Computer Networks: Physical Layer

By,

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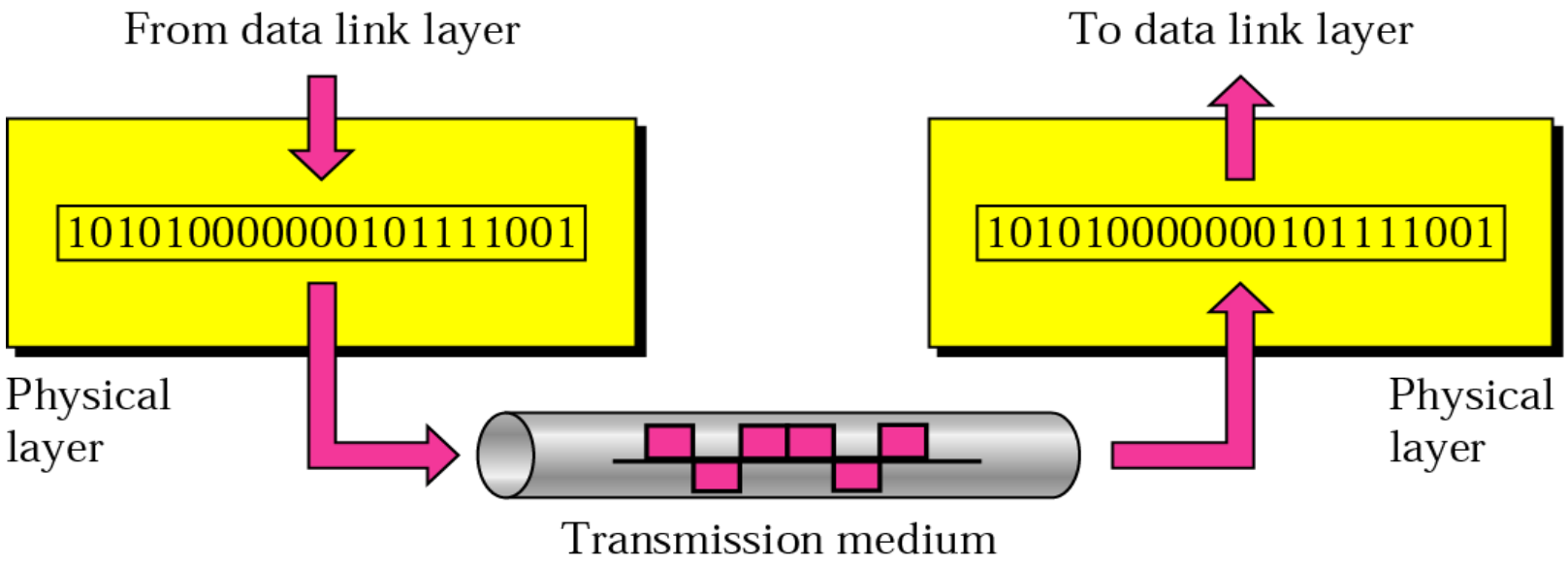
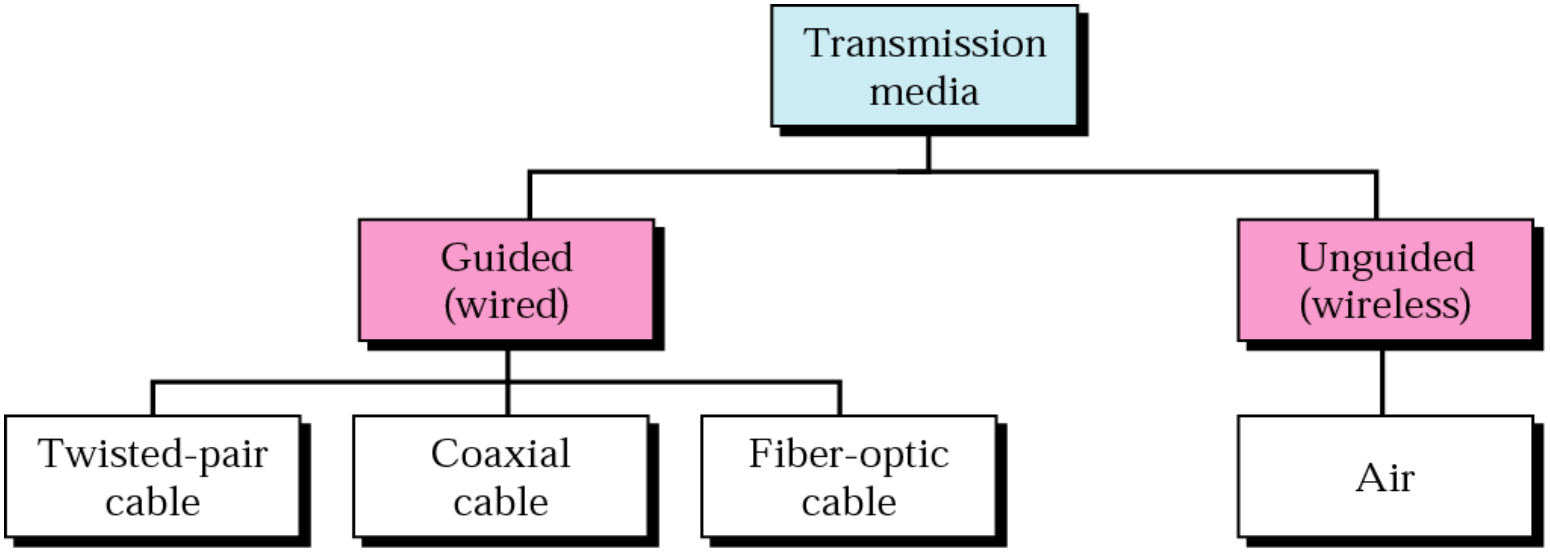
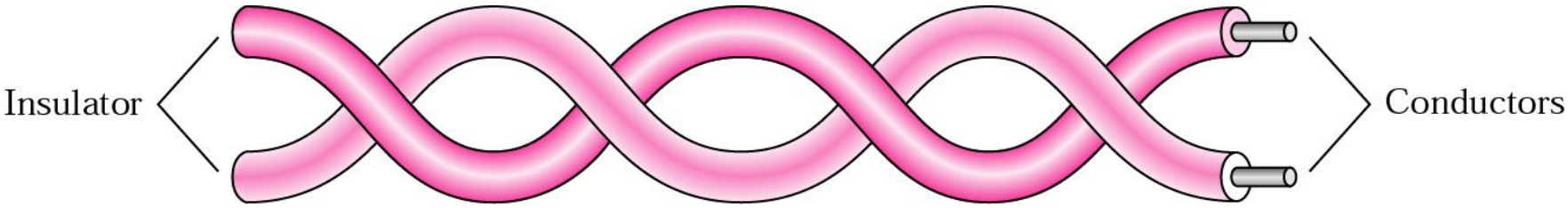
OSI Layers : Physical Layer



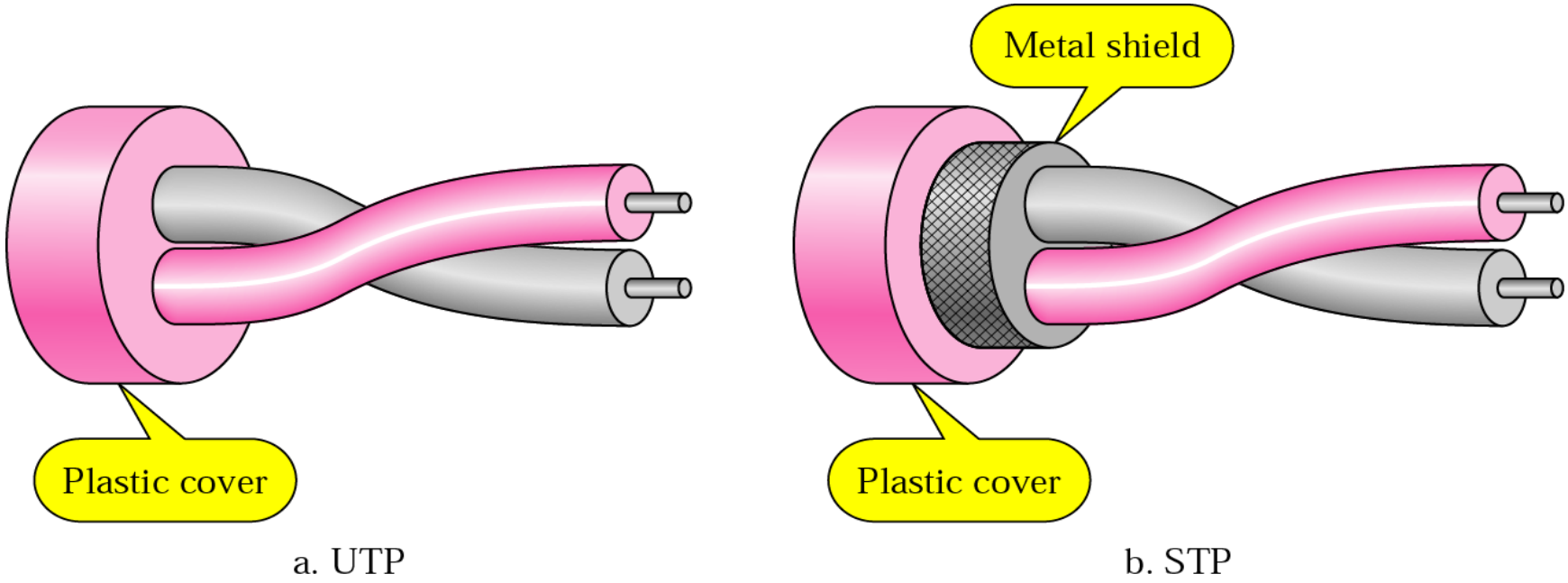
Transmission Media : Classes ??



