Transmission Control Protocol (TCP)

TCP is a connection oriented protocol and offers end-to-end packet delivery. It acts as back bone for connection.It exhibits the following key features:

- Transmission Control Protocol (TCP) corresponds to the Transport Layer of OSI Model.
- TCP is a reliable and connection oriented protocol.
- TCP offers:
  - Stream Data Transfer.
  - Reliability.
  - Efficient Flow Control
  - Full-duplex operation.
  - Multiplexing.
- TCP offers connection oriented end-to-end packet delivery.
- TCP ensures reliability by sequencing bytes with a forwarding acknowledgement number that indicates to the destination the next byte the source expect to receive.
- It retransmits the bytes not acknowledged with in specified time period.

TCP Services

TCP offers following services to the processes at the application layer:

- Stream Delivery Service
- Sending and Receiving Buffers
- Bytes and Segments
- Full Duplex Service
- Connection Oriented Service
- Reliable Service

Stream Deliver Service

TCP protocol is stream oriented because it allows the sending process to send data as stream of bytes and the receiving process to obtain data as stream of bytes.

Sending and Receiving Buffers

It may not be possible for sending and receiving process to produce and obtain data at same speed, therefore, TCP needs buffers for storage at sending and receiving ends.

Bytes and Segments

The Transmission Control Protocol (TCP), at transport layer groups the bytes into a packet. This packet is called segment. Before transmission of these packets, these segments are encapsulated into an IP datagram.

Full Duplex Service

Transmitting the data in duplex mode means flow of data in both the directions at the same time.

Connection Oriented Service

TCP offers connection oriented service in the following manner:

1. TCP of process-1 informs TCP of process – 2 and gets its approval.
2. TCP of process – 1 and TCP of process – 2 and exchange data in both the two directions.
3. After completing the data exchange, when buffers on both sides are empty, the two TCP's destroy their buffers.

Reliable Service

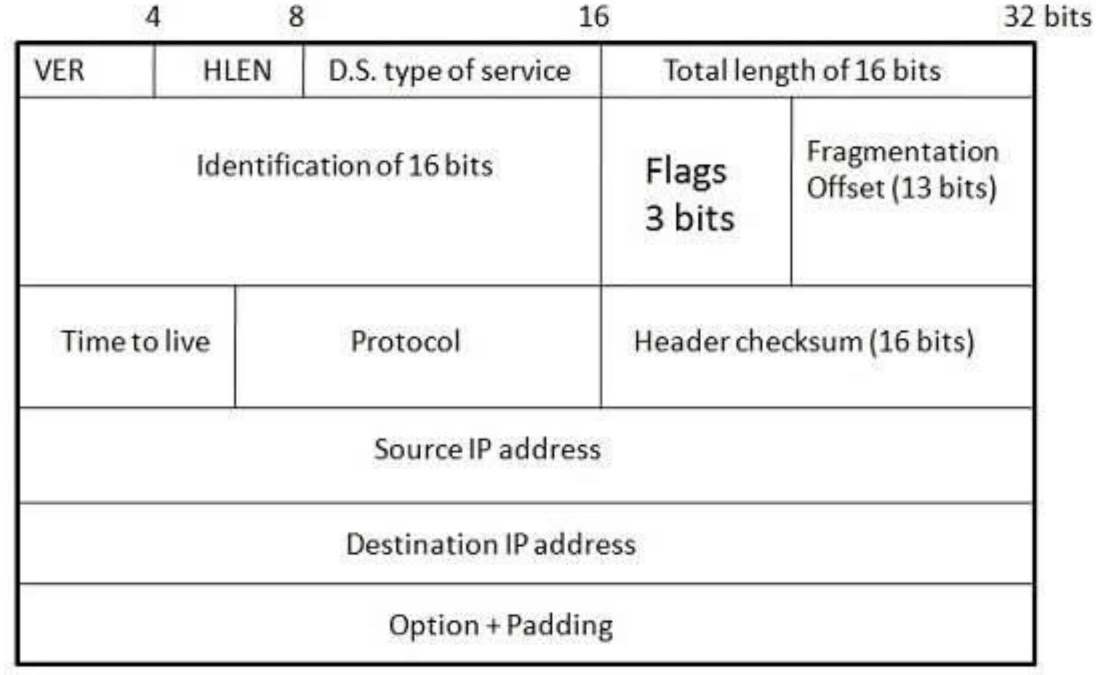
For sake of reliability, TCP uses acknowledgement mechanism.

Internet Protocol (IP)

Internet Protocol is **connectionless** and **unreliable** protocol. It ensures no guarantee of successfully transmission of data.

