Computer Networking

1. Fundamentals of Computer Networks

1.1 What is a Computer Network?

- A collection of interconnected devices (computers, printers, servers, etc.) that communicate and share resources.
- Purpose: **Resource sharing** (printers, data, files), centralized management, and communication.

1.2 Benefits of Networking

- Printer/data/information sharing
- Centralized management and security
- Enhanced communication (emails, messaging, conferencing)

1.3 History and Origin

- **Origin:** Concept began in 1969 as ARPANET, developed by US Dept. of Defense.
- ARPANET linked major universities and evolved into the Internet.

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2. Types of Networks (Based on Area)

2.1 PAN (Personal Area Network)

- **Coverage:** ~10 meters (Bluetooth, infrared, hotspot)
- **Example:** Smartphones, wireless keyboards/mice, TV remotes.

2.2 LAN (Local Area Network)

- **Coverage:** Up to 2 km, typically one building/campus.
- **Security:** High
- **Medium:** Wired (Ethernet/802.3), Wireless (Wi-Fi/802.11)
- **Example:** Offices, schools.

2.3 CAN (Campus/Corporate Area Network)

- **Coverage:** 1–5 km (across a campus, multiple buildings)
- **Example:** Universities, corporate parks.

2.4 MAN (Metropolitan Area Network)

- **Coverage:** City-wide (up to 30–40 km)
- **Example:** Cable TV networks, city broadband.

2.5 WAN (Wide Area Network)

- **Coverage:** Country/continent/global
- **Security:** Low
- **Medium:** Satellite, fiber, leased lines
- **Example:** The Internet (largest WAN)

2.6 SAN (Storage Area Network)

- **High-speed network for storage devices**

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3. Network Architecture

- **Peer-to-Peer (P2P):** No hierarchy, devices are equal, no server needed, best for file sharing.
- **Client/Server:** Central server manages and provides resources, clients request services.

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4. Network Topologies

4.1 Physical Topologies

- **Bus:** Single cable, multipoint, simple, fault tolerance is low.
- **Star:** All nodes connect to a central hub/switch; easy management, hub failure = total failure.
- **Ring:** Nodes form a closed loop; data moves in one direction; token-based.
- **Mesh:** Every device connects to every other; robust, expensive, best reliability.
- **Tree:** Hierarchical, multiple star topologies connected.
- **Hybrid:** Combines two or more topologies (e.g., star-bus).

4.2 Node

- Any device (computer, printer, router) on a network.

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5. Data Transmission & Media

5.1 Modes

- **Simplex:** One-way (keyboard to CPU)
- **Half Duplex:** Both ways, but not simultaneously (walkie-talkie)
- **Full Duplex:** Both ways simultaneously (telephones)

5.2 Transmission Media

- **Guided/Bonded:** Twisted pair (LAN), coaxial (TV), fiber optic (fastest, light-based)
- **Unguided/Unbounded:** Radio, microwave, infrared (Wi-Fi, remote controls, Bluetooth)

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6. Network Devices

6.1 Layer-wise Devices

Device	OSI Layer	Function
Hub	Physical	Broadcasts data to all devices
Repeater	Physical	Boosts/regenerates signal over long distances
Switch	Data Link	Directs data using MAC addresses
Bridge	Data Link/Physical	Connects LANs using same protocol
Router	Network	Routes packets between networks (IP address)
Gateway	All 7 layers	Connects dissimilar networks
Modem	Data Link/Physical	Converts digital ↔ analog signals
Firewall	Network/All	Controls traffic as per rules
Access Point	Data Link/Physical	Provides Wi-Fi connectivity

6.2 Specialized Devices

- **Network Interface Card (NIC):** Hardware with a unique MAC address, connects a device to network.
- **Wireless Network Interface Controller (WNIC):** For Wi-Fi connections.

