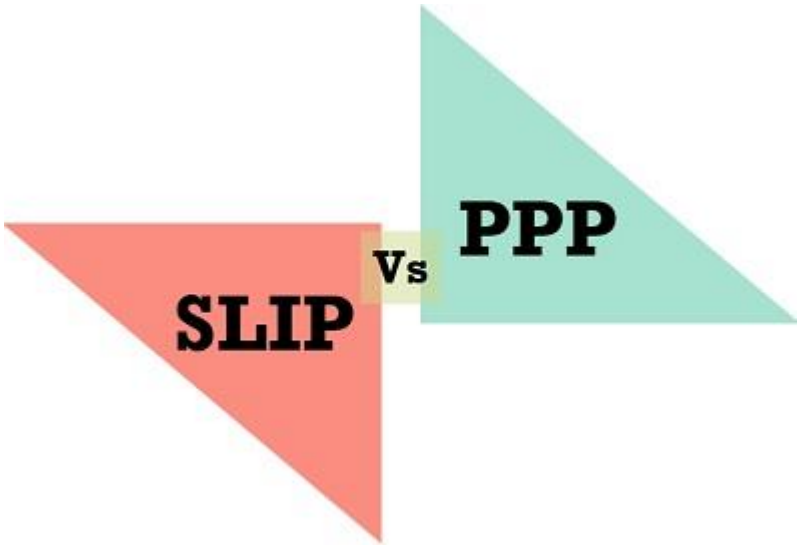
TCP/IP Network Interface Layer Protocols: SLIP and PPP

We need something to “fill the gap” between IP at layer three and the physical connection at layer one. To this end, a pair of special protocols have been defined that operate at layer two and provide the services that IP requires to function. These are:

- Serial Line Internet Protocol (SLIP): A very simple layer two protocol that provides only basic framing for IP.
- Point-to-Point Protocol (PPP): A more complex, full-featured data link layer protocol that provides framing as well as many additional features that improve security and performance.

These protocols involve just two devices and between those two devices, the straightforward communication takes place. It provides connectivity on the second layer for TCP/IP implementations.

Difference Between SLIP and PPP



SLIP and PPP are the two distinct independent serial link encapsulation protocols. The significant difference between the SLIP and PPP is that SLIP is the earlier version protocol while PPP is the later variant which gives several advantages over SLIP such as detection and prevention of misconfiguration, etcetera. Furthermore, PPP supplies greater built-in security mechanism.

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Content: SLIP Vs PPP

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Comparison Chart

BASIS FOR COMPARISON	SLIP	PPP
Relation	Predecessor protocol	Successor protocol
Encapsulates	IP packets	Datagram
Supports	Only IP	Including IP layer three protocols are also involved
Authentication	Not provided	Proper authentication is performed.
Derivative Protocols	CSLIP (Compressed SLIP)	PPPoE (PPP over Ethernet) and PPPoA (PPP over ATM)
IP addressing	Static assignment	Dynamic assignment
Data transfer	Synchronous	Synchronous as well as asynchronous

Definition of SLIP

The SLIP (Serial Line Internet Protocol) mainly serve the purpose of framing the IP packets along the serial lines mostly in a dial-up connection where the line transmission rate could be in the range of 1200 bps and 19.2 Kbps. However, there is no provision of for addressing, packet type identification, compression or error detection/correction mechanisms but it is easily implemented.

The SLIP was first introduced in the year of 1984 and implemented on the 4.2 Berkeley and Sun Microsystems Unix platforms. The development of slip is stimulated by the availability of Unix workstation enabled with TCP/IP capabilities. Later, the SLIP protocol development moved to personal computers when the personal computers evolved to support TCP/IP.

A SLIP connection facilitates PCs communication with the native Internet Protocol and turns it into an internet host. It eliminated the need of connecting the PC user to the internet connected central computer. So, SLIP provided the internet services to the personal computers directly.

Now, how does these PC's are connected to the internet? For establishing the connection between a PC and internet router (able to transfer TCP/IP protocols), telephone lines are used along with SLIP support. Practically, these internet routers can be internet host enabled with routing functions.

Hence, the SLIP protocol users physically connect to the central computer through dial-up. After initiating the protocol, the users can access other internet hosts transparently and the central computer starting as a part of the internet infrastructure.

Definition of PPP

PPP (Point-to-Point) protocol render a standard method for the transfer of the multiprotocol datagrams (packets) along a point-to-point link. The main elements of PPP are – a mechanism for encapsulating multi-protocol datagrams, LCP (Link Control Protocol) and a group of NCP (Network Control Protocols). LCP mainly sets up, configure and test the connections while NCP is responsible for establishing and configuring the distinct network layer protocols.

The PPP was developed by the IETF (Internet Engineering Task Force) in November 1989. As the antecedent, the non-standard method SLIP did not support features such as error detection and correction, and compression gave rise to the development of the PPP protocol. The earlier existing standard only assist datagram encapsulation for the popular local area network not for the serial connections.

PPP has emerged as an internet standard which facilitates in encapsulation and transfer of the datagrams over the point-to-point serial link. A datagram very similar to a packet in the context of the packet-switched network, but it does not rely on the physical network and does not contain packet switching node number and PSN destination ports.

Key Differences Between SLIP and PPP

1. The SLIP expands to Serial Line Internet Protocol while PPP stands for the Point-to-Point protocol.
2. SLIP is an outdated protocol, though it is still used in some places. It is good for just bridging the gap between the IP at layer 3 and serial link at layer 1. On the other hand, PPP is the newer protocol used for the same purpose as the SLIP but offer several new features.
3. SLIP encapsulates IP packets while PPP encapsulates datagram.
4. IP protocol is the only protocol supported by SLIP. On the contrary, PPP provides support for the other layer three protocols also.
5. PPP offers authentication, error detection, error correction, compression, encryption whereas SLIP does not have these features.
6. In SLIP the IP addresses are statically allocated. Conversely, PPP performs the dynamic assignment.
7. Data can be transferred in synchronous mode in SLIP. As against, PPP facilitates synchronous and asynchronous modes for data transfer.

Advantages of PPP over SLIP

- Multiplexing of network protocols – PPP can adapt several other networking technologies, rather than just restricting to the internet and TCP/IP.
- Link configuration – It employs a negotiation mechanism for setting up communication parameters between two PPP peers.
- Error detection – At the receiving end, it discards the corrupted packets.
- Value added communication characteristics – It also supports data commpression and encryption.
- Establishing network addresses – It sets network addresses required for the datagram routing.
- Authentication – Before initiating the communication, the two end users are authenticated first.

Conclusion

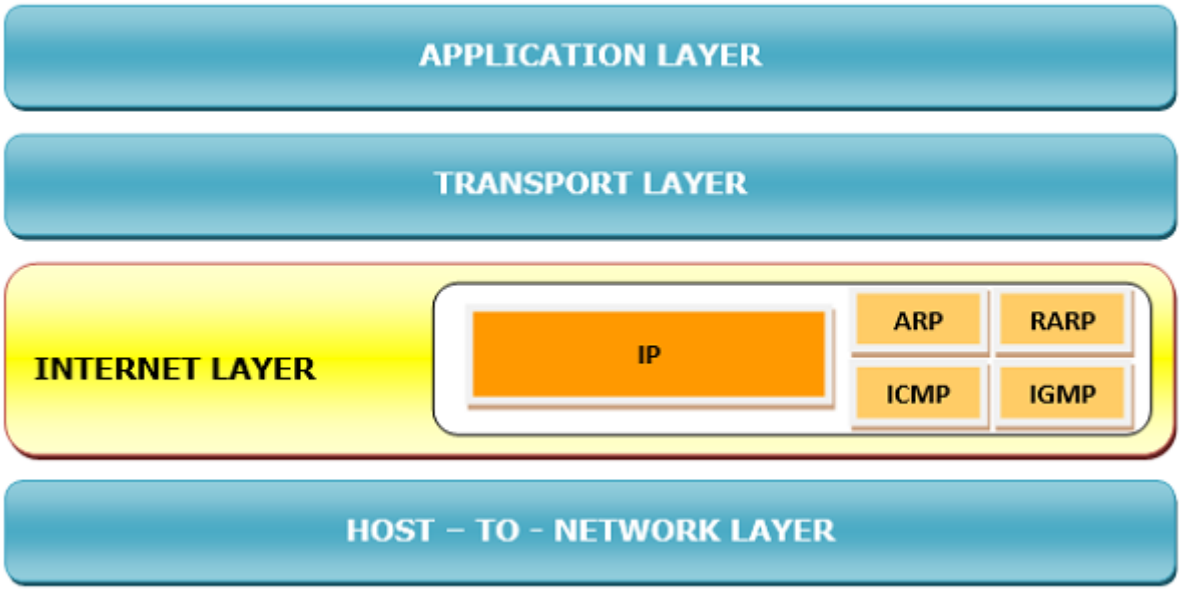
The SLIP and PPP protocol are used to provide the point-to-point serial communication between the two hosts. Since PPP is latter and advanced protocol, it offers several additional features along with just providing the point-to-point services.

