Computer Networks

Computer Science & Information Technology (CS)

20 Rank under AIR 100

Postal Correspondence

- ✓ Examination Oriented Theory, Practice Set
- ✓ Key concepts, Analysis & Summary

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CONTENT

Syllabus : Computer Networks: ISO/OSI stack, LAN technologies (Ethernet, Token ring), Flow and error control techniques, Routing algorithms, Congestion control, TCP/UDP and sockets, IP(v4), Application layer protocols (icmp, dns, smtp, pop, ftp, http); Basic concepts of hubs, switches, gateways, and routers. Network security – basic concepts of public key and private key cryptography, digital signature, firewalls.

CHAPTER-1
INTRODUCTION

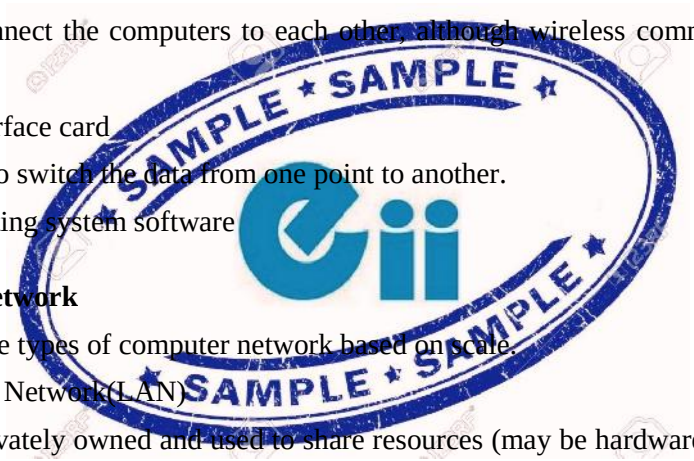
1. Introduction

A computer network consists of a collection of computers, printers and other equipment that is connected together so that they can communicate with each other. Data communication and computer network are two different things. Data communication is the exchange of information between two or more devices through some transmission media.

Components of a Network

A computer network comprises the following components:

a. A minimum of at least 2 computers
b. Cables that connect the computers to each other, although wireless communication is becoming more common
c. A network interface card
d. 'Switch' used to switch the data from one point to another.
e. Network operating system software



Types of Computer Network

There are basically three types of computer network based on scale.

(i) Local Area Network(LAN)

LAN is privately owned and used to share resources (may be hardware or software resources) and to exchange information with the capacity of few kilometer. LANs are reliable because they are restricted in size. LAN's can be used to provide service within single office, single building or an entire campus.

(ii) Metropolitan Area Network(MAN)

MAN is designed to extend over the entire city. MAN is wholly owned and operated by a private company or may be a service provided by a public company. MAN can be created using connecting multiple LANs.

(iii) Wide Area Network (WAN)

WAN provides long-distance transmission of data over large geographical areas that may comprise a country, continent or even the whole world. In contrast to LANs, WANs may utilize public, leased or private communication devices.

Types of Connection between Devices

There are basically two ways to connecting the devices with each other:

(i) Multipoint

In multipoint a link is shared among all the devices. All the devices communicate through that link only.

(ii) Point to Point

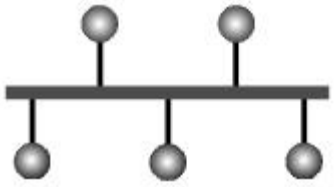
In point to point connection every device is connected with other device using a dedicated link.

Network TOPOLOGY

There are basically 4 network topology are defined. Network topology is basically determines the way of communicating and sharing of information with each other device.

(i) Bus Topology

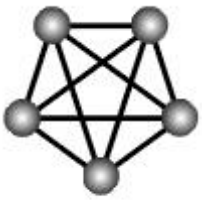
In this topology, there is a single bus (connection) is shared with all the devices. Bus topology basically provides the multipoint connection.



Bus

(ii) Mesh Topology

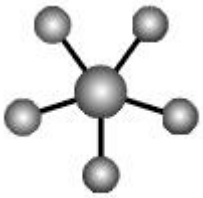
In the Mesh topology every device is connected with other device using a dedicated link.so in mesh topology we required (n (n-1))/2 links.