Transmission Media : Twisted Pair Cable



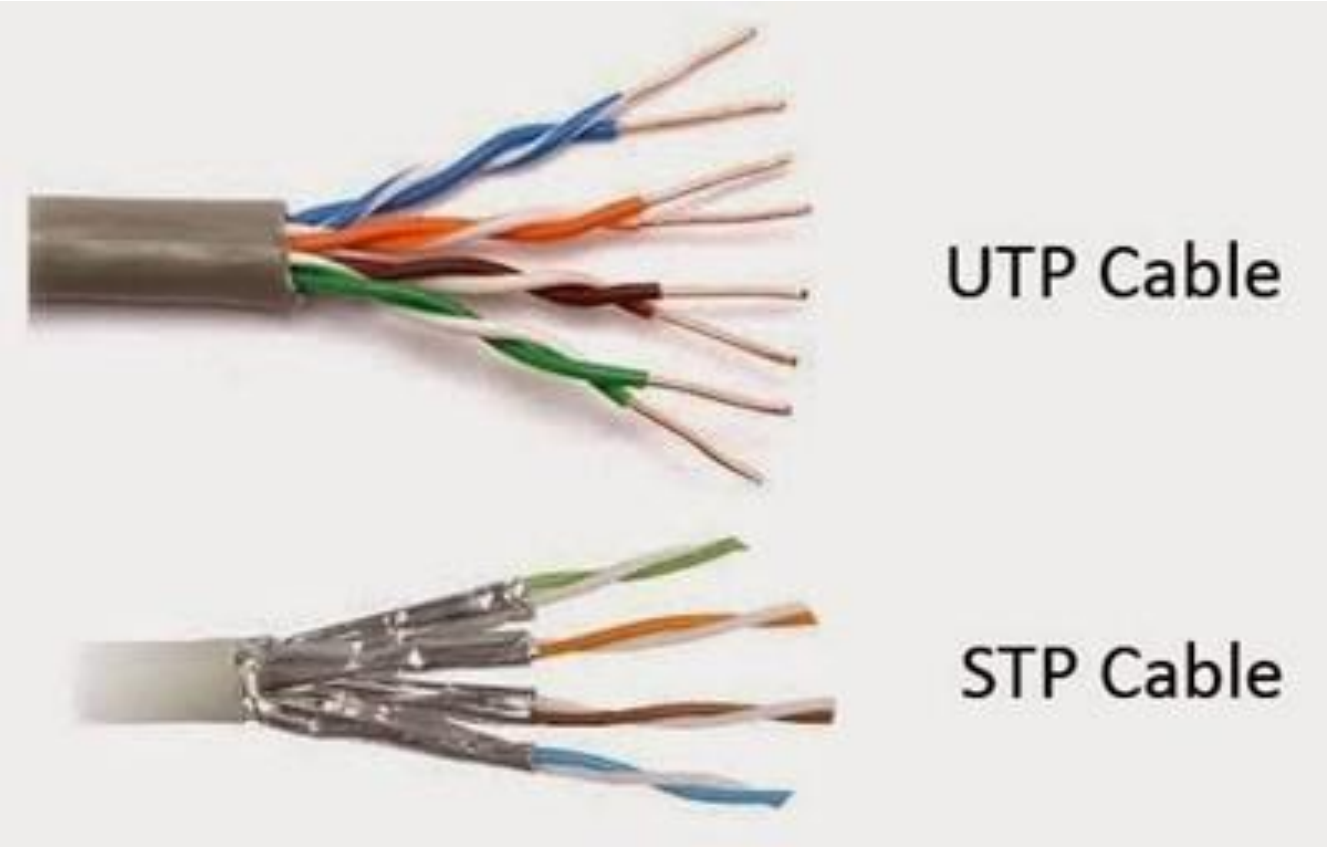
Twisted Pair Cable : STP and UTP



a. UTP

b. STP

Twisted Pair Cable : STP and UTP



Twisted Pair : Applications ??

- Most Common Medium.
- For Local Area Networks (LAN).
- Telephone Networks
  - Between House and Local Exchange (Subscriber Loop).
- Within Buildings
  - To Private Branch Exchange (PBX).
- Cable Connectors => RJ45 and RJ11.

Twisted Pair : UTP Categories

Category	Bandwidth	Data Rate	Digital/Analog	Use
1	Very Low	<100 Kbps	Analog	Telephone
2	< 2MHz	2Mbps	Analog/Digital	T-1 Lines
3	16 MHz	10 Mbps	Digital	LANs.
4	20 MHz	20 Mbps	Digital	LANs.
5	100 MHz	100 Mbps	Digital	LANs.
6	200 MHz	1000 Mbps	Digital	LANs

Twisted Pair : Latest Cables

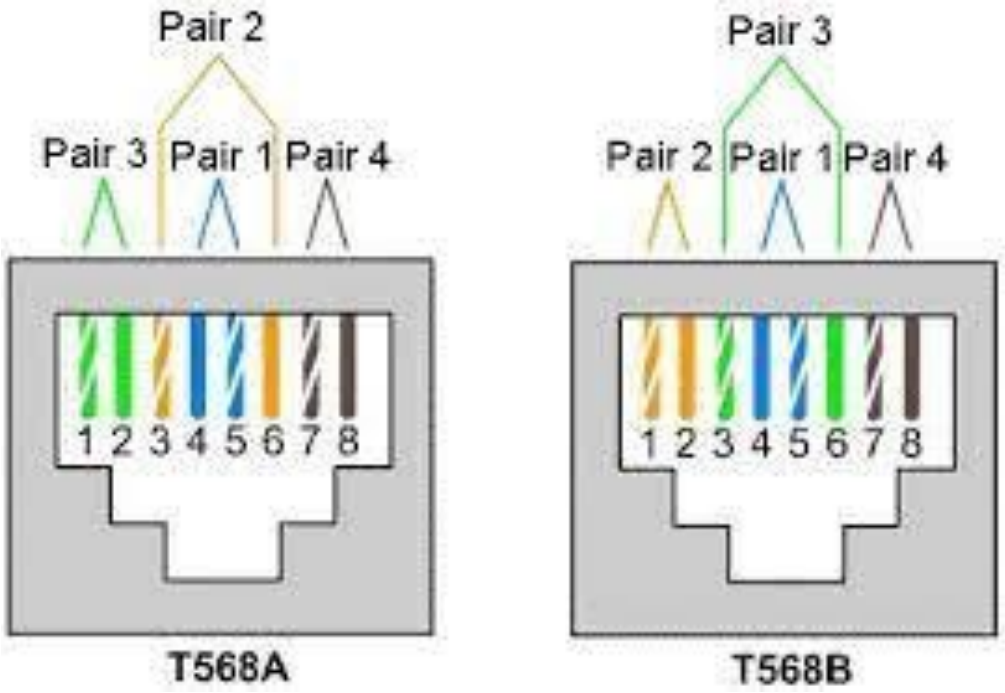
Cat6

Cat6a

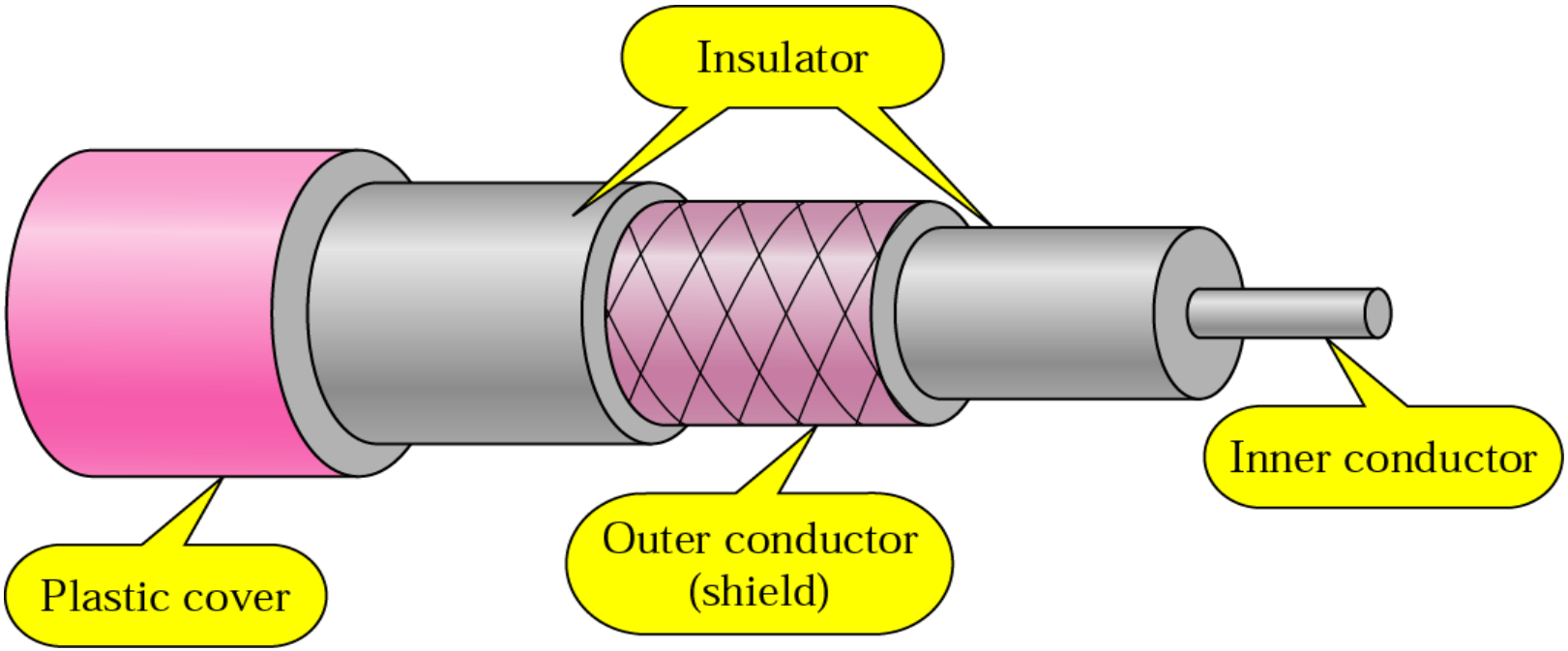
Cat7

Twisted Pair : Cable Connectors ??

Twisted Pair : T568A and T568B Standards



Coaxial Cable : Structure ?



Coaxial Cable : Applications ??

- Cable Television Distribution.
- Long Distance Telephone Transmission.
  - Can Carry 10,000 Voice Calls Simultaneously.
- Traditional LAN => Diskless Workstation in Novell Netware.
- Being Replaced by Optical Fibers.
- Baseband Cable and Broadband Cable

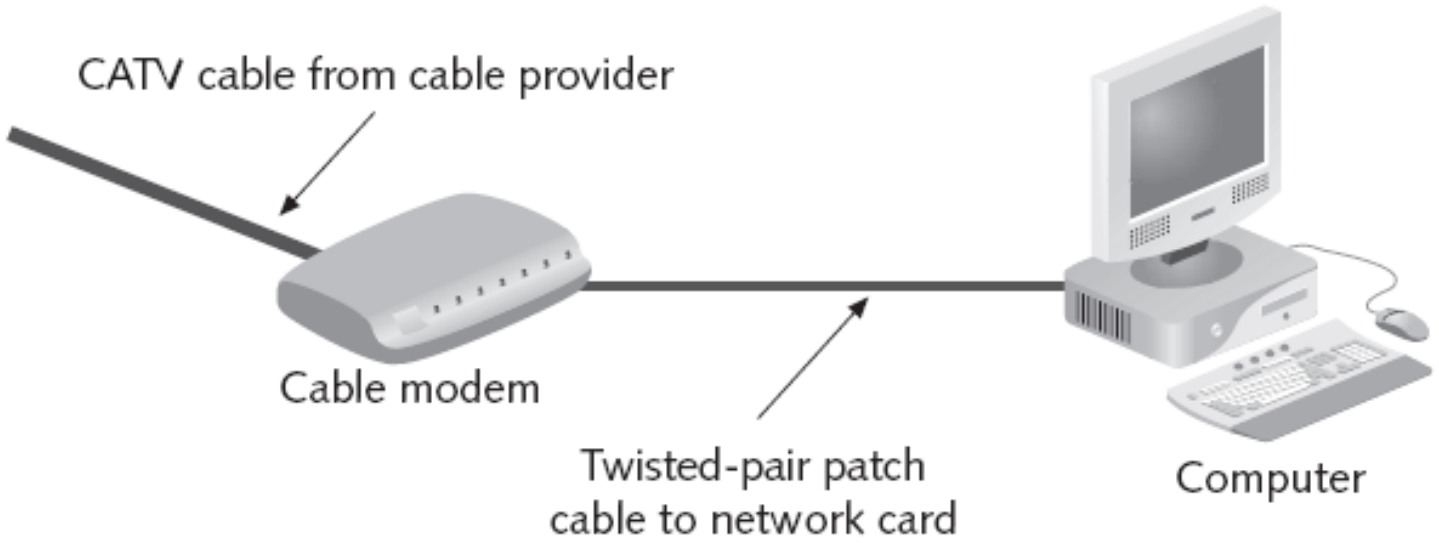
Coaxial Cable : Baseband Cable

- Carries Single Signal at a Fixed Frequency.
- It is used for Digital Transmission.
- Uses Digital Signaling Technique.
- It is used for Small Area.
- 10 Base 5 Cable => Distance up to 500m.
- Repeaters Can be used to deal with attenuation.

