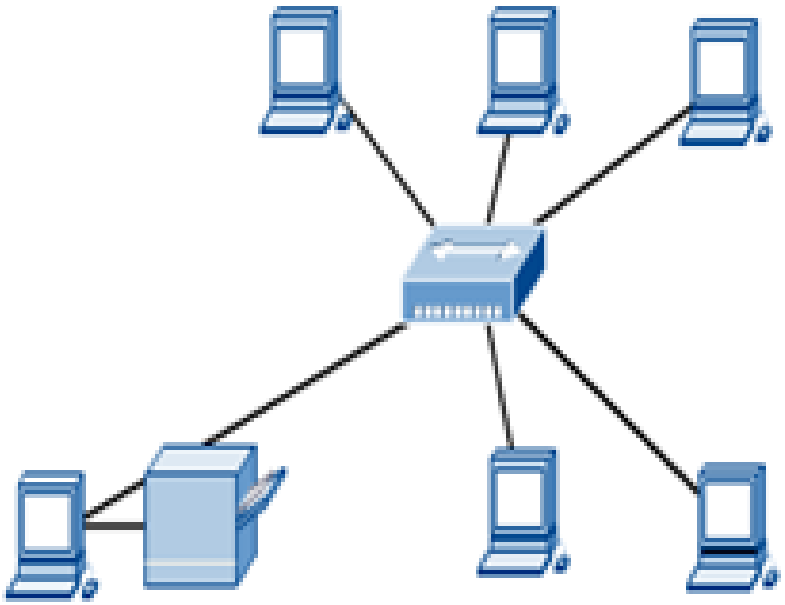
Computer Networks

Year	Subject Title	Sem	Sub Code
2018 -19 Onwards	Core: COMPUTER NETWORKS	IV	18BIT42C

- **UNIT I: Introduction- The Uses of Computer Networks – Networks hardware – Network software – Reference models.**
- **UNIT II: The Physical Layer - Transmission Media – Communication satellites – Wireless transmission –The public switched telephone system**
- **UNIT III: The Data Link layer - Data link layer Design Issues – Error Detection and Correction- Elementary Data link protocols. Medium Access Sub Layers The channel allocation problem – Multiple access protocols Carrier sense multiple access protocols, collision –free protocols, Limited contention protocols.**
- **UNIT IV: The Network Layer – Network Layer Design Issues – Routing Algorithms The optimality principle, shortest path routing, flooding, and distance vector routing, routing for mobile hosts.**
- **UNIT V: The Transport Layer – The Transport service – Services provided to the upper layers, transport service primitives – Elements of Transport protocols. Application Layer – DNS – The Domain Name System – Electronic mail – Architecture and services, the user agent.**
- **TEXT BOOKS**
- 1. Andrew S. Tanenbaum, “Computer Networks”, 4th Edition, Pearson Education Publ. 2014.
- **REFERENCE BOOKS**
- 1. Miller, “Data and Network Communications”, Vikas Publ., 2001.
- 2. William A Shay, “Understanding data communications and Networks”, 2nd Edition, Vikas
- Publ., 2001.

Computer Networks

- Computer network connects two or more autonomous computers.



- The computers can be geographically located anywhere.

Transmission Media

Transmission medium:: the physical path between transmitter and receiver.

- Repeaters or amplifiers may be used to extend the length of the medium.
- Communication of electromagnetic waves is *guided* or *unguided.*

  Guided media :: waves are guided along a physical path (e.g, twisted pair, coaxial cable and optical fiber).

  Unguided media:: means for transmitting but not guiding electromagnetic waves (e.g., the atmosphere and outer space).

Transmission Media Choices

Guided Media

- Twisted pair
- Coaxial cable
- Optical fiber
- Wireless communications

Transmission Media

- **Magnetic media**
  - Tapes, diskettes
  - High bandwidth
  - A 8 mm tape = 7 GB ➔ A 50*50*50 Cm box = 1000 tapes =7000 GB
    7000GB/24 Hrs= 648 Mbps 7000GB/1Hr=15Gbps
  - Sometimes it's cheaper and faster to load a box of tapes in your car!
  - Problem: Delay !

- **Twisted pair**
  - Simply two wires twisted together – thickness=1mm
    The twisting cuts down on electrical interference.
  - Heavily used in the phone system
    Typical office has four pairs for phones.
  - Until some Kilometers/ Some Mbps
  - For Analog and Digital

Transmission Media (2)

- Twisted pair
  - Bandwidth depends on thickness and distance

    Need repeater for long distances
  - Category 3 and 5 - with 5 having more twists and better insulation.
  - Popular by UTP (Unshielded Twisted Pair)

Cat3

Cat 5

Twisted Pair

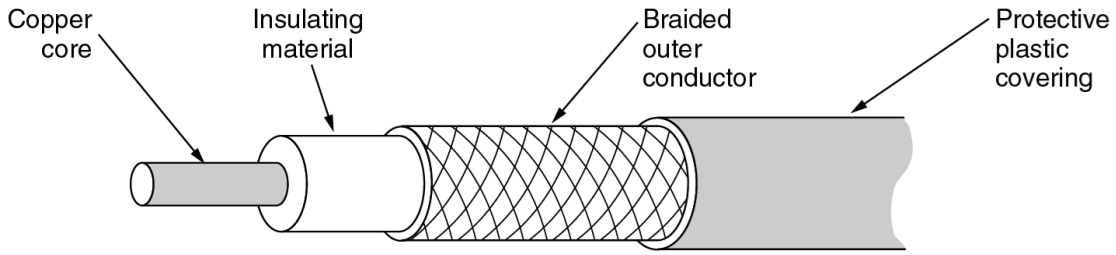
- Limited in distance, bandwidth and data rate due to problems with attenuation, interference and noise
  - Issue: cross-talk due to interference from other signals
  - “shielding” wire (shielded twisted pair (STP)) with metallic braid or sheathing reduces interference.
  - “twisting” reduces low-frequency interference and crosstalk.

Twisted Pair

- Two insulated wires arranged in a spiral pattern
- Copper or steel coated with copper
- The signal is transmitted through one wire and a ground reference is transmitted in the other wire.
- Typically twisted pair is installed in building telephone wiring.
- Local loop connection to central telephone exchange is twisted pair.

Transmission Media

- Baseband Coaxial cable
  - **Used for digital transmissions (called baseband.)**
  - **Good noise immunity.**
  - **Data rates as high as 2 Gbps for 1 Km distance.**
  - **Now being replaced by fiber.**
- Broadband Coaxial cable
  - **Used for analog transmissions (called broadband.)**
  - **Can run 300 MHz for long distances.**
  - **Analog signaling has better S/N than digital signaling.**
  - **Interfaces must convert digital signals to analog and vice versa.**
  - **Designed for long distances - can use amplifiers.**

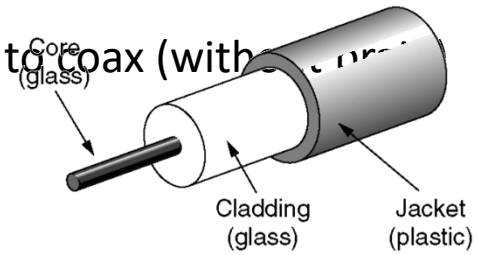


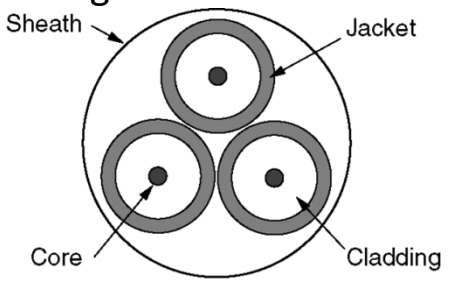
Transmission Media

- Fiber Optic (1)
  - Transmission of light through fiber
  - Bandwidth more than 50,000 Gbps !

