Computer Networks

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Introduction to Computer Networks

A computer network is a system that connects two or more computing devices for transmitting and sharing information. Computing devices include everything from a mobile phone to a server. These devices are connected using physical wires such as fiber optics, but they can also be wireless.

Networking Model

1. Computer networking models provide structured frameworks that describe how data communication processes occur over a network.

1. These models are essential for designing, implementing, and managing network systems effectively.

1. The two primary networking models are the OSI (Open Systems Interconnection) model and the TCP/IP (Transmission Control Protocol/Internet Protocol) model.

Protocols and Standards

Protocols are sets of rules and conventions for communication between network devices.

Protocols will define how data is formatted, transmitted, and received across a network.

Protocols ensure that devices from different manufacturers can work together and that data integrity is maintained during transmission.

Examples of Protocols are: TCP, FTP, HTTP, SMTP, IP, UDP etc.

OSI Model

The OSI model, developed by the International Organization for Standardization (ISO), is a conceptual framework that standardizes the functions of a telecommunication or computing system into seven distinct layers. Each layer serves a specific function and communicates with the layers directly above and below it. The seven layers are:

Physical Layer: It deals with the physical connection between devices, including the transmission of raw bitstreams over a physical medium. It contains hardware elements which are cables, switches, and network interface cards.

Data Link Layer: It provides node-to-node data transfer, error detection, and correction. It is responsible for creating and recognizing frame boundaries and managing MAC (Media Access Control) addresses.

Network Layer: This layers manages the routing of data packets across the network, determining the best path for data transfer. It handles logical addressing, often through IP addresses.

Transport Layer: Ensures complete data transfer and reliability, providing error recovery and flow control. Protocols such as TCP (Transmission Control Protocol) and UDP (User Datagram Protocol) operate at this layer.

Session Layer: Manages sessions between applications, establishing, maintaining, and terminating connections.

Presentation Layer: Translates data between the application layer and the network, handling data encoding, encryption, and compression

Application Layer: Closest to the end user, this layer interacts with software applications to implement network services. Protocols such as HTTP, FTP, and SMTP operate here.

PDU of each Layers

PDU Name	OSI Model Layers
Data	Application Layer
Data	Presentation Layer
Data	Session Layer
Segments	Transport Layer
Packets	Network Layer
Frames	Data Link Layer
Bits	Physical Layer

TCP/IP Model

The TCP/IP model which is also called as the Internet Protocol Suite, is the foundation of the internet and most modern networks.

It simplifies the functions into four layers, often considered a more practical implementation compared to the OSI model. The four layers are:

1. Network Interface Layer: Corresponds to the OSI model's physical and data link layers. It manages hardware addressing and the physical transmission of data.
2. Internet Layer: Corresponds to the OSI model network layer. It is responsible for logical addressing and routing. The primary protocol here is the Internet Protocol (IP).
3. Transport Layer: Similar to the OSI model transport layer, it manages end-to-end communication, error checking, and flow control. TCP and UDP are the key protocols.
4. Application Layer: Combines the functions of the OSI model's session, presentation, and application layers. It includes protocols like HTTP, FTP, SMTP, and DNS.

Networking Devices

Hubs : Basic networking device that operates at the physical layer (Layer 1) of the OSI model.

Hub broadcasts incoming data to all connected devices, which can lead to data collisions and inefficiencies.

Switch: A switch operates at the data link layer (Layer 2) of the OSI model and is used to connect devices within a single network, such as a LAN (Local Area Network).

Switches manage data traffic by using MAC addresses to forward data only to the device for which it is intended, reducing collisions and improving network efficiency.

Networking Devices

Routers: A router is a device that connects multiple networks and forwards data packets between them.

It determines the best path for data to travel from the source to the destination.

Bridge: While both bridges and switches serve to connect network segments and manage data traffic, switches are more advanced, capable, and suitable for modern network environments. Bridges are simpler and typically used in smaller or legacy networks. Switches offer higher performance, greater scalability, and more advanced features, making them the preferred choice for most current networking applications.

Bridge also work at Layer 2 of OSI model.

Transmission Media

Physical pathways through which data is transmitted from one device to another.

Classified into two main categories: wired (guided) and wireless (unguided).

Wired (Guided) Transmission Media

Twisted Pair Cable Unshielded Twisted Pair (UTP), Shielded Twisted Pair (STP), Coaxial Cable, Fiber Optic Cable.

Shielded Twisted Pair provides additional protection against interference.

Coaxial cable Consists of a central conductor, an insulating layer, a metallic shield, and an outer insulating layer.

Fiber Uses light to transmit data through strands of glass or plastic fibers. Light signals are less susceptible to electromagnetic interference.

Transmission Media

Wireless Medium (unguided)

Radio Waves: Use radio frequencies to transmit data wirelessly over short to long distances.

E.g. Wi-Fi, Bluetooth, Cellular Networks

Microwaves: Use higher frequency radio waves (1 GHz to 30 GHz) for point-to-point communication.

Infrared (IR) Uses infrared light waves for short-range communication.