Internet Layer Protocols

The protocols used in this layer are −

- **Internet Protocol, IP** − It is a connectionless and unreliable protocol that provides a best effort delivery service. It transports data packets called datagrams that travel over different routes across multiple nodes.
- **Address Resolution Protocol**, ARP −This protocol maps the logical address or the Internet address of a host to its physical address, as printed in the network interface card.
- **Reverse Address Resolution Protocol**, RARP − This is to find the Internet address of a host when its physical address is known.
- Internet Control Message Protocol, ICMP − It monitors sending the queries as well as the error messages.
- Internet Group Message Protocol, IGMP −It allows the transmission of a message to a group of recipients simultaneously.

The following diagram shows the network layer in the TCP/IP protocol suite −

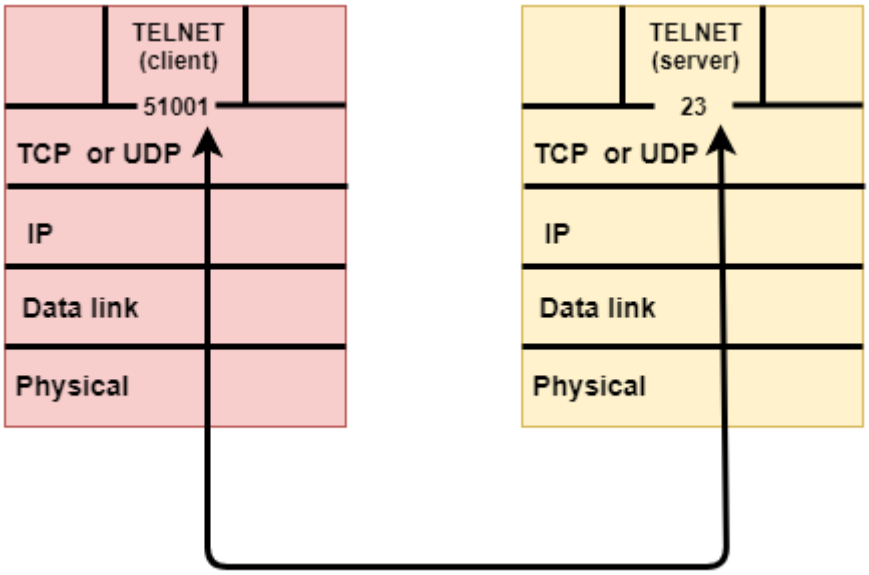


Transport Layer protocols

- The transport layer is represented by two protocols: TCP and UDP.
- The IP protocol in the network layer delivers a datagram from a source host to the destination host.
- Nowadays, the operating system supports multiuser and multiprocessing environments, an executing program is called a process. When a host sends a message to other host means that source process is sending a process to

a destination process. The transport layer protocols define some connections to individual ports known as protocol ports.

- An IP protocol is a host-to-host protocol used to deliver a packet from source host to the destination host while transport layer protocols are port-to-port protocols that work on the top of the IP protocols to deliver the packet from the originating port to the IP services, and from IP services to the destination port.
- Each port is defined by a positive integer address, and it is of 16 bits.

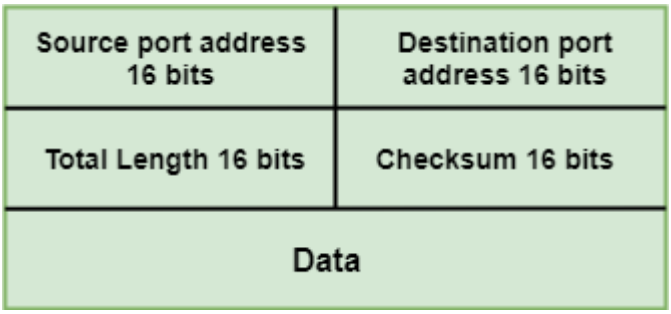


UDP

- UDP stands for User Datagram Protocol.
- UDP is a simple protocol and it provides no sequenced transport functionality.
- UDP is a connectionless protocol.
- This type of protocol is used when reliability and security are less important than speed and size.
- UDP is an end-to-end transport level protocol that adds transport-level addresses, checksum error control, and length information to the data from the upper layer.
- The packet produced by the UDP protocol is known as a user datagram.

User Datagram Format

The user datagram has a 16-byte header which is shown below:



Where,

- Source port address: It defines the address of the application process that has delivered a message. The source port address is of 16 bits address.
- Destination port address: It defines the address of the application process that will receive the message. The destination port address is of a 16-bit address.
- Total length: It defines the total length of the user datagram in bytes. It is a 16-bit field.
- Checksum: The checksum is a 16-bit field which is used in error detection.

Disadvantages of UDP protocol

- UDP provides basic functions needed for the end-to-end delivery of a transmission.
- It does not provide any sequencing or reordering functions and does not specify the damaged packet when reporting an error.
- UDP can discover that an error has occurred, but it does not specify which packet has been lost as it does not contain an ID or sequencing number of a particular data segment.

TCP

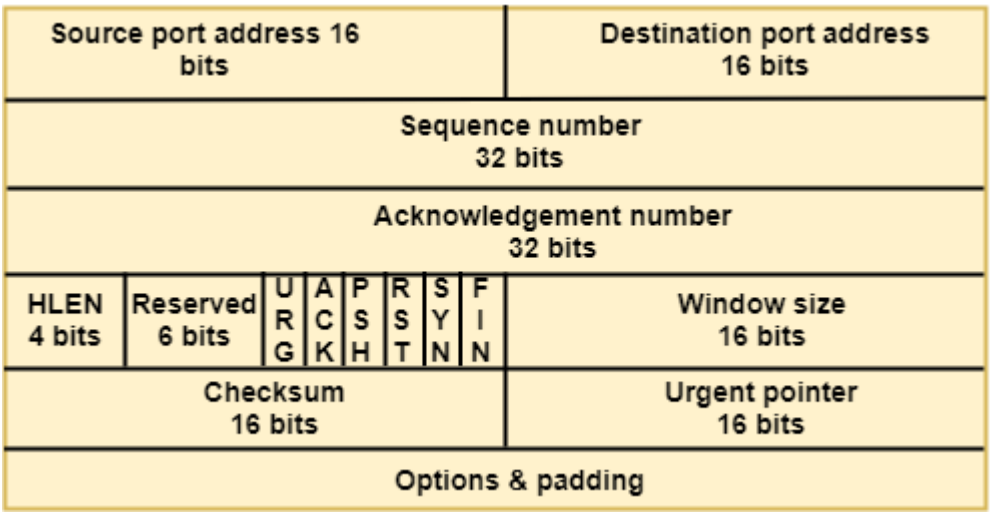
- TCP stands for Transmission Control Protocol.
- It provides full transport layer services to applications.
- It is a connection-oriented protocol means the connection established between both the ends of the transmission. For creating the connection,

TCP generates a virtual circuit between sender and receiver for the duration of a transmission.

Features Of TCP protocol

- Stream data transfer: TCP protocol transfers the data in the form of contiguous stream of bytes. TCP group the bytes in the form of TCP segments and then passed it to the IP layer for transmission to the destination. TCP itself segments the data and forward to the IP.
- Reliability: TCP assigns a sequence number to each byte transmitted and expects a positive acknowledgement from the receiving TCP. If ACK is not received within a timeout interval, then the data is retransmitted to the destination.
  The receiving TCP uses the sequence number to reassemble the segments if they arrive out of order or to eliminate the duplicate segments.
- Flow Control: When receiving TCP sends an acknowledgement back to the sender indicating the number the bytes it can receive without overflowing its internal buffer. The number of bytes is sent in ACK in the form of the highest sequence number that it can receive without any problem. This mechanism is also referred to as a window mechanism.
- Multiplexing: Multiplexing is a process of accepting the data from different applications and forwarding to the different applications on different computers. At the receiving end, the data is forwarded to the correct application. This process is known as demultiplexing. TCP transmits the packet to the correct application by using the logical channels known as ports.
- Logical Connections: The combination of sockets, sequence numbers, and window sizes, is called a logical connection. Each connection is identified by the pair of sockets used by sending and receiving processes.
- Full Duplex: TCP provides Full Duplex service, i.e., the data flow in both the directions at the same time. To achieve Full Duplex service, each TCP should have sending and receiving buffers so that the segments can flow in both the directions. TCP is a connection-oriented protocol. Suppose the process A wants to send and receive the data from process B. The following steps occur:
  - Establish a connection between two TCPs.
  - Data is exchanged in both the directions.
  - The Connection is terminated.

