

Basics of Computer Networks

Learning Objectives

In this Unit we will discuss :

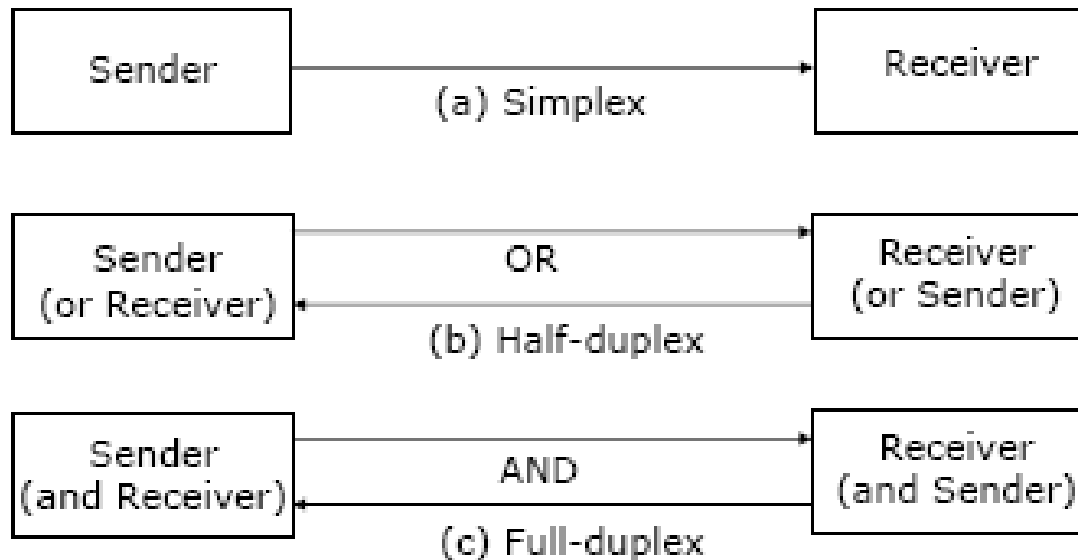
- Basic elements of a Communication System
- Data transmission media
- Digital and Analog Transmission
- Network topologies
- Network Types (LAN, WAN and MAN)
- Introduction to Communication protocols
- Inter networking tools

Basic Elements



Transmission Modes

Transmission Modes





Transmission Speed

§ **Bandwidth:** Range of frequencies available for data transmission. It refers to data transmission rate. Higher the bandwidth, the more data it can transmit

§ **Baud:** Unit of measurement of data transfer rate. Measured in bits per second (bps)

Transmission Speed

§ **Narrowband:** Sub-voice grade channels in range from 45 to 300 baud. Mainly used for telegraph lines and low-speed terminals

§ **Voiceband:** Voice grade channels with speed up to 9600 baud. Mainly used for ordinary telephone voice communication and slow I/O devices

§ **Broadband:** High speed channels with speed up to 1 million baud or more. Mainly used for high-speed computer-to-computer communication or for simultaneous transmission of data



Transmission Media

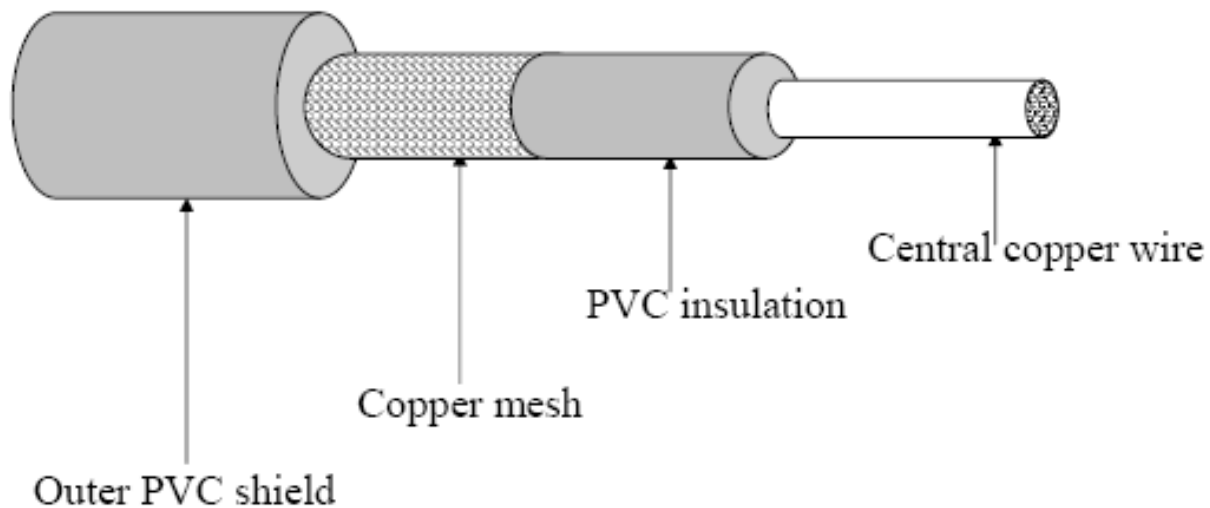
The most commonly used ones are:

- § Twisted-pair wire (UTP cable)
- § Coaxial cable
- § Microwave system
- § Communications satellite
- § Optical fibers

