CS6504

Mobile Computing

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Wireless Transmission, Cellular Telephony, and Satellite Networks

Outline

- Wireless transmission
- Cellular Systems
- Satellite Networks

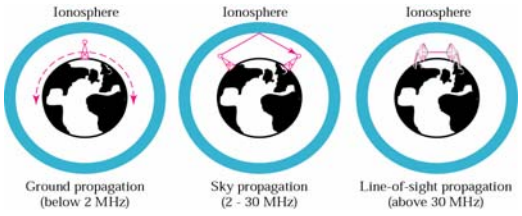
based on material from

Behrouz Forouzan, *Data Communications and Networking*, 3rd Ed, McGraw-Hill, 2004

Wireless Transmission 1/6

- When electrons move, they create electromagnetic waves that can propagate through free space
- Number of oscillations per second of an electromagnetic wave is called ***frequency*** and measured in **Hz** (Hertz)
- Distance between 2 consecutive maxima (or minima) is called the wavelength (λ)
- Electromagnetic spectrum
  - ➢3 KHz – 300 GHz Radio wave and microwave
  - ➢300 GHz – 400 THz Infrared

Wireless Transmission 2/6



Unguided Signals Propagation

Wireless Transmission 3/6

Section of electromagnetic spectrum defined as radio waves and microwaves is divided into 8 ranges called ***bands*** (regulated by government authorities)

VLF	3-30KHz	Long range radio navigation
LF	30-300KHz	Radio beacons
MF	300KHz-3MHz	AM radio
HF	3-30MHz	ship/aircraft communication
VHF	30-300MHz	VHF TV, FM radio
UHF	300MHz-3GHz	UHF T, cellular phones, paging, satellite
SHF	3-30GHz	satellite communication
EHF	30-300GHz	radar, satellite

Wireless Transmission 4/6

Radio waves

- Usually from 3KHz to 1 GHz
- Omnidirectional (propagated in all directions)
  - Sending and receiving antennas do not have to be aligned
  - Susceptible to interference by another antenna using the same frequency or band
- Useful for multicasting communication such as radio and television, and paging systems

Wireless Transmission 5/6

Microwaves

- from 1GHz to 300 GHz
- unidirectional
  - Sending and receiving antennas need to be aligned
  - Not susceptible to interference since sending and receiving antennas can be aligned
- Microwave propagation is line-of-sight (repeaters needed for long distances)
- Useful for unicast communication such as cellular telephones, satellite networks, and wireless LANs.

Wireless Transmission 6/6

Infrared

- Used for short range communication
- Have high frequencies, cannot penetrate walls (advantage?)
- Infrared remote control, wireless keyboard, wireless mouse (manufacturers provide IrDA port)

Cellular Telephony 1/6

•Communications between 2 moving units (Mobile stations (MS)), or between a mobile unit and a stationary unit

•Service provider

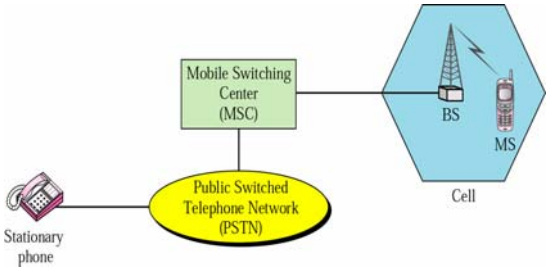
- ➢Locate and track a caller
- ➢Assign a channel to the call
- ➢Transfer the channel from BS to BS as the caller moves out of range

•Cellular service area divided into *cells*.

•Each cell contains an antenna and controlled by a BS

•Each BS in turn is controlled by a switching office called a *mobile switching center* (MSC)

Cellular Telephony 2/6



Cellular System

Cellular Telephony 3/6

•Cell size is not fixed and can be increased or decreased depending on population

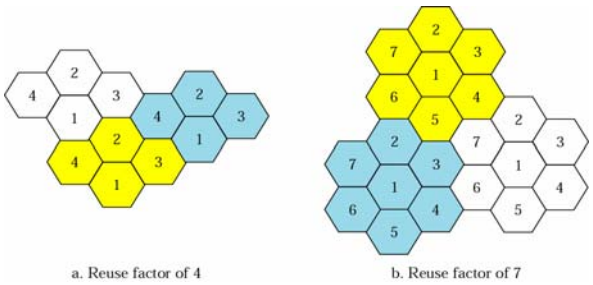
•Typical radius of a cell is 1 to 12 miles

•Neighboring cells cannot use the same set of frequencies for communication because it may create interference for the users located near the cell boundaries

•Set of frequencies available are limited → *frequency reuse*

- ➢A frequency reuse pattern is a configuration of *N* cells, (*N* is the reuse factor) in which each cell uses a unique set of frequencies
- ➢When pattern repeated, frequencies can be reused