TCP Segment Format



Where,

- Source port address: It is used to define the address of the application program in a source computer. It is a 16-bit field.
- Destination port address: It is used to define the address of the application program in a destination computer. It is a 16-bit field.
- Sequence number: A stream of data is divided into two or more TCP segments. The 32-bit sequence number field represents the position of the data in an original data stream.
- Acknowledgement number: A 32-field acknowledgement number acknowledge the data from other communicating devices. If ACK field is set to 1, then it specifies the sequence number that the receiver is expecting to receive.
- Header Length (HLEN): It specifies the size of the TCP header in 32-bit words. The minimum size of the header is 5 words, and the maximum size of the header is 15 words. Therefore, the maximum size of the TCP header is 60 bytes, and the minimum size of the TCP header is 20 bytes.
- Reserved: It is a six-bit field which is reserved for future use.
- Control bits: Each bit of a control field functions individually and independently. A control bit defines the use of a segment or serves as a validity check for other fields.

There are total six types of flags in control field:

- URG: The URG field indicates that the data in a segment is urgent.
- ACK: When ACK field is set, then it validates the acknowledgement number.
- PSH: The PSH field is used to inform the sender that higher throughput is needed so if possible, data must be pushed with higher throughput.

- RST: The reset bit is used to reset the TCP connection when there is any confusion occurs in the sequence numbers.
- SYN: The SYN field is used to synchronize the sequence numbers in three types of segments: connection request, connection confirmation (with the ACK bit set), and confirmation acknowledgement.
- FIN: The FIN field is used to inform the receiving TCP module that the sender has finished sending data. It is used in connection termination in three types of segments: termination request, termination confirmation, and acknowledgement of termination confirmation.
    - Window Size: The window is a 16-bit field that defines the size of the window.
    - Checksum: The checksum is a 16-bit field used in error detection.
    - Urgent pointer: If URG flag is set to 1, then this 16-bit field is an offset from the sequence number indicating that it is a last urgent data byte.
    - Options and padding: It defines the optional fields that convey the additional information to the receiver.

Differences b/w TCP & UDP

Basis for Comparison	TCP	UDP
Definition	TCP establishes a virtual circuit before transmitting the data.	UDP transmits the data directly to the destination computer without verifying whether the receiver is ready to receive or not.
Connection Type	It is a Connection-Oriented protocol	It is a Connectionless protocol
Speed	slow	high
Reliability	It is a reliable protocol.	It is an unreliable protocol.
Header size	20 bytes	8 bytes
acknowledgement	It waits for the acknowledgement of	It neither takes the acknowledgement, nor

	data and has the ability to resend the lost packets.	it retransmits the damaged frame.

Application Layer

The application layer in the OSI model is the closest layer to the end user which means that the application layer and end user can interact directly with the software application. The application layer programs are based on client and servers.

The Application layer includes the following functions:

- Identifying communication partners: The application layer identifies the availability of communication partners for an application with data to transmit.
- Determining resource availability: The application layer determines whether sufficient network resources are available for the requested communication.
- Synchronizing communication: All the communications occur between the applications requires cooperation which is managed by an application layer.

Services of Application Layers

- Network Virtual terminal: An application layer allows a user to log on to a remote host. To do so, the application creates a software emulation of a terminal at the remote host. The user's computer talks to the software terminal, which in turn, talks to the host. The remote host thinks that it is communicating with one of its own terminals, so it allows the user to log on.
- File Transfer, Access, and Management (FTAM): An application allows a user to access files in a remote computer, to retrieve files from a computer and to manage files in a remote computer. FTAM defines a hierarchical virtual file in terms of file structure, file attributes and the kind of operations performed on the files and their attributes.
- Addressing: To obtain communication between client and server, there is a need for addressing. When a client made a request to the server, the request contains the server address and its own address. The server response to the client request, the request contains the destination address, i.e., client address. To achieve this kind of addressing, DNS is used.

- Mail Services: An application layer provides Email forwarding and storage.
- Directory Services: An application contains a distributed database that provides access for global information about various objects and services.

  Authentication: It authenticates the sender or receiver's message or both.

Network Application Architecture

Application architecture is different from the network architecture. The network architecture is fixed and provides a set of services to applications. The application architecture, on the other hand, is designed by the application developer and defines how the application should be structured over the various end systems.

Application architecture is of two types:

- Client-server architecture: An application program running on the local machine sends a request to another application program is known as a client, and a program that serves a request is known as a server. For example, when a web server receives a request from the client host, it responds to the request to the client host.

Characteristics Of Client-server architecture:

- In Client-server architecture, clients do not directly communicate with each other. For example, in a web application, two browsers do not directly communicate with each other.
- A server is fixed, well-known address known as IP address because the server is always on while the client can always contact the server by sending a packet to the sender's IP address.

Disadvantage Of Client-server architecture:

It is a single-server based architecture which is incapable of holding all the requests from the clients. For example, a social networking site can become overwhelmed when there is only one server exists.

- P2P (peer-to-peer) architecture: It has no dedicated server in a data center. The peers are the computers which are not owned by the service provider. Most of the peers reside in the homes, offices, schools, and universities. The peers communicate with each other without passing the information through a dedicated server, this architecture is known as peer-to-peer

architecture. The applications based on P2P architecture includes file sharing and internet telephony.

Features of P2P architecture

- Self scalability: In a file sharing system, although each peer generates a workload by requesting the files, each peer also adds a service capacity by distributing the files to the peer.
- Cost-effective: It is cost-effective as it does not require significant server infrastructure and server bandwidth.

Client and Server processes

- A network application consists of a pair of processes that send the messages to each other over a network.
- In P2P file-sharing system, a file is transferred from a process in one peer to a process in another peer. We label one of the two processes as the client and another process as the server.
- With P2P file sharing, the peer which is downloading the file is known as a client, and the peer which is uploading the file is known as a server. However, we have observed in some applications such as P2P file sharing; a process can be both as a client and server. Therefore, we can say that a process can both download and upload the files.

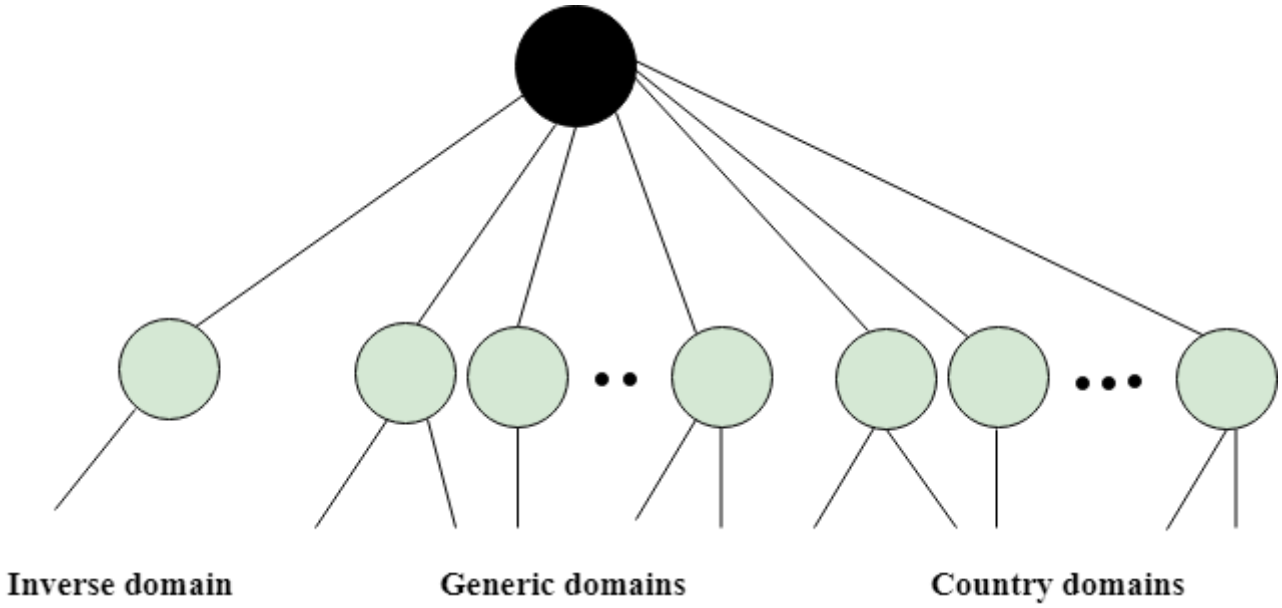
DNS

An application layer protocol defines how the application processes running on different systems, pass the messages to each other.

