

# Unit-V

## APPLICATION LAYER AND ITS PROTOCOL

## TOPICS:

### ❖ The Application Layer

- Domain Name System

- Electronic mail

- World Wide Web: Architectural overview, Dynamic web document and http.

### ❖ Application Layer protocols

- SNMP

- FTP

- SMTP

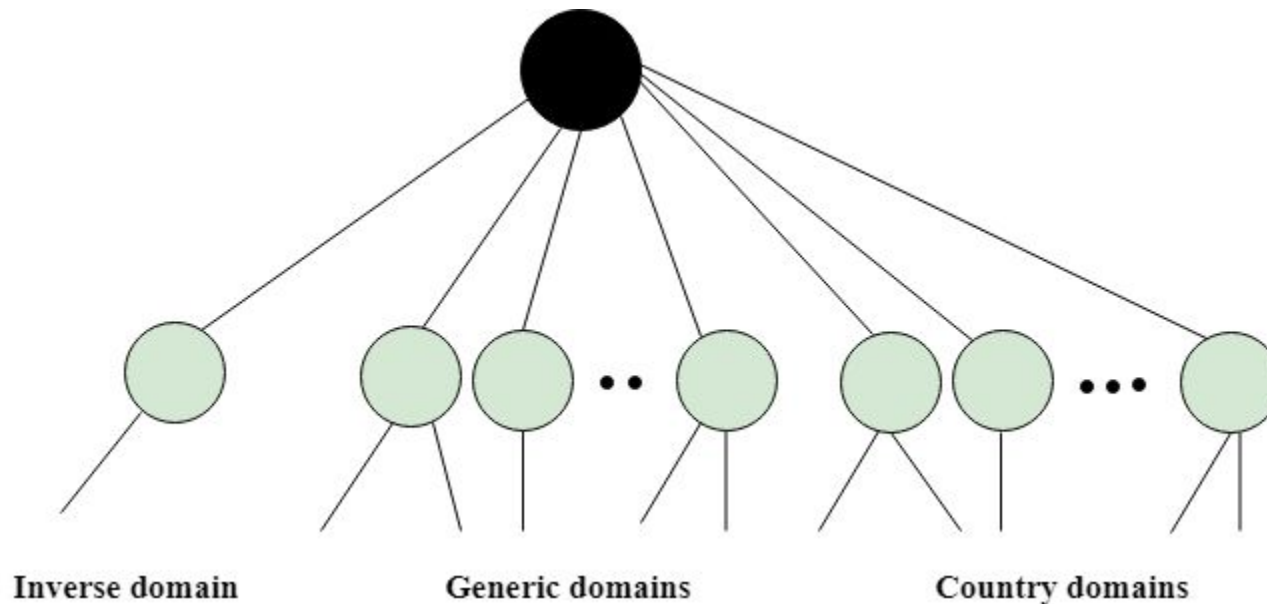
- Telnet

# DOMAIN NAME SYSTEM(DNS)

- 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.

# DOMAIN NAME SYSTEM(DNS)

- **DOMAIN SPACE:** The domain name space is divided into three different sections: generic domains, country domains, and inverse domain.



