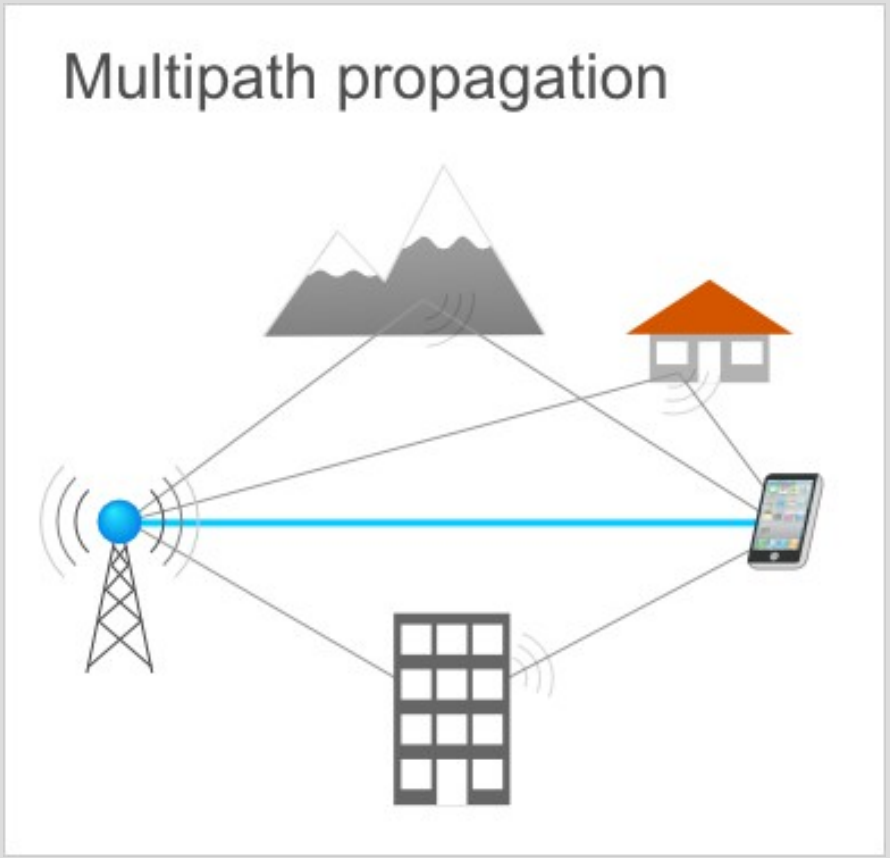
Multipath propagation

Redes Móveis

Assigment 2

Aluno : Vadym Hapanchak
Numero : 72669

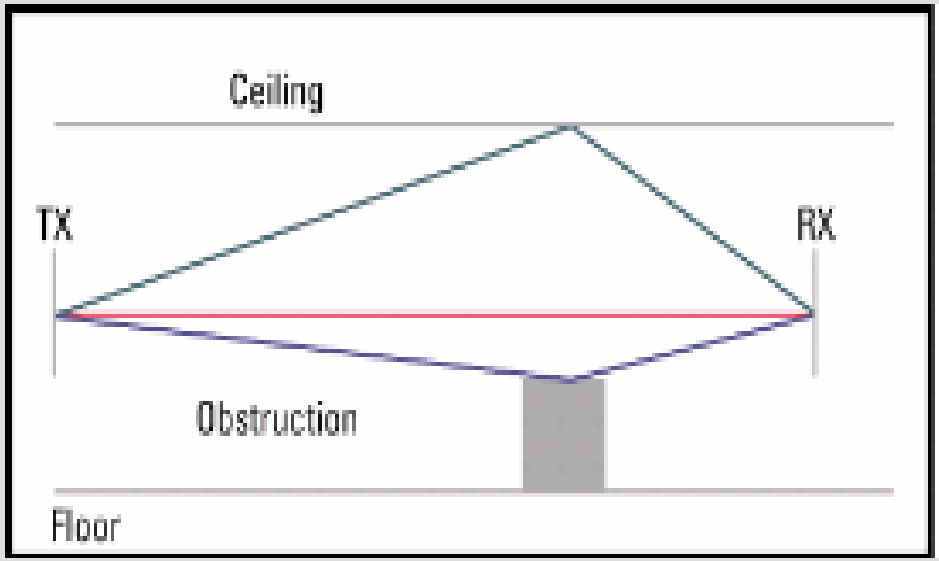
Multipath propagation

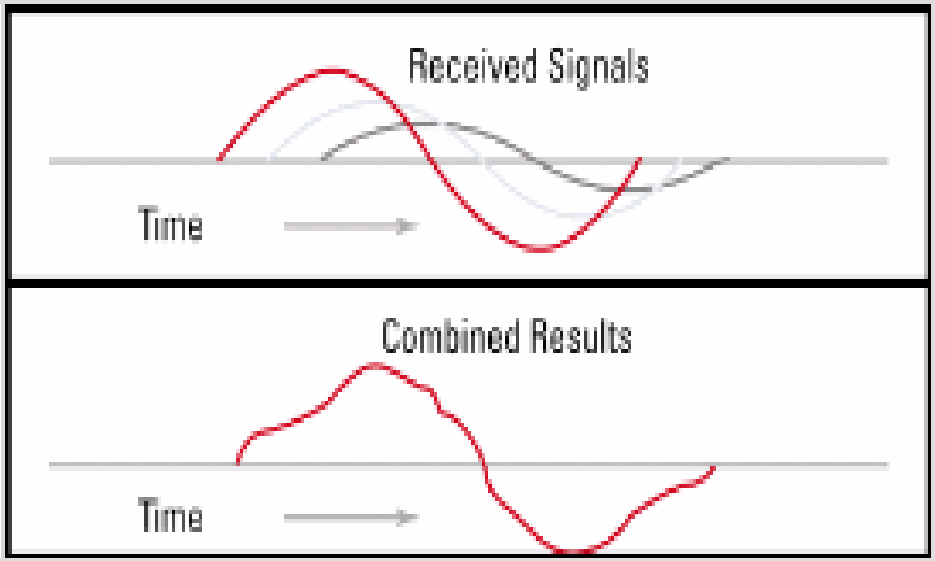


In wireless telecommunications, **multipath** is the propagation phenomenon that results in radio signals reaching the receiving antenna by two or more paths.

Causes of multipath include atmospheric ducting, ionospheric reflection