

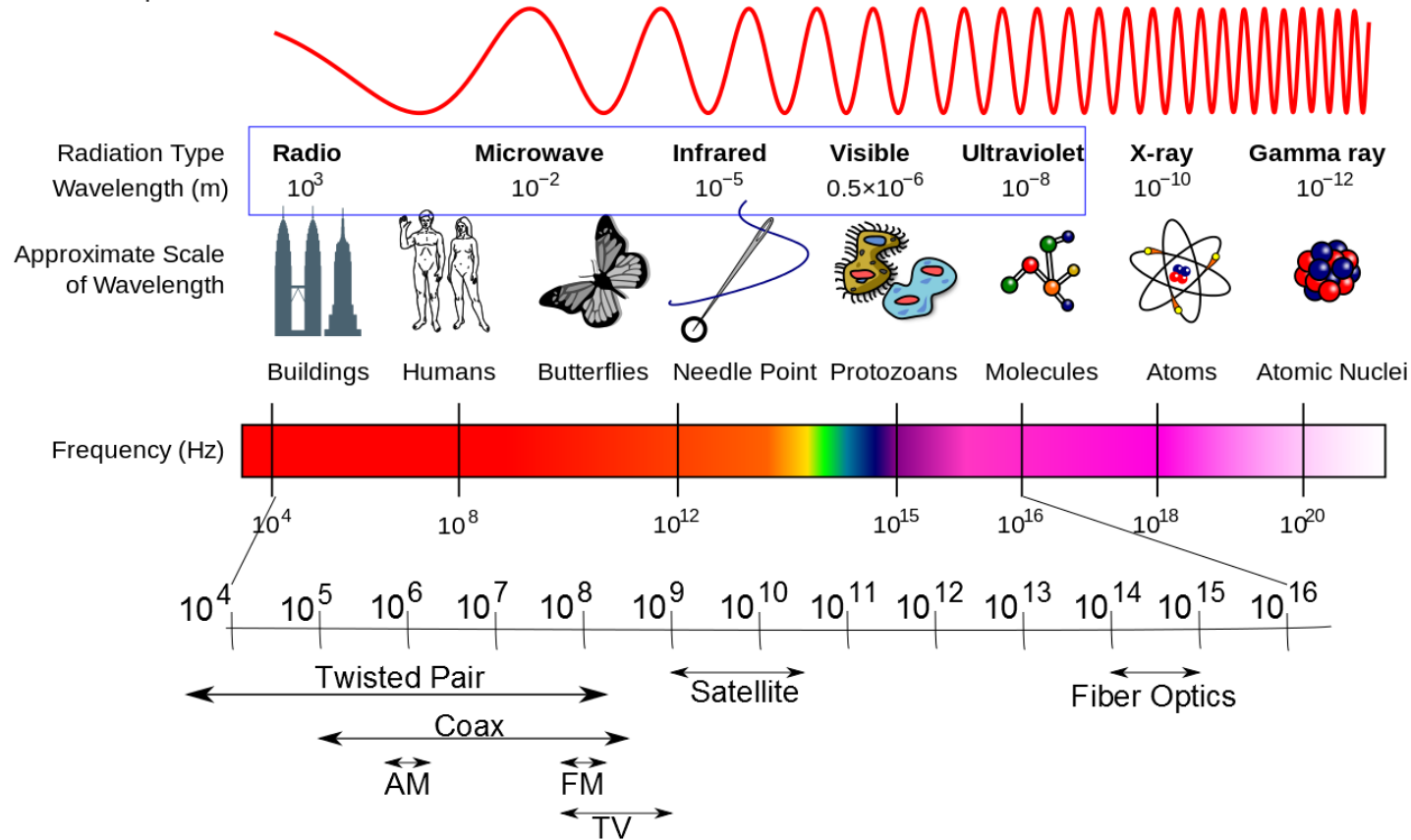
# Physical Layer: Components

Kameswari Chebrolu

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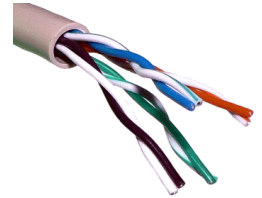
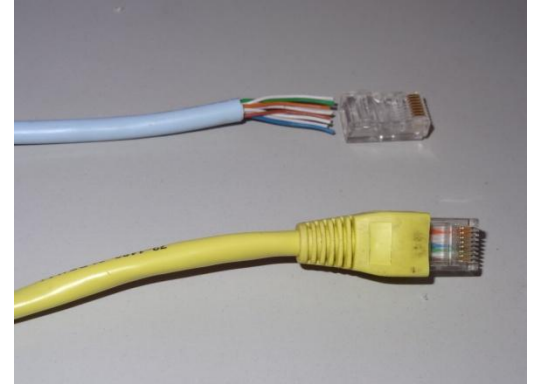
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# Electromagnetic Spectrum



# Twisted Pair

- Usage: Ethernet, Telephone Lines
- Different categories:
  - Cat 3: 16Mhz, 3-15dB/100m
  - Cat 5: 100Mhz, 2-24dB/100m
  - Cat 6: 250Mhz, 2-32dB/100m
- Typical distances under 100m
- Data rates between 10Mbps-1Gbps



# Coaxial Cable

- Usage: Cable TV
- Provides up to 1Ghz bandwidth
- Attenuation: 1-45dB/100m (for a given frequency its lower than twisted pair)
- Typical distances under 500m
- Data rates between 10-100Mbps



# Fiber Optics

- Usage: Long Haul Transmission (Internet Backbone)
- Supports terahz  $(100 \text{ to } 300) * 10^{12} \text{Hz}$
- Attenuation is 0.2dB/km
- Typical distances: tens of kms
- Data rates: 100 to 10Gpbs



# Wireless

- Usage: TV, Satellite, Cellular, WiFi, WiMax
- Spectrum ranges from Khz to few hundred Ghz
  - Actual allocated spectrum varies with technology
  - E.g. Max channel bandwidth for WiFi: 40Mhz, LTE(cellular): 20Mhz, WiMax: 20Mhz
- Attenuation (free-space):  $32.45 + 20\log(d) + 20\log(f)$  **dB** (where d is in km and f is in MHz)
  - E.g: At 1km and 100Mhz, loss:74dB; at 1Ghz, loss: 94dB
- Typical distances: few meters to few kms
- Data rates: few kbps to hundreds of Mbps



# Types of Links

- Full-duplex: Support data flow in either direction
- Half-duplex: Support data flow in only one direction at a time (e.g. walkie-talkie)
- Simplex: Support permanent uni-direction communication (e.g. one way street)

# Summary

- Looked inside a computer (node)
  - Hardware, network code organization and data transfer mechanisms
- Studied about links (which carry electromagnetic waves)
  - Imperfections, spectrum (bandwidth of links), types of links
- Going Ahead: Data to signal transformation