FADING & INTER SYMBOL INTERFERENCE (ISI)

Prepared by

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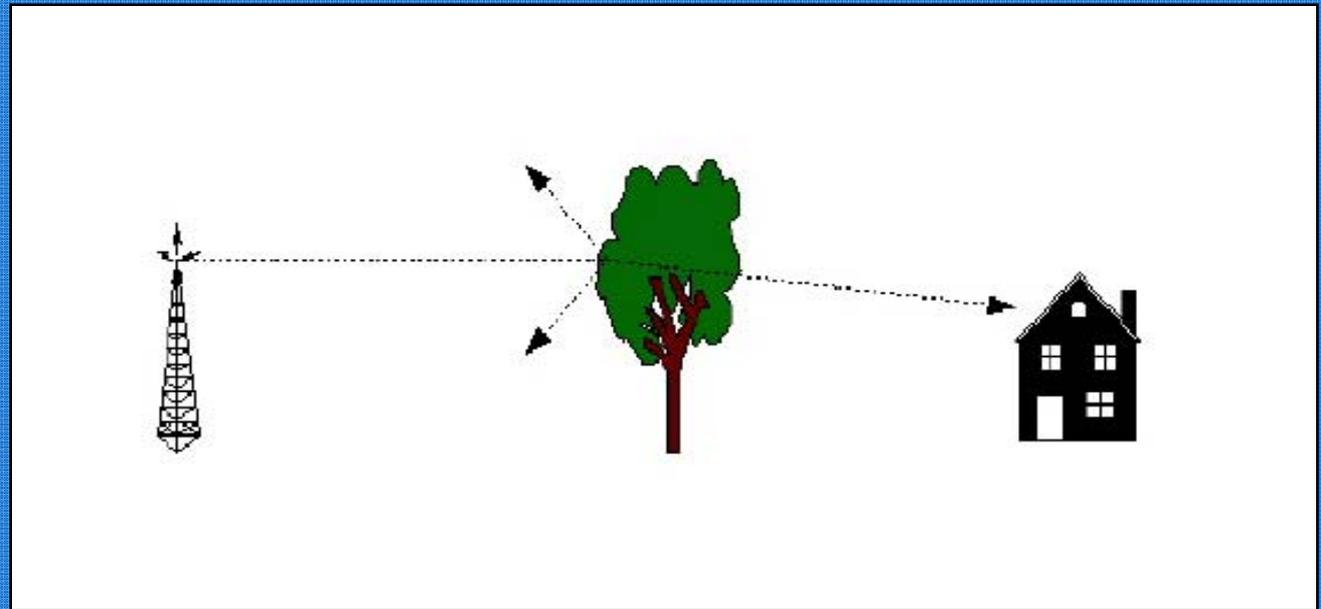# Review of Relevant Concepts

