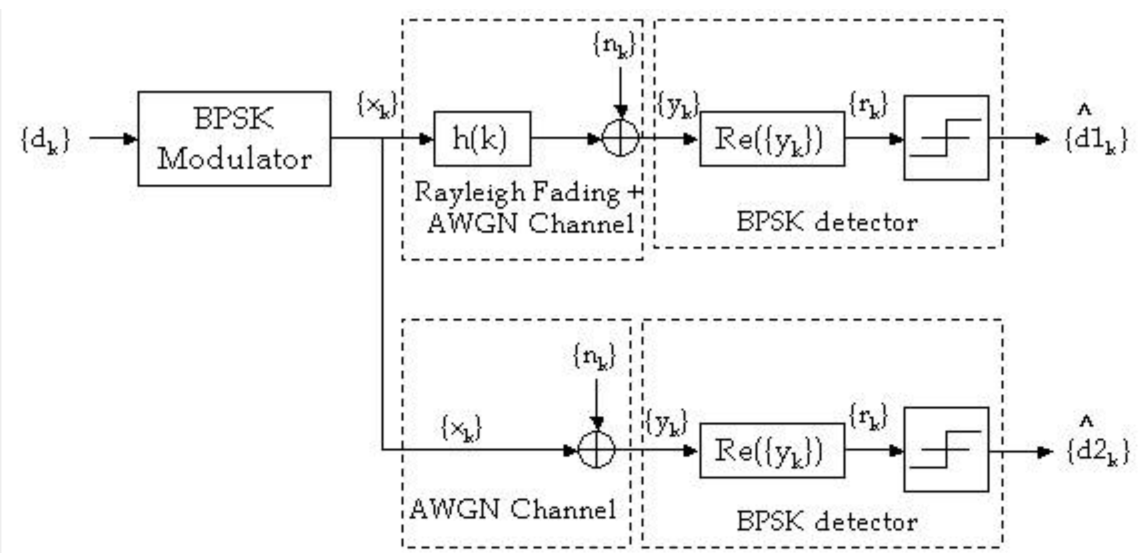
$$P_b=1/2\ (1-\sqrt{E_b/N_0/1+E_b/N_0})$$

The theoretical BER for BPSK modulation scheme over an AWGN channel is given here for comparison

$$P_b=1/2\ \mathrm{erfc}\ (\sqrt{E_b/N_0})$$

Simulation Model:

The following model is used for the simulation of BPSK over Rayleigh Fading channel and its comparison with AWGN channel



BPSK Modulation over Rayleigh and AWGN channel

Source: http://www.gaussianwaves.com/2011/05/ebn0-vs-ber-for-bpsk-over-rayleigh-channel-and-awgn-channel-2/