Mesh

(iii) Star Topology

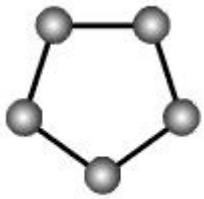
In the star topology every device is connected through using a single device called hub. Here number links required became number of devices (n).



Star

(iv) Ring Topology

In the ring topology devices are connected in the form of ring. Every device is connected to 2 devices. Number of links required in the ring topology is 2n.



Ring

Transmission Modes

There are four types of transmission modes which are used to determine how data is going to transfer across the network.

(i) Unicast Transmission Mode

In the unicast transmission mode, information is sent by one sender to one receiver.

(ii) Broadcast Transmission Mode

This mode generally allows addressing the packet to all nodes on the network. When such a packet is transmitted and received by all the machines on the network.

(iii) MulticastTransmission Mode

This mode is used when the same information must be sent to a set of recipients.

(iv) Anycast Transmission Mode

In this transmission mode, a set of receivers is identified. When a source sends information towards this set of receivers, the network ensures that the information is delivered to one receiver that belongs to this set.

Reference Model

Reference model determines that how network architecture will be. There are two reference models.

a. TCP/IP reference model
b. OSI reference model

ISO OSI (Open Systems Interconnection) Reference Model

It deals with connecting the systems which are open for communication with other systems. The OSI model has seven layers. Every layer performs a different functionality. Interface is provided in between layers. Just below layer provide the services to upper layer.

(i) Physical Layer

Physical layer is responsible of transmitting individual bits from one node to next node. Physical layers also deal with transmission media, interference, line states and encoding of the data and the connector types. Physical layer service is an unreliable connection-oriented service.There exist a variety of physical layer protocols such as RS-232C, Rs-449 standards developed by Electronics Industries Association (EIA).

(ii) Data Link Layer

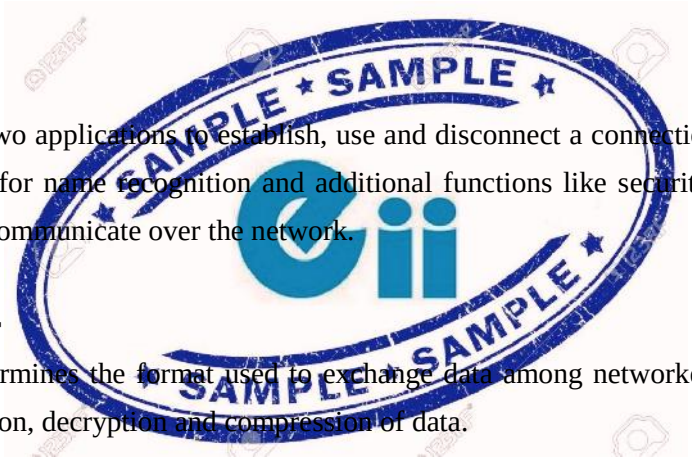
Data Link Layer is responsible of delivery of frames from one node to next node. The main function of this layer are handles the physical transfer, farming (the assembly of data into a single unit or block), flow control and error-control functions over a single transmission link, physical addressing. The data link layer is often subdivided into two parts Logical Link Control (LLC) and Medium Access Control (MAC).

(iii)Network Layer

Network Layer is responsible of delivery of packet from source to destination. The main function of this layer are handles the routing, fragmentation, traffic shaping, logical addressing. Internet datagram, address resolution protocol, reverse address resolution protocol are the protocol of network layer.

(iv)Transport Layer

Transport layer is responsible of delivery of segment from process to process. The main function of this layer are handles the segmentation, end to end flow and error control, port addressing. Transmission Control Protocol, User Datagram Protocol and Stream transfer control protocol are the protocol of transport layer.



(v)Session Layer

Session layer allows two applications to establish, use and disconnect a connection between them called a session. It provides for name recognition and additional functions like security, which are needed to allow applications to communicate over the network.

