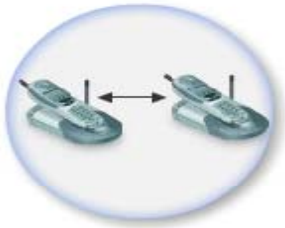
Introduction to Wireless Communication

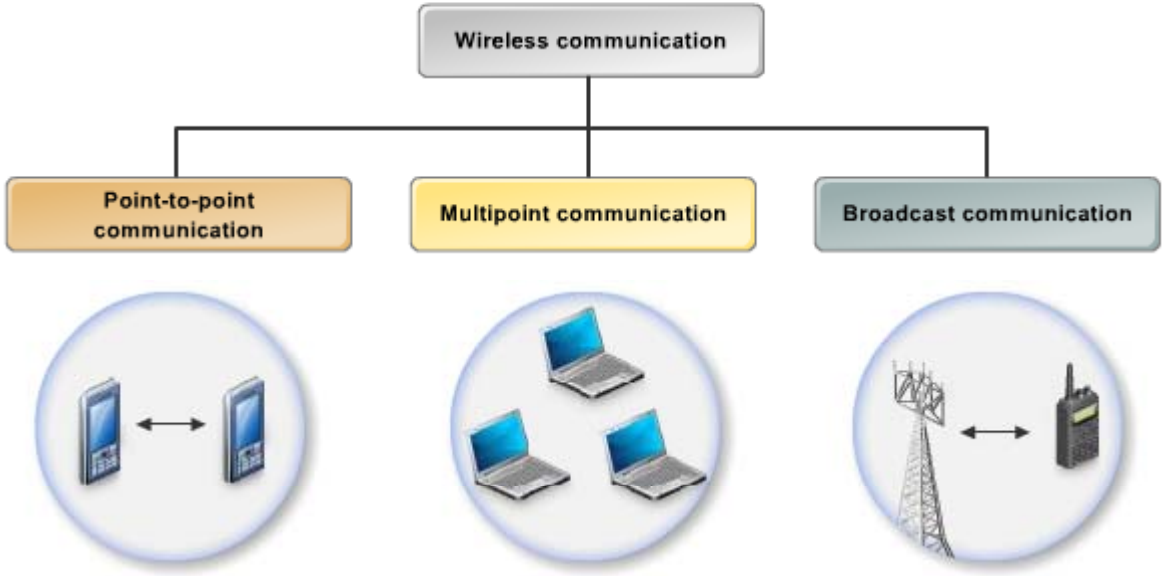

History of wireless communication

- Guglielmo Marconi invented the wireless telegraph in 1896
  - Communication by encoding alphanumeric characters in analog signal
  - Sent telegraphic signals across the Atlantic Ocean
- 1914 – first voice communication over radio waves
- Communications satellites launched in 1960s
- Advances in wireless technology
  - Radio, television, mobile telephone, communication satellites
- More recently
  - Satellite communications, wireless networking, cellular technology

What is Wireless Communication ?

