

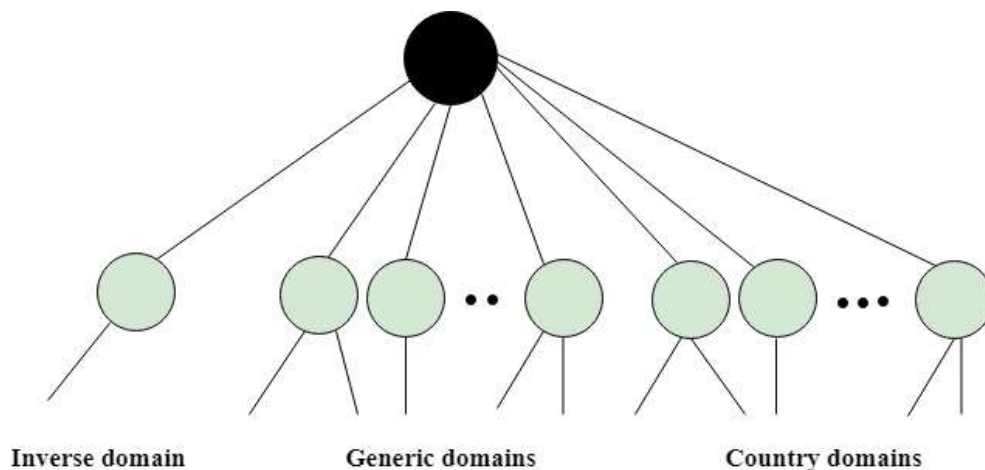
Que : 1 What is DNS? Explain characteristics, hierarchy and working of DNS.

DNS and its characteristics

- DNS stands for Domain Name System.
- DNS is a directory service that provides a mapping between the name of a host on the network and its numerical address.
- DNS is required for the functioning of the internet.
- Each node in a tree has a domain name, and a full domain name is a sequence of symbols specified by dots.
- DNS is a service that translates the domain name into IP addresses. This allows the users of networks to utilize user-friendly names when looking for other hosts instead of remembering the IP addresses.
- For example, suppose the FTP site at EduSoft had an IP address of 132.147.165.50, most people would reach this site by specifying ftp.EduSoft.com. Therefore, the domain name is more reliable than IP address.

Hierarchy

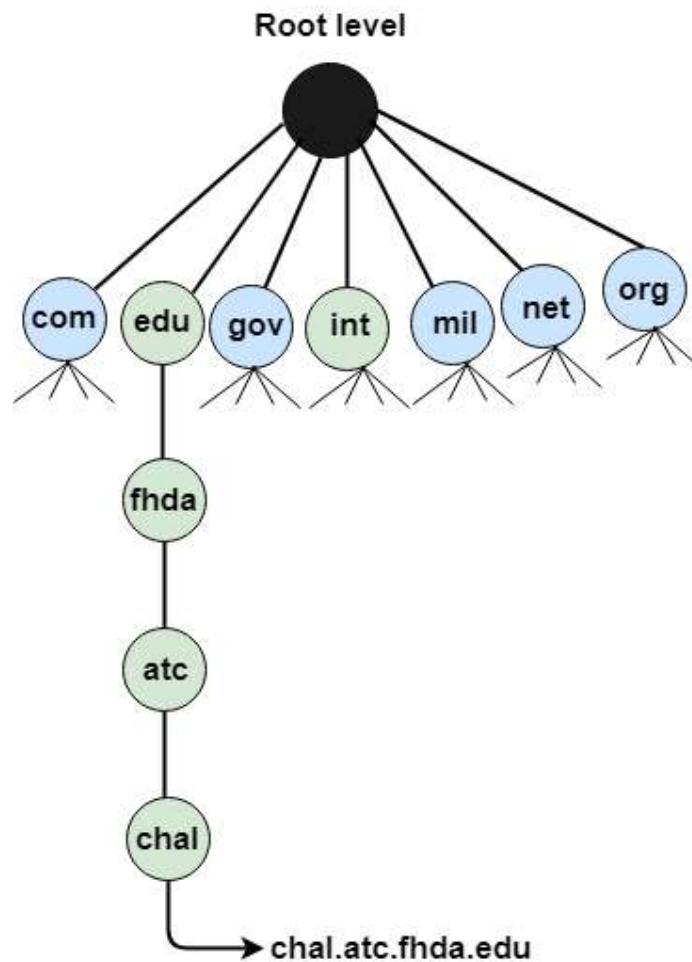
DNS is a TCP/IP protocol used on different platforms. The domain name space is divided into three different sections: generic domains, country domains, and inverse domain.



Generic Domains

- It defines the registered hosts according to their generic behavior.
- Each node in a tree defines the domain name, which is an index to the DNS database.
- It uses three-character labels, and these labels describe the organization type.