    But now restricted to 1Gbps!

    Reason: Electrical and optical signal conversion
  - Including 3 components:
    1. Light source: Pulse of light=1, absence of light=0
    2. Transition medium: an ultra-thin fiber of glass
    3. detector: generate an electrical pulse when light falls on it
  - Similar to coax (with [illegible])





Transmission Media

- Fiber Optic (2)
  - Thickness of core: 8~10 microns or 50 microns
  - Two typically light sources:

    1. LED (Light Emitting Diode)

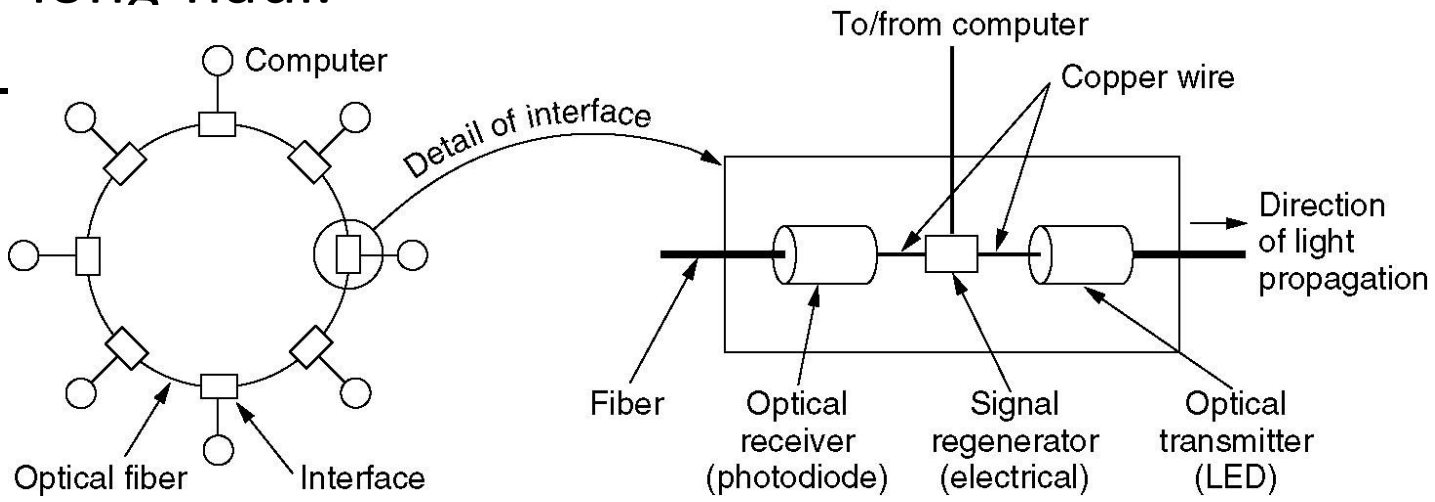
       response time=1ns ➔ data rate = 1Gbps

    2. Semiconductor laser

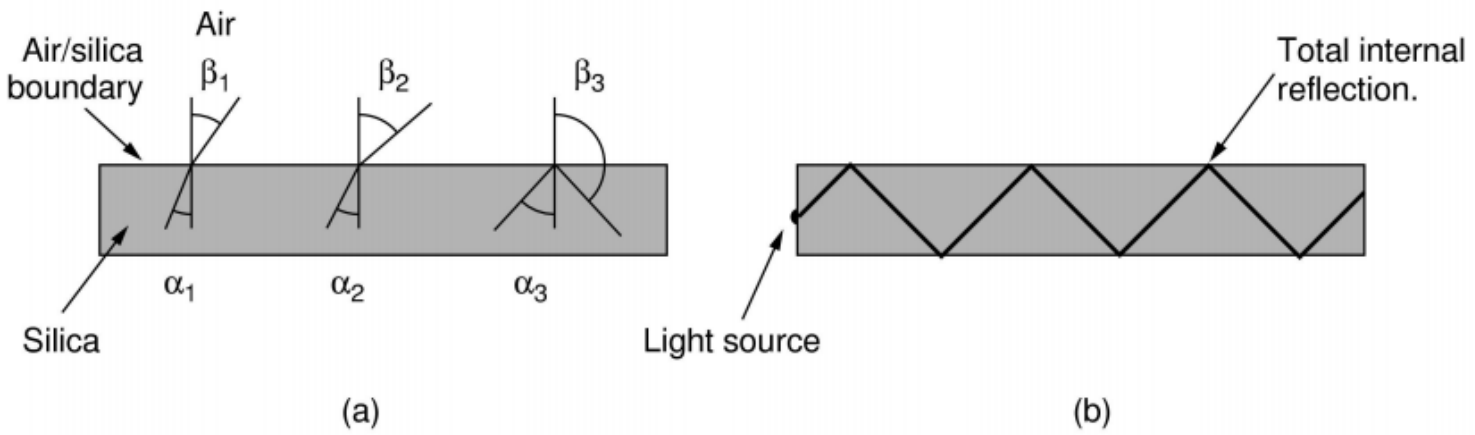
Item	LED	Semiconductor laser
Data rate	Low	High
Fiber type	Multimode	Multimode or single mode
Distance	Short	Long
Lifetime	Long life	Short life
Temperature sensitivity	Minor	Substantial
Cost	Low cost	Expensive

Transmission Media

- Fiber Optic (3)
  - Properties include total internal reflection and attenuation of particular frequencies.
  - Fiber Optic Networks - can be used for LANs and long-haul.
  -



Fiber Optics (2)



Light trapped by total internal reflection.

