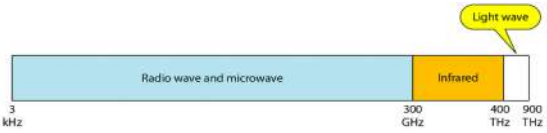
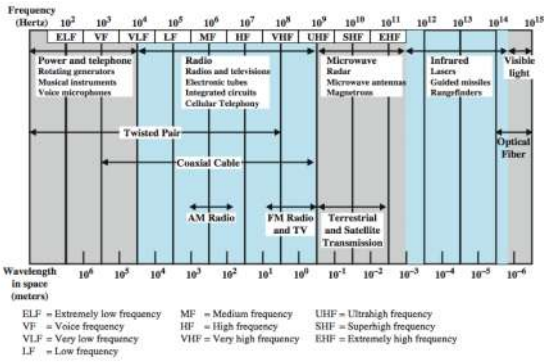
Unguided Media

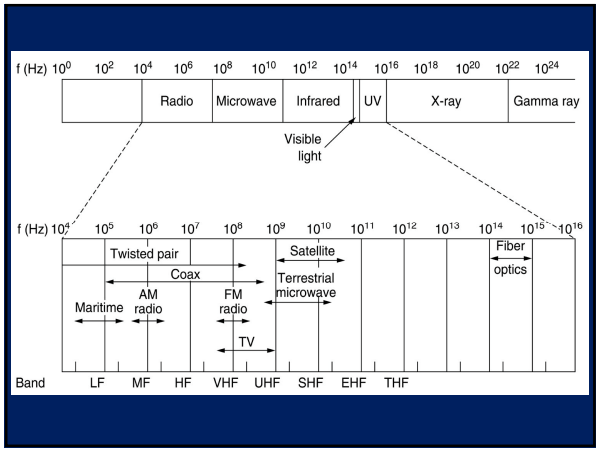
Unguided Media

- Unguided media **transport electromagnetic waves** without using a physical conductor.
- This type of communication is often referred to as **wireless communication**.
- Signals are **normally broadcast** through **free space** and thus are available to anyone who has a device capable of receiving them.



Electromagnetic Spectrum





Band	*Range*	*Propagation*	*Application*
VLF (very low frequency)	3-30 kHz	Ground	Long-range radio navigation
LF (low frequency)	30-300 kHz	Ground	Radio beacons and navigational locators
MF (middle frequency)	300 kHz-3 MHz	Sky	AM radio
HF (high frequency)	3-30 MHz	Sky	Citizens band (CB), ship/aircraft communication
VHF (very high frequency)	30-300 MHz	Sky and line-of-sight	VHF TV, FM radio
UHF (ultrahigh frequency)	300 MHz-3 GHz	Line-of-sight	UHF TV, cellular phones, paging, satellite
SHF (superhigh frequency)	3-30 GHz	Line-of-sight	Satellite communication
EHF (extremely high frequency)	30-300 GHz	Line-of-sight	Radar, satellite

Propagation Methods

- Unguided signals can travel from the source to destination in several ways:
- **Ground propagation**,
- **Sky-Propagation**, and
- **Line-of-Sight Propagation**

Propagation Methods

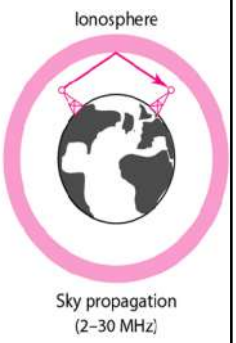
1. Ground propagation mode:

- Radio waves **travel close to the earth**.
- These **low-frequency signals** proceed in all directions from the transmitting antenna and follow the **curvature of the planet**.
- **Distance** depends on the amount of **power in the signal**: The greater the power, the greater the distance.

Propagation Methods

2. Sky propagation mode:

- In this **higher-frequency radio waves** radiate upward into the ionosphere where **they are reflected back** to earth.
- Ionosphere is the layer of atmosphere where **particles exist as ions**.
- This type of transmission allows for **greater distances with lower output power**.