How to Choose Right Transmission Media?

Choosing the Right Transmission Media

The choice of transmission media depends on several factors:

- Distance: Fiber optics for long distances, twisted pair or coaxial for shorter distances.
- Bandwidth Requirements: Fiber optics for high bandwidth needs, twisted pair or coaxial for moderate needs.
- Environment: Shielded cables or fiber optics in high-interference areas, wireless for mobility.
- Cost: Twisted pair is cost-effective, fiber optics is more expensive but offers superior performance.

MCQ's for practice

1. Which of the following is an example of a physical layer protocol? a) Ethernet b) TCP c) HTTP d) ISP

Ethernet

2. The PPP of the OSI model operates at ---------- a) Physical layer b) Data link layer c) Network layer d) Transport layer

Data Link Layer

3. Which protocol is responsible for error detection and correction at the transport layer? a) TCP b) UDP c) ICMP d) ARP

TCP

MCQ's

4. Which application layer protocol is used for sending and receiving emails? a) HTTP b) FTP c) SMTP d) POP

-SMTP

5. What is a computer network?

a) A device used to display information on a computer screen

b) A collection of interconnected computers and devices that can communicate and share resources

c) A type of software used to create documents and presentations

d) The physical casing that protects a computer's internal components

-A collection of interconnected computers and devices that can communicate and share resources

MCQ

6. What is full form of OSI?

a) optical service implementation

b) open service Internet

c) open system interconnection

d) operating system interface

- Open system interconnection

MCQ

7. What are nodes in a computer network?

a) the computer that routes the data

b) the computer that terminates the data

c) the computer that originates the data

d) all of the mentioned

-all of the mentioned.

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MCQS

1. The physical layer is concerned with _____
a) bit-by-bit delivery
b) process to process delivery
c) application to application delivery
d) port to port delivery
Answer: a
2. Which transmission media provides the highest transmission speed in a network?
a) coaxial cable
b) twisted pair cable
c) optical fiber
d) electrical cable
Answer: c
The fiber optics transmission runs at 1000Mb/s. It is called as 1000Base-Lx whereas IEEE standard for it is 802.3z.
3. The physical layer provides _____
a) mechanical specifications of electrical connectors and cables
b) electrical specification of transmission line signal level
c) specification for IR over optical fiber
d) all of the mentioned
Answer: d
4.A single channel is shared by multiple signals by _____
a) analog modulation
b) digital modulation
c) multiplexing
d) phase modulation
Answer: c

5. Wireless transmission of signals can be done via _____
a) radio waves
b) microwaves
c) infrared
d) all of the mentioned
Answer: d
6. A local telephone network is an example of a _____ network.
a) Packet switched
b) Circuit switched
c) Bit switched
d) Line switched
Answer: b
Explanation: Circuit switching is connection oriented switching technique, whereas in the case of packet switching, it is connectionless.
Circuit switching is implemented in the Physical layer, whereas packet switching is implemented in the Network layer. Internet too is based on the concept of circuit switching.
7.Most packet switches use this principle _____
a) Stop and wait
b) Store and forward
c) Store and wait
d) Stop and forward
View Answer
Answer: b

8.Physical or logical arrangement of network is _____

a) Topology

b) Routing

c) Networking

d) Control

Answer: a

Explanation: Topology in networks is the structure or pattern in which each and every node in the network is connected.

There are many topologies in networking like bus, tree, ring, star, mesh, and hybrid topology.

There is no particular best topology and a suitable topology can be chosen based on the kind of application of the network .

9.Which network topology requires a central controller or hub?

a) Star

b) Mesh

c) Ring

d) Bus

Answer: a

10. _____ topology requires a multipoint connection.
a) Star
b) Mesh
c) Ring
d) Bus
Answer: d
11. OSI stands for _____
a) open system interconnection
b) operating system interface
c) optical service implementation
d) open service Internet
Answer: a
12. TCP/IP model does not have _____ layer but OSI model have this layer.
a) session layer
b) transport layer
c) application layer
d) network layer
Answer: a
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13. TCP/IP model was developed _____ the OSI model.
a) prior to
b) after
c) simultaneous to
d) with no link to
Answer: a
Several TCP/IP prototypes were developed at multiple research centers between 1978 and 1983, whereas OSI reference model was developed in the year 1984. TCP/IP was developed with the intention to create a model for the Internet while OSI was intended to be a general network model.
14. Which address is used to identify a process on a host by the transport layer?
a) physical address
b) logical address
c) port address
d) specific address
View Answer
Answer: c
Explanation: A port number is a way to identify a specific process to which an Internet or other network message is to be forwarded when it arrives at a server. Some examples of port numbers are port 20 which is used for FTP data, port 22 which is used for SSH remote login ,and port 23 which is used for TELNET.
15. Transmission data rate is decided by _____
a) network layer
b) physical layer
c) data link layer
d) transport layer
Answer: b
Physical layer is a layer 1 device which deals with network cables or the standards in use like connectors, pins, electric current used etc. Basically the transmission speed is determined by the cables and connectors used