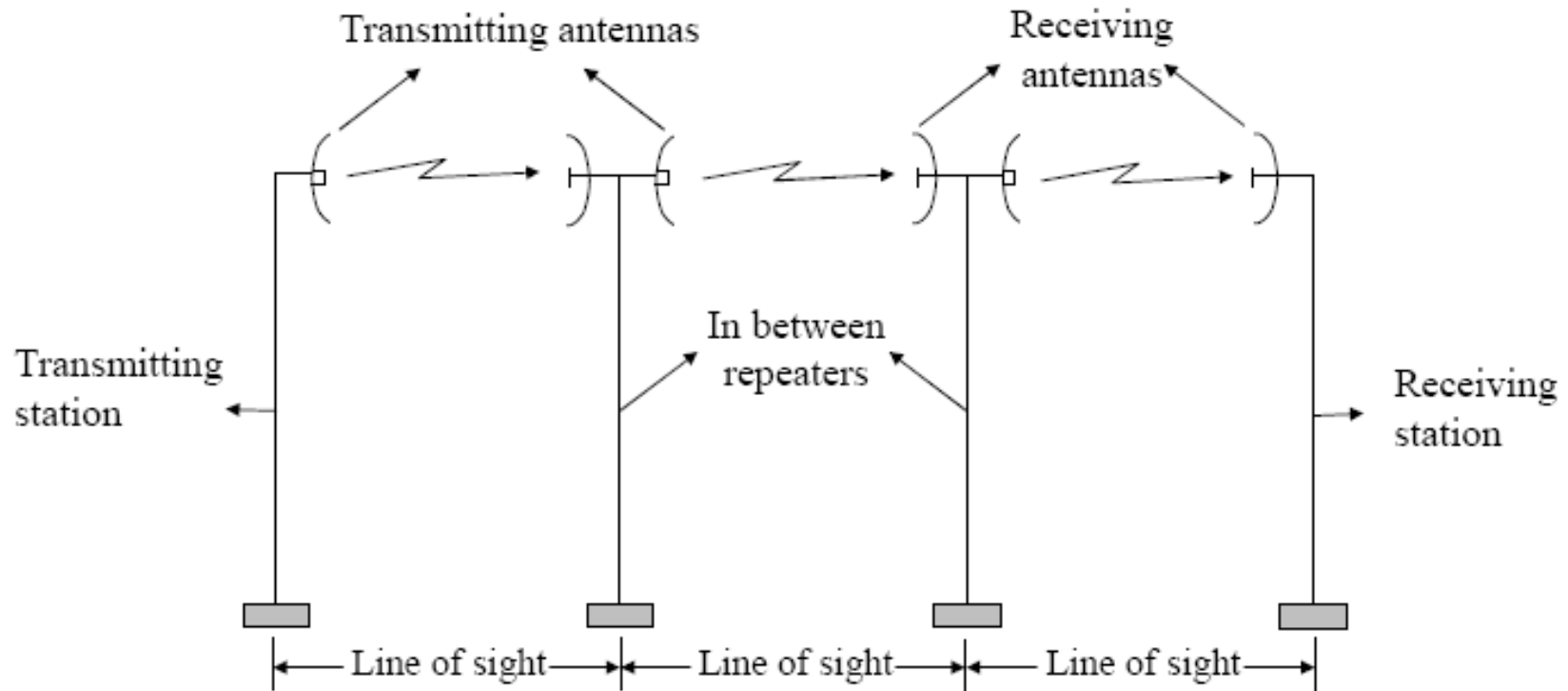
Twisted Pair



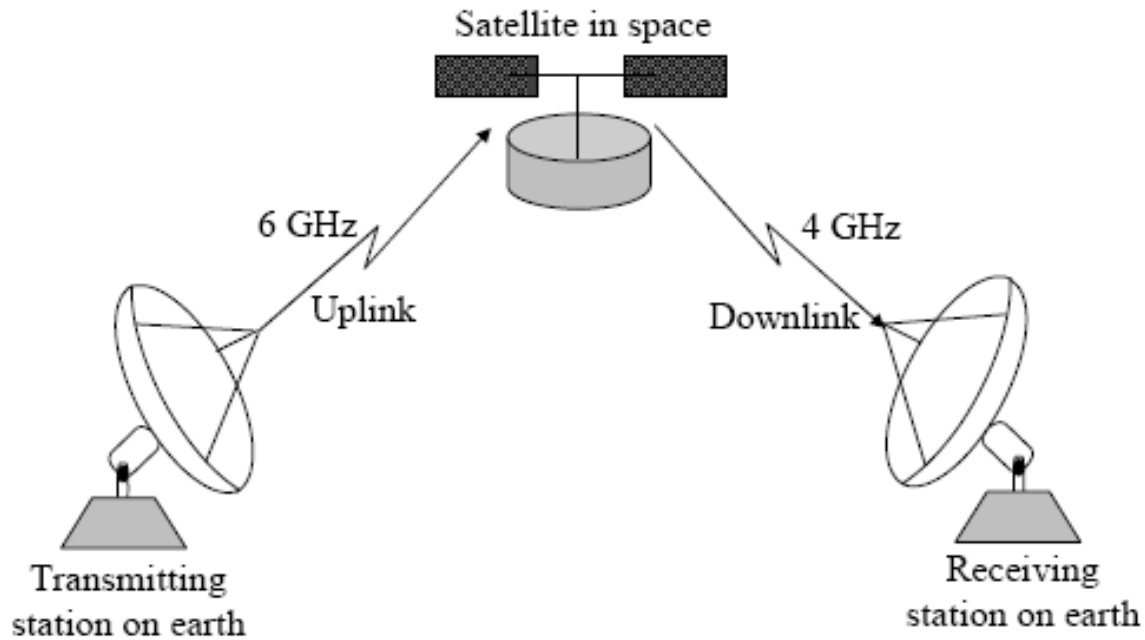
Coaxial Cable



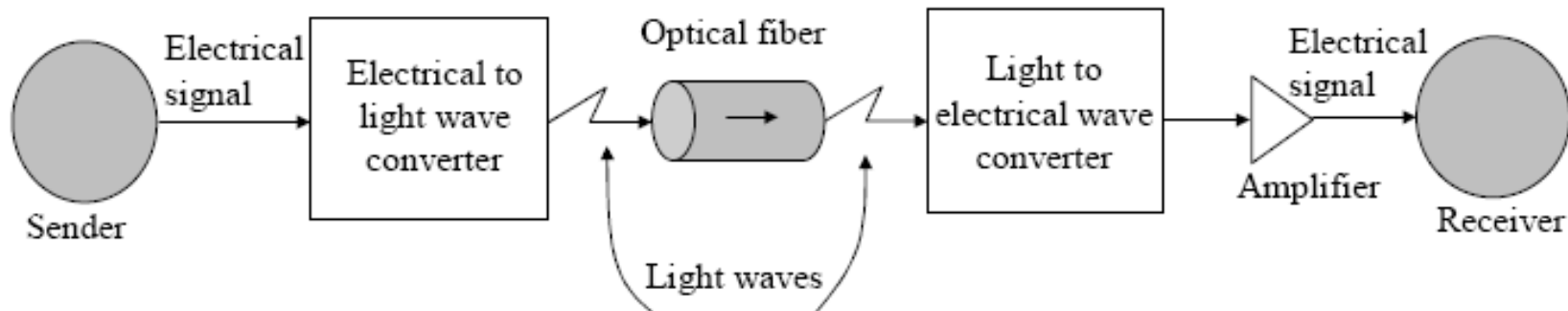
Microwave



Satellite



Optical Fiber



Digital and Analog Data

§ *Analog signal*: Transmitted power varies over a continuous range. Example: sound, light, and radio Waves

§ *Digital signal*: Sequence of voltage pulses represented in binary form

§ Computer generated data signal is digital, whereas telephone lines carry analog signals

Digital and Analog Data

§ *Analog signal*: Transmitted power varies over a continuous range. Example: sound, light, and radio Waves

§ *Digital signal*: Sequence of voltage pulses represented in binary form

§ Computer generated data signal is digital, whereas telephone lines carry analog signals

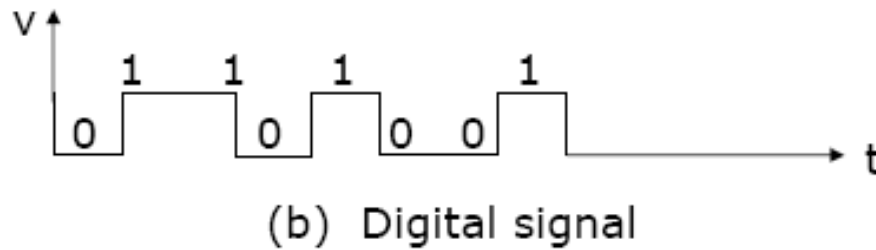
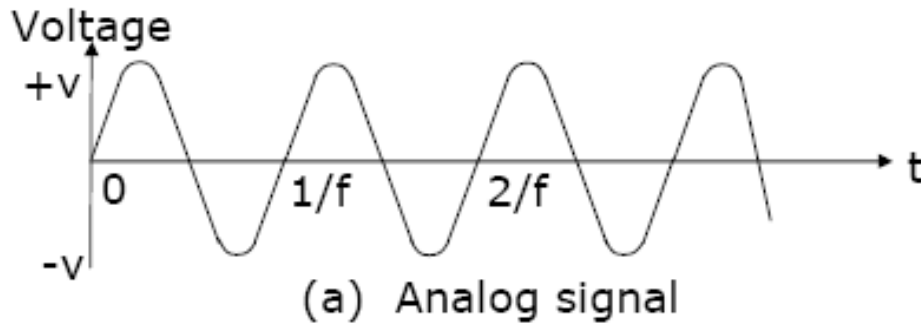
§ When digital data is to be sent over an analog facility, digital signals must be converted to analog form

§ Conversion of digital signal to analog form is known as Modulation

§ Conversion of analog signal to digital form is known as Demodulation

§ Digital transmission of data is preferred over analog transmission of data due to lower cost, higher transmission speeds, and lower error rate

Digital and Analog Signals



Modulation Techniques

§ **Amplitude Modulation (AM):** Two binary values (0 and 1) of digital data are represented by two different amplitudes of the carrier signal, keeping frequency and phase constant

§ **Frequency Modulation (FM):** Two binary values of digital data are represented by two different frequencies, while amplitude and phase are kept constant

