Class- BSc(IT)-5th sem

Subject-Computer Network

Paper-I

By-

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Syllabus

UNIT – I

Basic concepts of Computer Networks, Client Server Network topologies. OSI Reference Model, TCP/IP Model Comparison and Critiques, Concepts of Routers, bridges, Repeaters, Gateways.

UNIT – II

Data Transmission: – Analog & Digital Transmission, Modem, Codec, Pulse Code Modulation Multiplexing, Circuit Switching, Packet Switching, message Switching, Hybrid Switching. Transmission Media: –

Twisted Pair, Co–axial Cable, Baseband, Broadband, Fibre optics, Satellite, Wireless Transmission, Telephone System

The Data link Layer: Design Issues, Error Detection and Correction, Data Link Sliding Window Protocols.

UNIT – III

IEEE Standard 802 for LAN's and MAN's Routing Algorithm. Internetworking, Network Security.

Covered Syllabus

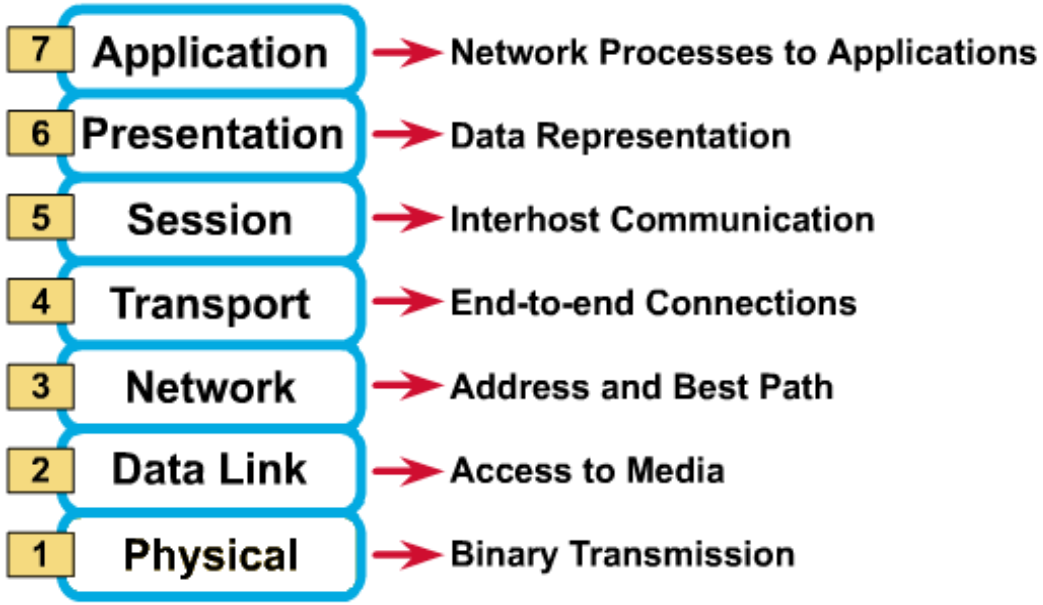
- OSI Model
- Comparison of OSI with TCP/IP Model
- Critique of OSI Model
- Transmission Media
  - Guided Media
    - Twisted Pair
    - Coaxial Cable
    - Fiber Optic
  - Unguided Media
    - Microwave
    - Satellite
- Telephone System

OSI MODEL

Open Systems Interconnection (OSI) Model

- International standard organization (ISO) established a committee in 1977 to develop an architecture for computer communication.
- Open Systems Interconnection (OSI) reference model is the result of this effort.
- In 1984, the Open Systems Interconnection (OSI) reference model was approved as an international standard for communications architecture.
- Term “open” denotes the ability to connect any two systems which conform to the reference model and associated standards.

OSI Reference Model: 7 Layers



Physical Layer

- Provides physical interface for transmission of information.
- Defines rules by which bits are passed from one system to another on a physical communication medium.
- Covers all - mechanical, electrical, functional and procedural - aspects for physical communication.
- Such characteristics as voltage levels, timing of voltage changes, physical data rates, maximum transmission distances, physical connectors, and other similar attributes are defined by physical layer specifications.

Data Link Layer

- Data link layer attempts to provide reliable communication over the physical layer interface.
- Breaks the outgoing data into frames and reassemble the received frames.
- Create and detect frame boundaries.
- Handle errors by implementing an acknowledgement and retransmission scheme.
- Implement flow control.
- Supports points-to-point as well as broadcast communication.
- Supports simplex, half-duplex or full-duplex communication.

Network Layer

- Implements routing of frames (packets) through the network.

- Defines the most optimum path the packet should take from the source to the destination
- Defines logical addressing so that any endpoint can be identified.
- Handles congestion in the network.
- Facilitates interconnection between heterogeneous networks (Internetworking).
- The network layer also defines how to fragment a packet into smaller packets to accommodate different media.

Transport Layer

- Purpose of this layer is to provide a reliable mechanism for the exchange of data between two processes in different computers.
- Ensures that the data units are delivered error free.
- Ensures that data units are delivered in sequence.
- Ensures that there is no loss or duplication of data units.
- Provides connectionless or connection oriented service.
- Provides for the connection management.
- Multiplex multiple connection over a single channel.