In order to make it reliable, it must be paired with reliable protocol such as TCP at the transport layer.

Internet protocol transmits the data in form of a datagram as shown in the following diagram:



<table>
<tr><td></td><td>4</td><td></td><td>8</td><td>16</td><td>32 bits</td></tr>
<tr><td>VER</td><td colspan="2">HLEN</td><td>D.S. type of service</td><td colspan="2">Total length of 16 bits</td></tr>
<tr><td colspan="4">Identification of 16 bits</td><td>Flags
3 bits</td><td>Fragmentation Offset (13 bits)</td></tr>
<tr><td colspan="2">Time to live</td><td colspan="2">Protocol</td><td colspan="2">Header checksum (16 bits)</td></tr>
<tr><td colspan="6">Source IP address</td></tr>
<tr><td colspan="6">Destination IP address</td></tr>
<tr><td colspan="6">Option + Padding</td></tr>
</table>

Points to remember:

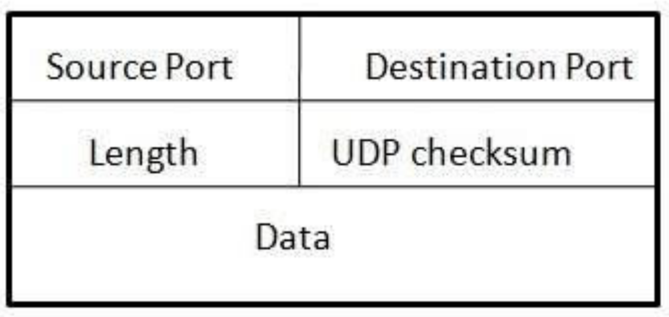
- The length of datagram is variable.
- The Datagram is divided into two parts: **header** and **data.**
- The length of header is 20 to 60 bytes.

- The header contains information for routing and delivery of the packet.

User Datagram Protocol (UDP)

Like IP, UDP is connectionless and unreliable protocol. It doesn't require making a connection with the host to exchange data. Since UDP is unreliable protocol, there is no mechanism for ensuring that data sent is received.

UDP transmits the data in form of a datagram. The UDP datagram consists of five parts as shown in the following diagram:



Source Port	Destination Port
Length	UDP checksum
Data	

Points to remember:

- UDP is used by the application that typically transmit small amount of data at one time.
- UDP provides protocol port used i.e. UDP message contains both source and destination port number, that makes it possible for UDP software at the destination to deliver the message to correct application program.

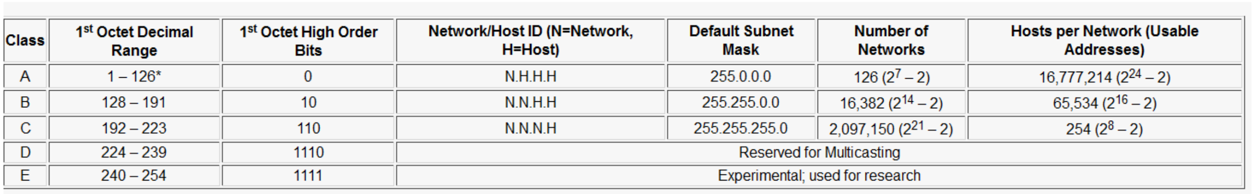
IP Addressing:

IP addresses:

- Configured, or learned dynamically
- Like a postal mailing address
- Hierarchical name space of 32 bits (e.g., 12.178.66.9)
- Not portable, and depends on where the host is attached
- Used to get a packet to destination IP subnet

An **Internet Protocol address** (**IP address**) is a numerical label assigned to each device (e.g., computer, printer) participating in a computer network that uses the Internet Protocol for communication. An IP address serves two principal functions: host or network interface identification and location addressing.

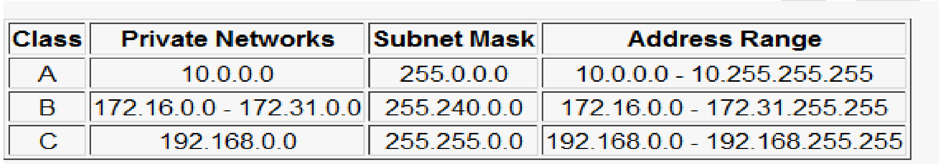
IP address classes:



Class	1st Octet Decimal Range	1st Octet High Order Bits	Network/Host ID (N=Network, H=Host)	Default Subnet Mask	Number of Networks	Hosts per Network (Usable Addresses)
A	1 – 126*	0	N.H.H.H	255.0.0.0	126 (2^7 – 2)	16,777,214 (2^{24} – 2)
B	128 – 191	10	N.N.H.H	255.255.0.0	16,382 (2^{14} – 2)	65,534 (2^{16} – 2)
C	192 – 223	110	N.N.N.H	255.255.255.0	2,097,150 (2^{21} – 2)	254 (2^8 – 2)
D	224 – 239	1110	Reserved for Multicasting			
E	240 – 254	1111	Experimental; used for research			

Note: Class A addresses 127.0.0.0 to 127.255.255.255 cannot be used and is reserved for loopback and diagnostic functions.

