

## ASSIGNMENT-4

Date:

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What is the role of the Transport Layer in the OSI model?

The transport Layer (Layer 4) is responsible for end to end communication between devices. It ensures reliable or unreliable data delivery, depending on the protocol used.

Key Functions of the Transport Layer :-

- Segmentation and Reassembly :- Breaks large data into smaller segments and reassembles them at the destination.
- Flow Control :- Manages data transmission speed to prevent congestion.
- Error Detection and Recovery :- Ensures data integrity and retransmits lost data.
- Multiplexing :- Allows multiple applications to communicate simultaneously.
- Connection Establishment & Termination :- Manages sessions between sender and receiver.

What services does the Transport Layer provide to applications?

ans The Transport layer (Layer 4) ensures reliable and efficient communications between applications running on different devices. It provides following key services:-

### ① Segmentation and Reassembly :-

- Breaks large message into smaller segments for transmission
- Reassembles them at the destination in the correct order

### ② Connection Management

- Connection-Oriented (TCP) :- Establishes and maintains a reliable connection before data transfer
- Connectionless (UDP) :- Sends data without establishing a connection, useful for fast communication

### ③ Flow Control

- Regulates data transmission speed to prevent congestion.
- Ensures sender does not overwhelm the receiver

### ④ Error Detection and Recovery

- Detects lost or corrupted data and ensures retransmission (TCP)

UDP does not provide error recovery but may use application-level checks.

## Multiplexing and Demultiplexing

Allows multiple applications to send / receive data simultaneously using port numbers (e.g. HTTP - port 80, FTP - port 21)

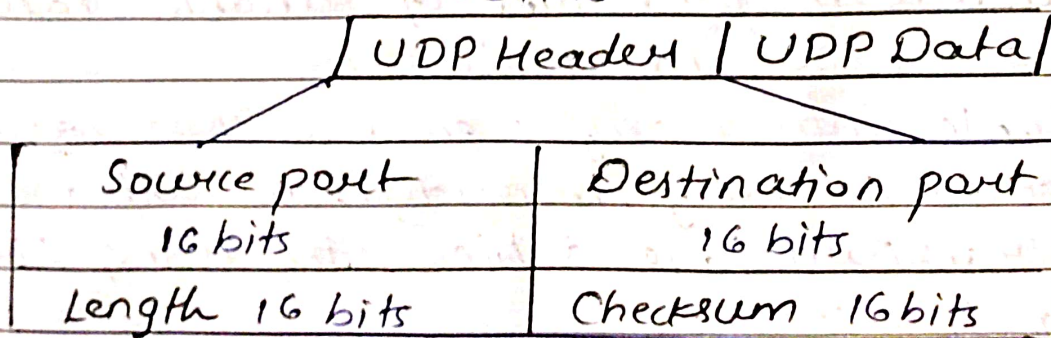
## End-to-End Delivery

Ensures data is delivered ~~completely~~ completely and in sequence between source and destination applications

What is the UDP Header format?

UDP Header Format :- The User Datagram Protocol (UDP) is a connectionless transport layer protocol that enables fast data transfer without establishing a connection. The UDP header is 8 bytes (64 bits) long and consist of four fields.

8 BYTES



- ① Source port :-
  - Identifies the port number of the sender's application.
  - Helps the recipient know where the message came from.
- ② Destination port :-
  - Specifies the port number of the receiver's application.
  - Ensures the data reaches the correct services.
- ③ Length :-
  - Indicates the total size of the UDP header plus the data in bytes.
  - Minimum value is 8 bytes (header only, no data).
- ④ Checksum :-
  - Used for error detection to ensure data integrity.
  - Optional in IPv4, but mandatory in IPv6.

Que. 4 What are the principles of reliable data transfer in the Transport Layer?

ans Reliable data transfer ensures that data is delivered correctly, in order, and without errors. The Transport Layer achieves this using several key principles:-

### ① Error Detection & Correction :-

- Uses checksums to detect corrupted data
- If errors are found, the receiver requests a retransmission.

### ② Acknowledgement (ACK) & Negative Acknowledgement (NACK)

- ACK :- Confirms successful data receipt
- NACK :- Signals that data was lost or corrupted, prompting retransmission

### ③ Retransmission & Timeout :-

- If an ACK is not received within a set timeout, the sender retransmits the data.
- Ensures data is not lost due to network issues

### ④ Sequencing & Ordering :-

- Data is assigned sequence no. to ensure it arrives in the correct order.
- The receiver reorders out-of-sequence packets

### ⑤ Flow Control (Avoiding Overload) :-

- Prevents a fast sender from overwhelming a slow receiver
- Sliding Window Protocol dynamically adjusts the data transmission rate.

### ⑥ Congestion Control (Avoiding Network Overload) :-

- Prevents excessive traffic from slowing down the network
- TCP uses algorithm like TCP Reno to manage congestion

- ④ Connection Establishment & Termination (for TCP)
- Three-Way Handshake (SYN, SYN-ACK, ACK) ensures a reliable connection
  - Graceful termination ensures all data is delivered before closing.
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Ques How does TCP establish a connection between two hosts?

ans TCP (Transmission Control Protocol) uses a three-way handshake to establish a reliable, connection-oriented communication b/w two hosts.

