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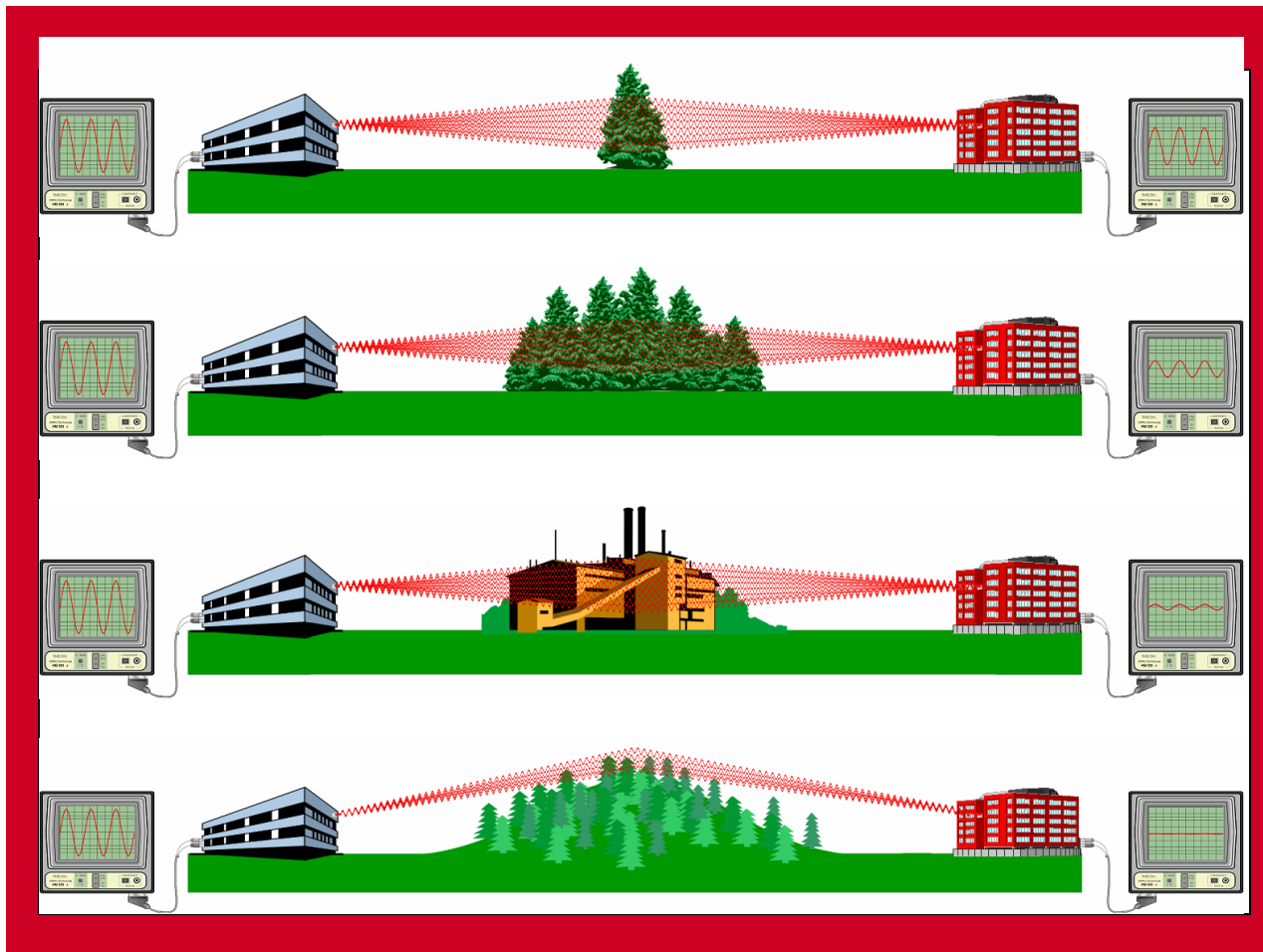
# Distance Obstruction challenges