Private IP Address:



Class	Private Networks	Subnet Mask	Address Range
A	10.0.0.0	255.0.0.0	10.0.0.0 - 10.255.255.255
B	172.16.0.0 - 172.31.0.0	255.240.0.0	172.16.0.0 - 172.31.255.255
C	192.168.0.0	255.255.0.0	192.168.0.0 - 192.168.255.255

Sub Mask and Subnet Addressing:

Subnet mask is a mask used to determine what subnet an IP address belongs to. An IP address has two components, the network address and the host address. For example, consider the IP address **150.215.017.009**. Assuming this is part of a Class B network, the first two numbers (**150.215**) represent the Class B network address, and the second two numbers (**017.009**) identify a particular host on this network.

Subnetting enables the network administrator to further divide the host part of the address into two or more subnets. In this case, a part of the host address is reserved to identify the particular subnet. This is easier to see if we show the IP address in binary format.

Subnet addressing allows us to split one IP network address into smaller multiple physical networks known as subnetworks. Some of the node numbers are used as a subnet number instead. A Class B address gives us 16 bits of node numbers translating to 64,000 nodes. Most organizations do not use 64,000 nodes, so there are free bits that can be reassigned. Subnet addressing makes use of those bits that are free, as shown below.

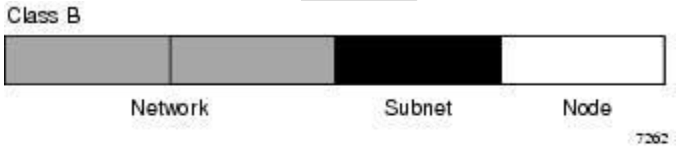


Figure 2-2

A Class B address can be effectively translated into multiple Class C addresses. For example, the IP address of 172.16.0.0 is assigned, but node addresses are limited to 255 maximum, allowing eight extra bits to use as a subnet address. The IP address of 172.16.97.235 would be interpreted as IP network address 172.16, subnet number 97, and node number 235. In addition to extending the number of addresses available, subnet addressing provides other benefits. Subnet addressing allows a network manager to construct an address scheme for the network by using different subnets for other geographical locations in the network or for other departments in the organization.

Although the preceding example uses the entire third octet for a subnet address, note that you are not restricted to octet boundaries in subnetting. To create more network numbers, you need only shift some bits from the host address to the network address. For instance, to partition a Class C network number (192.68.135.0) into two, you shift one bit from the host address to the network address. The new net mask (or subnet mask) is 255.255.255.128. The first subnet has network number 192.68.135.0 with hosts 192.68.135.1 to 129.68.135.126, and the second subnet has network number 192.68.135.128 with hosts 192.68.135.129 to 192.68.135.254.

Note: The number 192.68.135.127 is not assigned because it is the broadcast address of the first subnet. The number 192.68.135.128 is not assigned because it is the network address of the second subnet.

The full address is:

10010110.11010111.00010001.00001001

The Class B network part is:

10010110.11010111

The host address is:

00010001.00001001

If this network is divided into 14 subnets, however, then the first 4 bits of the host address (0001) are reserved for identifying the subnet.

The subnet mask is the network address plus the bits reserved for identifying the subnetwork -- by convention, the bits for the network address are all set to 1, though it would also work if the bits were set exactly as in the network address. In this case, therefore, the subnet mask would be 11111111.11111111.11110000.00000000. It's called a *mask* because it can be used to identify the subnet to which an IP address belongs by performing a bitwise AND operation on the mask and the IP address. The result is the subnetwork address:

Subnet Mask	255.255.240.000	11111111.11111111.11110000.00000000
IP Address	150.215.017.009	10010110.11010111.00010001.00001001
Subnet Address	150.215.016.000	10010110.11010111.00010000.00000000

The subnet address, therefore, is 150.215.016.000.

Internet Control Protocols:

In computer networking, **Internet Protocol Control Protocol** (IPCP) is a Network **Control Protocol** (NCP) for establishing and configuring **Internet Protocol** over a Point-to-Point **Protocol** link.