Comparison of Fiber optics and Copper Wire

- Fiber can handle much higher bandwidth than copper
- Less number of repeaters are needed for fiber cables than copper
- Fiber is thin and light weight
- Fibers do not leak light and are very difficult to tap
- Fibers are easily damaged when bent too much
- Fiber interfaces cost more than electrical interfaces

Transmission Media (7)

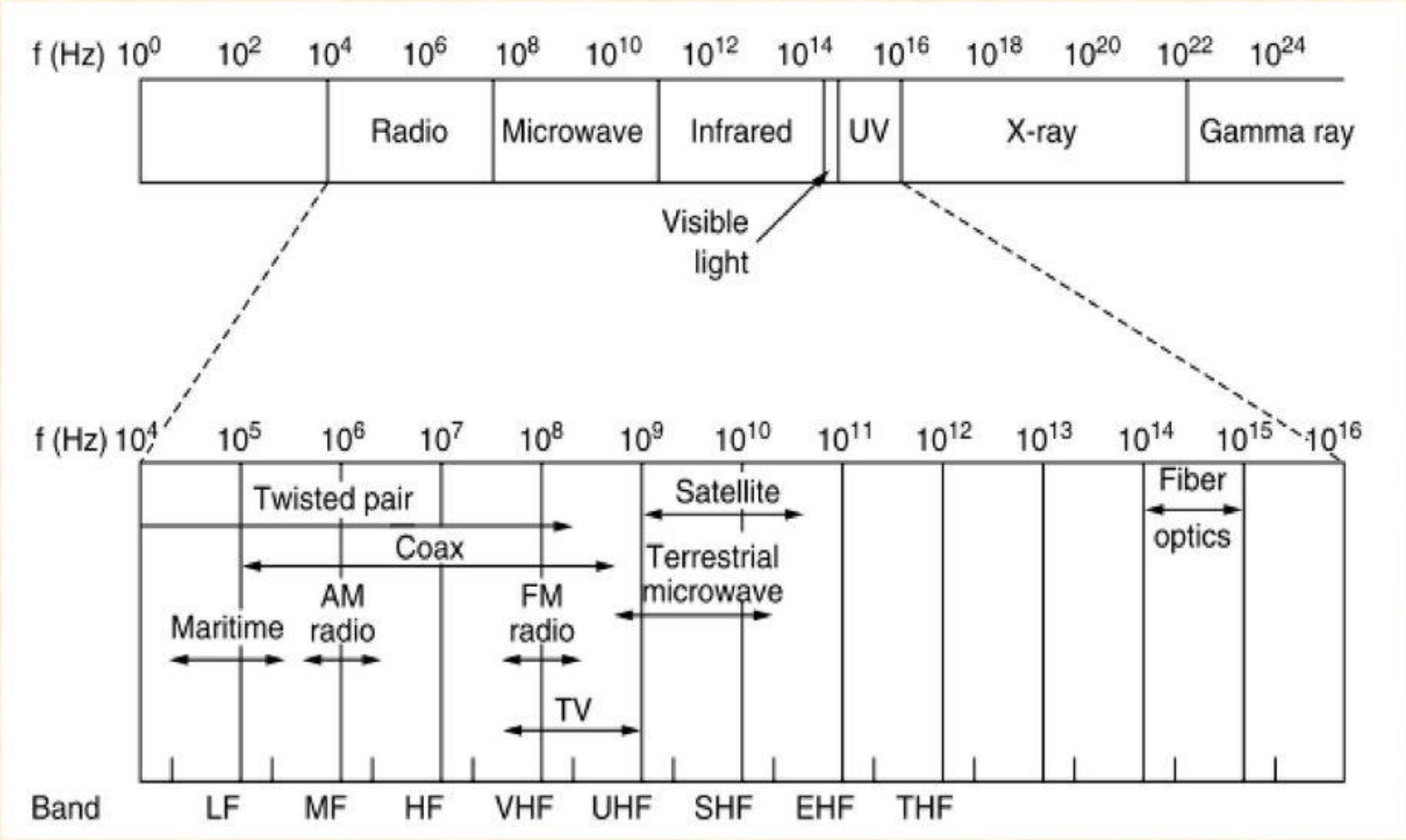
- Comparison of fiber optic and copper wire

	Fiber	Copper
Bandwidth	Higher	Lower
Distance between repeaters	30 KM	5 Km
Interference	Low	High
Physical	Smaller/Lighter	-
Flow	Uni-directional	Bi-directional

Wireless Transmission

- The Electromagnetic spectrum
- Radio Transmission
- Microwave transmission
- Infrared and millimeter waves
- Light wave transmission

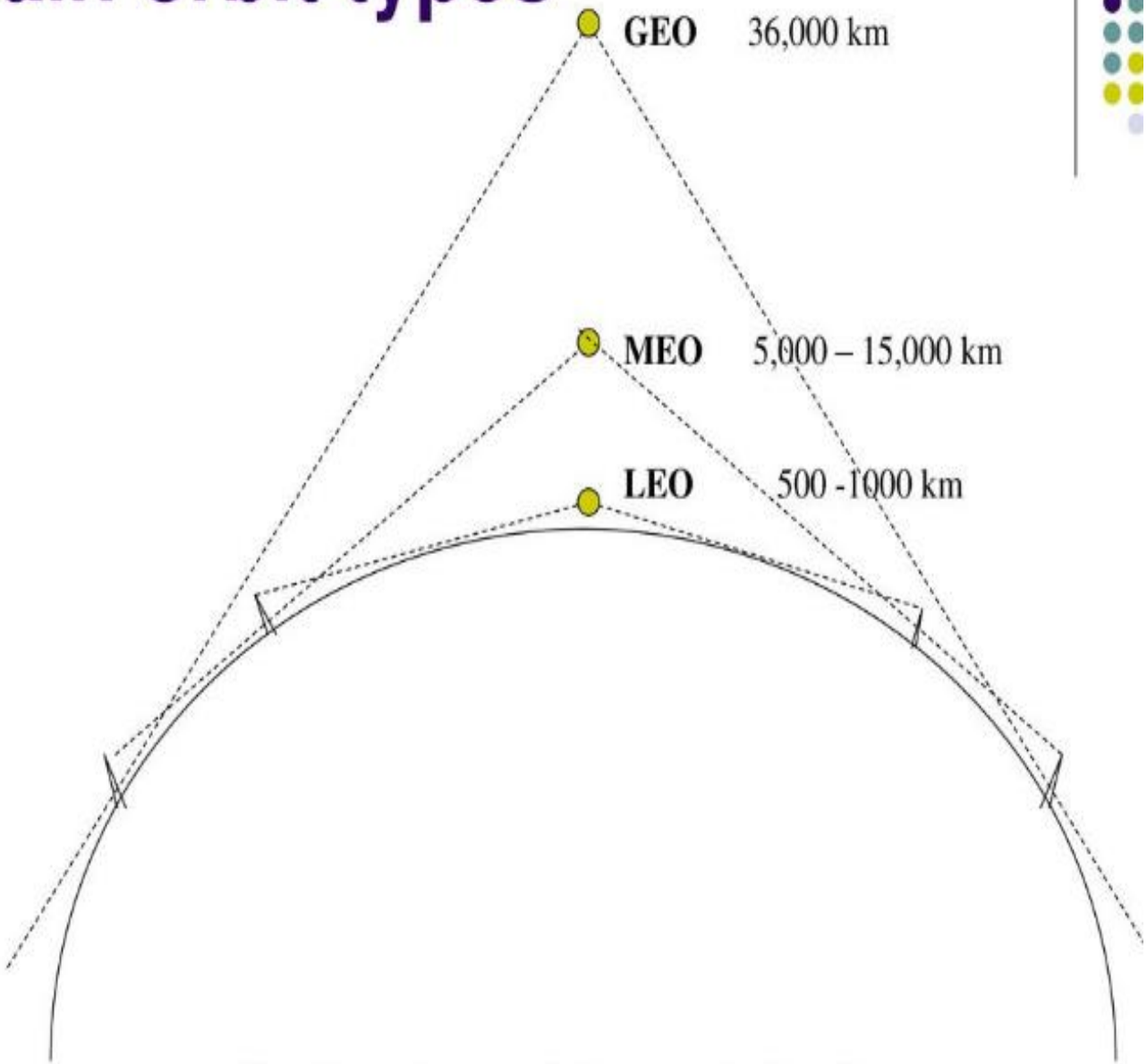
The electromagnetic spectrum(1)