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7. Addressing in Networks

7.1 IP Address (Internet Protocol)

- **IPv4:** 32 bits, decimal notation (e.g., 192.168.56.115), divided into 4 octets (0–255)
- **IPv6:** 128 bits, hexadecimal notation
- **Types:** Private (reserved for local), Public (assigned by ISP)
- **Classes:** A (1–126), B (128–191), C (192–223), D (224–239 multicast), E (240–254 reserved)
- **Loopback:** 127.0.0.1
- **Broadcast:** 255.255.255.255
- **IP can be changed (dynamic/static), logical address, managed by IANA/APNIC**

7.2 MAC Address (Media Access Control)

- **48 bits (12 hexadecimal digits)**; permanent, assigned by manufacturer.
- **Found on NIC**, works at Data Link Layer.
- **Aliases:** Physical address, hardware address, burned-in address.

7.3 Comparison: IP vs. MAC Address

Feature	IP Address	MAC Address
Purpose	Internet identification	Local network identification

Feature	IP Address	MAC Address
Changeable	Yes	No (Permanent)
Layer	Network Layer (3)	Data Link Layer (2)
Example	192.168.1.1	00:1A:2B:3C:4D:5E

7.4 Domain Name System (DNS)

- **Maps domain names to IP addresses.**
- **Managed globally by ICANN/IANA.**
- **DNS Root Servers:** 13

7.5 URL and Protocols

- **URL:** Unique resource locator; structure includes protocol (e.g., https), domain, path.
- **Example:** https://www.ncert.nic.in/index.html

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8. Network Protocols and Ports

- **HTTP (80):** Web
- **HTTPS (443):** Secure web
- **FTP (20/21):** File transfer
- **SFTP (22):** Secure file transfer
- **TELNET (23):** Remote login
- **SMTP (25):** Send email
- **DNS (53):** Name resolution
- **DHCP (67/68):** Assigns IP
- **POP3 (110), IMAP (143):** Receive email
- **IRC (194):** Chat
- **TCP/IP:** Suite for Internet communication
- **ARP/RARP:** MAC-IP address resolution

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9. OSI and TCP/IP Models

9.1 OSI Model (7 Layers)

1. Physical: Bits/cables/signals (hub, repeater)
2. Data Link: Frames/MAC address (switch, bridge)
3. Network: Packets/IP address/routing (router)
4. Transport: Segments/ports/TCP-UDP
5. Session: Connection management
6. Presentation: Data translation, encryption, compression
7. Application: Network services (HTTP, FTP, SMTP, DNS)

9.2 TCP/IP Model (4/5 Layers)

- Application, Transport, Internet, Network Access (sometimes includes Data Link and Physical separately)
- Developed by Vint Cerf, Bob Kahn, DARPA.

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10. Wireless Networking

- **Wi-Fi (IEEE 802.11):** Wireless LAN, uses radio waves; versions a/b/g/n/ac/ax (Wi-Fi 1–6).
- **Security Protocols:** WEP (weak), WPA, WPA2, WPA3 (strongest).
- **Frequency Bands:** 2.4 GHz, 5 GHz.
- **Bluetooth (IEEE 802.15):** Standard for short-range WPAN.
- **Wireless Access Point (WAP):** Enables Wi-Fi connections.

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11. Internet, WWW, and Web Technologies

11.1 Internet and WWW

- **Internet:** The largest WAN, connects millions of networks.
- **WWW:** Collection of web documents accessed via HTTP/HTTPS.
- **Browser:** Software for web access (Chrome, Firefox, Safari).
- **Web Server:** Hosts web pages (Apache, IIS).
- **HTML:** Structure; **CSS:** Styling.
- **Cookies:** Data stored by browsers for sessions/personalization.

