CNND DEC 2024 Answers

Q1

a) Explain in detail TCP Timers.

TCP (Transmission Control Protocol) uses several **timers** to ensure reliable communication between sender and receiver. These timers help manage connection setup, data transmission, and connection termination.

Types of TCP Timers

1. Retransmission Timer

- **Purpose**: Used to retransmit data if an acknowledgment (ACK) is not received within a certain time.
- **How it works**:
  - When a segment is sent, the timer starts.
  - If the ACK is not received before the timer expires, TCP **assumes packet loss** and retransmits the segment.
- **Calculation**: Uses **Estimated RTT (Round Trip Time)** and **Deviation** to dynamically adjust timeout using this formula:

  $$\text{Timeout Interval} = \text{EstimatedRTT} + 4 \times \text{DevRTT}$$

2. Persistence Timer

- **Purpose**: Prevents **deadlock** when the receiver's window size is 0 (receiver is temporarily full).
- **How it works**:
  - When the sender receives a window size of 0, it starts the persistence timer.
  - On expiry, the sender sends a small probe (1-byte segment) to check if the receiver is now ready.
  - This continues until the receiver advertises a non-zero window.

3. Keepalive Timer

- **Purpose**: Detects whether the other end of an **idle connection** is still alive.
- **How it works**:
    - If no data is received for a long time, the timer sends a **keepalive probe**.
    - If no response is received after several probes, TCP **closes the connection**.

4. Time-Wait Timer (2MSL Timer)

- **Purpose**: Ensures the final acknowledgment in a connection **termination** process is received.
- **How it works**:
    - After closing a TCP connection, the side that sent the final ACK waits for **2 × MSL (Maximum Segment Lifetime)**.
    - This prevents delayed segments from a previous connection being misinterpreted by a new connection.

c) What is the difference between MAC address and Ip address?

Feature	MAC Address	IP Address
Full Form	Media Access Control Address	Internet Protocol Address
Purpose	Identifies a device **physically** on a network	Identifies a device's **location** on a network
Level	Data Link Layer (Layer 2)	Network Layer (Layer 3)
Assigned By	Manufacturer (burned into network card)	Network administrator or assigned by ISP/DHCP
Format	48-bit address (e.g., `00:1A:2B:3C:4D:5E`)	IPv4: 32-bit (`192.168.0.1`), IPv6: 128-bit
Changeable?	Usually fixed (can be changed using software)	Can change (e.g., moving to another network)
Uniqueness	Globally unique	Unique within a network (can be reused in different ones)
Used By	Switches and NICs for local communication	Routers for identifying devices across networks
Example Use	Ethernet communication within a LAN	Sending data between different networks via the Internet

Q2

a) Explain in detail Link State Routing

The **Link State Routing Protocol** is a dynamic routing protocol used in large and complex networks. Unlike Distance Vector Routing, which relies on distance metrics, Link State Routing uses the complete knowledge of the network topology to calculate the shortest path to all destinations. It ensures more reliable, faster, and scalable routing.

How Link State Routing Works

1. **Topology Discovery**:
   - Each router discovers its neighbors (directly connected devices) using a process such as "Hello" packets.

2. **Link State Advertisement (LSA)**:
   - Each router creates an LSA, a data packet containing information about its links and their costs.
   - LSAs are flooded throughout the network, so every router learns the full network topology.

3. **Topology Database**:
   - Using the received LSAs, each router builds a Link-State Database (LSDB) that represents the network graph.

4. **Path Calculation**:
   - Each router runs the **Dijkstra Algorithm** on the LSDB to compute the shortest path to every other node in the network.
   - The results are stored in the routing table.

5. **Periodic Updates**:
   - LSAs are exchanged when there are changes in the network (e.g., link failure) or periodically, ensuring that all routers maintain an accurate view of the topology.

Q6

a) Write a short note on Image compression

Image compression is the process of reducing the size of an image file without significantly degrading its quality. It helps in **saving storage space**, **reducing transmission time**, and **improving loading speed** over networks.

Types of Image Compression

1. **Lossless Compression**
   - No loss of image quality.
   - Original image can be perfectly reconstructed.
   - Used in PNG, GIF.
   - Techniques: Run-Length Encoding (RLE), Huffman Coding.

2. **Lossy Compression**
    - Some image quality is lost for higher compression.
    - Original image cannot be exactly recovered.
    - Used in JPEG.
    - Techniques: Discrete Cosine Transform (DCT), Quantization.

Advantages

- Reduces bandwidth and storage requirements.
- Faster image transmission over networks.
- Makes web pages and apps load faster.

Applications

- Web images (JPEG, PNG).
- Digital photography.
- Medical imaging (compressed without loss).
- Multimedia apps and streaming.