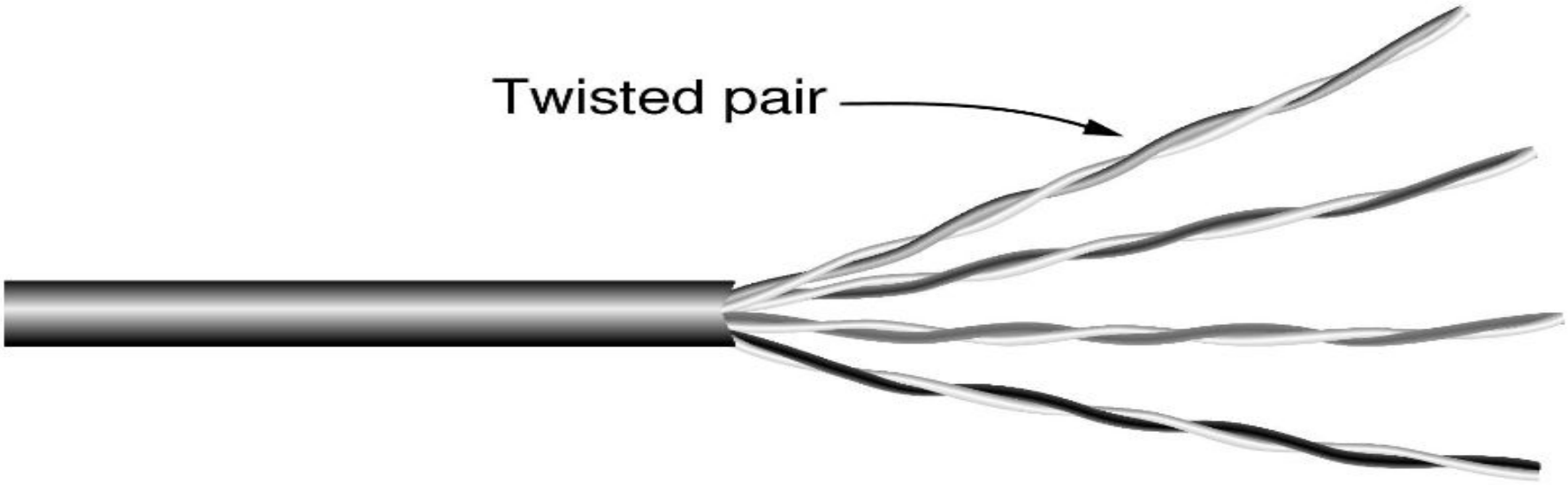
Guided Transmission Media

- Magnetic media
- Twisted pairs
- Coaxial cable
- Fiber optics

Magnetic Media

- Write data onto magnetic media
  - Disks
  - Tapes
- Data transmission speed
  - Never underestimate the bandwidth of a station wagon full of tapes hurtling down the highway.

Twisted Pairs



Category 5 UTP cable with four twisted pairs


UTP
STP

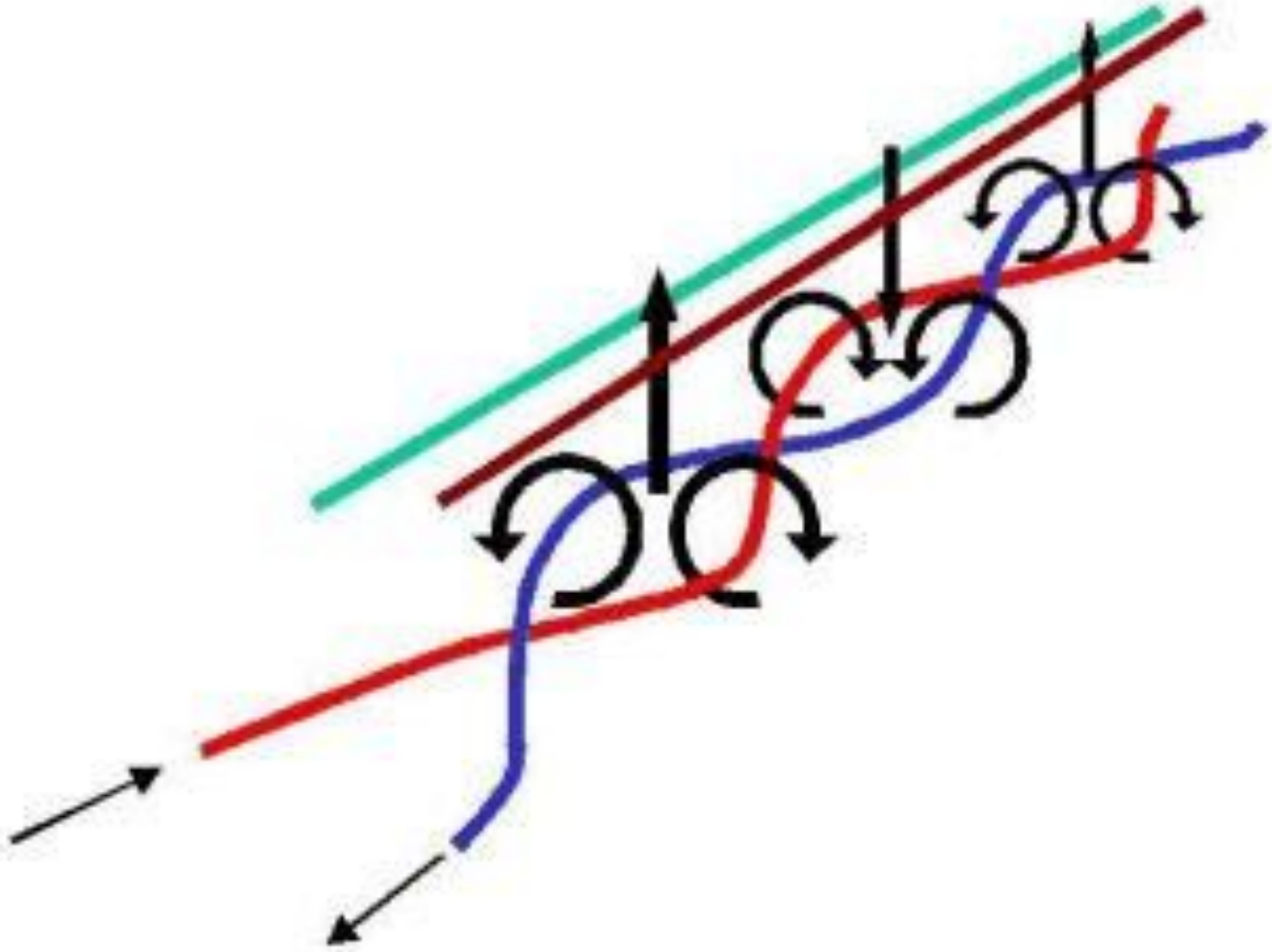
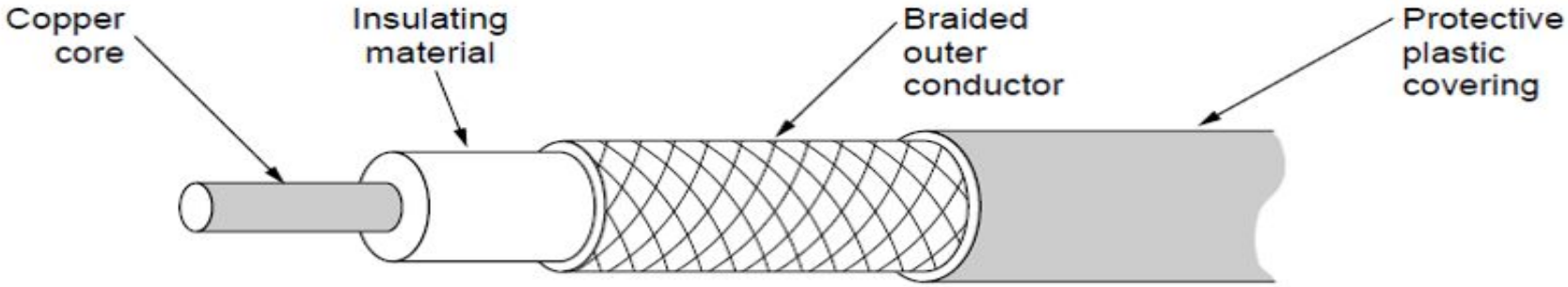


Figure 2-3. (a) Category 3 UTP. (b) Category 5 UTP.

