

Transport Layer - TCP and UDP

- Multiplexing - It is the process by which the transport layer collects data from multiple application sockets, adds headers, and sends the resulting segments to the network layer.
- Demultiplexing - It is the process by which the transport layer delivers received data to the correct application socket based on port numbers.
- Segment - It is the data unit used at the transport layer, formed by encapsulating application data with transport-layer headers (e.g., TCP or UDP).
- Socket is the software interface between an application process and the transport layer, used to send and receive data over the network.

TCP header Fields and their function:

- Source and Destination Port Number - Multiplexing/Demultiplexing: Identifies which application or socket the data belongs to.
- FIN Flag - Closing a Connection: Signals the end of data transmission, used to terminate a TCP connection gracefully.
- SYN Flag - Establishing a Connection: Used during the TCP three-way handshake to initiate a new connection.
- Window Size - Flow Control: Tells the sender how much data the receiver can accept before it must wait for an acknowledgment.
- Sequence and Acknowledgment Numbers - Error Control: Ensure reliable, ordered delivery by tracking which bytes have been sent and received successfully.

Principles of Reliable Data Transfer

- In the Stop-and-Wait protocol, the sender transmits one packet at a time and waits for its acknowledgment before sending the next. This ensures reliable data transfer, but since only one packet is in transit at any moment, it is not a pipelined protocol and has a send window size of 1.
- In the Go-Back-N protocol, the sender can transmit up to N unacknowledged packets at once. This is called the send window of size N. If a packet is lost, the sender retransmits that packet and all subsequent ones, making it a sliding window protocol that improves efficiency over stop-and-wait.
- In the Selective Repeat protocol, the sender can transmit multiple packets within a sliding window, and each packet has its own timer, so only lost packets are retransmitted. To avoid ambiguity between new and old packets (due to sequence number wraparound), the window size must be \leq half the total sequence number space.
- In a pipelining protocol, the sender can transmit several packets consecutively before receiving acknowledgments, which improves network efficiency by keeping the communication channel fully utilized.
- A cumulative acknowledgment A(n) means that the receiver sends a single ACK to confirm it has correctly received all packets up to a certain sequence number, so the sender knows it doesn't need to retransmit any of those packets.
- Explicit Congestion Notification (ECN) allows routers to signal congestion without dropping packets, and it works only if both endpoints and all routers along the path support it at Layers 2, 3, and the transport layer.

Network Layer - IP Header

- At the network layer, the transmission unit is called a packet - it encapsulates the transport-layer segment with a network-layer header (e.g., the IP header).
- Forwarding refers to the router-local action of transferring a packet from an input link interface to the appropriate output link interface.
- Routing refers to the network-wide process that determines the end-to-end paths that packets take from source to destination.
- The data plane handles the forwarding of packets based on the routing table, while the control plane is responsible for running routing protocols and determining the best routes.
- The IP header does not contain port numbers; they are part of the TCP or UDP headers, which identify the application to demultiplex the packet is to.
- The protocol field in the IP header specifies the upper-layer protocol (e.g., TCP, UDP, ICMP) so the IP layer knows which protocol should receive the next packet.

- When a router forwards an IPv4 datagram (without fragmentation), it decrements the TTL (Time To Live) by 1 and recalculates the Header Checksum to reflect this change.

Software-Defined Networking:

- In Software Defined Networking (SDN), a centralized controller manages and decides the routing logic for the entire network, while switches simply follow the controller's instructions.
- In SDN, the data plane remains inside the routers or switches to forward packets, while the control plane is moved to a remote controller that makes routing decisions.

Intra & Inter ISP Protocols

- OSPF is used for intra-AS routing, allowing routers within the same Autonomous System (AS) to share network information.
- e-BGP handles inter-AS routing, exchanging route information between different ASes.
- i-BGP distributes externally learned routes (from e-BGP) within the same AS so that all routers know how to reach external networks.

Ethernet header=14B, Ethernet footer=4B

Which IPv4 header fields... if fragment is required? - total length, flags, fragment offset, TTL, Header checksum

Which IPv4 header fields will the router modify in the forwarded datagram, if fragmentation is not required? – TTL, HeaderChecksum

BGP, 問題文見て、AS1 is running RIPなら、i-BGP, if it's running OSPF, it will be OSPF

Link state: each router must independently calculate the shortest path to every destination, faster convergence

Distance vector: less complex, subject to a count-to-infinity problem

Frag.offset, はNon-header length/8(total len includes 20B)

A port number field in the IP header is used to identify which application to demultiplex the packet to. – **false**

The job of gathering data chunks at the source host from different sockets, encapsulating each data chunk with header info to create segments, and passing the segments to the network layer is called “**multiplexing**”

The transmission unit at the transport layer is called a “**segment**”

A process sends message into, and receives messages from, the network through a software interface called “**socket**”

“**Routing**” refers to the network-wide process that determines the end-to-end paths that packets take from source to destination

“**Ping**” tests whether a given IP address is reachable

The go-back-N protocol: **has a send window of size N, is a sliding window protocol**

In software defined networking, the data plane of the routers is located at a remote controller – **false**

The data plane in a router is responsible for participating in routing protocol in order to determine which routes should be used - **false**

The stop-and-wait protocol: **provides reliable data transport, uses sequence numbers to determine if a packet is a duplicate**

Import, sock.bind, data

