Overview of Wireless Channels

Wireless Channels 101-1

Objective and Scope

Note: **This is continuous running presentation**

1. By the time this presentation completes,
2. The listener will have a basic idea of what a wireless channel is.
3. The different types of wireless channel
4. The approach and philosophy of modeling a channel
5. A wide perspective on why radio propagation and channel modeling is important to decide certain aspects of a comm/wireless system.

Radio Propagation

Let us start with one basic aspect, how we can physically model a wireless channel.

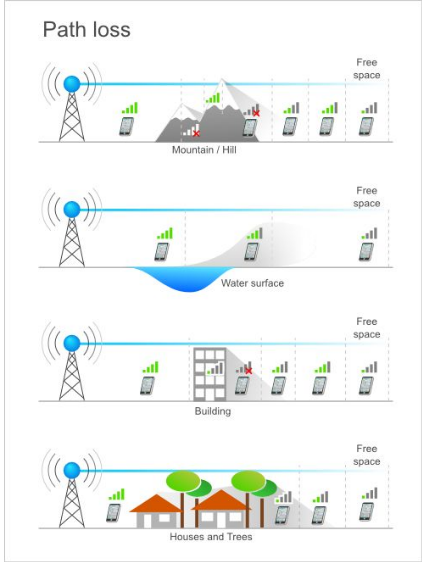
Consider Fig. 2

A Tx and Rx, a Tx sends data into free space (called by different names like air interface, space, ether….)

Tx and Rx operates in Electromagnetic(EM) Radiation, so in principle solving EM field equations (maxwell's equations) and get an idea of the Rx signal would look like.

Catch: This is a tedious process, but can be done.

All these measurements are empirical mostly which are a function of time, frequency, location.



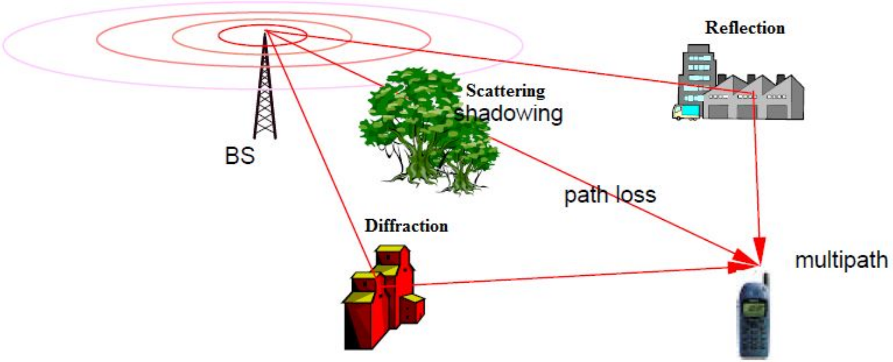


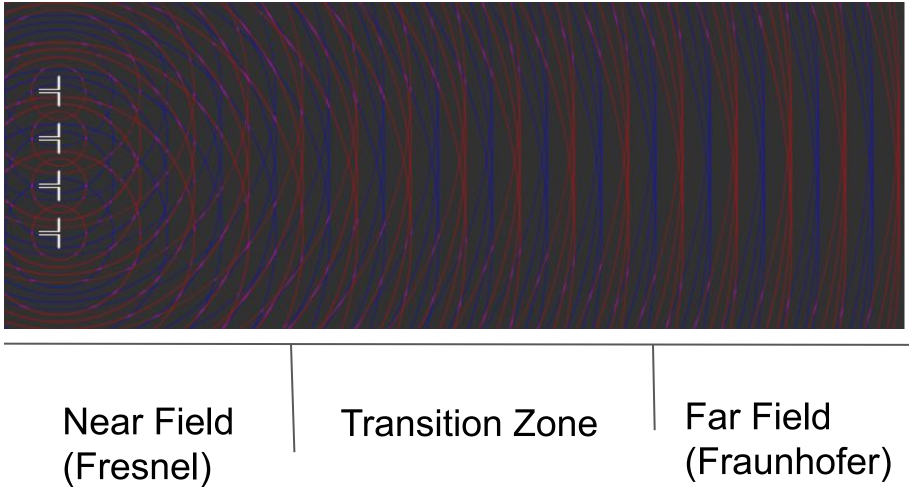
Fig 2

The Radio “Zones”

When coming in the zone of radio propagation, there are two main zones that one needs to consider,

