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Computer Networks

Assignment1

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1 What is a computer network? What are the uses of computer networks? Mention any two typical disadvantages of computer networks.

Computer networking refers to interconnected computing devices that can exchange data and share resources with each other via a system of rules, called communications protocols, to transmit information over physical or wireless technology.
The uses of computer networks are:

- Resource sharing
- Information sharing
- Communications
- E-commerce
- VoIP
- Entertainment

Two typical disadvantages of computer networks are:

- Risk of security issues
- High initial hardware and software cost

2 What is physical and logical topology? List out the different physical topology with the merits and demerits of each.

Physical topology, as the name suggests, represents the physical layout of the network. It represents the actual interconnected structure of a network. This is the actual pathway or route during the transmission in a network.
Logical topology, as the name suggests, represents the logical layout of the network. It represents the way that the data passes through the network from one device to the next. It is a high level representation of data flow.

There are four main physical topologies.They are:

- Mesh Topology
  - Merits
    - If one link fails, only that link is affected
    - Fast
    - Reliable
    - No traffic issue
    - High Security and Privacy
  - Demerits

        * Requires large number of hardware parts
        * Difficult to install and configure
        * Expensive
        * High redundancy
        * Requires more space and cable

- Bus Topology
    - Merits
        * Cheaper
        * Easy to install and configure
        * Shorter cables
        * Robust: Breaking of a node doesn't affect others
        * Scalable: Easy to add nodes
    - Demerits
        * High dependency on bus
        * Too many nodes slows down the system
        * Chances of bottleneck
        * High collision
        * Security and privacy issue

- Star Topology
    - Merits
        * Relatively cheaper
        * Easy to install and configure
        * If one link fails, only that link is affected.
        * Easy fault detection and correction
        * Scalable: east to add nodes
    - Demerits
        * High dependency on hub
        * Hub acts as a bottleneck
        * Long cables
        * Maximum number of nodes limited to the number of ports in hub
        * Slow transmission

- Ring Topology
    - Merits
        * No collision:Unidirectional
        * Easy to install and configure
        * Scalable
        * Easy to troubleshoot
        * Reduced cabling

- Demerits
  - Breaking of ring breaks the whole system
  - Addition/Removal of stations can disturb the whole system
  - Not robust
  - Slow transmission
  - Difficult to reconfigure

To maximize merits and minimize demerits we can use hybrid of two or more topologies for optimal networking.

3 What is layered network architecture? Why is layering important? Discuss.

Computer layered network architecture is used for the systematic transmission of data between the users in order to converse and send data efficiently and in an ordered manner. The basic idea of a layered architecture is to divide the task of network communication into small pieces to create a link between the sender and the receiver as well as delivering data in a seamless manner.
The importance of layering is:

- It breaks the system into small parts.This allows complex system to be divided into simple systems.
- It provides modularity to the system such that a part of the system can be updated and reconfigures without altering the others.
- It provides flexibility as each small system can be altered independently of the rest.
- It allows information hiding and implementation abstraction.
- It allows functionality sharing as upper layers can share lower layer functionality.
- It decouples changes.

4 What is protocol? List out ten different standard protocols having at least one in each layer of TCP/IP reference model.

Protocol is the set of mutually accepted and implemented rules at both ends of the communication channel for the proper exchange of information. It can also be defined as the digital language through which we can communicate with others on the internet. It defines how each agent must behave, including the timing, format and content of messages that it sends and receives. A protocol specification consists of the syntax, and the semantic, which specifies the action taken by each entity when specific events occurs.
Different protocols for different layers are:

- Network Access Layer
  - Ethernet
  - Token Ring
  - FDDI
  - HDLC
  - PPP
- Internet Layer
  - IP
  - ICMP
- Transport Layer
  - TCP
  - UDP
- Application Layer
  - TELNET
  - FTP
  - SMTP
  - DNS
  - HTTP

5 What is data encapsulation? Explain the different steps of data encapsulation briefly.

Data encapsulation is the process of packaging data before transmission during communication. Each message is wrapped with the appropriate bits of header and trailers in each layer during transmission. The different steps of data encapsulation are:

- Build Data: In application layer, the data required is generated.
- Package data for end-to-end transport: In transport layer, the data is segmented into segments for transmission. And thus, segment header gets added.
- Add IP Addresses to network header: In network layer, IP addresses are added as packet header. Thus, packet is obtained.
- Add data link headers and trailer: In data link layer, data link header and trailer are added. These are medium dependent and creates frame for transmission.
- Convert to bits for transmission: Finally in physical layer, the frame is converted to bits for transmission.

This is encapsulation process. When done in reverse order, it is called data de-encapsulation.

