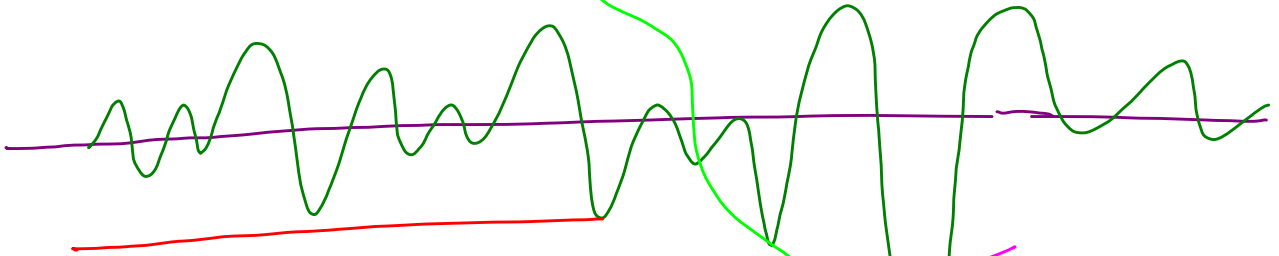


Deep Fade Analysis of wireless communication:

Why is the performance of
a wireless communication system
poor? ————— Can be explained
based on the "Deep Fade" events
in wireless communication.

How does Deep Fade impact wireless communication.



Fading wireless Channel

Drastic Dip in the strength of wireless channel.

Deep Fade event

consider our fading channel model.

$$y = hx + n$$

y is the Rx Symbol

$h = ae^{j\phi}$ is the Fading coefficient

n is white Gaussian noise with variance σ^2

Transmitted Symbol.
Power = P

Noise Power = σ^2

Received Power
 $= P \cdot |h|^2 = Pa^2$
 $= a^2 P$

System is in deep fade, if signal power is lower than noise threshold.

$$\text{Received Power} < \sigma^2$$

$$\left\{ \begin{array}{l} a^2 P < \sigma^2 \\ \text{"Deep Fade"} \end{array} \right.$$

$$\Rightarrow a^2 < \frac{\sigma^2}{P} = \frac{1}{\text{SNR}}$$

$$\Rightarrow a < \frac{1}{\sqrt{\text{SNR}}}$$

Deep Fade occurs, when

$$a < \frac{1}{\sqrt{\text{SNR}}}$$

What is the probability of deep fade?

$$P_{\text{DF}} = \Pr \left(a < \frac{1}{\sqrt{\text{SNR}}} \right)$$

$$\begin{aligned}
 P_{DF} &= \Pr\left(a < \frac{1}{\sqrt{\text{SNR}}}\right) \\
 \text{Probability of Deep Fade.} &= \int_0^{\frac{1}{\sqrt{\text{SNR}}}} \underbrace{f_A(a)}_{2ae^{-a^2}} da \\
 &= \int_0^{\frac{1}{\sqrt{\text{SNR}}}} \underbrace{2ae^{-a^2}}_{\text{Rayleigh Density}} da \\
 P_{DF} &= -e^{-a^2} \Big|_0^{\frac{1}{\sqrt{\text{SNR}}}} = 1 - e^{-\frac{1}{\text{SNR}}}
 \end{aligned}$$

$$P_{DF} = 1 - e^{-\frac{1}{SNR}}$$

IF $x \approx 0$

$$e^{-x} \approx 1 - x$$

$$\approx 1 - \left(1 - \frac{1}{SNR}\right) \quad \text{at high SNR}$$

$$P_{DF} \approx \frac{1}{SNR}$$

Probability of Deep Fade.
at high SNR

$$BER = \frac{1}{2 \cdot SNR} \propto \frac{1}{SNR} = P_{DF}.$$

$$BER \propto P_{DF}$$

Bit Error Rate $\propto$ Prob of Deep Fade.

↓
Poor performance of wireless channel arises from deep fade events.

Destructive interference $\Rightarrow$ "DEEP FADE"

To improve performance