Label	Description
aero	Airlines and aerospace companies
biz	Businesses or firms
com	Commercial Organizations
coop	Cooperative business Organizations
edu	Educational institutions
gov	Government institutions
info	Information service providers
int	International Organizations
mil	Military groups
museum	Museum & other nonprofit organizations
name	Personal names
net	Network Support centers
org	Nonprofit Organizations
pro	Professional individual Organizations



Country Domain

The format of country domain is same as a generic domain, but it uses two-character country abbreviations (e.g., us for the United States) in place of three character organizational abbreviations.

Inverse Domain

The inverse domain is used for mapping an address to a name. When the server has received a request from the client, and the server contains the files of only authorized clients. To determine whether the client is on the authorized list or not, it sends a query to the DNS server and ask for mapping an address to the name.

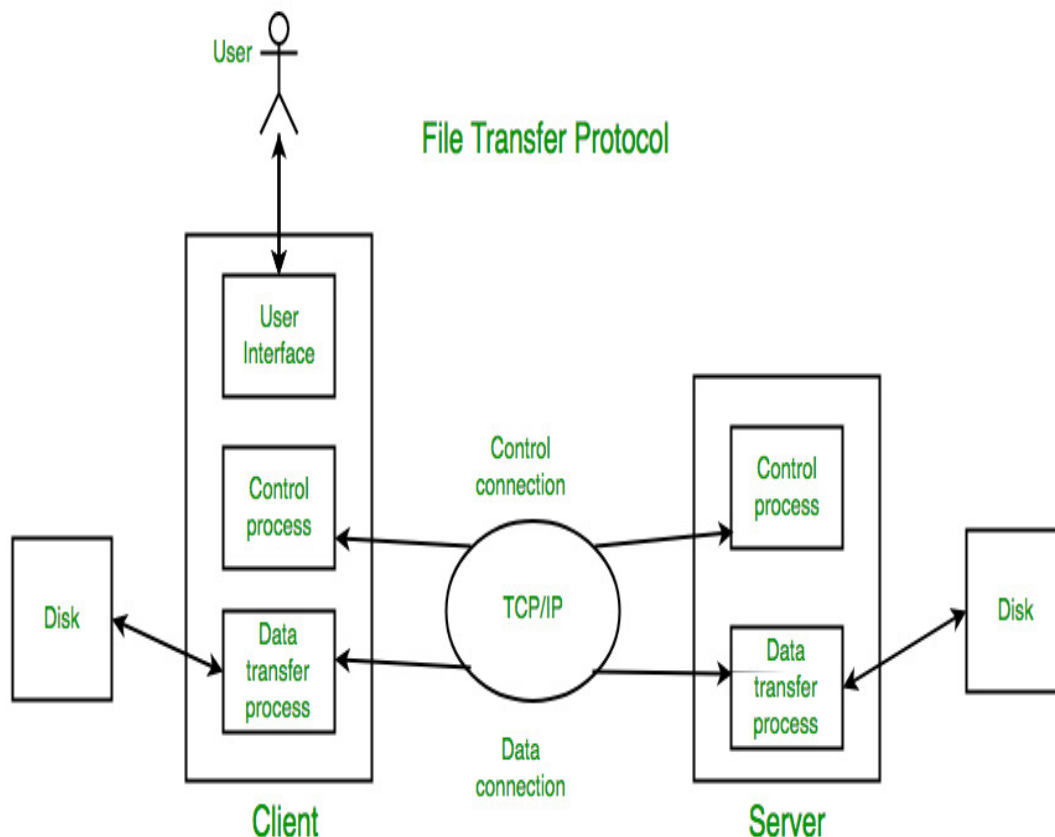
Working of DNS

- DNS is a client/server network communication protocol. DNS clients send requests to the. Server while DNS servers send responses to the client.

- Client requests contain a name which is converted into an IP address known as a forward DNS lookups while requests containing an IP address which is converted into a name known as reverse DNS lookups.
- DNS implements a distributed database to store the name of all the hosts available on the internet.
- If a client like a web browser sends a request containing a hostname, then a piece of software such as **DNS resolver** sends a request to the DNS server to obtain the IP address of a hostname. If DNS server does not contain the IP address associated with a hostname, then it forwards the request to another DNS server. If IP address has arrived at the resolver, which in turn completes the request over the internet protocol.

Que : 2 What is FTP? Explain its modes and FTP commands.

File Transfer Protocol (FTP) is an application layer protocol which moves files between local and remote file systems. It runs on the top of TCP, like HTTP. To transfer a file, 2 TCP connections are used by FTP in parallel: control connection and data connection.



What is control connection?

For sending control information like user identification, password, commands to change the remote directory, commands to retrieve and store files, etc., FTP makes use of control connection. The control connection is initiated on port number 21.

