M242 – COMPUTER NETWORS AND SECURITY

UNIT - II OSI MODEL AND LAN PROTOCOLS

2.1. **Network Models**:

1. Explain Network model

A network is a combination of hardware and software that sends data from one location to another. The hardware consists of the physical equipment that carries signals from one point of the network to another. The software consists of instruction sets that make possible the services that expect from a network.

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2. Write short notes on Protocol and Standards

Protocol

A protocol is a set of rules that govern data communications. The key elements of a protocol are syntax, semantics, and timing.

- **Syntax** It is the structure or format of the data, meaning the order in which they are presented.
- **Semantics** The word semantics refers to the meaning of each section of bits. How are a particular pattern to be interpreted, and what action is to be taken based on that interpretation?
- **Timing** The term timing refers to two characteristics: when data should be sent and how fast they can be sent.

Standards

Standards provide guidelines to manufacturers, vendors, government agencies, and other service providers to ensure the kind of interconnectivity necessary in today's marketplace and in international communications.

Data communication standards fall into two categories:

- **De facto** (meaning "by fact" or "by convention") **and De jure** (meaning "by law" or "by regulation").
- **De facto** Standards that have not been approved by an organized body but have been adopted as standards through widespread use are de facto standards.
- **De jure** those standards that have been legislated by an officially recognized body are de jure standards.

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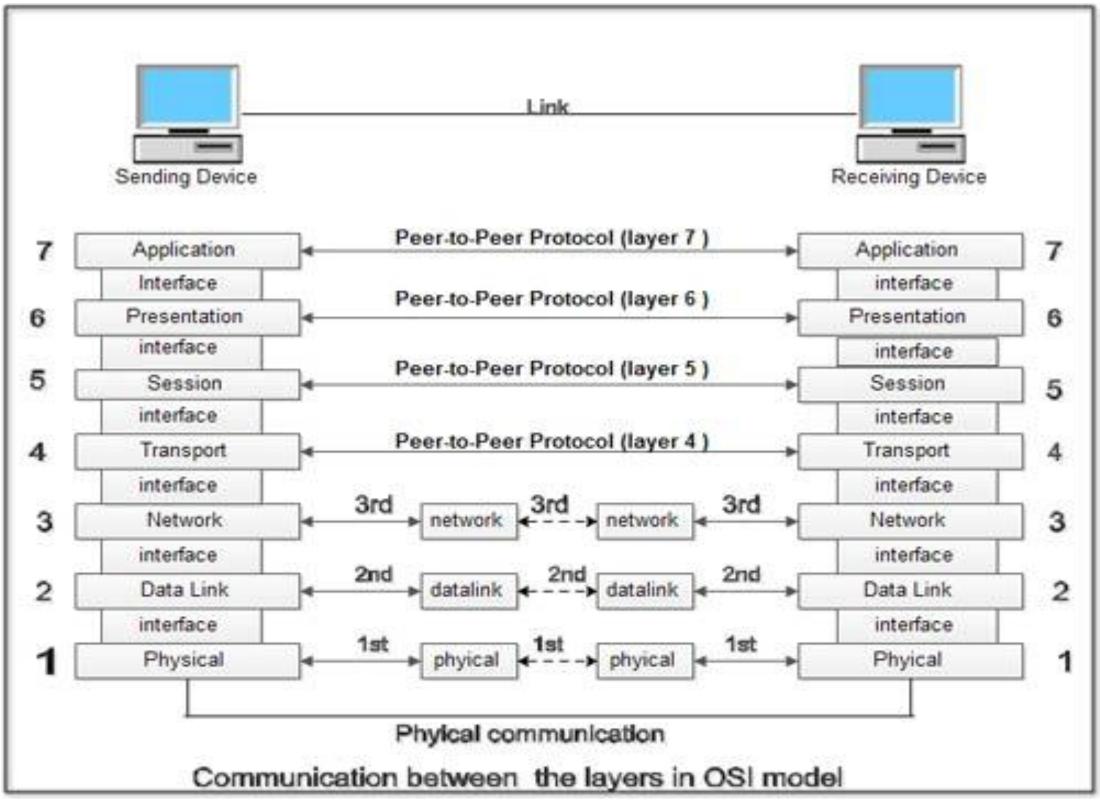
3. Briefly explain the OSI model layer with neat diagram

The International Standards Organization (ISO) developed the Open Systems Interconnection (OSI) Reference Model to define functional communications standards. The OSI model describes the functions that are performed in data communications. OSI Model provides the following services

1. Provide peer to peer logical services with layer physical implementation
2. Provides standard for communication between system
3. Define point of interconnection for exchange information between systems
4. Each layer should perform well defined functions.