Address Resolution Protocol

If a machine talks to another machine in the same network, it requires its physical or MAC address. But ,since the application has given the destination's IP address it requires some mechanism to bind the IP address with its MAC address. This is done through Address Resolution protocol (ARP).IP address of the destination node is broadcast and the destination node informs the source of its MAC address.

1. Assume broadcast nature of LAN
2. Broadcast IP address of the destination
3. Destination replies it with its MAC address.
4. Source maintains a cache of IP and MAC address bindings

But this means that every time machine A wants to send packets to machine B, A has to send an ARP packet to resolve the MAC address of B and hence this will increase the traffic load too much, so to reduce the communication cost computers that use ARP maintains a cache of recently acquired IP_to_MAC address bindings, i.e. they don't have to use ARP repeatedly. ARP Refinements Several refinements of ARP are possible: When machine A wants to send packets to machine B, it is possible that machine B is going to send packets to machine A in the near future. So to avoid ARP for machine B, A should put its IP_to_MAC address binding in the special packet while requesting for the MAC address of B. Since A broadcasts its initial request for the MAC address of B, every machine on the network should extract and store in its cache the IP_to_MAC address binding of A When a new machine appears on the network (e.g. when an operating system reboots) it can broadcast its IP_to_MAC address binding so that all other machines can store it in their caches. This will eliminate a lot of ARP packets by all other machines, when they want to communicate with this new machine.

Example displaying the use of Address Resolution Protocol:

Consider a scenario where a computer tries to contact some remote machine using ping program, assuming that there has been no exchange of IP datagrams previously between the two machines and therefore arp packet must be sent to identify the MAC address of the remote machine.
The arp request message (who is A.A.A.A tell B.B.B.B where the two are IP addresses) is broadcast on the local area network with an Ethernet protocol type 0x806. The packet is discarded by all the machines except the target machine which responds with an arp response message (A.A.A.A is hh:hh:hh:hh:hh:hh where hh:hh:hh:hh:hh:hh is the Ethernet source address). This packet is unicast to the machine with IP address B.B.B.B. Since the arp request message included the hardware address (Ethernet source address) of the requesting computer, target machine doesn't require another arp message to figure it out.

Reverse Address Resolution Protocol

RARP is a protocol by which a physical machine in a local area network can request to learn its IP address from a gateway server's Address Resolution Protocol table or cache. This is needed since the machine may not have permanently attacded disk where it can store its IP address permanently. A network administrator creates a table in a local area network's gateway router that maps the physical machine (or Medium Access Control - MAC) addresses to corresponding Internet Protocol addresses. When a new machine is set up, its RARP client program requests from the RARP server on the router to be sent its IP address. Assuming that an entry has been set up in the router table, the RARP server will return the IP address to the machine which can store it for future use.

Request:

Like an ARP message, a RARP message is sent from one machine to the another encapsulated in the data portion of a network frame. An ethernet frame carrying a RARP request has the usual preamle, Ethernet source and destination addresses, and packet type fields in front of the frame. The frame conatins the value 8035 (base 16) to identify the contents of the frame as a RARP message. The data portion of the frame contains the 28-octet RARP message. The sender braodcasts a RARP request that specifies itself as both the sender and target machine, and supplies its physical network address in the target hardware address field. All machines on the network receive the request, but only those authorised to supply the RARP services process the request and send a reply, such machines are known informally as RARP servers. For RARP to succeed, the network must contain at least one RARP server.

Reply:

Servers answers request by filling in the target protocol address field, changing the message type from request to reply, and sending the reply back directly to the machine making the request.

Drawbacks of RARP

- Since it operates at low level, it requires direct addresss to the network which makes it difficult for an application programmer to build a server.
- It doesn't fully utilizes the capability of a network like ethernet which is enforced to send a minimum packet size since the reply from the server contains only one small piece of information, the 32-bit internet address.

RARP is formally described in RFC903.

ICMP

This protocol discusses a mechanism that gateways and hosts use to communicate control or error information.The Internet protocol provides unreliable,connectionless datagram service,and that a datagram travels from gateway to gateway until it reaches one that can deliver it directly to its final destination. If a gateway cannot route or deliver a datagram,or if the gateway detects an unusual condition, like network congestion, that affects its ability to forward the datagram, it needs to instruct the original source to take action to avoid or correct the problem. The Internet Control Message

Protocol allows gateways to send error or control messages to other gateways or hosts;ICMP provides communication between the Internet Protocol software on one machine and the Internet Protocol software on another. This is a special purpose message mechanism added by the designers to the TCP/IP protocols. This is to allow gateways in an internet to report errors or provide information about unexpecter circumstances. The IP protocol itself contains nothing to help the sender test connectivity or learn about failures.