Session Layer

- Session layer provides mechanism for controlling the dialogue between the two end systems. It defines how to start, control and end conversations (called sessions) between applications.
- This layer requests for a logical connection to be established on an end-user's request.
- Any necessary log-on or password validation is also handled by this layer.
- Session layer is also responsible for terminating the connection.
- This layer provides services like dialogue discipline which can be full duplex or half duplex.
- Session layer can also provide check-pointing mechanism such that if a failure of some sort occurs between checkpoints, all data can be retransmitted from

Presentation Layer

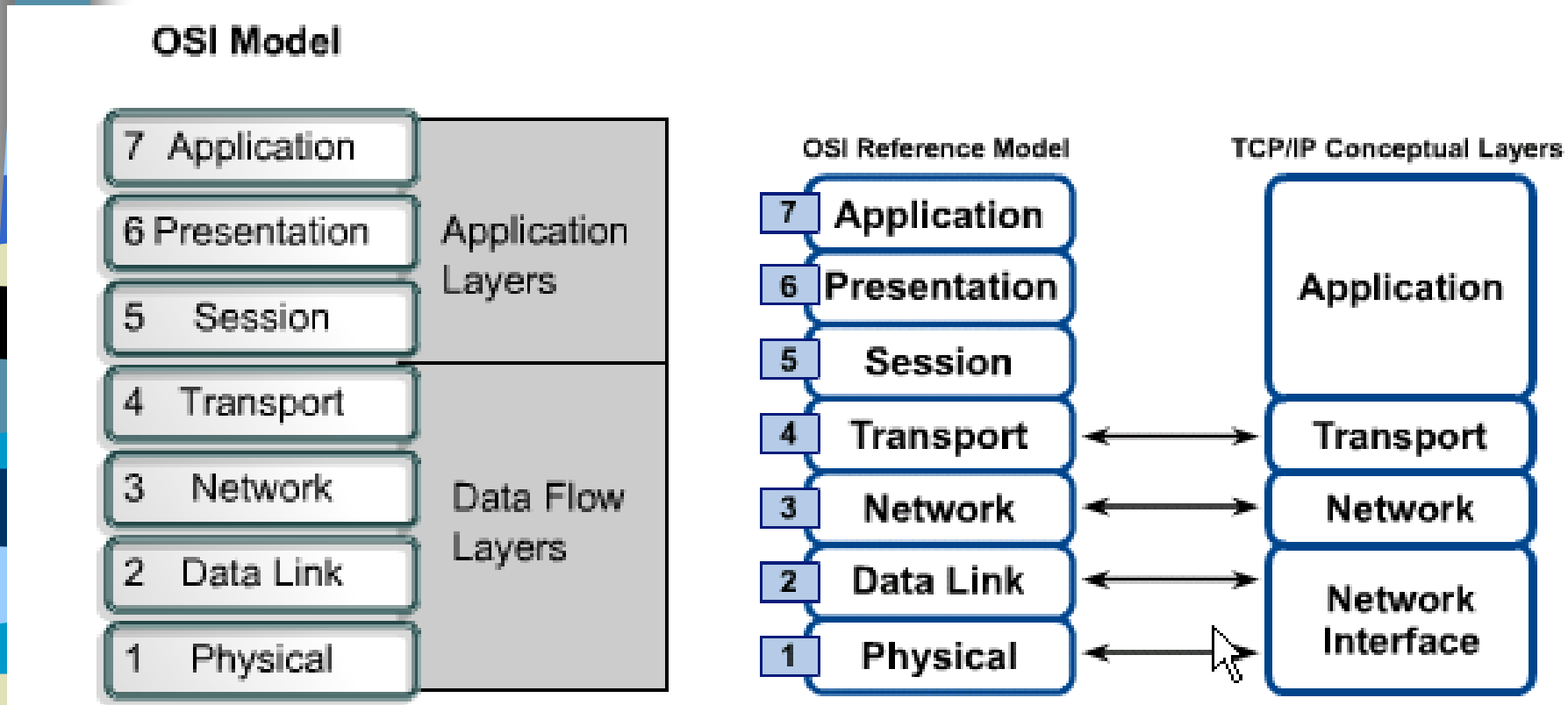
- Presentation layer defines the format in which the data is to be exchanged between the two communicating entities.
- Also handles data compression and data encryption (cryptography).

Application Layer

- Application layer interacts with application programs and is the highest level of OSI model.
- Application layer contains management functions to support distributed applications.
- Examples of application layer are applications such as file transfer, electronic mail, remote login etc.

Comparison of OSI and TCP/IP

OSI & TCP/IP Models



OSI

- OSI makes the distinction between services, interfaces, and protocol.
- The OSI model was devised before the protocols were invented. It can be made to work in diverse heterogeneous networks.

TCP/IP

- TCP/IP does not originally clearly distinguish between services, interface, and protocol.
- TCP/IP model was just a description of the existing protocols. The model and the protocol fit perfectly.

OSI

- The OSI model supports both connectionless and connection-oriented communication in the network layer, but only connection-oriented communication in the transport layer.

TCP/IP

- The TCP/IP model has only one mode in the network layer (connectionless) but supports both modes in the transport layer, giving the user choice.

OSI	TCP/IP
The network-layer addressing defines network addressing domains--IDP (AFI, IDI) and DSP.	IP address consists of 32 bits, include network-number part and host-number part.
It identifies the abstract service access point between the transport and network layers.	It identifies the actual point of attachment of a computer system to a real sub-network (the “network interface”).

OSI

- The Session layer handles session setup, data or message exchanges, and tear down when the session ends.
- It also monitors session identification so only designated parties can participate and security services to control access to session information.

TCP/IP

- The TCP/IP model does not have a general session layer protocol.
- In TCP/IP the term “sockets” and “ports” are used to describe the path over which cooperating application communicates.