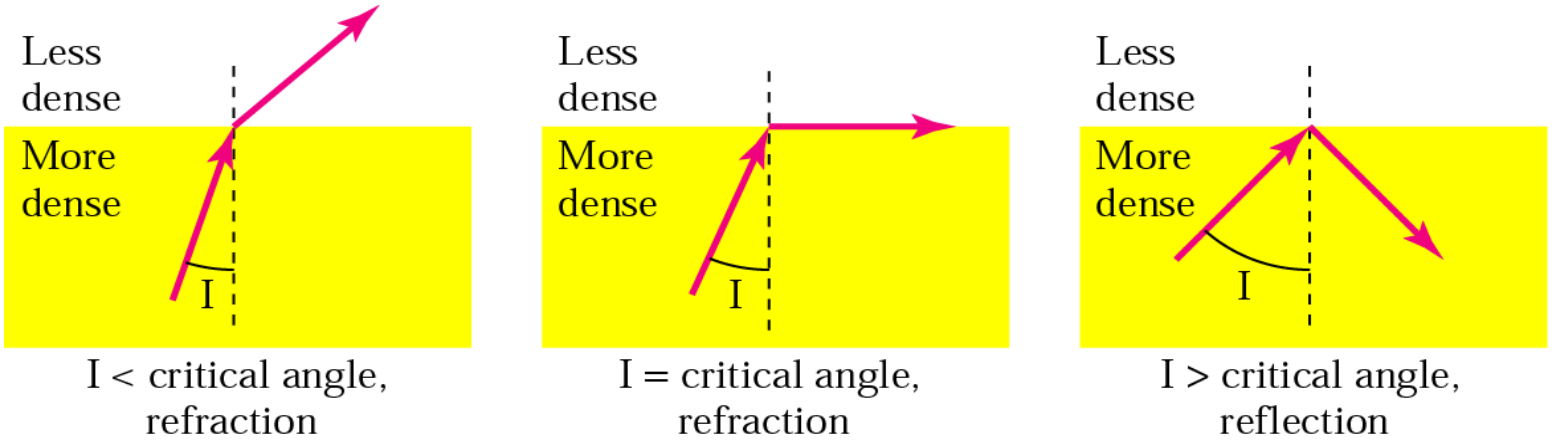
Coaxial Cable : Broadband Cable

- Carries Multiple Signals => Multiplexing.
- It is used for Analog Transmission.
- Uses Analog Signaling Technique.
- It is used for Large Area => Cable Television
- Amplifiers Can be used to deal with attenuation.

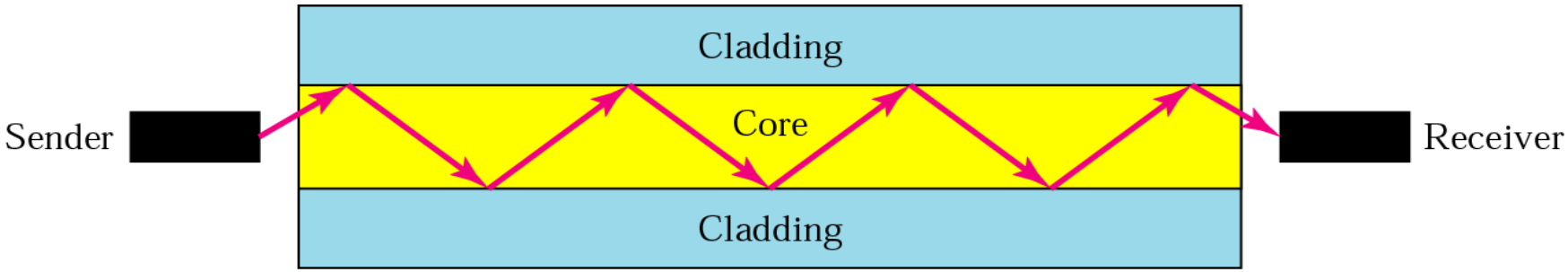
Coaxial Cable : Applications



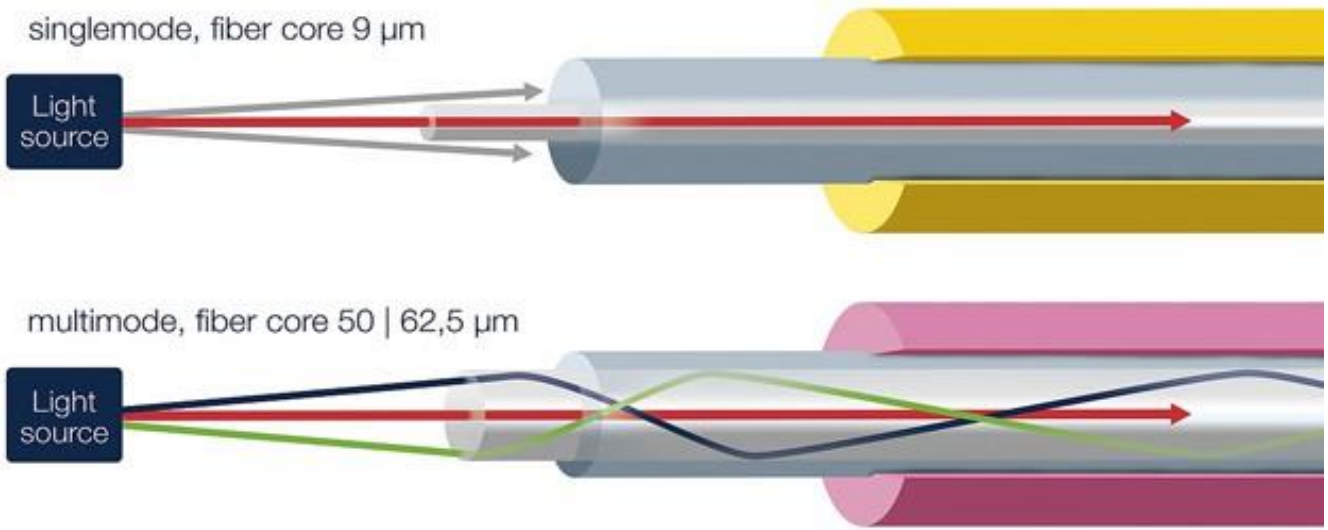
Optical Fiber : Bending of Light Ray



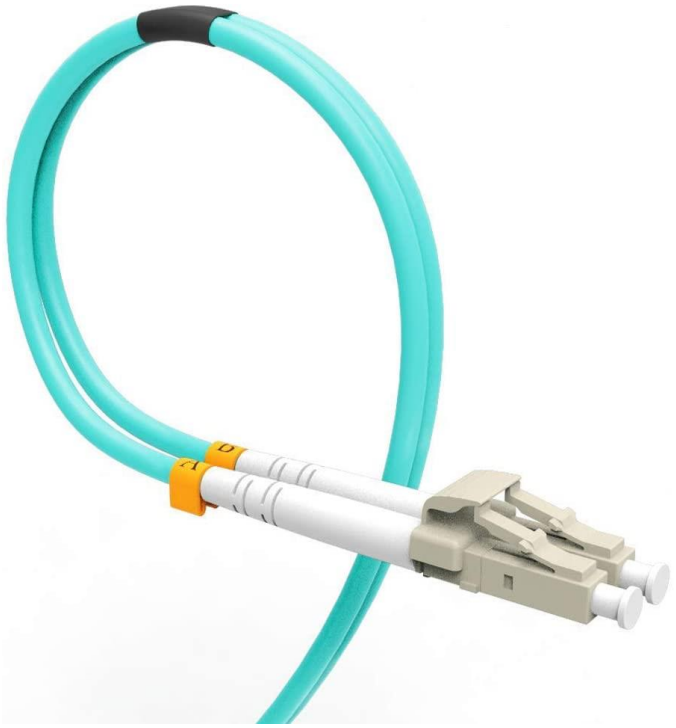
Optical Fiber : Structure ?



Optical Fiber: Types ?



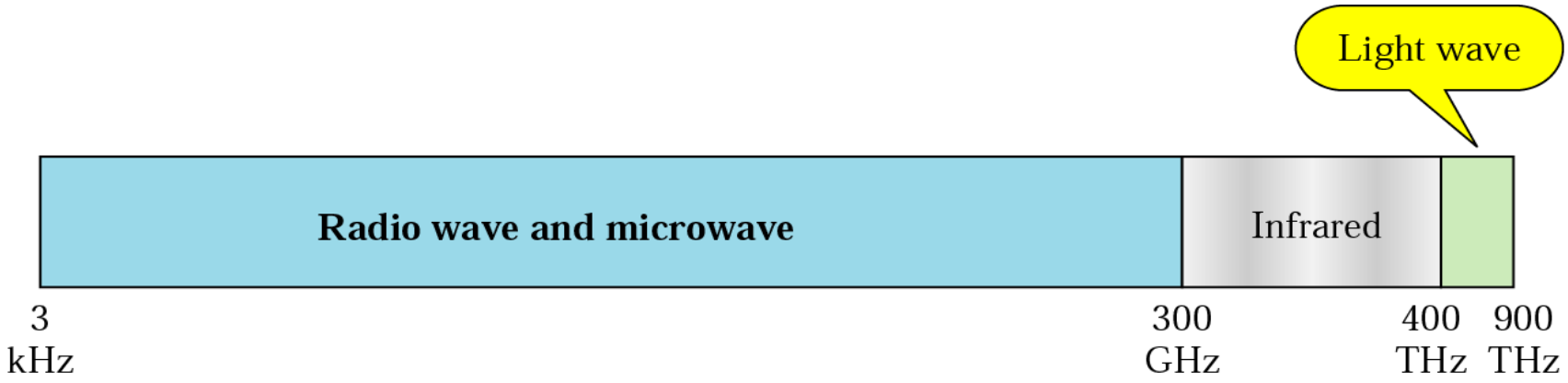
Optical Fiber: Patch Cables ??