(vi)Presentation Layer

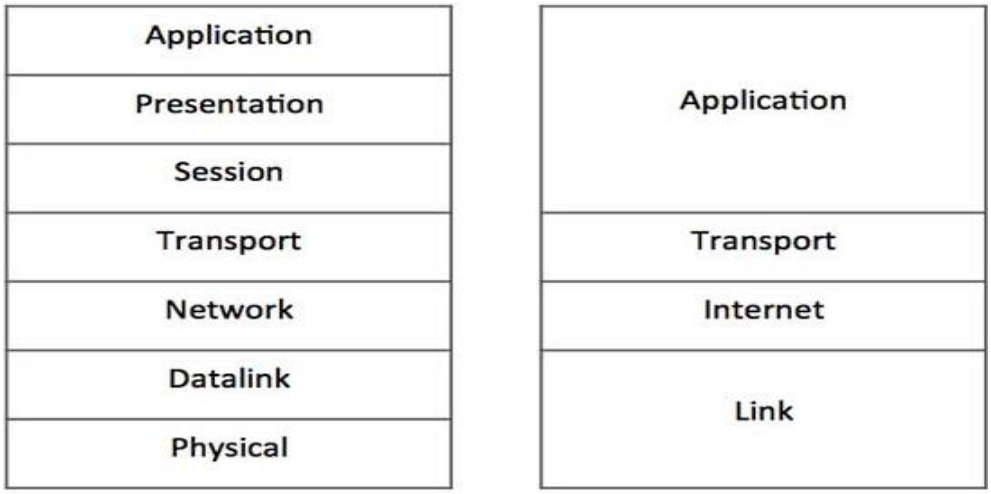
Presentation layer Determines the format used to exchange data among networked computers. it is also responsible for encryption, decryption and compression of data.

(vii)Application Layer

Application layer is responsible for providing services to user. There are so many protocols that are working on application layer like File transfer (FTP),Remote login (telnet)Mail (SMTP),News (NNTP),Web (HTTP).

TCP/IP reference model

The TCP/IP reference model is the network model used in the current Internet architecture. All three top layers of OSI Model are compressed together in single Application layer of TCP/IP Model. Transport and Internet layers of TCP/IP correspond to the transport and network layer of OSI respectively.



Networking Device

Hubs, Bridges, Switches and Routers are used to build networks.

Hubs are used to build a LAN by connecting different computers in a star/hierarchal network topology. A hub is a very simple device called as dumb terminal, once it gets data packet sent from any computer, it does not check the destination address of that packet. It just forwards that packet to all other computers within the network. The node to which it is made will then pick it up while other nodes discard it. This amplifies that the traffic is shared.

Passive Hub: The signal is forwarded as it is. It does not require any power supply.

Active Hub: active hub first amplify the signal then transmit. Active Hub also called as multiport repeaters. Hubs work on the physical layer (lowest layer). Because of this they can't deal with addressing or data filtering.

Switches checks for the destination MAC address in the packet header and forward it to the relevant port to reach that destination hostonly. Switches build a table of which MAC address belongs to which LAN segment. If a destination MAC address is not in the table it forwards to all segments except the source segment. If the destination is same as the source, frame is discarded.

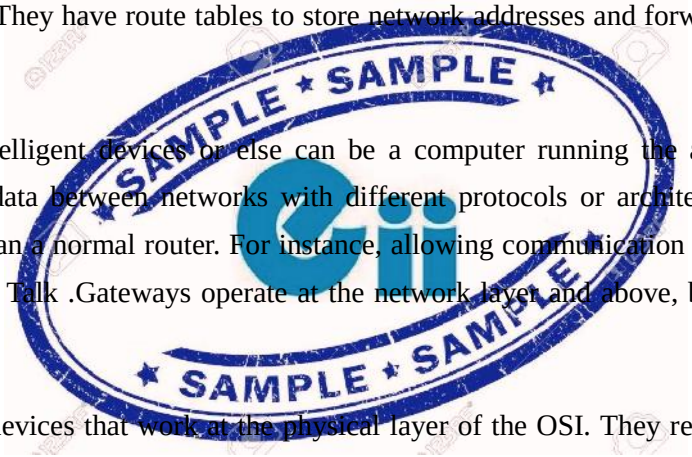
Switches have built-in hardware chips solely designed to perform switching capabilities, therefore they are fast and come with many ports. Sometimes they are referred to as intelligent bridges or multiport bridges.