OSI

- The Presentation Layer handles data format information for networked communications. For outgoing messages, it converts data into a generic format that can survive the rigors of network transmission; for incoming messages, it converts data from its generic networked representation into a format that will make sense to the receiving application.

TCP/IP

- Presentation layer is not present in TCP/IP model. Instead this function is frequently handled within the applications in TCP/IP through External Data Representation Standard(XDR) and Multipurpose Internet Mail Extensions (MIME).

Critique

OSI

- Bad timing, by the time the OSI protocols appeared, the competition TCP/IP protocols were already in widespread use.
- Bad technology, both the model and the protocols are flawed, the model along with the associated service definitions and protocols are very complex.

TCP/IP

- The model does not clearly distinguish the concepts of services, interface, and protocol.
- It is not at all general and is poorly suited to describing any protocol stack other than TCP/IP.

OSI

- Bad implementation, the initial implementations were huge, unwieldy, and slow. (poor quality)
- Bad politics, it was thought to be the creature of the government.

TCP/IP

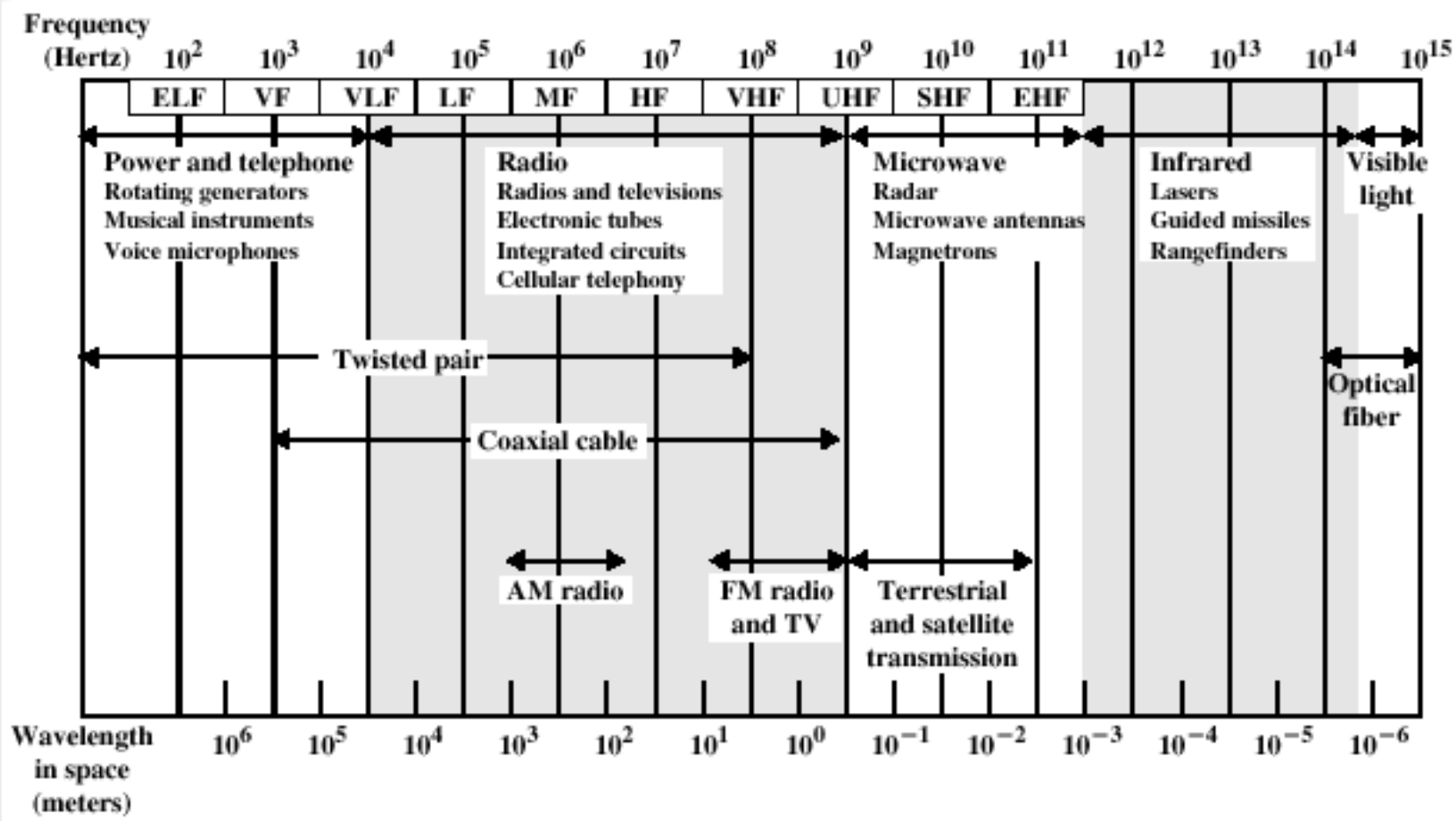
- The host-to-network layer is not really a layer.
- The model does not distinguished the physical and data link layers

Transmission Media

Classes of Transmission Media

- Conducted or guided media
  - use a conductor such as a wire or a fiber optic cable to move the signal from sender to receiver
- Wireless or unguided media
  - use radio waves of different frequencies and do not need a wire or cable conductor to transmit signals

Electromagnetic Spectrum for Transmission Media



Guided Transmission Media

- Transmission capacity depends on the distance and on whether the medium is point-to-point or multipoint
- Examples
  - twisted pair wires
  - coaxial cables
  - optical fiber