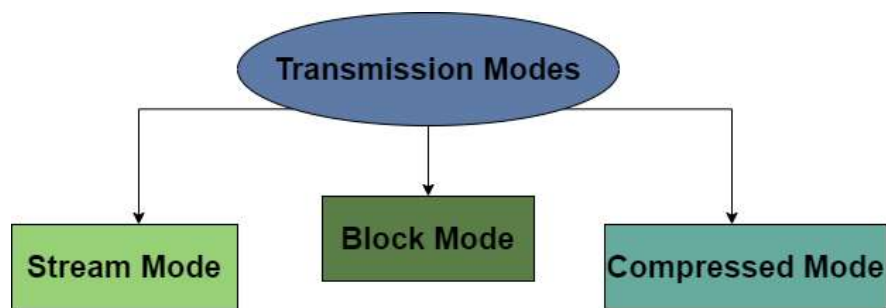
What is data connection?

For sending the actual file, FTP makes use of data connection. A data connection is initiated on port number 20.

FTP sends the control information out-of-band as it uses a separate control connection. Some protocols send their request and response header lines and the data in the same TCP connection. For this reason, they are said to send their control information in-band. HTTP and SMTP are such examples.

Modes

FTP can transfer a file across the data connection using one of the three given modes:

**1. Stream Mode**

Stream Mode is the default mode of transmission used by FTP. In this mode, the File is transmitted as a continuous stream of bytes to TCP.

If the data is simply in the form of the stream of bytes then there is no need for End-of-File, Closing of data connection by the sender is considered as EOF or end-of-file. If the data is divided into records (that is the record structure), each record has an I-byte of EOR(end-of-record).

2. Block Mode

Block mode is used to deliver the data from FTP to TCP in the form of blocks of data. Each block of data is preceded by 3 bytes of the header where the first byte represents the block descriptor while the second and third byte represents the size of the block.

3. Compressed Mode

In this mode, if the file to be transmitted is very big then the data can be compressed. This method is normally used in Run-length encoding. In the case of a text file, usually, spaces/blanks are removed. While in the case of the binary file, null characters are compressed.

FTP Commands

Some of the FTP commands are :

USER – This command sends the user identification to the server.

PASS – This command sends the user password to the server.

CWD – This command allows the user to work with a different directory or dataset for file storage or retrieval without altering his login or accounting information.

RMD – This command causes the directory specified in the path-name to be removed as a directory.

MKD – This command causes the directory specified in the pathname to be created as a directory.

PWD – This command causes the name of the current working directory to be returned in the reply.

RETR – This command causes the remote host to initiate a data connection and to send the requested file over the data connection.

STOR – This command causes to store a file into the current directory of the remote host.

LIST – Sends a request to display the list of all the files present in the directory.

ABOR – This command tells the server to abort the previous FTP service command and any associated transfer of data.

QUIT – This command terminates a USER and if file transfer is not in progress, the server closes the control connection.

Que: 3 what is Email? Explain structure of email and how it work on internet.

Electronic Mail (email or e-mail) is a method of exchanging messages between people using electronic devices. Email first entered limited use in the 1960s and by the middle of 1970s had taken the form now recognized as email. Email operates across computer networks, which is primarily called as Internet.

Earlier email systems required the sender and the recipient to both be online at the same time, in common with instant messaging. Today's email systems are based on a store-and-forward model. Email servers accept, forward, deliver, and store messages.

The structure of the E-mail address is username@domain name

An example of E-mail address is **raman@gmail.com**

An E-mail address consists of two parts separated by @ symbol. The first part Raman is the user name that identifies the address and the second part gmail.com is the domain name of the E-mail server.

How Email works on the Internet:

To send Internet e-mail, requires an Internet connection and access to a mail server. The standard protocol used for sending Internet e-mail is called **SMTP (Simple Mail Transfer Protocol)**. The SMTP protocol is used to both send and receive email messages over the Internet.

When a message is sent, the email client sends the message to the SMTP server. If the recipient of the email is local the message is kept on the server for accessing by the **POP, IMAP** or other mail services for later retrieval.

If the recipient is remote (i.e. at another domain), the SMTP server communicates with a Domain Name Server (DNS) to find the corresponding IP address for the domain being sent to. Once the IP address has been resolved, the SMTP server connects with the remote SMTP server and the mail is delivered to this server for handling.

If the SMTP server sending the mail is unable to connect with the remote SMTP server, then the message goes into a queue. Messages in this queue will be retried periodically. If the message is still undelivered after a certain amount of time (30 hours by default), the message will be returned to the sender as undelivered.

Structure of Email.



To: This field consists of the address to whom the message has to be sent. This is mandatory.

CC: Short for carbon copy. This is optional. The people who were mailed copies of the message. The recipients' of the message will know to whom all the copies have been sent.