Cellular Telephony 4/6



Frequency Reuse Patterns

Cellular Telephony 5/6

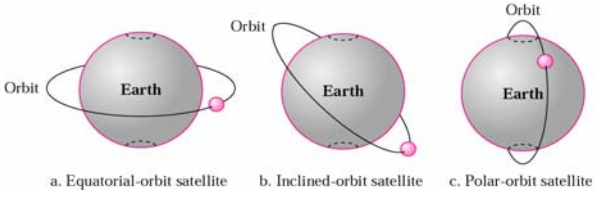
- To place a call to a stationary unit
  - Caller enters a phone number and presses the send button
  - MS scans the band, seeking a setup channel with a strong signal, sending the phone number to the closest BS using that channel
  - The BS relays the data to MSC
  - The MSC sends the data to the central telephone office
  - If the called party is available, a connection is made and the result is relayed back to MSC
  - MSC assigns an unused voice channel to the call, and a connection is established
  - MS automatically adjusts its tuning to the new channel

Cellular Telephony 6/6

- Receiving a call
  - Telephone central office sends the number to MSC
  - MSC searches for location of MS by using paging (query signals to each cell)
  - Once found, MSC transmits a ringing signal
  - When MS answers, a voice channel is assigned to the call
- Hard and soft handoff
- Roaming

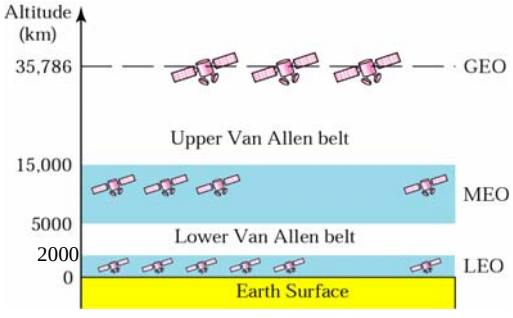
Satellite Networks 1/6

- Combination of nodes that provides communication from one point on the earth to another (a node can be a satellite, an earth station, or end-user terminal or telephone)
- Satellite's orbit: path in which it travels around the earth (equatorial, inclined, or polar)



Satellite Networks 2/6

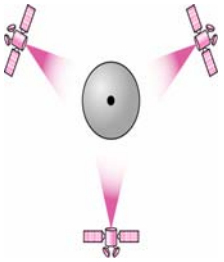
- Satellite categories: GEO, LEO, and MEO



Satellite Networks 3/6

Geosynchronous Satellites (GEO)

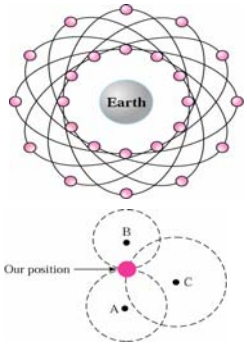
- Line-of-sight propagation necessitates that sending and receiving antennas be locked onto each other's location
- For constant communication, satellite must move at same speed as the earth (seems fixed above a certain spot) → geosynchronous
- One geosynchronous satellite cannot cover the whole earth (curvature of earth a problem)



Satellite Networks 4/6

Medium-Earth Orbit (MEO)

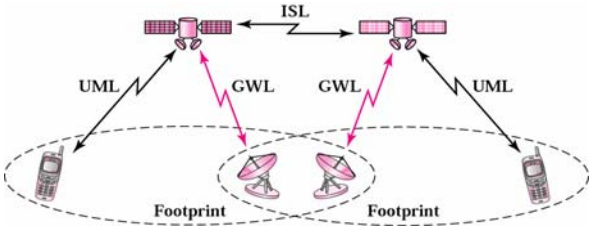
- Takes approx. 6 hours to circle earth
- Example is GPS (18,000 km above earth)
- Based on *triangulation* principle
- Uses 24 satellites in 6 orbits
- 4 satellites visible from any point on earth (Why 4?)



Satellite Networks 5/6

Low-Earth Orbit Satellites (LEO)

- Have polar orbits, close to earth, RTT propagation delay < 20 ms
- 3 categories: little LEOs (low data rate messaging), big LEOs, and broadband LEOs (communication similar to fiber-optic networks)



Satellite Networks 6/6

Low-Earth Orbit Satellites (LEO)

- Sample LEO systems
  - ➢ Iridium (66 satellites)
    - ✓ direct worldwide communication using handheld terminals
    - ✓ 2.4 to 4.8 Kbps voice and data transmission
  - ➢ Globalstar (48 satellites)
  - ➢ Teledesic (Broadband Internet access for users, nicknamed Internet in the Sky. Target 288 satellites)
- For more information http://www.spaceandtech.com/spacedata/constellations/constellations.shtml