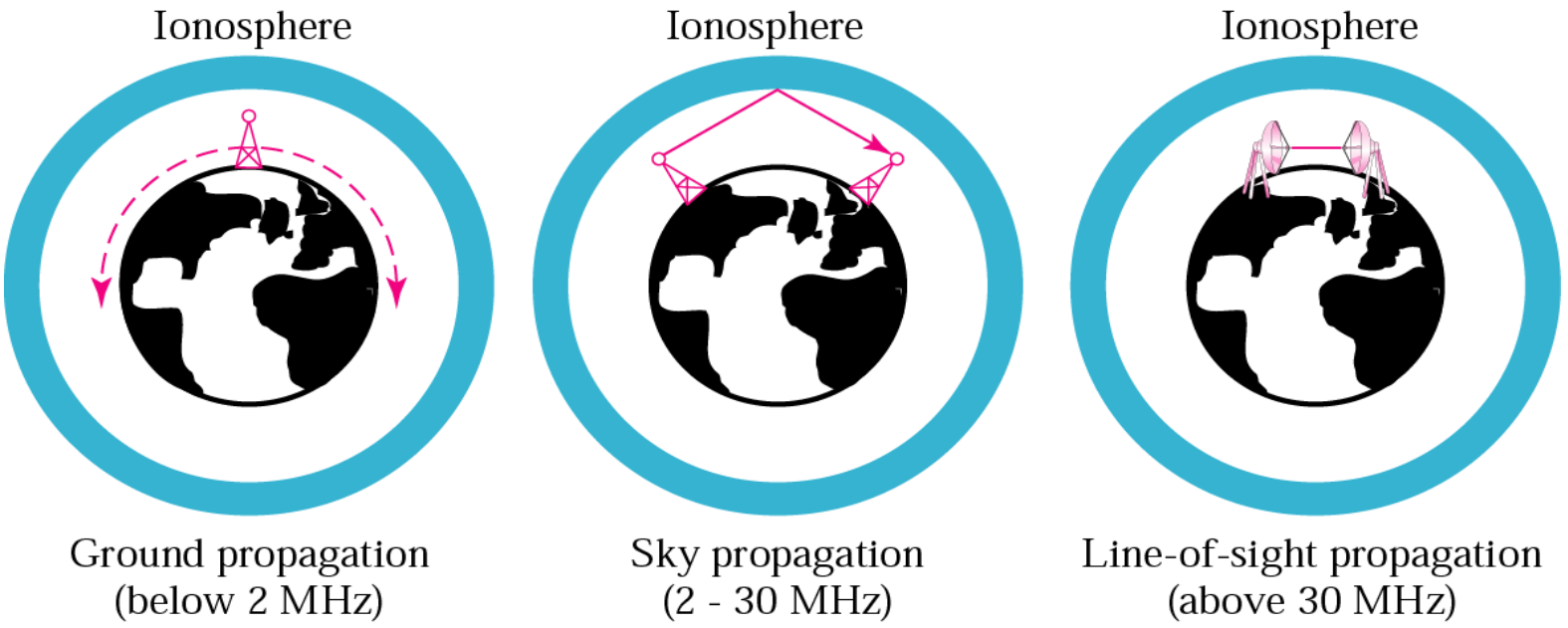
Optical Fiber : Benefits ??

- Supports Higher Data Rate => Up to Tera Bits Per Second (Tbps)
- Smaller Size and Weight.
- Lower Attenuation
- Electromagnetic Isolation
- Greater Repeater Spacing

Electromagnetic Spectrum: Wireless Communication



Propagation Methods ??



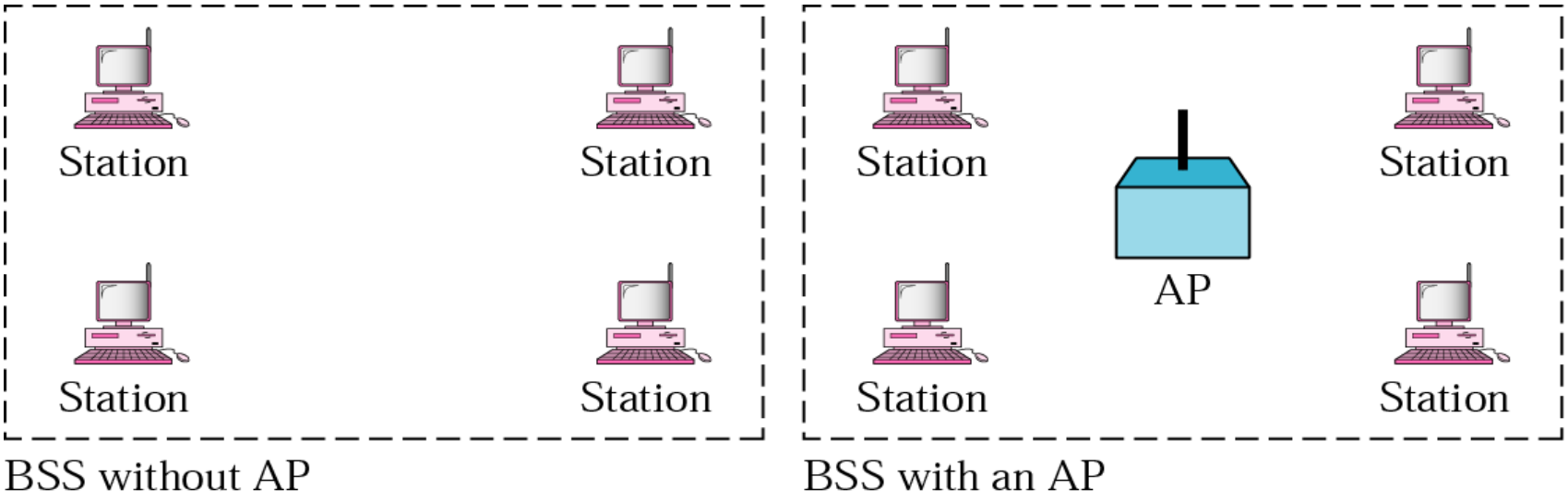
Wireless LANs: Architecture

- Wireless Communication is one of the growing Technologies.
- Found everywhere => Home, Office Buildings, Campuses.

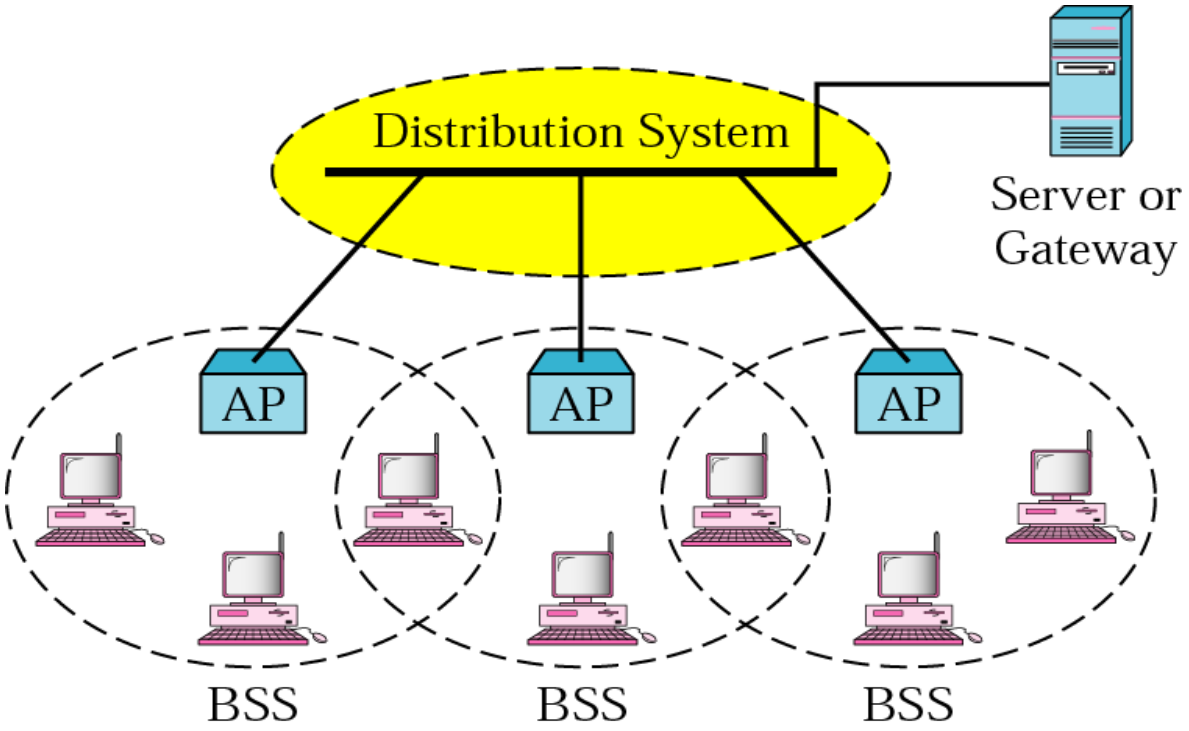
- Promising Wireless LAN Technologies
  - IEEE 802.11 Wireless LAN
  - Bluetooth

- IEEE 802.11 Wireless LAN is also referred as Wireless Ethernet.
- A Bluetooth LAN is an ad hoc Network.
- The gadgets find each other and make a network called Piconet.
- Bluetooth is defined by the IEEE 802.15 Standard.
- It defines Wireless PAN operable in an area of room or a hall.