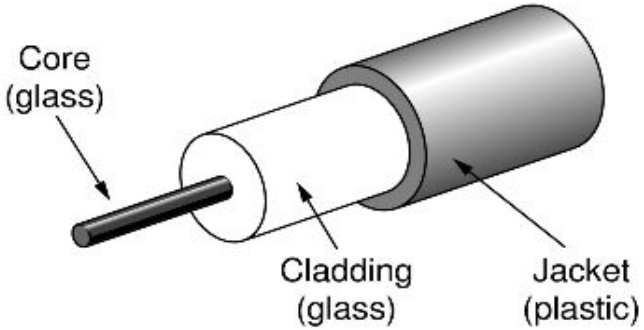
(a) (b)

Coaxial Cable

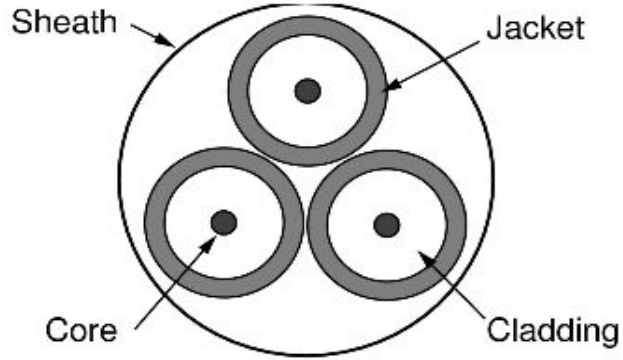


A coaxial cable

Fiber Cables



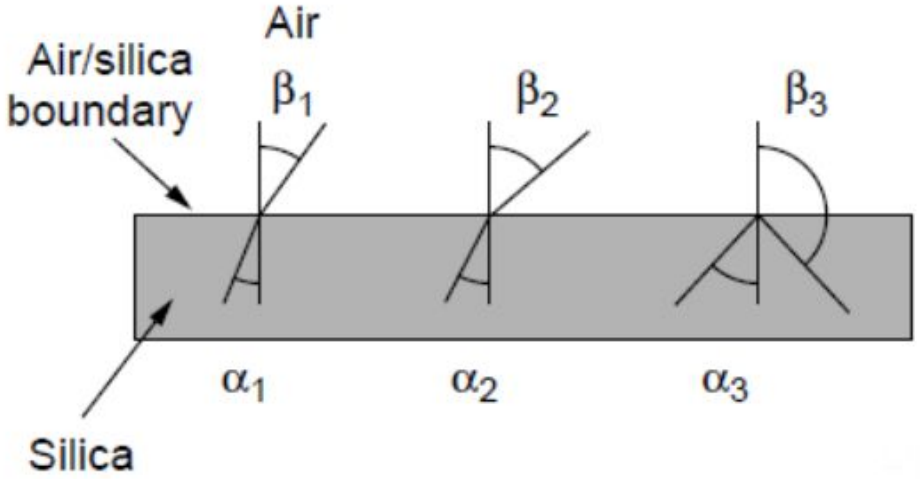
(a)



(b)

Views of a fiber cable

Fiber Optics



Three examples of a light ray from inside a silica fiber impinging on the air/silica boundary at different angles.

Figure 2-9. A fiber optic ring with active repeaters.