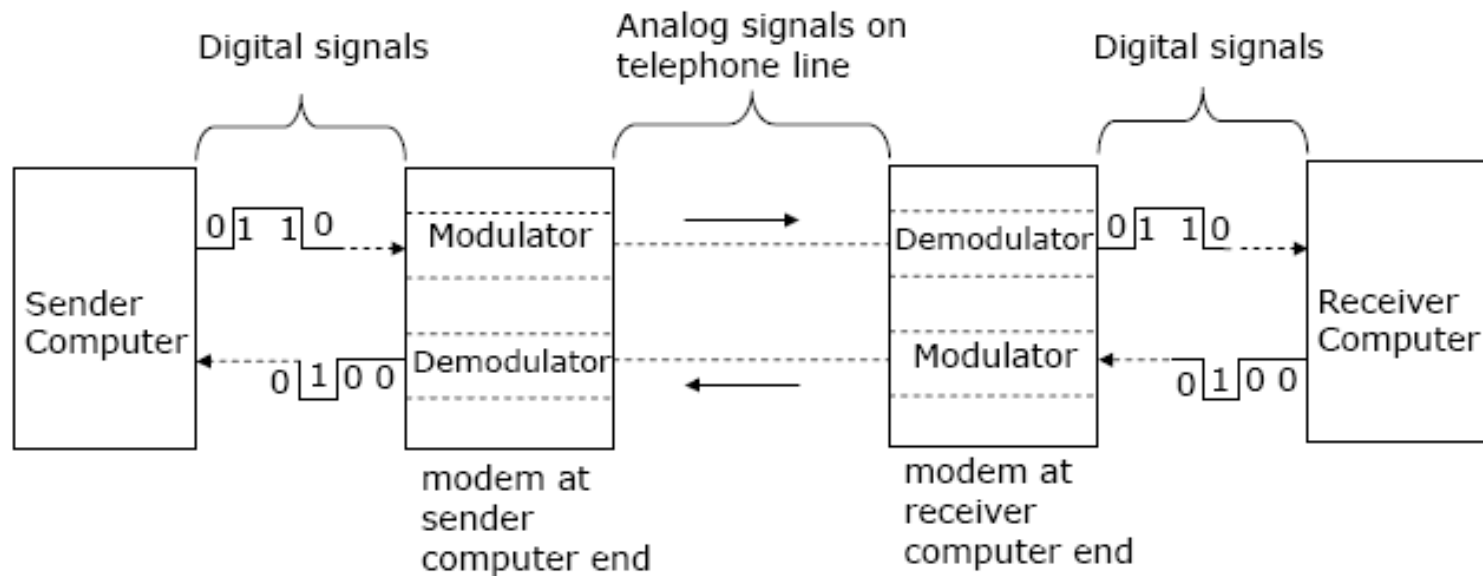
§ **Phase Modulation (PM):** Two binary values of digital data are represented by shift in phase of carrier signal

§ Modem is short for **MO**dulator/**DE**Modulator

§ Special device used for conversion of digital data to analog form (modulation) and vice-versa (demodulation)

§ Essential piece of hardware where two digital devices (say two computers) want to communicate over an analog transmission channel (say a telephone line)

Use of MODEM



Factors for MODEM Selection : -

- § Transmission speed
- § Internal versus external
- § Facsimile facility



Transmission Services

Data transmission service providers are popularly known as *common carriers*

Various types of services offered by common carriers are:

§ **Dial-up line:** Operates in a manner similar to a telephone line

§ **Leased line:** Special conditioned telephone line that directly and permanently connects two computers

§ **Integrated Services Digital Network (ISDN):**

Telephone system that provides digital (not analog) telephone and data services



Transmission Services

Value Added Network (VAN): Provides value-added data transmission service. Value added over and above the standard services of common carriers may include e-mail, data encryption/decryption, access to commercial databases, and code conversion for communication between computers

Multiplexing

§ Method of dividing physical channel into many logical channels so that a number of independent signals may be simultaneously transmitted

§ Electronic device that performs multiplexing is known as a *multiplexer*

§ Multiplexing enables a single transmission medium to concurrently transmit data between several transmitters and receivers

Multiplexing

§ Method of dividing physical channel into many logical channels so that a number of independent signals may be simultaneously transmitted

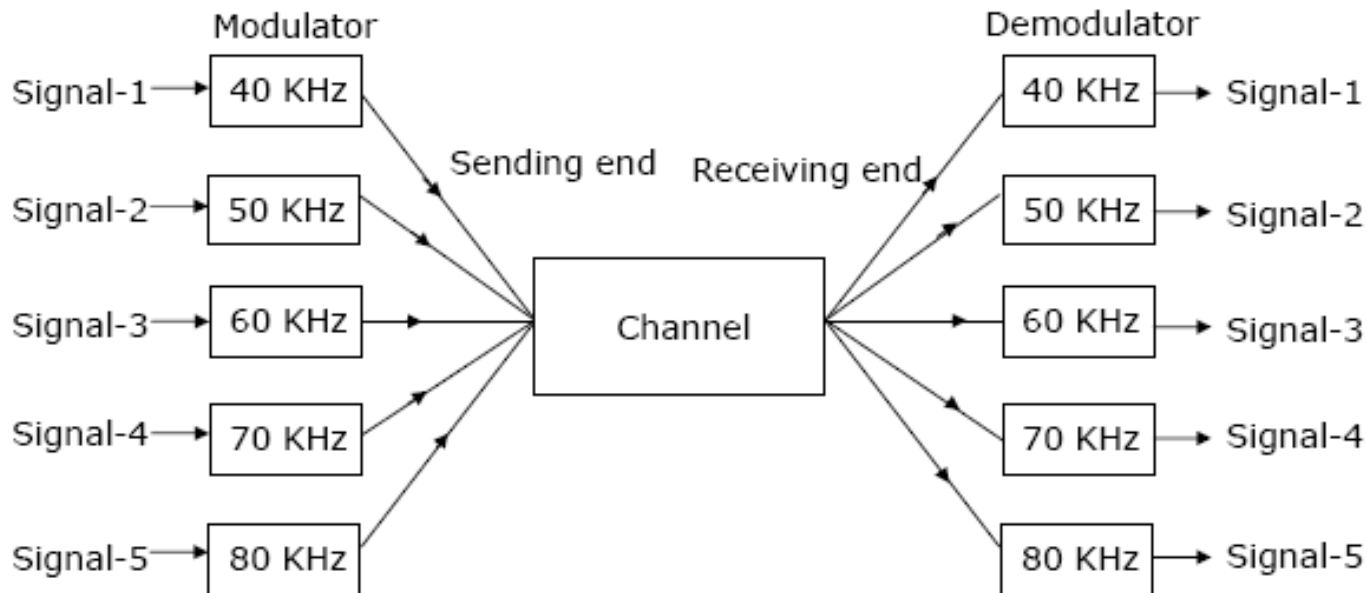
§ Electronic device that performs multiplexing is known as a *multiplexer*

§ Multiplexing enables a single transmission medium to concurrently transmit data between several transmitters and receivers

Types of Multiplexing

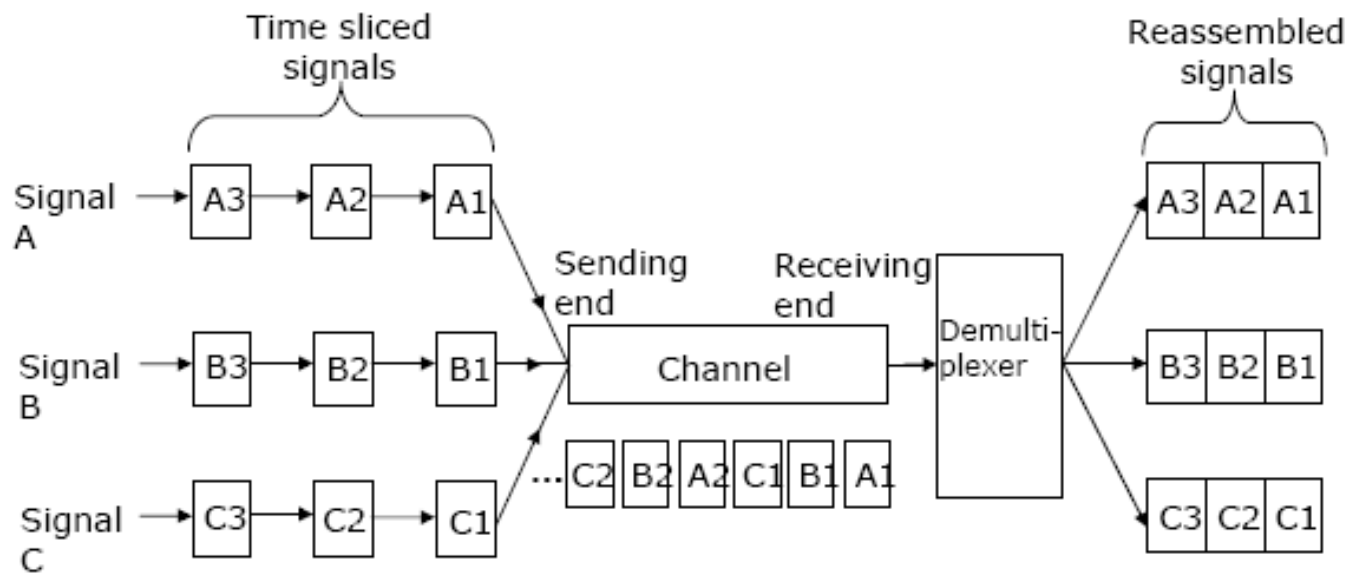
§ **Frequency-Division Multiplexing (FDM):** Available bandwidth of a physical medium is divided into several smaller, disjoint logical bandwidths. Each component bandwidth is used as a separate communication line

