**Unit-3**

**Q.1) Explain the The transport service?**

* In a computer network, transport service refers to the process of delivering data between applications running on different devices.
* The transport layer is the fourth layer of the OSI (Open Systems Interconnection) model, which is responsible for providing reliable data transfer between devices on a network.
* The main functions of the transport layer are to provide end-to-end communication between applications, to segment and reassemble data, and to provide flow control and error recovery.
* Some examples of transport services in computer networks include:
* **Transmission Control Protocol (TCP)** - This is a transport protocol that provides a reliable, connection-oriented service for transmitting data.
* It uses a three-way handshake (SYN, SYN-ACK, ACK) to establish a connection before data transmission.
* Once the connection is established, data is transmitted in segments and acknowledged by the receiving device.
* If an acknowledgement is not received, the data is retransmitted.
* This ensures that all data is received in the correct order and that any lost or corrupted data is resent.
* **User Datagram Protocol (UDP) -** This is another transport protocol that provides an unreliable, connectionless service for transmitting data.
* Unlike TCP, UDP does not guarantee delivery of the data, it does not establish a connection before transmitting data, and it does not retransmit lost or corrupted data.
* It is faster and more efficient than TCP because it has a lower overhead.
* **Stream Control Transmission Protocol (SCTP) -** This is a transport protocol that provides a reliable, connection-oriented service for transmitting data, similar to TCP.
* It is designed to work well with multi-homing and multi-path routing.
* Which means that it can use multiple paths to transmit data and automatically switch to a different path if one becomes unavailable.
* **Datagram Congestion Control Protocol (DCCP) -** This is a transport protocol that provides a congestion control mechanism for unreliable transport services such as UDP.
* DCCP uses a congestion control algorithm to avoid overloading the network, and it provides a way for applications to request congestion control for their specific needs.
* The transport service in computer networks plays a crucial role in ensuring that data is delivered correctly and efficiently between devices.
* They are responsible for end-to-end communication, error recovery, flow control, and segmentation and reassembly of data.
* The choice of transport protocol depends on the specific requirements of the application, such as reliability, speed, and congestion control.

**Q.2) Explain the Elements of transport protocols?**

* Transport protocols are used to establish a reliable, efficient, and secure communication channel between two endpoints in a network.
* The two main transport protocols used on the internet are Transmission Control Protocol (TCP) and User Datagram Protocol (UDP).
* The main elements of transport protocols include:

1. **Segmentation and reassembly:** The process of dividing a large amount of data into smaller units called segments.

* Which are then transmitted over the network and reassembled at the destination.
* **For example,** when you are transferring a large file over the internet, the file is divided into smaller segments and each segment is sent as a separate packet.
* At the receiver end, these packets are reassembled to form the original file.

1. **Flow control:** A mechanism to ensure that the sender does not overwhelm the receiver with too much data.

* This can be achieved through the use of windowing, where the receiver sends an acknowledgement message to the sender indicating how much data it can receive at a time.
* **For example,** let's say, the sender is sending data at a rate of 1MB/s and the receiver can only receive at a rate of 500KB/s. In this case, the receiver will send an acknowledgement message to the sender indicating that it can only receive 500KB of data at a time.
* The sender will then adjust its rate accordingly, so that the receiver can process the data without any issues.

1. **Error control:** A mechanism to detect and recover from errors that occur during transmission.

* This can be achieved through the use of checksums and retransmission of lost or corrupted segments.
* **For example,** let's say, while transferring a file, one of the packets gets lost or corrupted.
* The receiver will send an error message to the sender, indicating that the packet is missing or corrupted.
* The sender will then retransmit that specific packet, ensuring that the receiver receives the correct data.

1. **Congestion control:** A mechanism to ensure that the network is not overloaded with too much traffic, which can cause delays and dropped packets.

* This can be achieved through the use of techniques such as packet dropping and rate limiting.
* **For example,** when many users are trying to access the internet at the same time, the network can become congested, causing delays and dropped packets.
* To prevent this, the transport protocol will limit the rate at which data is sent, so that the network does not become overloaded.

1. **Multiplexing and demultiplexing:** A mechanism to allow multiple applications or processes to share a single network connection.

* This can be achieved through the use of port numbers, which are used to identify the different applications or processes at the destination.
* **For example,** when you are browsing the internet and streaming music at the same time, both of these activities are using the same network connection.
* The transport protocol uses different port numbers for these two activities, so that the data for each activity can be properly directed to the correct application or process.

1. **Security:** A mechanism to protect the data from unauthorized access, modification or disclosure and to authenticate the sender and recipient of the data.