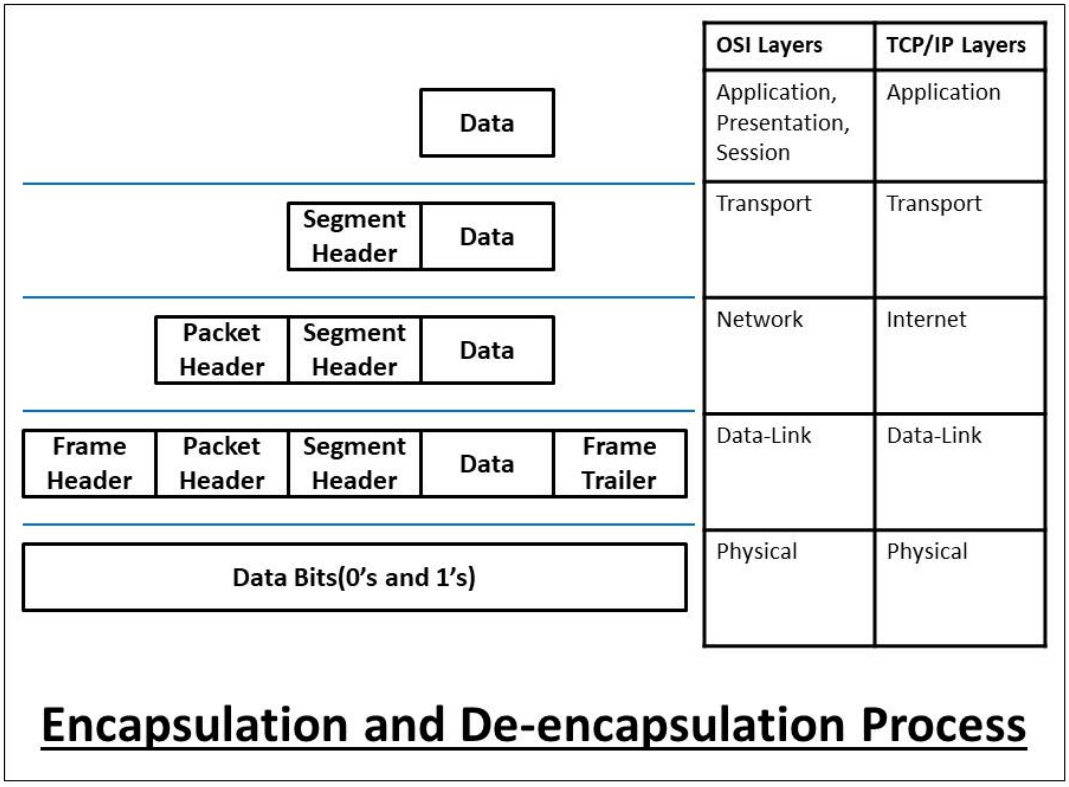

Figure 1: Data Encapsulation and De-encapsulation

6 List out the different categories of twisted pair cable with their typical features and applications.

Twisted pair cable is one of the oldest and most commonly used transmission media. Twisted pair are of two types:

- UTP(Unshielded Twisted Pair)
  Features of UTP:
  Speed and throughput—10 to 1000 Mbps
  Average cost per node—Least expensive
  Media and connector size—Small
  Maximum cable length—100 m (short)
  The **features and application** of different UTP categories are in the table next page.

- STP(Shielded Twisted Pair)
  Features of STP:
  Speed and throughput—10 to 100 Mbps
  Average cost per node—Moderately expensive
  Media and connector size—Medium to large
  Maximum cable length—100 m (short)
  Application of STP:
  STP is not generally used in networks because they are very expensive. STPs are usually used in Europe only.

Name	Cable Type	Max. Data Rate	Bandwidth	Application
Cat1	Twisted Pair	1 Mbps	0.4 MHz	Telephone and modem lines
Cat2	Twisted Pair	4 Mbps	4 MHz	Older terminal systems, e.g. IBM 3270
Cat 3	Twisted Pair	10 Mbps	16 MHz	10BASE-T and 100BASE-T4 Ethernet
Cat 4	Twisted Pair	16 Mbps	20 MHz	16Mbit/s Token Ring
Cat 5	Twisted Pair	100 Mbps	100 MHz	100BASE-TX & 1000BASE-T Ethernet
Cat5e	Twisted Pair	1 Gbps	100 MHz	100BASE-TX & 1000BASE-T Ethernet
Cat 6	Twisted Pair	10 Gbps	250 MHz	10GBASE-T Ethernet
Cat 6a	Twisted Pair	10 Gbps	500 MHz	10GBASE-T Ethernet
Cat 7	Twisted Pair	10 Gbps	600 MHz	10GBASE-T Ethernet or POTS/CATV/1000BASE-T over single cable
Cat 7a	Twisted Pair	10 Gbps	1000 MHz	10GBASE-T Ethernet or POTS/CATV/1000BASE-T over single cable
Cat 8/8.1	Twisted Pair	40 Gbps	1600-2000 MHz	40GBASE-T Ethernet or POTS/CATV/1000BASE-T over single cable
Cat 8.2	Twisted Pair	40 Gbps	1600-2000 MHz	40GBASE-T Ethernet or POTS/CATV/1000BASE-T over single cable

