Computer Networks - Important Notes

1. Explain IP Header Format (10 Marks)

The IP (Internet Protocol) header is a part of each IP packet and contains essential information required for routing and delivery of the packet from source to destination.

The standard IPv4 header is 20 bytes (160 bits) long (without options) and consists of the following fields:

- Version (4 bits): Specifies the IP version (4 for IPv4).
- Header Length (IHL - 4 bits): Length of the IP header in 32-bit words; minimum value is 5 (20 bytes).
- Type of Service (8 bits): Specifies priority and QoS (e.g., delay, throughput, reliability).
- Total Length (16 bits): Total length of the IP packet (header + data) in bytes, max 65,535 bytes.
- Identification (16 bits): Used for fragmentation and reassembly of packets.
- Flags (3 bits): Controls fragmentation (Reserved, Don't Fragment, More Fragments).
- Fragment Offset (13 bits): Position of a fragment in the original packet, measured in 8-byte units.
- Time To Live (TTL) (8 bits): Limits packet lifetime (number of hops).
- Protocol (8 bits): Specifies the upper-layer protocol (TCP=6, UDP=17, ICMP=1).
- Header Checksum (16 bits): Error checking for the header only.
- Source IP Address (32 bits): IP address of the sender.
- Destination IP Address (32 bits): IP address of the receiver.
- Options (variable): Optional control information (rarely used).
- Padding (variable): Added to make the header a multiple of 32 bits.

2. TCP Congestion Control Protocol Policies (5 Marks)

TCP uses congestion control to manage data transmission rates and prevent network congestion.

The main policies are:

- Slow Start: Starts with a small congestion window (cwnd), increases exponentially each ACK received.
- Congestion Avoidance: After reaching threshold (ssthresh), cwnd increases linearly to avoid congestion.
- Fast Retransmit: Retransmits lost packet immediately after receiving 3 duplicate ACKs without waiting for timeout.
- Fast Recovery: After fast retransmit, reduces cwnd but avoids slow start to maintain efficient transmission.

3. Difference Between Go-Back-N and Selective Repeat Protocol (5 Marks)

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Go-Back-N (GBN) and Selective Repeat (SR) are ARQ protocols used for reliable data transmission.

Key differences:

- Acknowledgment: GBN uses cumulative ACK, SR uses individual ACK for each frame.
- Error Handling: GBN retransmits all frames after a lost one; SR retransmits only erroneous frames.
- Efficiency: SR is more efficient by avoiding unnecessary retransmissions.
- Sender Window Size: GBN window size is N; SR window size is about (N-1)/2.
- Complexity: GBN is simpler; SR is more complex due to multiple timers and buffers.

4. Short Notes (5 Marks Each)

-. ARP (Address Resolution Protocol)

Used to map IP addresses to MAC addresses in a local network.
Broadcasts ARP requests and receives MAC in reply.
Operates between Network and Data Link layers.

-. Slotted ALOHA

Random access protocol with time divided into slots.
Devices transmit only at slot beginnings.
Collisions cause retransmission after random delay.
More efficient than pure ALOHA.

-. Distance Vector Routing Protocol

Each router maintains a table of distances to destinations.
Routers exchange tables with neighbors periodically.
Uses algorithms like Bellman-Ford.
Simple but slow convergence.

-. Leaky Bucket and Token Bucket Algorithm

Leaky Bucket controls output rate by constant leak of data from buffer.
Token Bucket controls sending by requiring tokens for each packet.
Token bucket allows bursts; leaky bucket smooths traffic.

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-. DNS (Domain Name System)

Translates domain names to IP addresses.

Hierarchical and distributed database.

Essential for user-friendly internet navigation.