The following figure shows to explain the model architecture of OSI layers with defining specific functions.



Communication between the layers in OSI model

Layer 1 Physical

- ✓ This layer transmits raw bits over a communication channel. The Physical layer defines the how a physical medium or cable is connected to the network.
- ✓ It defines the characteristics of the connectors, data transmission rates and distances, and the interface voltages.

Devices: Hubs, Hardware, Ethernet, bus or Token ring

Layer 2 Data Link

- ✓ This layer groups zeros and ones in to frames. A frame is a series of bits that forms a unit of data.
- ✓ The Data Link layer also defines the topology of the network (bus, star, dual ring, and so on).

- ✓ Flow control at the Data Link layer is defined for transmitting and receiving frames sequentially and error control mechanism is used for detect and correct errors in the data communication.

Layer 3 Network

- ✓ The Network layer defines routing services that allow multiple data links to be combined into an internetwork.
- ✓ The Network layer defines network-addressing schemes that logically identify network devices.
- ✓ The most common network addressing protocols are IP, IPX, and AppleTalk. Typical routing protocols that run at this level are RIP, OSPF, IGRP, and NLSP.

Layer 4 Transport

- ✓ The Transport layer is responsible for reliable end to end data transfer. Hence optimum utilization of network resources.
- ✓ The transport layer performs the service of sending and receiving of data to session layer.
- ✓ It also provides flow control, sequence numbering and message acknowledgement. .
- ✓ The most common transport protocols are IP, IPX, Routing protocols, ARP.

Layer 5 Session

- ✓ The session layer is responsible for creating, managing and termination sessions that are used by entities at the presentation layer.
- ✓ The session layer is responsible for coordinating the service requests and responses generated and received by a station when it is communication with other entities on the internetwork.

Layer 6 Presentation

- ✓ The Presentation layer is responsible for encoding and decoding data that is passed from the application layer to another station on the internetwork.
- ✓ This layer is responsible for encoding data in a format that the receiving station can interpret and for decoding data received from other stations.
- ✓ Data compression and encryption are accomplished at this layer. Typical coding schemes include ASCII, EBCDIC, MPEG, GIF, and JPEG.

Layer 7 Application

- ✓ The Application layer provides the interface to the user. Any user application that requires network communication accesses the communication resources through this layer.
- ✓ This layer also is responsible for finding and determining the availability of communication partners. Typical protocol used in the TCP/IP protocols is Simple Mail Transfer Protocol (SMTP), Telnet, and File Transfer Protocol (FTP).

2.2. **802.X Protocols:**

4. Explain 802.x Protocols

- ✓ 802 is the standard for LAN network formulated by IEEE. It deals with local area networks and metropolitan area networks.
- ✓ In IEEE 802 divides the Data link layer into two sub layers logical link control and media access control. The following standards are used for 802 protocols
  802.3-CSMA/CD-bus (Ethernet)
  802.4-Token bus
  802.5-Token Ring
  802.11- Wireless LAN

These MAC Protocols are concerned with the transportation of packets from one node to another on a single network segment.

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5. Explain the Concepts and PDU format of CSMA/CD (802.3)

CARRIER SENSE MULTIPLE ACCESS WITH COLLISION DETECTION (CSMA/CD)

- ✓ Ethernet uses *carrier sense multiple access with collision detection* (CSMA/CD) as the method of medium access, and has been standardized by the IEEE. The frame format can be seen below.
- ✓ The basic idea behind CSMA/CD is that a station needs to be able to receive while transmitting to detect a collision. When there is no collision, the station receives one signal: its own signal. When there is a collision, the station receives two signals: its own signal and the signal transmitted by a second station.