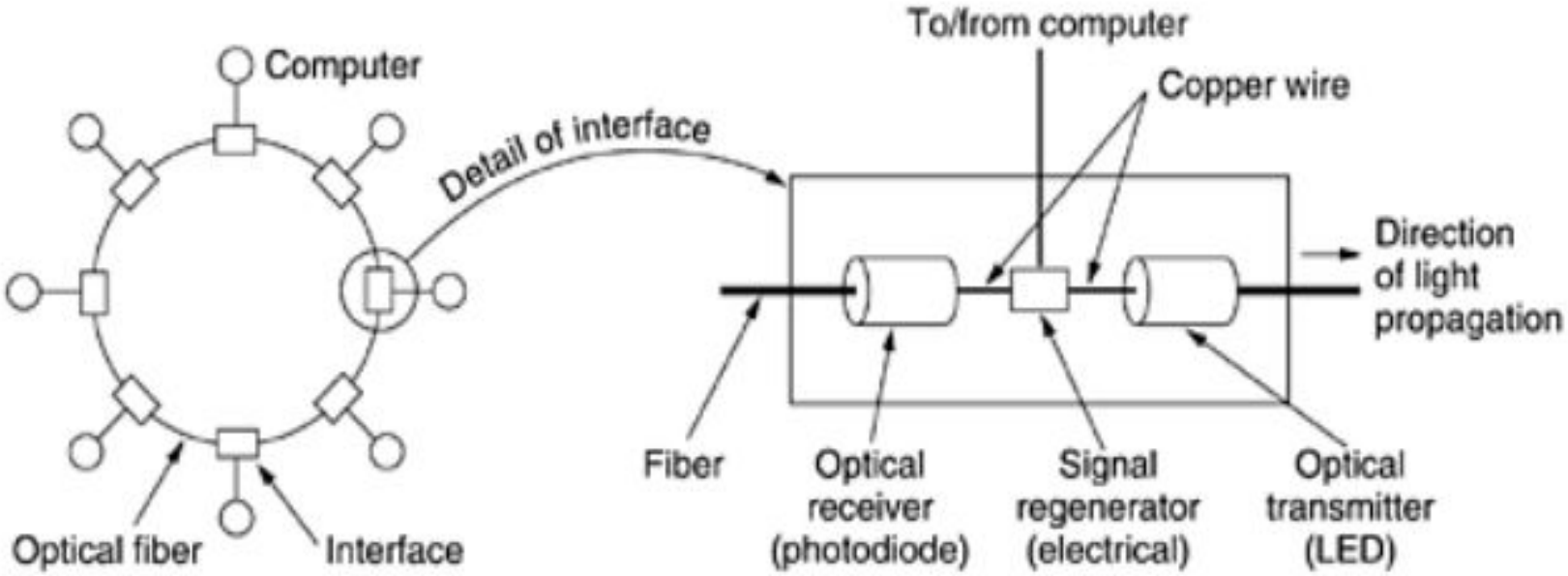
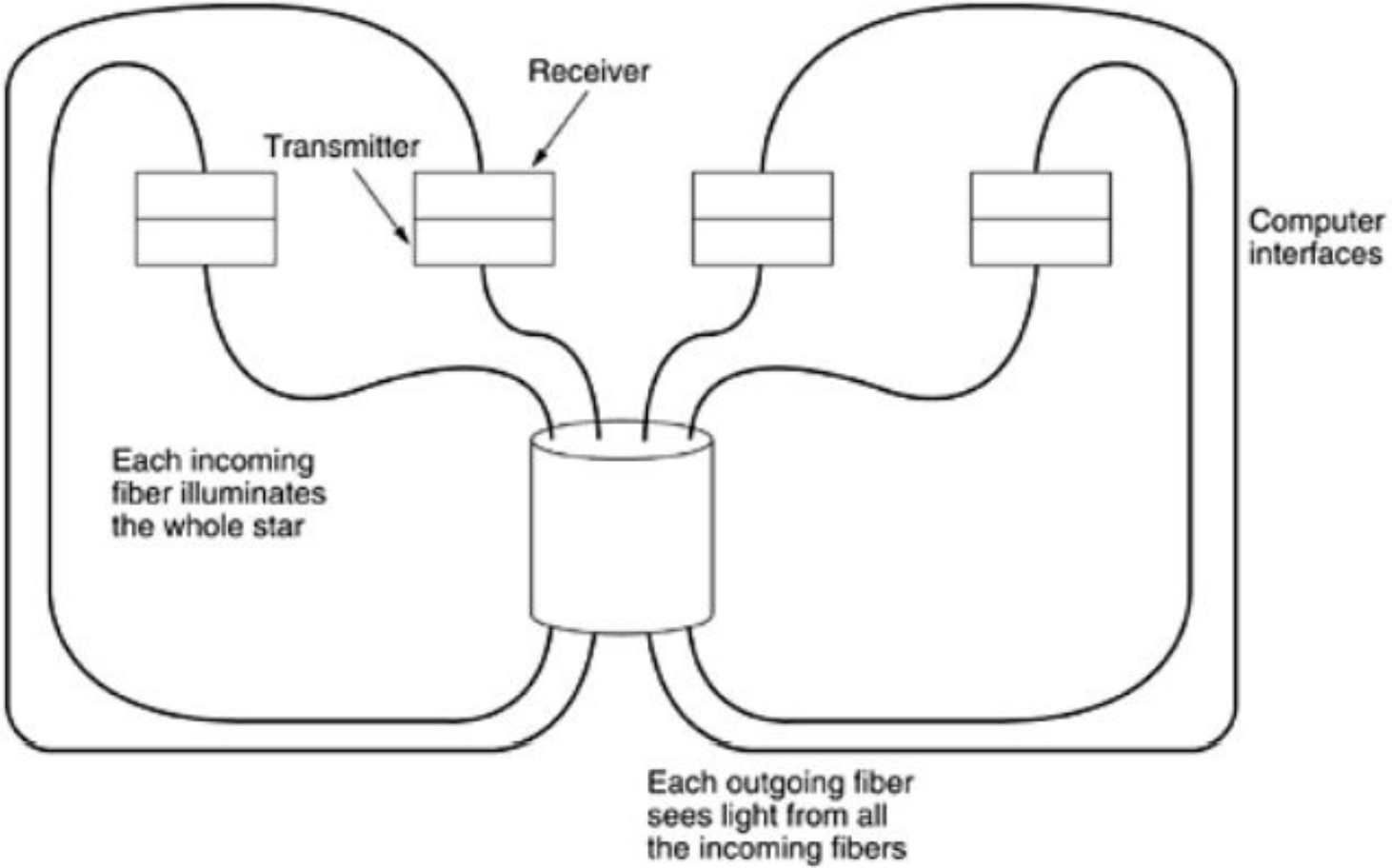


Figure 2-10. A passive star connection in a fiber optics network.



Comparison of copper with fiber

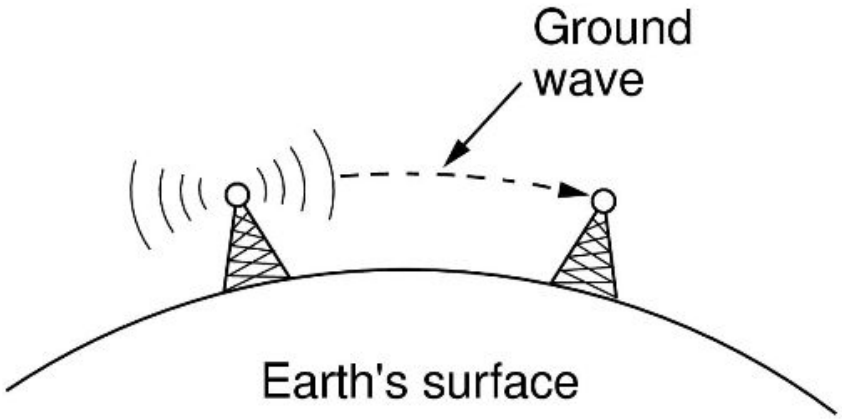
Fiber advantages compare to copper wire- high bandwidth, low attenuation, not affected by power surges, electromagnetic interference or power failures, not affected by chemicals, thin and lightweight, avoids expensive and bulky support systems, provides excellent security- difficult to tap.

Downsides of fiber- requires skilled individuals, delicate- broken easily, interfacing is costly, usually unidirectional.

Unguided media-->Wireless Transmission

- Radio Transmission
- Microwave Transmission
- Infrared Transmission
- Light Transmission

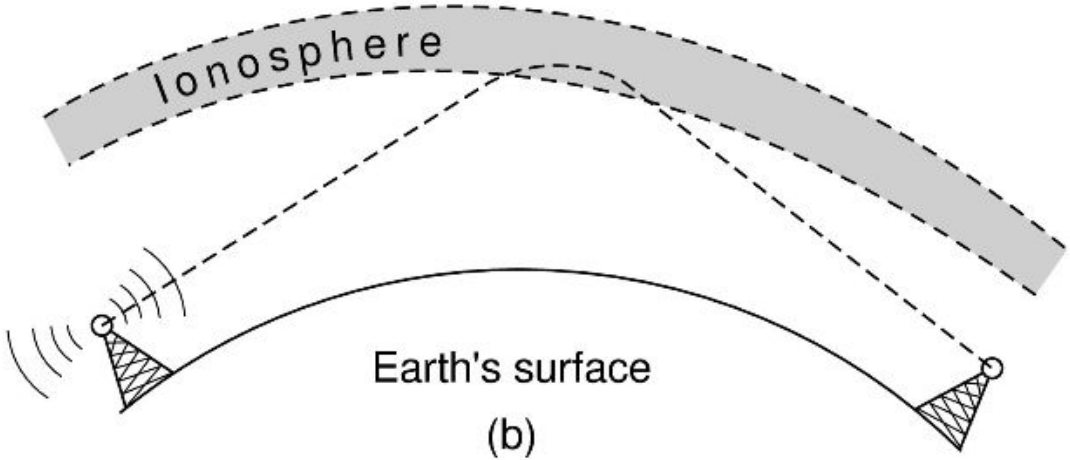
Radio Transmission



(a)

In the VLF, LF, and MF bands, radio waves follow the curvature of the earth

Radio Transmission



In the HF band, they bounce off the ionosphere.

Microwave Transmission

- Electromagnetic waves above 100 MHz tend to travel in a straight line and signals over them can be sent by beaming those waves towards one particular station.
- Because Microwaves travels in straight lines, both sender and receiver must be aligned to be strictly in line-of-sight.
- Microwaves can have wavelength ranging from 1 mm – 1 meter and frequency ranging from 300 MHz to 300 GHz.
- Microwaves have higher frequencies and do not penetrate wall like obstacles.
- Microwave transmission depends highly upon the weather conditions and the frequency it is using.