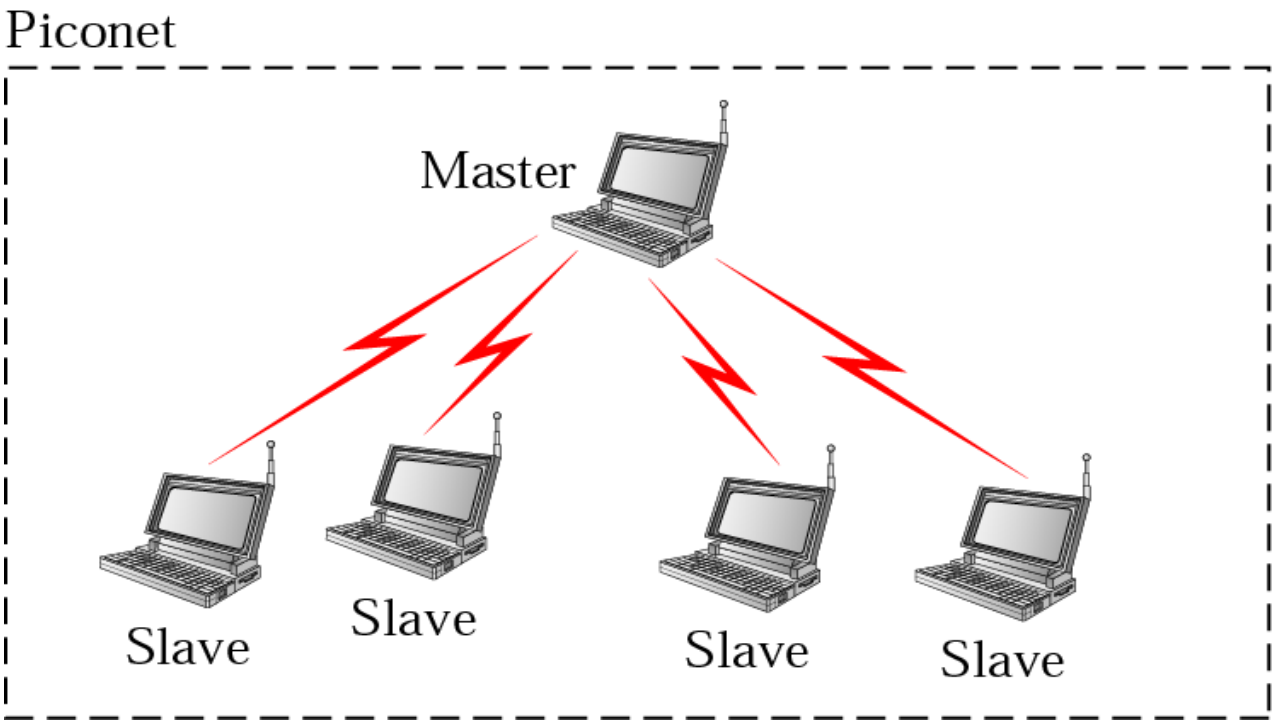
Wireless LANs: Basic Service Set



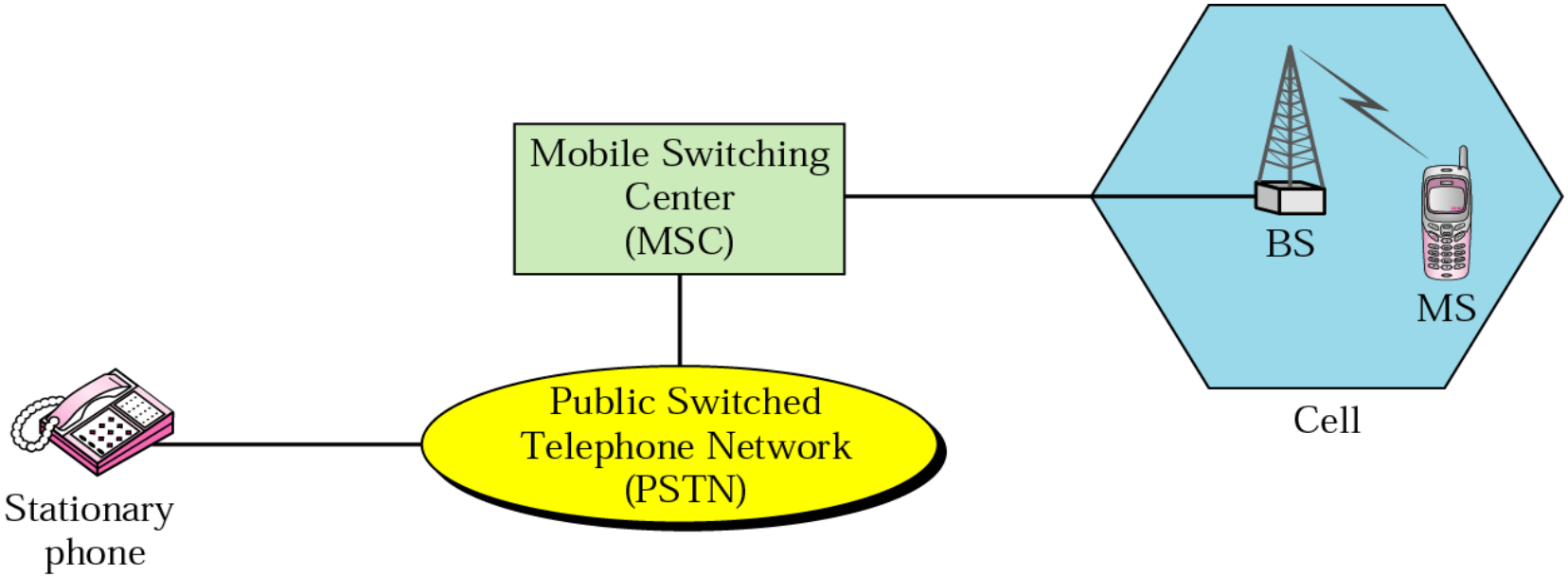
Wireless LANs: Extended Service Set



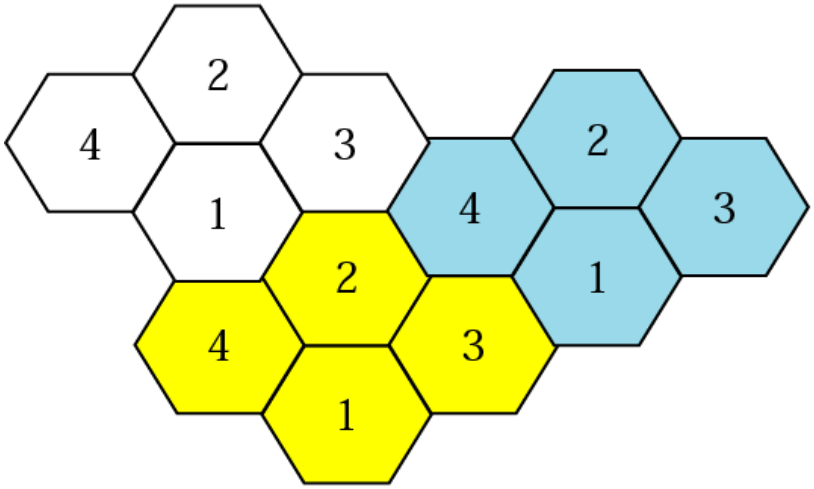
Bluetooth: Piconet



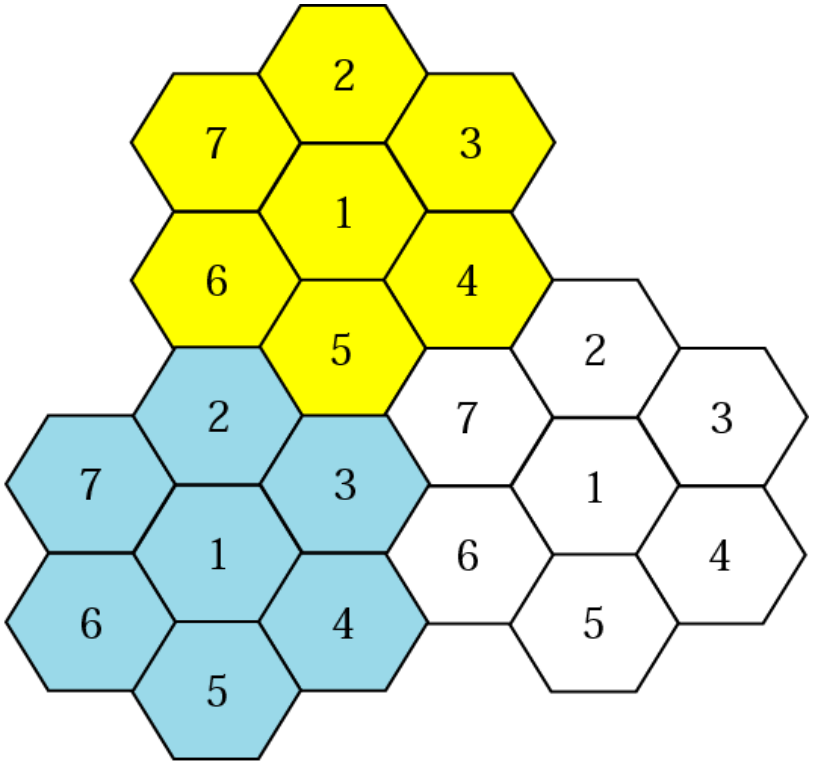
Cellular system



Frequency reuse patterns

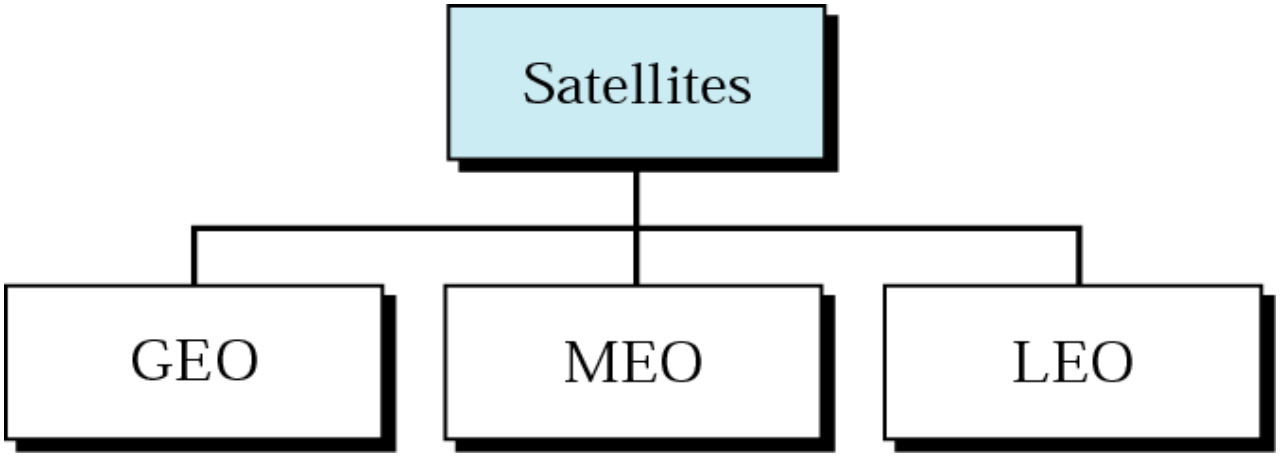


