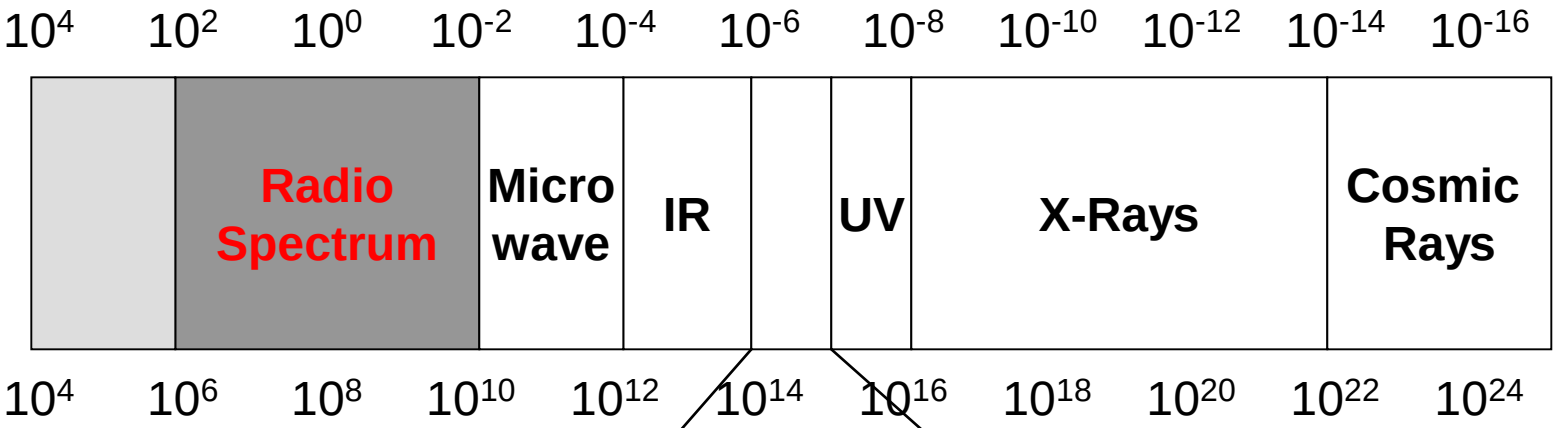
What is Wireless and Mobile Communication?

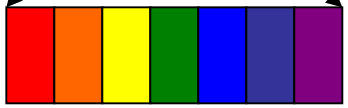
Wireless Communication

- Transmitting voice and data using electromagnetic waves in open space
- 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

Electromagnetic Spectrum



1MHz ==100m
100MHz ==1m
10GHz ==1cm



Visible light

< 30 KHz	VLF
30-300KHz	LF
300KHz – 3MHz	MF
3 MHz – 30MHz	HF
30MHz – 300MHz	VHF
300 MHz – 3GHz	UHF
3-30GHz	SHF
> 30 GHz	EHF

Wavelength of Some Technologies

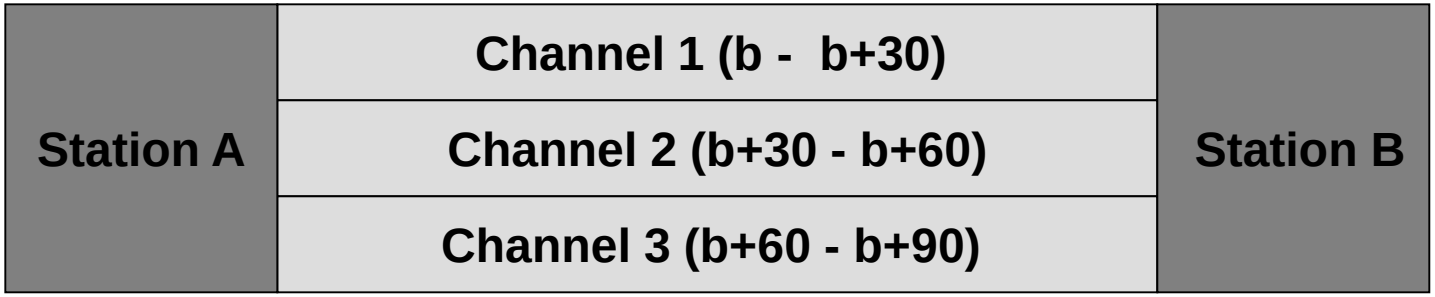
- GSM Phones:
  - frequency ~= 900 Mhz
  - wavelength ~= 33cm
- PCS Phones
  - frequency ~= 1.8 Ghz
  - wavelength ~= 17.5 cm
- Bluetooth:
  - frequency ~= 2.4Gz
  - wavelength ~= 12.5cm