Error Reporting vs Error Correction

ICMP only reports error conditions to the original source; the source must relate errors to individual application programs and take action to correct problems. It provides a way for gateway to report the error It does not fully specify the action to be taken for each possible error. ICMP is restricted to communicate with the original source but not intermediate sources.

ICMP Message Delivery

ICMP messages travel across the internet in the data portion of an IP datagram,which itself travels across the internet in the data portion of an IP datagram,which itself travels across each physical network in the data portion of a frame.Datagrams carryin ICMP messages are routed exactly like datagrams carrying information for users;there is no additional reliability or priority.An exception is made to the error handling procedures if an IP datagram carrying an ICMP messages are not generated for errors that result from datagrams carrying ICMP error messages.

ICMP Message Format

It has three fields;an 8-bit integer message TYPE field that identifies the message,an 8-bit CODE field that provides further information about the message type,and a 16-bit CHECKSUM field(ICMP uses the same additive checksum algorithm as IP,but the ICMP checksum only covers the ICMP message).In addition , ICMP messages that report errors always include the header and first 64 data bits of the datagram causing the problem. The ICMP TYPE field defines the meaning of the message as well as its format.

The Types include :

TYPE FIELD	**ICMP MESSAGE TYPE**
0	ECHO REPLY
3	DESTINATION UNREACHABLE
4	SOURCE QUENCH
5	REDIRECT(CHANGE A ROUTE)
8	ECHO REQUEST
11	TIME EXCEEDED FOR A DATAGRAM
12	PARAMETER PROBLEM ON A DATAGRAM
13	TIMESTAMP REQUEST
14	TIMESTAMP REPLY

15	INFORMATION REQUEST(OBSOLETE)
16	INFORMATION REPLY(OBSOLETE)
17	ADDRESS MASK REQUEST
18	ADDRESS MASK REPLY TESTING DESTINATION

Reachabilty and Status :

TCP/IP protocols provide facilities to help network managers or users identify network problems.One of the most frequently used debugging tools invokes the ICMP echo request and echo reply messages.A host or gateway sends an ICMP echo request message to a specified destination.Any machine that receives an echo request formulates an echo reply and returns to the original sender.The request contains an optional data area; the reply contains a copy of the data sent in the request.The echo request and associated reply can be used to test whether a destination is reachable and responding.Because both the request and reply travel in IP datagrams,successful receipt of a reply verifies that major pieces of the transport system work.

1.1 : IP software on the source must route the datagram

2.2 : Intermediate gateways between the source and destination must be operating and must route datagram correctly.

3.3 : The destination machine must be running , and both ICMP and IP software must be working.

4.4 : Routes in gateways along the return path must be correct.

Echo Request and Reply

The field listed OPTIONAL DATA is a variable length field that contains data to be returned to the sender.An echo reply always returns exactly the same data as was received in the request.Fields IDENTIFIER and SEQUENCE NUMBER are used by the sender to match replies to request.The value of the TYPE field specifies whether the message is a request(8) or a reply(0).

Reports of Unreachable Destinations

The Code field in a destination unreachable message contains an integer that further describes th problem.Possible values are :

CODE VALUE	**MEANING**
0	NETWORK UNREACHABLE
1	HOST UNREACHABLE
2	PROTOCOL UNREACHABLE
3	PORT UNREACHABLE
4	FRAGMENTATION NEEDED AND DF SET
5	SOURCE ROOT FAILED
6	DESTINATION NETWORK UNKNOWN
7	DESTINATION HOST UNKNOWN
8	SOURCE HOST ISOLATED
9	COMMUNICATION WITH DESTINATION NETWORK ADMINISTRATIVELY PROHIBITED
10	COMMUNICATION WTTH DESTINATION HOST ADMINISTRATIVELY PROHIBITED
11	NETWORK UNREACHABLE FOR TYPE OF SERVICE
12	HOST UNREACHABLE FOR TYPE OF SERVICE