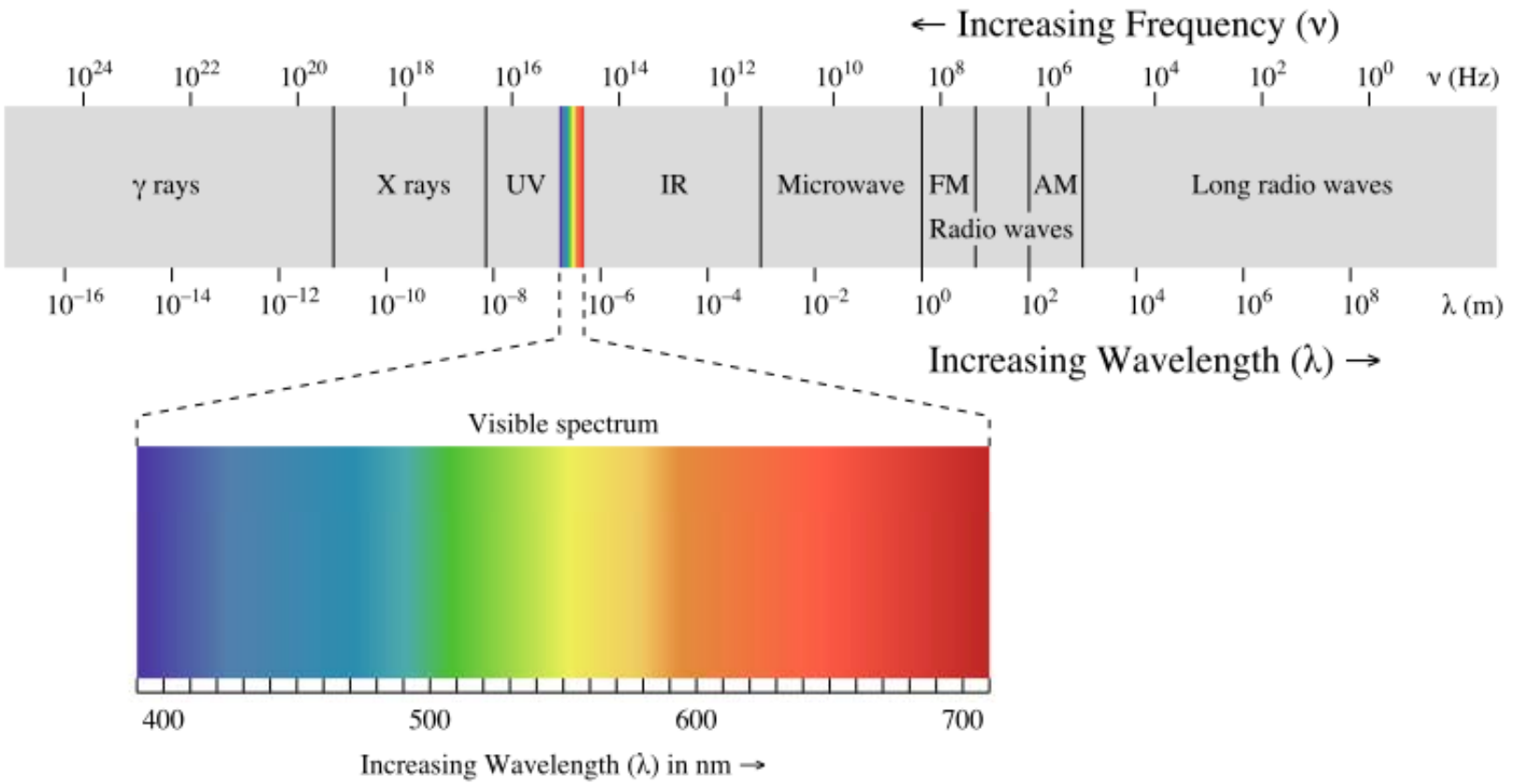
- Transmitting voice and data using electromagnetic waves in open space (atmosphere)
- Electromagnetic waves
  - Travel at speed of light ($c = 3x10^8$ m/s)
  - Has a frequency (f) and wavelength (λ)
    - $c = f \times \lambda$
  - Higher frequency means higher energy photons
  - The higher the energy photon the more penetrating is the radiation

Types of wireless communication



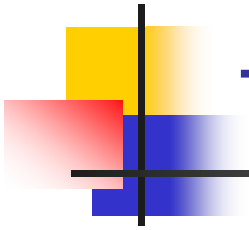
celullar **wireless computer network** **radio service**

Electromagnetic radiation spectrum



Wavelength of Some Technologies

- GSM Phones:
  - frequency ~= 900 Mhz
  - wavelength ~= 33cm
- PCS Phones
  - frequency ~= 1.8 Ghz
  - wavelength ~= 17.5 cm
- Bluetooth:
  - frequency ~= 2.4Gz
  - wavelength ~= 12.5cm