- 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.

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.

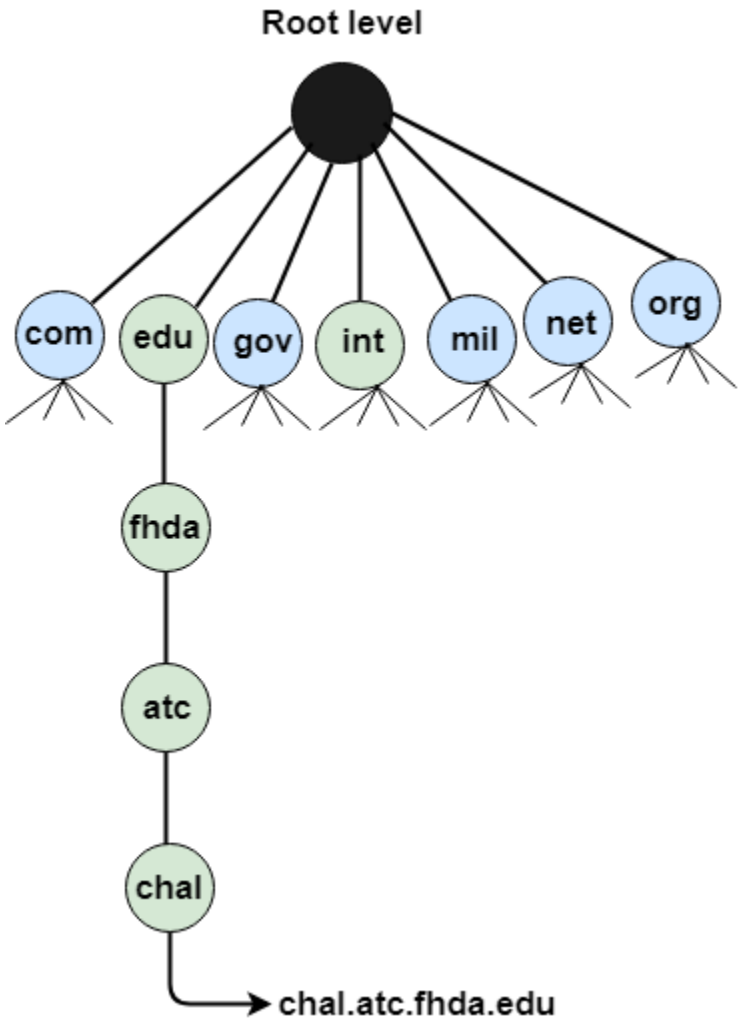


Generic Domains

- 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.

FTP

- FTP stands for File transfer protocol.
- FTP is a standard internet protocol provided by TCP/IP used for transmitting the files from one host to another.
- It is mainly used for transferring the web page files from their creator to the computer that acts as a server for other computers on the internet.
- It is also used for downloading the files to computer from other servers.

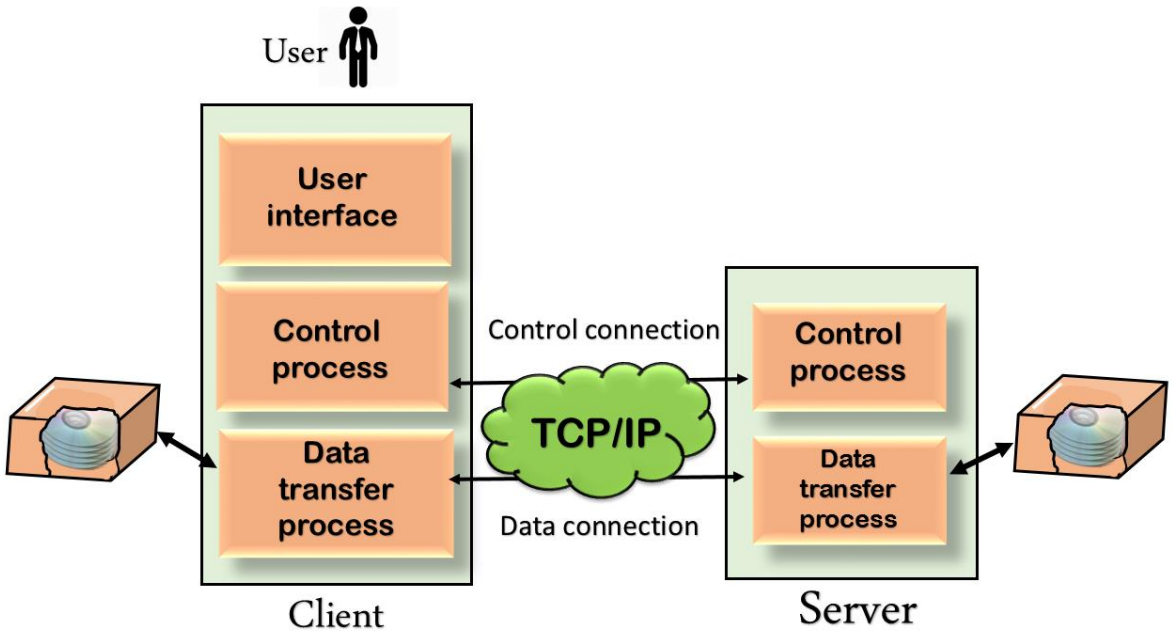
Objectives of FTP

- It provides the sharing of files.
- It is used to encourage the use of remote computers.
- It transfers the data more reliably and efficiently.

Why FTP?

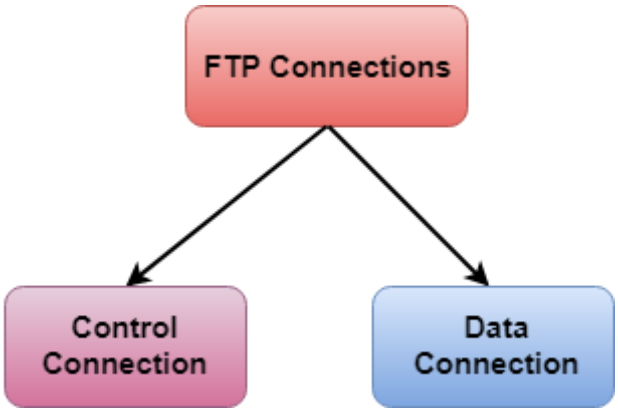
Although transferring files from one system to another is very simple and straightforward, but sometimes it can cause problems. For example, two systems may have different file conventions. Two systems may have different ways to represent text and data. Two systems may have different directory structures. FTP protocol overcomes these problems by establishing two connections between hosts. One connection is used for data transfer, and another connection is used for the control connection.

Mechanism of FTP



The above figure shows the basic model of the FTP. The FTP client has three components: the user interface, control process, and data transfer process. The server has two components: the server control process and the server data transfer process.

There are two types of connections in FTP:



- Control Connection: The control connection uses very simple rules for communication. Through control connection, we can transfer a line of command or line of response at a time. The control connection is made between the control processes. The control connection remains connected during the entire interactive FTP session.
- Data Connection: The Data Connection uses very complex rules as data types may vary. The data connection is made between data transfer processes. The data connection opens when a command comes for transferring the files and closes when the file is transferred.

FTP Clients

- FTP client is a program that implements a file transfer protocol which allows you to transfer files between two hosts on the internet.
- It allows a user to connect to a remote host and upload or download the files.
- It has a set of commands that we can use to connect to a host, transfer the files between you and your host and close the connection.
- The FTP program is also available as a built-in component in a Web browser. This GUI based FTP client makes the file transfer very easy and also does not require to remember the FTP commands.

Advantages of FTP:

- Speed: One of the biggest advantages of FTP is speed. The FTP is one of the fastest way to transfer the files from one computer to another computer.
- Efficient: It is more efficient as we do not need to complete all the operations to get the entire file.
- Security: To access the FTP server, we need to login with the username and password. Therefore, we can say that FTP is more secure.
- Back & forth movement: FTP allows us to transfer the files back and forth. Suppose you are a manager of the company, you send some information to all the employees, and they all send information back on the same server.