11.2 CMS (Content Management Systems)

- Examples: WordPress, Drupal, Joomla

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12. E-Mail and Internet Services

- **Protocols:** SMTP (send), POP3/IMAP (receive)
- **Spam:** Unwanted email
- **Thread:** Linked message sequence
- **Podcast:** Digital audio broadcast
- **E-commerce:** Online trade

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13. Internet History and Governance

- **ARPANET:** First Internet, US DoD, 1969
- **Inventors:** Tim Berners-Lee (WWW), Vint Cerf (Internet), Ray Tomlinson (Email)
- **India:** Internet by VSNL, 1995
- **Governance:** ICANN, IANA, IETF, W3C

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14. Security and Other Network Topics

- **Intranet:** Private, internal organizational network
- **Extranet:** Extension of intranet to partners
- **IoT:** Network of smart, sensor-embedded objects
- **Deep Web/Dark Web:** Not indexed/hidden parts of the web
- **Firewall/Proxy:** Control/filter network access

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15. Essential Standards and Numbers

- **MAC Address:** 48 bits (12 hex)
- **IPv4:** 32 bits; **IPv6:** 128 bits
- **OSI Layers:** 7
- **DNS Root Servers:** 13
- **Ethernet Speeds:** 10/100/1000 Mbps
- **Wi-Fi:** IEEE 802.11

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16. IEEE Standards Reference

- 802.3: Ethernet
- 802.5: Token Ring
- 802.11: WLAN (Wi-Fi)
- 802.15: PAN (Bluetooth)
- 802.16: WIMAX

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17. Network Ports (Common)

Protocol	Port	Use
FTP	21	File Transfer
SFTP	22	Secure File Transfer
TELNET	23	Remote Login
SMTP	25	Email (Send)
DNS	53	Name Resolution
DHCP	67/68	IP Assignment
HTTP	80	Web
POP3	110	Email (Receive)
IMAP	143	Email (Receive)
HTTPS	443	Secure Web

Question and Answers

Q1. Which of the following is an example of a Personal Area Network (PAN)?
A: Two smartphones connected via Bluetooth
Q2. Which device regenerates weakened signals in a network?
A: Repeater
Q3. What does 'IP' stand for in IP address?
A: Internet Protocol
Q4. Which topology connects each device to every other device?
A: Mesh
Q5. Which protocol is used to retrieve linked web pages?
A: HTTP
Q6. Which network type is used to connect computers within a university campus?
A: LAN
Q7. What is the full form of MAC in MAC address?
A: Media Access Control
Q8. Which device connects a local network to the Internet?
A: Router
Q9. Which networking device uses a MAC address to identify devices?
A: NIC
Q10. Which of the following is a secure version of HTTP?
A: HTTPS
Q11. Which topology uses a single central device to connect all other devices?
A: Star
Q12. Which device determines the best route for data packets?
A: Router
Q13. The first version of Wi-Fi standard (802.11) was introduced in:
A: 1997
Q14. Which of the following is an example of a Wide Area Network (WAN)?
A: The Internet
Q15. What does DNS stand for?
A: Domain Name System
Q16. Which of the following is used to uniquely identify a computer on a network physically?
A: MAC address
Q17. Which of these is a wired networking interface card?
A: NIC
Q18. Which cable connector is used in Ethernet networks?
A: RJ45
Q19. Which device connects multiple networks together?
A: Router
Q20. What is the purpose of a gateway in a network?
A: Entry and exit point of a network
Q21. Which network is typically used in a single building or campus?
A: LAN
Q22. In which topology is data transferred unidirectionally in a ring?
A: Ring
Q23. Which device broadcasts data to all devices in a network segment?
A: Hub
Q24. What kind of device is a modem?
A: Modulator-demodulator