- Attenuation
  - Excess Path Loss
- Fading
  - Multipath
- Dispersion
- Polarization Shift
- Dead zones



- RF Signals are highly attenuated by an obstructed path.
- RF Signals will get to a destination by:
  - Diffraction around an object
  - Reflection off objects
    - Refracted signal loss and Scattering
  - Penetration through the obstruction.
- Total Path Loss =  
Free Space Path Loss + Excess Path Loss
- Link works if  
System Gain > Total Path Loss

## Excess Path Loss is Based upon type of Obstruction



**20dB**

**1/100<sup>th</sup>**

**30dB**

**1/1,000<sup>th</sup>**

**30 – 40dB**

**1/1,000<sup>th</sup> to  
1/10,000<sup>th</sup>**

**40dB**

**1/10,000<sup>th</sup>**

All links are subject to periodic fading

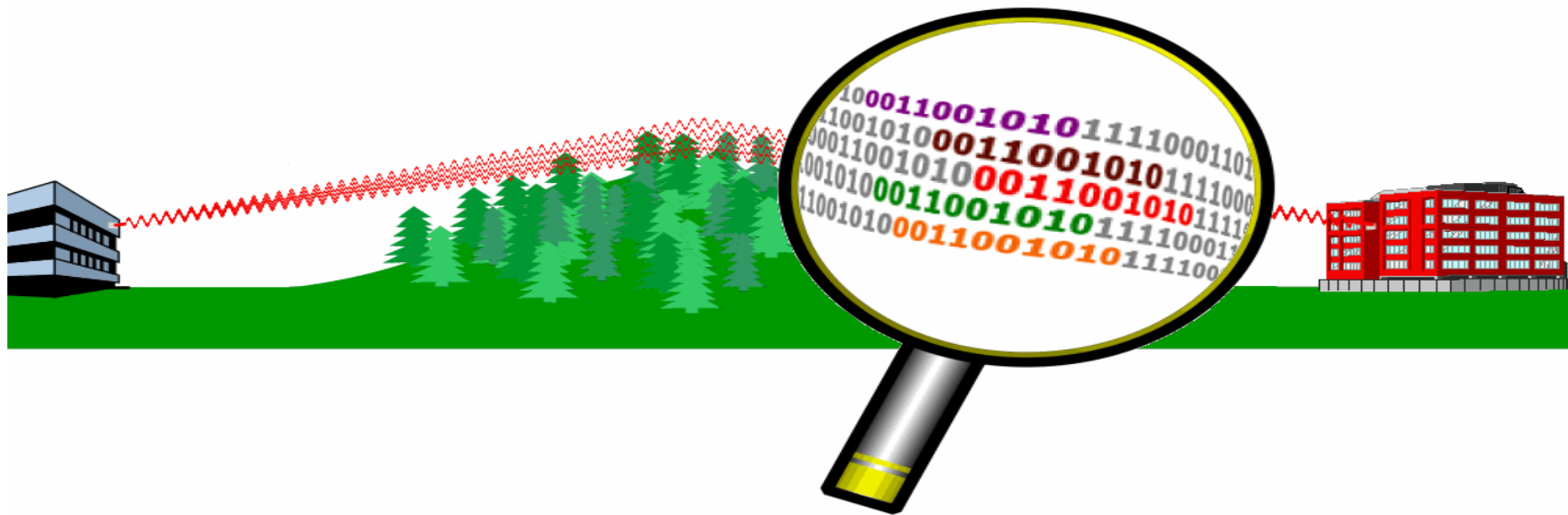
## LOS Fading

- Multipath - Signals arrive via different paths. Multiple paths arrive out of phase and cancel each other.