FRAME FORMAT

- ✓ The Ethernet frame contains seven fields: preamble, SFD, DA, SA, length or type of protocol data unit (PDU), upper-layer data, and the CRC.
- ✓ Ethernet does not provide any mechanism for acknowledging received frames, The format of the MAC frame is shown in Figure

7 byte	1 byte	6 byte	6 byte	2 byte	46 to 1500 byte	4 byte
Preamble	**Start frame Delimiter**	**Destination Address**	**Source Address**	**Length**	**Data**	**Frame Check Sequence**

Frame Format

- ✓ **Preamble**. The first field of the 802.3 frame contains 7 bytes (56 bits) of alternating Os and is that alerts the receiving system to the coming frame and enables it to synchronize its input timing. The preamble is actually added at the physical layer and is not (formally) part of the frame.

- ✓ **Start frame delimiter (SFD).** The second field signals the beginning of the frame.
- ✓ **Destinations address (DA).** The DA field is 6 bytes and contains the physical address of the destination station or stations to receive the packet.
- ✓ **Sources address (SA).** The SA field is also 6 bytes and contains the physical address of the sender of the packet.
- ✓ **Length or type.** This field is defined as a type field or length field. The IEEE standard used it as the length field to define the number of bytes in the data field.
- ✓ **Data.** This field carries data encapsulated from the upper-layer protocols. It is a minimum of 46 and a maximum of 1500 bytes.
- ✓ **Frame check sequence (FCS)** - Is filed by the source station with a calculated cyclic redundancy check for error detection such as find whether the frames are lost or damaged.

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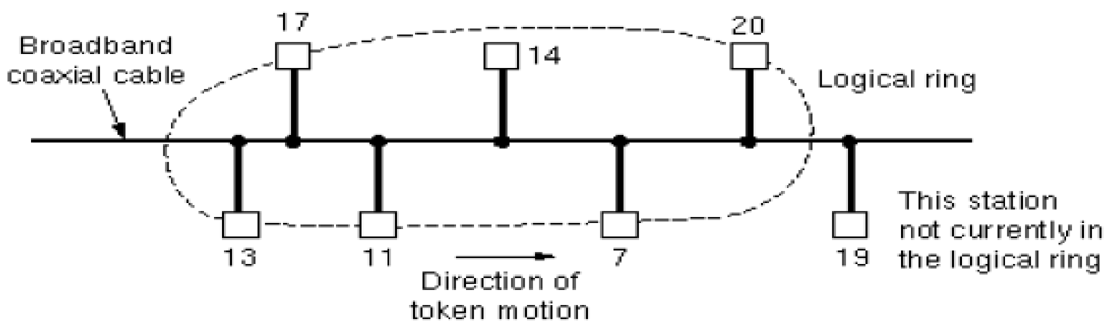
6. Explain the concept of Token bus (802.4)

- ✓ A token bus network is much like a token-ring network except that the ends of the network do not meet to form the ring. Instead, the network is still terminated at both ends.
- ✓ A token is still required before a node can use the network. Like in a token-ring, it needs to include the address of the destination along with the data it needs to send. Although in the token bus, it implements a virtual ring on the coaxial cable.



Token Bus (802.4)

- ✓ Token bus was standardized by IEEE standard 802.4. It is mainly used for industrial applications. Token bus was used by Motors for their Manufacturing Automation Protocol (MAP) standardization effort.