Q25. Which of the following is an advantage of mesh topology?
A: High redundancy and reliability
Q26. What does ARPANET stand for?
A: Advanced Research Projects Agency Network
Q27. Which address can change when a device changes its network?
A: IP address
Q28. Which network covers the smallest area?
A: PAN
Q29. The first email system was developed by:
A: Roy Tomlinson
Q30. Which device sends data only to the intended recipient?
A: Switch
Q31. Which topology is most cost-effective and simple to install?
A: Bus
Q32. Which network connects devices within a city?
A: MAN
Q33. What is the full form of URI?
A: Uniform Resource Identifier
Q34. Which technology is used to design web pages?
A: HTML
Q35. Which network component determines the destination address of a data packet?
A: Switch
Q36. Which protocol ensures secure transfer of web pages?
A: HTTPS
Q37. Which address type is permanently assigned to a network interface card?
A: MAC address
Q38. A DNS server translates domain names into:
A: IP addresses
Q39. Which network component drops corrupted packets and requests retransmission?
A: Switch
Q40. Which device can connect dissimilar networks?
A: Gateway
Q41. What is the data transfer speed of a Gigabit Ethernet?
A: 1000 Mbps
Q42. Which network type connects multiple LANs and MANs across continents?
A: WAN
Q43. Which of the following allows devices to share Internet without wires?
A: Wi-Fi
Q44. Which one is not a network topology?
A: Circle
Q45. Who developed the World Wide Web?
A: Tim Berners-Lee
Q46. The arrangement of computers in a network is called:
A: Topology
Q47. What kind of signal does a modem convert digital data into?
A: Analog
Q48. Which of these devices works at the physical layer of OSI model?
A: Hub
Q49. Which topology connects all devices in a closed loop?
A: Ring
Q50. What is the main disadvantage of mesh topology?
A: Complex cabling

Q51. Which of the following is a wireless PAN technology?
A: Bluetooth
Q52. Which protocol is used to send emails?
A: SMTP
Q53. What is the primary role of a NIC?
A: Connect to network
Q54. A MAC address consists of how many bits?
A: 48
Q55. A sample IPv4 address is:
A: 192.168.0.1
Q56. The physical connection between nodes is called:
A: Link
Q57. Which device receives data and transmits it to the Internet?
A: Modem
Q58. Which protocol is used for file transfer over the Internet?
A: FTP
Q59. Which network is most commonly used in homes?
A: LAN
Q60. Which one is NOT a function of a router?
A: Signal amplification
Q61. Which part of the MAC address identifies the manufacturer?
A: First 6 digits
Q62. Which network allows you to connect multiple cities?
A: WAN
Q63. Which component is necessary for a computer to access a wired network?
A: NIC
Q64. In which topology does failure of the central hub lead to total failure?
A: Star
Q65. The unique address used to identify a device over the Internet is called:
A: IP address
Q66. What is the default range of values in each segment of an IPv4 address?
A: 0 to 255
Q67. A device that boosts signal strength beyond 100 meters is a:
A: Repeater
Q68. Which layer of networking does DNS operate in?
A: Application
Q69. Which organization manages DNS root servers?
A: IANA
Q70. Which of the following is NOT a function of a switch?
A: Broadcasts data to all devices
Q71. Which protocol is used in domain name resolution?
A: DNS
Q72. How many root DNS servers are there?
A: 13
Q73. Which topology uses the least cabling?
A: Bus
Q74. Which of these is not required for a computer to access the Internet?
A: Switch
Q75. The WWW uses which protocol to transfer pages?
A: HTTP
Q76. Which protocol adds encryption to secure communication on the web?
A: HTTPS

Q77. What kind of address is "www.ncert.nic.in"?
A: URL
Q78. Which part of a URL specifies the web protocol?
A: HTTP/HTTPS
Q79. How many hexadecimal digits are in a MAC address?
A: 12
Q80. Which of these is not part of a typical URL?
A: IP address
Q81. The speed of a standard Ethernet connection is:
A: 10 Mbps
Q82. The speed of a Gigabit Ethernet connection is:
A: 1000 Mbps
Q83. Which device divides large networks into smaller parts?
A: Router
Q84. Which device is used only to extend range in physical signal?
A: Repeater
Q85. Which topology is best for scalability and error isolation?
A: Star
Q86. In star topology, communication between nodes is controlled by:
A: Hub/Switch
Q87. A hybrid topology may include combinations of:
A: Bus, Star, Ring
Q88. Who coined the term 'Internet'?
A: Vint Cerf
Q89. Which network allows for video conferencing within the same building?
A: LAN
Q90. Which device allows mobile phones to act as a small wireless network?
A: Hotspot
Q91. The main function of a DNS server is to:
A: Resolve domain names to IP addresses
Q92. What type of address is 2001:0db8:0000:0000:0000:ff00:0042:8329?
A: IPv6
Q93. Which protocol works with domain names?
A: DNS
Q94. A switch sends data to:
A: Only the destination device
Q95. Which topology is most reliable but most expensive?
A: Mesh
Q96. Which network device is responsible for dividing signals at home broadband?
A: Router
Q97. Which network has the shortest range, typically 10 meters?
A: PAN
Q98. The address '164.100.60.233' belongs to which format?
A: IP (IPv4)
Q99. Which of these is NOT a characteristic of a LAN?
A: Covers countries
Q100. Which component is essential to convert analog signals to digital in a network?
A: Modem
Q101. Who invented the World Wide Web (WWW)?
A: Tim Berners-Lee
Q102. What is the World Wide Web?
A: The part of the Internet that enables information-sharing via interconnected pages