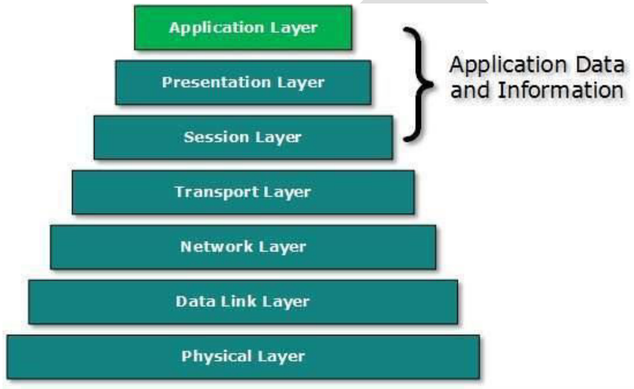
Whenever an error prevents a gateway from routing or delivering a datagram, the gateway sends a destination unreachable message back to the source and then drops the datagram.Network unreachable errors usually imply roting failures ; host unreachable errors imply delivery failures.Because the message contains a short prefix of the datagram that caused the problem, the source will know exactly which address is unreachable. Destinations may be unreachable because hardware is temporarily out of service, because the sender specified a nonexistent destination address, or because the gateway does not have a route to the destination network. Although gateways send destination unreachable messages if they cannot route or deliver datagrams, not all such errors can be detected.If the datagram contains the source route option with an incorrect route, it may trigger a source route failure message.If a gateway needs to fragment adatagram but the "don't fragment" bit is set, the gateway sends a fragmentation needed message back to the source.

Application Layer

Application layer is the top most layer in OSI and TCP/IP layered model. This layer exists in both layered Models because of its significance, of interacting with user and user applications. This layer is for applications which are involved in communication system.

A user may or may not directly interacts with the applications. Application layer is where the actual communication is initiated and reflects. Because this layer is on the top of the layer stack, it does not serve any other layers. Application layer takes the help of Transport and all layers below it to communicate or transfer its data to the remote host.

When an application layer protocol wants to communicate with its peer application layer protocol on remote host, it hands over the data or information to the Transport layer. The transport layer does the rest with the help of all the layers below it.

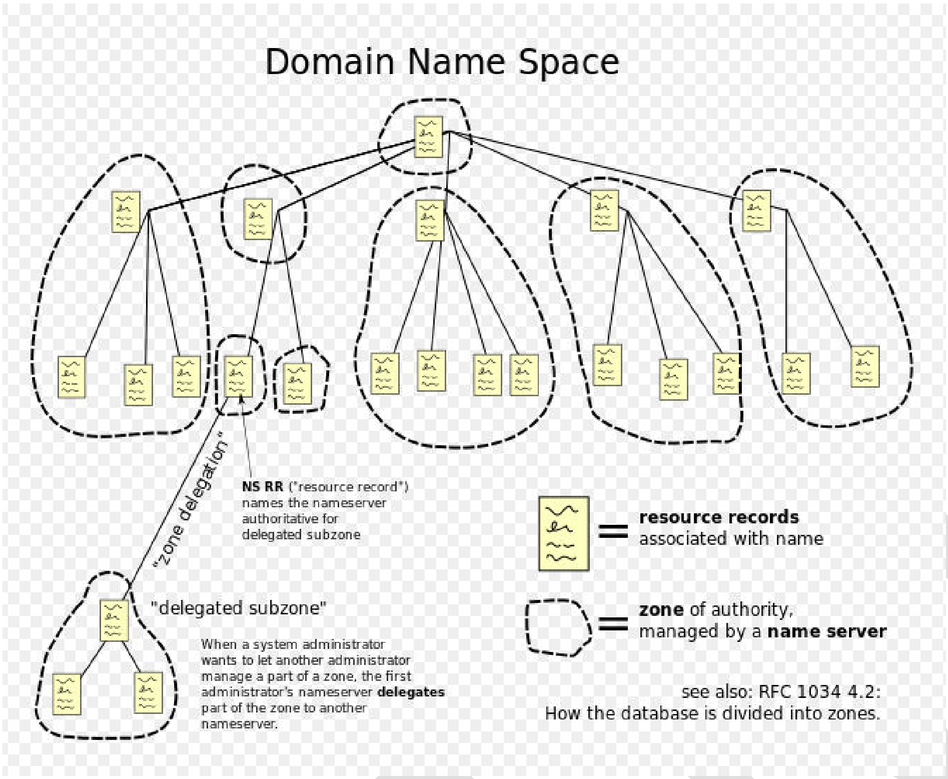


There's an ambiguity in understanding Application Layer and its protocol. Not every user application can be put into Application Layer. Except those applications which interact with the communication system. For example, designing software or text-editor cannot be considered as application layer programs.

On the other hand, when we use a Web Browser, which is actually using Hyper Text Transfer Protocol (HTTP) to interact with the network. HTTP is Application Layer protocol.

Domain Name System

The **Domain Name System** (**DNS**) is a hierarchical decentralized naming system for computers, services, or any resource connected to the Internet or a private network. It associates various information with domain names assigned to each of the participating entities. Most prominently, it translates more readily memorized domain names to the numerical IP addresses needed for the purpose of locating and identifying computer services and devices with the underlying network protocols.