Infrared and millimeter waves

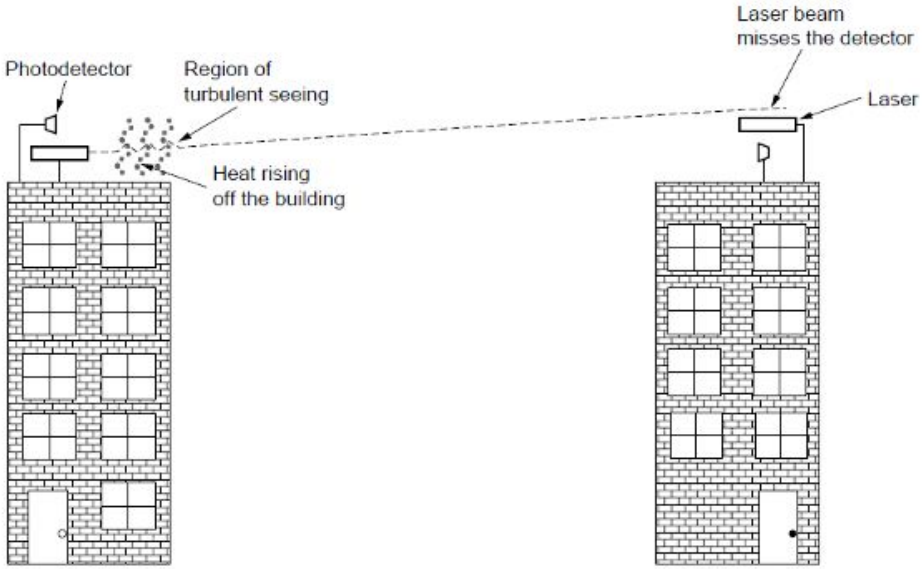
Unguided infrared and millimeter waves are widely used for short-range communication.

The remote controls used on televisions, VCRs, and stereos all use infrared communication.