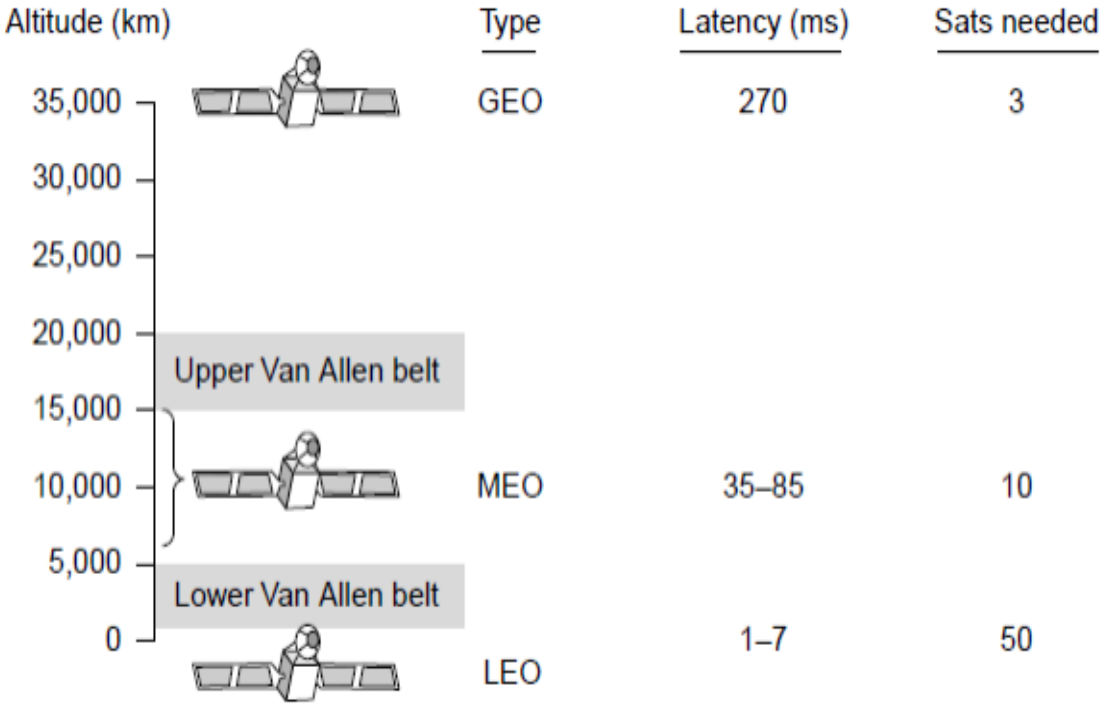


Communication Satellites

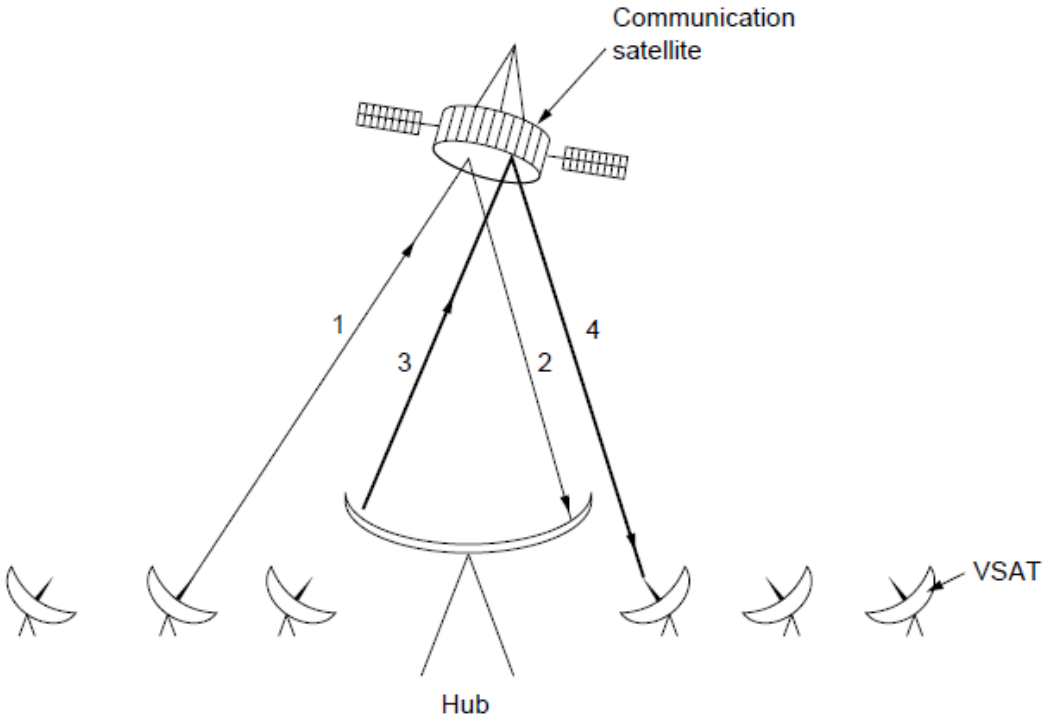
- Geostationary Satellites
- Medium-Earth Orbit Satellites
- Low-Earth Orbit Satellites
- Satellites Versus Fiber

Main orbit types





Communication satellites, some properties, including: altitude above earth, round-trip delay time, number of satellites for global coverage.



VSATs using a hub.

GEO (GEOSTATIONARY ORBIT)

- In the equatorial plane
- Orbital Period = 23 h 56 min. 4.091 s
  = one ***Sidereal Day*** (defined as one complete rotation relative to the fixed stars)
- Satellite appears to be **stationary** over a point on the equator to an observer
- Radius of orbit, ***r***, = 42,164.57 km

Satellite vs. Fiber

Satellite:

- \+ Can rapidly set up anywhere/anytime communications (after satellites have been launched)
- \+ Can broadcast to large regions
- – Limited bandwidth and interference to manage