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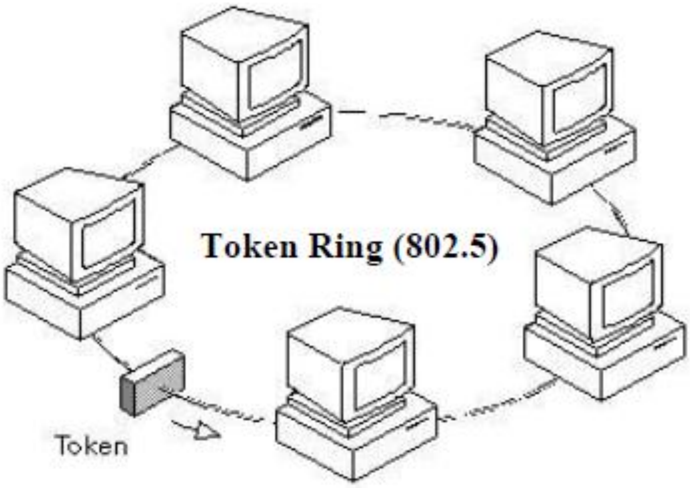
7. Explain the concept of Token Ring (802.5)

- ✓ A token ring network is a local area network (LAN) topology where nodes/stations are arranged in a ring topology.
- ✓ Data passes sequentially between nodes on the network until it returns to the source station.
- ✓ To prevent congestion and collision, a token ring topology uses a token to ensure that only one node/station on the line is used at a time.



The token ring LAN process is processed by the following sequence of events:

- A token continually circulates inside the token ring LAN
- To transmit a message, a node inserts a message and destination address inside an empty token.
- The token is examined by each successive node.
- The destination node copies the message data and returns the token to the source with the source address and a data receipt message.
- The source receives the returned token, verifies copied and received data and empties the token.
- The empty token now changes to circulation mode, and the process continues.

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8. Explain Ethernet and its types

Ethernet

- ✓ Ethernet is the most popular physical layer LAN technology in use today. It defines the number of conductors that are required for a connection, and provides the framework for data transmission.
- ✓ A standard Ethernet network can transmit data at a rate up to 10 Megabits per second (10 Mbps).

Types of Ethernet

10BASE5: THICK ETHERNET

- ✓ The first implementation is called **10Base5, thick Ethernet, or Thicknet.**
- ✓ 10BaseS was the first Ethernet specification to use a bus topology with an external **transceiver** (transmitter/receiver) connected via a tap to a thick coaxial cable. The maximum length of the coaxial cable must not exceed 500 m.
- ✓ The second implementation is called 10Base2, **thin** Ethernet, or Cheapernet. 10Base2 also uses a bus topology, but the cable is much thinner and more flexible.
- ✓

10BASE-T: TWISTED-PAIR ETHERNET

- ✓ The third implementation is called 10Base-T or twisted-pair Ethernet. 1OBase-T uses a physical star topology.
- ✓ The stations are connected to a hub via two pairs of twisted cable. Note that two pairs of twisted cable create two paths (one for sending and one for receiving) between the station and the hub.

10BASE-F: FIBER ETHERNET

- ✓ The most common fiber Ethernet is called 10Base-F. 10Base-F uses a star topology to connect stations to a hub.
- ✓ The stations are connected to the hub using two fiber-optic cables.

FAST ETHERNET

- ✓ Fast Ethernet was designed to compete with LAN protocols such as FDDI or Fiber Channel (or Fibre Channel, as it is sometimes spelled).
- ✓ IEEE created Fast Ethernet under the name 802.3u. Fast Ethernet is backward-compatible with Standard Ethernet, but it can transmit data 10 times faster at a rate of 100 Mbps.

The goals of Fast Ethernet can be summarized as follows:

1. Upgrade the data rate to 100 Mbps.
2. Make it compatible with Standard Ethernet.
3. Keep the same 48-bit address.
4. Keep the same frame format.
5. Keep the same minimum and maximum frame lengths.

GIGABIT ETHERNET

- ✓ The need for an even higher data rate resulted in the design of the Gigabit Ethernet protocol (1000 Mbps).
- ✓ The IEEE committee calls the Standard 802.3.

The goals of the Gigabit Ethernet design can be summarized as follows:

1. Upgrade the data rate to 1 Gbps.
2. Make it compatible with Standard or Fast Ethernet.
3. Use the same 48-bit address.
4. Use the same frame format.