Propagation Methods

3. Line-of-sight propagation mode:

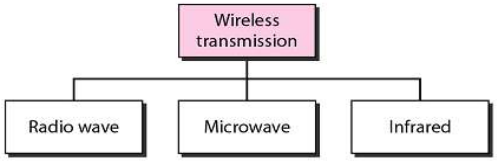
- In this, **very high-frequency** signals are transmitted **in straight lines** directly from **antenna to antenna**.
- Antennas must be **directional**, facing each other and tall enough
- Line-of-sight propagation **is tricky** because radio transmissions cannot be completely focused.

Wireless (Unguided Media) Transmission

- Transmission and reception are achieved by means of an antenna
- **Directional**
  - Transmitting antenna puts out **focused beam**
  - **Transmitter and receiver must be aligned**
- **Omnidirectional**
  - Signal spreads out in **all directions.**
  - Can be **received by many antennas**

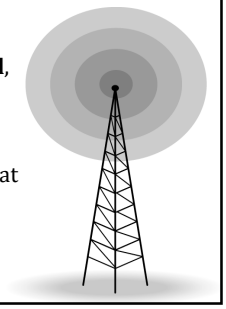
Classification of Wireless Media

- Wireless communication may be via:
  - **Radio frequency** communication
  - **Microwave** communication
  - **Infrared** short range communication



Radio Wave Transmission

- Electromagnetic waves ranging in frequency between **3 kHz and 1 GHz** are normally called radio waves.
- Radio waves, are **omnidirectional**, they are **propagated in all directions**.
- A sending antenna sends waves that can be received by **any receiving antenna**.



Radio Wave Transmission

- Radio waves, particularly of **low and medium frequencies**, **can penetrate walls**.
- It is an **advantage** because, an **AM radio** can receive signals **inside a building**.
- It is a **disadvantage** because we **cannot isolate** a communication to just **inside or outside a building**.

Radio Wave Transmission

- The omnidirectional property has a disadvantage.
  - The radio waves transmitted by **one antenna are susceptible to interference by another antenna** that may send signals using the **same frequency or band**.
- Radio waves, propagate in the sky mode, can **travel long distances**.

Radio Wave Transmission

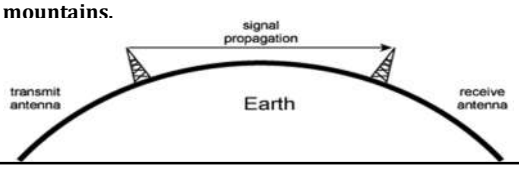
- **Applications**
- The omnidirectional characteristics of radio waves make them useful for **multicasting**, in which there is **one sender but many receivers**.
- **AM and FM radio**,
- **Television**,
- **Maritime radio**,
- **Cordless phones**, and **paging**.

Microwave Transmission

- Electromagnetic waves having frequencies between **1GHz and 300 GHz** are called microwaves.
- Microwaves are **unidirectional**.
- When an antenna transmits microwave waves, they can be **narrowly focused**.
- This means that the **sending and receiving antennas need to be aligned**.
- The unidirectional property has an obvious advantage.
  - A pair of antennas can be aligned without interfering with another pair of aligned antennas.

Microwave Transmission

- **Line-of-sight transmission**.
- This means that microwaves must be transmitted in a **straight line** and that **no obstructions** can exists, such as **buildings or mountains**, between microwave stations.
- To avoid possible obstructions, microwave antennas often are positioned on the **tops of buildings**, **towers**, or **mountains**.