a. Reuse factor of 4

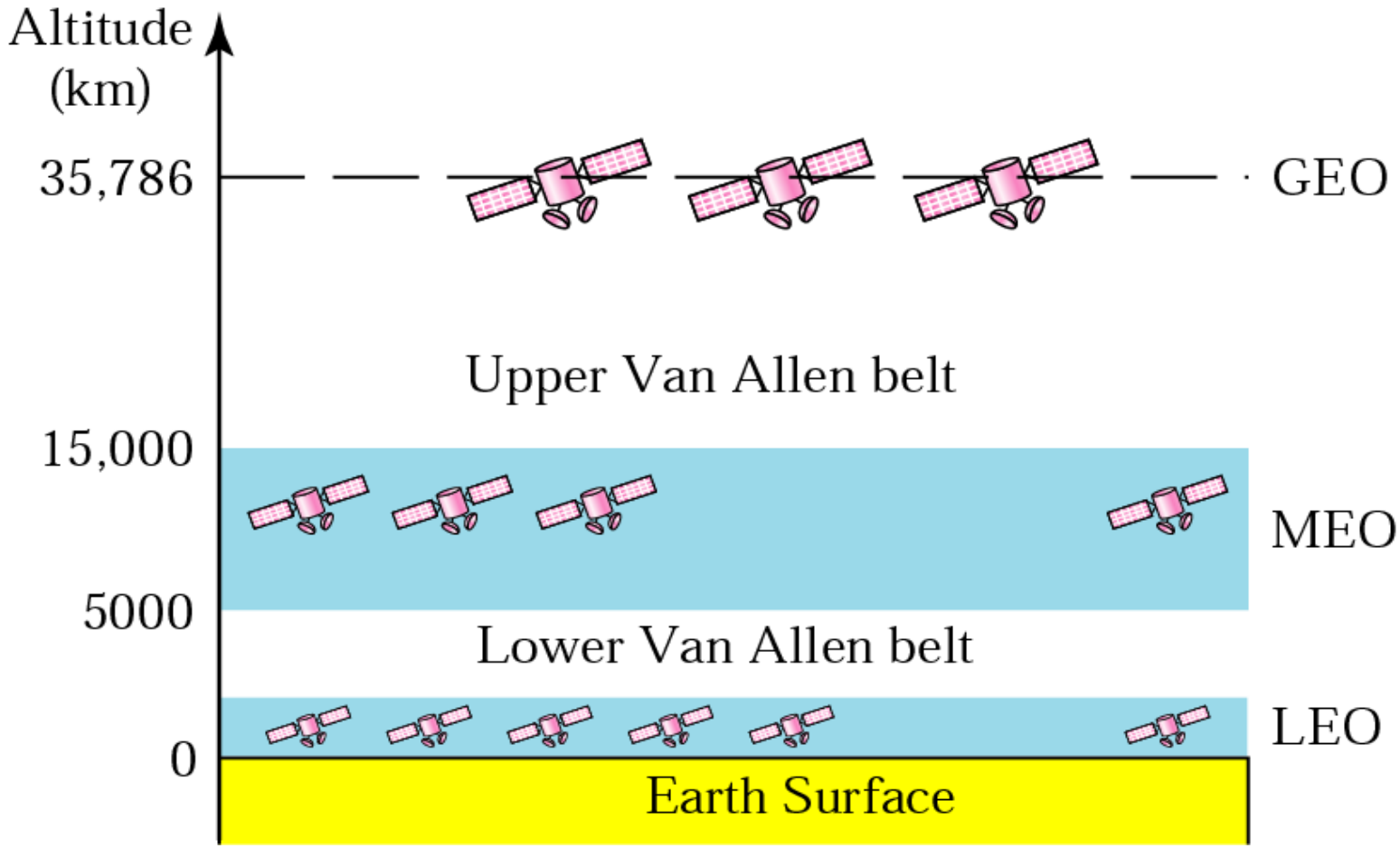


b. Reuse factor of 7

Satellite categories



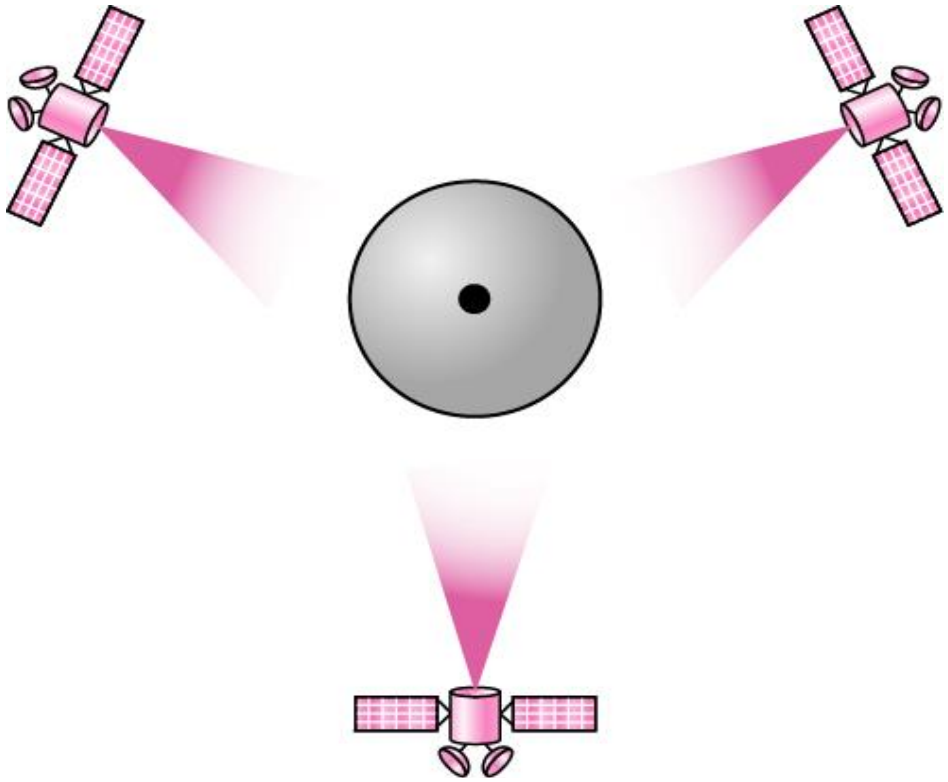
Satellite orbit altitudes



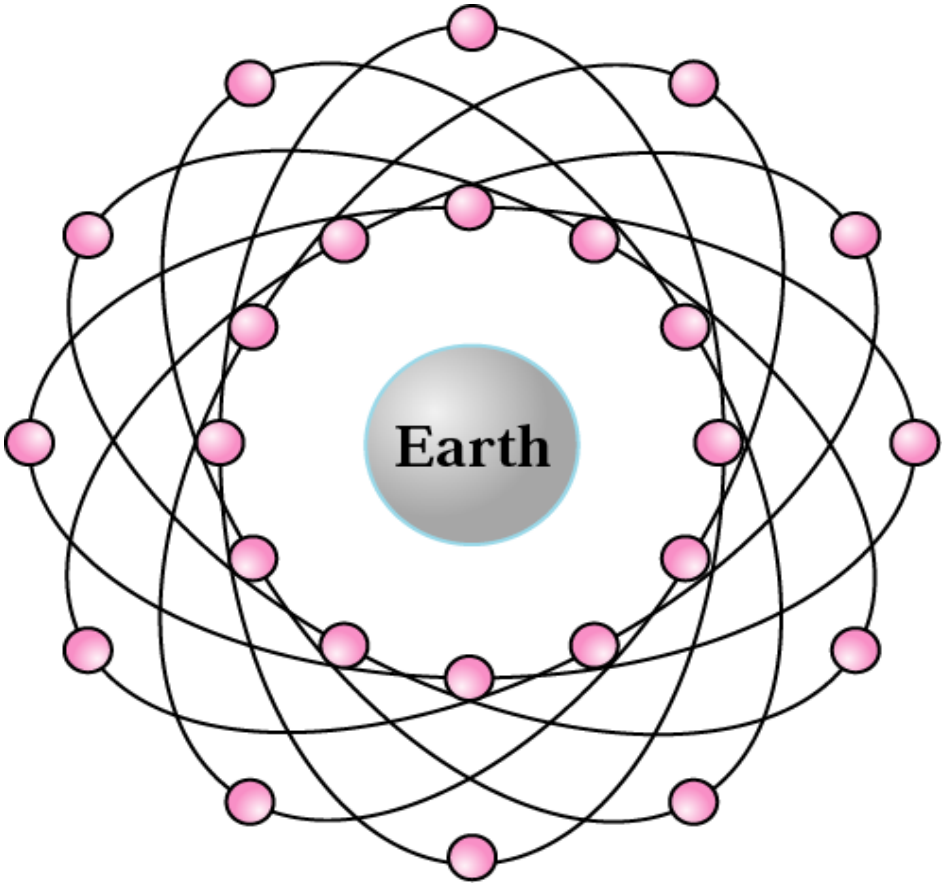
Satellite frequency band

Band	Downlink, GHz	Uplink, GHz	Bandwidth, MHz
L	1.5	1.6	15
S	1.9	2.2	70
C	4	6	500
Ku	11	14	500
Ka	20	30	3500