§ **Time-Division Multiplexing (TDM):** Total time available in a channel is divided among several users, and each user of the channel is allotted a time slice during which he/she may transmit a message



Frequency-Division Multiplexing

TDM





Transmission Modes

§ Two modes of data transmission on a communication line are asynchronous and synchronous

§ Asynchronous transmission

§ Sender can send data at any convenient time and the receiver will accept it

§ Data is transmitted character by character at irregular intervals

§ Well suited to many keyboard type terminals

§ Two modes of data transmission on a communication line are asynchronous and synchronous

Asynchronous transmission

§ Sender can send data at any convenient time and the receiver will accept it

§ Data is transmitted character by character at irregular intervals

§ Well suited to many keyboard type terminals



Transmission Modes

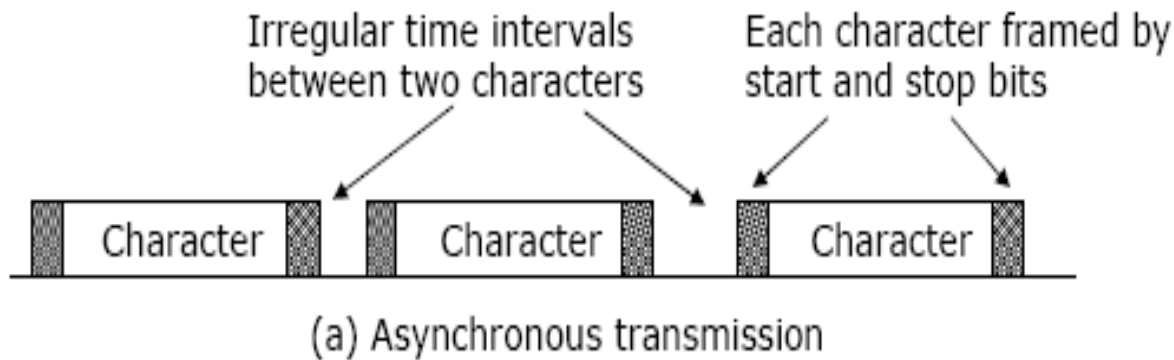
Synchronous transmission

§ Sender and receiver must synchronize with each other to get ready for data transmission before it takes place

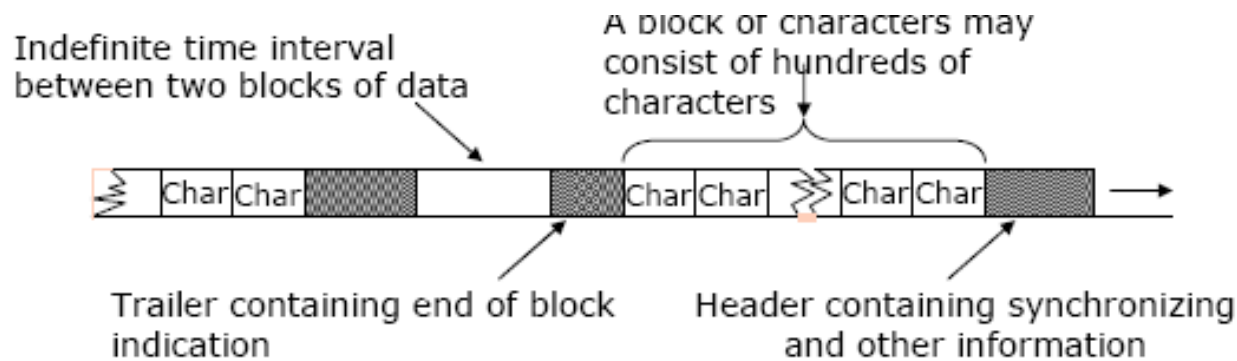
§ Entire blocks of characters are framed and transmitted together

§ Well suited to remote communication between a computer and such devices as buffered terminals and printers

Transmission Modes



Transmission Modes



(b) Synchronous transmission



Switching Techniques

§ Data is often transmitted from source to destination through a network of intermediate nodes

§ Switching techniques deal with the methods of establishing communication links between the sender and receiver in a communication network

Three commonly used switching techniques are:

§ **Circuit switching:** Dedicated physical path is established between sending and receiving stations through nodes of the network for the duration of communication

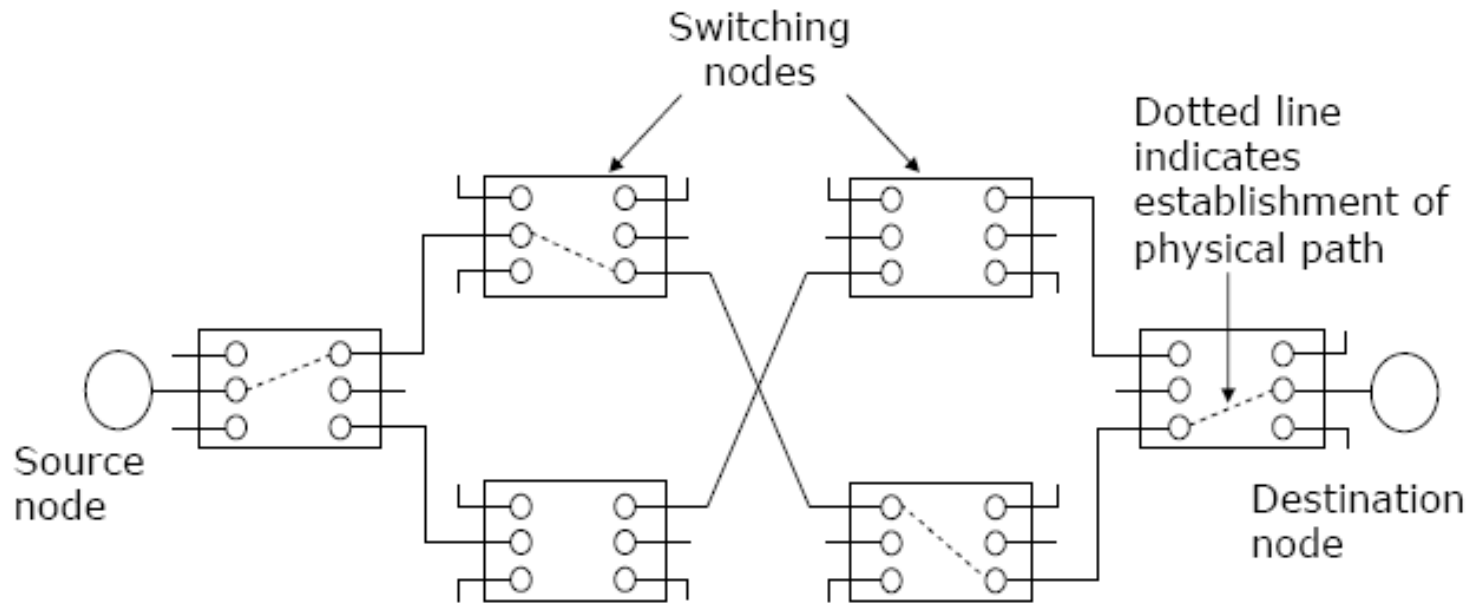


Switching Techniques

§ **Message switching:** Sender appends receiver's destination address to the message and it is transmitted from source to destination either by store-and-forward method or broadcast method