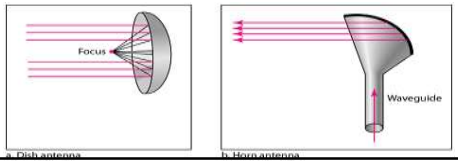


Microwave Transmission

- **Characteristics of microwave propagation**:
- Microwave propagation is **line-of-sight**.
  - Towers that are far apart need to be very tall.
  - Repeaters are often needed for long distance communication.
- Very high-frequency microwaves **cannot penetrate walls**.
  - disadvantage if receivers are inside buildings.
- The **microwave band is relatively wide**, almost **299 GHz**.
  - Therefore wider sub bands, and a **high data rate is possible**.
- Use of certain portions of the band requires permission from authorities.

Microwave Transmission

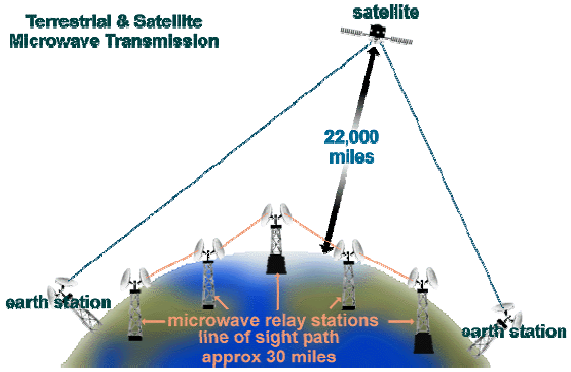
- **A parabolic dish antenna:**
  - Every signal that hits a dish reflects off the curve at angles such that all the lines intersect in a common point called the **focus**.
  - In this way, more of the signal is recovered than would be possible with a single-point receiver.
- **Horn Antenna:**
  - Outgoing transmissions are broadcast through a horn aimed at the dish.
  - The microwaves hit the dish and are deflected outward in a reversal of the receipt path.



Microwave Transmission

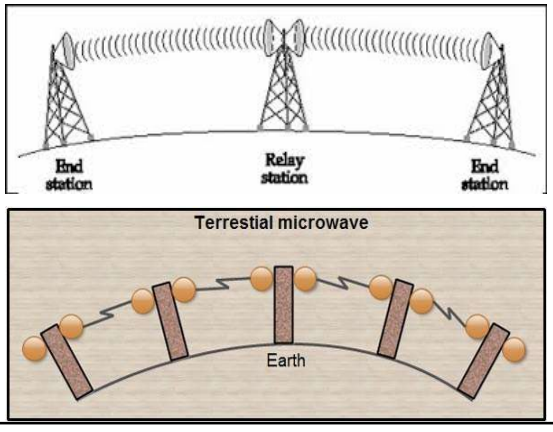
- **Applications :**
- Microwaves, due to their unidirectional properties, are very useful when unicast (one-to-one)communication is needed between the sender and the receiver.
- They are used in
  - **Cellular phones,**
  - **Televisions**
  - **Satellite networks, and**
  - **wireless LANs.**

Types of Microwave Systems



A. Terrestrial Microwave

- Used for **long-distance telephone service.**
- Uses radio frequency spectrum, from **2 to 40 GHz**.
- Parabolic dish transmitter, mounted high.
- Requires **unobstructed line of sight** between source and receiver
- Curvature of the earth requires stations (**repeaters**) 30 miles apart



- **Advantages:**
  - Effect of noise is reduced because of repeaters.
  - Maintenance is less as compared to cable.
  - No interference with other transmission channels.
- **Disadvantages:**
  - Communication can be affected because of atmospheric phenomenon and passing airplanes and rain
  - Line of sight requirement
  - Expensive towers and repeaters.

