

What is Wireless Communication?

Transmitting voice and data using electromagnetic waves in open space

Why Wireless?

Freedom from wires

- No cost of installing the wires, No bunches of wires
- running around e.g. Bluetooth , Wi-Fi

Global coverage

- where wires communication is not feasible or costly
- e.g. rural areas, battle field and outer space.

Stay Connected

- Any where any time

Flexibility

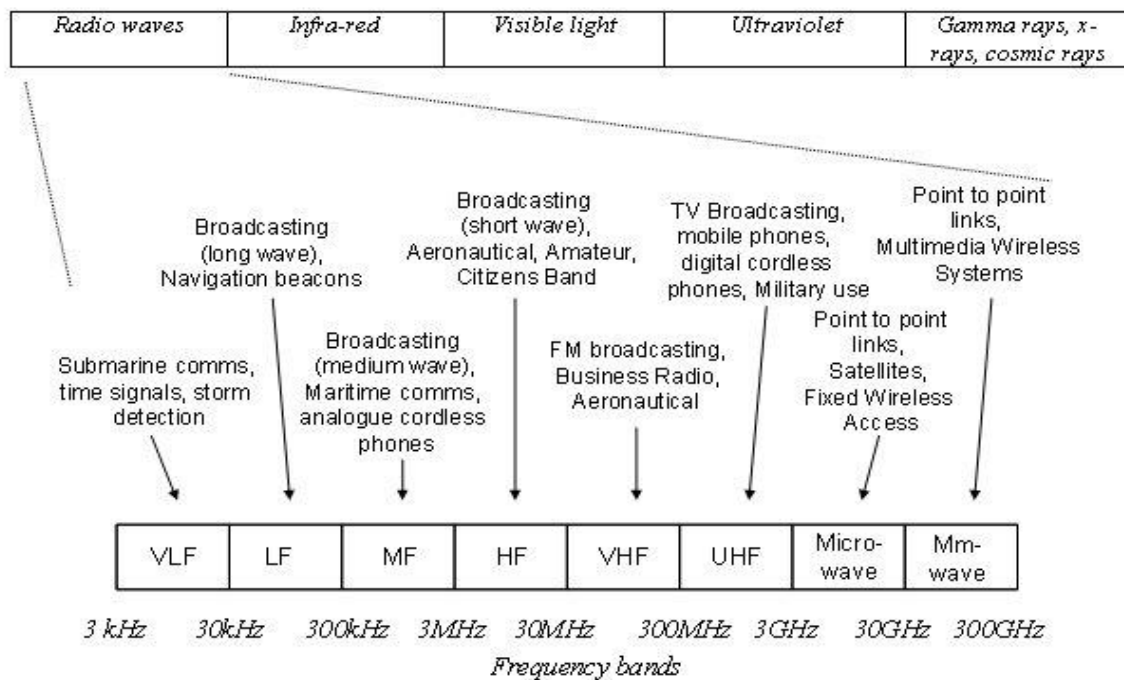
- Connect to multiple devices simultaneously

Wireless History

- Ancient Systems: Smoke Signals, Carrier Pigeons...
- Using light and flags for wireless communication remained important for the navy until radio transmission was introduced. Even today a sailor has to know some codes represented by flags if all other means of wireless communication fail.
- James C Maxwell (1831- 1879) laying the theoretical foundation for EM fields with his famous equations
- Heinrich Hertz (1857- 1894) was the first to demonstrate the wave character of electrical transmission through space (1886).(Note Today the unit Hz reminds us of this discovery).
- Radio invented in the 1880s by Marconi
- The first transatlantic transmission followed in 1901.
- WARC – World Administration Radio Conference took place ,coordinating world wide use of radio frequencies
- The 1st radio broadcast took place in 1906 when Reginald A Fessenden transmitted voice and music for Christmas.
- The invention of electronic vacuum tube in 1906 by Lee De Forest (1873- 1961) &Robert Von Lieben (1878 – 1913)Helped to reduce the size of sender and receiver .
- One of the 1st mobile transmitter was on board at Zeppelin in 1911
- In 1915 , the first wireless voice transmission was set up between New York and San Francisco