5. Keep the same minimum and maximum frame lengths.
6. To support auto negotiation as defined in Fast Ethernet.

TEN-GIGABIT ETHERNET

The IEEE committee created Ten-Gigabit Ethernet and called it Standard 802.3. 63
The goals of the Ten-Gigabit Ethernet design can be summarized as follows:
1. Upgrade the data rate to 10 Gbps.
2. Make it compatible with Standard, Fast, and Gigabit Ethernet.
3. Use the same 48-bit address.
4. Use the same frame format.
5. Keep the same minimum and maximum frame lengths.
6. Allow the interconnection of existing LANs into a metropolitan area network (MAN) or a wide area network (WAN).
7. Make Ethernet compatible with technologies such as Frame Relay and ATM.

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9. Explain the comparison between 802.3, 802.4 AND 802.5

Standard specification	**802.3**	**802.4**	**802.5**
Structure	Size of the frame format is 1572 bytes	Size of the frame format is 8202 bytes	Variable size
Data field	Size of the field is 0 to 1500 bytes	Size of the data field is 0 to 8182 bytes	No limit
Priority	No priorities	Supports priorities	Priorities possible
Frame Requirement	Minimum frame short required is 64 bytes	It can handle short minimum frames	it support frames
Efficiency and throughput	Efficiency decrease and collision affects the throughput	It can handle short minimum frames	It supports frames.
Modem	Modems are not required	Modems are required	Modems are required
Protocol	Protocol is simple complex	Protocol is extremely complex	Protocol is moderately complex

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2.3. **FDDI**

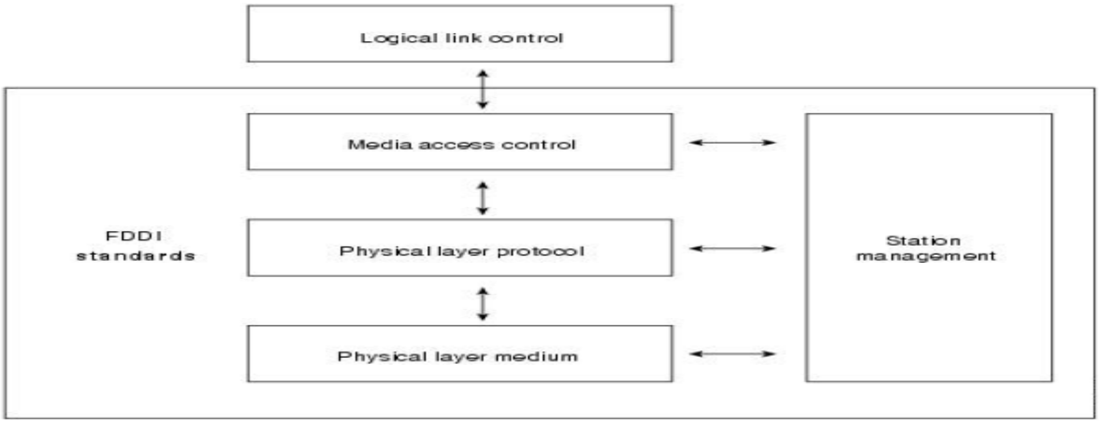
10. Explain Fiber Distributed Data Interface (FDDI) in detail

Fiber Distributed Data Interface

- ✓ The Fiber Distributed Data Interface (FDDI) specifies a 100-Mbps token-passing, dual-ring LAN using fiber-optic cable. FDDI is frequently used as high-speed backbone technology because of its support for high bandwidth and greater distances than copper.

FDDI Specifications

- ✓ FDDI specifies the physical and media-access portions of the OSI reference model. FDDI is not actually a single specification, but it is a collection of four separate specifications, each with a specific function.