BCC: Its stands for Black Carbon Copy. It is used when we do not want one or more of the recipients to know that someone else was copied on the message. This is optional.

Subject: The Subject field indicates the purpose of e-mail.

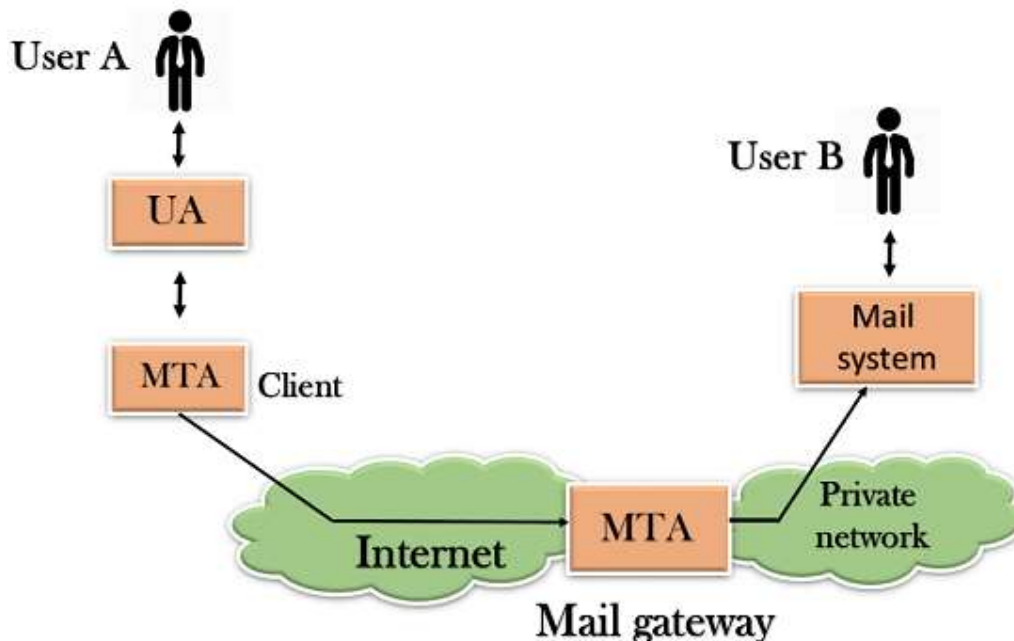
Attachment: Attachment contains files that you are sending, linked documents, pictures, etc. along with an e-mail.

Body: The email body is the main part of an email message. It contains the message's text, images and other data (such as attachments). The email's body is distinct from its header, which contains control information and data about the message (such as its sender, the recipient and the path an email took to reach its destination).

Signature: Name of the sender

Que: 4 Email Protocols**SMTP**

- SMTP stands for Simple Mail Transfer Protocol.
- SMTP is a set of communication guidelines that allow software to transmit an electronic mail over the internet is called **Simple Mail Transfer Protocol**.
- It is a program used for sending messages to other computer users based on e-mail addresses.
- It provides a mail exchange between users on the same or different computers, and it also supports:
 - It can send a single message to one or more recipients.
 - Sending message can include text, voice, video or graphics.
 - It can also send the messages on networks outside the internet.
- The main purpose of SMTP is used to set up communication rules between servers. The servers have a way of identifying themselves and announcing what kind of communication they are trying to perform. They also have a way of handling the errors such as incorrect email address. For example, if the recipient address is wrong, then receiving server reply with an error message of some kind.



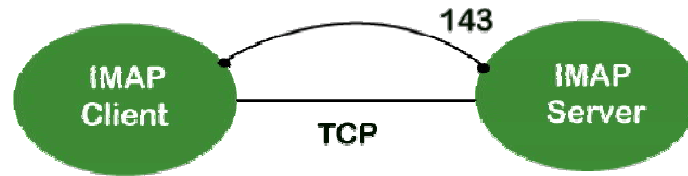
Working of SMTP

1. **Composition of Mail:** A user sends an e-mail by composing an electronic mail message using a Mail User Agent (MUA). Mail User Agent is a program which is used to send and receive mail. The message contains two parts: body and header. The body is the main part of the message while the header includes information such as the sender and recipient address. The header also includes descriptive information such as the subject of the message. In this case, the message body is like a letter and header is like an envelope that contains the recipient's address.
2. **Submission of Mail:** After composing an email, the mail client then submits the completed e-mail to the SMTP server by using SMTP on TCP port 25.
3. **Delivery of Mail:** E-mail addresses contain two parts: username of the recipient and domain name. For example, vivek@gmail.com, where "vivek" is the username of the recipient and "gmail.com" is the domain name. If the domain name of the recipient's email address is different from the sender's domain name, then MSA will send the mail to the Mail Transfer Agent (MTA). To relay the email, the MTA will find the target domain. It checks the MX record from Domain Name System to obtain the target domain. The MX record contains the domain name and IP address of the recipient's domain. Once the record is located, MTA connects to the exchange server to relay the message.
4. **Receipt and Processing of Mail:** Once the incoming message is received, the exchange server delivers it to the incoming server (Mail Delivery Agent) which stores the e-mail where it waits for the user to retrieve it.
5. **Access and Retrieval of Mail:** The stored email in MDA can be retrieved by using MUA (Mail User Agent). MUA can be accessed by using login and password.