Disadvantages of FTP:

- The standard requirement of the industry is that all the FTP transmissions should be encrypted. However, not all the FTP providers are equal and not all the providers offer encryption. So, we will have to look out for the FTP providers that provides encryption.
- FTP serves two operations, i.e., to send and receive large files on a network. However, the size limit of the file is 2GB that can be sent. It also doesn't allow you to run simultaneous transfers to multiple receivers.
- Passwords and file contents are sent in clear text that allows unwanted eavesdropping. So, it is quite possible that attackers can carry out the brute force attack by trying to guess the FTP password.
- It is not compatible with every system.

Telnet

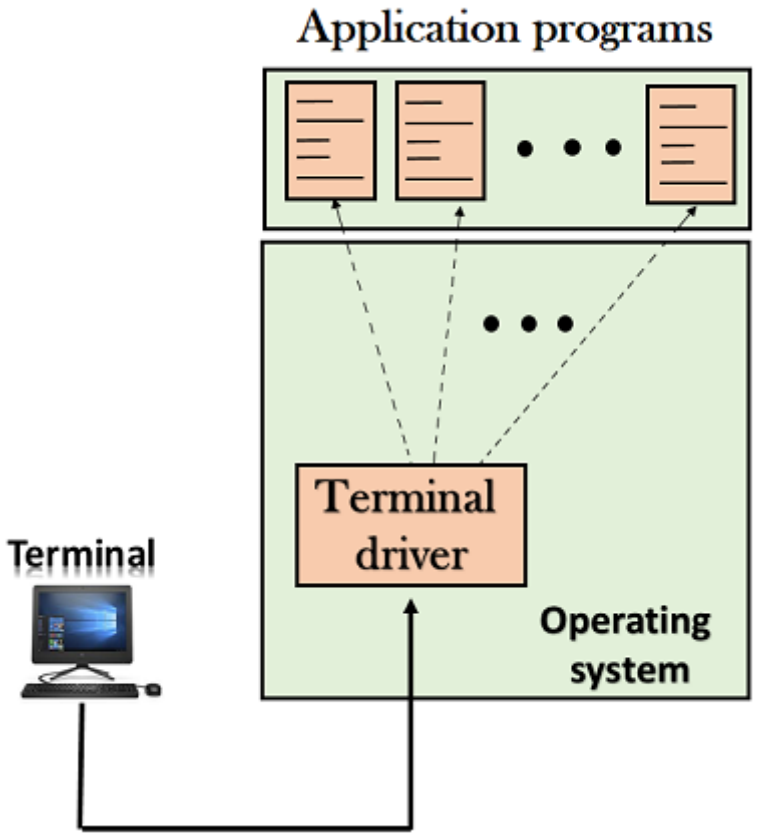
- The main task of the internet is to provide services to users. For example, users want to run different application programs at the remote site and

transfers a result to the local site. This requires a client-server program such as FTP, SMTP. But this would not allow us to create a specific program for each demand.

- The better solution is to provide a general client-server program that lets the user access any application program on a remote computer. Therefore, a program that allows a user to log on to a remote computer. A popular client-server program Telnet is used to meet such demands. Telnet is an abbreviation for Terminal Network.
- Telnet provides a connection to the remote computer in such a way that a local terminal appears to be at the remote side.

There are two types of login:

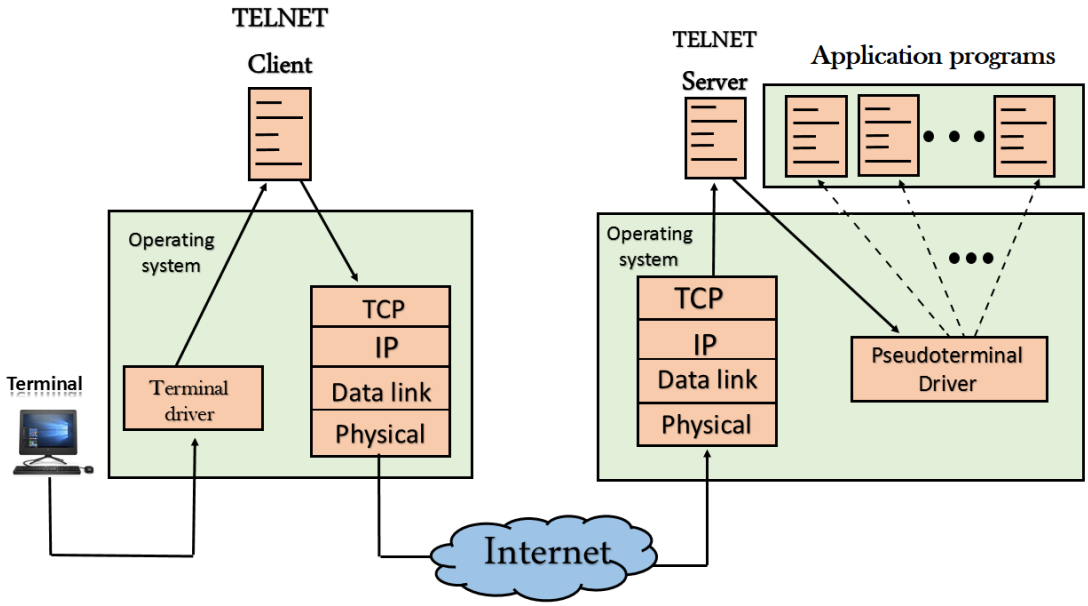
Local Login



- When a user logs into a local computer, then it is known as local login.
- When the workstation running terminal emulator, the keystrokes entered by the user are accepted by the terminal driver. The terminal driver then passes these characters to the operating system which in turn, invokes the desired application program.

- However, the operating system has special meaning to special characters. For example, in UNIX some combination of characters have special meanings such as control character with "z" means suspend. Such situations do not create any problem as the terminal driver knows the meaning of such characters. But, it can cause the problems in remote login.

Remote login



- When the user wants to access an application program on a remote computer, then the user must perform remote login.

How remote login occurs

At the local site

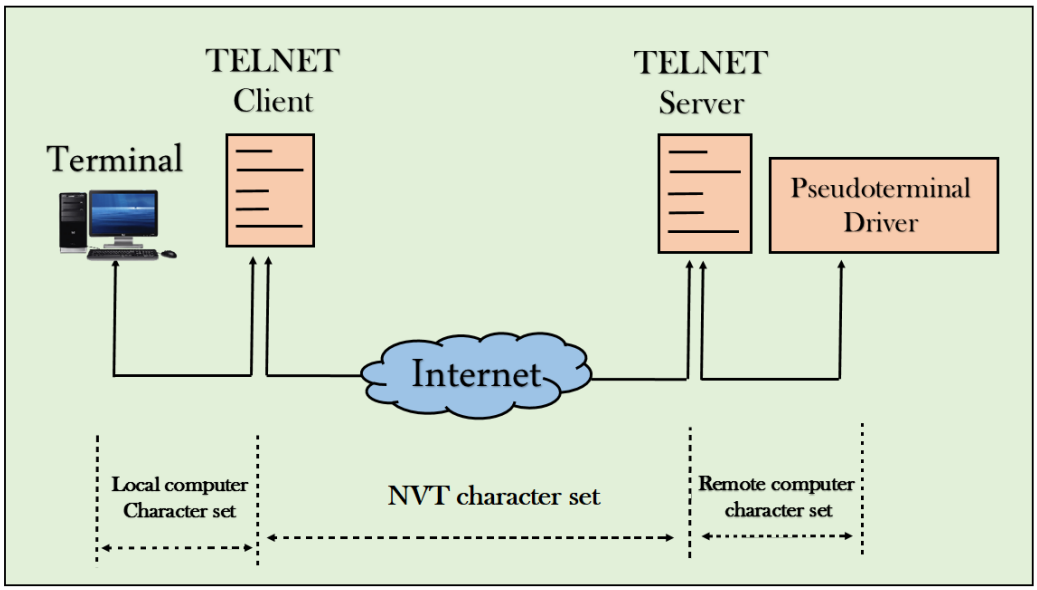
The user sends the keystrokes to the terminal driver, the characters are then sent to the TELNET client. The TELNET client which in turn, transforms the characters to a universal character set known as network virtual terminal characters and delivers them to the local TCP/IP stack

At the remote site

The commands in NVT forms are transmitted to the TCP/IP at the remote machine. Here, the characters are delivered to the operating system and then pass to the TELNET server. The TELNET server transforms the characters which can be understandable by a remote computer. However, the characters cannot be directly passed to the operating system as a remote operating system does not receive the characters from the TELNET server.

Therefore it requires some piece of software that can accept the characters from the TELNET server. The operating system then passes these characters to the appropriate application program.