They are relatively directional, cheap, and easy to build

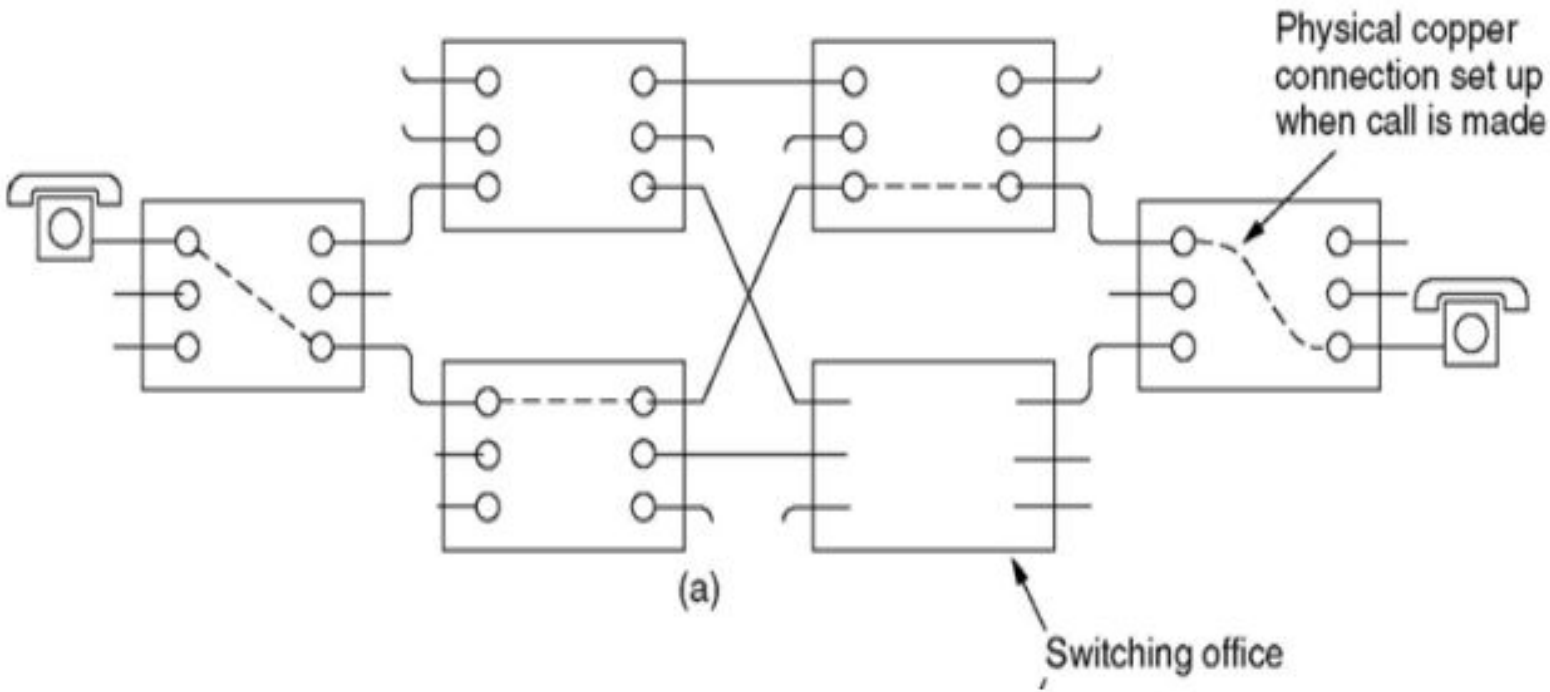
They do not pass through solid objects

Light Transmission

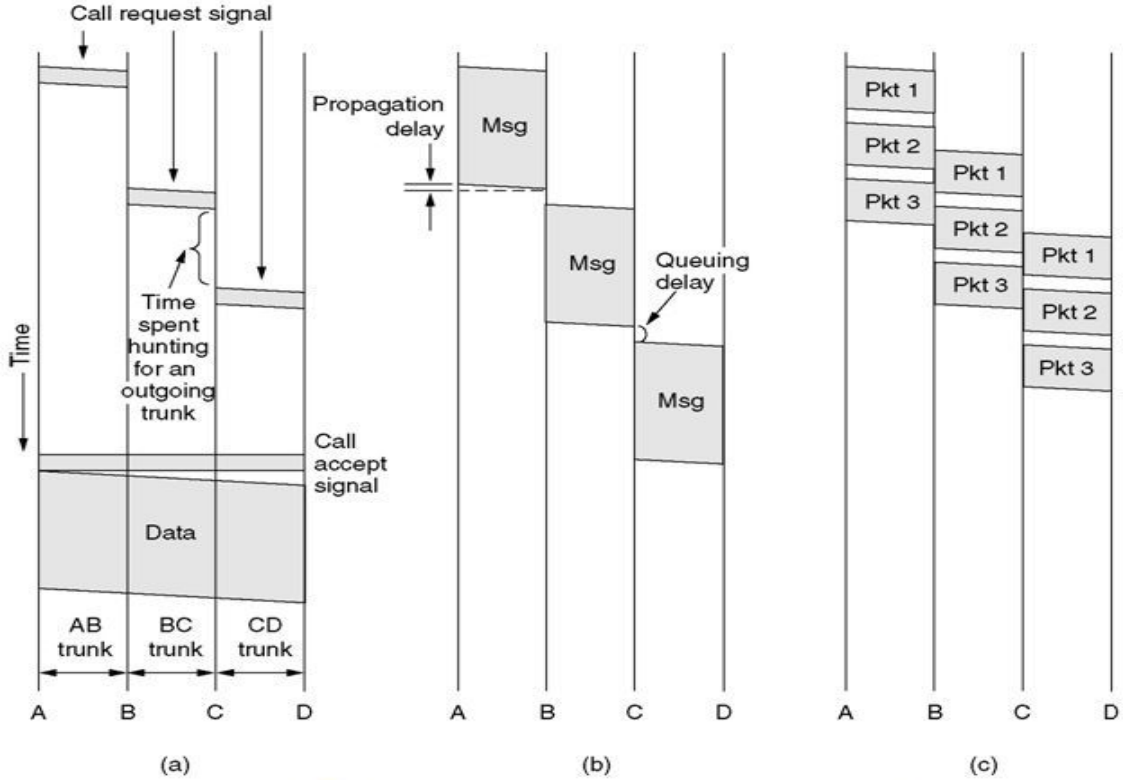


Convection currents can interfere with laser communication systems. A bidirectional system with two lasers is pictured here.