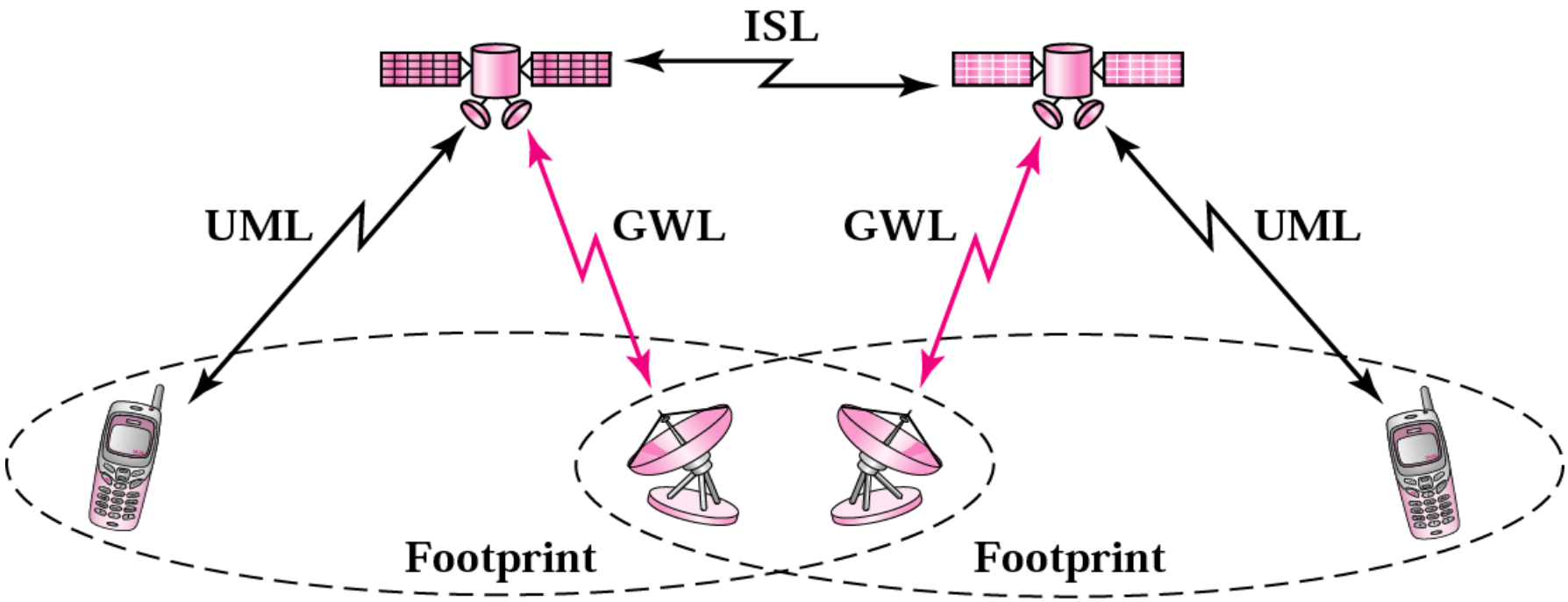
Satellites in geosynchronous orbit



GPS



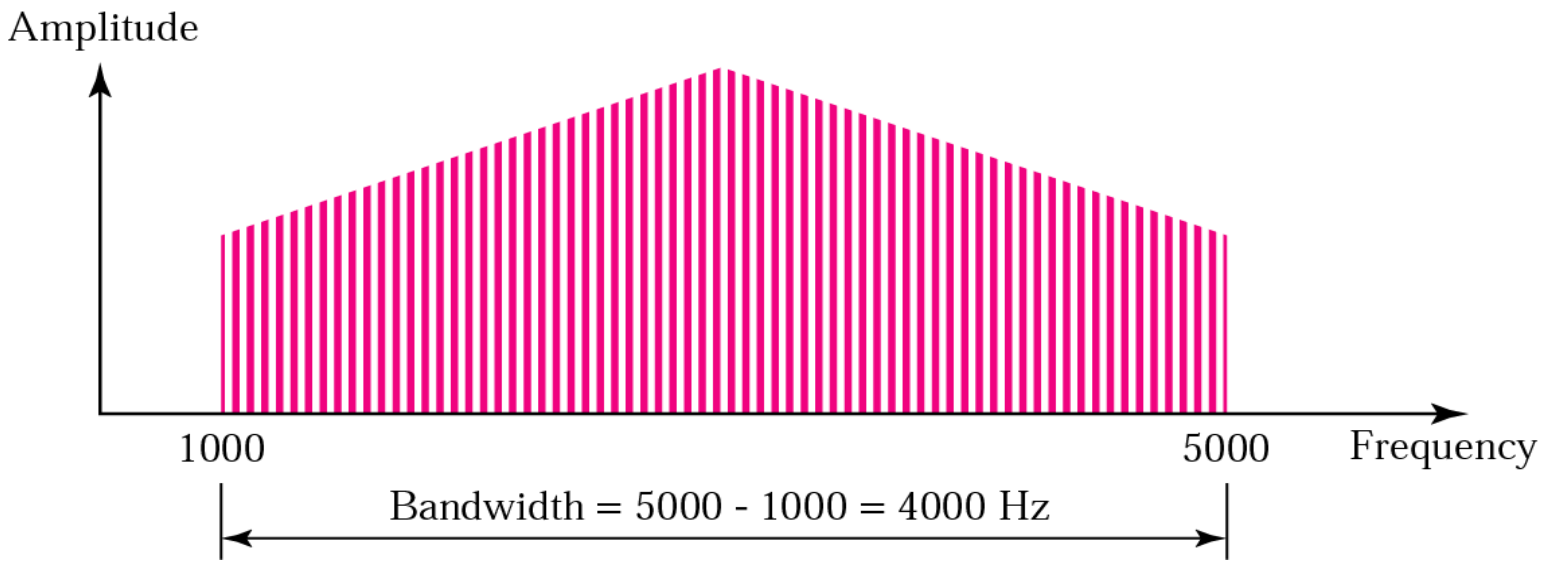
LEO satellite system



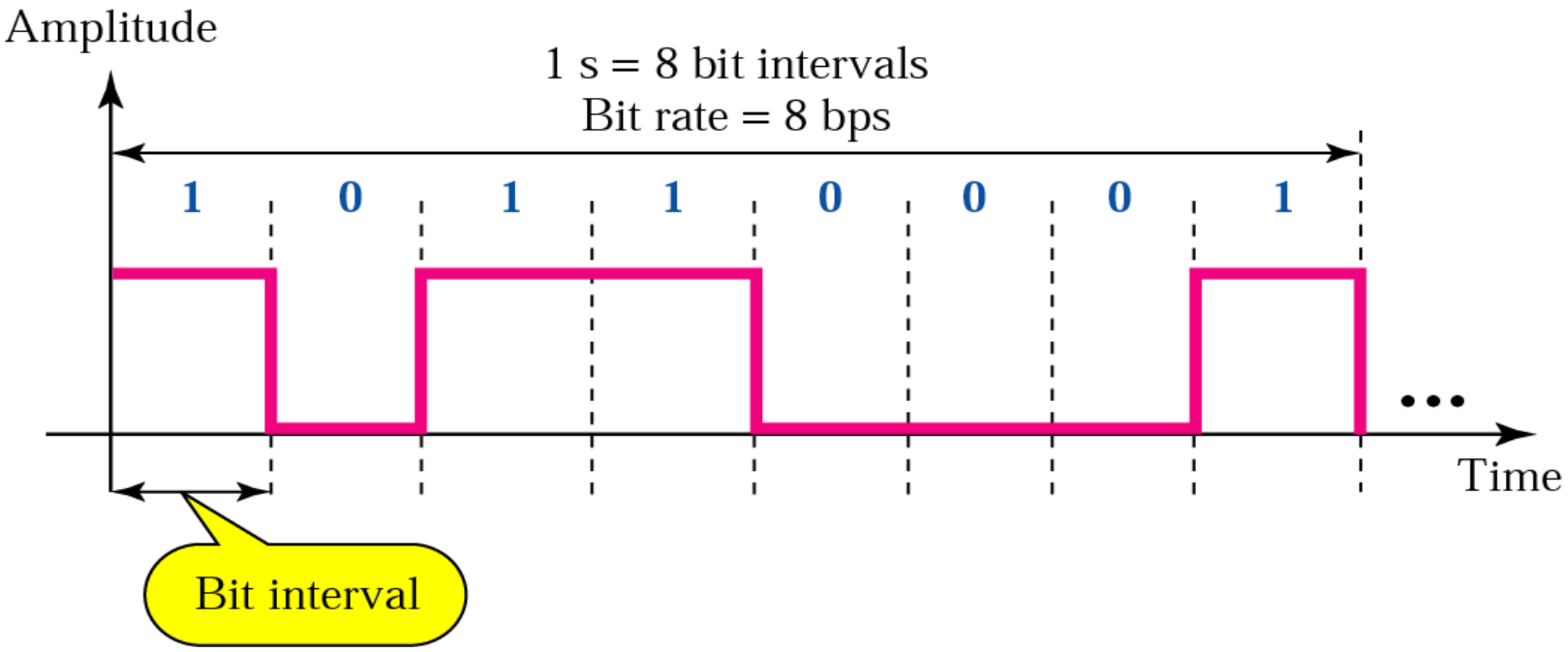
UML : User Mobile Link
GWL : Gateway Link

Bandwidth

- The bandwidth is a property of a medium.
- It is the difference between the highest and the lowest frequencies that the medium can satisfactorily pass.
- Bit Rate and Bandwidth are proportional to each other.

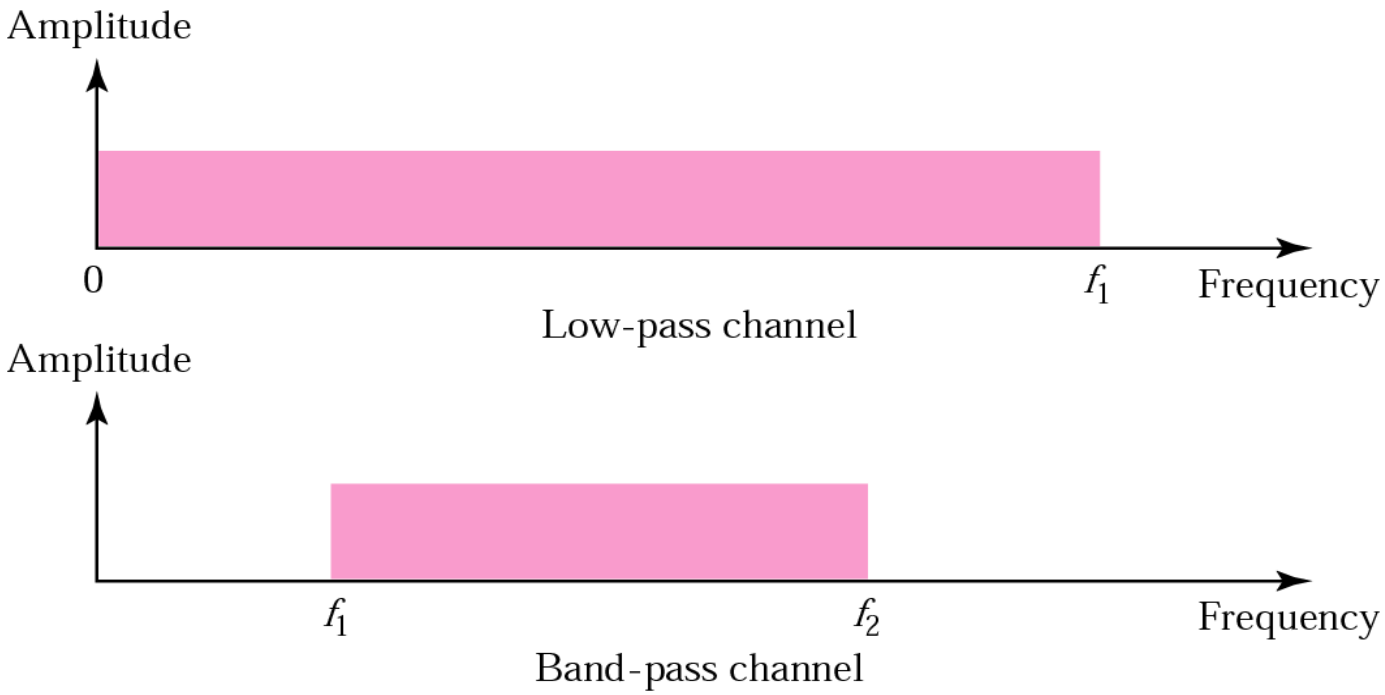


Bit Rate and Bit Interval



- Bit Interval is the Inverse of Bit Rate.
- The analog bandwidth of a medium is expressed in hertz; the digital bandwidth, in bits per second.

Channels: Low Pass and Band Pass Channel



Baud Rate Vs. Bit Rate

- The baud rate of a data communications system is the number of symbols per second transferred.
- A symbol may have more than two states.