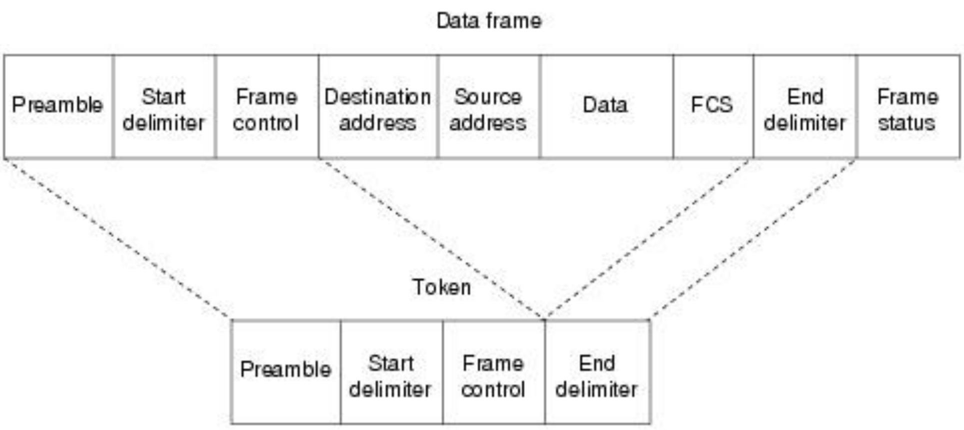


FDDI Specifications

FDDI's four specifications are the Media Access Control (MAC), Physical Layer Protocol (PHY), Physical-Medium Dependent (PMD), and Station Management (SMT) specifications

- ✓ The MAC specification defines how the medium is accessed, including frame format, token handling, addressing, algorithms for calculating cyclic redundancy check (CRC) value, and error-recovery mechanisms.
- ✓ The PHY specification defines data encoding/decoding procedures, clocking requirements, and framing, among other functions.
- ✓ The PMD specification defines the characteristics of the transmission medium, including fiber-optic links, power levels, bit-error rates, optical components, and connectors.
- ✓ The SMT specification defines FDDI station configuration, ring configuration, and ring control features, including station insertion and removal, initialization, fault isolation and recovery, scheduling, and statistics collection.

FDDI Frame Format



FDDI Frame Fields

The following descriptions summarize the FDDI data frame and token fields illustrated in the above figure.

- **Preamble** - Gives a unique sequence that prepares each station for an upcoming frame.
- **Starts delimiter** - Indicates the beginning of a frame by employing a signaling pattern that differentiates it from the rest of the frame.
- **Frame control** - Indicates the size of the address fields and whether the frame contains asynchronous or synchronous data, among other control information.
- **Destination address** - Contains a unicast (singular), multicast (group), or broadcast (every station) address. As with Ethernet and Token Ring addresses, FDDI destination addresses are 6 bytes long.
- **Source address** - Identifies the single station that sent the frame. As with Ethernet and Token Ring addresses, FDDI source addresses are 6 bytes long.
- **Data** - Contains either information destined for an upper-layer protocol or control information.
- **Frame check sequence (FCS)** - Is filed by the source station with a calculated cyclic redundancy check value dependent on frame contents (as with Token Ring and Ethernet). The destination address recalculates the value to determine whether the frame was damaged in transit. If so, the frame is discarded.
- **End delimiter** - Contains unique symbols; cannot be data symbols that indicate the end of the frame.
- **FRAME STATUS** Allows the source station to determine whether an error occurred; identifies whether the frame was recognized and copied by a receiving station.

ADVANTAGES OF FDDI

- Token passing topology
- High speed fiber optic transmission
- Fiber optic cabling is more secure than copper wire
- It can send data for larger distances than Token Ring or Ethernet
- FDDI has a dual ring that is fault-tolerant. The benefit here is that if a station on the ring fails or if the cable becomes damaged, the dual ring is automatically doubled back onto itself into a single ring.

DISADVANTAGES OF FDDI

- High Cost
- Distance limitations improve over other LANs, too limiting for WANs
- Difficult for multiple ring failures.
- As the network grows, this possibility grows larger and larger.
- The uses of fiber optic cables are expensive.