Circuit Switching

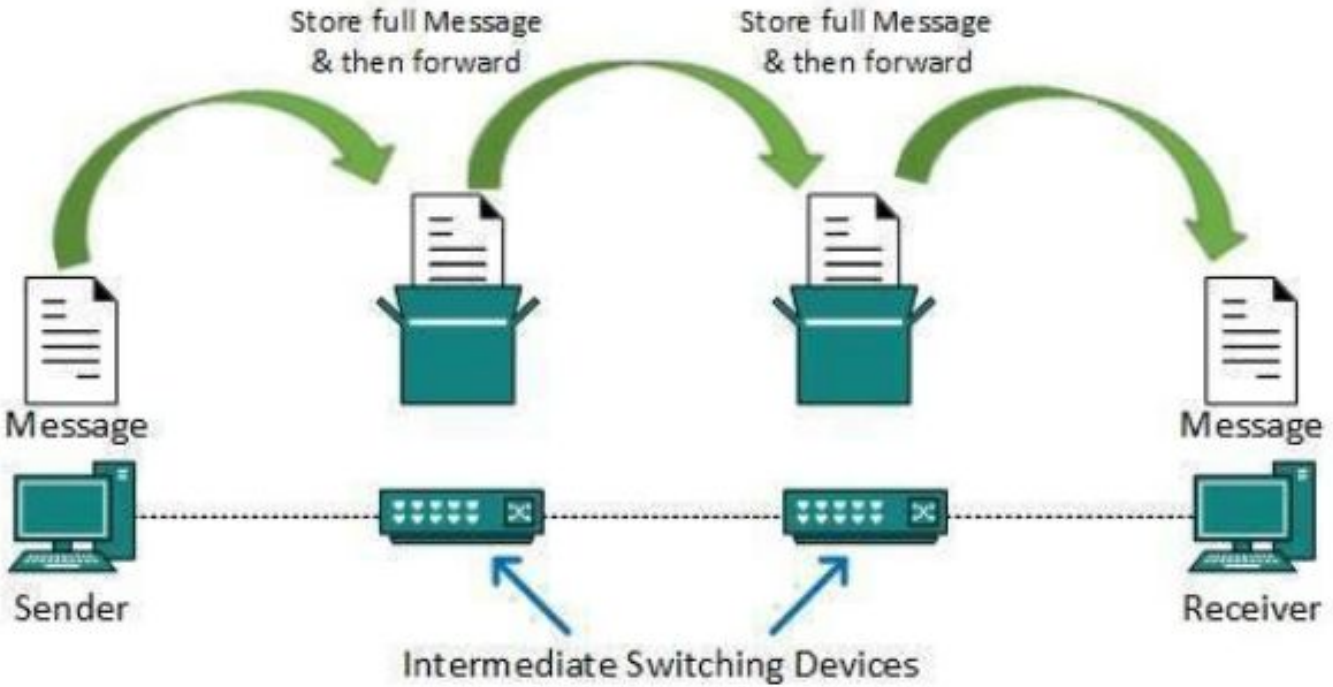


Message Switching



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

Message Switching

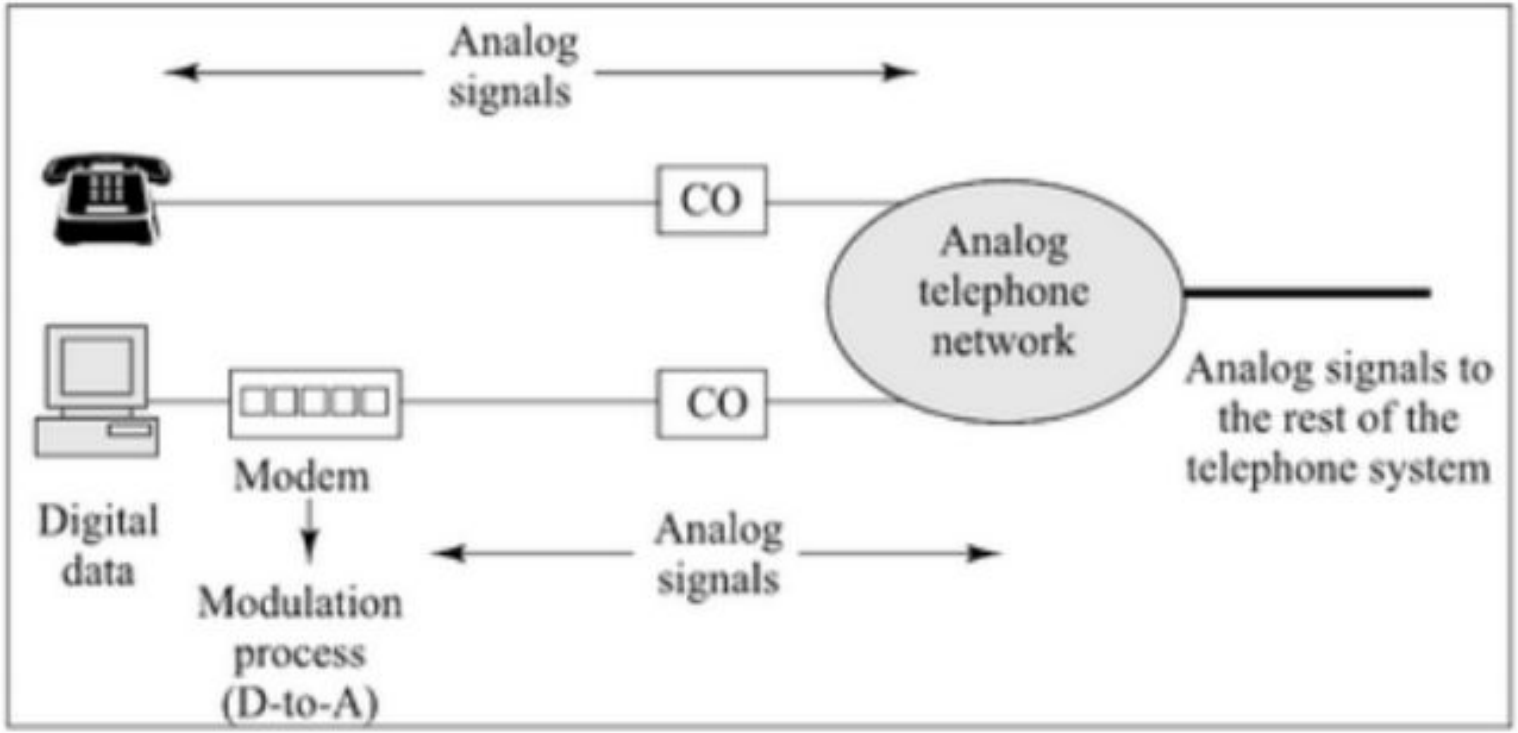


Circuit Switching vs. Packet Switching

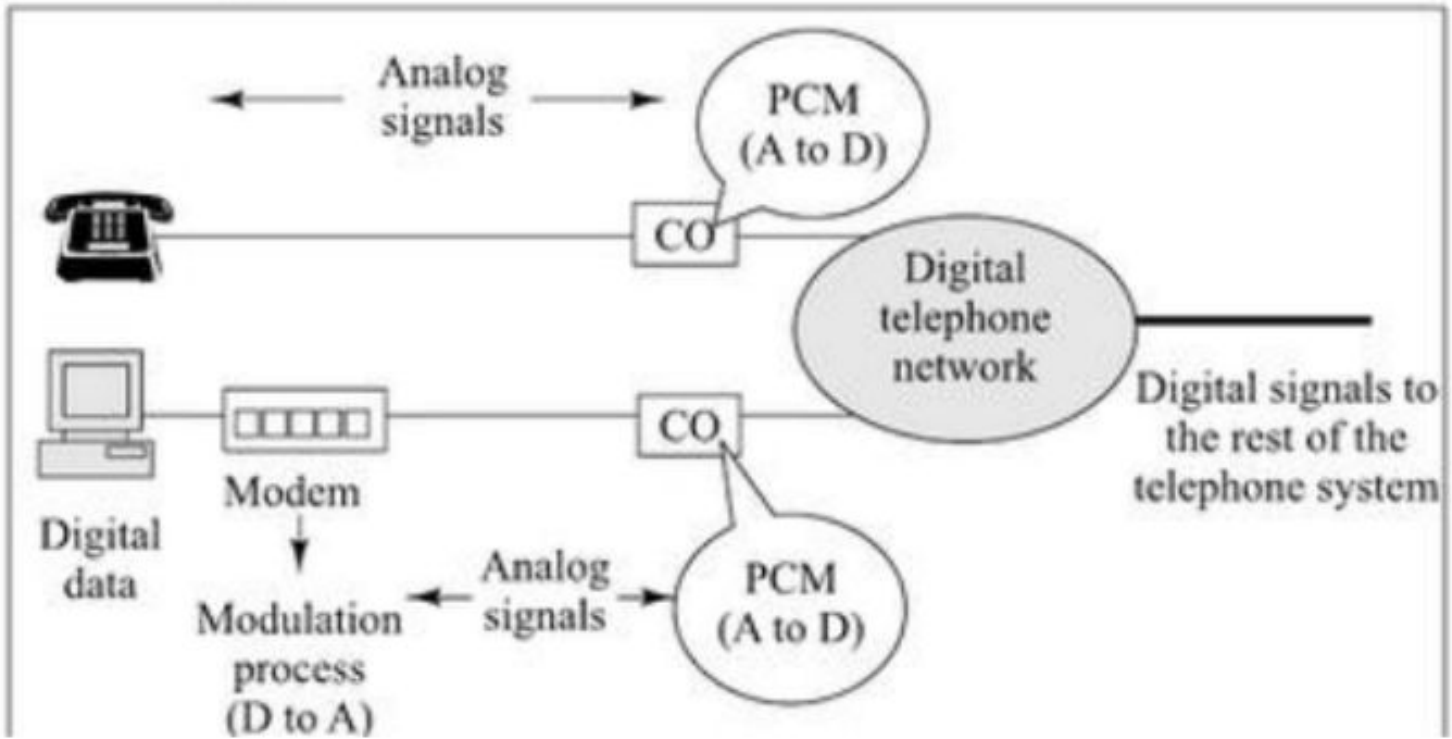
Item	Circuit-switched	Packet-switched
Call setup	Required	Not needed
Dedicated physical path	Yes	No
Each packet follows the same route	Yes	No
Packets arrive in order	Yes	No
Is a switch crash fatal	Yes	No
Bandwidth available	Fixed	Dynamic
When can congestion occur	At setup time	On every packet
Potentially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

A comparison of circuit switched and packet-switched networks.

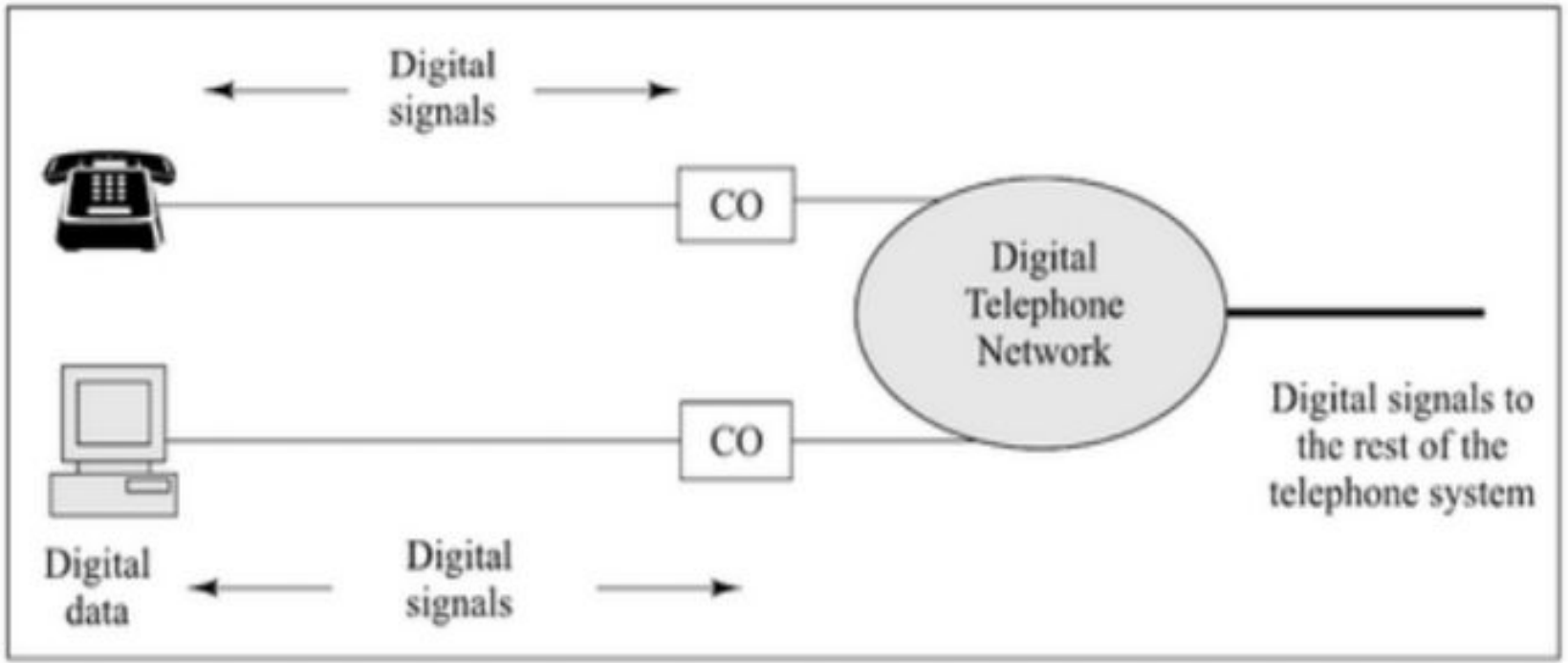
Analog Communication for Voice and Data



Mixed Communication for Voice and Data



ISDN


Digital signals
CO
Digital Telephone Network
CO
Digital signals to the rest of the telephone system
Digital data
Digital signals

