5.6 Power delay profile

- The power delay profile relates the received power of a signal through a multipath channel as a function of the time delay.
- The total received power is the sum of the powers in the individual multipath components.
- The power delay profile can be measured empirically.
- Time dispersion parameters are used to quantify the time-dispersive properties of multipath channels, and can be determined form the power-delay profile.

5.7 Coherence bandwidth

- The delay spread is a natural phenomenon caused by reflected and scattered propagation paths in the radio channel.
- The coherence bandwidth (B_c) is a statistical measure of the range of frequencies over which the channel can be considered "flat"
    - Spectral components within B_c pass with approximately equal gain & linear phase.
    - B_c is derived from the rms delay spread (σ_τ).
- Two sinusoids with frequency separation greater than B_c are affected quite differently by the channel, and their amplitudes would be considered uncorrelated.
    - If the coherent bandwidth (B_c) is defined as the bandwidth over which the frequency correlation function is above 0.9 (90%), then the coherence bandwidth is approximated by

$$B_c \approx \frac{1}{50\sigma_\tau}$$

- If the frequency correlation function is above 0.5 (50%) (relaxed definition), then the coherence bandwidth is approximately

$$B_c \approx \frac{1}{5\sigma_\tau}$$

5.8 Fading effects due to multipath time delay spread

- Time dispersion due to multipath causes the transmitted signal to undergo either one of the following:
    1. Flat fading
    2. Frequency selective fading

1- Flat fading

- The received signal undergoes ***flat fading*** if the channel has a constant gain and linear phase response over a bandwidth which is greater than the bandwidth of the transmitted signal.
- In frequency domain: $B_S < B_C$

  B_s: signal bandwidth

  B_c: coherence bandwidth

- In time domain: $T_S > \sigma_\tau$

  $\boldsymbol{T_s}$**:** symbol period (reciprocal bandwidth)

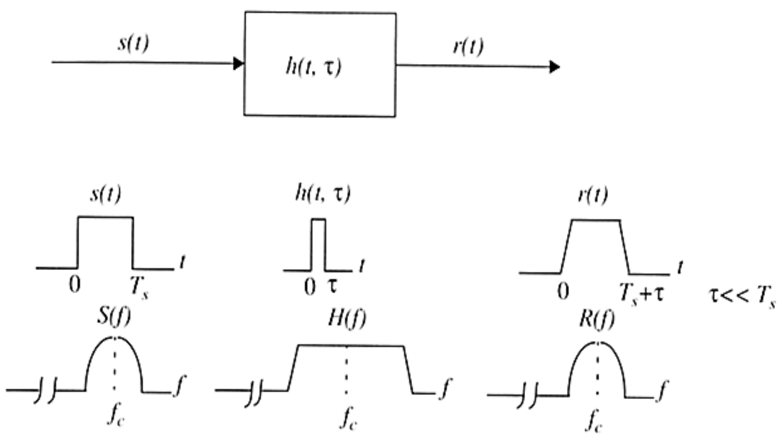
  $\boldsymbol{\sigma_\tau}$**:** rms delay spread of channel

  In general $\sigma\tau \leq 0.1\, T_S$

- ***Inter-symbol interference (ISI) is low (negligible)***

- The received signal strength changes with time, due to fluctuations in the gain of the channel caused by multipath.
- The spectral characteristics of the transmitted signal are preserved.
- Flat fading channel is also called:
  - Amplitude varying channel.
  - Narrow band channel: bandwidth

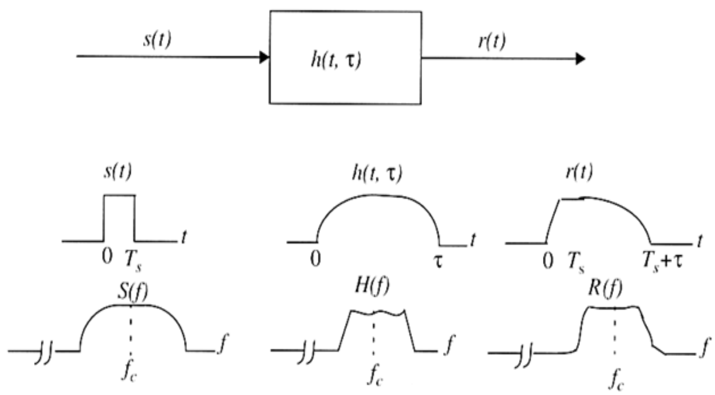
  of the applied signal is narrow as compared to the channel bandwidth.
- Channel modeling:
  - Rayleigh flat fading channel model.



Flat fading channel characteristics

2- Frequency selective fading

- The channel creates ***frequency selective fading*** if the channel possesses a constant gain and linear phase response over a bandwidth that is smaller than the bandwidth of transmitted signal.
- **In frequency domain:** $B_S > B_C$
  - ***B_s*:** signal bandwidth
  - ***B_c*:** coherence bandwidth
- **In time domain:** $T_S > \sigma_\tau$
  - ***T_s*:** symbol period (reciprocal bandwidth)
  - **σ_τ:** rms delay spread
- ***Inter-symbol interference (ISI) is high (significant).***
- Frequency selective fading is due to time dispersion of the transmitted symbols within the channel, and causes inter-symbol interference (ISI).
- Frequency selective fading channels are much more difficult to model than flat fading channels.
- Statistic impulse response models:
  - 2-ray Rayleigh fading model
  - Computer generated models
  - Measured impulse response



Frequency selective fading channel characteristics