

Transport Layer

- **Definition:** The transport layer is responsible for reliable data delivery between applications on different devices. It provides services like connection establishment, flow control, error detection, retransmissions, and congestion control.
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TCP (Transmission Control Protocol)

- **Definition:** A connection-oriented protocol that ensures reliable, ordered, and error-checked delivery of data between applications. It handles retransmissions, acknowledgments, flow control, and congestion control.
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UDP (User Datagram Protocol)

- **Definition:** A connectionless transport layer protocol that provides faster data delivery without guarantees for reliability, ordering, or error correction. It is often used for real-time applications like video streaming or gaming.
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Multiplexing

- **Definition:** The process where the transport layer combines multiple application-layer messages into a single transport-layer segment, which is then handed over to the network layer for transmission.
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Demultiplexing

- **Definition:** The process where the transport layer on the receiving host separates incoming transport-layer segments and delivers each segment's data to the correct application process.
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TCP Three-Way Handshake

- **Definition:** A three-step process used by TCP to establish a reliable connection between a client and server. It involves:
 1. **SYN:** Client requests connection.
 2. **SYN-ACK:** Server acknowledges the request and responds.
 3. **ACK:** Client confirms the connection.

TCP Header

- **Definition:** A data structure in TCP segments that contains essential information, such as source and destination ports, sequence numbers, acknowledgment numbers, flags, and window size, for ensuring reliable communication.

Connection Establishment

- **Definition:** The process of initiating a communication session between two devices using TCP's three-way handshake, ensuring both parties are ready to transmit and receive data.

Connection Termination

- **Definition:** A four-step process where TCP gracefully ends a connection by exchanging **FIN** (finish) and **ACK** (acknowledgment) flags to ensure all data has been transmitted and acknowledged.

Flow Control

- **Definition:** A TCP mechanism that prevents the sender from overwhelming the receiver's buffer by adjusting the rate of data transmission based on the receiver's advertised window size.

Sliding Window Protocol

- **Definition:** A mechanism used in TCP for efficient and reliable data transfer. It allows the sender to transmit multiple segments before waiting for an acknowledgment, based on the receiver's advertised window size.

Receive Window (rwnd)

- **Definition:** A field in the TCP header that specifies the amount of buffer space available on the receiver's side, used to control the flow of data from the sender.
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TCP Retransmissions

- **Definition:** The process of resending TCP segments that are lost, corrupted, or unacknowledged to ensure reliable delivery.
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Retransmission Scenarios

1. **Timeout Retransmission:** Occurs when the sender does not receive an acknowledgment within the retransmission timeout period.
 2. **Fast Retransmit:** Triggered when the sender receives three duplicate ACKs, indicating a segment is likely lost.
 3. **SACK (Selective Acknowledgment):** Allows the receiver to specify which data blocks have been received, enabling efficient retransmission of only the missing segments.
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Round-Trip Time (RTT)

- **Definition:** The time taken for a packet to travel from the sender to the receiver and for the acknowledgment to return. TCP uses RTT to dynamically calculate the retransmission timeout value.
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Congestion Control

- **Definition:** A mechanism in TCP to prevent network congestion by adjusting the data transmission rate based on network conditions. Key components include:
 1. **Slow Start:** Increases the transmission rate gradually.
 2. **Congestion Avoidance:** Avoids congestion by reducing the transmission rate when packet loss is detected.
 3. **Fast Recovery:** Recovers quickly from packet loss using duplicate ACKs.
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Checksum

- **Definition:** A field in the TCP header used to verify the integrity of the transmitted data. If the checksum fails at the receiver, the segment is discarded, and the sender retransmits it.
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Duplicate Acknowledgments (ACKs)

- **Definition:** Repeated acknowledgments sent by the receiver for the last correctly received segment when out-of-order or missing segments are detected.
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Selective Acknowledgment (SACK)

- **Definition:** A TCP feature that allows the receiver to inform the sender about which specific data blocks have been successfully received, enabling retransmission of only the missing segments.
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Cumulative Acknowledgment

- **Definition:** The default acknowledgment mechanism in TCP, where the receiver acknowledges all bytes up to the highest in-order byte received, even if subsequent segments are received out of order.
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TCP Flags

- **Definition:** Control bits in the TCP header used for managing connections and data transfer. Key flags include:
 1. **SYN:** Initiates a connection.
 2. **ACK:** Acknowledges data.
 3. **FIN:** Terminates a connection.
 4. **RST:** Resets a connection.
 5. **PSH:** Pushes data to the application immediately.
 6. **URG:** Marks urgent data.
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SYN Flood Attack

- **Definition:** A type of denial-of-service (DoS) attack where a malicious actor sends a large number of SYN requests without completing the handshake, overloading the server and consuming its resources.
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Congestion Window (cwnd)

- **Definition:** A TCP sender-side variable that determines how much data can be sent before receiving an acknowledgment. It dynamically changes based on network conditions to prevent congestion.

Maximum Segment Size (MSS)

- **Definition:** The largest amount of data (in bytes) that a TCP segment can carry, excluding the TCP and IP headers. It is negotiated during the connection setup.

Maximum Transmission Unit (MTU)

- **Definition:** The maximum size of a packet, including headers, that can be sent over a specific network medium without fragmentation.

Fast Retransmit

- **Definition:** A mechanism in TCP that retransmits a segment immediately upon receiving three duplicate ACKs, rather than waiting for the retransmission timeout.

Timeout

- **Definition:** A predefined period after which the sender retransmits a segment if no acknowledgment is received. Timeout values are dynamically adjusted based on RTT measurements.

Full-Duplex Communication

- **Definition:** A feature of TCP that allows data to flow in both directions simultaneously, enabling bi-directional communication between applications.
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