## TCP and UDP Protocols in Transport Layer

Transmission Control Protocol (TCP)

TCP is one of the main protocols of the Internet protocol suite. It lies between the Application and Network Layers which are used in providing reliable delivery services. It is a **connection-oriented protocol** for communications that helps in the exchange of messages between different devices over a network. The Internet Protocol (IP), which establishes the technique for sending data packets between computers, works with TCP.
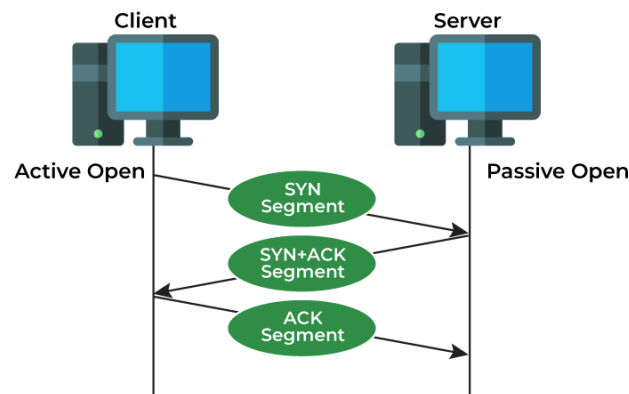
Transmission Control Protocol

Features of TCP

- TCP keeps track of the segments being transmitted or received by assigning numbers to every single one of them.

- Flow control limits the rate at which a sender transfers data. This is done to ensure reliable delivery.

- TCP implements an error control mechanism for reliable data transfer.

- TCP takes into account the level of congestion in the network.

Applications of TCP

- **World Wide Web (WWW)** : When you browse websites, TCP ensures reliable data transfer between your browser and web servers.

- **Email** : TCP is used for sending and receiving emails. Protocols like **SMTP** (Simple Mail Transfer Protocol) handle email delivery across servers.

- **File Transfer Protocol (FTP)** : FTP relies on TCP to transfer large files securely. Whether you're uploading or downloading files, TCP ensures data integrity.

- **Secure Shell (SSH)** : SSH sessions, commonly used for remote administration, rely on TCP for encrypted communication between client and server.

- **Streaming Media** : Services like Netflix, YouTube, and Spotify use TCP to stream videos and music. It ensures smooth playback by managing data segments and retransmissions.

Advantages of TCP

- It is reliable for maintaining a connection between Sender and Receiver.

- It is responsible for sending data in a particular sequence.

- Its operations are not dependent on Operating System .

- It allows and supports many routing protocols.

- It can reduce the speed of data based on the speed of the receiver.

Disadvantages of TCP

- It is slower than UDP and it takes more bandwidth.

- Slower upon starting of transfer of a file.

- Not suitable for LAN Networks.

- It does not have a multicast or broadcast category.

- It does not load the whole page if a single data of the page is missing.

User Datagram Protocol (UDP)

UDP is a part of the Internet Protocol suite, referred to as the UDP/IP suite. Unlike TCP, it is an unreliable and connectionless protocol. So, there is no need to establish a connection before data transfer. The UDP helps to establish low-latency and loss-tolerating connections establish over the network. The UDP enables process-to-process communication.
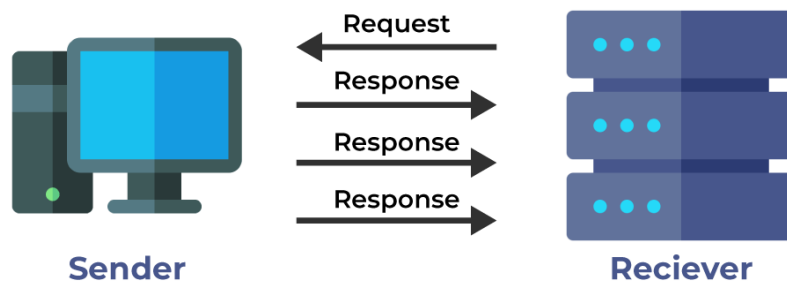
User Datagram Protocol

Features of UDP

- Used for simple request-response communication when the size of data is less and hence there is lesser concern about flow and error control.