Q103. The central organization responsible for creating and maintaining web standards is?
A: W3C
Q104. WWW was invented in which year?
A: 1990
Q105. Name the first ever website.
A: CERN
Q106. Name the first web browser.
A: Nexus
Q107. Name the first graphical web browser.
A: Mosaic
Q108. Name the free & open source web browser.
A: Mozilla Firefox
Q109. The address of a website is also known as?
A: URL
Q110. Internet data is broken up as?
A: Variable Length Packets
Q111. The communication protocol used by Internet is?
A: TCP/IP
Q112. Who provides us Internet?
A: ISP
Q113. The Internet was originally a project of which agency?
A: ARPA
Q114. The process of transferring files from a computer on the Internet to your computer is called?
A: Downloading
Q115. What is included in an E-mail address?
A: User's name followed by domain name
Q116. What is the full form of EDI?
A: Electronic Data Interchange
Q117. The process of trading goods over the Internet is known as?
A: E-commerce
Q118. What is a website?
A: A location on the world wide web
Q119. Which protocol is used for remote terminal connection service?
A: TELNET
Q120. WWW stands for?
A: World Wide Web
Q121. What is a CMS in web design?
A: Content Management System
Q122. What does CSS stand for?
A: Cascading Style Sheets
Q123. What does the acronym ISP stand for?
A: Internet Service Provider
Q124. IPv4 address is how many bits?
A: 32 bit
Q125. IPv6 address is how many bits?
A: 128 bit
Q126. Which protocol assigns IP address to the client connected in the internet?
A: DHCP
Q127. The standard protocol of the Internet is?
A: TCP/IP
Q128. What is the default subnet mask of Class C IP addressing?
A: 255.255.255.0

Q129. Who is responsible for assigning IP addresses?
A: IANA
Q130. Which class of IP Address is reserved for multicasting?
A: Class D
Q131. Loopback address is also called as?
A: Local Host
Q132. Physical address is also called as?
A: MAC Address
Q133. Hardware address is known as?
A: MAC Address
Q134. MAC address works on which layer of OSI model?
A: Layer 2
Q135. How many layers are there in the OSI model?
A: 7
Q136. Which layer of OSI model is responsible for routing packets?
A: Network layer
Q137. The application layer of the OSI model is which layer?
A: Seventh layer
Q138. In OSI model, dialogue control and token management are responsibilities of which layer?
A: Session layer
Q139. In which layer does encryption and decryption occur in OSI model?
A: Presentation layer
Q140. In which topology do devices communicate in a master-slave relationship?
A: Star or Tree
Q141. Which device helps prevent congestion and data collisions?
A: Switch
Q142. Which device connects networks with different protocols?
A: Gateway
Q143. Device that creates a wireless local area network, or WLAN?
A: Wireless Access Point (WAP)
Q144. WI-FI stands for?
A: Wireless Fidelity
Q145. IEEE standard for WI-FI is?
A: 802.11
Q146. Which is the latest version of WI-FI?
A: 802.11ax (Wi-Fi 6)
Q147. Which among them has the strongest wireless security?
A: WPA3
Q148. What is Wired Equivalent Privacy (WEP)?
A: Security algorithm for wireless networks
Q149. Speed of Internet is measured in?
A: Gbps
Q150. In the context of internet, what is the full form of URL?
A: Uniform Resource Locator
Q151. Who first started Internet services in India?
A: VSNL
Q152. What is the official birthday of the Internet?
A: January 1, 1983
Q153. Which of the following is the most popular activity on the Internet?
A: Searching
Q154. What is a thread (in Internet terminology)?
A: A series of linked messages

