Computer Networks

TCP/IP and Network Architecture Quiz – Answer Key

1. **(B) Network Layer.** Layer 3 (Network) handles logical addressing (IP) and routing packets between different networks. Data Link handles local delivery; Transport handles end-to-end communication.

2. **(B) Acknowledgments and retransmissions.** TCP uses sequence numbers, acknowledgments, checksums, and retransmission timers to ensure reliable, ordered delivery of data.

3. **(B) Translating domain names to IP addresses.** DNS is a hierarchical naming system that resolves human-readable domain names (e.g., google.com) to IP addresses (e.g., 142.250.80.46).

4. **(B) UDP.** User Datagram Protocol is connectionless and unreliable (no acknowledgments or retransmissions). TCP is connection-oriented and reliable; IP is Network Layer; HTTP is Application Layer.

5. **(B) 254.** A /24 network has 256 addresses (2^8), but the network address (first) and broadcast address (last) are reserved, leaving 254 usable host addresses.

6. **True.** ARP operates at the Data Link Layer to discover the MAC (hardware) address associated with an IP address on the local network segment.

7. **False.** HTTP/2 specification allows unencrypted connections (h2c), though most browser implementations require TLS (h2). HTTP/3 (QUIC) similarly doesn't mandate but typically uses encryption.

8. **False.** Switches operate at the Data Link Layer (Layer 2) and make forwarding decisions based on MAC addresses. Routers operate at the Network Layer and use IP addresses.

9. **TCP Characteristics:**

   - Connection-oriented (three-way handshake)
   - Reliable delivery (acknowledgments, retransmissions)
   - Ordered delivery (sequence numbers)
   - Flow control (sliding window)
   - Congestion control (slow start, congestion avoidance)
   - Higher overhead

   UDP Characteristics:

   - Connectionless (no handshake)
   - Unreliable (no acknowledgments or retransmissions)
   - No ordering guarantees
   - No flow/congestion control
   - Lower overhead, faster

TCP Use Cases: Web browsing (HTTP), email (SMTP), file transfer (FTP), SSH—applications requiring complete, ordered data delivery.

UDP Use Cases: Video streaming, VoIP, online gaming, DNS queries—applications tolerating some loss but requiring low latency; real-time applications where retransmission is counterproductive.

Selection criteria: Choose TCP when data integrity is critical; choose UDP when speed/latency matters more than perfect delivery.

10. TCP Three-Way Handshake:

Step 1 - SYN:

- Client sends SYN (synchronize) segment to server
- Contains client's initial sequence number (ISN)
- Client enters SYN_SENT state

Step 2 - SYN-ACK:

- Server receives SYN, responds with SYN-ACK
- Acknowledges client's ISN (ACK = client_ISN + 1)
- Includes server's own ISN
- Server enters SYN_RECEIVED state

Step 3 - ACK:

- Client acknowledges server's ISN (ACK = server_ISN + 1)
- Client enters ESTABLISHED state
- Upon receipt, server enters ESTABLISHED state
- Connection ready for data transfer

Purpose:

- Establishes connection parameters
- Synchronizes sequence numbers for reliable transfer
- Confirms both parties are ready to communicate

Packet loss handling:

- If SYN lost: Client retransmits after timeout
- If SYN-ACK lost: Server retransmits; client may retransmit SYN
- If final ACK lost: Server retransmits SYN-ACK; client responds with ACK again
- Exponential backoff prevents network congestion