IMAP Protocol

IMAP stands for **Internet Message Access Protocol**. It is an application layer protocol which is used to receive the emails from the mail server. It is the most commonly used protocols like POP3 for retrieving the emails.

It also follows the client/server model. On one side, we have an IMAP client, which is a process running on a computer. On the other side, we have an IMAP server, which is also a process running on another computer. Both computers are connected through a network.



The IMAP protocol resides on the TCP/IP transport layer which means that it implicitly uses the reliability of the protocol. Once the TCP connection is established between the IMAP client and IMAP server, the IMAP server listens to the port 143 by default, but this port number can also be changed.

By default, there are two ports used by IMAP:

- Port 143: It is a non-encrypted IMAP port.
- Port 993: This port is used when IMAP client wants to connect through IMAP securely.

IMAP Features

IMAP was designed for a specific purpose that provides a more flexible way of how the user accesses the mailbox. It can operate in any of the three modes, i.e., online, offline, and disconnected mode. Out of these, offline and disconnected modes are of interest to most users of the protocol.

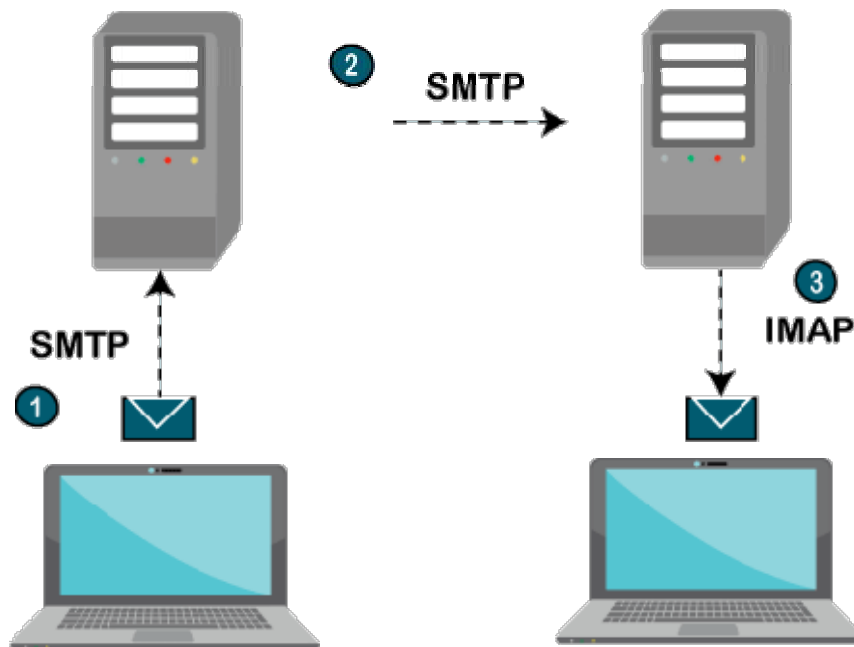
The following are the features of an IMAP protocol:

- Access and retrieve mail from remote server: The user can access the mail from the remote server while retaining the mails in the remote server.
- Set message flags: The message flag is set so that the user can keep track of which message he has already seen.
- Manage multiple mailboxes: The user can manage multiple mailboxes and transfer messages from one mailbox to another. The user can organize them into various categories for those who are working on various projects.
- Determine information prior to downloading: It decides whether to retrieve or not before downloading the mail from the mail server.
- Downloads a portion of a message: It allows you to download the portion of a message, such as one body part from the mime-multi part. This can be useful when there are large multimedia files in a short-text element of a message.
- Organize mails on the server: In case of POP3, the user is not allowed to manage the mails on the server. On the other hand, the users can organize the mails on the

server according to their requirements like they can create, delete or rename the mailbox on the server.

- Search: Users can search for the contents of the emails.
- Check email-header: Users can also check the email-header prior to downloading.
- Create hierarchy: Users can also create the folders to organize the mails in a hierarchy.