2.4 Switching

11. Explain the concept of switching and its types

Switching

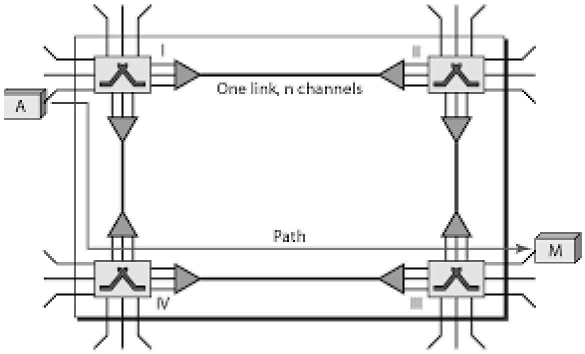
A switched network consists of a series of interlinked nodes, called switches. Switches are devices capable of creating temporary connections between two or more devices linked to the switch. In a switched network, some of these nodes are connected to the end systems (computers or telephones, for example). Others are used only for routing.

Traditionally, three methods of switching have been important:

- Circuit switching
- Packet switching
- Message switching

Circuit switching

A circuit-switched network consists of a set of switches connected by physical links. A connection between two stations is a dedicated path made of one or more links. However, each connection uses only one dedicated channel on each link.

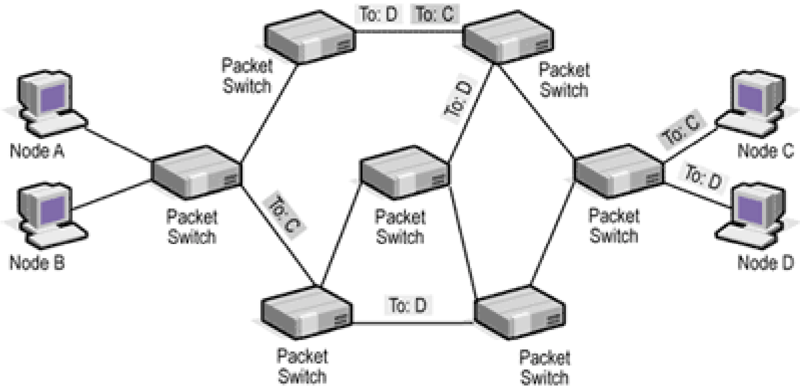


- ✓ The end systems, such as computers or telephones, are directly connected to a switch. We have shown only two end systems for simplicity.
- ✓ When end system A needs to communicate with end system M, system A needs to request a connection to M that must be accepted by all switches as well as by M itself. This is called the setup phase;
- ✓ A circuit (channel) is reserved on each link, and the combination of circuits or channels defines the dedicated path.
- ✓ After the dedicated path made of connected circuits (channels) is established, data transfer can take place. After all data have been transferred, the circuits are tom down.

Packet switching

- ✓ In data communications, we need to send messages from one end system to another.

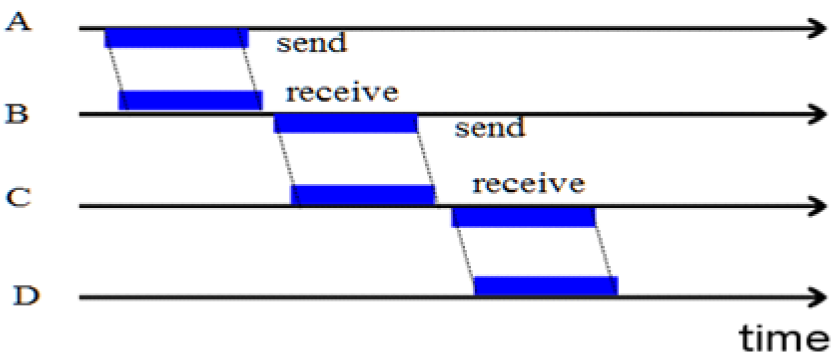
- ✓ If the message is going to pass through a packet-switched network, it needs to be divided into packets of fixed or variable size. The size of the packet is determined by the network and the governing protocol.
- ✓ In packet switching, there is no resource allocation for a packet. This means that there is no reserved bandwidth on the links



- ✓ In this example, all four packets (or datagram) belong to the same message, but may travel different paths to reach their destination.
- ✓ This is so because the links may be involved in carrying packets from other sources and do not have the necessary bandwidth available to carry all the packets

Message switching

- ✓ Each message is treated as a separate entity. Each message contains addressing information, and at each switch this information is read and the transfer path to the next switch is decided.
- ✓ Depending on network conditions, a conversation of several messages may not be transferred over the same path.