There are two types of switches are there:
1. Cut-through Switch: Directly forward what the switch gets.
2. Store and forward Switch: receive the full frame before retransmitting it.

Switches works on the data link layer that's why they deal with frames and filter them based on MAC addresses. VLANs (Virtual LANs) and broadcast domains: Switches do not control broadcast domains by default, however, if a VLAN is configured in a switch it will has its own broadcast domain.

Bridges are used to extend networks by maintaining signals and traffic. Bridges are on the data link layer so in principle they are capable to do what switches do like data filtering and separating the collision domain, but they are less advanced. In a comparison with switches, they are slower because they use software to perform switching. They do not control broadcast domains and usually come with less number of ports.

Routersare used to connect different LANs or a LAN with a WAN (e.g. the internet). Routers control both collision domains and broadcast domains. If the packet's destination is on a different network, a router is used to pass it the right way, so without routers the internet could not functions. Routers use NAT (Network Address Translation) in conjunction with IP Masquerading to provide the internet to multiple nodes in the LAN under a single IP address. Routers work on the network layer so they can filter data based on IP addresses. They have route tables to store network addresses and forward packets to the right port.



Gateways are very intelligent devices or else can be a computer running the appropriate software to connect and translate data between networks with different protocols or architecture, so their work is much more complex than a normal router. For instance, allowing communication between TCP/IP clients and IPX/SPX or Apple Talk .Gateways operate at the network layer and above, but most of them at the application layer.

Repeaters are simple devices that work at the physical layer of the OSI. They regenerate signals (active hubs do that too).

Key Point:

1. Internet is a collection of networks or network of networks. Various networks such as LAN and WAN connected through suitable hardware and software to work in a seamless manner.
2. A protocol is a formal set of rules and conventions that governs how computers exchange information over a network medium. A protocol implements the functions of one or more of the OSI layers.
3. Session layer is also called as port layer.
4. The Physical Layer PDU (protocol data unit) is the packet, consisting of bits or, more generally, symbols .it can be called as stream of bits.
5. The Data Link Layer PDU is the frame
6. The Network Layer PDU is the packet
7. The Transport Layer PDU is the segment for TCP , or the datagram for UDP

8. The Application Layer (layer 5,6,7) PDU is the Message.
9. VLAN is a logical group of network devices located on different LAN physical segments. However they are logically treated as if they were located on a single segment.
10. **Circuit Switching:** In this, a virtual path will be established between source and destination and then data is transferred on that virtual path and then connection will be released.
11. **Packet Switching:** In this data travels in all the direction. There is no relationship in between any packet. Every packet travels individual.

Gate Questions

1. In the following pairs of OSI protocol layer/sub-layer and its functionality, the Incorrect pair is

(a.) Network layer and Routing

(b.) Data link layer and Bit synchronization.

(c.) Transport layer and End – to – end process communication

(d.) Medium access control sub-layer and channel sharing **GATE:2014**

ANS: b

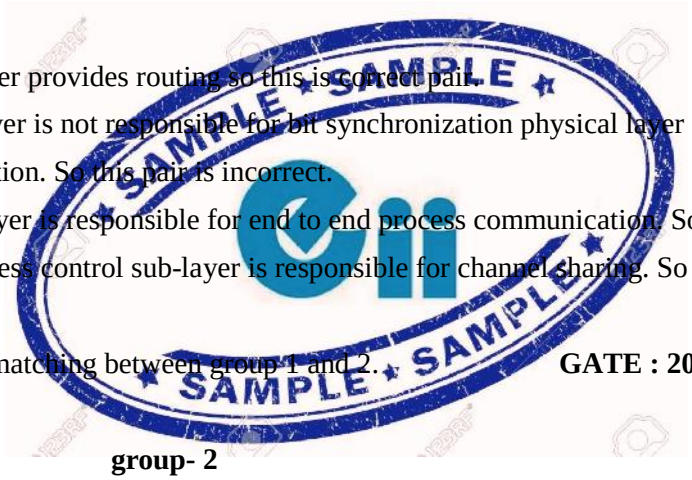
EXP:

(a) Network layer provides routing so this is correct pair.

