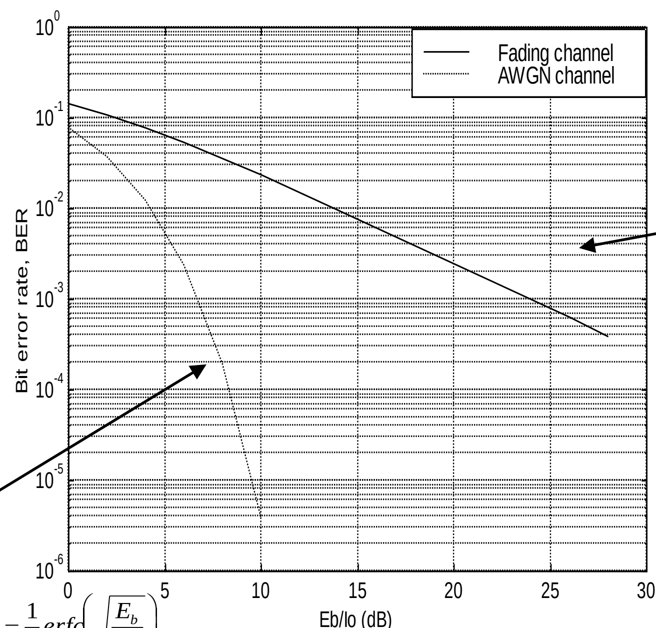
ASSIGNMET : WIRELESS ACCESS NETWORK (EL5061)
Due date : The day of Final Exam Sem I 2017/2018
REPORT : INDIVIDUAL (Collected by the day of final exam)

Performance of digital signal transmission through wireless channel is presented in terms of bit error rate (BER) as a function of signal-to-noise ratio per bit (SNR) or ratio of bit energy to noise power spectral (E_b/N_0) as shown in the Figure below: each for the AWGN channel as well as for the Rayleigh fading channel.

BER Performance in AWGN and Rayleigh fading Channel



$$\overline{P_e} = BER = \frac{1}{2}\left(1-\sqrt{\frac{\overline{E_b/N_0}}{1+\overline{E_b N_0}}}\right)$$

$$\overline{P_e} = BER = Q\left(\sqrt{\frac{2E_b}{N_0}}\right) = \frac{1}{2}erfc\left(\sqrt{\frac{E_b}{N_0}}\right)$$

Tasks :

1. To verify the BER = f(Eb/No) formula, students need to construct a computer simulation to prove the BER in AWGN channel for E_b/N_0 = 0, 2, 4, 6, dan 8 dB. The bit error is computed using Monte Carlo with 5 runs of simulation for each setting of E_b/N_0 given above. Plot the BER curve versus E_b/N_0 obtained from Monte Carlo simulation and compare with the theoretical BER versus E_b/N_o curve.

2. Construct computer simulation to plot the BER as a function of E_b/N_o for transmission through Rayleigh fading channel for E_b/N_0 = 0, 5, 10, 15, 20, dan 25 dB. Compare the results with that of theoretical performance. Fading channel **simulator** is provided in Matlab function (attached) as can be described as → y = fading(a, b, c), with a = the number of bit, b = maximum Doppler shift (fading rate), and c = bit period. Choose the Doppler shift f_D = 30 Hz, and the data rate = 128 Kbps with BPSK modulation.

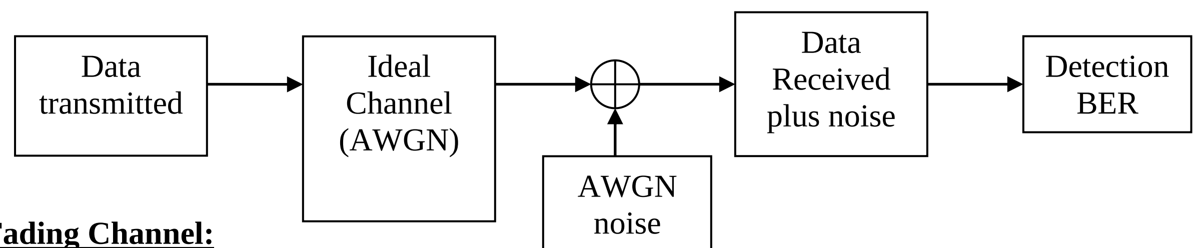
3. Construct computer simulation to show the performance impovement of Rayleigh fading channel using SNR-based fixed-step Power Control methods with step-size of 2 dB. For Doppler frequency of 30 Hz, 50 Hz, and 100 Hz, for BPSK modulation with data rate of 128 kbps, then show the fading signal strength, the power-controlled transmit signal strength, and the power controlled SNR (SNR target is set to 10 dB), and also show the BER performance versus Eb/No,and explain the effect of fading/power control rate. Use control rate of the power control algorithm = 1,5 kHz.