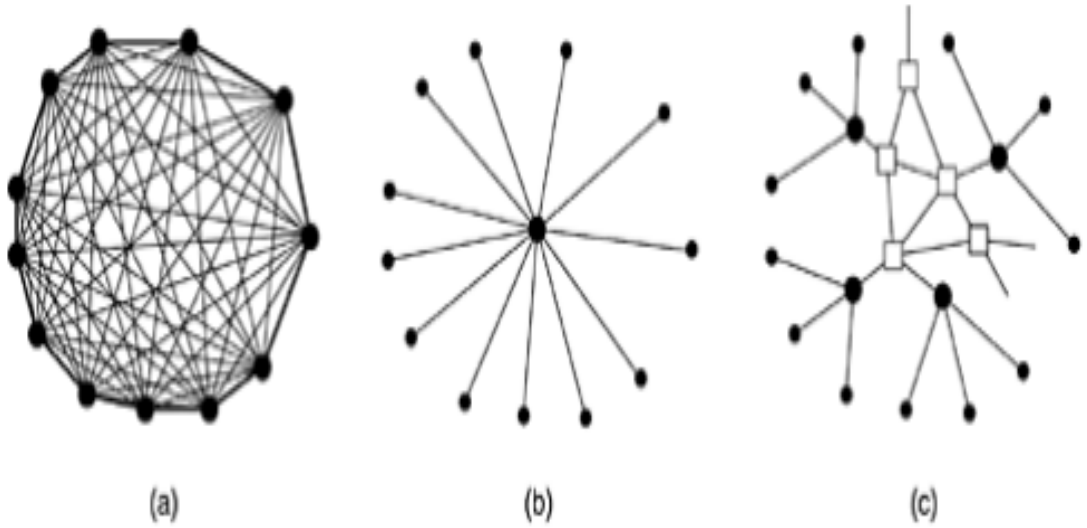
Fiber:

- \+ Enormous bandwidth over long distances
- – Installation can be more expensive/difficult
- – Doesn't work at sea or in remote areas

Public switched telephone network

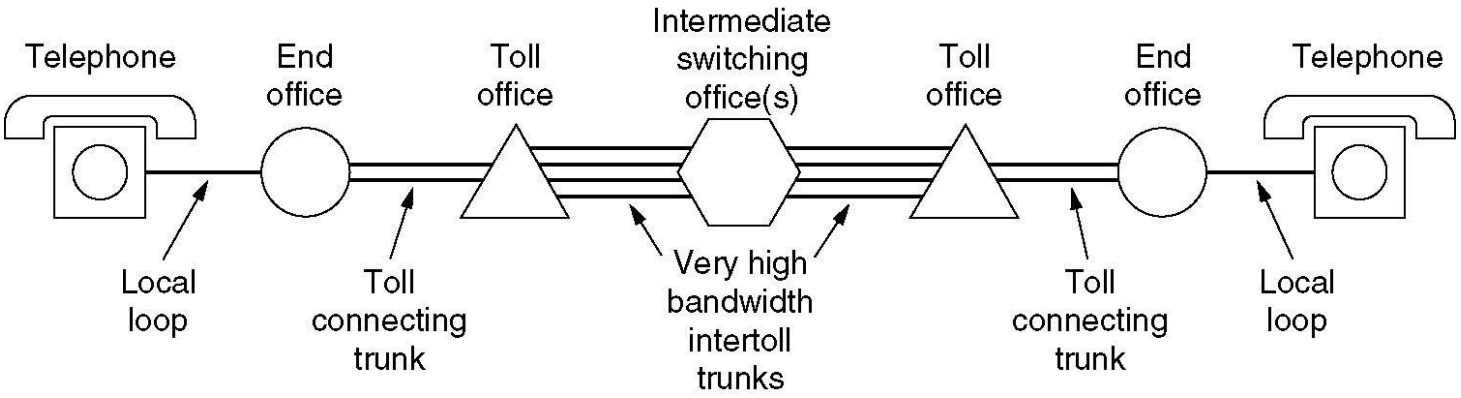
Structure of the telephone system

Figure 2-20. (a) Fully-interconnected network. (b) Centralized switch. (c) Two-level hierarchy.



PSTN

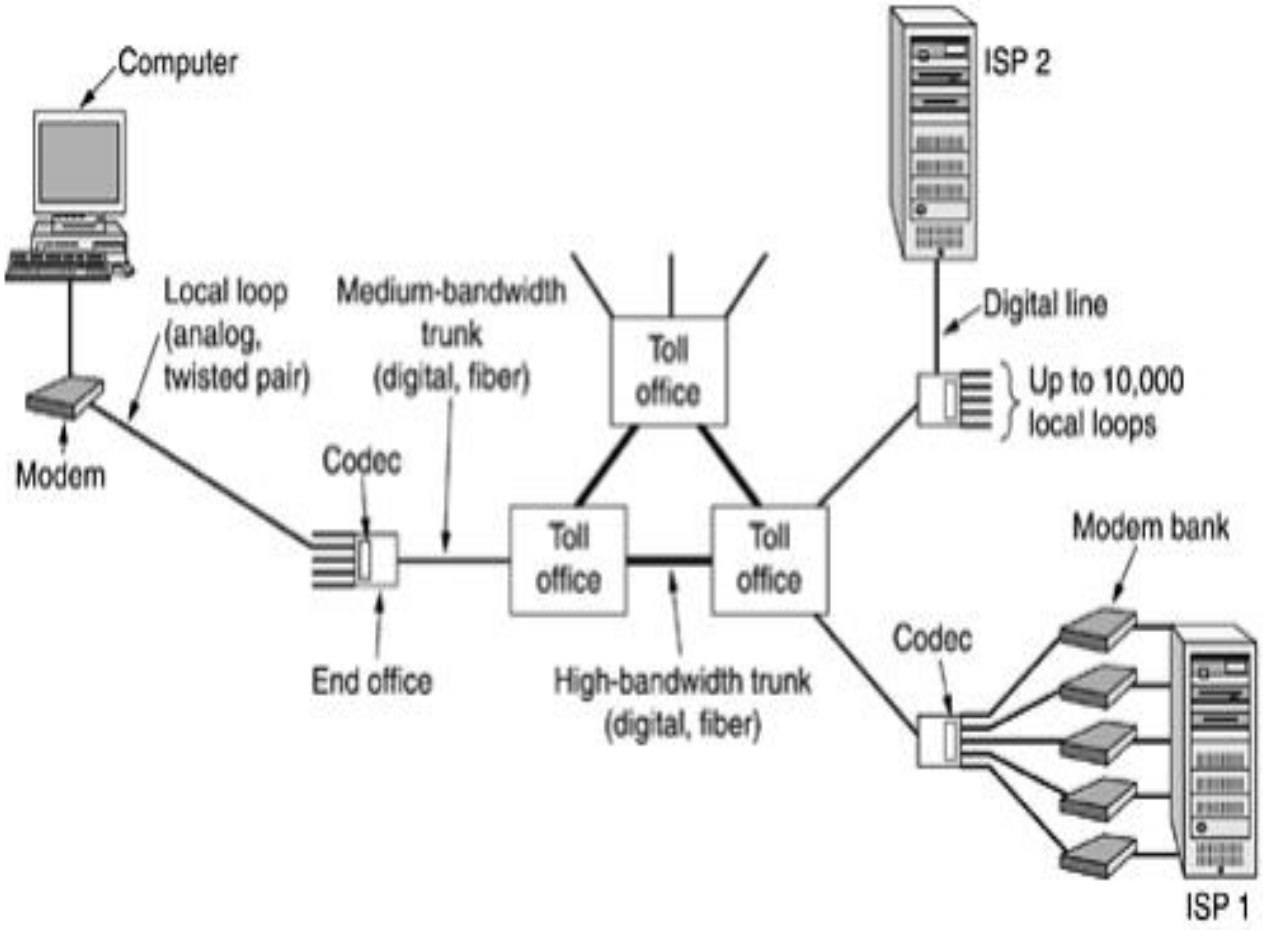
- A typical circuit route for a medium-distance call