THREE way HANDSHAKE PROCESS:-

Step 1:- SYN (Synchronize)

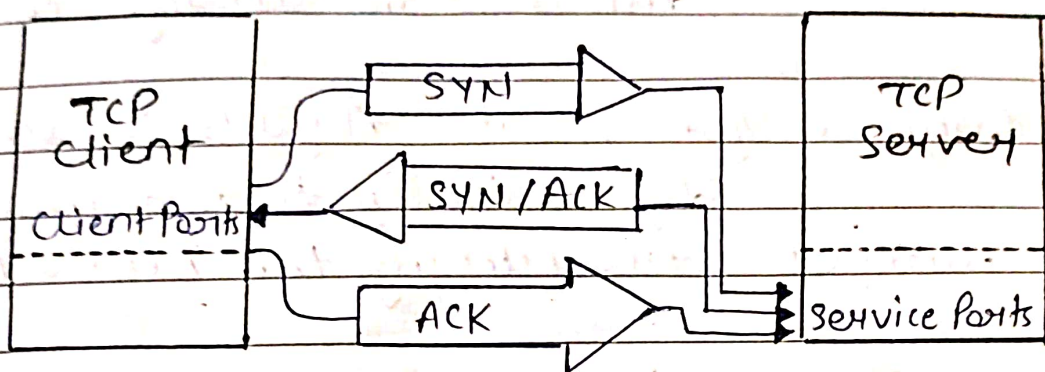
- The client sends a SYN (synchronize) message to the server
- This message contains an initial sequence no. (ISN) to start the communication

Step 2:- SYN-ACK (Synchronize - Acknowledge)

- The server responds with a SYN-ACK message
- The SYN part acknowledges the request and sends its own ISN
- The ACK confirms the receipt of the client's SYN request

### Step 3:- ACK (Acknowledge)

The clients send a final ACK message to the server. This confirms the connection is established, and the data transfer can begin.



What is TCP congestion control, and why is it necessary?

TCP Congestion Control :- TCP (Transmission Control

Protocol) congestion control is a mechanism that regulates network traffic to prevent congestion and packet loss. It ensures efficient data transmission by adjusting the rate at which data is sent based on network conditions. TCP uses various algorithms to detect congestion and control the flow of packets.

Its Necessity :- Without congestion control, too many packets could be sent at once, leading to network congestion, packet loss, & degraded performance. TCP congestion control is necessary to

- ① Prevent Packet Loss :- Helps avoid excessive packet drops that occur due to overloaded network devices.
- ② Improve Network Efficiency :- Ensures fair bandwidth distribution among users.
- ③ Optimize Throughput :- Adjusts the sending rate dynamically to maximize data flow without overwhelming the networks.
- ④ Maintain Fairness :- Ensures that no single connection dominates the available bandwidth.
- ⑤ Enhance Stability :- Prevents sudden traffic spikes that can cause network crashes or severe delays.

Ques What is SCTP, and how does it differ from TCP & UDP?

ans SCTP :- SCTP (Stream Control Transmission Protocol) is a transport-layer protocol designed for reliable, message-oriented communication. It combines features of both TCP and UDP while adding unique capabilities like multi-streaming & multi-homing. SCTP is often used in applications requiring high reliability, such as telecommunications, VoIP, and real-time data transmission.

## Difference b/w SCTP, TCP and UDP

| Feature                                   | SCTP                                                      | TCP                                             | UDP                                                       |
|-------------------------------------------|-----------------------------------------------------------|-------------------------------------------------|-----------------------------------------------------------|
| Connection Type                           | Connection-oriented                                       | Connection-oriented                             | Connectionless                                            |
| Reliability                               | Reliable (acknowledgements, re-transmissions)             | Reliable (acknowledgements, re-transmissions)   | Unreliable (no retransmissions)                           |
| Data Transfer Mode                        | Message-oriented (sends discrete messages)                | Byte stream oriented (continuous flow of bytes) | Message oriented (but unreliable)                         |
| Multiplexing (Streams)                    | Support multiple independent stream within one connection | Single stream per connection                    | Single stream per connection                              |
| Multi-homing (Multiple IP per connection) | Yes (supports failover b/w multiple network paths)        | No                                              | No                                                        |
| Congestion Control                        | Yes (similar to TCP)                                      | Yes                                             | No                                                        |
| Use Cases                                 | VoIP, telecom signaling, real-time data transfer          | Web browsing, file transfer (HTTP, FTP, SSH)    | Streaming, DNS, gaming, VoIP (with packet loss tolerance) |

## Key Advantages of SCTP over TCP and UDP

- Multi-streaming :- Reduces head-of-line blocking by allowing independent streams within a connection.
  - Multi-homing :- Provides redundancy by allowing a connection to use multiple IP addresses for failover.
  - Message-oriented :- Ensures that messages are received in full, unlike TCP's continuous byte stream.
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