Now assume only the best 3 channel states are used

$$\frac{0.9}{\gamma_0} = 1 + \sum_{i=1}^{3} \frac{1}{\gamma_i} p_i \Rightarrow \quad \gamma_0 = 0.6742 < 1 \qquad \therefore \text{ok!}$$

$$\frac{S(\gamma)}{S} = \begin{cases} 1.3832 & \gamma = \gamma_1 = 10 \\ 1.1670 & \gamma = \gamma_2 = 3.1623 \\ 0.4832 & \gamma = \gamma_3 = 1 \\ 0 & \gamma = \gamma_4 = 0.1 \end{cases}$$

$$C/B = 2.3389 bps/Hz$$

(b) $\sigma = 0.7491$
$C/B = \log_2(1+\sigma) = 0.8066 bps/Hz$

(c) $\left(\frac{C}{B}\right)_{max} = 2.1510 bps/Hz$ obtained by using the best 2 channel states.
With $p_{out} = 0.1 + 0.2 = 0.3$

7. (a) Maximize capacity given by

$$C = \max_{S(\gamma): \int S(\gamma)p(\gamma)d\gamma = S} \int_\gamma B \log\left(1 + \frac{S(\gamma)\gamma}{S}\right) p(\gamma) d\gamma.$$

Construct the Lagrangian function

$$\mathcal{L} = \int_\gamma B \log\left(1 + \frac{S(\gamma)\gamma}{S}\right) p(\gamma) d\gamma - \lambda \int \frac{S(\gamma)}{S} p(\gamma) d\gamma$$

Taking derivative with respect to $S(\gamma)$, (refer to discussion section notes) and setting it to zero, we obtain,

$$\frac{S(\gamma)}{S} = \begin{cases} \frac{1}{\gamma_0} - \frac{1}{\gamma} & \gamma \geq \gamma_0 \\ 0 & \gamma < \gamma_0 \end{cases}$$

Now, the threshold value must satisfy

$$\int_{\gamma_0}^{\infty} \left(\frac{1}{\gamma_0} - \frac{1}{\gamma}\right) p(\gamma) d\gamma = 1$$

Evaluating this with $p(\gamma) = \frac{1}{10} e^{-\gamma/10}$, we have

$$1 = \frac{1}{10\gamma_0} \int_{\gamma_0}^{\infty} e^{-\gamma/10} d\gamma - \frac{1}{10} \int_{\gamma_0}^{\infty} \frac{e^{-\gamma/10}}{\gamma} d\gamma \tag{1}$$

$$= \frac{1}{\gamma_0} e^{-\gamma_0/10} - \frac{1}{10} \int_{\frac{\gamma_0}{10}}^{\infty} \frac{e^{-\gamma}}{\gamma} d\gamma \tag{2}$$

$$= \frac{1}{\gamma_0} e^{-\gamma_0/10} - \frac{1}{10} \text{EXPINT}(\gamma_0/10) \tag{3}$$

where EXPINT is as defined in matlab. This gives $\gamma_0 = 0.7676$. The power adaptation becomes

$$\frac{S(\gamma)}{S} = \begin{cases} \frac{1}{0.7676} - \frac{1}{\gamma} & \gamma \geq 0.7676 \\ 0 & \gamma < 0.7676 \end{cases}$$

Wireless Communication Goldsmith Problem Solution Manual

Andrea Goldsmith

Wireless Communication Goldsmith Problem Solution Manual:

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