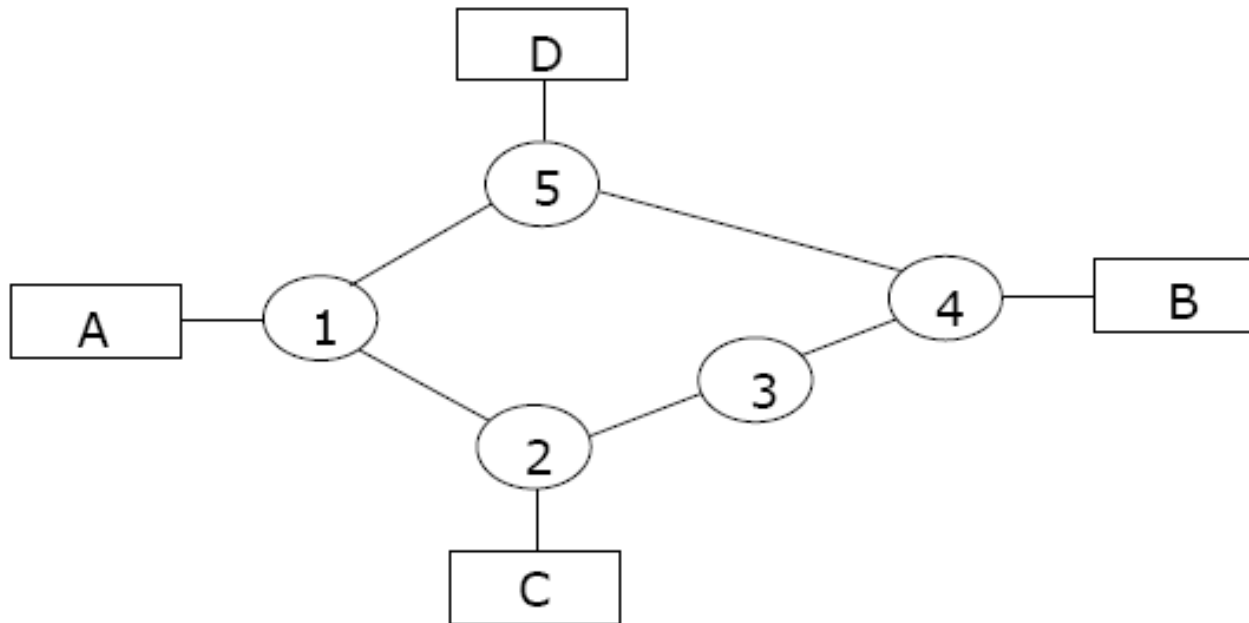
§ **Packet switching:** Message is split up into fixed size packets and each packet is transmitted independently from source to destination node. Either store-and forward or broadcast method is used for transmitting the packets. All the packets of a message are reassembled into original message at the destination node

Circuit Switching



Message Switching

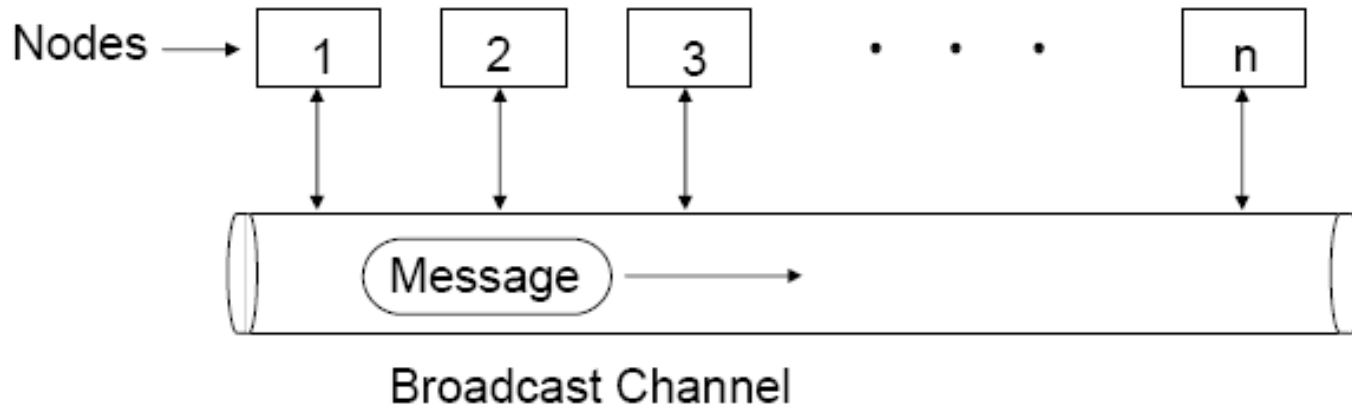
Store and Forward Method



Either path 1-2-3-4 or 1-5-4 may be used to transmit a message from A to B.

Message Switching

Broadcast Method





Message Switching

§ In a WAN, when multiple paths exist between the source and destination nodes of a packet, any one of the paths may be used to transfer the packet

§ Selection of path to be used for transmitting a packet is determined by the routing technique used

Two popularly used routing algorithms are:

§ **Source routing:** Source node selects the entire path before sending the packet

§ **Hop-by-hop routing:** Each node along the path decides only the next node for the path

Routing

§ In a WAN, when multiple paths exist between the source and destination nodes of a packet, any one of the paths may be used to transfer the packet

§ Selection of path to be used for transmitting a packet is determined by the routing technique used

Two popularly used routing algorithms are:

§ **Source routing:** Source node selects the entire path before sending the packet

§ **Hop-by-hop routing:** Each node along the path decides only the next node for the path

Topologies

§ Term *network topology* refers to the way in which the nodes of a network are linked together

§ Although number network topologies are possible, four major ones are:

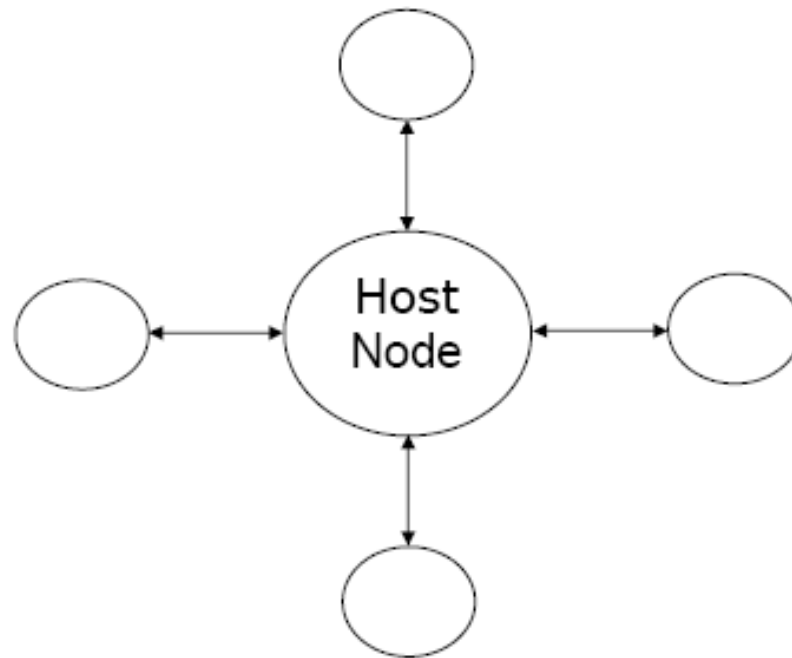
§ Star network

§ Ring network

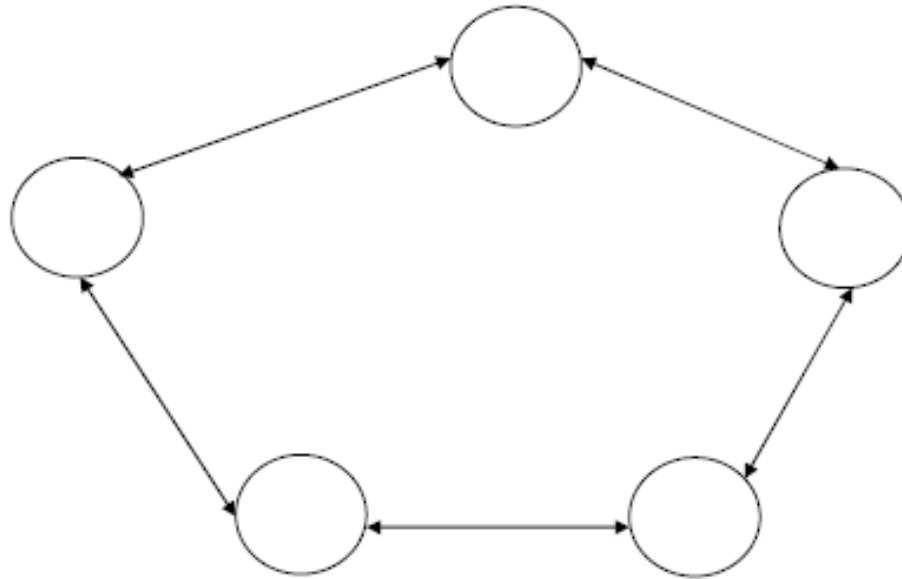
§ Completely connected network

§ Multi-access bus network

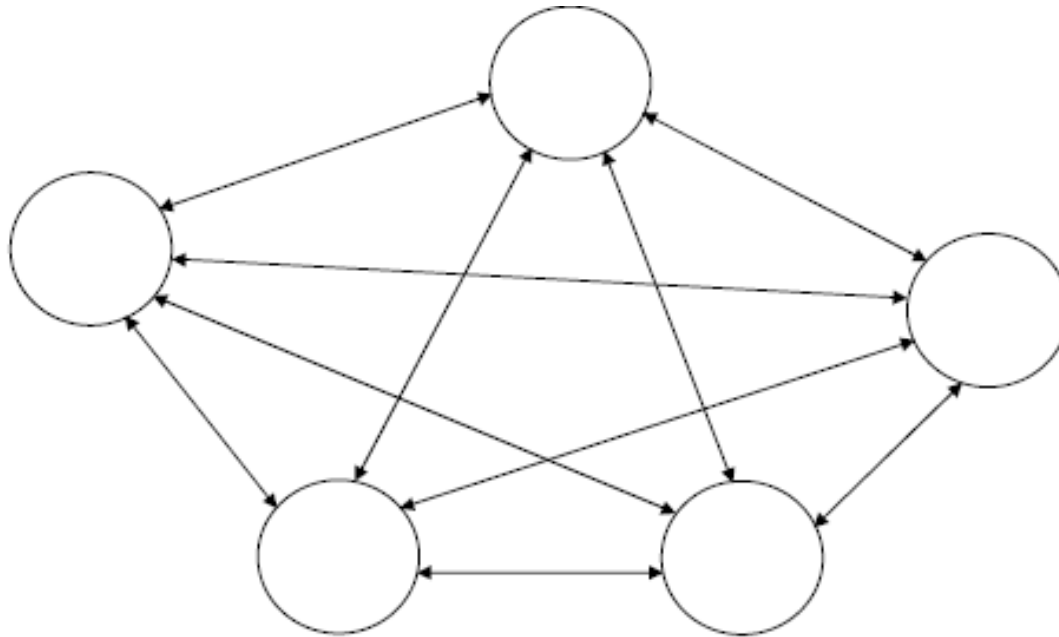
Star



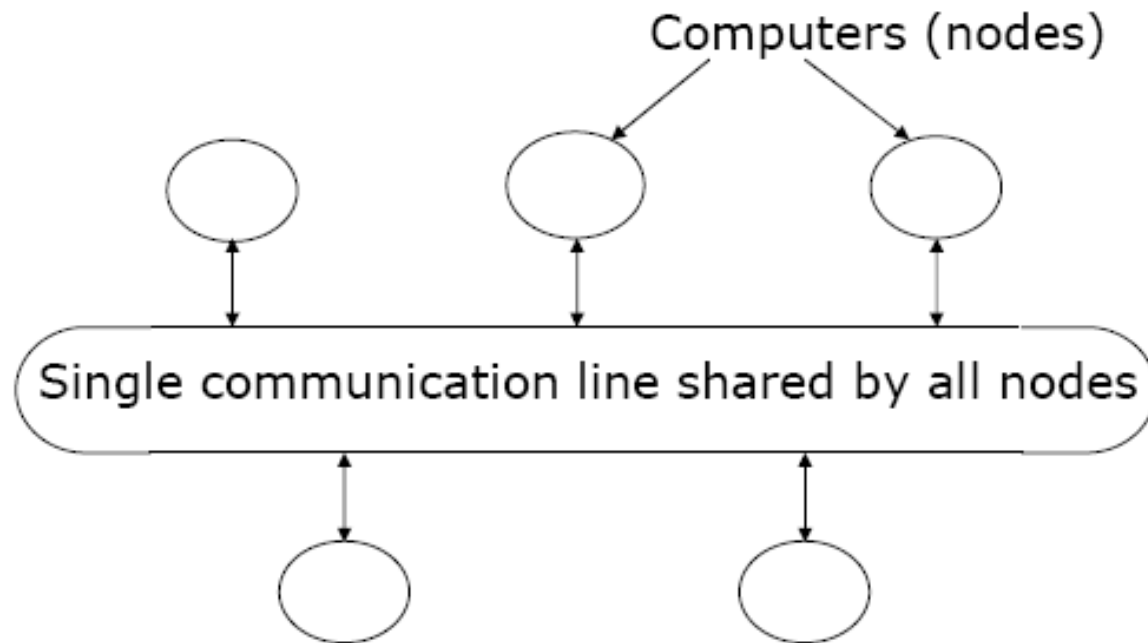
Ring



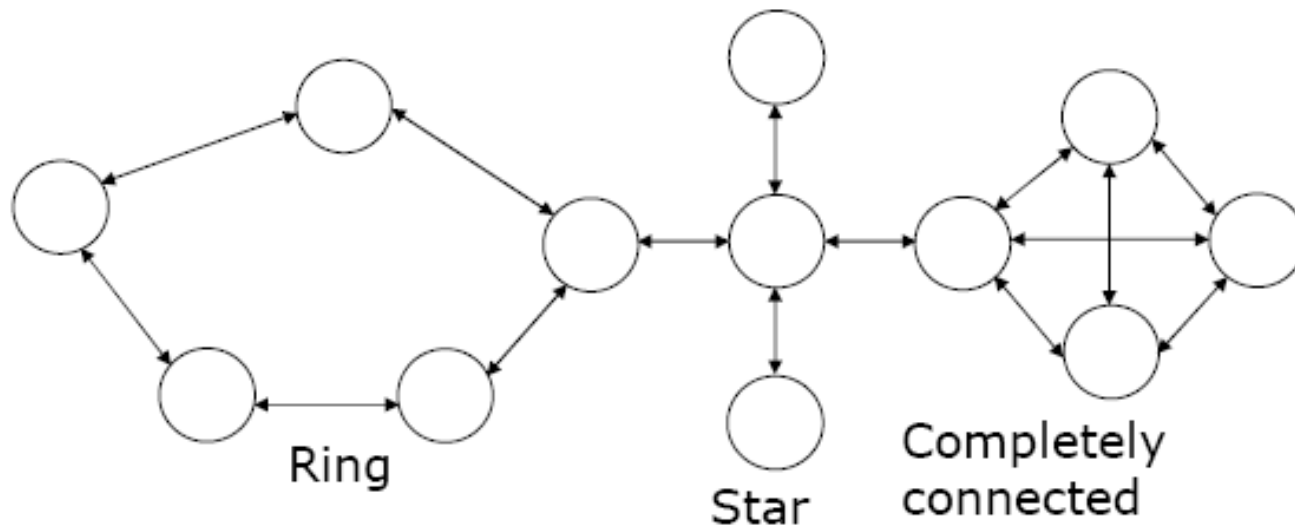
Completely Connected



BUS



Hybrid



Network Types

Networks are broadly classified into two types: Local Area Network (LAN) and Wide Area Network (WAN)