# DOMAIN NAME SYSTEM(DOMAIN SPACE)

## A) Generic Domains

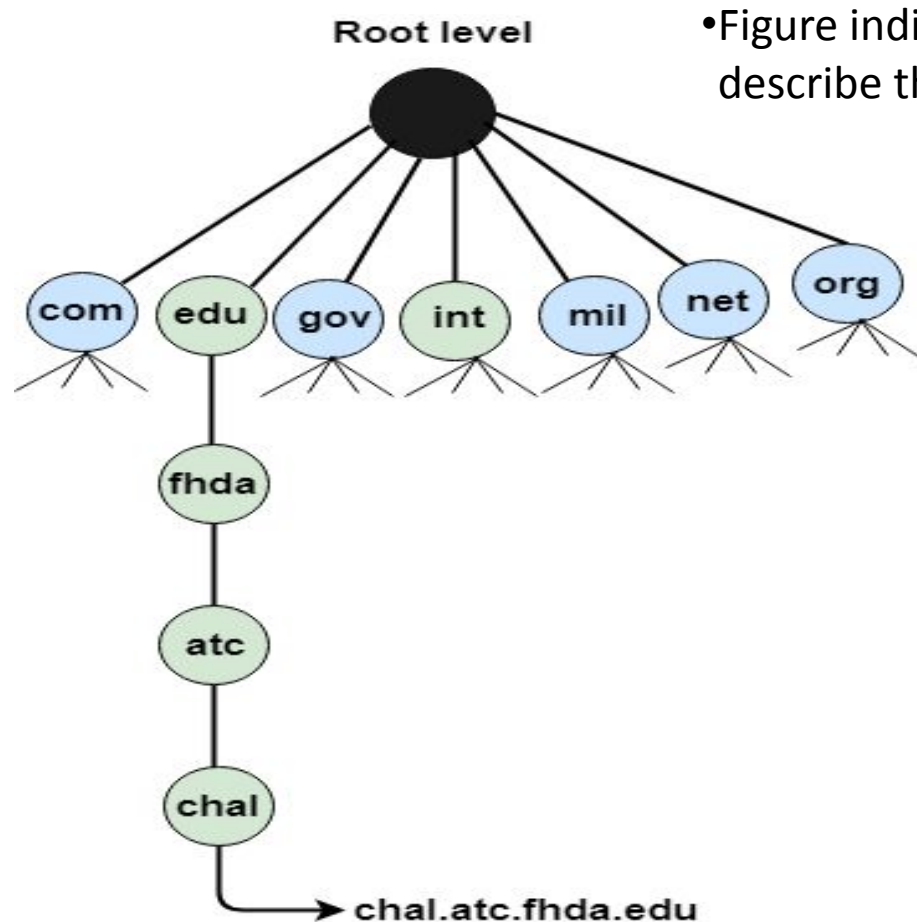
- It defines the registered hosts according to their generic behavior.
- Each node in a tree defines the domain name, which is an index to the DNS database.
- It uses three-character labels, and these labels describe the organization type.

# DOMAIN NAME SYSTEM(DOMAIN SPACE)

- TABLE INDICATING  
DIFFERENT  
GENERIC DOMAINS

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

# DOMAIN NAME SYSTEM(DOMAIN SPACE)



- Figure indicating it uses three-character labels, and these labels describe the organization type.

# DOMAIN NAME SYSTEM(DOMAIN SPACE)

## B) 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.

## C) 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.



# DOMAIN NAME SYSTEM(DOMAIN RESOURCE RECORDS)

Every domain, whether it is a single host or a top-level domain, can have a set of resource records associated with it. These records are the DNS database

A resource record is a five-tuple. Although they are encoded in binary for efficiency, in most expositions resource records are presented as ASCII text, one line per resource record. The format we will use is as follows: Domain name Time to live Class Type Value

# DOMAIN NAME SYSTEM(DOMAIN RESOURCE RECORDS)

The Domain name tells the domain to which this record applies. Normally, many records exist for each domain and each copy of the database holds information about multiple domains.

This field is thus the primary search key used to satisfy queries. The order of the records in the database is not significant.

# DOMAIN NAME SYSTEM(DOMAIN RESOURCE RECORDS)

The Time to live field gives an indication of how stable the record is. Information that is highly stable is assigned a large value, such as 86400 (the number of seconds in 1 day). Information that is highly volatile is assigned a small value, such as 60 (1 minute).

We will come back to this point later when we have discussed caching. The third field of every resource record is the Class. For Internet information, it is always IN. For non-Internet information, other codes can be used, but in practice these are rarely seen.

The Type field tells what kind of record this is.

# DOMAIN NAME SYSTEM(DOMAIN RESOURCE RECORDS)

RECORD TYPE WITH VALUE FIELD IS AS IN TABLE BELOW:

Type	Meaning	Value
SOA	Start of authority	Parameters for this zone
A	IPv4 address of a host	32-Bit integer
AAAA	IPv6 address of a host	128-Bit integer
MX	Mail exchange	Priority, domain willing to accept email
NS	Name server	Name of a server for this domain
CNAME	Canonical name	Domain name
PTR	Pointer	Alias for an IP address
SPF	Sender policy framework	Text encoding of mail sending policy
SRV	Service	Host that provides it
TXT	Text	Descriptive ASCII text

# DOMAIN NAME SYSTEM(DOMAIN RESOURCE RECORDS)

## RECORD TYPE EXPLANATION:

The most important record type is the **A (Address) record**. It holds a 32-bit IPv4 address of an interface for some host.

The corresponding **AAAA, or “quad A,”** record holds a 128-bit IPv6 address. Every Internet host must have at least one IP address so that other machines can communicate with it. Some hosts have two or more network interfaces, in which case they will have two or more type A or AAAA resource records. Consequently, DNS can return multiple addresses for a single name.