Fading:
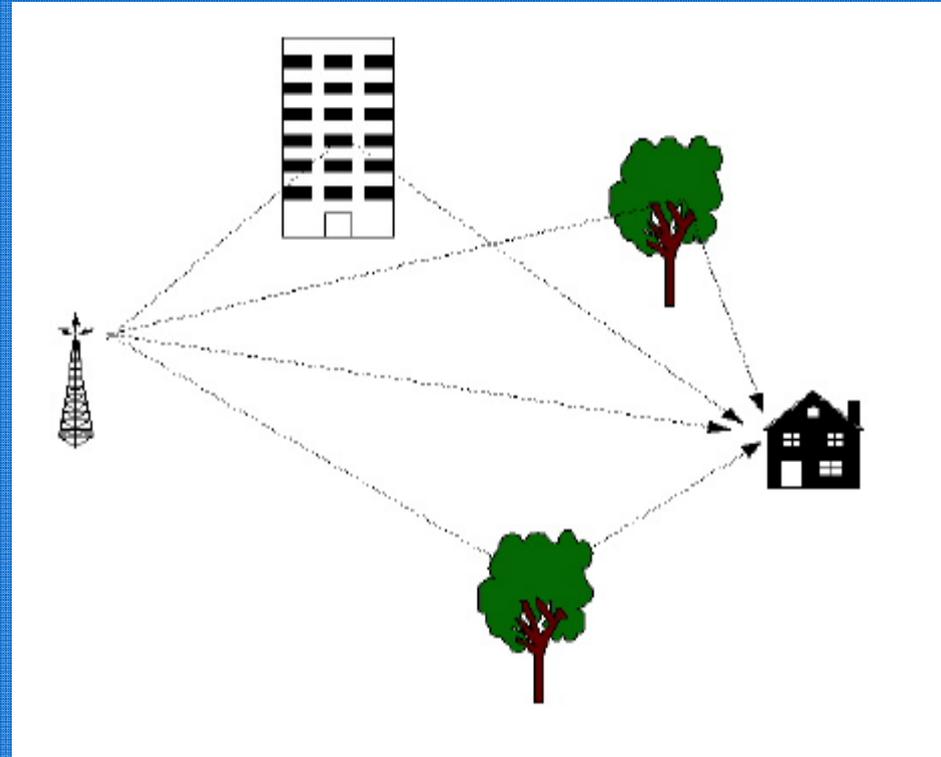
1) Flat Fading

2) Frequency Selective Fading

3) Other Multi-path Concerns

Flat Fading

Flat Fading is caused by absorbers between the two antennae and is countered by antenna placement and transmit power level.
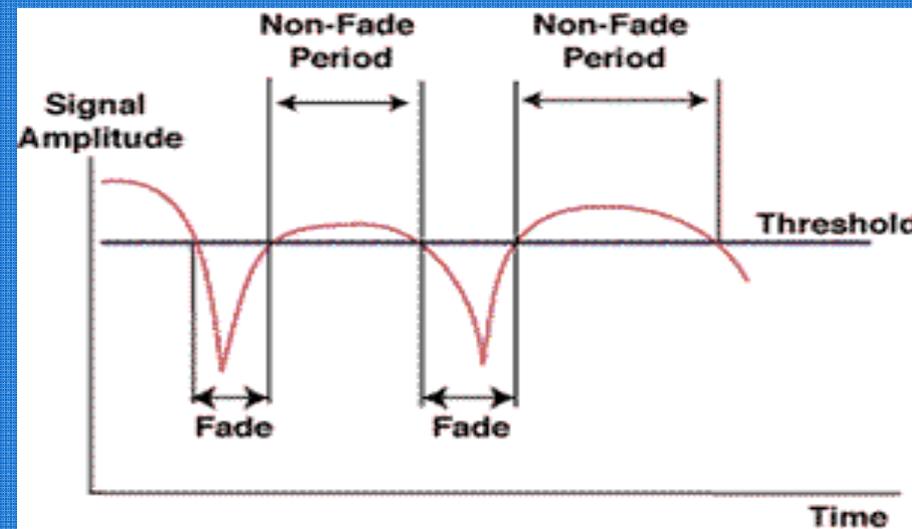
Frequency Selective Fading

Frequency selective fading is caused by reflectors between the transmitter and receiver creating multi-path effects.
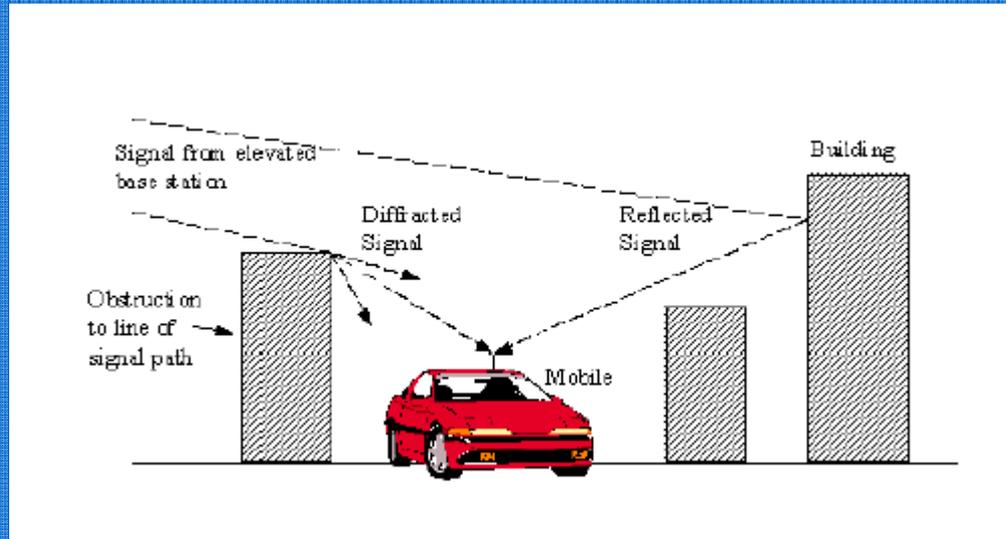
Effects of Frequency Selective Fading

- The dips or fades in the response due to reflection cause cancellation of certain frequencies at the Receiver.