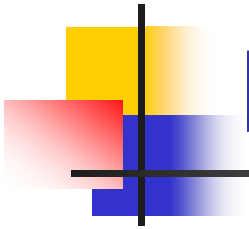
Types of electromagnetic carriers

- when the distance between the sender and receiver is short (e.g. TV box and a remote control) infrared waves are used
- for long range distances between sender and receiver (e.g. TV broadcasting and cellular service) both microwaves and radio waves are used
  - *radio waves* are ideal when large areas need to be coverd and obstacles exist in the transmission path
  - *microwaves* are good when large areas need to be coverd and no obstacles exist in the transmission path

Wireless applications (services)

Advantages and disadvantages of wireless communication

- advantages:
  - mobility
  - a wireless communication network is a solution in areas where cables are impossible to install (e.g. hazardous areas, long distances etc.)
  - easier to maintain
- disadvantages:
  - has security vulnerabilities
  - high costs for setting the infrastructure
  - unlike wired comm., wireless comm. is influenced by physical obstructions, climatic conditions, interference from other wireless devices

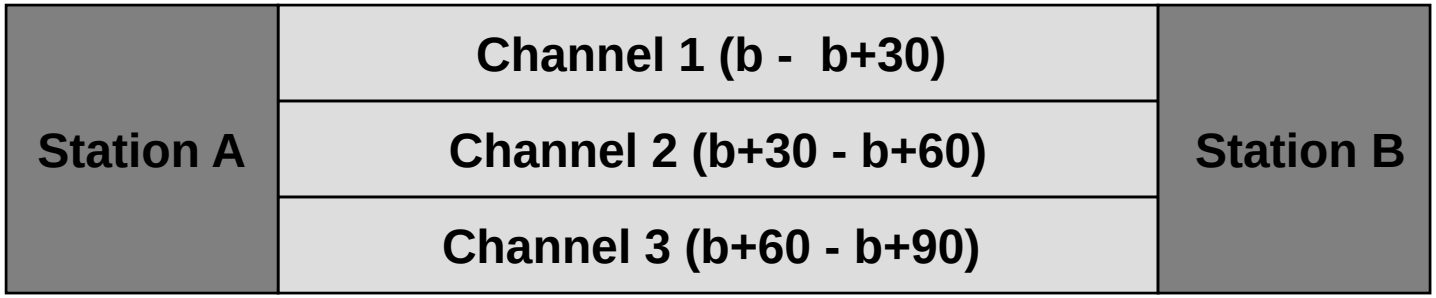


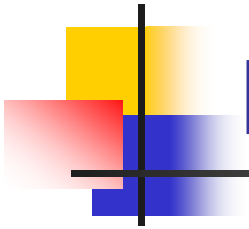
Frequency Carries/Channels

- The information from sender to receiver is carrier over a well defined frequency band.
- This is called a channel
- Each channel has a fixed frequency bandwidth (in KHz) and Capacity (bit-rate)
- Different frequency bands (channels) can be used to transmit information in parallel and independently.

Example

- Assume a spectrum of 90KHz is allocated over a base frequency b for communication between stations A and B
- Assume each channel occupies 30KHz.
- There are 3 channels
- Each channel is simplex (Transmission occurs in one way)
- For full duplex communication:
  - Use two different channels (front and reverse channels)
  - Use time division in a channel