* This can be achieved through the use of encryption and authentication protocols.
* **For example,** when you are making an online transaction or accessing your bank account, the transport protocol will encrypt the data being sent, so that it cannot be intercepted by unauthorized parties.
* It also authenticates the sender and recipient, ensuring that the data is only being sent to the intended recipient.

**Q.3) Explain the following Internet transport protocols in Detail :**

1. **UDP and TCP:**

* UDP (User Datagram Protocol) and TCP (Transmission Control Protocol) are two of the most commonly used transport protocols in computer networks.
* They are both used to transmit data over the internet, but they have different characteristics and use cases.
* UDP is a connectionless, unreliable protocol.
* It does not establish a connection before transmitting data, and it does not guarantee that data will be received correctly or in the correct order.
* However, it has low overhead and is faster and more efficient than TCP.
* TCP, on the other hand, is a connection-oriented, reliable protocol.
* It establishes a connection before transmitting data, and it uses a system of acknowledgements and retransmissions to ensure that data is received correctly and in the correct order.
* This makes it more reliable than UDP, but it also has more overhead and is slower.
* **Example of how they work:**
* **Video streaming:** In a video streaming application, where real-time delivery of data is important and some occasional lost packets can be tolerated, UDP can be used as it is faster than TCP.
* **File transfer:** In a file transfer application, where it is important that all data is received correctly and in the correct order, TCP is used.
* Overall, the choice between using UDP or TCP depends on the specific requirements of the application.
* If reliability and correct order of data is important, TCP should be used, if speed is important and occasional lost packets can be tolerated, then UDP should be used.
* It is also worth noting that there are many other transport protocols available in addition to UDP and TCP, and that there are also variations and extensions of these protocols, such as TCP with congestion control (TCP-CC), which are designed to address specific issues and provide additional functionality.

1. **The Domain Name System (DNS):.**

* The Domain Name System (DNS) is a hierarchical, distributed naming system for computers and other resources connected to the internet.
* It is used to translate human-friendly domain names (such as www.example.com) into the IP addresses that computers use to identify each other (such as 192.0.2.1).
* DNS is typically made up of multiple components:
* The domain name space, which is a tree-like structure of domain names and the associated IP addresses
* DNS servers, which are the servers that store and retrieve information about the domain names
* DNS clients, which are the programs that send requests to the DNS servers to resolve domain names
* DNS works by resolving domain names in a hierarchical manner, starting with the root domain name servers, which are responsible for resolving the top-level domain names (such as .com, .org, .edu), and then working down through the hierarchy to the specific domain name of the resource.
* **For example,** when a user types www.example.com into their web browser, the browser sends a request to a local DNS resolver (DNS client), which then sends a request to the root domain name server for the top-level domain (in this case, .com).
* The root server responds with the IP address of the authoritative server for the next level of the hierarchy (the com domain), the com server responds with the IP address of the authoritative server for the example.com domain, and the example.com server responds with the IP address of the www.example.com server.
* Overall, the DNS is an essential service for the internet, as it allows people to use domain names instead of IP addresses to access resources on the internet, making it much more user-friendly and easier to remember.
* It's important to note that the DNS protocol is based on the User Datagram Protocol (UDP) and Transmission Control Protocol (TCP) and uses port number 53 for both. DNS queries are sent to the server using UDP and if the response is larger than 512 bytes, the server will respond using TCP.

1. **Electronic mail, The world wide web:**

* Electronic mail (email) and the World Wide Web (WWW) are two of the most commonly used internet applications, and they both rely on different transport protocols to function.
* **Email:** Electronic mail (email) is a system for sending and receiving messages electronically.
* It uses the Simple Mail Transfer Protocol (SMTP) for sending messages and the Post Office Protocol (POP) or Internet Message Access Protocol (IMAP) for receiving messages.
* SMTP is used to send messages from the sender's email server to the recipient's email server.
* It uses a "store and forward" method, which means that the message is stored on the sender's server and then forwarded to the recipient's server when a connection is available.
* POP and IMAP are used to retrieve messages from the email server and download them to the user's computer or mobile device.
* POP is typically used for downloading email from a single device, while IMAP is used for downloading email from multiple devices or for accessing email from a web-based interface.
* **Example:** If you have an email account on Gmail and you are sending an email to an account on Yahoo, the email will be sent from your Gmail account to the Yahoo mail server using SMTP.
* When the recipient wants to check their email on their computer or mobile device, they will use either POP or IMAP to download the messages to their device.
* **WWW:** The World Wide Web (WWW) is a system of interlinked documents and other resources, linked by hyperlinks and URLs.
* It uses the Hypertext Transfer Protocol (HTTP) for transmitting data over the internet.
* HTTP is used to request and retrieve web pages and other resources from a web server.
* When a user types a URL into their web browser or clicks on a link, the browser sends an HTTP request to the server for the resource.
* The server then responds with the resource, which is typically in the form of an HTML document.
* **Example:** When you type "www.google.com" in your browser, the browser sends an HTTP request to the Google server, asking for the web page associated with that URL.
* The server responds with the HTML document that makes up the Google homepage, which is then displayed in the browser.
* Overall, both email and the WWW are essential services that rely on different transport protocols to function.
* Email relies on SMTP, POP and IMAP while the WWW relies on HTTP. They are used by billions of people around the world, making them among the most widely used internet applications.