- It is a suitable protocol for multicasting as UDP supports packet switching .

- UDP is used for some routing update protocols like RIP(Routing Information Protocol) .

- Normally used for real-time applications which can not tolerate uneven delays between sections of a received message.

Application of UDP

- **Real-Time Multimedia Streaming** : UDP is ideal for streaming audio and video content. Its low-latency nature ensures smooth playback, even if occasional data loss occurs.

- **Online Gaming** : Many online games rely on UDP for fast communication between players.

- **DNS (Domain Name System) Queries** : When your device looks up domain names (like converting "www.example.com" to an IP address), UDP handles these requests efficiently .

- **Network Monitoring** : Tools that monitor network performance often use UDP for lightweight, rapid data exchange.

- **Multicasting** : UDP supports packet switching, making it suitable for multicasting scenarios where data needs to be sent to multiple recipients simultaneously.

- **Routing Update Protocols** : Some routing protocols, like RIP (Routing Information Protocol), utilize UDP for exchanging routing information among routers.

Advantages of UDP

- It does not require any connection for sending or receiving data.

- Broadcast and Multicast are available in UDP.

- UDP can operate on a large range of networks.

- UDP has live and real-time data.

- UDP can deliver data if all the components of the data are not complete.

Disadvantages of UDP

- We can not have any way to acknowledge the successful transfer of data.

- UDP cannot have the mechanism to track the sequence of data.

- UDP is connectionless, and due to this, it is unreliable to transfer data.

- In case of a Collision, UDP packets are dropped by Routers in comparison to TCP.

- UDP can drop packets in case of detection of errors.

Differences between TCP and UDP

Basis	Transmission Control Protocol	User Datagram Protocol
Type of Service	TCP is a connection-oriented protocol. Connection orientation means that the communicating devices should establish a connection before transmitting data and should close the connection after transmitting the data.	UDP is the Datagram-oriented protocol. This is because there is no overhead for opening a connection, maintaining a connection, or terminating a connection. UDP is efficient for broadcast and multicast types of network transmission.
Reliability	TCP is reliable as it guarantees the delivery of data to the destination router.	The delivery of data to the destination cannot be guaranteed in UDP.
Error checking mechanism	TCP provides extensive error-checking mechanisms. It is because it provides flow control and acknowledgment of data.	UDP has only the basic error-checking mechanism using checksums.
Acknowledgment	An acknowledgment segment is present.	No acknowledgment segment.
Sequence	Sequencing of data is a feature of Transmission Control Protocol (TCP). this means that packets arrive in order at the receiver.	There is no sequencing of data in UDP. If the order is required, it has to be managed by the application layer.
Speed	TCP is comparatively slower than UDP.	UDP is faster, simpler, and more efficient than TCP.
Retransmission	Retransmission of lost packets is possible in TCP, but not in UDP.	There is no retransmission of lost packets in the User Datagram Protocol (UDP).

Basis	Transmission Control Protocol	User Datagram Protocol
Header Length	TCP has a (20-60) bytes variable length header.	UDP has an 8 bytes fixed-length header.
Weight	TCP is heavy-weight.	UDP is lightweight.
Handshaking Techniques	Uses handshakes such as SYN, ACK, SYN-ACK	It's a connectionless protocol i.e. No handshake
Broadcasting	TCP doesn't support Broadcasting.	UDP supports Broadcasting.
Protocols	TCP is used by HTTP, HTTPs , FTP , SMTP and Telnet .	UDP is used by DNS , DHCP , TFTP, SNMP , RIP , and VoIP .
Stream Type	The TCP connection is a byte stream.	UDP connection is a message stream.
Overhead	Low but higher than UDP.	Very low.
Applications	This protocol is primarily utilized in situations when a safe and trustworthy communication procedure is necessary, such as in email, on the web surfing, and in military services.	This protocol is used in situations where quick communication is necessary but where dependability is not a concern, such as VoIP, game streaming, video, and music streaming, etc.