- Reflections off near-by objects (e.g. ground, buildings, trees, etc) can lead to multi-path signals of similar signal power to the direct signal.

- This can result in deep nulls in the received signal power due to destructive interference.

Figure Explaining Multi-path Fading

When the waves of multi-path signals are out of phase, reduction of the signal strength at the receiver can occur.

Other Multi-path Concerns

Apart from creating frequency selective fading,

Multi-path can also cause inter-symbol interference.

Coherence Bandwidth

Coherence Bandwidth is a statistical measure of the range of frequencies over which the channel can be considered flat that is a channel which passes all spectral components with approximately equal gain and linear phase. It is the range of frequencies over which the two frequency components have a strong potential for amplitude correlation.

Definition: Delay spread (frequency-selective fading), in which a bit arrives at the receiver at different times because of the different paths taken, causing bits to run into each other and thus cause inter-symbol interference (ISI). This limits the usable digital signaling rate far a given rate. In other words, if the modulation bandwidth exceeds the coherence bandwidth of the radio channel Inter Symbol Interference or ISI occurs. This causes significant error in high bit rate systems.

Inter Symbol Interference Representation
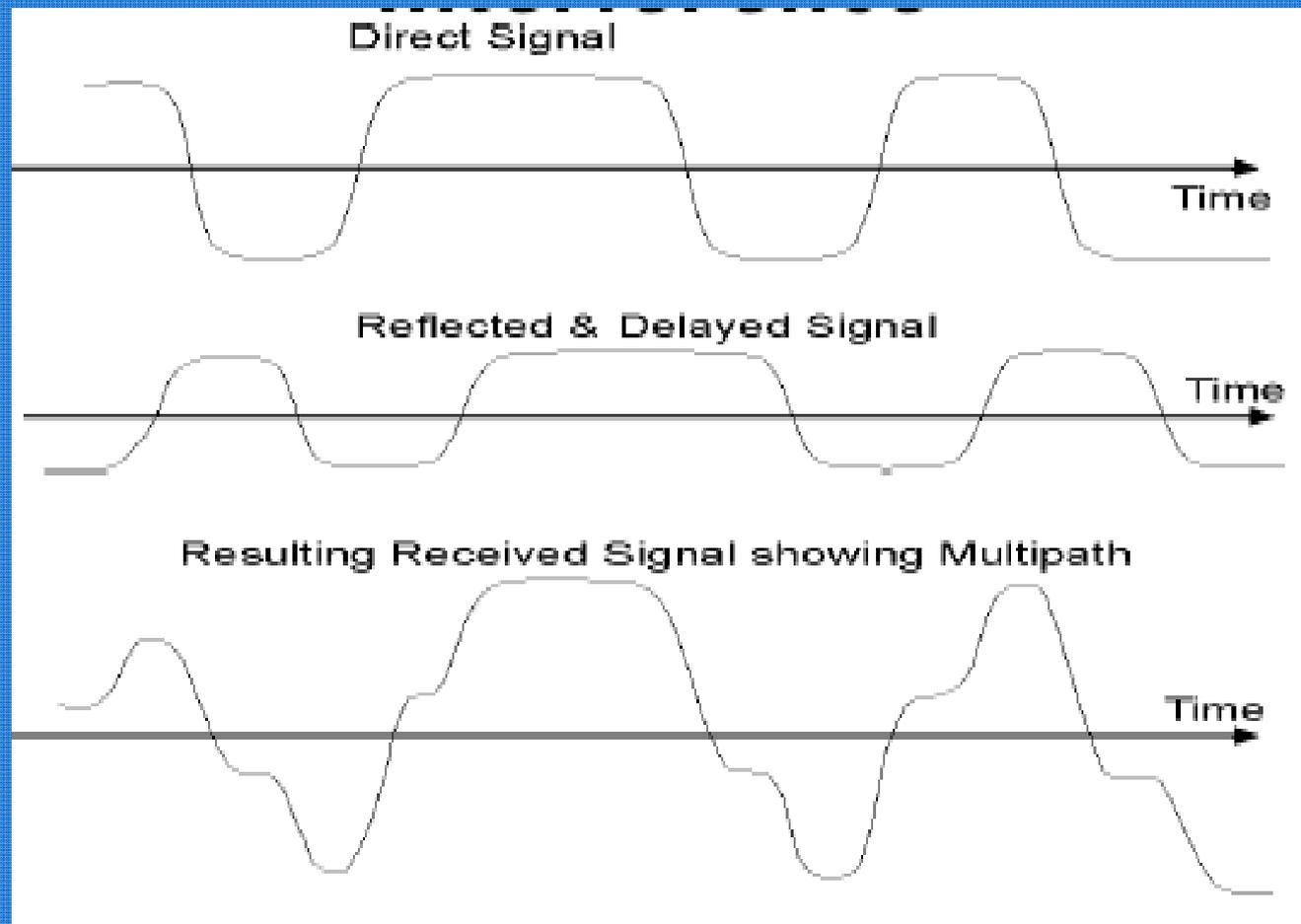
Inter-Symbol Interference (ISI)