# DOMAIN NAME SYSTEM(DOMAIN RESOURCE RECORDS)

## RECORD TYPE EXPLANATION:

A common record type is the **MX record**. It specifies the name of the host prepared to accept email for the specified domain. It is used because not every machine is prepared to accept email. If someone wants to send email to, for example, `bill@microsoft.com`, the sending host needs to find some mail server located at `microsoft.com` that is willing to accept email. The MX record can provide this information.

# DOMAIN NAME SYSTEM(DOMAIN RESOURCE RECORDS)

## RECORD TYPE EXPLANATION:

Another important record type is the **NS record**. It specifies a name server for the domain or subdomain. Inturn holding copy of the details of Main Domain.

# DOMAIN NAME SYSTEM(DOMAIN RESOURCE RECORDS)

## RECORD TYPE EXPLANATION:

**CNAME records** allow aliases to be created.

For example, a person familiar with Internet naming in general and wanting to send a message to user abhi in the computer science department at ML.R.I.T might guess that `abhi@cs.mlrit.edu` will work.

Actually, this address will not work, because the domain for M.L.R.I.T.'s computer science department is `csail.mlrit.edu`. However, as a service to people who do not know this, M.L.R.I.T could create a CNAME entry to point people and programs in the right direction.

An entry like this one might do the job: `cs.mlrit.edu 86400 IN CNAME csail.mlrit.edu`



# DOMAIN NAME SYSTEM(DOMAIN RESOURCE RECORDS)

## RECORD TYPE EXPLANATION:

Like CNAME, **PTR points** to another name. However, unlike CNAME, which is really just a macro definition (i.e., a mechanism to replace one string by another), PTR is a regular DNS data type whose interpretation depends on the context in which it is found.

**SRV is a newer type of record** that allows a host to be identified for a given service in a domain. For example, the Web server for cs.washington.edu could be identified as cockatoo.cs.washington.edu. This record generalizes the MX record that performs the same task but it is just for mail servers

# DOMAIN NAME SYSTEM(DOMAIN RESOURCE RECORDS)

## RECORD TYPE EXPLANATION:

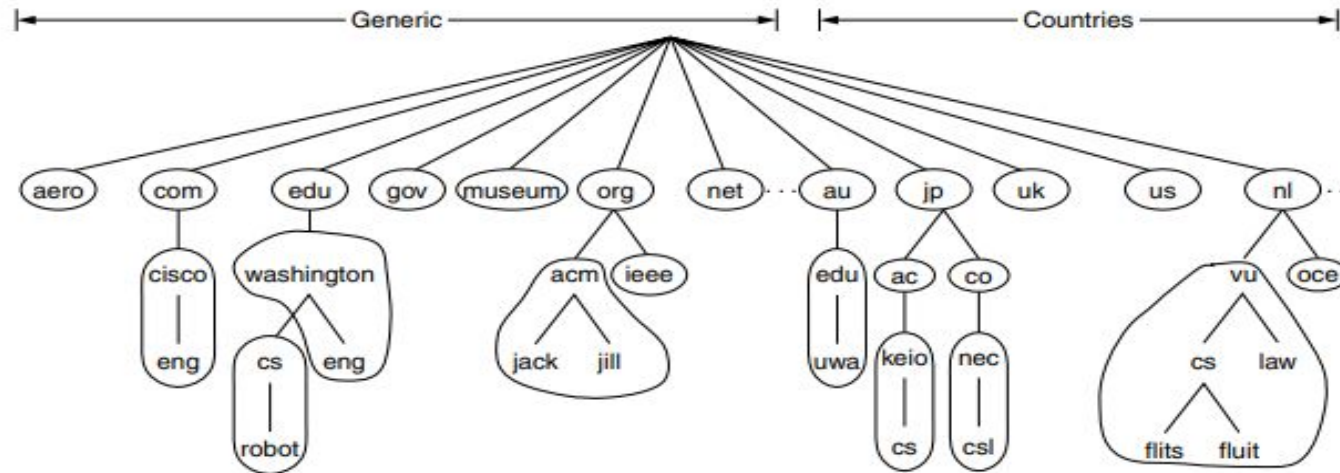
**SPF** is also a newer type of record. It lets a domain encode information about what machines in the domain will send mail to the rest of the Internet. This helps receiving machines check that mail is valid.

Last on the list, **TXT records** were originally provided to allow domains to identify themselves in arbitrary ways. Nowadays, they usually encode machinereadable information, typically the SPF information.