Applications

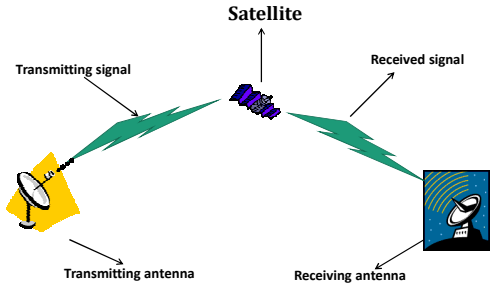
- Long-distance telecommunication service
  - requires **fewer amplifiers or repeaters** than coaxial cable
  - Example
    - telephone system
    - TV distribution
- Short point-to-point links
  - Data link between local area network
  - Closed-Circuit TV

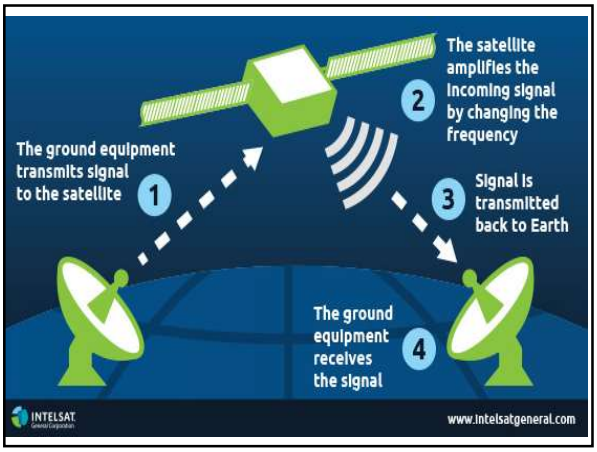
Satellite

- **A Satellite is a solid object which revolves around earth due to the effect of gravitational forces**

OR

- **A satellite is an object which has been placed into orbit by human endeavor.**
- **Types**
  - **I. Natural satellites**
  - **II. artificial satellites**



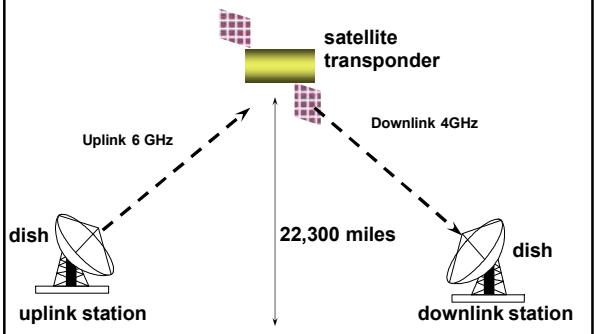


Satellite Communication

- In satellite communication,
  - signal transfer is done with the help of **satellite**.
- In this,

1. The signal, a beam of **modulated microwaves** is sent towards the satellite called **UPLINK (6 Ghz).**
2. Then the satellite processes the signal and send it back to the receiver's antenna present on the earth's surface called as **DOWNLINK (4Ghz).**

Satellite Communication



Satellite Communication

- The satellite has to **receive**, **process** and **transmit** the signal.
- All these functions are performed by a unit called as **Satellite Transponder**.
- The communication satellite has two sets of transponders.
- Each set having **12 transponders**.
- Each transponder has a bandwidth of 36MHz.

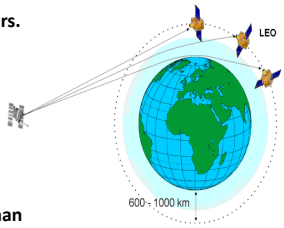
Satellite Communication

- Types of Satellite by there purpose
  - **Communication** Satellite
  - **Weather** satellite
  - **Remote- Sensing** Satellite
  - **Scientific** Satellite

Satellite Communication

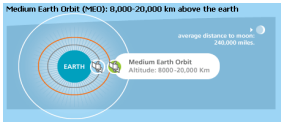
Low-Earth-Orbit (LEO)

- **Altitude (375-1000 miles)**
- **Revolution time: 90 min - 3 hours.**
- **Advantages:**
  - **Reduces transmission delay**
  - **Eliminates need for bulky receiving equipment.**
- **Disadvantages:**
  - **Smaller coverage area.**
  - **Shorter life span (5-8 yrs.) than GEOs (10 yrs).**



Satellite Communication

Middle-Earth-Orbiting (MEO)

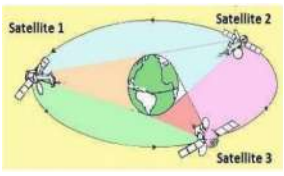


- MEOs orbits between the altitudes of **8000-20,000 Km**.
- These satellites cover the North and South Pole.
- MEOs are placed in an **elliptical (oval-shaped) orbit**.
- Approximately a **dozen medium Earth orbiting** satellites are necessary to provide continuous global coverage 24 hours a day.

