

COMPUTER NETWORKS

CHAPTER 1: INTRODUCTION TO COMPUTER NETWORKS

A computer network is a system that connects two or more computing devices to share information and resources.

Devices are linked using wired connections (cables, fiber optics) or wireless connections (Wi-Fi, Bluetooth, radio waves).

Analog and digital signals are used for data communication.

Networks enable file sharing, internet access, collaborative work, and resource sharing.

ARPANET (Advanced Research Projects Agency Network) was the world's first computer network, developed in the late 1960s by the U.S. Department of Defense. It is considered the seed of the modern internet.

CHAPTER 2: COMPONENTS OF COMPUTER NETWORK

SERVER: A powerful computer that provides services like file storage, email, or hosting applications. Examples: Web server, application server, database server.

CLIENT: A device that requests and uses resources or services from servers.

NETWORK INTERFACE CARD (NIC): Hardware installed on devices that allows them to connect to a network. Also called Ethernet card, network adapter, LAN card, or external network card.

TRANSMISSION MEDIA: The physical or wireless medium through which data is transmitted.

- Wired: Twisted pair cable (Cat5, Cat6), Coaxial cable, Fiber optic cable
- Wireless: Wi-Fi, Bluetooth, Radio waves, Infrared, Satellite

PROTOCOLS: Rules that govern data exchange over the network. Examples: TCP/IP, HTTP, FTP, SMTP, DNS.

CHAPTER 3: TYPES OF COMPUTER NETWORK

1. PAN (Personal Area Network)

- Very small network, typically within a range of 10 metres
- Used to connect personal devices like smartphones, laptops, tablets
- Example: Bluetooth connection between phone and earphones
- Organized by an individual for personal use

2. LAN (Local Area Network)

- Used in a small geographical area (0 to 1 km range)
- Usually private networks, easily set up and managed by individuals
- Data communication speed is fast
- Also known as Ethernet technology
- Has the lowest error rate among all network types
- Examples: Home network, office Wi-Fi, school computer lab

3. MAN (Metropolitan Area Network)

- Covers a larger area than LAN but smaller than WAN (1 to 100 km range)
- Connects multiple LANs within a city or region
- Enables communication between offices, schools, businesses
- Examples: Cable TV networks, city-wide Wi-Fi

4. WAN (Wide Area Network)

- World's largest network spread across the globe (more than 100 km)
- Connects multiple MANs and LANs across countries
- Offers slower speeds compared to LAN
- Also called Long Haul Network
- The Internet is the largest example of a WAN
- Uses satellite links to connect with other devices
- Usually managed by ISP (Internet Service Provider) or Telecom operator

5. CAN (Campus Area Network)

- Connects multiple LANs within a campus like a university or business campus
- Larger than LAN but smaller than MAN

6. SAN (Storage Area Network)
 - Specialised network designed to provide high-speed, reliable access to storage devices
 - Used by large organisations for centralised data storage and backup
7. VPN (Virtual Private Network)
 - Creates a secure, encrypted connection over the internet
 - Allows users to access a private network remotely from any location
 - Commonly used by remote workers to access company resources securely

SPEED ORDER (Ascending): WAN < MAN < LAN AREA ORDER (Ascending): PAN < LAN < CAN < MAN < WAN

CHAPTER 4: NETWORKING DEVICES

HUB:

- A centralised device used to connect multiple devices in a LAN
- Transmits data to ALL connected devices, regardless of the intended recipient
- Cannot filter or manage data traffic
- Also called "dumb device" or "non-intelligent device"
- Types: Passive Hub (no signal boost), Active Hub (boosts signals), Intelligent Hub (manages traffic), Switching Hub (sends data to the correct device)
- Associated with Star network

SWITCH:

- Also a centralised device like a hub but much smarter
- Forwards data ONLY to the specific device it is intended for
- Uses MAC (Media Access Control) addresses to identify devices
- Also called the "intelligent device"
- Improves efficiency and reduces network congestion
- Works at Data Link Layer (Layer 2) of OSI model
- Most commonly used to connect computers within a LAN