IMAP General Operation

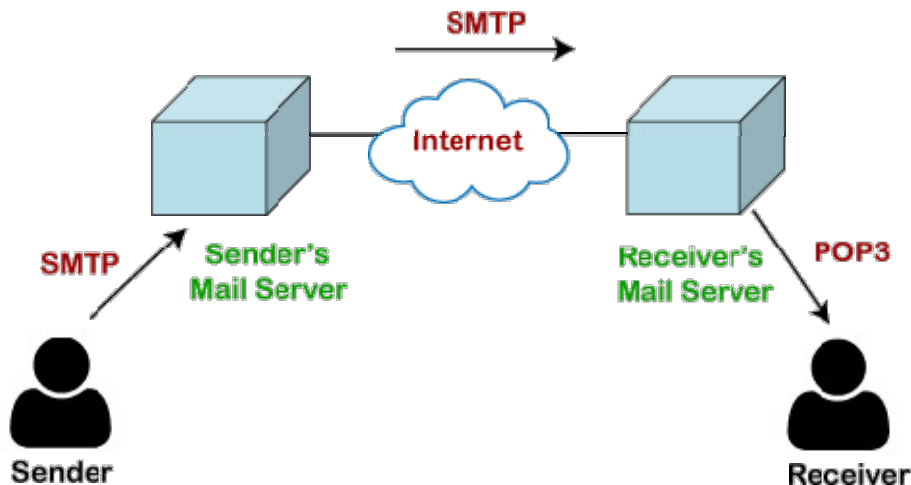


1. The IMAP is a client-server protocol like POP3 and most other TCP/IP application protocols. The IMAP4 protocol functions only when the IMAP4 must reside on the server where the user mailboxes are located. In c the POP3 does not necessarily require the same physical server that provides the SMTP services. Therefore, in the case of the IMAP protocol, the mailbox must be accessible to both SMTP for incoming mails and IMAP for retrieval and modifications.
2. The IMAP uses the Transmission Control Protocol (TCP) for communication to ensure the delivery of data and also received in the order.
3. The IMAP4 listens on a well-known port, i.e., port number 143, for an incoming connection request from the IMAP4 client.

POP Protocol

The POP protocol stands for Post Office Protocol. As we know that SMTP is used as a message transfer agent. When the message is sent, then SMTP is used to deliver the message from the client to the server and then to the recipient server. But the message is sent from the recipient server to the actual server with the help of the Message Access Agent. The Message Access Agent contains two types of protocols, i.e., POP3 and IMAP.

How is mail transmitted?



Suppose sender wants to send the mail to receiver. First mail is transmitted to the sender's mail server. Then, the mail is transmitted from the sender's mail server to the receiver's mail server over the internet. On receiving the mail at the receiver's mail server, the mail is then sent to the user. The whole process is done with the help of Email protocols. The transmission of mail from the sender to the sender's mail server and then to the receiver's mail server is done with the help of the SMTP protocol. At the receiver's mail server, the POP or IMAP protocol takes the data and transmits to the actual user.

Since SMTP is a push protocol so it pushes the message from the client to the server. As we can observe in the above figure that SMTP pushes the message from the client to the recipient's mail server. The third stage of email communication requires a pull protocol, and POP is a pull protocol. When the mail is transmitted from the recipient mail server to the client which means that the client is pulling the mail from the server.

Advantages of POP3 protocol

The following are the advantages of a POP3 protocol:

- It allows the users to read the email offline. It requires an internet connection only at the time of downloading emails from the server. Once the mails are downloaded from the server, then all the downloaded mails reside on our PC or hard disk of our

computer, which can be accessed without the internet. Therefore, we can say that the POP3 protocol does not require permanent internet connectivity.

- It provides easy and fast access to the emails as they are already stored on our PC.
- There is no limit on the size of the email which we receive or send.
- It requires less server storage space as all the mails are stored on the local machine.
- There is maximum size on the mailbox, but it is limited by the size of the hard disk.
- It is a simple protocol so it is one of the most popular protocols used today.
- It is easy to configure and use.

Disadvantages of POP3 protocol

The following are the advantages of a POP3 protocol:

- If the emails are downloaded from the server, then all the mails are deleted from the server by default. So, mails cannot be accessed from other machines unless they are configured to leave a copy of the mail on the server.
- Transferring the mail folder from the local machine to another machine can be difficult.
- Since all the attachments are stored on your local machine, there is a high risk of a virus attack if the virus scanner does not scan them. The virus attack can harm the computer.
- The email folder which is downloaded from the mail server can also become corrupted.
- The mails are stored on the local machine, so anyone who sits on your machine can access the email folder.

MIME Protocol

MIME stands for Multipurpose Internet Mail Extensions. It is used to extend the capabilities of Internet e-mail protocols such as SMTP. The MIME protocol allows the users to exchange various types of digital content such as pictures, audio, video, and various types of documents and files in the e-mail. MIME was created in 1991 by a computer scientist named Nathan Borenstein at a company called Bell Communications.