Network Virtual Terminal (NVT)



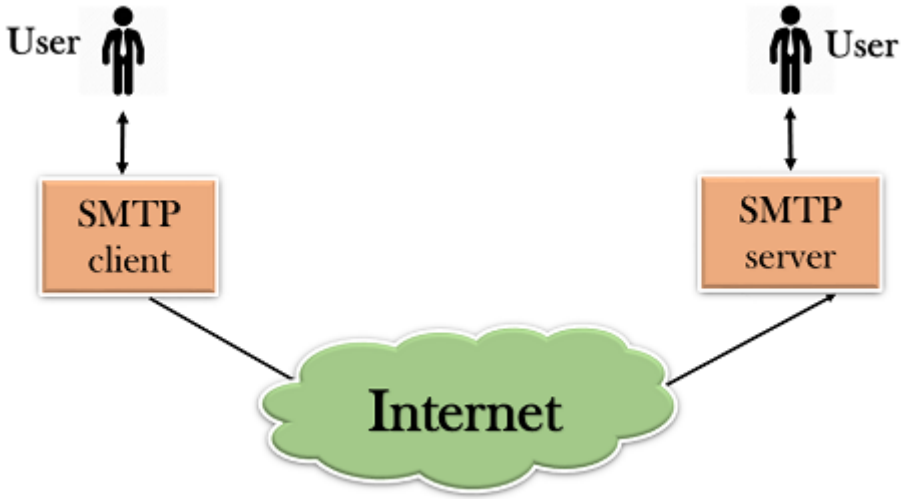
- The network virtual terminal is an interface that defines how data and commands are sent across the network.
- In today's world, systems are heterogeneous. For example, the operating system accepts a special combination of characters such as end-of-file token running a DOS operating system *ctrl+z* while the token running a UNIX operating system is *ctrl+d*.
- TELNET solves this issue by defining a universal interface known as network virtual interface.
- The TELNET client translates the characters that come from the local terminal into NVT form and then delivers them to the network. The Telnet server then translates the data from NVT form into a form which can be understandable by a remote computer.

SMTP

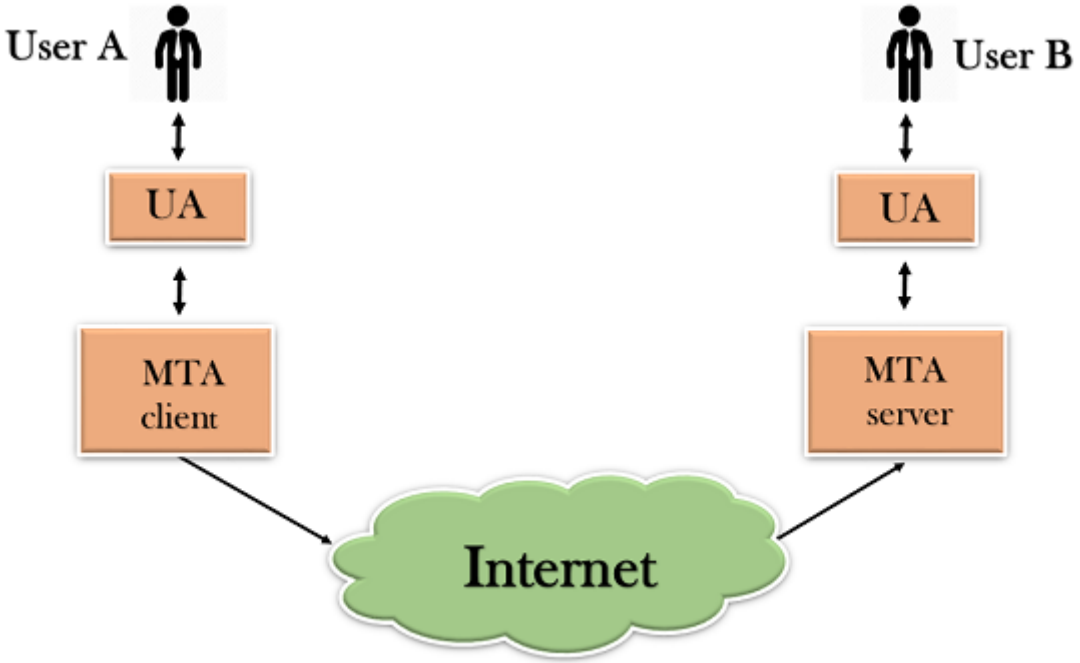
- SMTP stands for Simple Mail Transfer Protocol.
- SMTP is a set of communication guidelines that allow software to transmit an electronic mail over the internet is called Simple Mail Transfer Protocol.
- It is a program used for sending messages to other computer users based on e-mail addresses.

- 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.

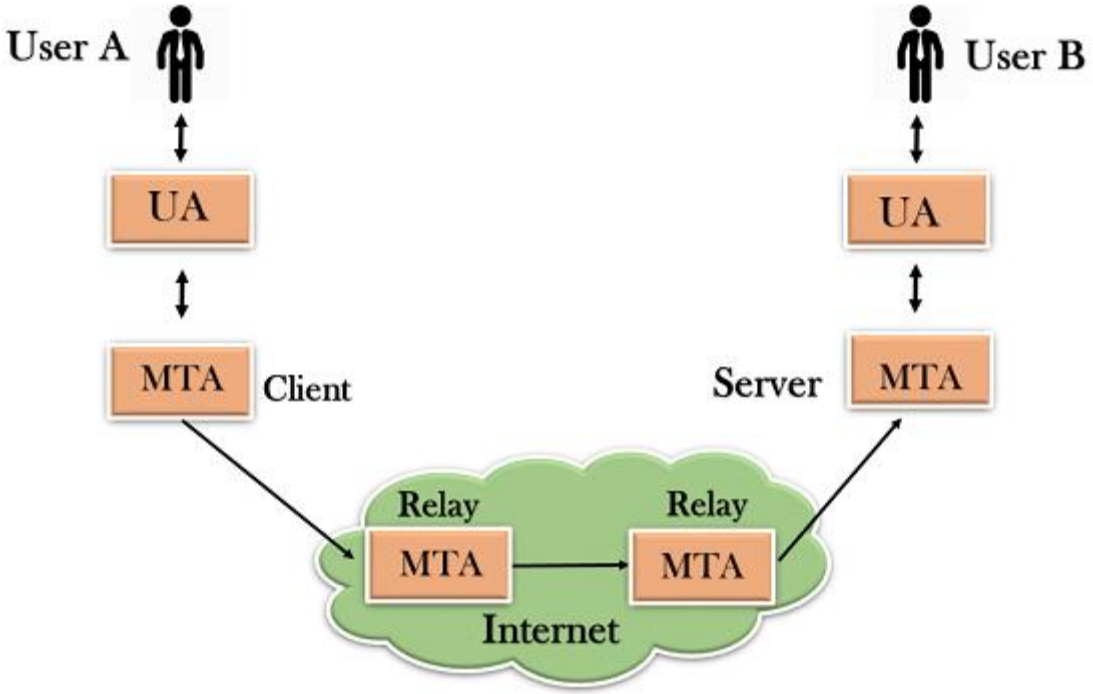
Components of SMTP



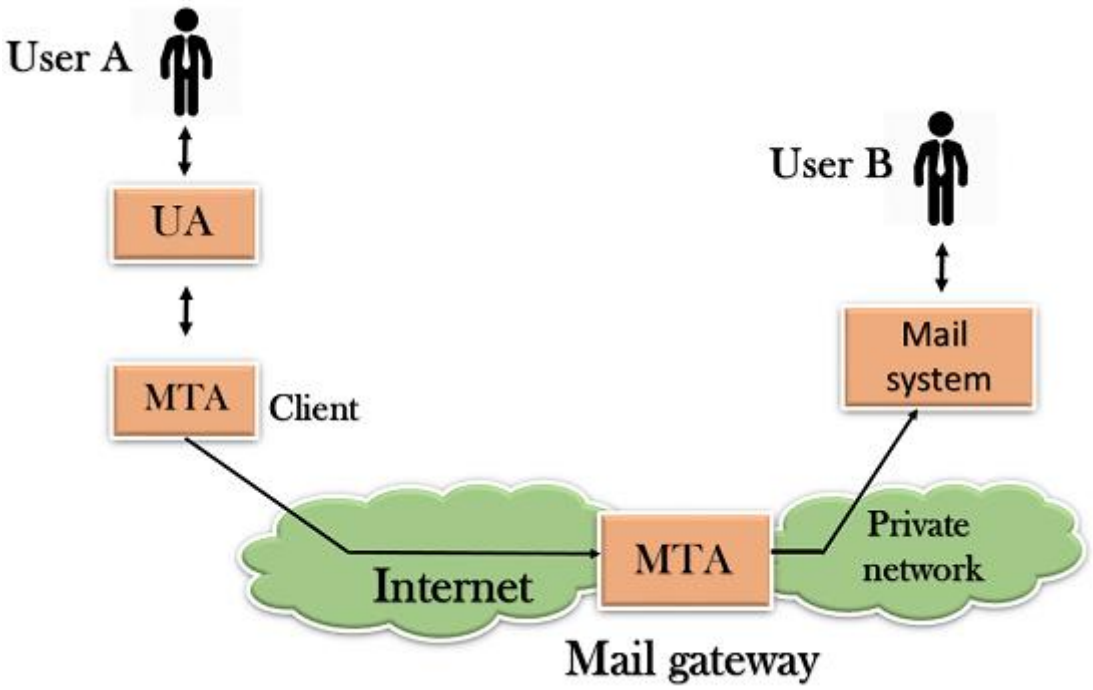
- First, we will break the SMTP client and SMTP server into two components such as user agent (UA) and mail transfer agent (MTA). The user agent (UA) prepares the message, creates the envelope and then puts the message in the envelope. The mail transfer agent (MTA) transfers this mail across the internet.