ROUTER:

- Used to determine the best path for data packets to travel
- Helps information reach its correct destination across different networks
- Operates at the Network Layer (Layer 3) of the OSI model
- Uses IP addresses to determine the path for forwarding packets
- Primary function: Forwarding data packets between different networks

BRIDGE:

- Connects two or more similar types of network segments
- Operates at the Data Link Layer (Layer 2) of the OSI model
- Reduces network congestion by dividing large networks into smaller segments
- Used to connect two LANs

GATEWAY:

- Connects two DIFFERENT types of networks that use different protocols
- Works at multiple layers of the OSI model
- Converts one protocol to another
- Also called "protocol converter"
- Serves as the entry and exit point of a network

REPEATER:

- Converts a weak signal into a strong signal between two computer networks
- Works at the Physical Layer (Layer 1) of the OSI model
- Regenerates a signal before transmitting data
- Allows signals to travel longer distances

MODEM (Modulator-Demodulator):

- Connects a computer or network to the internet via telephone lines
- Converts digital signals to analog signals (Modulation) and vice versa (Demodulation)
- Full form: Modulator-Demodulator
- Data transfer rate in modems is measured in BPS (Bits Per Second)

FIREWALL:

- A system designed to prevent unauthorised access to or from a private network
- Can be hardware-based, software-based, or both
- Monitors and filters network traffic based on a set of rules
- A Proxy Firewall filters at the application layer
- A Packet-filter Firewall filters at the network or transport layer
- Network layer firewall works as a packet filter

NIC (Network Interface Card):

- A hardware device that connects a computer to a network both functionally and physically
- Each NIC has a unique MAC address (like a fingerprint for devices)

CHAPTER 5: NETWORK TOPOLOGY

Network topology refers to the arrangement of different elements (devices, links, nodes) in a computer network. It defines how the devices are connected and how data flows between them. Also called the Physical Layout of a network.

1. BUS TOPOLOGY

- All devices connected to a single cable (backbone cable)
- Information sent based on device destination address
- Cable called "backbone" or "back bone cable"
- If destination address does not match, data is terminated
- Also called Linear or Multi-point topology
- Used in Local Area Network (LAN)
- Terminators used at both ends
- Advantages: Easy to add/remove nodes; low cost; if one computer fails, network unaffected
- Disadvantages: If main cable fails, entire network shuts down; becomes slow as nodes increase; difficult to locate damaged node

2. RING TOPOLOGY

- Devices connected in a closed loop (ring)
- All devices remain connected to their nearest two devices
- Works on token passing technology
- In this, all devices work like a repeater
- Data flows in ONE direction only
- Also called circular topology
- Advantages: Easy to manage; cost-effective; minimum collision; high data transfer speed
- Disadvantages: If one device or cable fails, whole network affected; troubleshooting difficult

3. STAR TOPOLOGY

- All computers connected to a central device (hub or switch)
- Most commonly used network topology today
- Network speed not affected by increasing the number of computers
- Computers can be easily increased or decreased
- Advantages: No point-to-point connections; failure of one device doesn't affect others; low data collision
- Disadvantages: Expensive to install (requires more cables); if central device fails, entire network affected

4. TREE TOPOLOGY

- Combination of Bus and Star topologies
- Devices connected in a hierarchical tree structure
- Generally uses twisted pair cables
- Difficult to connect nodes; used less
- Many switches connected to a single cable
- Advantages: Scalable and flexible; easy to manage and expand; issues in one branch don't impact entire network
- Disadvantages: Difficult to install; if root node fails, whole network affected; expensive

5. MESH TOPOLOGY

- Used in places where the network breaks frequently

- Also called Point-to-Point topology
- Data flow can happen in any direction
- Most suitable topology for long-distance networks
- All devices connected to each other
- Formula for connections: $n \times (n-1)/2$ physical links required for n nodes (e.g., 6 nodes need 15 links)
- Advantages: High security and privacy; highly reliable and fault-tolerant; multiple paths for data transmission; highest fault tolerance
- Disadvantages: Difficult to install; expensive; requires many cables

6. HYBRID TOPOLOGY

- A combination of two or more topologies
- Flexible and scalable
- Used in large networks

NOTE: Ring topology is NOT a broadcast type topology. Mesh topology has the highest reliability. Ethernet uses Bus topology.