ISDN

- **ISDN** or **Integrated Services Digital Network** is a circuit-switched telephone network system that transmits both data and voice over a digital line.
- You can also think of it as a set of communication standards to transmit data, voice, and signaling.
- These digital lines could be copper lines. It was designed to move outdated landline technology to digital.
- ISDN connections have a reputation for providing better speeds and higher quality than traditional connections.
- Faster speeds and better connections allow data transmissions to travel more reliably.
- ISDN was born out of necessity. Analog phone networks failed constantly and proved to be unreliable for long-distance connections.

ISDN

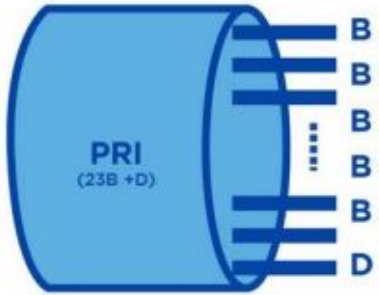
Channel Types

Channel	Data rate in Kbps
Bearer (B)	64
Data (D)	16/64
Hybrid (H)	384/1536/1920

Interfaces

- **Basic rate interface (BRI)**
  - Basic access service or 2B+D
    - Two 64 Kbps bearer 'B' channels (for voice or data)
    - One 16 Kbps control signaling 'D' channel
  - Can be installed over existing telephones lines (if less than 3.5 miles)
  - Requires BRI specific end connections

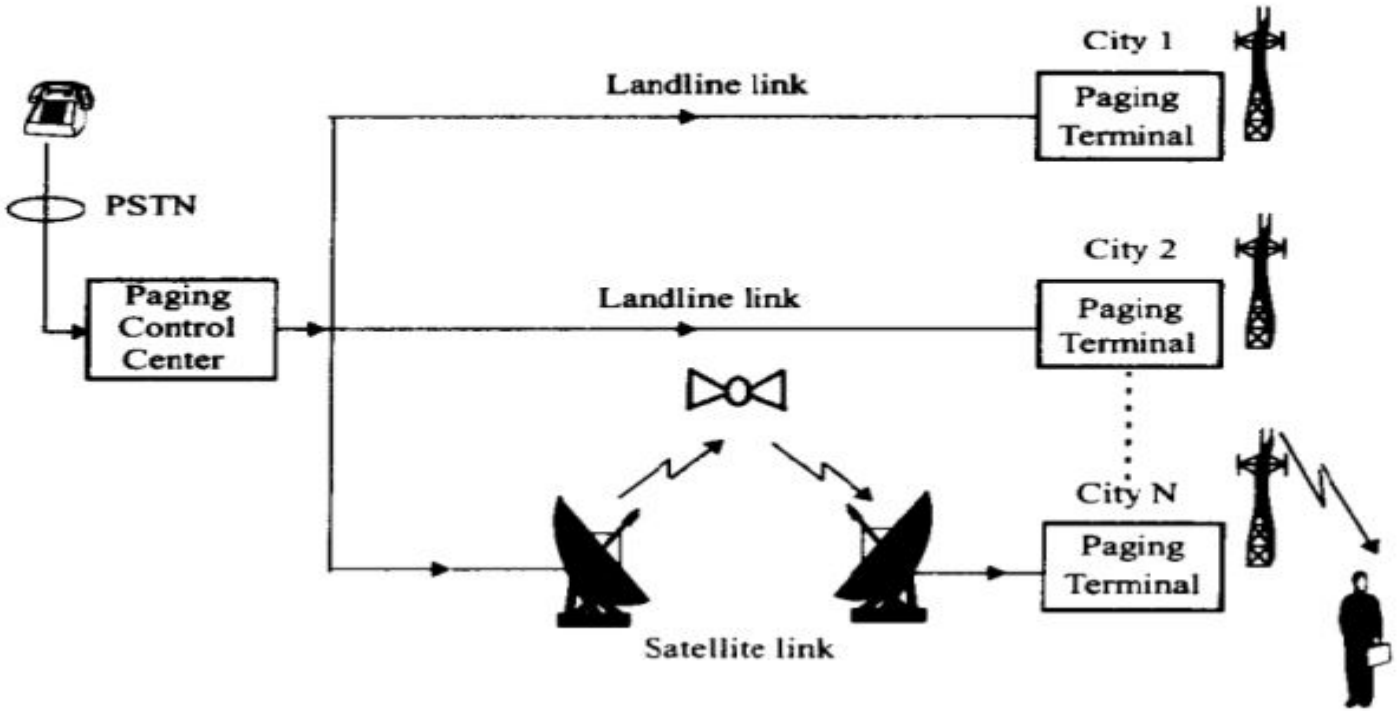
- **Primary rate interface (PRI)**
  - Primary access service or 23B+D
    - Twenty three 64 Kbps 'B' channels
    - One 64 Kbps 'D' channel (basically T-1 service)
  - Requires T1 like special circuit



Broadband ISDN

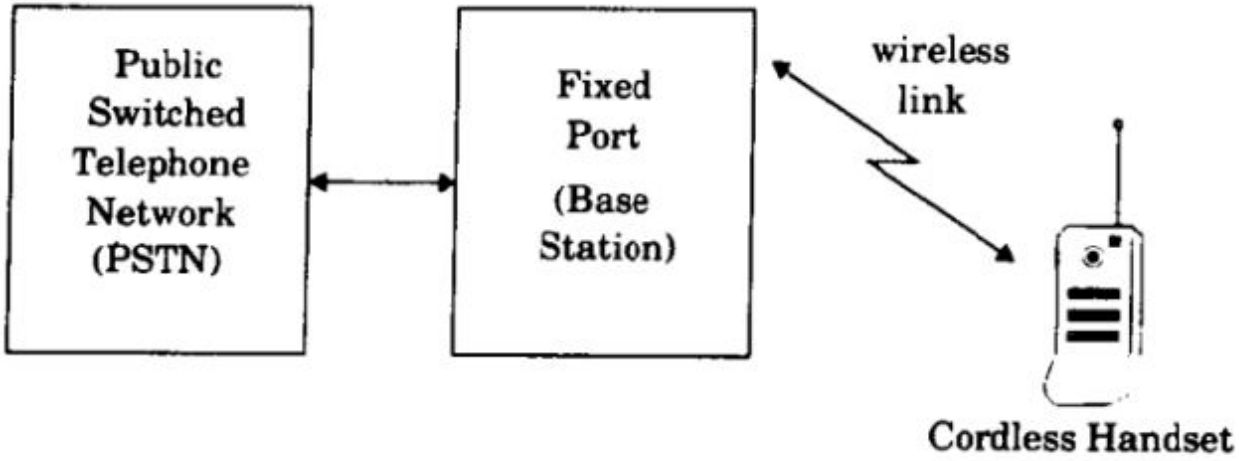
- ISDN was primarily developed for higher bandwidths to the home and business users.
- However soon it was realized that the BRI and PRI maximum transmission rates of 128 Kbps and 1.544 Mbps were not good enough for some high-end applications like video transmissions.
- Which gave the birth to the next generation ISDN services called **Broadband ISDN** (**B-ISDN**). The original ISDN is now called **Narrowband ISDN** (**N-ISDN**).
- B-ISDN provides data rate up to 600 Mbps over fiber optic lines.
- The B-ISDN technology closely related with Asynchronous Transfer Mode (ATM) technology.