- Major Components of the Telephone System
  - Local loops: Analog twisted pairs going to houses and businesses
  - Trunks: Digital fiber optics connecting the switching offices
  - Switching offices: Where calls are moved from one trunk to another

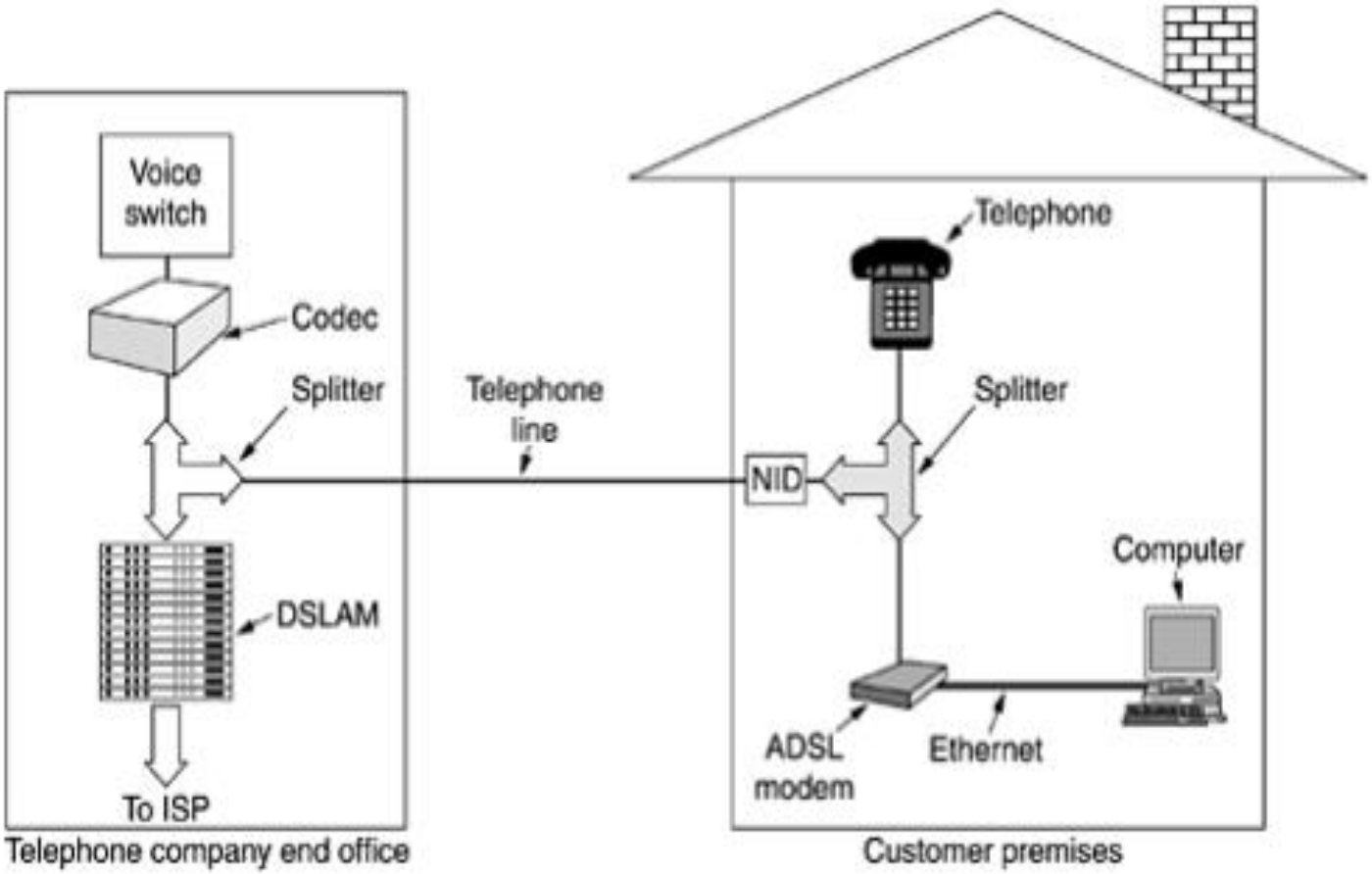
The local loop: Modems, ADSL, and Wireless

Figure 2-23. The use of both analog and digital transmission for a computer to computer call. Conversion is done by the modems and codecs.



Digital subscriber lines

Figure 2-29. A typical ADSL equipment configuration.



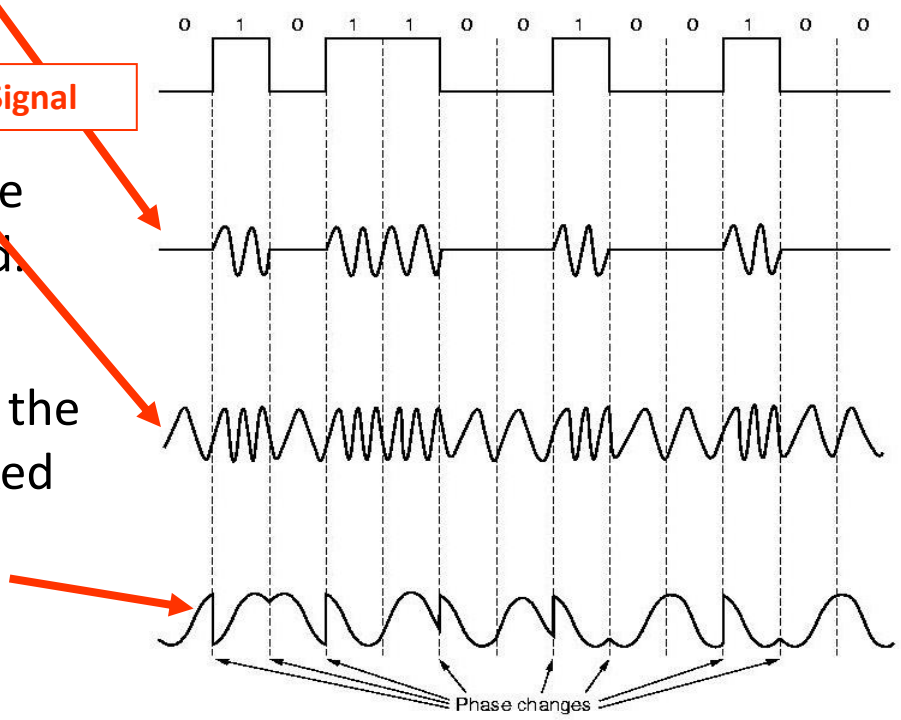
PSTN

- Transmission Impairments:
  - Attenuation - the loss of energy as the signal propagates
  - Delay Distortion - different frequencies travel at different speeds so the wave form spreads out.
  - Noise - unwanted energy that combines with the signal - difficult to tell the signal from the noise.

- Modem
  - A device that converts digital data to and from an analog signal for transmission over phone lines.