Finally, we have the **Value field**. This field can be a number, a domain name, or an ASCII string. The semantics depending on the record type

# DOMAIN NAME SYSTEM(NAME SERVER)

To avoid the problems associated with having only a single source of information, the DNS name space is divided into **nonoverlapping zones**. One possible way to divide the name space is as shown in figure below



# DOMAIN NAME SYSTEM(NAME SERVER)

Each zone is also associated with one or more name servers. These are hosts that hold the database for the zone. Normally, a zone will have one primary name server, which gets its information from a file on its disk, and one or more secondary name servers, which get their information from the primary name server.

To improve reliability, some of the name servers can be located outside the zone.

# DOMAIN NAME SYSTEM(NAME SERVER)

The process of looking up a name and finding an address is called **name resolution**. When a resolver has a query about a domain name, it passes the **query to a local name server**. If the domain being sought falls under the jurisdiction of the name server, such as top.cs.vu.nl falling under cs.vu.nl, it returns the **authoritative resource records**. An authoritative record is one that comes from the authority that manages the record and is thus always correct. Authoritative records are in contrast to **cached records**, which may be out of date.

# DOMAIN NAME SYSTEM(NAME SERVER)

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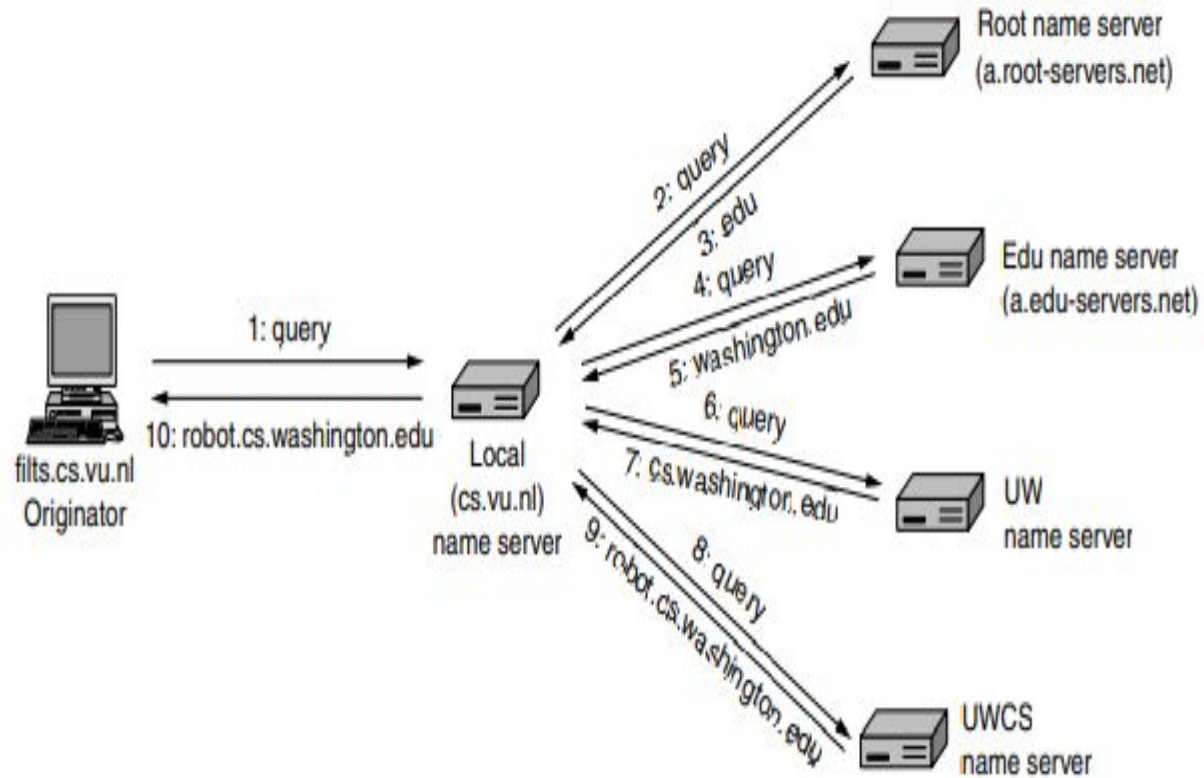
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# DOMAIN NAME SYSTEM(NAME SERVER)

What happens when the domain is remote, such as when flits.cs.vu.nl wants to find the IP address of robot.cs.washington.edu at UW (University of Washington)?

In this case, and if there is **no cached information about the domain available locally**, the name server begins a **remote query**. This query follows the process shown in Figure below

# DOMAIN NAME SYSTEM(NAME SERVER)





# DOMAIN NAME SYSTEM(NAME SERVER)

**Step 1** shows the query that is sent to the local name server.

The query contains the domain name sought, the type (A), and the class(IN)

The **next step** is to start at the top of the name hierarchy by asking one of the root name servers. These name servers have information about each top-level domain.