Twisted Pair Wires

- Consists of two insulated copper wires arranged in a regular spiral pattern to minimize the electromagnetic interference between adjacent pairs
- Often used at customer facilities and also over distances to carry voice as well as data communications
- Low frequency transmission medium

Types of Twisted Pair

- STP (shielded twisted pair)
  - the pair is wrapped with metallic foil or braid to insulate the pair from electromagnetic interference
- UTP (unshielded twisted pair)
  - each wire is insulated with plastic wrap, but the pair is encased in an outer covering

Ratings of Twisted Pair

- Category 3 UTP
  - data rates of up to 16mbps are achievable
- Category 5 UTP
  - data rates of up to 100mbps are achievable
  - more tightly twisted than Category 3 cables
  - more expensive, but better performance
- STP
  - More expensive, harder to work with

Twisted Pair Advantages

- Inexpensive and readily available
- Flexible and light weight
- Easy to work with and install

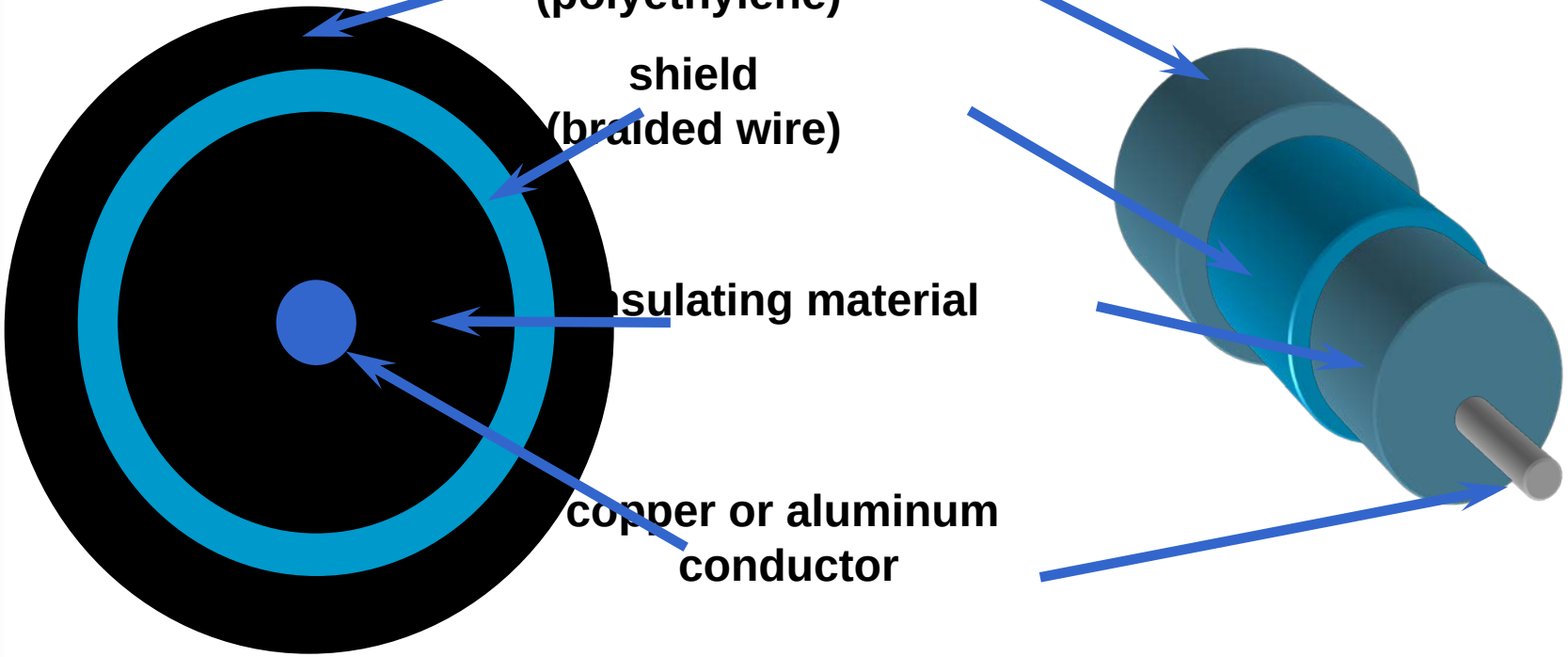
Twisted Pair Disadvantages

- Susceptibility to interference and noise
- Attenuation problem/ Short Range
  - For analog, repeaters needed every 5-6km
  - For digital, repeaters needed every 2-3km
- Relatively Low data rate

Coaxial Cable (or Coax)

- Used for cable television, LANs, telephony
- Has an inner conductor surrounded by a braided mesh
- Both conductors share a common center axial, hence the term “co-axial”

Coax Layers


outer jacket
(polyethylene)
shield
(braided wire)
nsulating material
copper or aluminum
conductor

Coax Advantages

- Higher bandwidth
  - 400 to 600Mhz
  - up to 10,800 voice conversations
- Can be tapped easily (pros and cons)
- Much less susceptible to interference than twisted pair