(b) Data link layer is not responsible for bit synchronization physical layer is responsible for bit synchronization. So this pair is incorrect.

(c) Transport layer is responsible for end to end process communication. So this is correct pair.

(d) Medium access control sub-layer is responsible for channel sharing. So this is correct pair.



2. Choose the best matching between group 1 and 2. **GATE : 2004**

Group- 1	**group- 2**
(P.) data link layer point-to-point	1. Ensures reliable transport of data over a physical
(Q.) network layer	2. Encodes/decodes data for physical transmission
(R.) transport layer	3. Allows end-to-end communication between two processes
	4. Routed data from one network from one network node to the next.

(a.) P- 1, Q- 4, R-3 (b.) P- 2, Q- 4, R- 1

(c.) P- 2, Q- 3, R- 1 (d.) P- 1, Q- 3, R-2

ANS: a

EXP:

→ Data link layer is responsible for reliable transfer of data over a physical link.

→ Network – layer is responsible for routing

Transport layer is responsible for process to process communication

Level-I

(1.) Network layer activities are

(*a*) Logical addressing (*b*) Port addressing

(*c*) Access control (*d*) All of these

(2.) Hop-to-Hop delivery is related to

(*a*) Data link layer (*b*) Network layer

(*c*) Transport layer (*d*) All of these

(3.) Process-to-Process delivery is related to

(*a*) Data link layer (*b*) Network layer (*c*) Transport layer (*d*) All of these

(4.) Which one of the following OSI layers performs error checking of data?

(*a*) Network (*b*) Transport (*c*) Data link (*d*) Physical

(5.) Flow control is the responsibility of

(*a*) Data link layer (*b*) Transport layer

(*c*) Both (*a*) and (*b*) (*d*) Application layer

(6.) Which of the following address cannot be changed?

(*a*) Hardware address (*b*) Logical address

(*c*) Both (*a*) and (*b*) (*d*) None of these

(7.) Congestion control is done in

(*a*) MAC layer (*b*) Data link layer

(*c*) Transport layer (*d*) Application layer

(8.) Network to network delivery is done on

(*a*) Network layer (*b*) Transport layer

(*c*) Application layer (*d*) Data link layer

(9.) Port number is

(*a*) Process number (*b*) Computer's physical address

(*c*) Both (*a*) and (*b*) (*d*) None of these

(10.) Which of these network devices belongs at the OSI physical layer (layer one)?

(*a*) Repeater (*b*) Router (*c*) Switch (*d*) Bridge

(11.) Which of these network devices belong at the OSI data link layer (layer two)?

(*a*) Router (*b*) Bridge (*c*) VPN (*d*) None of these

(12.) Which of these network devices primarily functions at the OSI network layer (layer 3)?

(*a*) Switch (*b*) Gateway (*c*) Router (*d*) All of these

(13.) In OSI, the term PDU stands for

(*a*) Private data unit (*b*) Protected data unit

(*c*) Public data unit (*d*) Protocol data unit

(14.) What is the Protocol Data Unit (PDU) employed at the Data Link Layer?

(*a*) bits (*b*) frames (*c*) packets (*d*) segments

(15.) Which layer of OSI model provides services directly to user applications?

(*a*) application (*b*) presentation (*c*) session (*d*) transport

(16.) What network topology implements at least two paths to and from each node?

(*a*) bus (*b*) ring (*c*) star (*d*) mesh

(17.) What type of network topology is depicted by a single cable where devices connect using 'T' connectors?

(*a*) star (*b*) bus (*c*) ring (*d*) 10 base T

(18.) Which layer of the OSI model deal with physical transmission across a physical network?