MIME is an e-mail extension protocol, i.e., it does not operate independently, but it helps to extend the capabilities of e-mail in collaboration with other protocols such as [SMTP](#). Since MIME was able to transfer only text written file in a limited size English language with the

help of the internet. At present, it is used by almost all e-mail related service companies such as Gmail, Yahoo-mail, Hotmail.

Need of MIME Protocol

MIME protocol is used to transfer e-mail in the computer network for the following reasons:

1. The MIME protocol supports multiple languages in e-mail, such as Hindi, French, Japanese, Chinese, etc.
2. Simple protocols can reject mail that exceeds a certain size, but there is no word limit in MIME.
3. Images, audio, and video cannot be sent using simple e-mail protocols such as SMTP. These require MIME protocol.
4. Many times, emails are designed using code such as HTML and CSS, they are mainly used by companies for marketing their product. This type of code uses MIME to send email created from HTML and CSS.

MIME Header

MIME adds five additional fields to the header portion of the actual e-mail to extend the properties of the simple email protocol. These fields are as follows:

1. MIME Version
2. Content Type
3. Content Type Encoding
4. Content Id
5. Content description

1. MIME Version

It defines the version of the MIME protocol. This header usually has a parameter value 1.0, indicating that the message is formatted using MIME.

2. Content Type

It describes the type and subtype of information to be sent in the message. These messages can be of many types such as Text, Image, Audio, Video, and they also have many subtypes such that the subtype of the image can be png or jpeg. Similarly, the subtype of Video can be WEBM, MP4 etc.

3. Content Type Encoding

In this field, it is told which method has been used to convert mail information into ASCII or Binary number, such as 7-bit encoding, 8-bit encoding, etc.

4. Content Id

In this field, a unique "Content Id" number is appended to all email messages so that they can be uniquely identified.

5. Content description

This field contains a brief description of the content within the email. This means that information about whatever is being sent in the mail is clearly in the "Content Description". This field also provides the information of name, creation date, and modification date of the file.

Features of MIME Protocol

1. It supports multiple attachments in a single e-mail.
2. It supports the non-ASCII characters.
3. It supports unlimited e-mail length.
4. It supports multiple languages.

Advantage of the MIME

The MIME protocol has the following advantages:

1. It is capable of sending various types of files in a message, such as text, audio, video files.
2. It also provides the facility to send and receive emails in different languages like Hindi, French, Japanese, Chinese etc.
3. It also provides the facility of connecting HTML and CSS to email, due to which people can design email as per their requirement and make it attractive and beautiful.
4. It is capable of sending the information contained in an email regardless of its length.
5. It assigns a unique id to all e-mails.

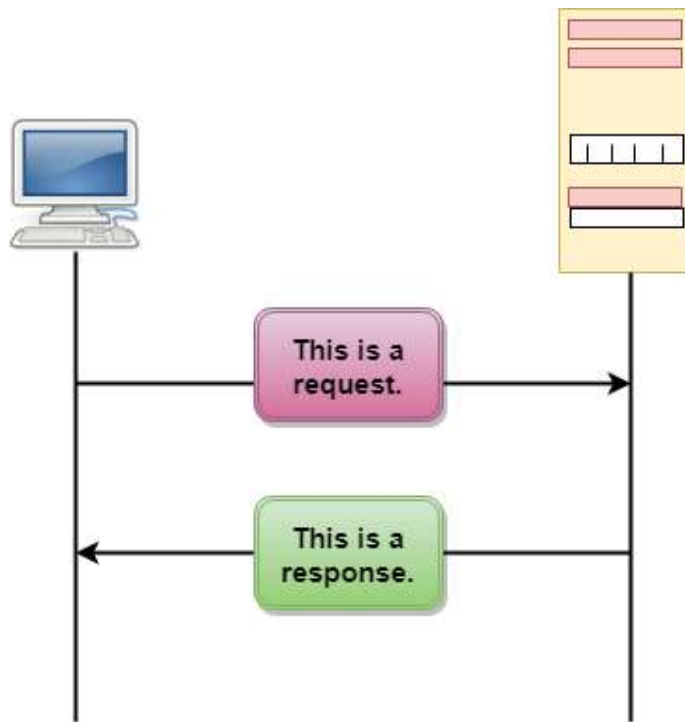
Que : 5 HTTP and UDP**HTTP**

- HTTP stands for **HyperText Transfer Protocol**.
- It is a protocol used to access the data on the World Wide Web (www).
- The HTTP protocol can be used to transfer the data in the form of plain text, hypertext, audio, video, and so on.
- This protocol is known as HyperText Transfer Protocol because of its efficiency that allows us to use in a hypertext environment where there are rapid jumps from one document to another document.
- HTTP is similar to the FTP as it also transfers the files from one host to another host. But, HTTP is simpler than FTP as HTTP uses only one connection, i.e., no control connection to transfer the files.
- HTTP is used to carry the data in the form of MIME-like format.
- HTTP is similar to SMTP as the data is transferred between client and server. The HTTP differs from the SMTP in the way the messages are sent from the client to the server and from server to the client. SMTP messages are stored and forwarded while HTTP messages are delivered immediately.