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



Simplex Communication

- Normally, on a channel, a station can transmit only in one way.
  - This is called simplex transmision
- To enable two-way communication (called full-duplex communication)
  - We can use Frequency Division Multiplexing
  - We can use Time Division Multiplexing

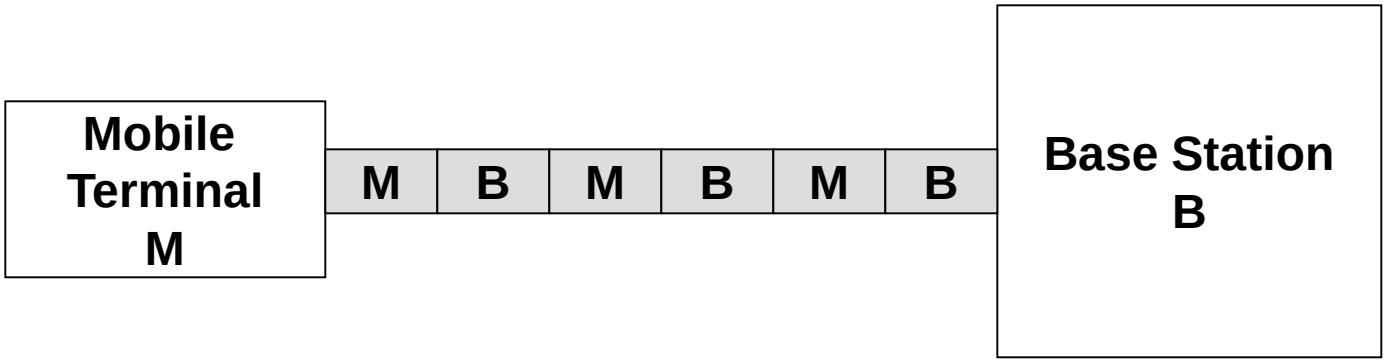
Duplex Communication - FDD

- FDD: Frequency Division Duplex

Forward Channel and Reverse Channel use different frequency bands

Duplex Communication - TDD

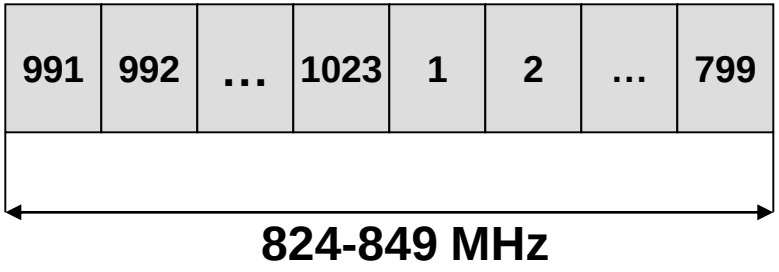
- TDD: Time Division Duplex



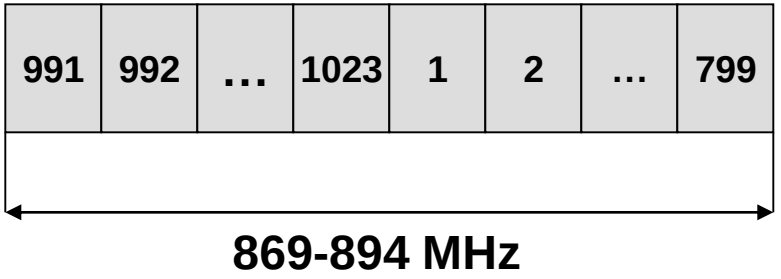
A singe frequency channel is used. The channel is divided into time slots. Mobile station and base station transmits on the time slots alternately.

Example - Frequency Spectrum Allocation in U.S. Cellular Radio Service

Reverse Channel



Forward Channel



Channel Number	Center Frequency (MHz)
Reverse Channel 1 <=N <= 799	0.030N + 825.0
991 <= N <= 1023	0.030(N-1023) + 825.0
Forward Channel 1 <=N <= 799	0.030N + 870.0
991 <= N <= 1023	0.030(N-1023) + 870.0

(Channels 800-990 are unused)

Channel bandwidth is 45 MHz