and refraction, and reflection from water bodies and terrestrial objects such as mountains and buildings.

Multipath effect's

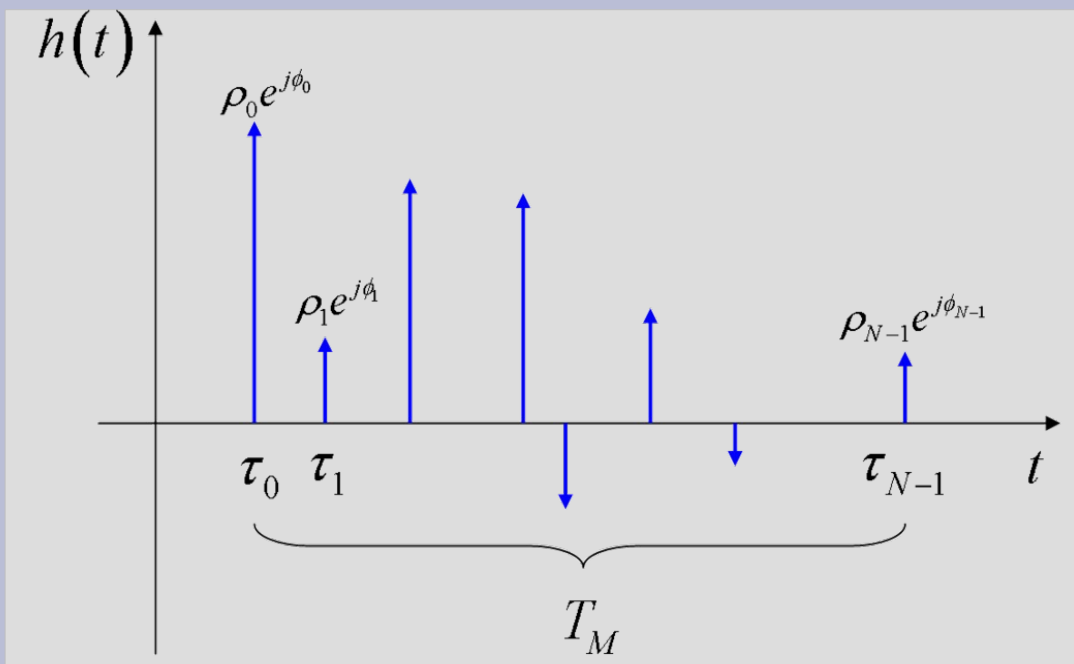




In short, you are adding sinusoids together, when multipath occurs.

The most harmful effect of multipath distortion is the Inter-Symbol Interference (ISI). Due to this effect, the effective bandwidth is reduced. Furthermore, if the channel is not static, the multipath effect turns probabilistic.