CHAPTER 6: OSI MODEL (Open Systems Interconnection)

OSI stands for Open Systems Interconnection.

The OSI model is a conceptual framework developed by the International Organisation for Standardisation (ISO) in 1980.

It breaks down the complex process of data communication into 7 distinct layers.

NOTE: The OSI model is only a theoretical model and is NOT used directly in real-world communication.

Mnemonic to remember layers (bottom to top): "Please Do Not Throw Sausage Pizza Away"

LAYERS OF OSI MODEL (Bottom to Top):

LAYER 1 — PHYSICAL LAYER

- Data Unit: Bits
- Devices: Hub, Repeater, Cables, NIC
- Protocols: USB, DSL, Wi-Fi, ISDN
- Handles physical transmission of data
- Defines electrical, mechanical, and procedural specifications

LAYER 2 — DATA LINK LAYER

- Data Unit: Frames
- Devices: Network Interface Cards, Switches, Bridge
- Protocols: PPP, STP, FDDI
- Ensures node-to-node delivery and framing of data
- Main function: Error detection and correction
- Switches work at Data Link layer and forward data based on MAC addresses

LAYER 3 — NETWORK LAYER

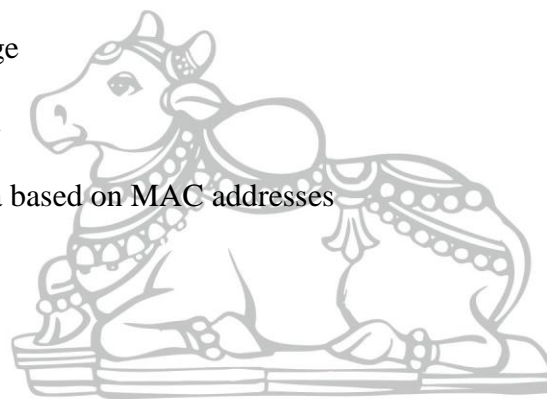
- Data Unit: Packets
- Devices: Router
- Protocols: IP, ICMP, ARP, OSPF
- Responsible for routing (determining best path)
- Routing of packets takes place here

LAYER 4 — TRANSPORT LAYER

- Data Unit: Segments
- Devices: Gateway, Firewalls
- Protocols: TCP, UDP, SCTP
- Provides end-to-end connection (also called Host-to-Host layer)
- Also called the "heart of OSI model"
- UDP provides a connectionless service between hosts
- TCP provides connection-oriented service

LAYER 5 — SESSION LAYER

- Data Unit: Message/Data
- Devices: Gateway
- Protocols: NetBIOS, RPC, ZIP, NFS



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- Manages sessions (sync and send to port)
- Layer 5 lies between Presentation layer and Transport layer

LAYER 6 — PRESENTATION LAYER

- Data Unit: Message/Data
- Devices: Gateway
- Protocols: SSL, TLS, JPEG, GIF
- Handles syntax layer functions
- Encryption and decryption are functions of this layer

LAYER 7 — APPLICATION LAYER

- Data Unit: Message/Data
- Devices: Computers, Servers
- Protocols: HTTP, FTP, SMTP, DNS, POP3, IMAP, Telnet
- End user layer; also called "user interface layer"
- Provides network services directly to applications

GROUPINGS IN OSI MODEL:

- Software/Host layers: Session, Presentation, Application layers
- Hardware/Media layers: Physical, Data Link, Network layers
- Transport layer is the heart of OSI model

CHAPTER 7: TCP/IP MODEL

The TCP/IP model is a simplified framework for communication between devices on a network, especially the Internet.

Also called the "protocol suite." It is the foundation of modern networking.