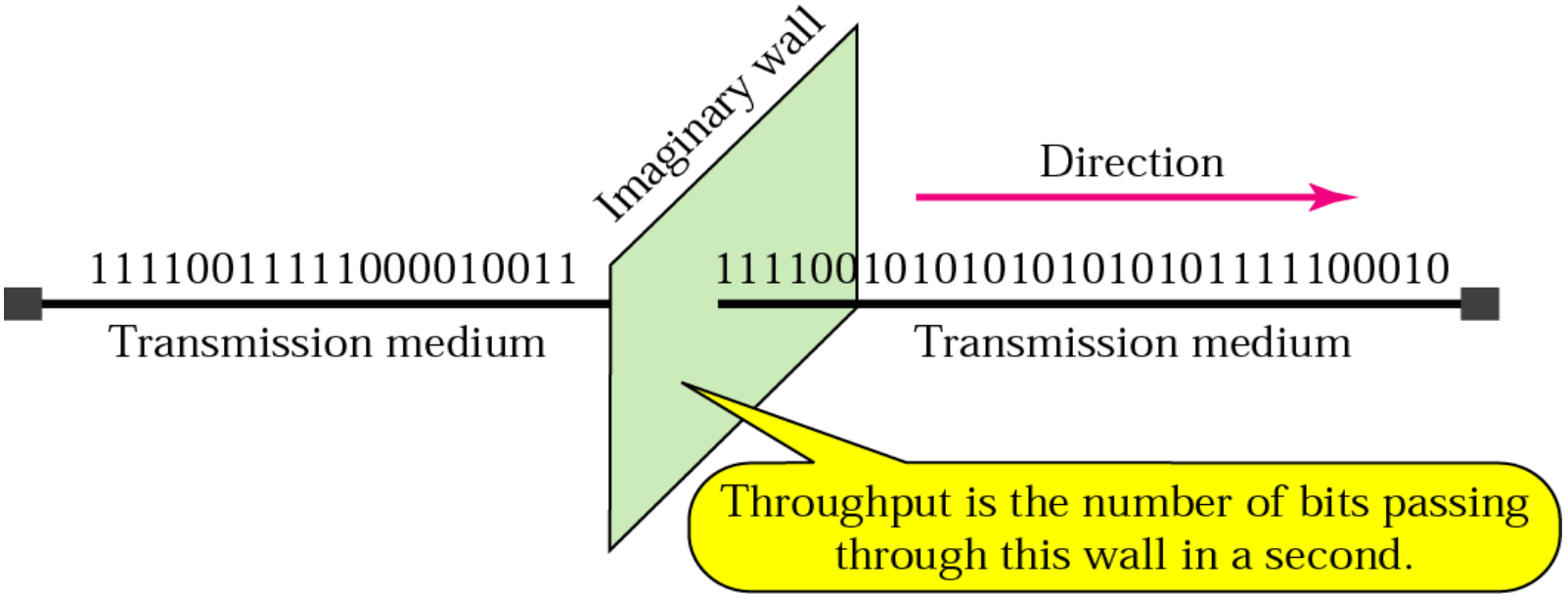
Bit Rate = Baud per second x No of bits per baud.

- No of bits per baud depends on modulation technique.
- Bell 212A modem uses Phase Shift Keying (PSK) modulation, and each symbol has one of four phase shifts (of 0(deg), 90(deg), 180(deg), or 270(deg)).=> 2 Bits Required to represent 4 shifts.
- This Modem transmits data at the rate of 1200 bps at 600 baud.
- For 64QAM Modem M = 64 => 6 Bits Required.
- Bit Rate is 6 Times the Baud Rate

!! Analogy of Baud Rate and Bit Rate !!

Passenger in a Highway Bus

Throughput


Imaginary wall
Direction
11110011111000010011
Transmission medium
11110010101010101010111100010
Transmission medium
Throughput is the number of bits passing through this wall in a second.

Bandwidth Delay Product

- Bandwidth-delay product refers to the product of a data link's capacity (in bits per second) and its round-trip delay time (in seconds)

Moderate speed satellite network: 512 Kbit/s, 900 ms RTT
$B \times D = 512 \times 10^3$ b/s $\times$ 900×10^{-3} s = 460,800 b., / 8 = 57,600 B

Residential DSL: 2 Mbit/s, 50 ms RTT
$B \times D = 2 \times 10^6$ b/s $\times$ 50×10^{-3} s = 100×10^3 b, or 100 Kb, or 12.5 KB.

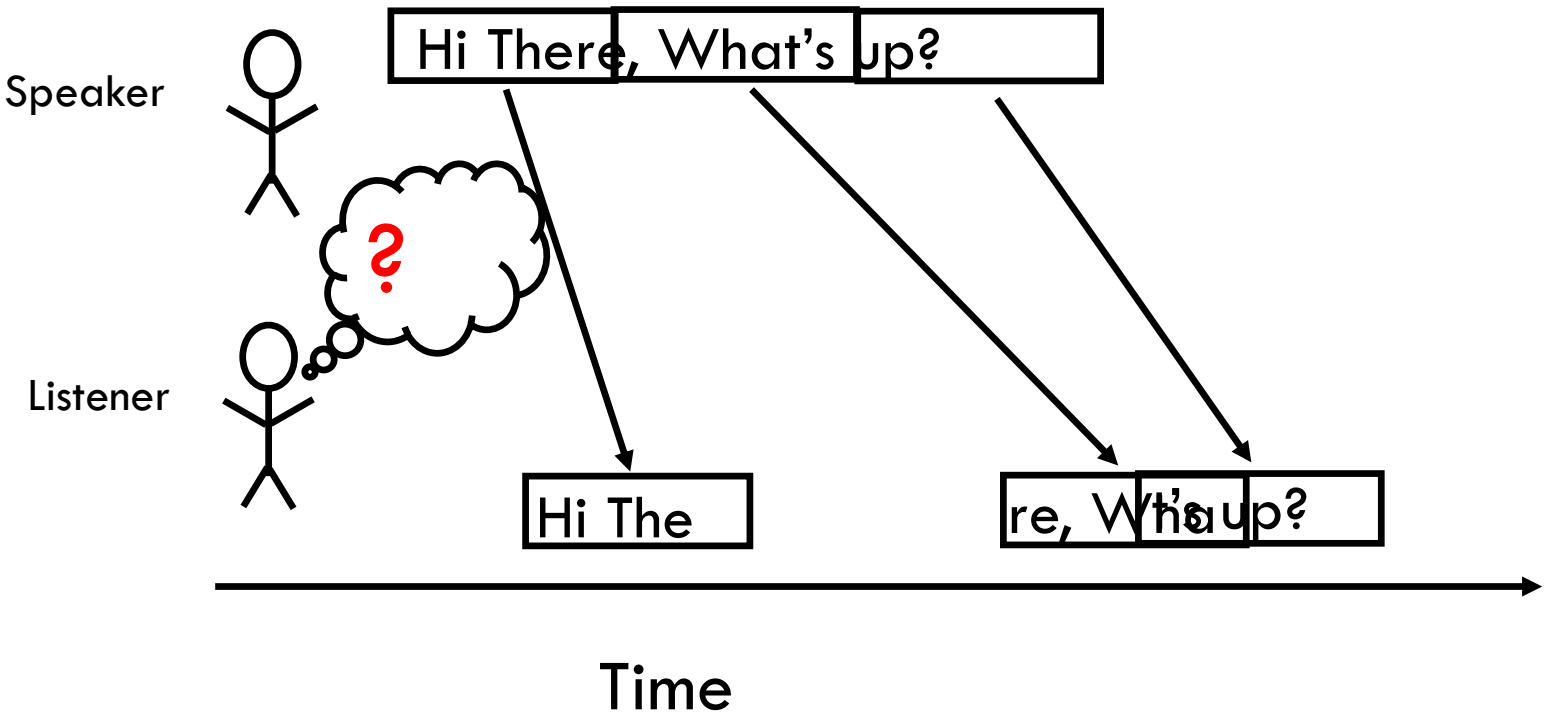
Mobile broadband (HSDPA): 6 Mbit/s, 100 ms RTT
$B \times D = 6 \times 10^6$ b/s $\times$ 10^{-1} s = 6×10^5 b, or 600 Kb, or 75 KB.

Residential ADSL2+: 20 Mbit/s (from DSLAM to residential modem), 50 ms RTT
$B \times D = 20 \times 10^6$ b/s $\times$ 50×10^{-3} s = 10^6 b, or 1 Mb, or 125 KB.

High-speed terrestrial network: 1 Gbit/s, 1 ms RTT
$B \times D = 10^9$ b/s $\times$ 10^{-3} s = 10^6 b, or 1 Mb, or 125 KB.

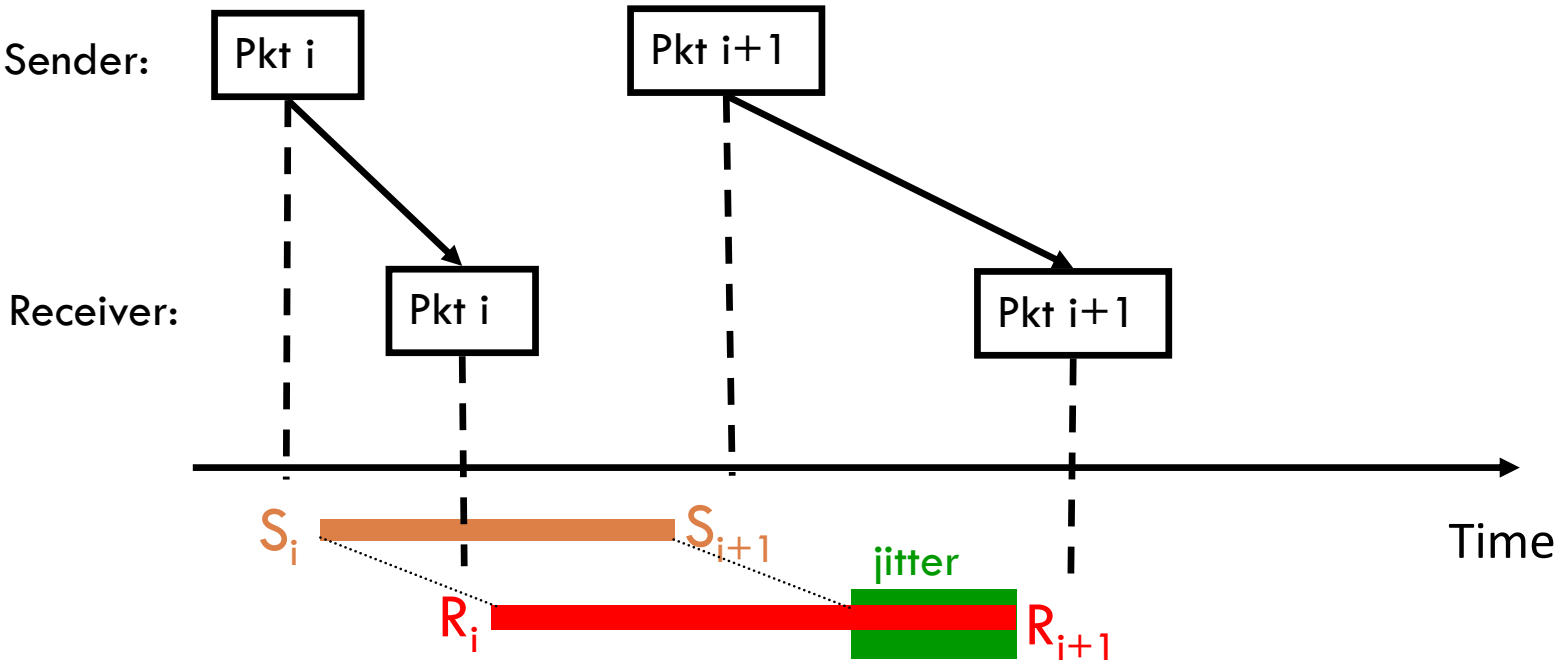
Jitter

- The Internet makes no guarantees about time of delivery of a packet
- Consider an IP telephony session:



Jitter (cont'd)

- A Packet Pair's Jitter is the difference between the transmission time gap and the receive time gap



- Desired time-gap: $S_{i+1} - S_i$ Received time-gap: $R_{i+1} - R_i$
- Jitter between packets i and i+1: $(R_{i+1} - R_i) - (S_{i+1} - S_i)$

Thank You