1. Fresnel Zone
2. Fraunhofer Zone

->Antennas are the point of contact to outside world, all these zones are from antenna end

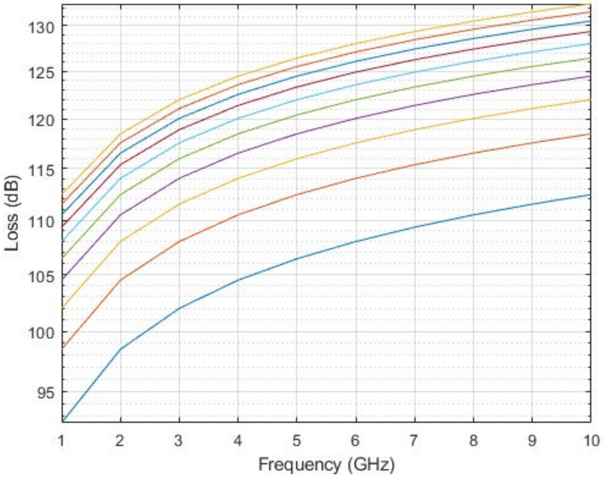


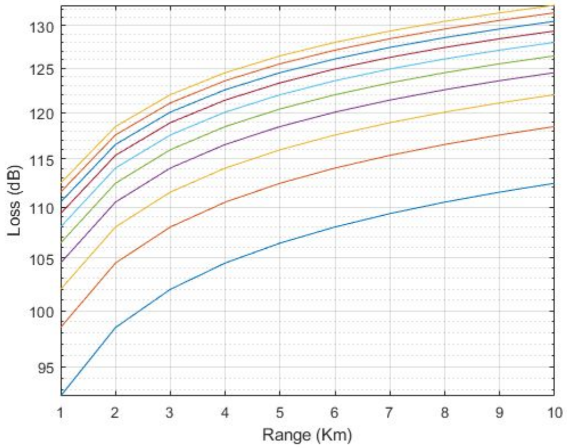
Attenuation in free space

EM waves deteriorate with distance and frequency.

The higher the frequency, the lower the wavelength (c/wavelength)

Similarly higher the frequency the worse the attenuation is.

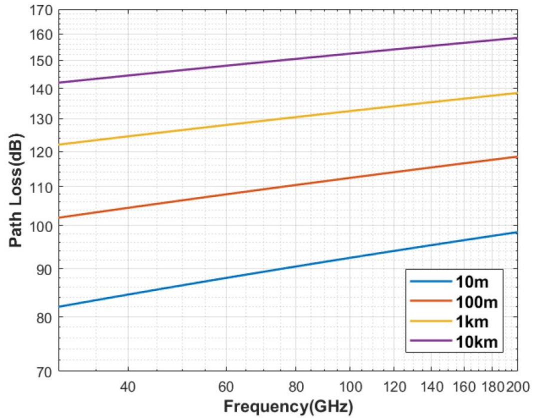


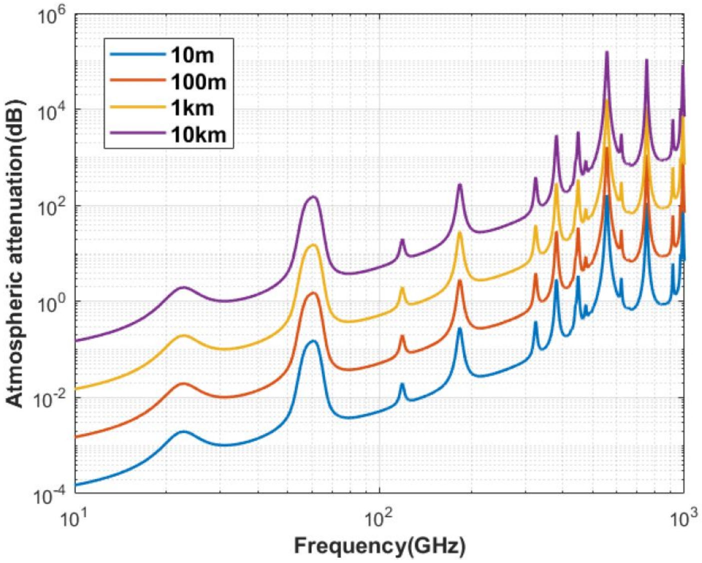


More details on attenuation

Also dependent on gas and other atmospheric effects like rain and fog.