(*a*) physical (*b*) data link (*c*) network (*d*) Transport

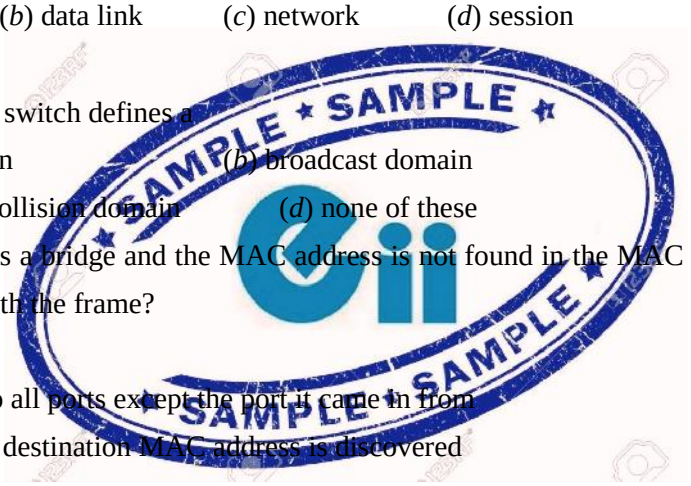
(19.) HTTP uses

(*a*) TCP/IP protocol (*b*) UDP/IP protocol

(*c*) OSI protocol (*d*) SMTP protocol

(20.) At which layer of the OSI model does a switch exit

(*a*) physical (*b*) data link (*c*) network (*d*) session



(21.) Every port on a switch defines a

(*a*) collision domain (*b*) broadcast domain

(*c*) broadcast and collision domain (*d*) none of these

(22.) If a frame enters a bridge and the MAC address is not found in the MAC address table, what will the bridge to with the frame?

(*a*) Drop it

(*b*) forward it to all ports except the port it came in from

(*c*) hold it until the destination MAC address is discovered

(*d*) block it

(23.) A hub is a

(*a*) router (*b*) bridge (*c*) repeater (*d*) all of these

(24.) Modulation and demodulation are done by

(*a*) hub (*b*) modem (*c*) bridge (*d*) none of thee

(25.) Which one of the following devices can be used to connect two LAN networks which use similar protocols?

(*a*) bridge (*b*) trans receiver (*c*) repeater (*d*) gateway

(26.) Which one is not true for repeater?

(*a*) A repeater connects segments of a LAN

(*b*) A repeater has filtering capability

(*c*) A repeater is a regenerator

(*d*) A repeater cannot act as an amplifier

(27.) Describe the function of the hub at the center of a star network.

(*a*) Device to store information temporarily then sends it out to another destination on the

network

(*b*) hardware device which will enable any printer to be connected to the network

(*c*) A central location for the attachment of cabling from a number of PCs

(*d*) All of these

(28.) If switches are used to replace hubs on a network, which of the following statements is true?

(*a*) the number of broadcast domains will increase

(*b*) the number of collision domains will increase

(*c*) the number of collision domains will decrease

(*d*) the number of broadcast domains will decrease

(29.) When a bridge forwards an Ethernet frame, the Ethernet frame contains:

(*a*) the broadcast address as its source address

(*b*) the next bridge's LAN address for its destination address

(*c*) the bridge's LAN address for its source address

(*d*) none of these

(30.) A network bridge table is used to perform the following:

(*a*) Mapping MAC addresses to bridge port numbers

(*b*) Forwarding frames directly to outbound ports for MAC addresses it handles.

(*c*) Filtering (discarding) frames that are not destined for MAC addresses it handles.

(*d*) All of these

ANSWER KEY

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
a)	a)	c)	c)	c)	a)	c)	a)	a)	a)
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
b)	c)	d)	b)	a)	d)	b)	b)	a)	b)
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
a)	b)	c)	b)	a)	b)	a)	b)	d)	a)

Level-2

(1.) Which layer of the OSI model is responsible for converting the data from one presentation format to another?

(*a*) application (*b*) presentation (*c*) session (*d*) transport

(2.) Which layer of the OSI model is responsible for communication modes such as simplex, half duplex, and full-duplex?

(*a*) application (*b*) session (*c*) transport (*d*) physical

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