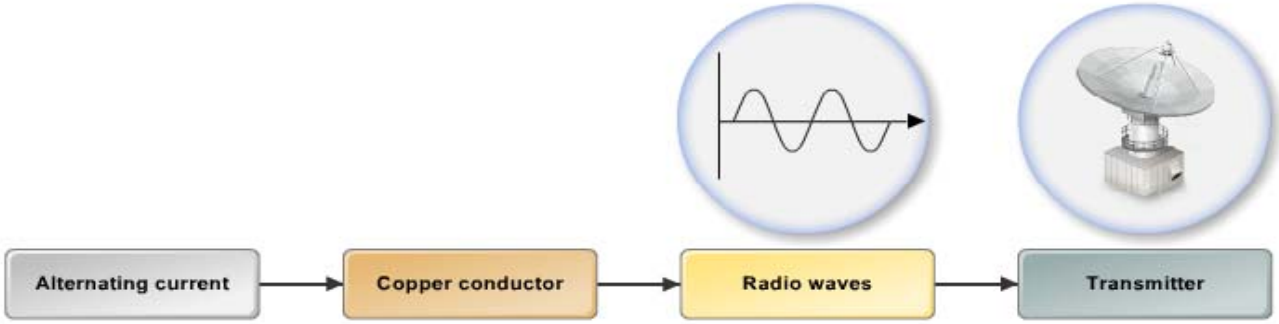




Basics of Radio Communication

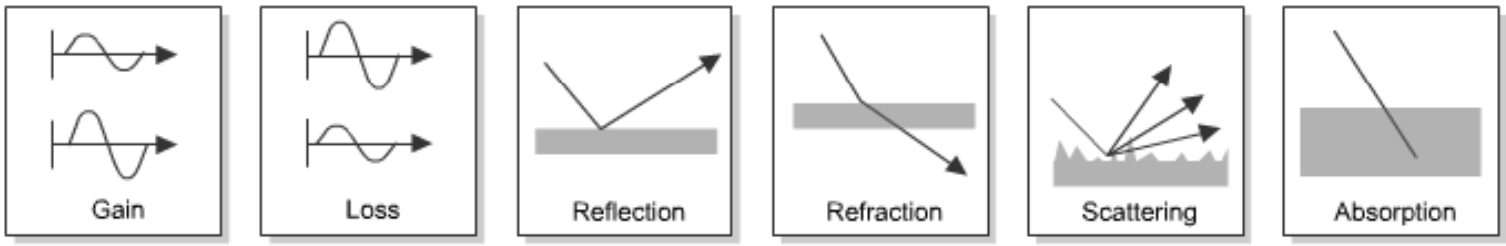
Radio waves generation

- when a high-frequency alternating current (AC) passes through a copper conductor it generates radio waves which are propagated into the air using an antena



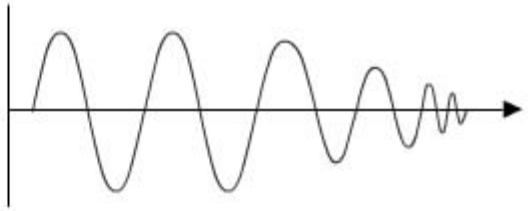
- radio waves have frequencies between:
  - 3 Hz – 300 KHz - low frequency
  - 300 KHz – 30 MHz – high frequency
  - 30 MHz – 300 MHz – very high frequency
  - 300 MHz – 300 GHz – ultra high frequency

Radio propagation



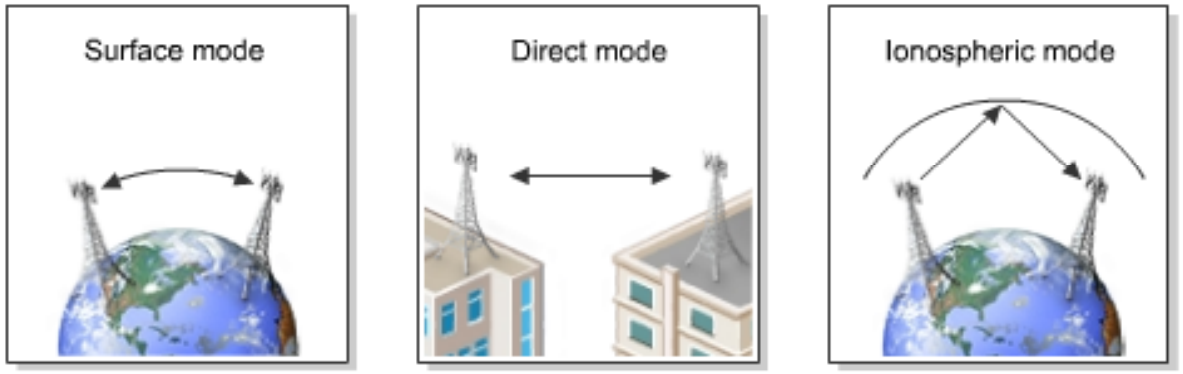
Radio propagation (2)

- radio waves are generated by an antenna and they propagate in all directions as a straight line
- radio waves travel at a velocity of 186.000 miles per second
- radio waves become weaker as they travel a long distance