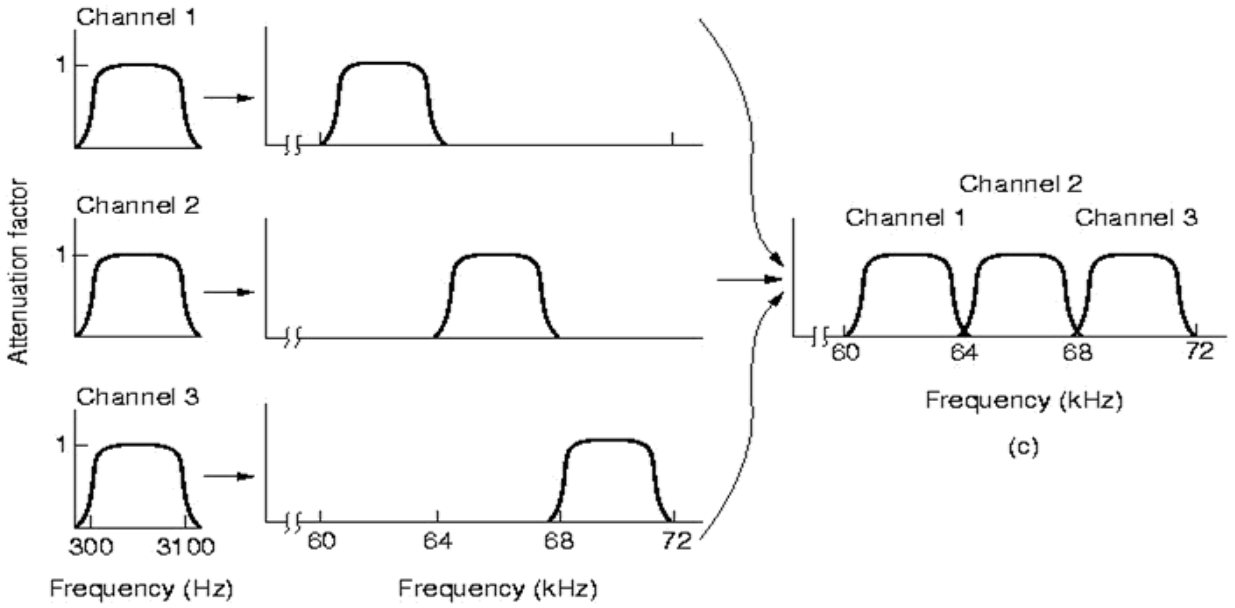
PSTN

- Modem
  - **Amplitude modulation:** Two different amplitudes of sine wave are used to represent 1's and 0's.
  - **Frequency modulation:** Two (or more) different frequencies, close to the carrier frequency, are used.
  - **Phase modulation:** The phase of the sine wave is changed by some fixed amount.



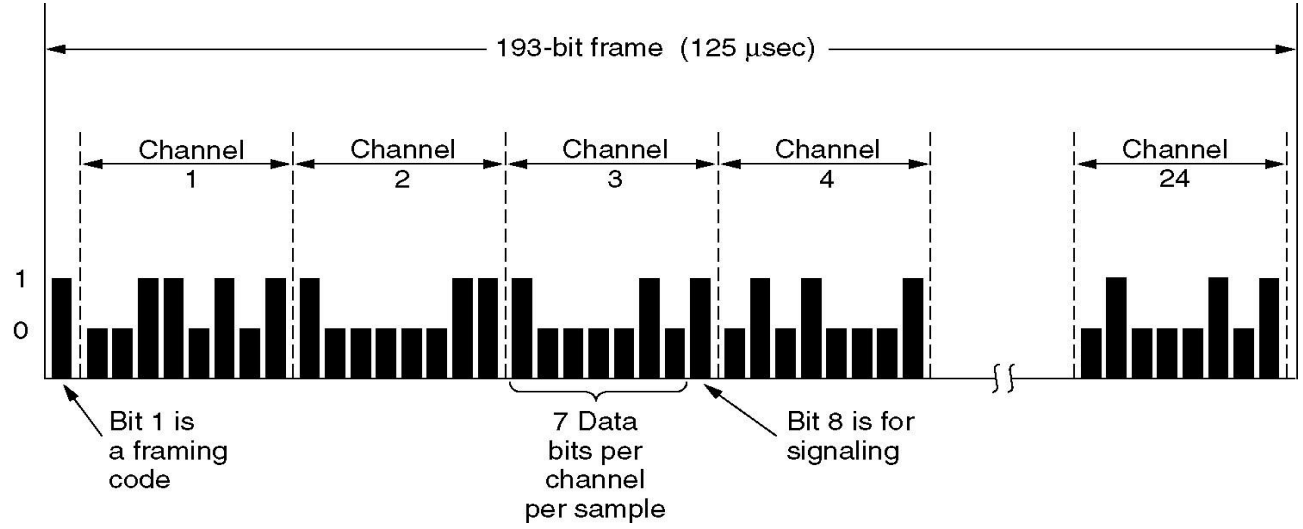
Trunks and multiplexing

- The cost of a wire is independent of the bandwidth of that wire - costs come from installation and maintenance of the physical space (digging)
- **Frequency Division Multiplexing (FDM):**
  - The frequency spectrum is divided up among the logical channels - each user hangs on to a particular frequency. Note that this is analog stuff.



PSTN

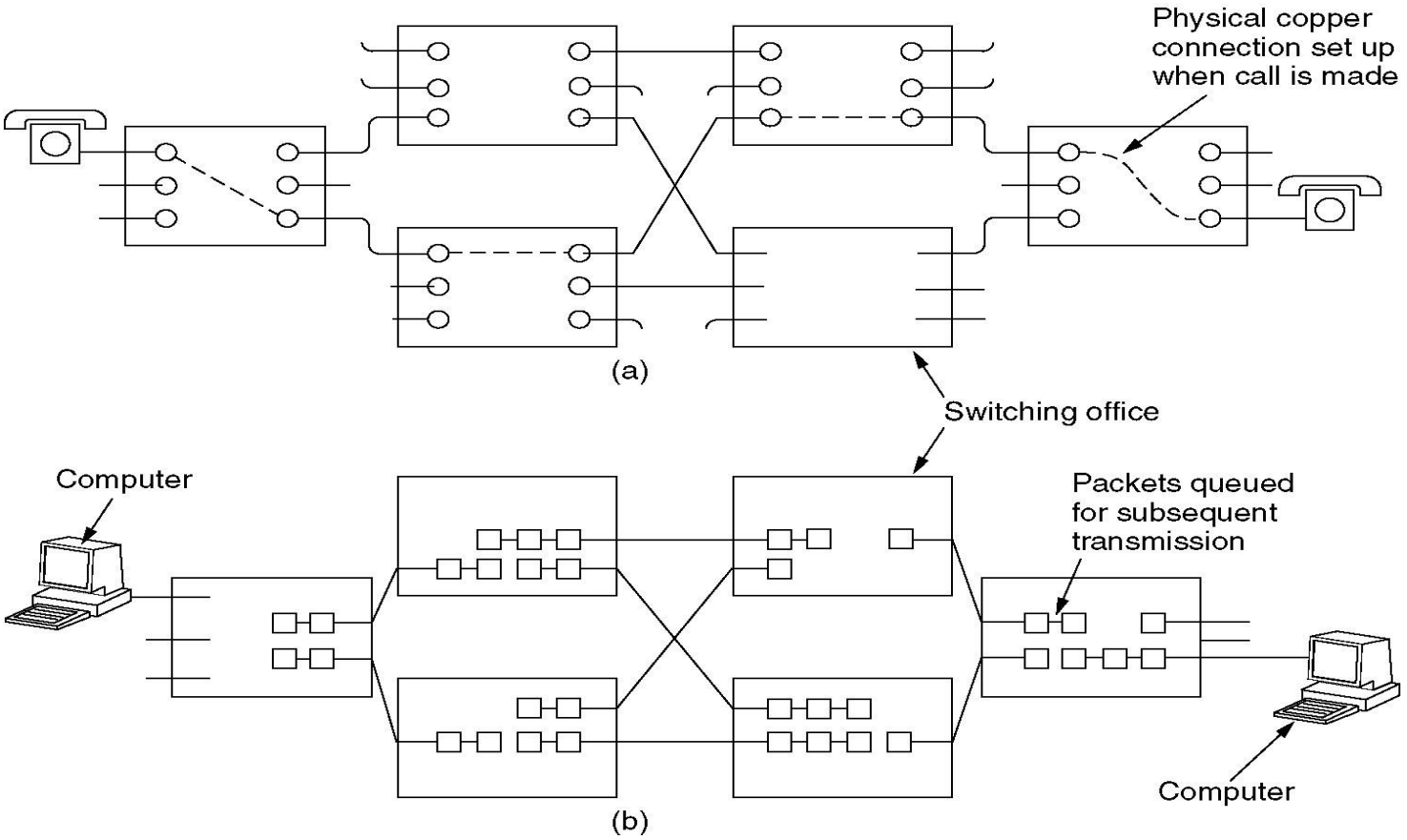
- **Wavelength Division Multiplexing (WDM):**
  - The same as FDM, but applied to fibers. There's great potential for fibers since the bandwidth is so huge (25,000 GHz).
- **Time Division Multiplexing (TDM):**
  - In TDM, the users take turns, each one having exclusive use of the medium in a round robin fashion. TDM can be all digital.
  - Ex. T1=24 channels, each 8 bits =192 bits +1 ➔ 1.544 Mbps