Figure 2: Twisted pair categories

7 What is switching? Discuss the importance of switching in the telecommunication networks.

When a user accesses the internet or another computer network outside their immediate location, messages are sent through the network of transmission media. This technique of transferring the information from one port to another is known as switching. Switching is important in telecommunication because:

- Switch increases the bandwidth of the network.
- It reduces the workload on individual devices.
- It increases the overall performance of the network.
- It reduces frame collision.

8 Discuss briefly on:

- **X.25**
  X.25 is the first international standard packet switching network. It was designed to become a worldwide public data network similar to the global telephone system for voice, but it never came to. It has been used primarily outside the U.S. for low speed applications (up to 56 Kbps) such as credit card verifications and automatic teller machine (ATM) and other financial transactions. It has also been used for signaling networks in first-generation cellular systems. It provides a connection-oriented technology for transmission over highly error-prone facilities, which were more common when it was first

introduced. Error checking is performed at each node, which can slow overall throughput and renders X.25 incapable of handling real-time voice and video. It operates three protocol layers: Physical, Data-Link and Packet Layer.

- **Frame Relay**
  A frame relay is a high-speed packet switching protocol used in wide area networks (WANs). It Provides a granular service of up to DS3 speed (45 Mbps). It is mostly used for connections across remote distances, and services are offered by most major carriers. It is much faster than X.25, the first packet-switched WAN standard, because frame relay was designed for reliable circuits and performs less error detection. It does not process the packets; it relays them from the switch's input port to the output port, hence the name frame relay. It operates in two protocol layers: Physical and Data-Link Layers

- **VoIP**
  VoIP stands for Voice Over IP(Internet Protocol). It is a digital telephone service that uses the Internet for transport. Since calls originate and terminate in telephones, PSTN is used. When dealing with hardware, modern digital phones support VoIP whereas old analog phones need an adapter. However, VoIP may be entirely software based(called softphone), which uses an app in a mobile device or a computer equipped with microphone and speakers. Skype is a very popular softphone-based VoIP service provider. VoIP uses two telephony protocols for handling connections (SIP and H.323), and most VoIP systems support both. Skype uses its own protocol. Along with other features, voicemail, caller ID, call forwarding and a softphone option are typically part of a VoIP package. Nowadays, VoIP even support virtual phone numbers.

- **NGN**
  NGNs stand for Next Generation Networks. It is an umbrella term for packet-based, mixed voice and data networks running over the IP protocol. It is provides multiple broadband telecommunication services based on internet technology. It is also able to use QoS. It uses H.323 protocol as its major component.

- **MPLS**
  MPLS stands fpr MultiProtocol Label Switching. It is an IETF(Internet Engineering Task Force) standard for directing packets in a wide area IP network. It operates below the IP layer and above the optical layer. It is used to ensure that packets take the same route. It is deployed by telcos and ISPs to support service level agreements (SLAs) that guarantee bandwidth. Large enterprises may also use MPLS in national private networks. An MPLS router attaches labels containing forwarding information to outgoing IP packets. These "label edge routers" (LERs) sit at the edge of the network and perform the complex packet analysis and classification before the packet enters the core of the network. The routers within the core, known as "label switching routers" (LSRs), quickly examine the label and forward the packet per its directions without having to look up data in tables and compute the forwarding path each time. The edge routers at the receiving end remove the labels.

- **xDSL**

Digital Subscriber Line(DSL) is a technology that increases the digital capacity of ordinary telephone for Internet and TV service. xDSL represents digital subscriber line technologies in general, including ADSL, HDSL, SDSL and VDSL. Depending on the DSL version, speed is based on the distance between the customer and telco central office or telephone junction box. At the central office, DSL traffic is aggregated in a unit called the DSL Access Multiplexor (DSLAM) and forwarded to the appropriate ISP or data network.

- **Bandwidth**
  Bandwidth is the measure of range of the frequency band. It is the theoretical maximum of number of bits that can be transmitted over a network in given period of time. Digital bandwidth is the number of pulses per second measured in bits per second. Analog bandwidth is the difference between the highest and lowest frequencies, measured in cycles per second, or Hertz (Hz).

- **Throughput**
  Throughput is the practical bandwidth of a system measured at given time. It is the amount of work performed by a computer within a given time. It is a combination of internal processing speed, peripheral speeds and the efficiency of the operating system, other system software and applications all working together. Transactions processed per second (TPS) is one metric commonly used to gauge throughput.