Coax Disadvantages

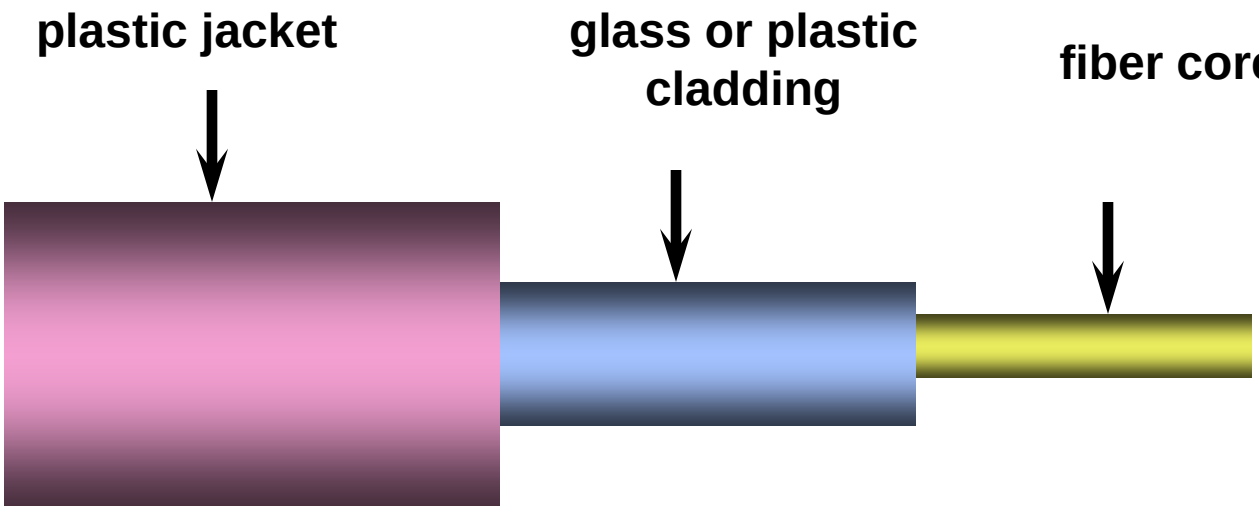
- High attenuation rate makes it expensive over long distance
- Bulky

Fiber Optic Cable

- Relatively new transmission medium used by telephone companies in place of long-distance trunk lines
- Also used by private companies in implementing local data communications networks
- Require a light source with injection laser diode (ILD) or light-emitting diodes (LED)

Fiber Optic Layers

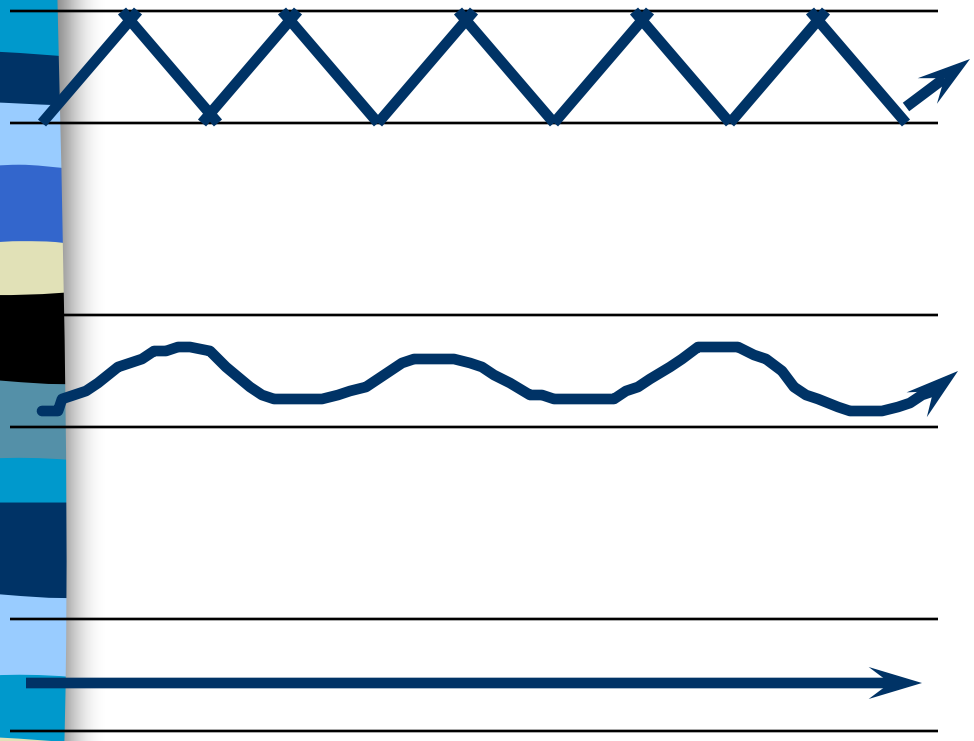
- consists of three concentric sections



Fiber Optic Types

- multimode step-index fiber
  - the reflective walls of the fiber move the light pulses to the receiver
- multimode graded-index fiber
  - acts to refract the light toward the center of the fiber by variations in the density
- single mode fiber
  - the light is guided down the center of an extremely narrow core

Fiber Optic Signals



fiber optic multimode step-index

fiber optic multimode graded-index

fiber optic single mode

Fiber Optic Advantages

- greater capacity (bandwidth of up to 2 Gbps)
- smaller size and lighter weight
- lower attenuation
- immunity to environmental interference
- highly secure due to tap difficulty and lack of signal radiation

Fiber Optic Disadvantages

- expensive over short distance
- requires highly skilled installers
- adding additional nodes is difficult

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

Wireless Examples

- microwave
- satellite

Microwave

- used for long-distance telephone service
- uses radio frequency spectrum, from 2 to 40 Ghz
- parabolic dish transmitter, mounted high
- used by common carriers as well as private networks
- requires unobstructed line of sight between source and receiver
- curvature of the earth requires stations (repeaters) ~30 miles apart