Developed by the U.S. Department of Defense in the 1970s.

This model consists of 4 layers (as against 7 in OSI).

TCP/IP LAYERS (Bottom to Top):

1. NETWORK INTERFACE LAYER (also called Link Layer / Network Access Layer)
 - Lowest layer of TCP/IP model
 - Handles physical transmission of data between devices over a network medium
 - Corresponds to OSI Physical + Data Link layers
2. INTERNET LAYER (also called Network Layer)
 - Transmits data packets between devices and manages logical addressing
 - Works similar to the Network Layer of OSI
 - Uses IP (Internet Protocol)
3. TRANSPORT LAYER
 - Ensures data packets are delivered accurately and reliably
 - Also called the Host-to-Host layer
 - Two protocols: UDP (User Datagram Protocol) and TCP (Transmission Control Protocol)
 - TCP: Connection-oriented, reliable
 - UDP: Connectionless, faster but less reliable
4. APPLICATION LAYER
 - Topmost layer of TCP/IP model
 - Corresponds to OSI Application + Presentation + Session layers
 - Provides network services directly to applications
 - Protocols: HTTP, FTP, SMTP, DNS, Telnet, SNMP

COMPARISON:

- OSI has 7 layers; TCP/IP has 4 layers
- Application layer of TCP/IP = 3 layers (App + Presentation + Session) of OSI
- TCP/IP is practically used; OSI is theoretical

CHAPTER 8: IMPORTANT PROTOCOLS

HTTP (HyperText Transfer Protocol) — Used for web browsing; WWW uses HTTP to transmit data

HTTPS (HTTP Secure) — Encrypted version of HTTP using SSL/TLS

FTP (File Transfer Protocol) — Used for uploading and downloading files between computers

SMTP (Simple Mail Transfer Protocol) — Used for sending emails

POP3/IMAP — Used for receiving emails

DNS (Domain Name System) — Translates domain names to IP addresses

DHCP (Dynamic Host Configuration Protocol) — Assigns IP addresses dynamically to devices

ARP (Address Resolution Protocol) — Resolves IP addresses to MAC addresses

TCP (Transmission Control Protocol) — Reliable, connection-oriented data transfer

UDP (User Datagram Protocol) — Fast, connectionless data transfer (used in video streaming, gaming)

IP (Internet Protocol) — Defines addressing and routing of packets

TELNET — Remote login protocol with file edit capability

SSL/TLS — Secure Socket Layer / Transport Layer Security — used for encrypted communication

ICMP (Internet Control Message Protocol) — Used for error messages and network diagnostics

BGP (Border Gateway Protocol) — Used for routing between different autonomous systems; path-vector protocol

OSPF (Open Shortest Path First) — Based on link-state algorithm; used for routing within a network

IEEE 802.11 — Wi-Fi standard (wireless LAN)