Simulator of Fading channel in Matlab function as follows:

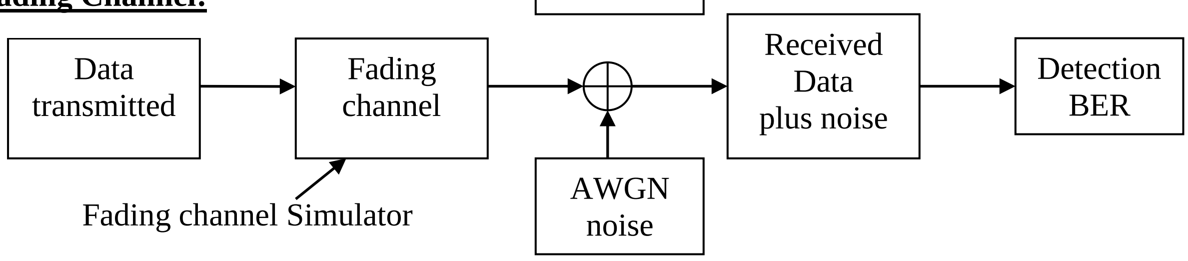
```
function y = fading(len, fd, T)
N = 34;
N0 = (N/2 - 1)/2;
alpha = pi/4;
xc = zeros(len,1);
xs = zeros(len,1);
sc = sqrt(2)*cos(alpha);
ss = sqrt(2)*sin(alpha);
ts = 0:len-1;
ts = ts'.*T + round(rand(1,1)*10000)*T;
wd = 2*pi*fd;
xc = sc.*cos(wd.*ts);
xs = ss.*cos(wd.*ts);
for lx =1:N0
  wn = wd*cos(2*pi*lx/N);
  xc = xc + (2*cos(pi*lx/N0)).*cos(wn.*ts);
  xs = xs + (2*sin(pi*lx/N0)).*cos(wn.*ts);
end;
y = (xc + i.*xs)./sqrt(N0+1);
```

Diagram of simulator as follows:

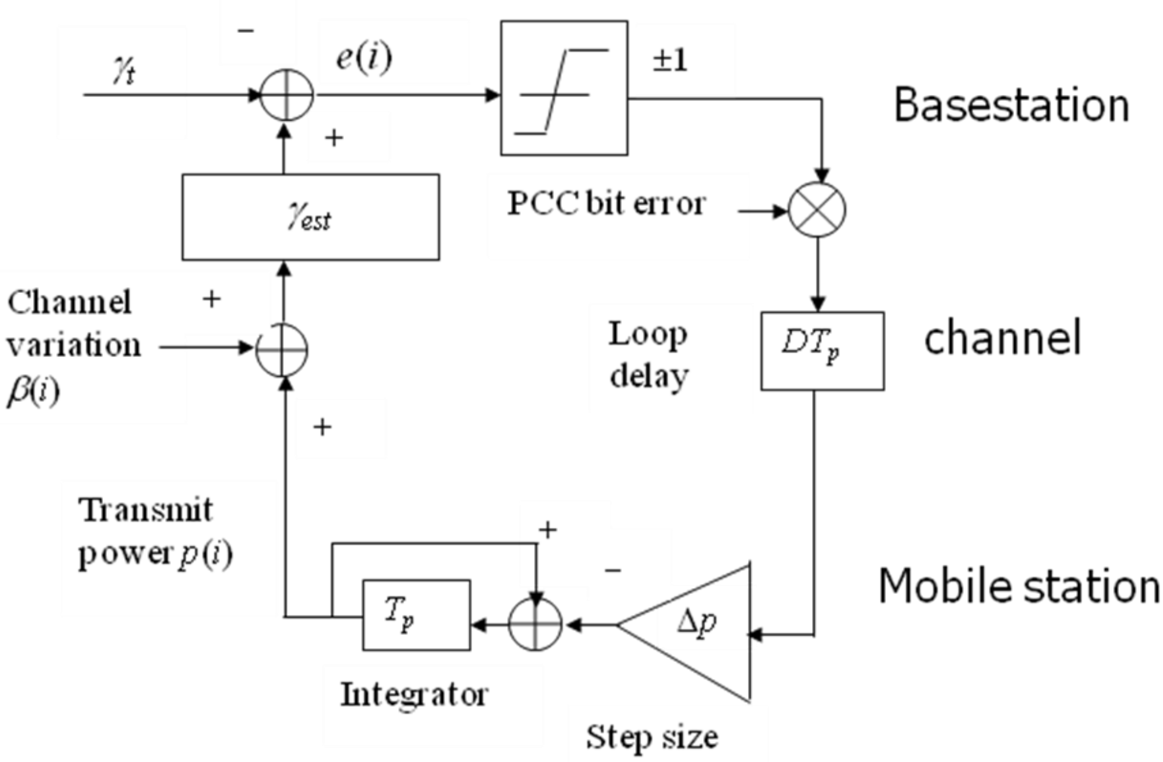
AWGN Channel



Fading Channel:



Power Control Techniques:



Notes:

1. To generate AWGN noise according to SNR in decibel (dB) can use conversion to linear scale using x dB = $10^{x/10}$.
2. For a known BER, determine the number of data required by the simulation program (the number of data error must be at least 10 for each run). For example, for BER = 10^{-3} will require the number of data at least 10 Kbit, for BER = 10^{-4} will require the number of data at least 100 Kbit.