§ Local Area Network (LAN) as compared to WAN:

§ Limited to a small geographic coverage

§ Has much higher data transmission rate

§ Experiences fewer data transmission errors

§ Has lower data communication cost

§ Typically owned by a single organization

§ Networks that share some of the characteristics of both LANs and WANs are referred to as Metropolitan Area Network (MAN)

Protocol is a set of formal operating rules, procedures, or conventions that govern a given process

Communication protocol describes rules that govern transmission of data over communication networks

§ Roles of communication protocol:

§ Data sequencing

§ Data routing

§ Data formatting

§ Flow control

§ Error control



Communication Protocols

- § Precedence and order of transmission
 - § Connection establishment and termination
 - § Data security
 - § Log information.
- § Communication protocols are normally split up into a series of modules logically composed of a succession of layers.
- § Terms *protocol suite*, *protocol family*, or *protocol stack* are used to refer to the collection of protocols (of all layers) of a network system

§ Hardware device that allows a computer to be connected to a network, both functionally and physically

§ Printed circuit board installed on to one of the expansion slots of computer

§ Provides a port on the back to which network cable is attached

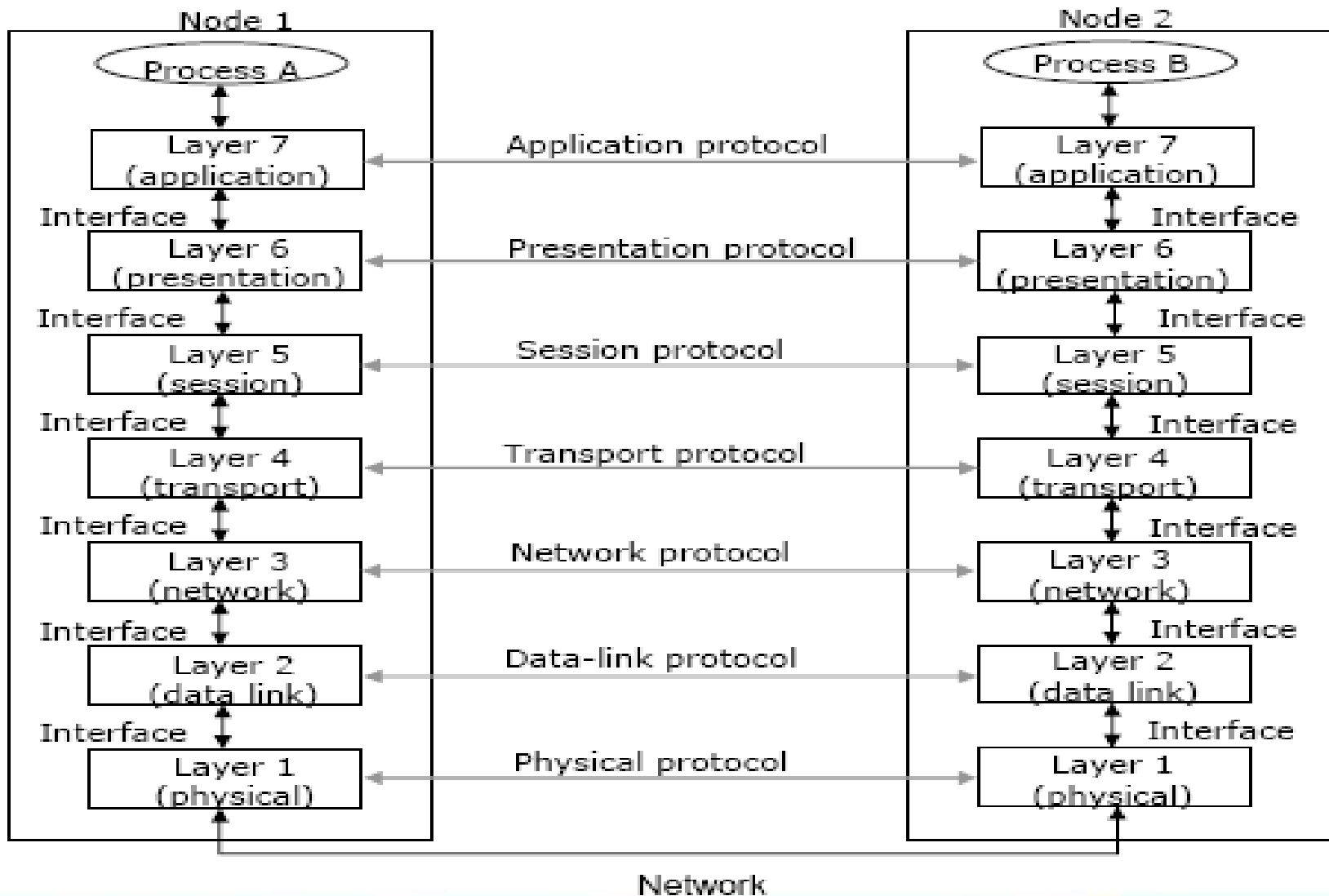
OSI Model

§ The Open System Interconnection (OSI) model is framework for defining standards for linking heterogeneous computers in a packet switched Network

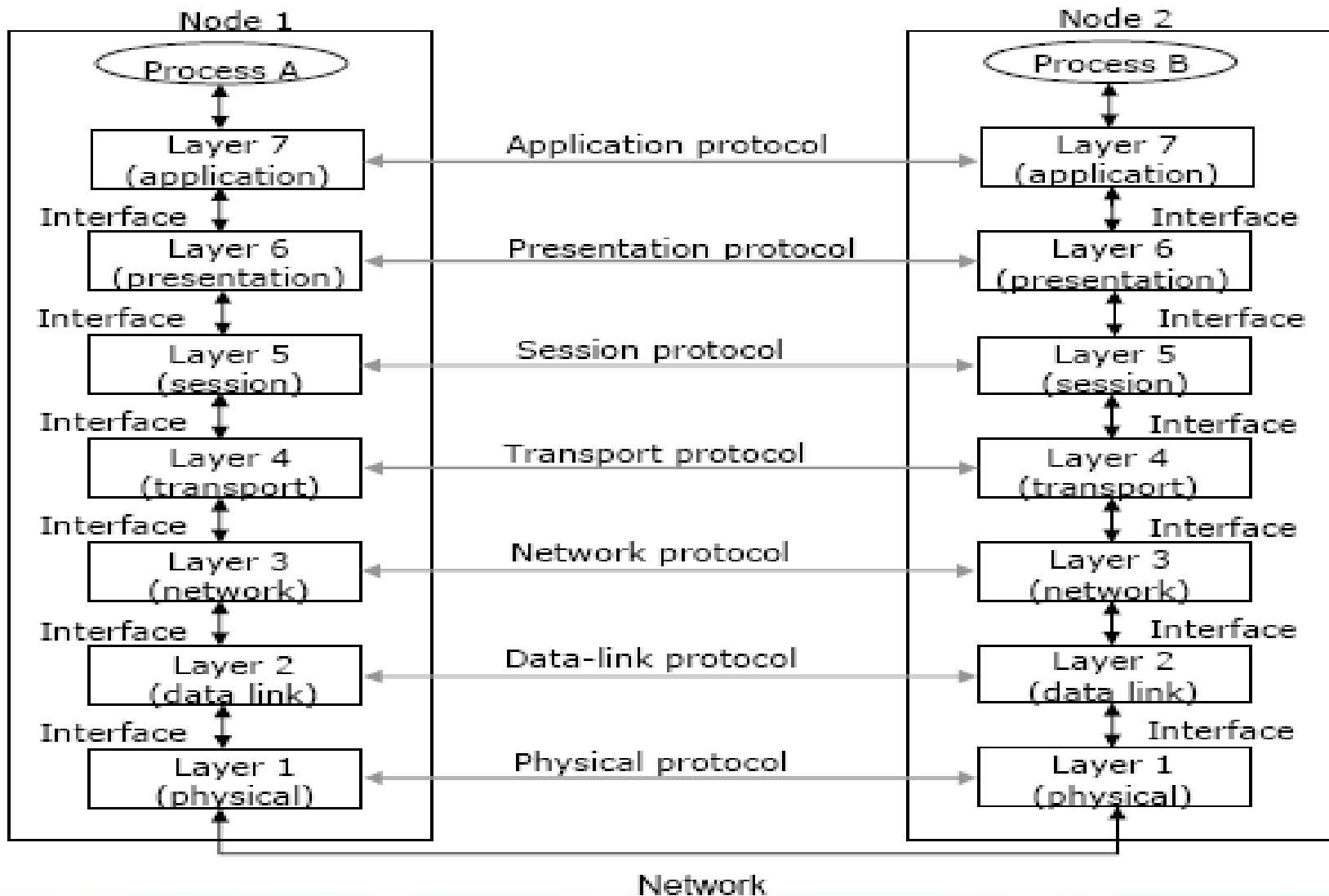
§ Standardized OSI protocol makes it possible for any two heterogeneous computer systems, located anywhere in the world, to easily communicate with each other