Rain attenuation is most visible in mmWave frequencies so is gas attenuation





Why understanding Radio propagation is important in measurement?

Helps us to understand some things

- Understanding key physical parameters
- What modeling issues will arise from the physical parameters

So, one question,

What are the defining trait of a wireless channel?

->**Variation of Rx signal strength which is a function of time, frequency, location and a bunch of other things (obstacles, foliage….)**

Classification of Wireless Propagation

Large Scale Model

- Macrocell Model
  - Large Scale phenomena
  - Free Space Model
  - Okumura Hata
  - COST-231 Hata
  - Stanford University Interim (SUI)
- Microcell Model
  - Cost231 Welfisch Ikegami

Small Scale Model

- Multipath
- Scattering
- Diffraction
- Reflection
- NLoS propagation
- Understanding deep fade

Modeling Philosophy

Things to be considered for our modeling philosophy

- Doppler Spread → Related to velocity
- Multipath Spread → Related to location
- Coherence Time
- Delay Spread
- Coherence Bandwidth → Related to time

Modeling Philosophy Contd …

From the previous slide, we are interested in a range of these conditions, all aspects of the aforementioned aspects are called as channel taps, given in literature as $\{h_l[m]\}$, but how much of these taps we need?

Here is where our modeling approach starts.

Modeling Approach

Two Approach,

Deterministic

Stochastic

Works best with large scale empirical model Ex: WINNER II and ITU and 3gpp models

The previous taps that we saw, we take that some key aspects of consideration happens at some **RANDOM** point in time.

This requires a probabilistic model, the most famous we know is most simplistic Gaussian Random Variable

A little Intro to Statistical models

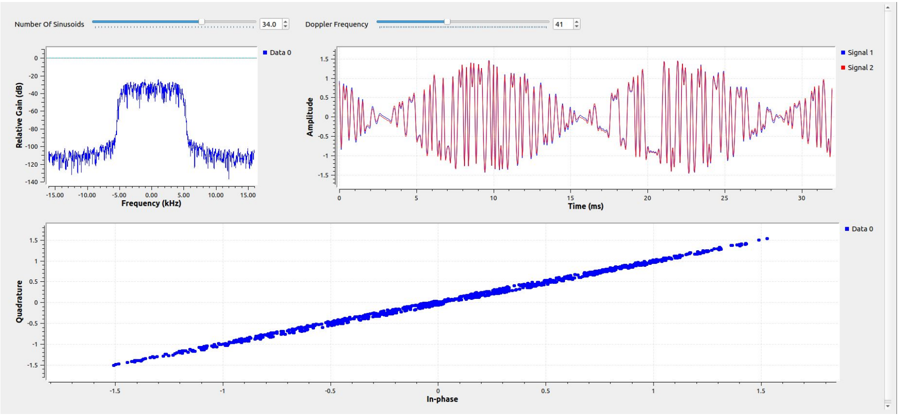
Rayleigh Fading

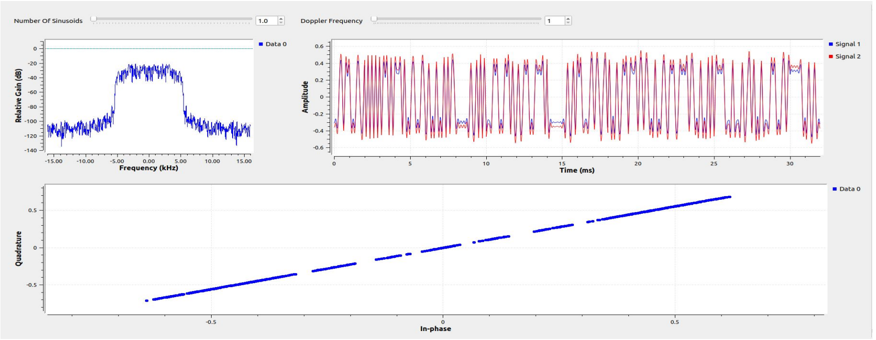
Most used and tested probability distribution model

This model assumes there is not many scatter in the wireless environment, so the impulse response will not be a gaussian but a rayleigh distributed function (i.e no dominant scatter or a main scatter, this is evenly distributed between 0-2*pi radians.

The impulse response from this is rayleigh distributed.

Very applicable in Urban modeling where large amount of scatter is normal





Hands On

GRC demo of a basic AWGN channel

References

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