Q155. Which is NOT a characteristic of a LAN?
A: Covers countries
Q156. What is 'intranet'?
A: Internal network designed to serve the informational needs of a single organization
Q157. Which protocol is used for file transfer between computers?
A: FTP
Q158. Which is NOT a function of a switch?
A: Broadcasts data to all devices
Q159. Which is the main function of a DNS server?
A: Resolve domain names to IP addresses
Q160. Which part of the MAC address identifies the manufacturer?
A: First 6 digits
Q161. In star topology, failure of which device will bring down the network?
A: Central hub/switch
Q162. Which network topology requires the most wiring?
A: Mesh
Q163. Which of these is NOT a means of personal communication on the Internet?
A: Instanotes
Q164. What is a bookmark (in browser terminology)?
A: A stored link to a web page for quick access
Q165. Which of the following is required to create an HTML document?
A: Text editor
Q166. HTML tags consist of keywords enclosed within:
A: Angular brackets <>
Q167. Which protocol provides E-mail facility among different hosts?
A: SMTP
Q168. Which protocol is used for remote terminal connection service?
A: TELNET
Q169. Which is the most popular web server on the web?
A: Apache
Q170. Which one is a free and open-source web browser?
A: Mozilla Firefox
Q171. Which browser was developed by Apple?
A: Safari
Q172. Which device is used to connect a number of LANs?
A: Router
Q173. Which OSI layer enables users to access the network?
A: Application layer
Q174. Which layer in OSI model is responsible for error detection?
A: Data Link layer
Q175. Which layer is the closest to the transmission medium?
A: Physical layer
Q176. Which layer is responsible for routing?
A: Network layer
Q177. How many classes are there in IP Addressing?
A: 5 Classes
Q178. Which class of IP address is reserved for future use?
A: Class E
Q179. Which class of IP address is reserved for multicast?
A: Class D
Q180. Which standard is NOT used in Wi-Fi data transmission?
A: 802.11q

Q181. Which protocol helps find MAC address when IP is known?
A: ARP
Q182. Which protocol helps find IP address when MAC is known?
A: RARP
Q183. What is the default subnet mask for Class A IP addressing?
A: 255.0.0.0
Q184. Which IP address is used as loopback address?
A: 127.0.0.1
Q185. Which organization is responsible for assigning IP addresses?
A: IANA
Q186. What is the first layer of the OSI model?
A: Physical layer
Q187. Which layer of OSI is also called the end-to-end layer?
A: Transport layer
Q188. Which protocol is NOT an application layer protocol?
A: TCP
Q189. Which protocol is a connectionless transport layer protocol?
A: UDP
Q190. What is the port number for HTTP?
A: 80
Q191. What is the port number for FTP?
A: 21
Q192. Which protocol is used in domain name resolution?
A: DNS
Q193. Who is known as the father of Wikipedia?
A: Jimmy Wales
Q194. The most powerful computer in a typical network is?
A: Network server
Q195. What is the main advantage of UDP?
A: Low overhead
Q196. Which wireless protocol uses TKIP?
A: WPA
Q197. The main use of a bridge in networking is?
A: Connect similar networks at Data Link layer
Q198. Which device is required to connect multiple computers on the same internet network?
A: Router
Q199. What is the nature of a cookie (browser)?
A: Non-volatile
Q200. Which is the latest version of Wi-Fi?
A: 802.11ax (Wi-Fi 6)