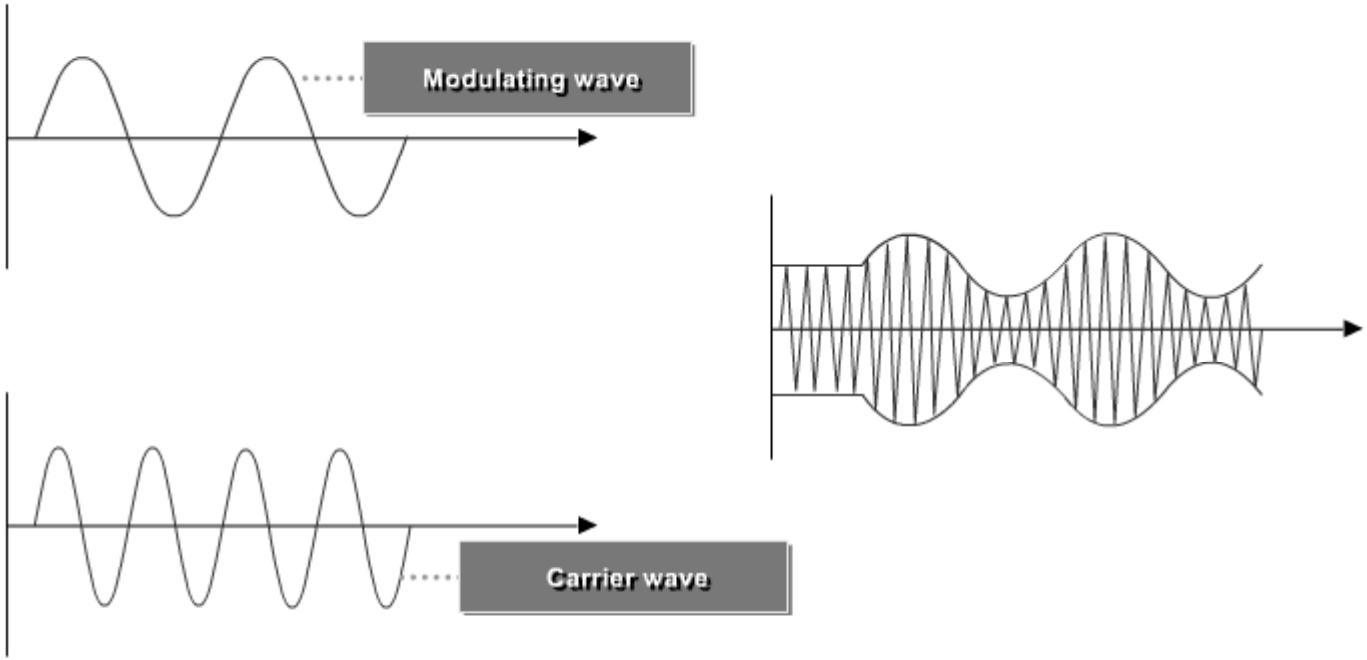
Radio propagation (3)

- there are 3 modes of propagation:
  - surface mode – for low frequency waves
  - direct mode – for high frequency waves
  - ionospheric mode – long distance high frequency waves