## NLoS Fading

- Multipath
- Obstruction Movement and Change

# Definition: Dispersion (...echoes from the past)



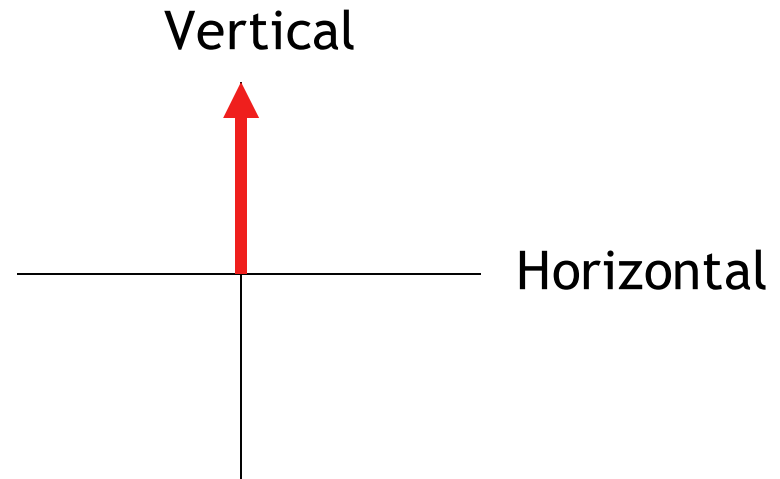
- Signals arrive via many paths with a time delay,
  - “Dispersed” Channel.
- Previous transmitted bits arrive at the same time as the current bits, called Multipath inter-symbol-interference.
- Resolving this requires Equalization



- Polarization describes the orientation of the E (electrical) and H (magnetic) components of an RF wave front.
  - Linear polarization (horizontal, vertical, slant linear)
  - Circular polarization (right-hand, left hand)
- Traditional RF has been transmitted (and received) with dominant polarization
- Approximately 25-30 dB isolation between vertical and horizontal polarization
  - Polarization provides a level of discrimination (attenuation) against different polarization signals, especially “opposite” polarization (e.g. horizontal versus vertical)
- Diffraction, multipath, and long distances (starts 10~15 Kilometer) can cause “Polarization Shift”
- About 3 dB isolation between linear and circular polarization

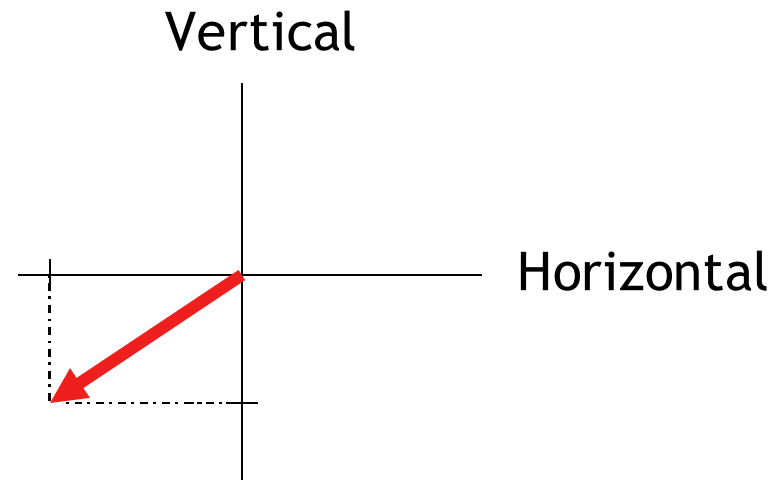
## Vertically Polarized RF Signal

- Signal has all energy in vertical plain
- Receiver will have vertical polarization