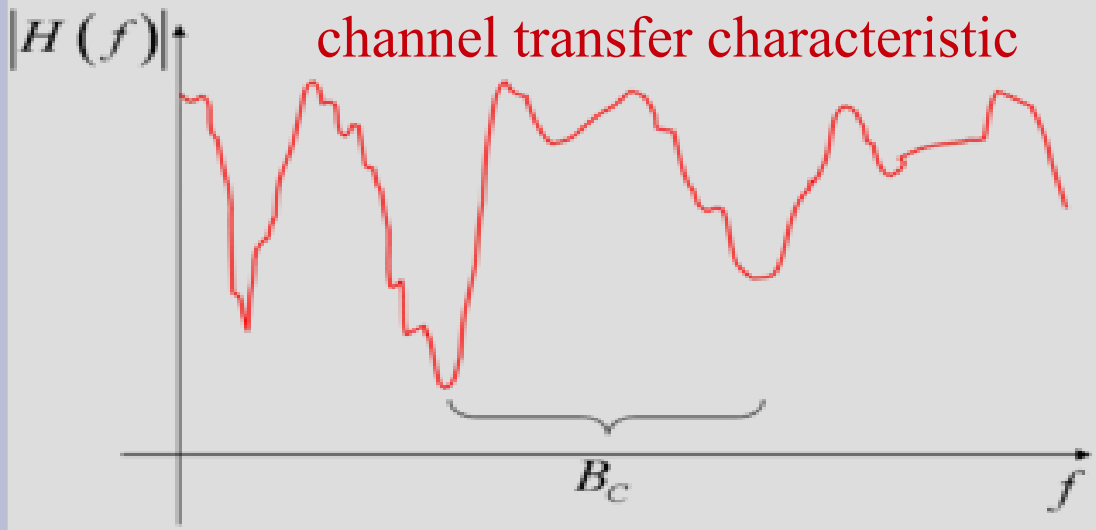
Mathematical modeling



$$x(t) = \delta(t)$$

$$y(t) = h(t) = \sum_{n=0}^{N-1} \rho_n e^{j\phi_n} \delta(t - \tau_n)$$

more than one pulse will be received

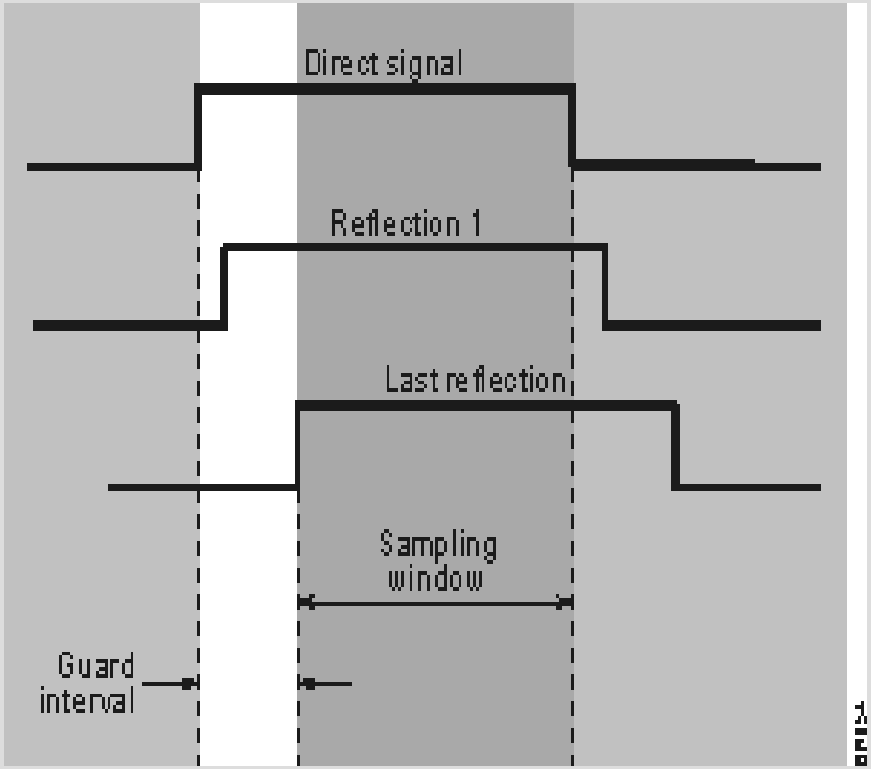


$$H(f) = \mathfrak{F}(h(t)) = \int_{-\infty}^{+\infty} h(t) e^{-j2\pi ft} dt = \sum_{n=0}^{N-1} \rho_n e^{j\phi_n} e^{-j2\pi f\tau_n}$$