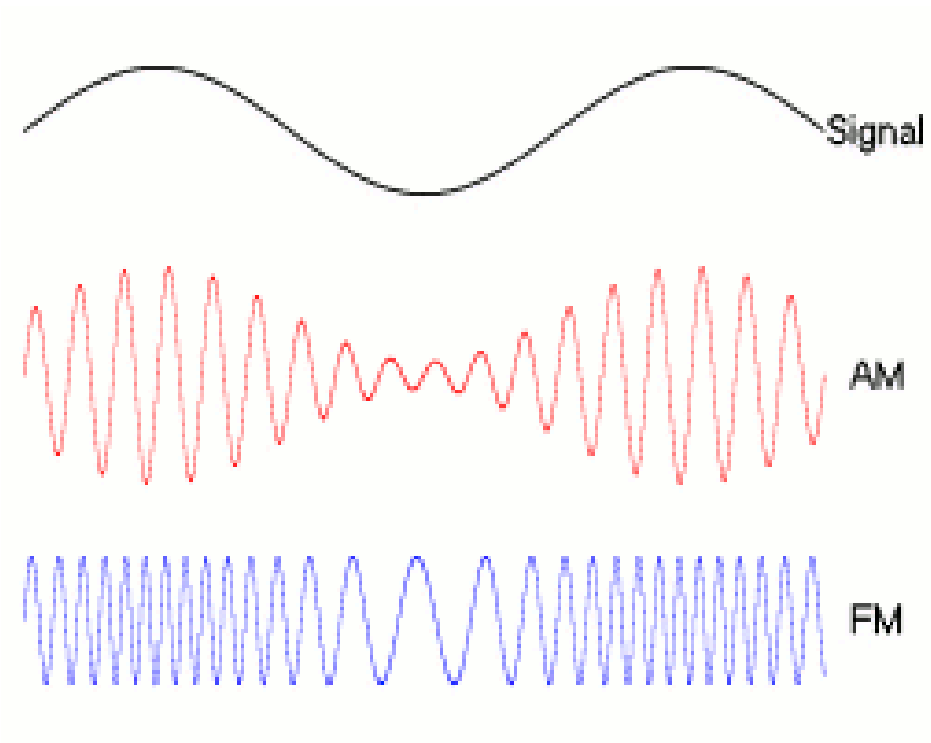


Modulation

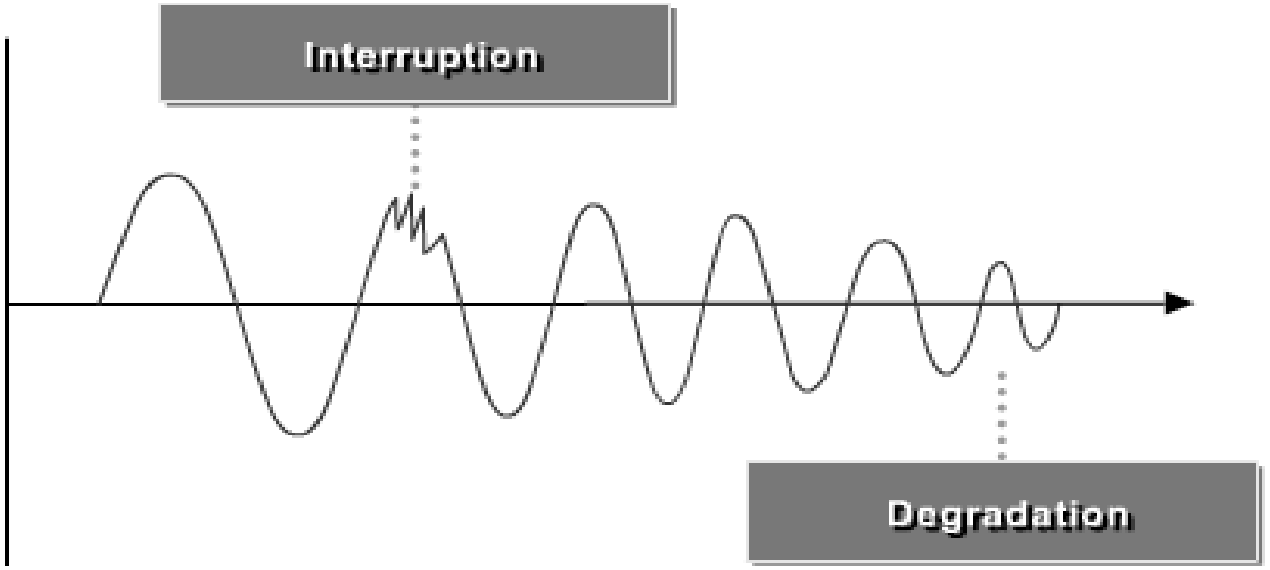
- modulation = adding information (e.g. voice) to a carrier electromagnetic (radio) signal



Frequency Modulation (FM). Amplitude Modulation (AM)



Radio frequency interference



Radio signal attenuation (path loss)