- SMTP allows a more complex system by adding a relaying system. Instead of just having one MTA at sending side and one at receiving side, more MTAs can be added, acting either as a client or server to relay the email.



- The relaying system without TCP/IP protocol can also be used to send the emails to users, and this is achieved by the use of the mail gateway. The mail gateway is a relay MTA that can be used to receive an email.



Working of SMTP

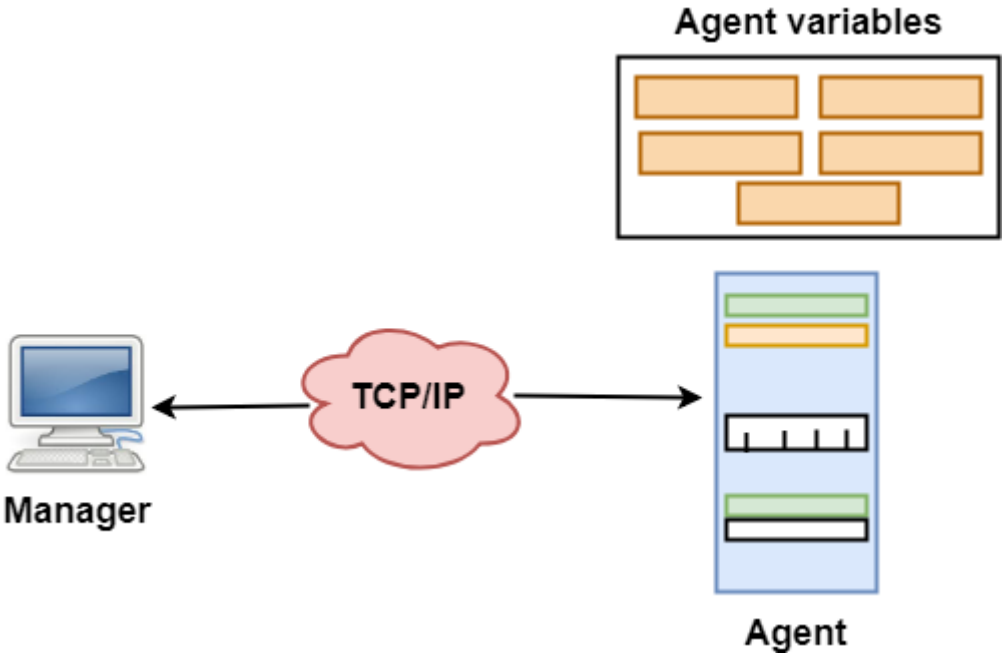
1. Composition of Mail: A user sends an e-mail by composing an electronic mail message using a Mail User Agent (MUA). Mail User Agent is a program which is used to send and receive mail. The message contains two parts: body and header. The body is the main part of the message while the header includes 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.

SNMP

- SNMP stands for Simple Network Management Protocol.
- SNMP is a framework used for managing devices on the internet.
- It provides a set of operations for monitoring and managing the internet.

SNMP Concept



- SNMP has two components Manager and agent.
- The manager is a host that controls and monitors a set of agents such as routers.
- It is an application layer protocol in which a few manager stations can handle a set of agents.
- The protocol designed at the application level can monitor the devices made by different manufacturers and installed on different physical networks.
- It is used in a heterogeneous network made of different LANs and WANs connected by routers or gateways.

Managers & Agents

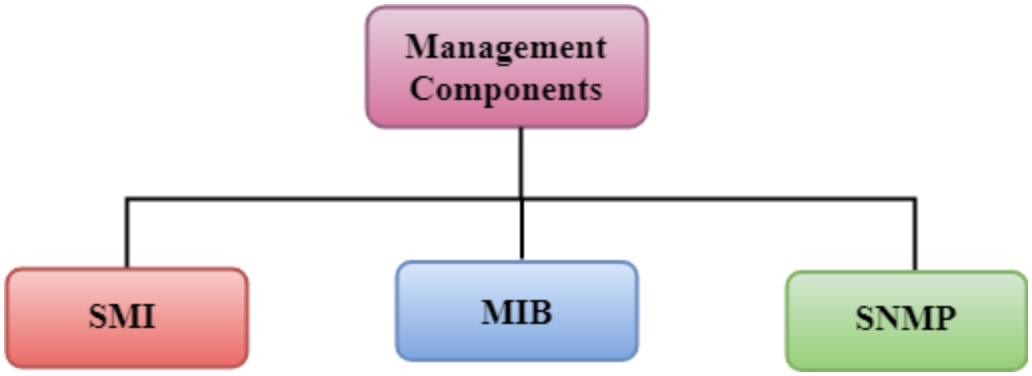
- A manager is a host that runs the SNMP client program while the agent is a router that runs the SNMP server program.
- Management of the internet is achieved through simple interaction between a manager and agent.
- The agent is used to keep the information in a database while the manager is used to access the values in the database. For example, a router can store the appropriate variables such as a number of packets received and forwarded while the manager can compare these variables to determine whether the router is congested or not.
- Agents can also contribute to the management process. A server program on the agent checks the environment, if something goes wrong, the agent sends a warning message to the manager.

Management with SNMP has three basic ideas:

- A manager checks the agent by requesting the information that reflects the behavior of the agent.
- A manager also forces the agent to perform a certain function by resetting values in the agent database.
- An agent also contributes to the management process by warning the manager regarding an unusual condition.

Management Components

- Management is not achieved only through the SNMP protocol but also the use of other protocols that can cooperate with the SNMP protocol. Management is achieved through the use of the other two protocols: SMI (Structure of management information) and MIB(management information base).
- Management is a combination of SMI, MIB, and SNMP. All these three protocols such as abstract syntax notation 1 (ASN.1) and basic encoding rules (BER).

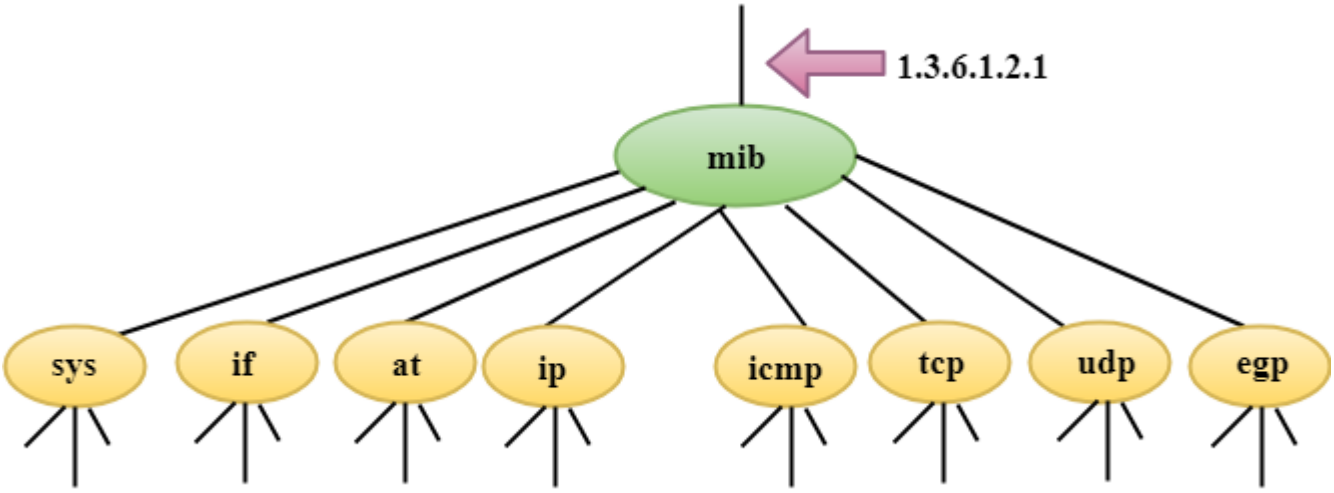


SMI

The SMI (Structure of management information) is a component used in network management. Its main function is to define the type of data that can be stored in an object and to show how to encode the data for the transmission over a network.