PSTN

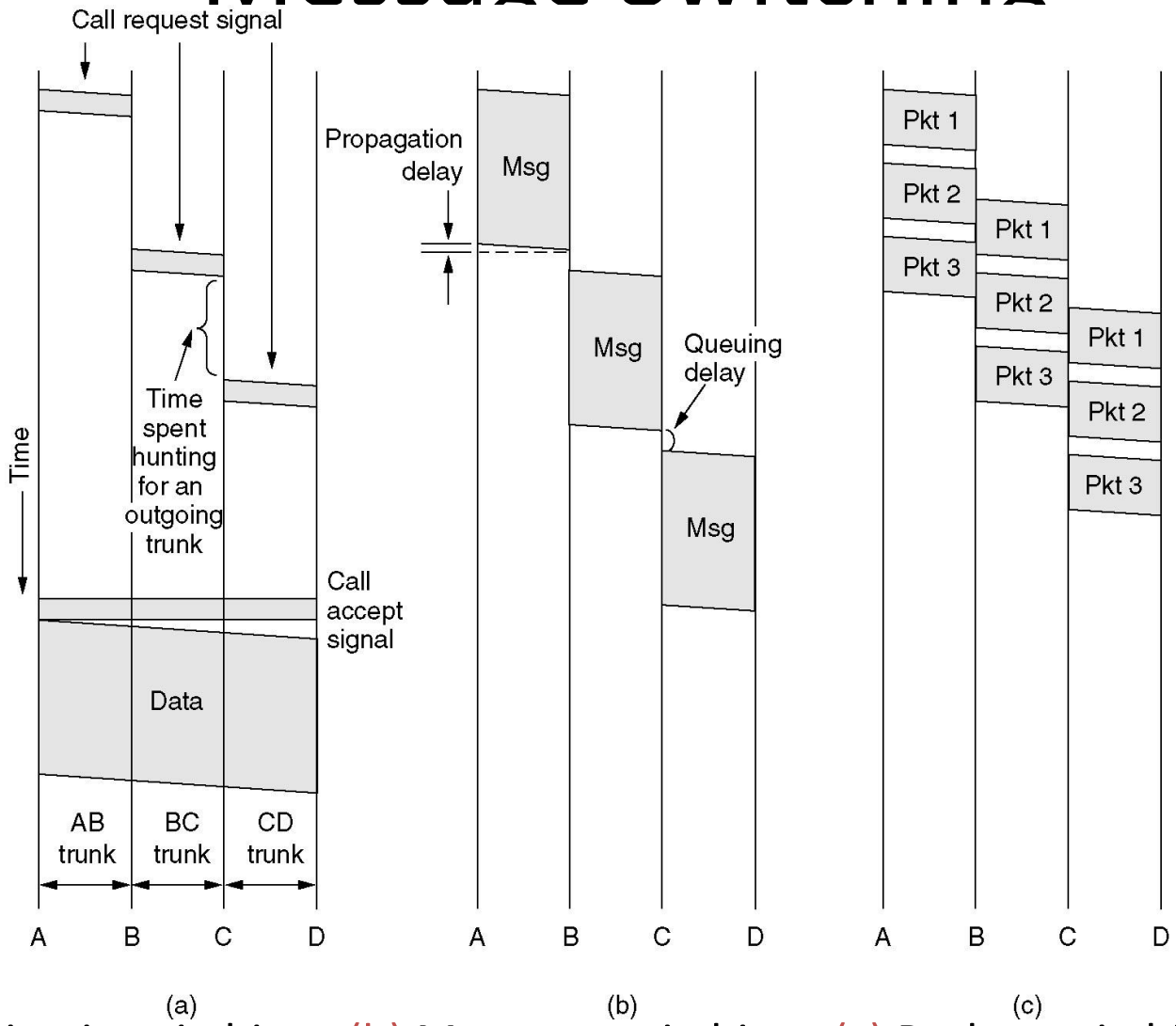
- Switching
  - **Circuit Switching:** A physical connection (electrical, optical, radio) is established from the caller phone to the calle phone. This happens BEFORE any data is sent.
  - **Message Switching:** The connection is determined only when there is actual data (a message) ready to be sent. The whole message is re-collected at each switch and then forwarded on to the next switch. This method is called store-and-forward. This method may tie up routers for long periods of time - not good for interactive traffic.
  - **Packet Switching**: Divides the message up into blocks (packets). Therefore packets use the transmission lines for only a short time period - allows for interactive traffic.

Circuit Switching



- (a) Circuit switching.
- (b) Packet switching.

Message Switching



- (a) Circuit switching (b) Message switching (c) Packet switching

A Comparison between Circuit-switched and Packet-switched Networks

Item	Circuit-switched	Packet-switched
Call setup	Required	Not needed
Dedicated physical path	Yes	No
Each packet follows the same route	Yes	No
Packets arrive in order	Yes	No
Is a switch crash fatal	Yes	No
Bandwidth available	Fixed	Dynamic
When can congestion occur	At setup time	On every packet
Potentially wasted bandwidth	Yes	No
Store-and-forward transmission	No	Yes
Transparency	Yes	No
Charging	Per minute	Per packet