Microwave Applications

- Television distribution
- Long-distance telephone transmission
- Private business networks

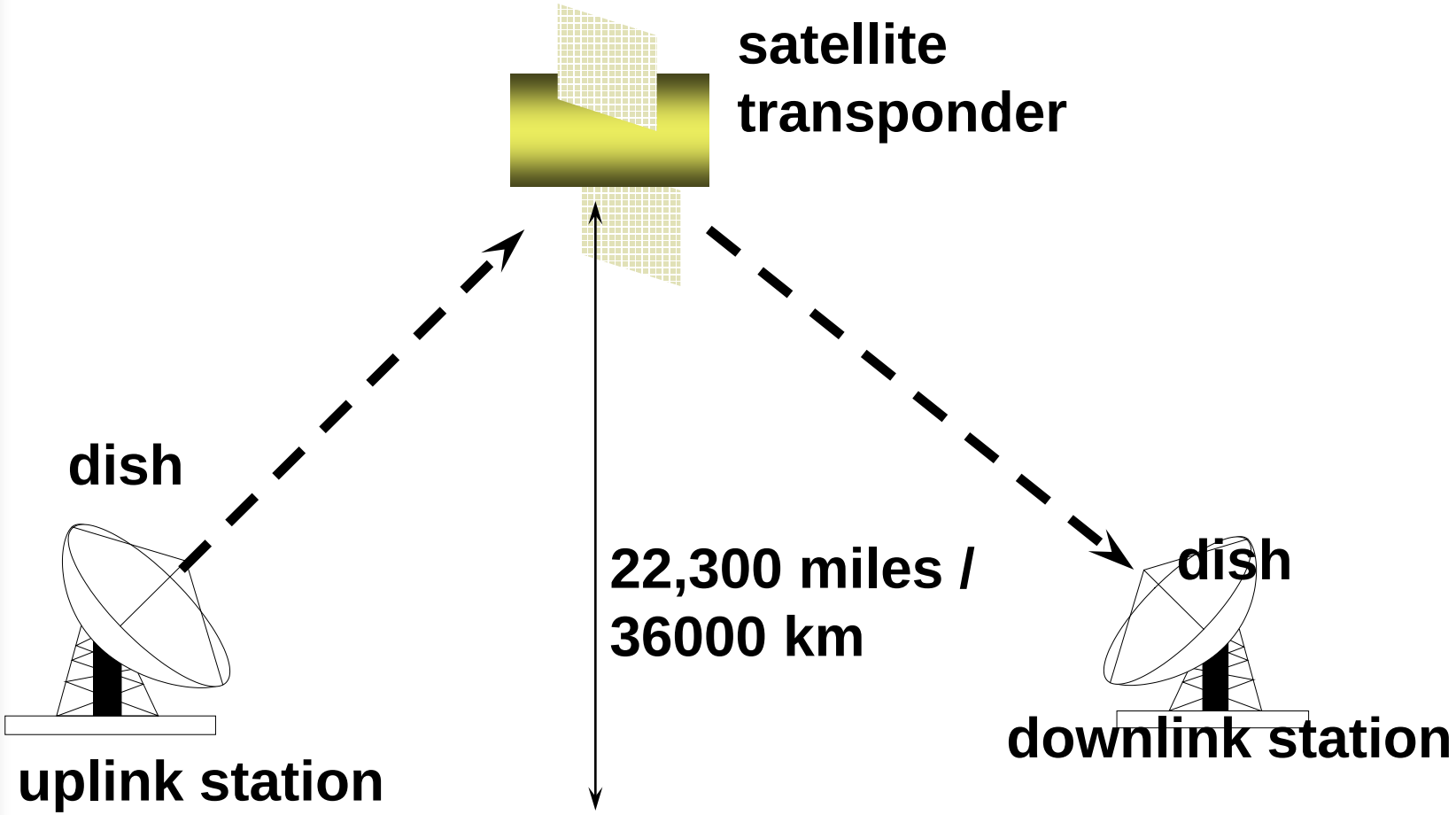
Microwave Transmission Disadvantages

- line of sight requirement
- expensive towers and repeaters
- subject to interference such as passing airplanes and rain

Satellite

- Today, satellite systems can provide a variety of services including broadband communications, audio/video distribution networks, maritime navigation, worldwide customer service and support as well as military command and control.
- Satellite systems are also expected to play an important role in the emerging 4G global infrastructure providing the wide area coverage necessary for the realization of the “Optimally Connected Anywhere, Anytime” vision that drives the growth of modern telecom industry.