- ✓ Each message is stored (usually on hard drive due to RAM limitations) before being transmitted to the next switch.
- ✓ Because of this it is also known as a 'store-and-forward' network.
- ✓ Email is a common application for message switching.

2.5 INTEGRATED SERVICES DIGITAL NETWORK (ISDN)

12. Explain the concept of ISDN in detail

ISDN

- ✓ Integrated Services Digital Network (ISDN) is a set of communication standards for simultaneous digital transmission of voice, video, data, and other network services over the traditional circuits of the public switched telephone network.
- ✓ The key feature of ISDN is that it integrates speech and data on the same lines, adding features that were not available in the classic telephone system.
- ✓ The ISDN standards define several kinds of access interfaces, such as Basic Rate Interface (BRI), Primary Rate Interface (PRI), Narrowband ISDN (N-ISDN), and Broadband ISDN (B-ISDN).

ISDN INTERFACES

BASIC RATE INTERFACE

- ✓ The entry level interface to ISDN is the Basic Rate Interface (BRI), a 128 kbit/s service delivered over a pair of standard telephone copper wires.
- ✓ The 144 kbit/s payload rate is broken down into two 64 kbit/s bearer channels ('B' channels) and one 16 kbit/s signaling channel ('D' channel or data channel).

PRIMARY RATE INTERFACE

- ✓ The other ISDN access available is the Primary Rate Interface (PRI), which is carried over an E1 (2048 kbit/s) in most parts of the world.
- ✓ An E1 is 30 'B' channels of 64 kbit/s, one 'D' channel of 64 kbit/s and a timing and alarm channel of 64 kbit/s.

Narrowband ISDN

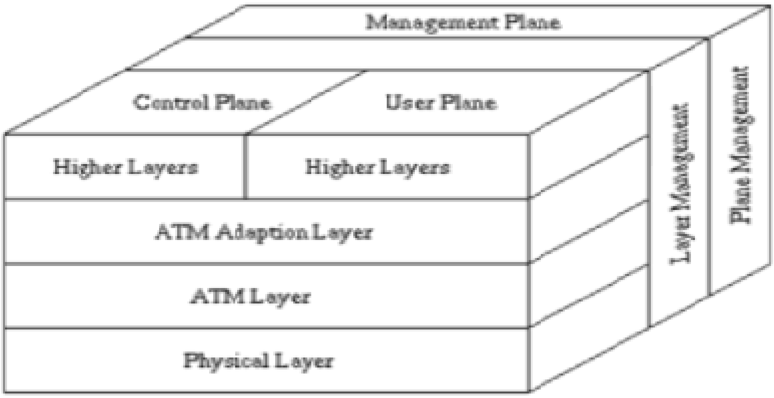
- ✓ **N-ISDN** (Narrowband Integrated Switch digital Network) was an attempt to replace the analog telephone system with a digital one.
- ✓ It generally uses 64 kbit/s channel as the basic unit of switching. It has a circuit switching orientation.
- ✓ It describes telecommunication that carries voice information in a narrow band of frequencies.

Broad band ISDN

- ✓ BISDN is both a concept and a set of services and developing standards for integrating digital transmission services in a broadband network of fiber optic and radio media.
- ✓ It is the next-generation of ISDN technology, with promised bandwidths from 150 megabits per second upward, sufficient to carry video-phone calls and movies.
- ✓ BISON will be carried over FIBRE-OPTIC cabling rather than wire.

PROTOCOL STRUCTURE OF B-ISDN

- ✓ Broadband ISDN protocol reference model is based on the ATM reference model. ATM adaption layer is responsible for mapping the service offered by ATM to the service expected by higher layers.
- ✓ ATM layer is independent of the physical medium over which transmission is to take place.



- ✓ Physical layer consists of two sub layers Transport convergence and physical medium.
- ✓ The control plane is responsible for the supervision of connections including call set up, call release and maintenance.
- ✓ The User plane provides for the Transfer of user information. It also includes mechanisms to perform error recovery and flow control.