Satellite Communication

Geostationary Earth Orbit (GEO)

- These satellites are in **orbit 35,863 km** above the earth's surface along the equator.
- Objects in Geostationary orbit revolve around the earth at **the same speed as the earth** rotates.
- This means GEO satellites **remain in the same position relative to the surface of earth**.



EACH SATELLITE COVER 40%AREA

Principal Satellite Transmission Bands

- **C band:**
  - **4(downlink) - 6(uplink) GHz**
  - the first to be designated
- **Ku band:**
  - **12(downlink) -14(uplink) GHz**
  - rain interference is the major problem
- **Ka band:**
  - **19(downlink) - 29(uplink) GHz**
  - equipment needed to use the band is still very expensive

Applications of satellite

- **Television** distribution
  - A network provides programming from a central location
  - Direct broadcast satellite (DBS)
- Long-distance **telephone** transmission
  - High-usage international trunks
- Private business networks
- **Military** Applications
- Other applications
  - **digital** cinema
  - Satellite **radio**
  - Satellite **internet access**

Infrared

- Infrared waves, with frequencies from **300 GHz to 400 THz** (wavelengths from **1 mm to 770 nm**),
- Used for **short-range communication**.
- Infrared waves, having high frequencies, **cannot penetrate walls**.
- This characteristic **prevents interference between one system and another**;
- a short-range communication system in one room cannot be affected by another system in the next room.

Infrared

- The **remote controls** used for televisions, VCRs, and stereos all use infrared communication.
- They are relatively directional, cheap, and easy to build.

- **Applications**
  - TV Remote control
  - Guidance in weapon system
  - Wireless keyboards and mouse.

Multiple Access Methods

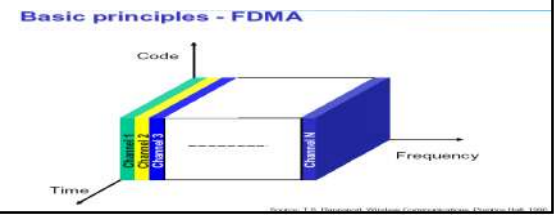
- In wireless communications, it is necessary to utilize limited frequency bands at the same time, allowing multiple users to share radio channel simultaneously.
- System employs different carrier frequency – FDMA system.
- System uses distinct time – TDMA system.
- System uses different code – CDMA system.

Multiple Access Methods

- Satellite Communication is based on Modulation Technique.
- Three Multiple Access Methods used by Satellite are:
  - **Frequency Division Multiple Access (FDMA)**
  - **Time Division Multiple Access (TDMA)**
  - **Code Division Multiple Access (CDMA)**

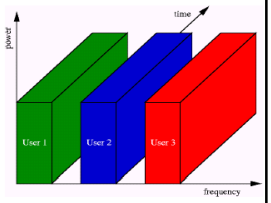
FDMA

- Simplest
- Best suited for analog links.
- Each station has its own frequency band, separated by guard bands.
- Receivers tune to the right frequency.

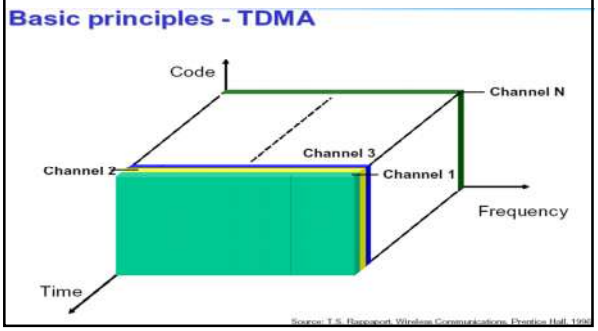


FDMA

- Individual channels are assigned to individual users for the time of an ongoing communication
- Inefficient if customer does not use the channel (voice call)
- In case of FDD a pair of frequencies is formed to a channel
- No equalization needed (symbol time > delay spread)
- No synchronization and framing bits are needed as in TDMA systems
- Continuous transmission
- AMPS first analog cellular system in the US uses FDMA/FDD