- ISI in the detection process due to the filtering effects of the system

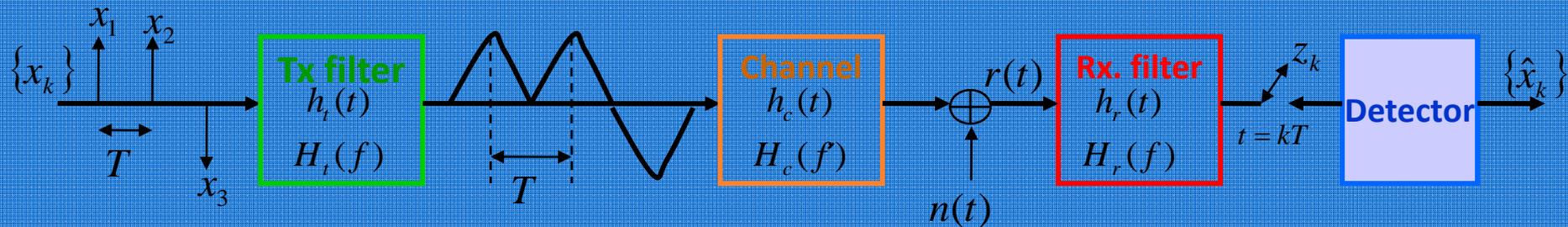- Overall equivalent system transfer function

$$H(f) = H_t(f)H_c(f)H_r(f)$$

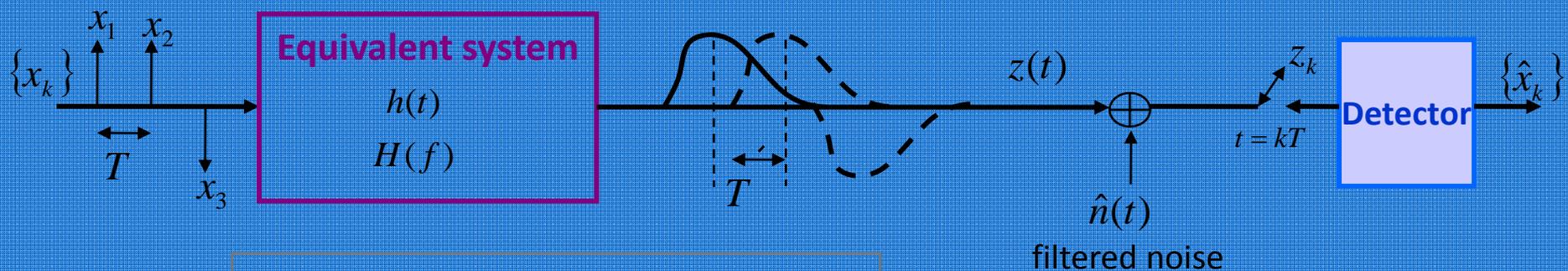- creates echoes and hence time dispersion
- causes ISI at sampling time

$$z_k = s_k + n_k + \sum_{i \neq k} \alpha_i s_i$$

Inter-symbol interference

- ## Baseband system model

- ## Equivalent model

$$H(f) = H_t(f)H_c(f)H_r(f)$$