IEEE 802.3 — Ethernet standard

CHAPTER 9: IMPORTANT ABBREVIATIONS

LAN = Local Area Network

WAN = Wide Area Network

MAN = Metropolitan Area Network

VPN = Virtual Private Network

IP = Internet Protocol

TCP = Transmission Control Protocol

UDP = User Datagram Protocol

FTP = File Transfer Protocol

DNS = Domain Name System

MAC = Media Access Control

DHCP = Dynamic Host Configuration Protocol

ARP = Address Resolution Protocol

NAT = Network Address Translation

ICMP = Internet Control Message Protocol

NIC = Network Interface Card

URL = Uniform Resource Locator

URI = Uniform Resource Identifier

MODEM = Modulator-Demodulator

ISDN = Integrated Services Digital Network

ISP = Internet Service Provider

WWW = World Wide Web

HTML = HyperText Markup Language

HTTP = HyperText Transfer Protocol

HTTPS = HyperText Transfer Protocol Secure

SSL = Secure Socket Layer

TLS = Transport Layer Security

SMTP = Simple Mail Transfer Protocol

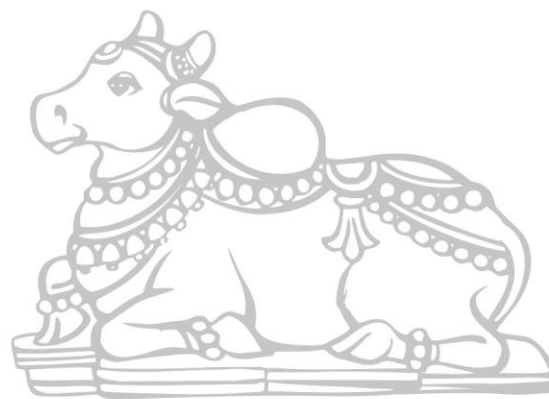
POP = Post Office Protocol

IMAP = Internet Message Access Protocol

OSPF = Open Shortest Path First

BGP = Border Gateway Protocol

Wi-Fi = Wireless Fidelity



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ARPANET = Advanced Research Projects Agency Network

SDN = Software-Defined Networking

NFV = Network Function Virtualisation

IoT = Internet of Things

CDMA = Code Division Multiple Access

SLIP = Serial Line Internet Protocol

PPP = Point-to-Point Protocol

SAN = Storage Area Network

CAN = Campus Area Network

PAN = Personal Area Network

DLL = Dynamic Link Library

ISDN = Integrated Services Digital Network

FTP = File Transfer Protocol

CHAPTER 10: KEY FACTS DRIVE (Important One-Liners)

1. The Internet is the world's largest computer network.
2. ARPANET is the world's FIRST computer network (late 1960s).
3. Broadcasting = Sending data to ALL devices in a network.
4. Multicasting = Sending data to a GROUP of devices.
5. Unicasting = Sending data to ONE specific device (point-to-point).
6. Modulation = Converting digital signal to analog signal.
7. Demodulation = Converting analog signal to digital signal.
8. Ethernet is the most widely used LAN technology (defined under IEEE 802.3).
9. MAC address = Unique physical address assigned to every NIC (like a fingerprint).
10. A Peer-to-Peer (P2P) network = Decentralised network; no central server; each computer acts as both server and client.
11. A Client-Server network = Centralised; clients request services, server provides them.
12. OSI model is only a THEORETICAL model.
13. The OSI model was developed by ISO in 1980.
14. TCP/IP was developed by the U.S. Department of Defense in the 1970s.
15. Bandwidth = Amount of data that can be transmitted over a network in a given period of time.
16. Data transfer rate is measured in BPS (bits per second).
17. LAN has the lowest error rate and the fastest speed.
18. Switching techniques = Methods used to direct data packets between devices.
19. NIC is also called Ethernet card, LAN card, or network adapter.
20. Repeater works at Physical Layer (Layer 1) of OSI.
21. Bridge and Switch work at Data Link Layer (Layer 2) of OSI.
22. Router works at Network Layer (Layer 3) of OSI.
23. Gateway works at multiple layers of OSI.
24. Transport layer = Heart of OSI model.
25. Application layer = User interface layer of OSI model.

CHAPTER 11: EMERGING/UPDATED CONCEPTS (2025 Edition)

SDN (Software-Defined Networking):

- An architecture that separates the control plane from the data plane
- Makes networks more efficient and easier to manage by controlling the flow of data through software
- Reduces reliance on hardware; more cost-effective

NFV (Network Function Virtualisation):

- Uses software to perform tasks that traditionally required specialised hardware (like firewalls, routers)
- Network functions are virtualised and run as software on general-purpose servers
- Increases flexibility and reduces cost

5G Network Slicing:

- Partitioning one physical network into multiple virtual networks (slices)
- Each slice dedicated to a different type of service (IoT, smartphones, etc.)