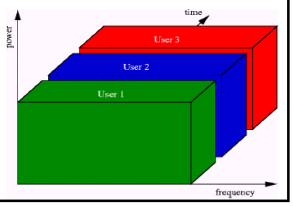


TDMA

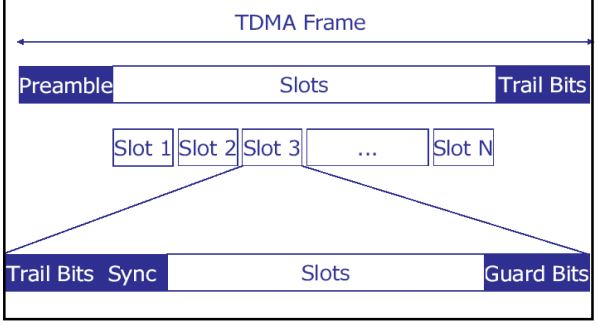


TDMA

- Spectrum is divided into time slots, where only one user is allowed to send per slot
- Cyclic usage of the slots (1, N+1, N+2, etc), N slots per frame
- Each frame and slot starts with preamble containing synchronization information
- Non-continuous transmission
- Guard times needed
- Data transmission in bursts result in low battery consumption
- Multiple slots per user possible
- Easy handoff because of idle times



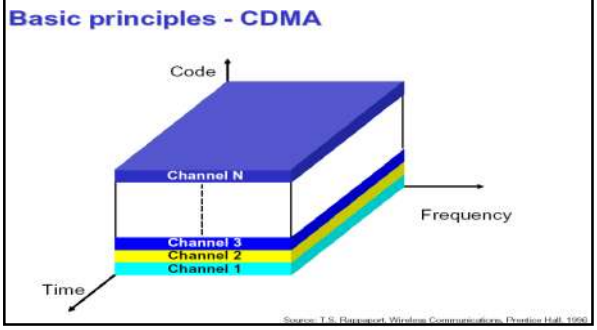
TDMA



TDMA

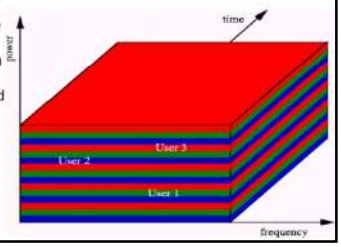
- All stations transmit data **on same frequency**, but at **different times**
- Needs **time synchronization**
- **Pros**
  - users can be given different amounts of bandwidth
  - mobiles can use idle times to determine best base station
  - can switch off power when not transmitting
- Cons
  - synchronization overhead
  - greater problems with multipath interference on wireless links

CDMA



CDMA

- The user's signal is spread by an unique sequence
- All user share the same bandwidth with different sequences
- A communication is identify by the sequence
- Sender and receiver know the sequence in advance
- Other ongoing communication appears to be noise
- Power control needed to avoid near far effect
- Soft capacity limit
- Multi-path is reduced due to spreading sequence



CDMA

- Users separated both by time and frequency
- Send at a different frequency at each time slot (*frequency hopping*)
- Or, convert a single bit to a code (*direct sequence*)
  - receiver can decipher bit by inverse process
- **Pros**
  - hard to spy
  - immune from narrowband noise
  - no need for all stations to synchronize
  - no hard limit on capacity of a cell
  - all cells can use all frequencies

CDMA

- **Cons**
  - Implementation complexity
  - Need for power control
    - to avoid capture
  - Need for a large contiguous frequency band (for direct sequence)
  - Problems installing in the field