Tx/Rx Signal Power.

Review:

AWGN Capacity $C = B \cdot \log_2(1 + \frac{P}{BN_0})$ bit/s

Flat Fading: $y = hx + n$.

CSIR, No CSIT

Scheme 1: $R = B \cdot \log_2(1 + \gamma_{min})$

Outage Capacity : $C = R \cdot Pr[\gamma \geq \gamma_{min}]$
Goodput $= R \cdot (1 - P_{out})$

Scheme 2:

Ergodic Capacity: $C = E\ B \cdot \log(1 + \gamma)$
$= \int_0^{+\infty} B \cdot \log(1+\gamma) \cdot f(\gamma) \cdot d\gamma$

$\gamma: \gamma_1, \gamma_2, \cdots \gamma_m$
$P: P_1, P_2, \cdots P_m$

$= \sum_{i=1}^{m} B \cdot \log(1+\gamma_i) \cdot P_i$

CSIR + CSIT: ~~Erd~~ Ergodic Capacity with shorter delay decoding delay. However, the capacity remain the same.

△ Power Adaptation with CSIT

Allow the transmit power to vary with SNR. thus.

$$P = \bar{P} \to P(\gamma) \quad \text{s.t.} \quad \overbrace{\int_0^\infty P(\gamma)\, f(\gamma)\, d\gamma}^{E_\gamma[P(\gamma)] =} = \bar{P}$$

$f(\gamma)$ ↑ PDF of γ

$$C = \max_{P(\gamma)} \int_0^\infty B \cdot \log_2\left(1 + \frac{P(\gamma)}{\bar{P}}\gamma\right) \cancel{g(\gamma)}\ f(\gamma)\, d\gamma$$

$$\text{s.t.} \int_0^\infty P(\gamma) \cdot f(\gamma)\, d\gamma = \bar{P}$$

where. $\gamma = \dfrac{g\bar{P}}{N_0 B}$

Optimal Solution (convex optimizatio

Lagrangian

$$J(\lambda) = \int_0^{+\infty} B \log_2\left(1 + \frac{p(\gamma)\gamma}{\bar{P}}\right) f(\gamma)\, d\gamma$$

$$- \lambda \left(\int_0^{+\infty} p(\gamma) f(\gamma)\, d\gamma - \bar{P} \right)$$

$$C = \underbrace{\min_{\lambda} \max_{p(\gamma)} J(\lambda)}$$

$$\Downarrow$$

$$\max_{P} \; B \cdot \log_2(1 + P \cdot \gamma / \bar{P}) f(\gamma) - \lambda P \cdot f(\gamma)$$

$$\Rightarrow \frac{B}{\ln 2} \frac{\gamma}{\bar{P}} \frac{1}{1 + \gamma P / \bar{P}} - \lambda = 0$$

$$\Rightarrow \frac{B}{\ln 2 \cdot \lambda} \frac{1}{\bar{P}/\gamma + P} = 1$$

$$\Rightarrow P = \frac{B}{\ln 2 \cdot \lambda} - \frac{\bar{P}}{\gamma} \Rightarrow \frac{P}{\bar{P}} = \overbrace{\boxed{\frac{B}{\ln 2 \cdot \lambda \cdot \bar{P}}}}^{\frac{1}{\gamma_0}} - \frac{1}{\gamma}$$

Because power is non-negative.

$$\frac{P}{\bar{P}} = \begin{cases} \frac{1}{\gamma_0} - \frac{1}{\gamma} & \gamma \geq \gamma_0 \\ 0 & \gamma < \gamma_0 \end{cases}$$

$$= \left(\frac{1}{\gamma_0} - \frac{1}{\gamma} \right)^+$$

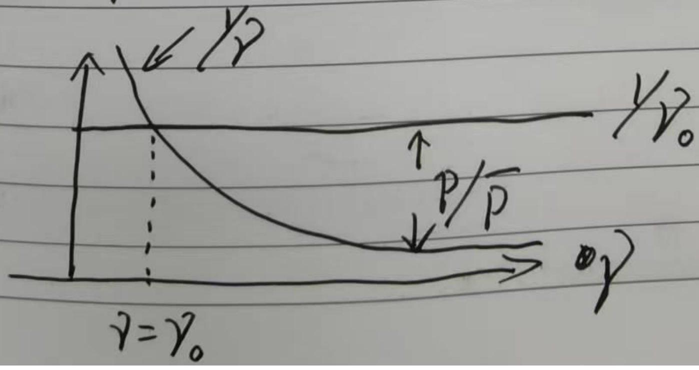
$$\int_0^{+\infty} p(\gamma) \cdot f(\gamma)\, d\gamma = \bar{P}$$

$$\Rightarrow \int_0^{+\infty} \frac{p(\gamma)}{\bar{P}} f(\gamma)\, d\gamma = 1$$

$$\Rightarrow \int_0^{+\infty} \left(\frac{1}{\gamma_0} - \frac{1}{\gamma} \right)^+ \cdot f(\gamma)\, d\gamma = 1$$

$$\Rightarrow \int_{\gamma_0}^{+\infty} \left(\frac{1}{\gamma_0} - \frac{1}{\gamma} \right) \cdot f(\gamma)\, d\gamma = 1$$

water-filling



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Ergodic capacity with Power Adaptation.

$$C = \int_0^{\infty} B \log_2\left(1+\frac{P(\gamma)}{\bar{P}}\gamma\right)\cdot f(\gamma)\,d\gamma$$

$$= \int_{\gamma_0}^{\infty} B \log_2\left(1+\frac{\gamma}{\gamma_0}-1\right) f(\gamma)\,d\gamma$$

22 初八
Tuesday / 星期二

$$= \int_{\gamma_0}^{\infty} B \log_2\left(\frac{\gamma}{\gamma_0}\right) f(\gamma)\,d\gamma.$$

△ CSIR & CSIT :

Zero-Outage Capacity , Channel Inversion

Fix SNR $P(\gamma)\gamma / \bar{P}$ to σ

$$\Rightarrow P(\gamma) = \frac{\sigma}{\gamma} \cdot \bar{P} \quad \text{or} \quad \frac{P(\gamma)}{\bar{P}} = \frac{\sigma}{\gamma}$$

Capacity with Channel Inversion.

$$C = B \cdot \log_2(1+\sigma)$$

What's the value of σ?

$$\int_0^{+\infty} P(\gamma) f(\gamma)\, d\gamma = \bar{P}$$

$$\Rightarrow \int_0^{+\infty} \frac{\sigma}{\gamma} \cdot f(\gamma)\, d\gamma = 1$$

$$\Rightarrow \sigma = 1 \Big/ \int_0^{+\infty} \frac{1}{\gamma} f(\gamma)\, d\gamma$$

$$= 1 / E[1/\gamma]$$

$$\Rightarrow C = B \cdot \log_2\left(1 + \frac{1}{E[1/\gamma]}\right)$$ zero-outage capacity