- Built using SDN and NFV technologies

Cloud Networking:

- Networks managed and hosted via cloud platforms
- Allows businesses to scale network resources without physical infrastructure

IoT (Internet of Things):

- Connecting everyday physical devices to the internet (smart TVs, fridges, wearables)
- Requires robust networking infrastructure

Wi-Fi 6 / Wi-Fi 7:

- Wi-Fi 6 (IEEE 802.11ax): Faster speeds, better performance in crowded areas
- Wi-Fi 7 (IEEE 802.11be): Even faster, lower latency, supports more simultaneous connections

Firewall Types:

- Packet filter firewall: Filters at network/transport layer
- Proxy/Application layer firewall: Filters at application layer
- Stateful inspection firewall: Tracks active connections

HTTP Error Codes:

- 400 Bad File Request: Invalid request due to incorrect syntax
- 401 Unauthorised: Authentication required
- 403 Forbidden: Server refuses to fulfill the request
- 404 File Not Found: Resource cannot be found on the server
- 500 Internal Server Error: Generic server-side error
- 502 Bad Gateway: Server received invalid response from upstream server

30 IMPORTANT MCQs WITH ANSWERS

Q1. Which networking device uses MAC addresses to forward data to the correct device? (a) Hub (b) Router (c) Switch (d) Repeater ANSWER: (c) Switch

Q2. The OSI model was developed by which organisation? (a) IEEE (b) ISO (c) ITU (d) ANSI ANSWER: (b) ISO

Q3. Which layer of the OSI model is also called the "Heart of OSI Model"? (a) Network Layer (b) Session Layer (c) Transport Layer (d) Data Link Layer ANSWER: (c) Transport Layer

Q4. Router works at which layer of the OSI model? (a) Physical Layer (b) Data Link Layer (c) Network Layer (d) Transport Layer ANSWER: (c) Network Layer

Q5. Which of the following topology requires $n \times (n-1)/2$ physical links for n nodes? (a) Star (b) Ring (c) Bus (d) Mesh ANSWER: (d) Mesh

Q6. What is the full form of MODEM? (a) Modulator-Demodulator (b) Modern-Demodulator (c) Mode-Modulator (d) None ANSWER: (a) Modulator-Demodulator

Q7. Which network covers the largest geographical area? (a) LAN (b) MAN (c) WAN (d) PAN ANSWER: (c) WAN

Q8. Which device is also known as a "protocol converter"? (a) Router (b) Switch (c) Gateway (d) Hub ANSWER: (c) Gateway

Q9. Ethernet is defined under which IEEE standard? (a) IEEE 802.11 (b) IEEE 802.3 (c) IEEE 802.16 (d) IEEE 1394 ANSWER: (b) IEEE 802.3

Q10. The process of converting analog signal to digital signal is called: (a) Modulation (b) Demodulation (c) Encryption (d) Broadcasting ANSWER: (b) Demodulation

Q11. Which layer of OSI model handles encryption and decryption? (a) Transport Layer (b) Session Layer (c) Presentation Layer (d) Application Layer ANSWER: (c) Presentation Layer

Q12. Which protocol is used for file uploading and downloading between computers? (a) HTTP (b) SMTP (c) FTP (d) ARP ANSWER: (c) FTP

Q13. In which topology, if the main cable fails, the entire network shuts down? (a) Star (b) Ring (c) Mesh (d) Bus ANSWER: (d) Bus

Q14. How many layers does the TCP/IP model have? (a) 5 (b) 7 (c) 4 (d) 6 ANSWER: (c) 4

Q15. Which topology is most suitable for long-distance networks and has the highest reliability? (a) Star (b) Bus (c) Mesh (d) Ring ANSWER: (c) Mesh

Q16. Which networking device works at Layer 1 (Physical Layer) of the OSI model? (a) Switch (b) Router (c) Bridge (d) Repeater ANSWER: (d) Repeater