- The 1st commercial radio station started in 1920
 - Note Sender & Receiver still needed huge antennas High transmission power.
- In **1926**, the first telephone in a train was available on the Berlin – Hamburg line
- **1928** was the year of many field trials for TV broadcasting. John L Baird (1888 – 1946) transmitted TV across Atlantic and demonstrated color TV
- Until **1932** , all wireless communication used AM which offered relatively poor quality due to interference.
- Invention of FM in 1933 by Edwin H Armstrong [1890 - 1954] .
- Both the modulation schemes are still used for today's radio broadcasting with FM having much better quality.
 - 1946, Public Mobile in 25 US cities, high power transmitter on large tower. Covers distance of 50 Km. Push to talk, uses 120kHz of RF bandwidth. 1950 channels doubled and BW 60k, 1960 4times increase, BW 30kHz
- After 2nd world war (in 1958) ,a network in Germany was built namely the analog A- Netz using a carrier frequency of 160 Mhz.
- Connection setup was only possible from the mobile station and no handover was possible
- 1982: **Groupe Spéciale Mobile** was launched to develop standards for pan-European mobile network
- GSM now stands for **Global System for Mobile Communications**
- 1992 Official commercial launch of GSM in Europe
- 1995 GSM specifications ported to PCS 1900
- 1997 - Wireless LANs
- 1998 - Specification for next generation CDMA starts Qualcomm starts work on wideband CDMA spec.
- 2000 - Bluetooth with 1Mbit/s specification, single cell Later work on 10Mbit/s spec with multi cell capability
- In 2002 Camera phones are first introduced in the U.S. market.
- In 2005 mobile phone subscribers exceed fixed phone subscriber.
- iTunes Application Store (July) and Android Market (October) open in 2008
- In 2010 First 4G handset is introduced at International CTIA WIRELESS show.
- In 2010 Apple introduced the iPad, another revolution in portable “tablet” computing.
- In 2010 FCC proposes National Broadband Plan, recommending 500MHz of spectrum be allocated for commercial use by 2020.
- In 2012 the number of subscriber reaches 1 million.

Electromagnetic Spectrum



Electromagnetic waves:

Travel at speed of light ($c = 3 \times 10^8$ m/s) and 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

Wavelength of Some Technologies

- **GSM Phones:**
 - frequency \approx 900 Mhz
 - wavelength \approx 33cm
- **PCS Phones**
 - frequency \approx 1.8 Ghz
 - wavelength \approx 17.5 cm
- **Bluetooth:**
 - frequency \approx 2.4Gz
 - wavelength \approx 12.5cm
 - Federal Communications Commission(FCC)
 - PTA

Frequency Carriers/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.

Wireless Communication System Examples

- Cellular Telephony
- Wide Area Wireless Data Systems
- High Speed Local and Personal Area Networks
- Paging Messaging Systems
- Satellite Based Mobile System

Wireless System Definitions**Mobile Switching Center**

Switching center which coordinates the routing of calls in a large service area. In a cellular radio system, the MSC connections the cellular base stations and the mobiles to the PSTN (telephone network). It is also called Mobile Telephone Switching Office (MTSO)

Subscriber

A user who pays subscription charges for using a mobile communication system

Transceiver

A device capable of simultaneously transmitting and receiving radio signals

Control Channel

Radio channel used for transmission of call setup, call request, call initiation and other beacon and control purposes.

Forward Channel

Radio channel used for transmission of information from the base station to the mobile

Reverse Channel

Radio channel used for transmission of information from mobile to base station

Simplex System

Communication systems which provide only one-way communication

Examples include Pagers

Half Duplex Systems

Communication Systems which allow two-way communication by using the same radio channel for both transmission and reception. At any given time, the user can either transmit or receive information.

Push-to-talk and release-to-listen systems

Full Duplex Systems

Communication systems which allow simultaneous two-way communication. Transmission and reception is typically on two different channels (FDD).

Handoff

The process of transferring a mobile station from one channel or base station to another.

Roamer

A mobile station which operates in a service area (market) other than that from which service has been subscribed.

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A brief message which is broadcast over the entire service area, usually in simulcast fashion by many base stations at the same time.

Cellular Telephony

It is characterized by

- High mobility provision
- Wide-range
- Two-way voice communication
- Handoff and roaming support
- Integrated with sophisticated public switched telephone network (PSTN)
- When mobile is turned on and not engaged in a call monitors the control channel for strongest BS.

Cellular Telephony Systems

- Mobile users and handsets
Very complex circuitry and design
- Base stations
Provides gateway functionality between wireless and wire line links
- Mobile switching centers
Connect cellular system to the terrestrial telephone network

Cellular Networks

- First Generation
 - Analog Systems
 - Analog Modulation, mostly FM
 - AMPS
 - Voice Traffic
 - FDMA/FDD multiple access
- Second Generation (2G)
 - Digital Systems
 - Digital Modulation
 - Voice Traffic
 - TDMA/FDD and CDMA/FDD multiple access
- 2.5G
 - Digital Systems
 - Voice + Low-datarate Data
- Third Generation
 - Digital
 - Voice + Highdatarate DATA
 - Multimedia Transmission also