coherence bandwidth

$$B_C \approx \frac{1}{T_M}$$

Interference caused by multipath propagation

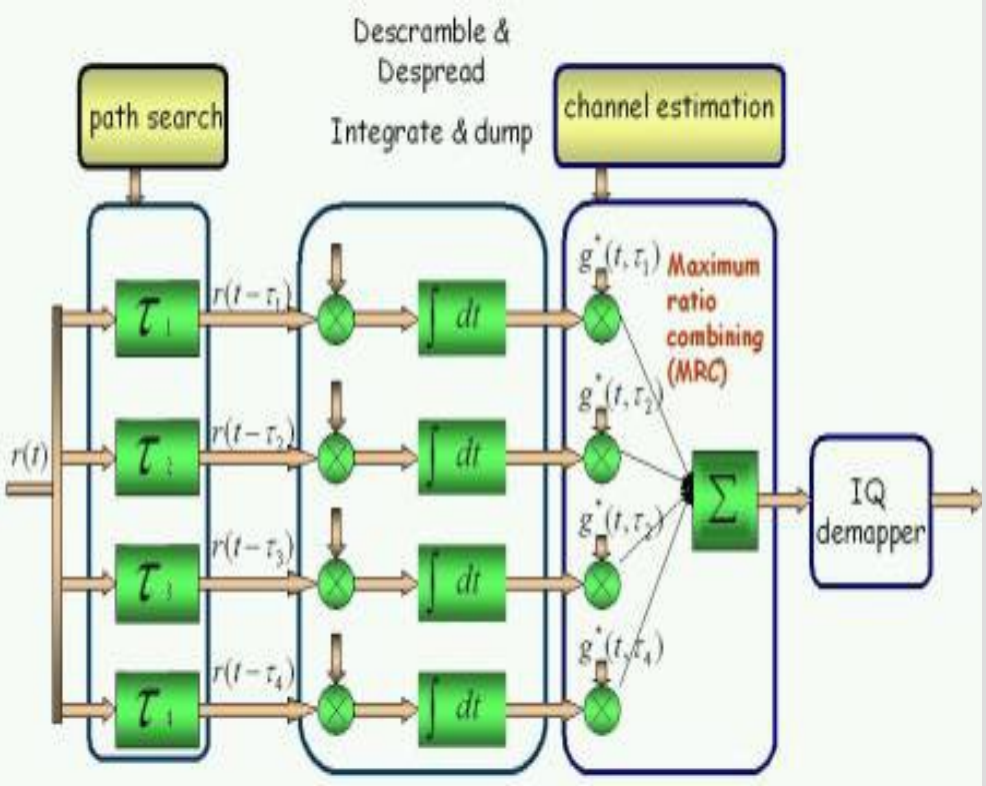


Multipath propagation can give rise to interference that can reduce the signal to noise ratio and reduce bit error rates for digital signals

This arises when the delay caused by the extended path length of the reflected signal. If the delay is significant proportion of a symbol, then the receiver may receive the direct signal which indicates one part of the symbol or one state, and another signal which is indicating another logical state

One way of overcoming this is to transmit the data at a rate the signal is sampled, only when all the reflections have arrived and the data is stable.