1. **Streaming audio and video:**

* Streaming audio and video refers to the ability to play audio or video content in real-time, while it is being transmitted over the internet.
* This is different from traditional methods of downloading audio and video, where the entire file must be downloaded before it can be played.
* There are several transport protocols used for streaming audio and video over the internet, some of the most common ones include:

1. **Real-Time Transport Protocol (RTP) -** RTP is a transport protocol that is used for real-time transmission of audio and video data. It is typically used in conjunction with the Real-Time Control Protocol (RTCP), which is used for quality of service (QoS) and control. RTP is designed to work with a wide range of codecs and can be used with both unicast and multicast streaming.
2. **Real-Time Streaming Protocol (RTSP) -** RTSP is a transport protocol that is used to control the delivery of audio and video data. It is similar to HTTP and is used to establish, maintain and terminate streaming sessions. RTSP can be used to control both unicast and multicast streaming.
3. **HTTP Live Streaming (HLS) -** HLS is a transport protocol that is used to stream live and on-demand video over the internet. It is based on HTTP and is designed to work well with the existing infrastructure of the web. HLS breaks the video into small segments, which can be downloaded and played in sequence.
4. **Dynamic Adaptive Streaming over HTTP (DASH) -** DASH is a transport protocol that is similar to HLS and it is used to stream video over the internet. It is based on HTTP and allows the video to be adapts to the viewer's network conditions and device capabilities, by using different bitrates and resolutions.

* **Example:** When you are streaming a video on YouTube, the video is being transmitted to your device using a transport protocol such as DASH or HLS. The video is broken into small segments, and each segment is downloaded and played in sequence. As you watch the video, the transport protocol will also adjust the video quality based on your network conditions.
* Overall, streaming audio and video is becoming increasingly popular as internet speeds and network conditions improve.
* The transport protocols used for streaming audio and video are designed to provide real-time transmission of audio and video data, while ensuring good quality of service and minimal delay.
* They also allow the video to adapt to the viewer's network conditions and device capabilities.

1. **Content delivery:**

* Content delivery refers to the process of delivering digital content, such as files, images, videos, and web pages, to users over the internet.
* There are several transport protocols that are used to deliver content, including:

1. **File Transfer Protocol (FTP) -** FTP is a transport protocol that is used to transfer files between computers on a network. It uses a client-server architecture and can be used to upload and download files. FTP uses two channels, a command channel and a data channel, to transfer files. It's one of the oldest protocols and it's not very secure.
2. **Hypertext Transfer Protocol (HTTP) -** HTTP is a transport protocol that is used to transfer web pages and other resources over the internet. It is the foundation of the World Wide Web (WWW) and is used by web browsers and web servers to communicate. HTTP uses a request-response model, where the client sends a request to the server and the server responds with the requested resource.
3. **Simple Object Access Protocol (SOAP) -** SOAP is a transport protocol that is used to transfer structured data, such as XML and JSON, between systems. It is typically used for web services and is designed to be platform and language independent. SOAP messages are typically sent using HTTP, but can also be sent using other transport protocols such as SMTP.
4. **Content Distribution Network (CDN) -** A CDN is a network of servers that are distributed around the internet and are used to deliver content to users. The goal of a CDN is to deliver content as quickly and efficiently as possible, by replicating content on multiple servers and delivering it from the server that is closest to the user.

* **Example:** When you access a webpage using your web browser, the browser sends an HTTP request to the server where the webpage is hosted.
* The server responds with the HTML document that makes up the webpage, which is then rendered by the browser.
* Additionally, when you are watching a video on Netflix, the video is being delivered to your device via a CDN, with the goal of delivering the video as quickly and efficiently as possible by replicating the video on multiple servers and delivering it from the server that is closest to you.
* Overall, content delivery is an essential service for the internet, as it allows users to access digital content from anywhere in the world.
* The transport protocols used for content delivery are designed to provide fast and efficient delivery of digital content, while ensuring good quality of service and minimal delay.