Features of HTTP:

- **Connectionless protocol:** HTTP is a connectionless protocol. HTTP client initiates a request and waits for a response from the server. When the server receives the request, the server processes the request and sends back the response to the HTTP client after which the client disconnects the connection. The connection between client and server exist only during the current request and response time only.
- **Media independent:** HTTP protocol is a media independent as data can be sent as long as both the client and server know how to handle the data content. It is required for both the client and server to specify the content type in MIME-type header.
- **Stateless:** HTTP is a stateless protocol as both the client and server know each other only during the current request. Due to this nature of the protocol, both the client and server do not retain the information between various requests of the web pages.

HTTP Transactions



The above figure shows the HTTP transaction between client and server. The client initiates a transaction by sending a request message to the server. The server replies to the request message by sending a response message.

Uniform Resource Locator (URL)

- A client that wants to access the document in an internet needs an address and to facilitate the access of documents, the HTTP uses the concept of Uniform Resource Locator (URL).
- The Uniform Resource Locator (URL) is a standard way of specifying any kind of information on the internet.
- The URL defines four parts: method, host computer, port, and path.



- **Method:** The method is the protocol used to retrieve the document from a server. For example, HTTP.

- **Host:** The host is the computer where the information is stored, and the computer is given an alias name. Web pages are mainly stored in the computers and the computers are given an alias name that begins with the characters "www". This field is not mandatory.
- **Port:** The URL can also contain the port number of the server, but it's an optional field. If the port number is included, then it must come between the host and path and it should be separated from the host by a colon.
- **Path:** Path is the pathname of the file where the information is stored. The path itself contain slashes that separate the directories from the subdirectories and files.

UDP

The User Datagram Protocol (UDP) is simplest Transport Layer communication protocol available of the TCP/IP protocol suite. It involves minimum amount of communication mechanism. UDP is said to be an unreliable transport protocol but it uses IP services which provides best effort delivery mechanism.

In UDP, the receiver does not generate an acknowledgement of packet received and in turn, the sender does not wait for any acknowledgement of packet sent. This shortcoming makes this protocol unreliable as well as easier on processing.

Requirement of UDP

A question may arise, why do we need an unreliable protocol to transport the data? We deploy UDP where the acknowledgement packets share significant amount of bandwidth along with the actual data. For example, in case of video streaming, thousands of packets are forwarded towards its users. Acknowledging all the packets is troublesome and may contain huge amount of bandwidth wastage. The best delivery mechanism of underlying IP protocol ensures best efforts to deliver its packets, but even if some packets in video streaming get lost, the impact is not calamitous and can be ignored easily. Loss of few packets in video and voice traffic sometimes goes unnoticed.

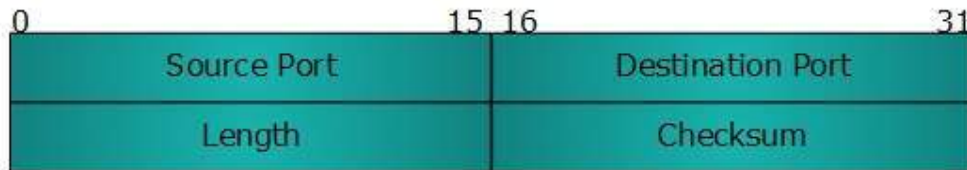
Features

- UDP is used when acknowledgement of data does not hold any significance.
- UDP is good protocol for data flowing in one direction.
- UDP is simple and suitable for query based communications.
- UDP is not connection oriented.
- UDP does not provide congestion control mechanism.
- UDP does not guarantee ordered delivery of data.
- UDP is stateless.

- UDP is suitable protocol for streaming applications such as VoIP, multimedia streaming.

UDP Header

UDP header is as simple as its function.



UDP header contains four main parameters:

- **Source Port** - This 16 bits information is used to identify the source port of the packet.
- **Destination Port** - This 16 bits information, is used identify application level service on destination machine.
- **Length** - Length field specifies the entire length of UDP packet (including header). It is 16-bits field and minimum value is 8-byte, i.e. the size of UDP header itself.
- **Checksum** - This field stores the checksum value generated by the sender before sending. IPv4 has this field as optional so when checksum field does not contain any value it is made 0 and all its bits are set to zero.

UDP application

Here are few applications where UDP is used to transmit data:

- Domain Name Services
- Simple Network Management Protocol
- Trivial File Transfer Protocol
- Routing Information Protocol
- Kerberos