Domain Name Space
"zone delegation"
NS RR ("resource record") names the nameserver authoritative for delegated subzone
"delegated subzone"
When a system administrator wants to let another administrator manage a part of a zone, the first administrator's nameserver delegates part of the zone to another nameserver.
= resource records associated with name
= zone of authority, managed by a name server
see also: RFC 1034 4.2: How the database is divided into zones.

Email

E-mail Protocols are set of rules that help the client to properly transmit the information to or from the mail server. Here in this tutorial, we will discuss various protocols such as **SMTP, POP,** and **IMAP.**

SMTP

SMTP stands for **Simple Mail Transfer Protocol**. It was first proposed in 1982. It is a standard protocol used for sending e-mail efficiently and reliably over the internet.

Key Points:

- SMTP is application level protocol.
- SMTP is connection oriented protocol.
- SMTP is text based protocol.
- It handles exchange of messages between e-mail servers over TCP/IP network.
- Apart from transferring e-mail, SMPT also provides notification regarding incoming mail.
- When you send e-mail, your e-mail client sends it to your e-mail server which further contacts the recipient mail server using SMTP client.
- These SMTP commands specify the sender's and receiver's e-mail address, along with the message to be send.
- The exchange of commands between servers is carried out without intervention of any user.
- In case, message cannot be delivered, an error report is sent to the sender which makes SMTP a reliable protocol.

SMTP Commands

The following table describes some of the SMTP commands:

S.N.	Command Description
1	**HELLO** This command initiates the SMTP conversation.
2	**EHELLO** This is an alternative command to initiate the conversation. ESMTP indicates that the sender server wants to use extended SMTP protocol.
3	**MAIL FROM** This indicates the sender’s address.
4	**RCPT TO** It identifies the recipient of the mail. In order to deliver similar message to multiple users this command can be repeated multiple times.
5	**SIZE** This command let the server know the size of attached message in bytes.
6	**DATA** The **DATA** command signifies that a stream of data will follow. Here stream of data refers to the body of the message.
7	**QUIT** This commands is used to terminate the SMTP connection.
8	**VERFY** This command is used by the receiving server in order to verify whether the given username is valid or not.
9	**EXPN** It is same as VRFY, except it will list all the users name when it used with a distribution list.

IMAP

IMAP stands for **Internet Mail Access Protocol.** It was first proposed in 1986. There exist five versions of IMAP as follows:

1. Original IMAP
2. IMAP2

3. IMAP3
4. IMAP2bis
5. IMAP4

Key Points:

- IMAP allows the client program to manipulate the e-mail message on the server without downloading them on the local computer.
- The e-mail is hold and maintained by the remote server.
- It enables us to take any action such as downloading, delete the mail without reading the mail.It enables us to create, manipulate and delete remote message folders called mail boxes.
- IMAP enables the users to search the e-mails.
- It allows concurrent access to multiple mailboxes on multiple mail servers.

IMAP Commands

The following table describes some of the IMAP commands:

S.N.	Command Description
1	**IMAP_LOGIN** This command opens the connection.
2	**CAPABILITY** This command requests for listing the capabilities that the server supports.
3	**NOOP** This command is used as a periodic poll for new messages or message status updates during a period of inactivity.
4	**SELECT** This command helps to select a mailbox to access the messages.
5	**EXAMINE** It is same as SELECT command except no change to the mailbox is permitted.
6	**CREATE** It is used to create mailbox with a specified name.
7	**DELETE** It is used to permanently delete a mailbox with a given name.
8	**RENAME** It is used to change the name of a mailbox.

9	**LOGOUT** This command informs the server that client is done with the session. The server must send BYE untagged response before the OK response and then close the network connection.

POP

POP stands for Post Office Protocol. It is generally used to support a single client. There are several versions of POP but the POP 3 is the current standard.

Key Points

- POP is an application layer internet standard protocol.
- Since POP supports offline access to the messages, thus requires less internet usage time.
- POP does not allow search facility.
- In order to access the messaged, it is necessary to download them.
- It allows only one mailbox to be created on server.
- It is not suitable for accessing non mail data.
- POP commands are generally abbreviated into codes of three or four letters. Eg. STAT.

POP Commands

The following table describes some of the POP commands:

S.N.	**Command Description**
1	**LOGIN** This command opens the connection.
2	**STAT** It is used to display number of messages currently in the mailbox.
3	**LIST** It is used to get the summary of messages where each message summary is shown.
4	**RETR** This command helps to select a mailbox to access the messages.
5	**DELE** It is used to delete a message.
6	**RSET** It is used to reset the session to its initial state.
7	**QUIT**

It is used to log off the session.