RAKE Receiver

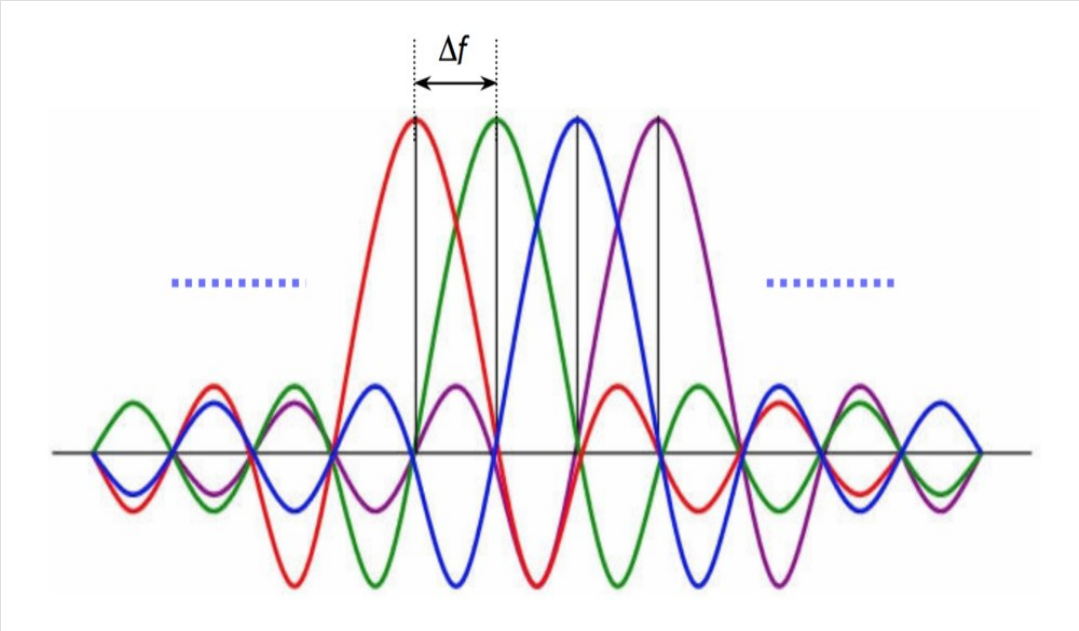


DS-CDMA RAKE Receiver

A rake receiver is a radio receiver designed to counter the effects of multipath fading.It does this by using several "sub-receivers" called *fingers*, that is, several correlators each assigned to a different multipath component.

Each finger independently decodes a single multipath component; at a later stage the contribution of all fingers are combined in order to make the most use of the different transmission characteristics of each transmission path. This could very well result in higher signal-to-noise ratio (or Eb/N0) in a multipath environment than in a "clean" environment.

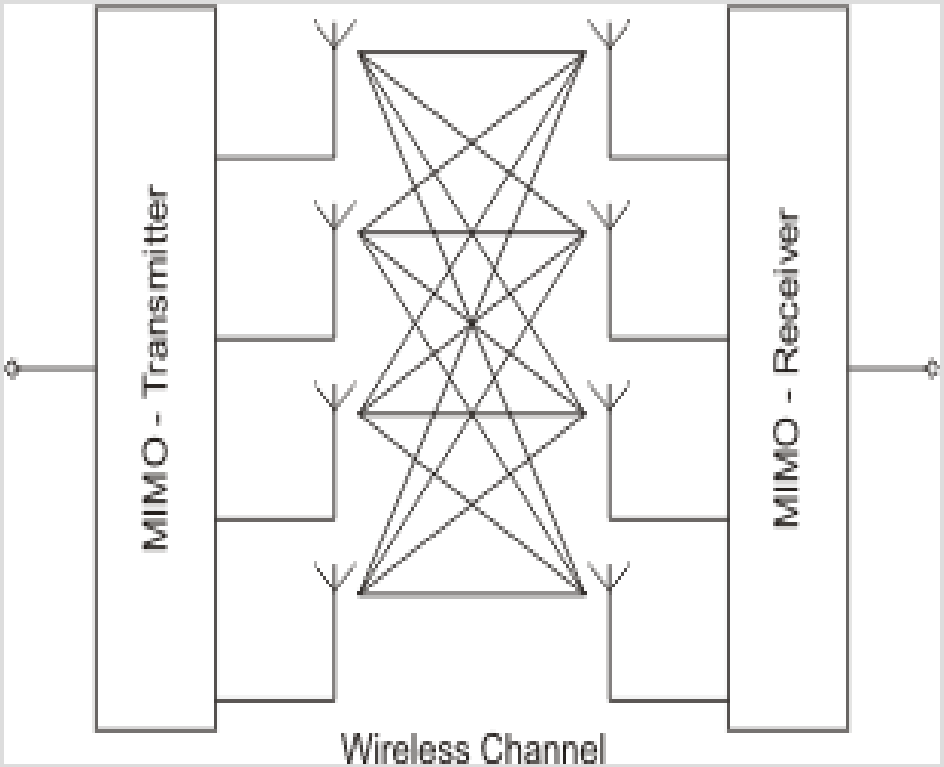
OFDM and multipath propagation



An OFDM signal comprises a large number of carriers, each of which are modulated with a low bit rate data stream. In this way the two contracting requirements for high data rate transmission, to meet the capacity requirements, and low bit rate to meet the intersymbol interference requirements can be met.

The applications include 802.11n Wi-Fi, LTE (Long Term Evolution for 3G cellular telecommunications), LTE Advanced (4G), WiMAX and many more. The fact that OFDM is being widely used demonstrates that it is an ideal format to overcome multipath propagation problems.

MIMO



While multipath propagation creates interference for many radio communications systems, it can also be used to advantage to provide additional capacity on a given channel

MIMO provides a way of utilizing the multiple signal paths that exist between a transmitter and receiver to significantly improve the data throughput available on a given channel with its defined bandwidth

The disadvantage to MIMO is that it requires the use of multiple antenna