- **Delay**
  Delay is one of the performance measure of a system. It is defined as the time it takes to transmit a signal from one place to another. It is dependent solely on distance and two thirds the speed of light. Signals going through a wire or fiber generally travel at two thirds the speed of light. It is typically measured in multiples or fractions of a second.

- **Latency**
  In general, latency is the time between initiating a request in the computer and receiving the answer. Data latency may refer to the time between a query and the results arriving at the screen or the time between initiating a transaction that modifies one or more databases and its completion. Disk latency is the time it takes for the selected sector to be positioned under the read/write head. Channel latency is the time it takes for a computer channel to become unoccupied in order to transfer data. Network latency is the delay introduced when a packet is momentarily stored, analyzed and then forwarded.

- **RTT**
  RTT stands for Round Trip Time. Round trip refers to the trip from the source to a destination and back to the source again. Round Trip Time is the time taken by a message sent from one end to reach the destination end and return back. It is also called round trip latency.

- **ISDN**
  ISDN stands for Integrated Services Digital Network. It is an international standard for switched, digital dial-up telephone service for voice and data. Analog telephones and fax machines are converted into digital by the ISDN

terminal adapter. ISDN uses 64 Kbps "B" (bearer) channels to carry voice and data. A separate "D" (delta) channel is used for control. The D channel signals the carrier's voice switch to make calls, put them on hold and activate features such as conference calling and call forwarding. It also receives caller ID data. Because the D channel connects directly to the telephone system's SS7 signaling network, ISDN calls are dialed much faster than regular telephone calls.

9 Differentatie

- LAN vs WAN

SN	Parameters	LAN	WAN
1	Fullform	Local Area Network	Wide Area Network
2	Range	Small area	Large geographical area
3	Broadcasting	Broadcasting is allowed.	Broadcasting is not allowed.
4	Transmission medium	Co-acial cables or UTP	PSTN or Satellite link
5	Setup cost	Low	High
6	Fault Tolerance	High	Low

- Internet vs Intranet

SN	Parameters	Internet	Intranet
1	Definition	Global network of computers	Small network of computers
2	Number of users	Large and expanding	Limited
3	Source of information	Various sources of information	Specific sources of information
4	Network	Public Network	Private Network
5	Security	Low security	Very secure
6	Access	Can be accessed by anyone	Only selected devices can access

- P2P vs Client-Server Network

SN	Parameters	P2P	Client-Server
1	Data	Decentralized, each peer has its own data	Centralized server for all data
2	Service	Any peer can request or respond	Client requests and Server responds to the requests
3	Scalability	High number of peers reduces performance as resources are shared	Number of clients have minimum impact in performance of server
4	Security	Vulnerable, vulnerability increases with increase in peers	Secure because server authenticates every client's access
5	Focus	Connectivity	Information sharing
6	Setup Cost	Low	High

- OSI vs TCP/IP reference model

SN	Parameters	OSI	TCP
1	Fullform	Open System Interconnection	Transmission Control Protocol
2	Developed by	ISO	ARPANET
3	Transport layer	Guarantees delivery of packets	Reliable but no guarantee
4	Approach	Vertical approach	Horizontal approach
5	Number of layers	7	4
6	Service by network layer	Both connection-oriented and connectionless	Only connectionless

- FDM vs TDM

SN	Parameters	FDM	TDM
1	Fullform	Frequency Division Multiplexing	Time Division Multiplexing
2	Definition	A multiplexing technique that shares frequency among given signals	A multiplexing technique that shares time among given signals
3	Working principle	Channel frequency is divided to create multiple channels	Whole channel frequency range used by a single signal at a time followed by another signal.
4	Signal support	Only analog signals	Both analog and digital signals
5	Hardware Module	Complex	Relatively simple
6	Efficiency	Quite inefficient	Very efficient

- Circuit switching vs Packet switching

SN	Parameters	Circuit Switching	Packet Switching
1	Path	A dedicated path is created between two points by setting the switches	no dedicated path is created between two points.
2	Bandwidth	Fixed because it is reserved in advance	Dynamic because it can be released if needed.
3	Routing scheme	Selected during setup	Each packet routed independently
4	Protocol	Simple protocols	Complex protocols
5	Installation cost	Low	high
6	Layer	Physical layer of OSI	Data-link and Network layer of OSI

- Datagram vs Virtual circuit switching

SN	Parameters	Datagram	Virtual circuit switching
1	Dedicated path	No fixed path	Path fixed for a session
2	Connection	Connectionless services	Connection oriented service
3	Reliability	Relatively low	Highly reliable
4	Packet header	Every packet needs a packet header	Since the path for a session is fixed, a global header is enough.
5	Setup Cost	Cheap	Expensive
6	Packet order	Packet may arrive at destination out of order.	Packets always arrive at destination in order.