Comparison between POP and IMAP

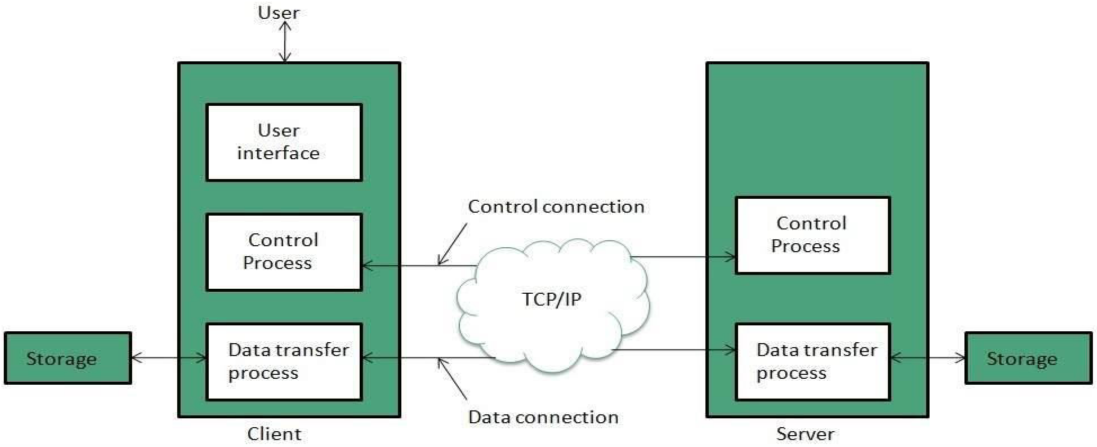
S.N.	POP	IMAP
1	Generally used to support single client.	Designed to handle multiple clients.
2	Messages are accessed offline.	Messages are accessed online although it also supports offline mode.
3	POP does not allow search facility.	It offers ability to search emails.
4	All the messages have to be downloaded.	It allows selective transfer of messages to the client.
5	Only one mailbox can be created on the server.	Multiple mailboxes can be created on the server.
6	Not suitable for accessing non-mail data.	Suitable for accessing non-mail data i.e. attachment.
7	POP commands are generally abbreviated into codes of three or four letters. Eg. STAT.	IMAP commands are not abbreviated, they are full. Eg. STATUS.
8	It requires minimum use of server resources.	Clients are totally dependent on server.
9	Mails once downloaded cannot be accessed from some other location.	Allows mails to be accessed from multiple locations.
10	The e-mails are not downloaded automatically.	Users can view the headings and sender of e-mails and then decide to download.
10	POP requires less internet usage time.	IMAP requires more internet usage time.

File Transfer Protocol (FTP)

FTP is used to copy files from one host to another. FTP offers the mechanism for the same in following manner:

- FTP creates two processes such as Control Process and Data Transfer Process at both ends i.e. at client as well as at server.

- FTP establishes two different connections: one is for data transfer and other is for control information.
- **Control connection** is made between **control processes** while **Data Connection** is made between <="" b="">
- FTP uses **port 21** for the control connection and **Port 20** for the data connection.



Network News Transfer Protocol (NNTP)

The Network News Transfer Protocol (NNTP) is an application protocol used for transporting Usenet news articles (Netnews) between news servers and for reading and posting articles by end user client.

NNTP (Network News Transfer Protocol) is the predominant protocol used by computer clients and servers for managing the notes posted on Usenet newsgroups. NNTP replaced the original Usenet protocol, UNIX-to-UNIX Copy Protocol (UUCP) some time ago. NNTP servers manage the global network of collected Usenet newsgroups and include the server at your Internet access provider. An NNTP client is included as part of a Netscape, Internet Explorer, Opera, or other Web browser or you may use a separate client program called a newsreader

Hyper Text Transfer Protocol (HTTP)

HTTP is a communication protocol. It defines mechanism for communication between browser and the web server. It is also called request and response protocol because the communication between browser and server takes place in request and response pairs.

HTTP Request

HTTP request comprises of lines which contains:

- Request line
- Header Fields
- Message body

HTTP Response

Like HTTP request, HTTP response also has certain structure. HTTP response contains:

- Status line
- Headers
- Message body

Overview of IPv6

Internet Protocol version 6 is a new addressing protocol designed to incorporate all the possible requirements of future Internet known to us as Internet version 2. This protocol as its predecessor IPv4, works on the Network Layer (Layer-3). Along with its offering of an enormous amount of logical address space, this protocol has ample features to which address the shortcoming of IPv4.