

$$0^{\text{th}} \text{ path} \text{ --- } a_0, \tau_0, \\ \text{Re} \{ a_0 s(t - \tau_0) e^{j2\pi f_c(t - \tau_0)} \}$$

$$1^{\text{st}} \text{ path} \text{ --- } a_1, \tau_1 \\ \text{Re} \{ a_1 s(t - \tau_1) e^{j2\pi f_c(t - \tau_1)} \}$$

⋮

$$(L-1)^{\text{th}} \text{ path} \text{ --- } a_{L-1}, \tau_{L-1} \\ \text{Re} \{ a_{L-1} s(t - \tau_{L-1}) e^{j2\pi f_c(t - \tau_{L-1})} \}$$

Received signal

= sum of the various multipath components.

$$\begin{aligned} y_p(t) &= \sum_{i=0}^{L-1} \operatorname{Re} \left\{ a_i s(t - \tau_i) e^{j2\pi f_c(t - \tau_i)} \right\} \\ &= \sum_{i=0}^{L-1} \operatorname{Re} \left\{ (a_i s(t - \tau_i) e^{-j2\pi f_c \tau_i}) e^{j2\pi f_c t} \right\} \\ &= \operatorname{Re} \left\{ \underbrace{\left(\sum_{i=0}^{L-1} a_i s(t - \tau_i) e^{-j2\pi f_c \tau_i} \right)}_{\text{complex Baseband}} \underbrace{e^{j2\pi f_c t}}_{\text{carrier}} \right\} \end{aligned}$$

$$y(t) = \sum_{i=0}^{L-1} a_i s(t - \tau_i) e^{-j2\pi f_c \tau_i}$$

complex Baseband Received Signal.

complex Phase Factor

$$\sum_{i=0}^{L-1} a_i s(t) e^{-j2\pi f_c \tau_i}$$

Narrowband Assumption:

$$s(t - \tau_i) \sim s(t)$$

GSM

$F_m \sim 200 \text{ kHz}$

$F_c \sim 900 \text{ MHz}$

$F_m \ll F_c$

Maximum Signal Freq

Carrier Freq.

$$y(t) = \underbrace{\left(\sum_{i=0}^{L-1} a_i e^{-j2\pi f_c \tau_i} \right)}_{\text{complex coefficient}} s(t)$$

$$h = \sum_{i=0}^{L-1} a_i e^{-j2\pi f_c \tau_i}$$

$$y(t) = h \times s(t)$$

Depends on the attenuation,
Delay of different multipath
components a_i, τ_i

$$L = 2$$

$$h = \sum_{i=0}^1 a_i e^{-j2\pi F_c \tau_i}$$

$$= a_0 e^{-j2\pi F_c \tau_0} + a_1 e^{-j2\pi F_c \tau_1}$$

$$a_0 = a_1 = 1 \quad \tau_0 = 0$$

$$\tau_1 = \frac{1}{2F_c}$$

$$\textcircled{h} = 1 \cdot e^0 + 1 \cdot e^{-j2\pi F_c \cdot \frac{1}{2F_c}}$$

Destructive interference.

$$= 1 + 1 \cdot e^{-j\pi} = 1 + (-1) = \textcircled{0}$$

$$y(t) = h \cdot s(t) = 0 \cdot s(t) = 0$$

$$a_0 = a_1 = 1$$

$$z_0 = 0$$

$$z_1 = \frac{1}{f_c}$$

$$h = 1 \cdot e^0 + 1 \cdot e^{-j2\pi f_c \cdot \frac{1}{f_c}}$$

$$= 1 + 1 \cdot e^{-j2\pi}$$

$$= 1 + 1 = 2$$

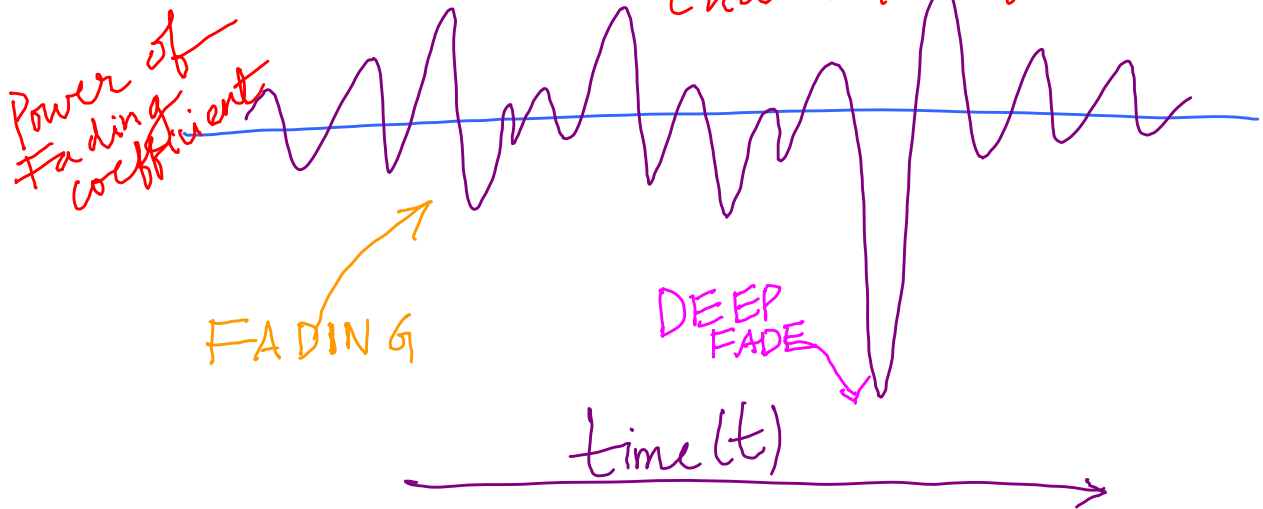
constructive interference

$$y(t) = \underline{2s(t)}$$

enhances signal amplitude at receiver

The coefficient h varies depending on the various channel attenuation factors a_i , Delays τ_i . $h = \sum_{i=0}^{L-1} a_i e^{-j2\pi f_c \tau_i}$

$h =$ Fading channel coefficient.



This **FADING** process, which causes the received power to vary, is an important and key aspect of wireless communication.

→ Develop models for fading channel coefficient. h