Satellite Transmission Process



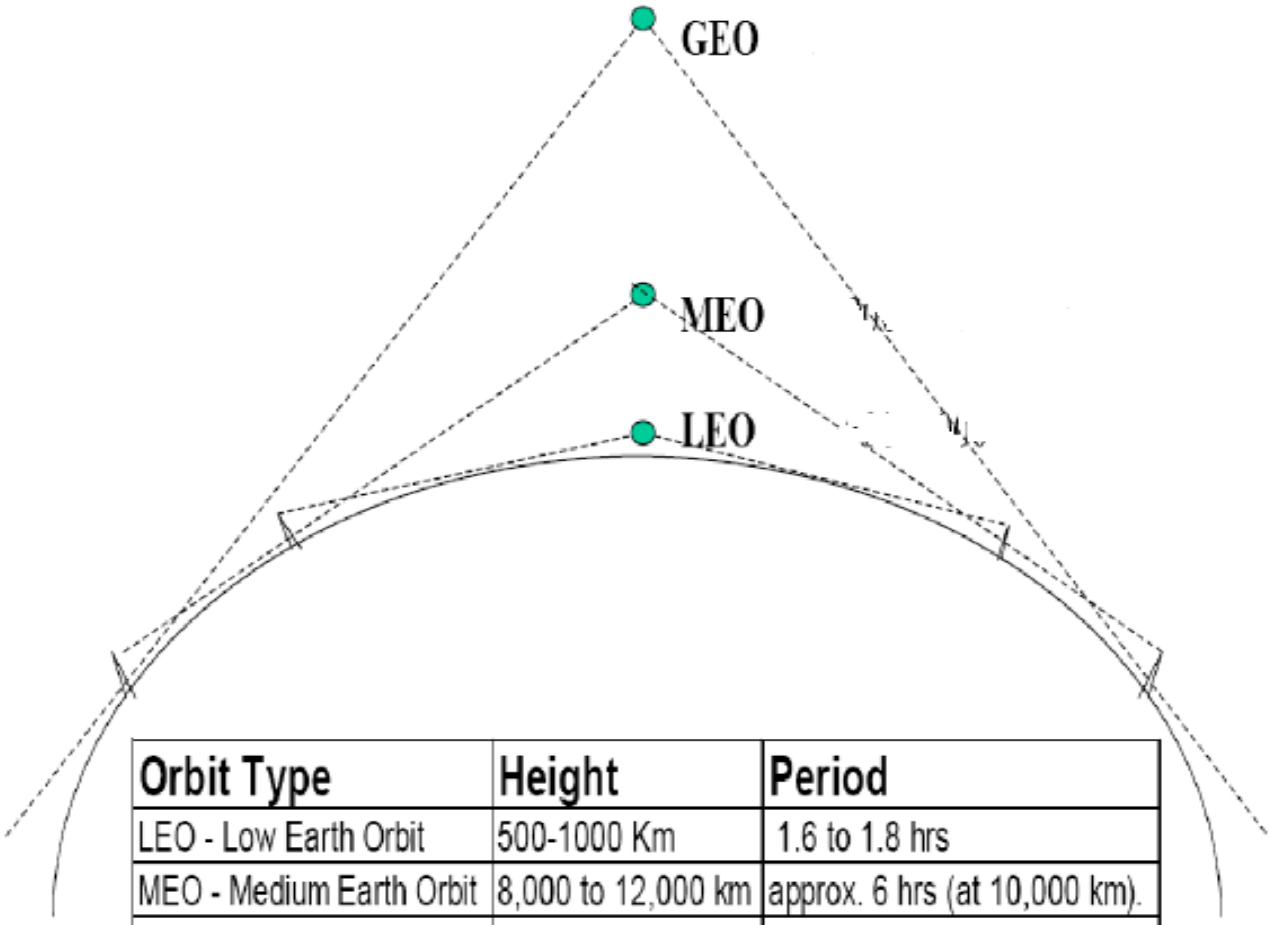
Satellite Transmission

- earth stations communicate by sending signals to the satellite on an uplink
- satellite Transponder converts the signal and sends it down to the second earth station. This is called a Downlink.
- the broadcast nature of the downlink makes it attractive for services such as the distribution of television programming

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

Satellite Types



Orbit Type	Height	Period
LEO - Low Earth Orbit	500-1000 Km	1.6 to 1.8 hrs
MEO - Medium Earth Orbit	8,000 to 12,000 km	approx. 6 hrs (at 10,000 km).
GEO - Geostationary	approx. 36,870 km	approx. 24 hrs

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.

GEO

Advantages

- A GEO satellite's distance from earth gives it a large coverage area, almost a fourth of the earth's surface.
- GEO satellites have a 24 hour view of a particular area.
- These factors make it ideal for satellite broadcast and other multipoint applications.

GEO

Disadvantages

- A GEO satellite's distance also cause it to have both a comparatively weak signal and a time delay in the signal, which is bad for point to point communication.
- GEO satellites, centered above the equator, have difficulty broadcasting signals to near polar regions

Low Earth Orbit (LEO)

- LEO satellites are much closer to the earth than GEO satellites, ranging from 500 to 1,500 km above the surface.
- LEO satellites don’t stay in fixed position relative to the surface, and are only visible for 15 to 20 minutes each pass.
- A network of LEO satellites is necessary for LEO satellites to be useful

LEO

Advantages

- A LEO satellite's proximity to earth compared to a GEO satellite gives it a better signal strength and less of a time delay, which makes it better for point to point communication.
- A LEO satellite's smaller area of coverage is less of a waste of bandwidth.

LEO

Disadvantages

- A network of LEO satellites is needed, which can be costly
- LEO satellites have to compensate for Doppler shifts cause by their relative movement.
- Atmospheric drag effects LEO satellites, causing gradual orbital deterioration.

Medium Earth Orbit (MEO)

- A MEO satellite is in orbit somewhere between 8,000 km and 18,000 km above the earth's surface.
- MEO satellites are similar to LEO satellites in functionality.
- MEO satellites are visible for much longer periods of time than LEO satellites, usually between 2 to 8 hours.
- MEO satellites have a larger coverage area than LEO satellites.

MEO

Advantage

- A MEO satellite's longer duration of visibility and wider footprint means fewer satellites are needed in a MEO network than a LEO network.

Disadvantage

- A MEO satellite's distance gives it a longer time delay and weaker signal than a LEO satellite, though not as bad as a GEO satellite.