§ Separate set of protocols is defined for each layer in its seven-layer architecture. Each layer has an independent function

OSI Model



OSI Model



Internetworking Devices

§ Interconnecting two or more networks to form a single network is called *internetworking*, and the resulting network is called an *internetwork*

§ Goal of internetworking is to hide details of different physical networks, so that resulting internetwork functions as a single coordinated unit

§ Tools such as bridges, routers, brouters, and gateways are used for internetworking

§ The Internet is the best example of an internetwork

Bridges

§ Operate at bottom two layers of the OSI model

§ Connect networks that use the same communication protocols above data-link layer but may use different protocols at physical and data-link layers

Routers

§ Operates at network layer of the OSI model

§ Used to interconnect those networks that use the same high-level protocols above network layer

§ Smarter than bridges as they not only copy data from one network segment to another, but also choose the best route for the data by using routing table

Gateways

- § Operates at the top three layers of the OSI model (session, presentation and application)
- § Used for interconnecting dissimilar networks that use different communication protocols
- § Since gateways interconnect dissimilar networks, protocol conversion is the major job performed by them

Wireless Communication

- § Wireless computing system uses wireless communication technologies for interconnecting computer systems
- § Enhances functionality of computing equipment by freeing communication from location constraints of wired computing systems
- § Wireless computing systems are of two types:
 - § **Fixed wireless systems:** Support little or no mobility of the computing equipment associated with the wireless network
 - § **Mobile wireless systems:** Support mobility of the computing equipment to access resources associated with the wireless network



Wireless Technology

- § 2G and 3G
- § Wireless LAN
- § WiMAX
- § Wireless Local Loop (WLL)
- § Radio-router
- § Multihop Wireless Network
- § Wireless Application Protocol (WAP)



Distributed Computing

§ Configuration where many independent computer systems are connected, and messages, processing task, programs, data, and other resources are transmitted between cooperating computer systems

§ Such an arrangement enables sharing of many hardware and software resources as well as information among several users who may be sitting far away from each other



Distributed Computing

- § Inherently distributed applications
- § Information sharing among distributed users
- § Resource sharing
- § Shorter response times and higher throughput
- § Higher reliability
- § Extensibility and incremental growth
- § Better flexibility in meeting users' needs

Conclusion

- Amplifier
- Amplitude Modulation (AM)
- Application layer
- ARPANET
- Asynchronous transmission
- Bandwidth
- Baud
- Bridge
- Broadband
- Broadcast
- C-band transmission
- Circuit switching
- Coaxial cable
- Common Carriers
- Communication protocol
- Communications satellite
- Completely connected network
- Computer network
- Concentrators
- Data-link layer
- Demodulation
- Dial-up line
- Distributed Computing System
- Ethernet
- Fax modem
- File Transfer Protocol (FTP)
- Font-End Processors (FEP)
- Frequency Modulation (FM)
- Frequency-Division Multiplexing (FDM)
- Full duplex
- Gateway
- Half duplex
- Hop-by-hop routing
- Hybrid network
- Internet Protocol (IP)
- Internetworking
- ISDN (Integrated Services Digital Network)
- Ku-band transmission
- Leased line
- Local Area Network (LAN)
- Message switching

Conclusion

- Metropolitan Area Network (MAN)
- Microwave system
- Mobile computing
- Modem
- Modulation
- Multi-access Bus network
- Multiplexer
- Narrowband
- Network Interface Card (NIC)
- Network layer
- Network topology
- Nomadic computing
- Optical fibers
- OSI Model
- Packet switching
- Phase Modulation (PM)
- Physical layer
- POTS (Plain Old Telephone Service)
- Presentation layer
- Protocol family
- Protocol stack
- Protocol suite (Continued from previous slide)
- Repeater
- Ring network
- Router
- Session layer
- Simplex
- Source routing
- Star network
- Store-and-forward
- Synchronous transmission
- Time-Division Multiplexing (TDM)
- Transport Control Protocol (TCP)
- Transport layer
- Twisted-pair
- Unshielded twisted-pair (UTP)
- User Datagram Protocol (UDP)
- Value Added Network (VAN)
- Voiceband
- VSAT (Very Small Aperture Terminals)
- Wide Area Network (WAN)
- Wireless network



MOC Course

Course Name: Introduction to Computer Networks and Internet Protocols by Prof. Bhushan Trivedi, GLS University

Registration Link:

https://swayam.gov.in/nd2_ugc19_cs10/preview

Duration: 15 Weeks

Objective Type Questions

1. What is ISDN ?
2. NIC stands for _____.
3. What do you mean by LAN ?
4. What is a repeater ?
5. What is Multiplexing ?
6. What do you mean by Bitrate and Baudrate ?
7. What do you mean by Hop-by-Hop routing?
8. What is Source routing ?
9. What is half-Duplex transmission modes ?
10. Difference between Synchronous and Asynchronous Communication.

Short Type Questions

1. What is Value Added Network?
2. List some applications that can benefit from wireless computing systems.
3. Why is layering used in design of communication networks ?
4. What is packet switching ?
5. What is routing ?
6. What is a multiplexer ?
7. What do you understand by Modulation and Demodulation ?



Short Type Questions

8. Write a short note on router ?
9. What is a Computer Network ?
10. Explain the terms – “bandwidth” and “baud” ?

Long Type Questions

1. What are internetworking devices ?
2. Explain transmission media ?
3. Difference between Analog and Digital transmission of data. Write their advantages and disadvantages.
4. Write a short note on different types of Data Transmission Services.
5. Explain Store-and-forward method of message switching. What are its advantages and disadvantages.
6. What is a communication protocol ? What normal functions are performed by these protocols.
7. What is Distributed Computing system ?

Long Type Questions

8. Differentiate among LAN, MAN & WAN with examples.
9. What is network? Explain the tradeoffs of various topologies of network.
10. Discuss the features of different layers of the OSI reference model with complete diagram. How it is different from TCP-IP model?
11. Explain the types of Switching techniques along with illustrative diagrams. What are their advantages and limitations?
12. Differentiate among Narrowband, Voice band and Broad communication channels. Give a practical application of each.

References

Main Reading Books:

1. P. K. Sinha and Priti Sinha , “Computer Fundamentals”, BPB Publications, 2007.
2. Alex Leon and Mathews Leon, “Fundamentals of Information Technology”, Leon Techworld, 2007.
3. V. Rajaraman, “Introduction to Information Technology”, PHI, 2006.

REFERENCES:

1. Alex Leon and Mathews Leon, “Introduction to Computers”, Vikas Publishing House, 2007.
2. Norton Peter, “Introduction to computers”, TMH, 4th Ed., 2006.
3. Simon Haykins, “Communication System”, John Wiley & Sons, 2006.
4. B. Basaraj, “Digital Fundamentals”, Vikas Publications, 1999.
5. V. Rajaraman, “Fundamentals of Computers”, PHI, 5th Ed., 2006.
6. David Anfinson and Ken Quamme, “IT Essentials PC Hardware and Software Component on Guide”, Pearson, 3rd Ed., 2008.
7. Malvino and Leach, “Digital Principles and Application”, TMH, 1999.
8. Ramesh S. Gaonkar, "Microprocessor Architecture Programming and Application with 8085", PHI, 2001.