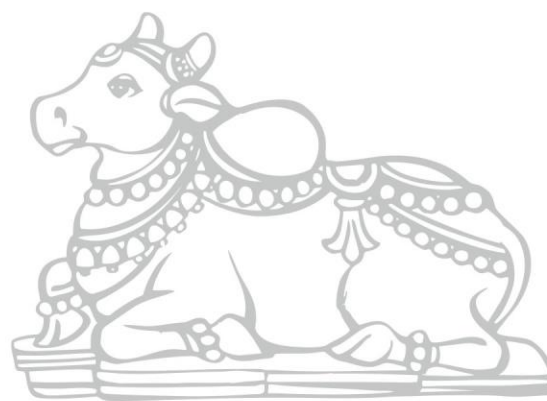
- Q17. A network that connects multiple LANs within a campus like a university is called: (a) WAN (b) MAN (c) CAN (d) PAN ANSWER: (c) CAN
- Q18. DNS stands for: (a) Data Networking System (b) Domain Name System (c) Dynamic Network Service (d) Direct Naming System ANSWER: (b) Domain Name System
- Q19. Which of the following provides connectionless service at the Transport Layer? (a) TCP (b) IP (c) UDP (d) ARP ANSWER: (c) UDP
- Q20. Which of the following is NOT a valid network topology? (a) Star (b) Bus (c) Grid (d) Mesh ANSWER: (c) Grid
- Q21. The Internet itself is a type of which network? (a) LAN (b) MAN (c) WAN (d) VPN ANSWER: (c) WAN
- Q22. Which device is used to connect two LANs or two segments of the same LAN? (a) Hub (b) Router (c) Switch (d) Bridge ANSWER: (d) Bridge
- Q23. ARPANET, the world's first computer network, was developed in the late: (a) 1950s (b) 1960s (c) 1970s (d) 1980s ANSWER: (b) 1960s
- Q24. In a star topology, all devices are connected to which type of central device? (a) Router only (b) Hub only (c) Hub or Switch (d) Bridge ANSWER: (c) Hub or Switch
- Q25. Which network type creates a secure, encrypted connection over the internet? (a) LAN (b) VPN (c) MAN (d) CAN ANSWER: (b) VPN
- Q26. The Hub is also called which of the following? (a) Intelligent device (b) Dumb device (c) Protocol converter (d) Smart device ANSWER: (b) Dumb device
- Q27. HTTP error 404 indicates: (a) Bad Request (b) Server Error (c) File Not Found (d) Unauthorised ANSWER: (c) File Not Found
- Q28. What is the correct ascending order of speed among LAN, MAN, and WAN? (a) WAN < MAN < LAN (b) LAN < MAN < WAN (c) MAN < WAN < LAN (d) WAN < LAN < MAN ANSWER: (a) WAN < MAN < LAN
- Q29. Which of the following technology is used for wireless LAN (Wi-Fi)? (a) IEEE 802.3 (b) IEEE 802.11 (c) IEEE 802.16 (d) IEEE 1394 ANSWER: (b) IEEE 802.11
- Q30. SDN (Software-Defined Networking) primarily separates which two planes? (a) Physical and Logical (b) Control and Data (c) Application and Network (d) Transport and Session ANSWER: (b) Control and Data

QUICK REVISION TABLE — OSI MODEL

Layer	Name	Data Unit	Key Devices	Key Protocols
1	Physical	Bits	Hub, Repeater, Cable	USB, DSL, Wi-Fi
2	Data Link	Frames	Switch, Bridge, NIC	PPP, STP, FDDI
3	Network	Packets	Router	IP, ICMP, ARP, OSPF
4	Transport	Segments	Gateway, Firewall	TCP, UDP, SCTP
5	Session	Message/Data	Gateway	NetBIOS, RPC, NFS
6	Presentation	Message/Data	Gateway	SSL, TLS, JPEG, GIF
7	Application	Message/Data	Computers, Servers	HTTP, FTP, SMTP, DNS

QUICK REVISION TABLE — NETWORK TYPES

Type	Full Form	Range	Speed	Key Feature
PAN	Personal Area Network	~10 m	High	Personal use, Bluetooth
LAN	Local Area Network	0-1 km	Fastest	Lowest error rate, Ethernet
CAN	Campus Area Network	1-5 km	High	University/campus
MAN	Metropolitan Area Network	1-100 km	Medium	City-wide
WAN	Wide Area Network	>100 km	Slowest	Internet, satellite

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