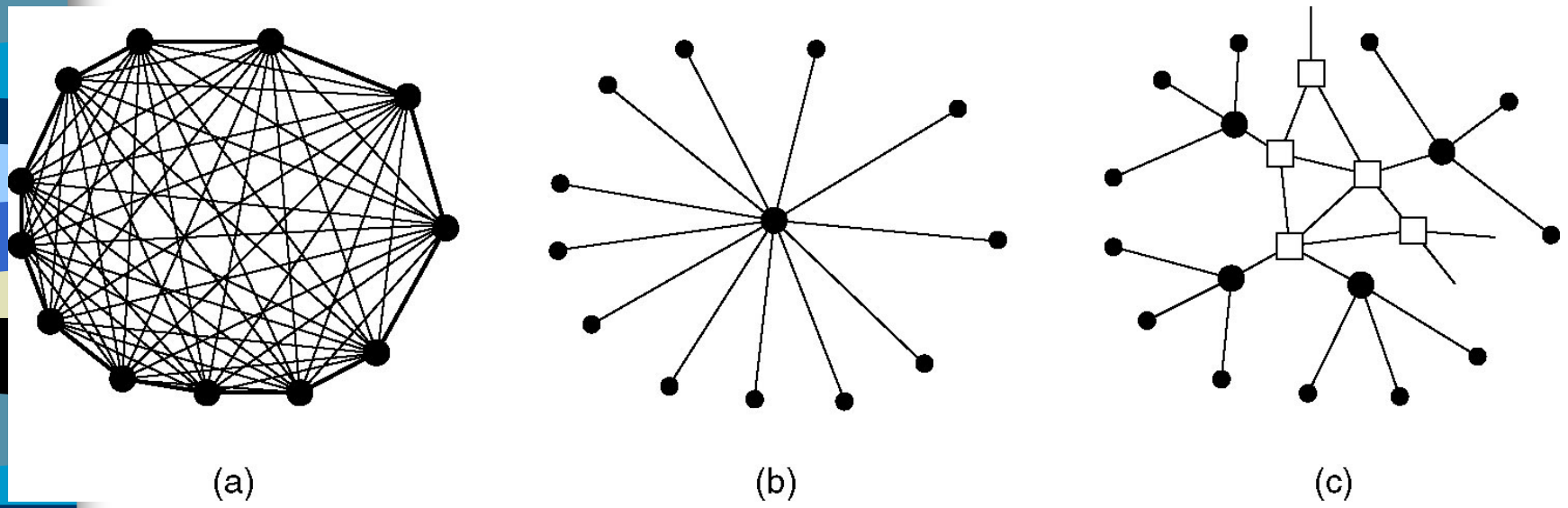
Advantages of Satellites

- The coverage area of a satellite greatly exceeds that of a terrestrial system.
- Transmission cost of a satellite is independent of the distance from the center of the coverage area.
- Satellite to Satellite communication is very precise.
- Higher Bandwidths are available for use.

Disadvantages of Satellites

- Launching satellites into orbit is costly.
- Satellite bandwidth is gradually becoming used up.
- There is a larger propagation delay in satellite communication than in terrestrial communication.

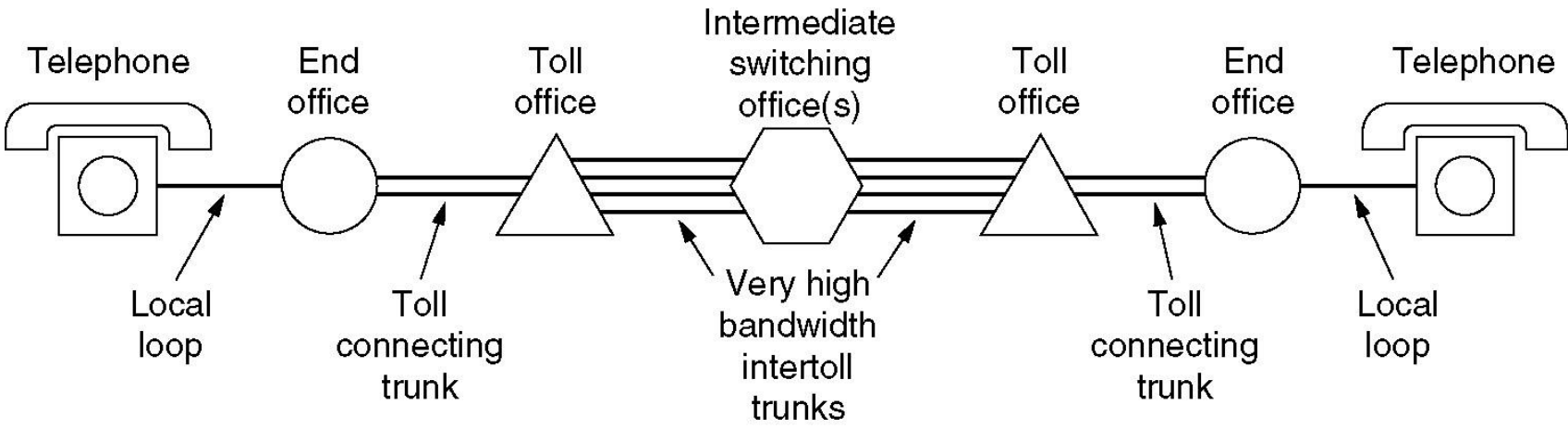
Telephone System



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

Telephone System

A typical circuit route for a telephone call.



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