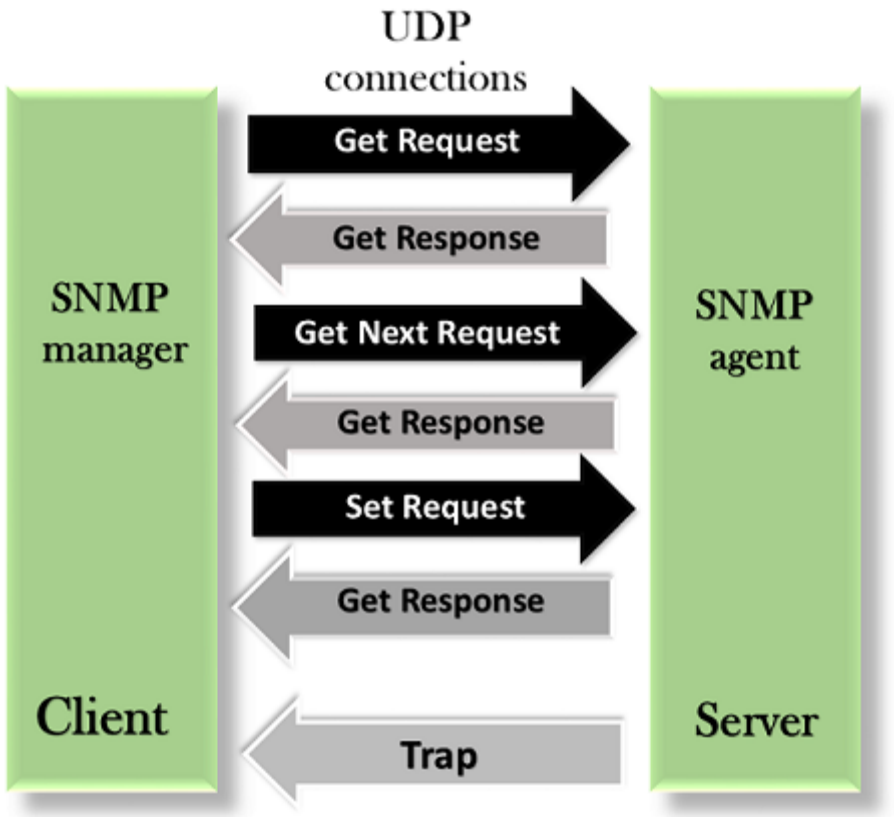
MIB

- The MIB (Management information base) is a second component for the network management.
- Each agent has its own MIB, which is a collection of all the objects that the manager can manage. MIB is categorized into eight groups: system, interface, address translation, ip, icmp, tcp, udp, and egp. These groups are under the mib object.



SNMP

SNMP defines five types of messages: GetRequest, GetNextRequest, SetRequest, GetResponse, and Trap.



GetRequest: The GetRequest message is sent from a manager (client) to the agent (server) to retrieve the value of a variable.

GetNextRequest: The GetNextRequest message is sent from the manager to agent to retrieve the value of a variable. This type of message is used to retrieve the values of the entries in a table. If the manager does not know the indexes of the entries, then it will not be able to retrieve the values. In such situations, GetNextRequest message is used to define an object.

GetResponse: The GetResponse message is sent from an agent to the manager in response to the GetRequest and GetNextRequest message. This message contains the value of a variable requested by the manager.

SetRequest: The SetRequest message is sent from a manager to the agent to set a value in a variable.

Trap: The Trap message is sent from an agent to the manager to report an event. For example, if the agent is rebooted, then it informs the manager as well as sends the time of rebooting.

HTTP

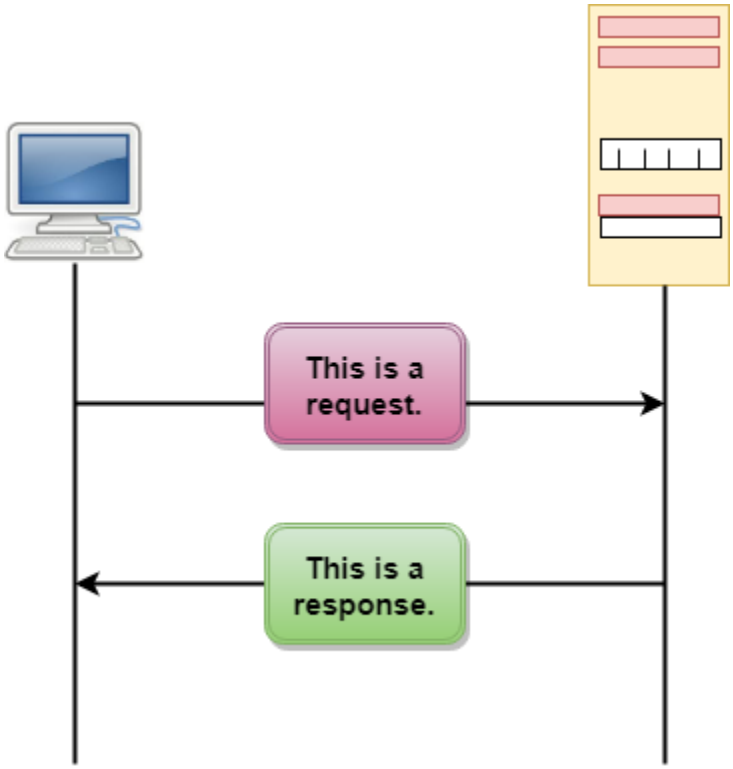
- HTTP stands for HyperText Transfer Protocol.

- 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.

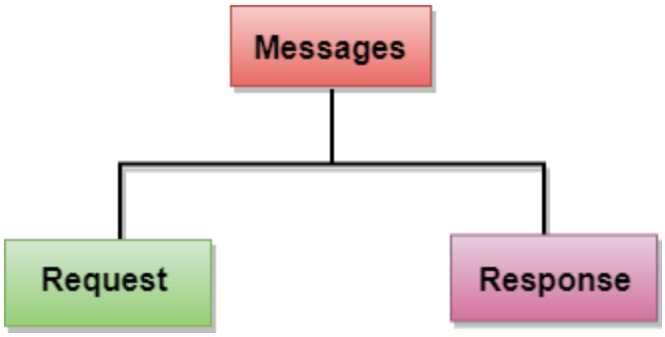
HTTP Transactions



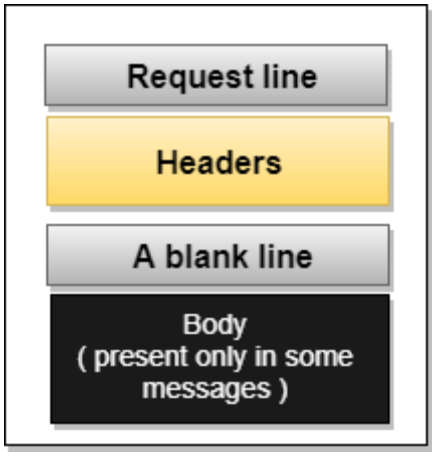
The above figure shows the HTTP transaction between client and server. The client initiates a transaction by sending a request message to the server. The server replies to the request message by sending a response message.

Messages

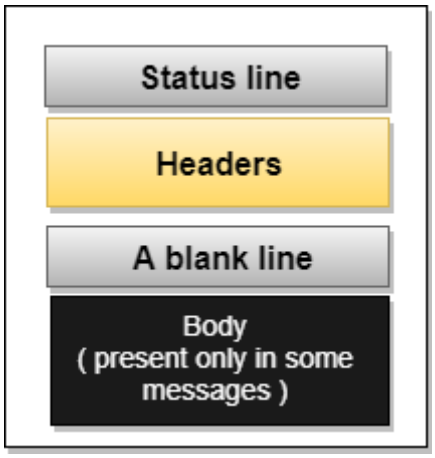
HTTP messages are of two types: request and response. Both the message types follow the same message format.



Request Message: The request message is sent by the client that consists of a request line, headers, and sometimes a body.



Response Message: The response message is sent by the server to the client that consists of a status line, headers, and sometimes a body.



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.