Paging System



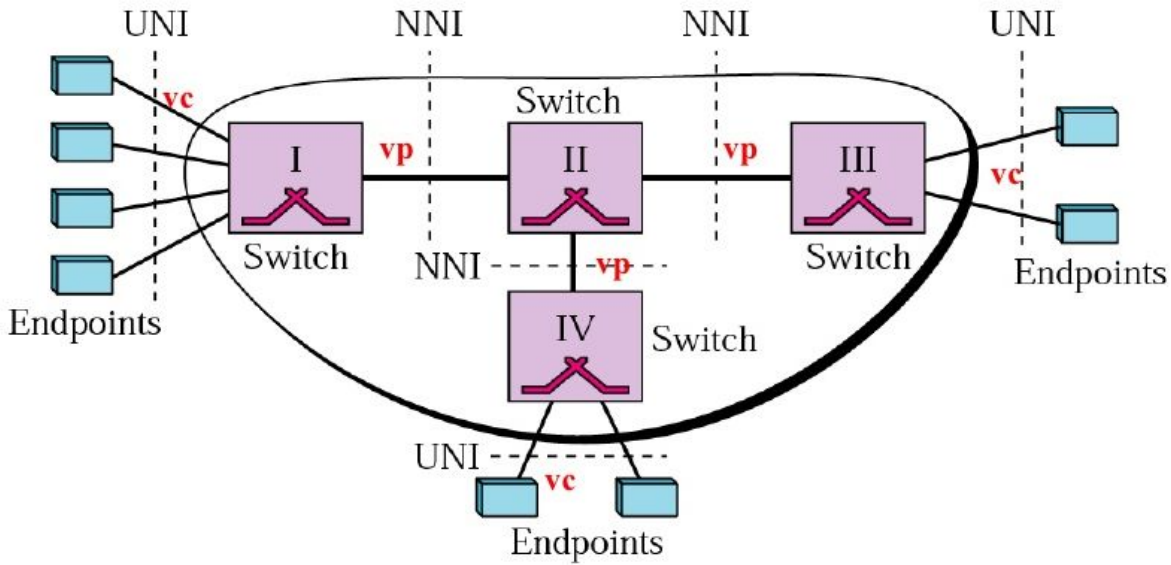
Cordless Telephone System

- Cordless telephone systems are full duplex communication systems that use radio to connect a portable handset to a dedicated base station, which is then connected to a dedicated telephone line with a specific telephone number on the public switched telephone network (PSTN).



ATM- Asynchronous Transfer Mode

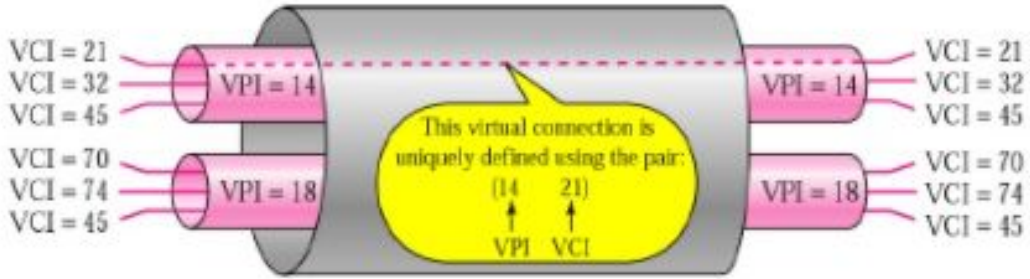
ATM Technology
Architecture of ATM Network



User-to-network interface (**UNI**): interface between endpoint (user access devices) and network switches.

Network-to-network interface (**NNIs**): interface between switches insides the network.

ATM Technology
ATM Virtual Connection



1- Transmission Path (TP): the physical connection (wire, cable, satellite, …) between an endpoint and a switch or between two switches.

2- Virtual Paths (VPs): provides a connection or a set of connections between two switches.

3- Virtual Circuits (VCs): Cell networks are based on virtual circuits. All cells belonging a single message follow the same virtual circuit and remain in their original order until they reach their destination.

VC must be set up across the ATM network prior to any data transfer.

ATM Layers

The ATM standard defines three layers. They are, from top to bottom, the application adaptation layer, the ATM layer, and the physical layer as shown in Figure 3.35.

Figure 3.35 *ATM layers*

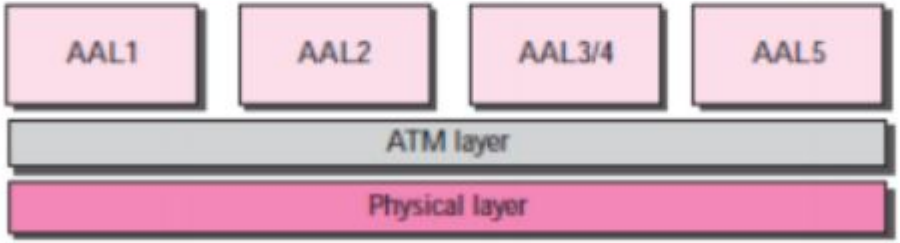
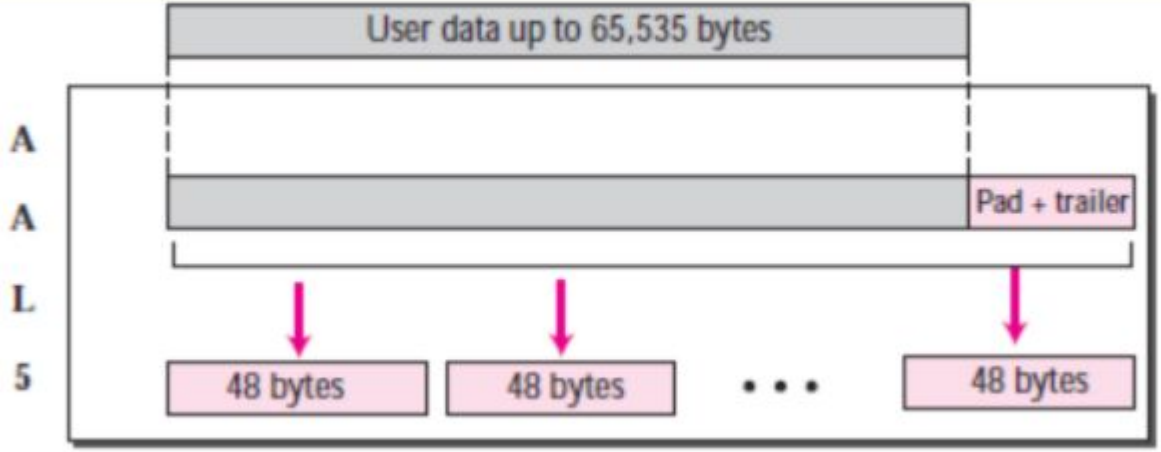


Figure 3.37 *AAL5*



ATM Layer