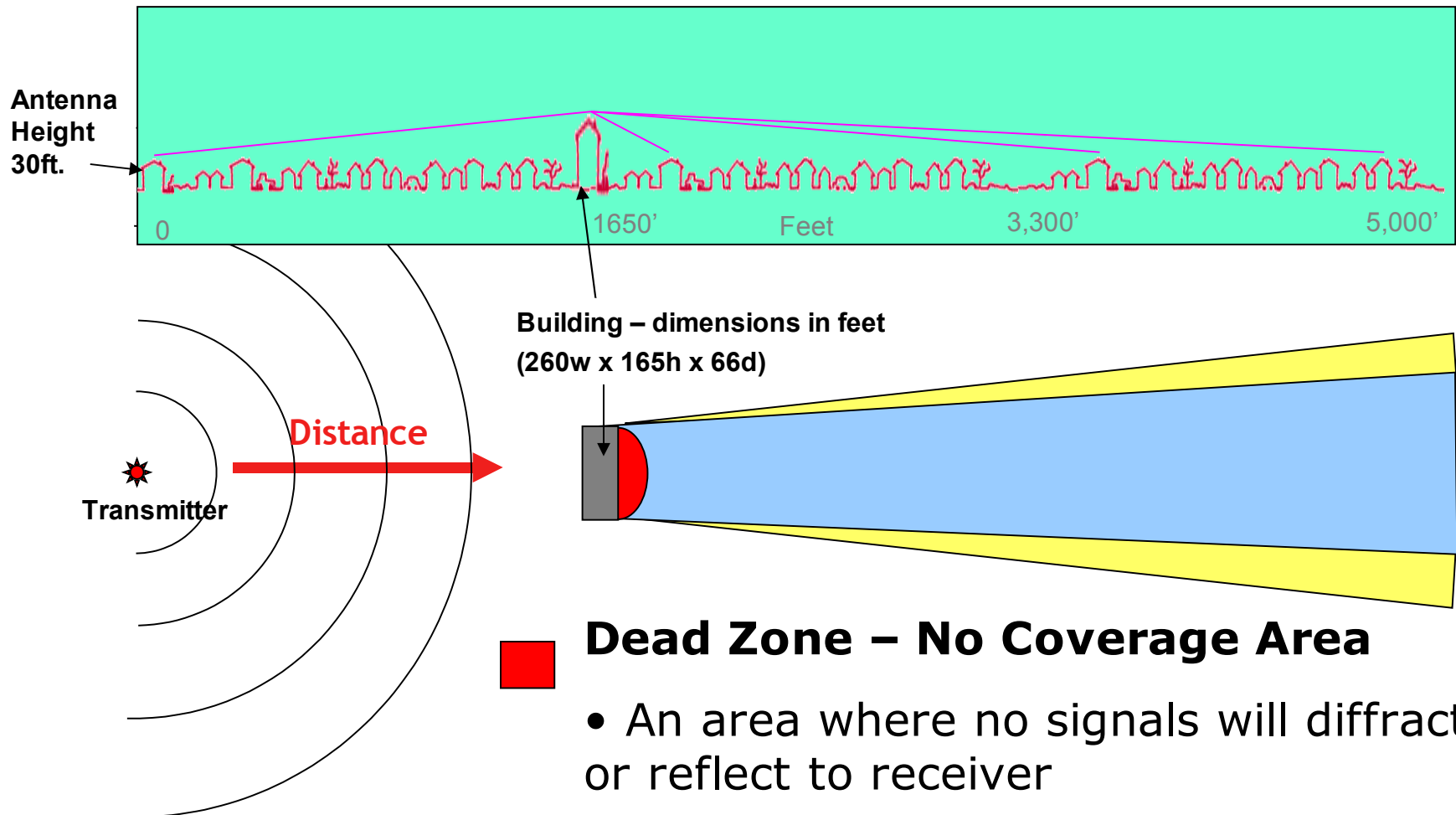
## RF Signal after Polarization Shift

- Signal no longer has enough energy in vertical plain for link
- Receiver can only hear vertical part of signal
- Horizontal part of signal is lost





# The Dead Zone



## Dead Zone – No Coverage Area

- An area where no signals will diffract or reflect to receiver
- Directly dependant on **distance** to obstruction