

Study Notes: Transport Layer (ITN Module 14)

1. Transport Layer Overview

- Provides logical communication between applications on different hosts.
- Acts as a link between the application layer and lower network layers.
- Responsible for tracking individual conversations, segmenting/reassembling data, and managing multiple conversations.
- Transport Layer Protocols:
 - TCP - Reliable, connection-oriented.
 - UDP - Unreliable, connectionless.

2. Transmission Control Protocol (TCP)

- Features:
 - Connection-oriented: Establishes a session before transmitting data.
 - Reliable delivery: Ensures all segments reach their destination.
 - Same-order delivery: Uses sequence numbers to maintain order.
 - Flow control: Adjusts data flow to prevent congestion.
 - Error detection & retransmission: Resends lost or corrupted data.
- TCP Three-Way Handshake (Connection Establishment):
 1. SYN - Client requests a connection.
 2. SYN-ACK - Server acknowledges the request.
 3. ACK - Client confirms and starts communication.

- TCP Session Termination:

1. FIN - Client requests to end the session.
2. ACK - Server acknowledges the request.
3. FIN - Server sends its own termination request.
4. ACK - Client acknowledges, and the session ends.

3. User Datagram Protocol (UDP)

- Features:

- Connectionless - No session establishment.
- Unreliable delivery - No acknowledgments or retransmissions.
- Minimal overhead - Faster but less secure than TCP.
- Used for time-sensitive applications like streaming and VoIP.

4. Port Numbers

- Purpose: Identify specific processes/services on a device and manage multiple simultaneous connections.
- Well-known Ports (0-1023): HTTP, FTP, SMTP, DNS, etc.
- Registered Ports (1024-49,151): Assigned to specific applications.
- Private/Dynamic Ports (49,152-65,535): Assigned dynamically by OS.

5. TCP Communication Process

- TCP Reliability Mechanisms:

- Sequencing - Ensures all data segments arrive in order.

- Acknowledgments (ACKs) - Confirms successful data delivery.
- Retransmission - Lost packets are resent.
- Selective Acknowledgment (SACK) - Allows acknowledgment of out-of-order segments.

6. UDP Communication Process

- UDP vs. TCP:
 - TCP: Reliable, connection-oriented, ordered delivery.
 - UDP: Unreliable, connectionless, best for real-time applications.
- No retransmission in UDP; used for streaming, VoIP, and DNS.

7. TCP Reliability and Flow Control

- Reliability Mechanisms:
 - Data loss recovery: Retransmits lost segments.
 - Acknowledgments (ACKs): Confirms received data.
 - Selective Acknowledgment (SACK): Optimizes retransmission.
- Congestion control: Prevents network overload.
- Flow Control:
 - Window Size: Controls data flow between source and destination.
 - Maximum Segment Size (MSS): Limits segment size to 1,460 bytes.
 - Congestion Avoidance: Prevents excessive packet loss.

8. Key Takeaways

- The transport layer provides end-to-end communication.

- TCP ensures reliability, ordering, and flow control.
- UDP provides fast, connectionless communication with low overhead.
- Port numbers manage multiple simultaneous conversations.
- TCP three-way handshake establishes a reliable connection.
- UDP is used in real-time applications that can tolerate packet loss.
- TCP uses congestion control and flow management to optimize performance.