# DOMAIN NAME SYSTEM(NAME SERVER)

To contact a root server, each name server **must have information about one or more root name servers**. This information is normally present in a **system configuration file** that is loaded into the DNS cache when the DNS server is started.

It is simply a list of NS records for the root and the corresponding A records. There are 13 root DNS servers, unimaginatively called a-root-servers.net through m.root-servers.net. Each root server could logically be a single computer.

# DOMAIN NAME SYSTEM(NAME SERVER)

However, since the entire Internet depends on the root servers, they are powerful and heavily replicated computers. Most of the servers are present in multiple geographical locations and reached using **anycast routing**, in which a packet is delivered to the nearest instance of a destination address.

# DOMAIN NAME SYSTEM(NAME SERVER)

The replication improves reliability and performance. The root name server is unlikely to know the address of a machine at UW, and probably does not know the name server for UW either.

But it must know the name server for the edu domain, in which cs.washington.edu is located. It returns the name and IP address for that part of the **answer in step 3**.

The local name server then continues its quest. It sends the entire query to the edu name server (a.edu-servers.net)

# DOMAIN NAME SYSTEM(NAME SERVER)

**That name server returns the name server for UW. This is shown in steps 4 and 5. Closer now, the local name server sends the query to the UW name server (step 6). If the domain name being sought was in the English department, the answer would be found, as the UW zone includes the English department.**

# DOMAIN NAME SYSTEM(NAME SERVER)

**But the Computer Science department has chosen to run its own name server. The query returns the name and IP address of the UW Computer Science name server (step 7).**

Finally, the local name server queries the UW Computer Science name **server (step 8)**. This server is authoritative for the domain cs.washington.edu, so it must have the answer. **It returns the final answer (step 9), which the local name server forwards as a response to flits.cs.vu.nl (step 10). The name has been resolved.**

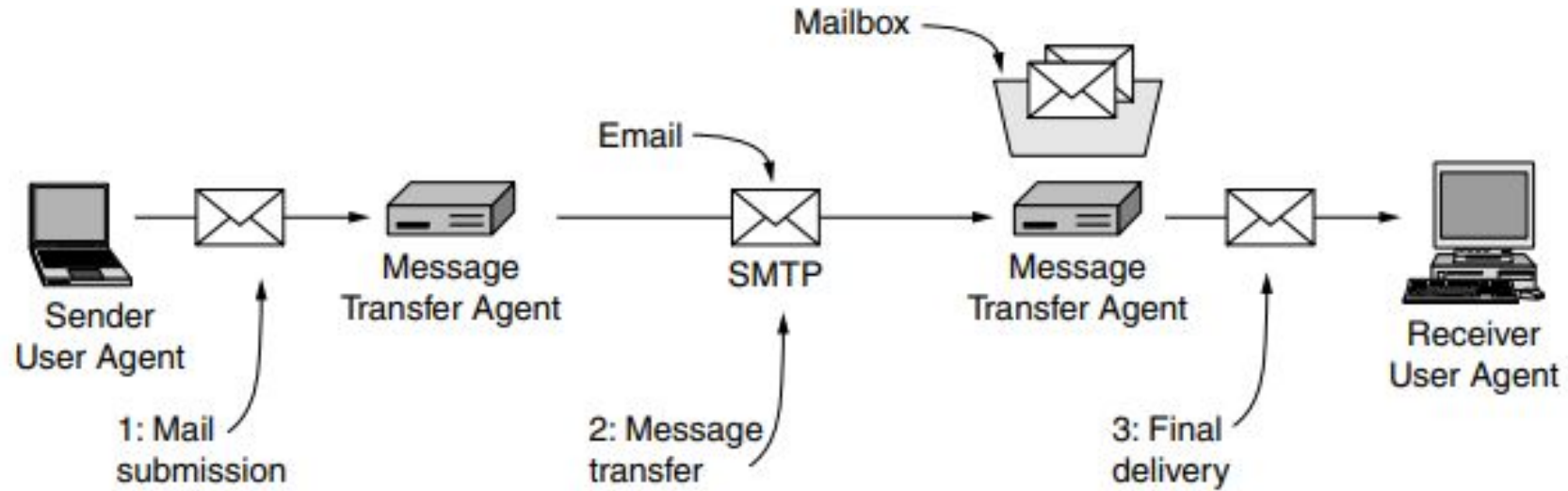
# ELECTRONIC MAIL(e-mail)

## **A. Architecture and Services**

In this section, we will provide an overview of how email systems are organized and what they can do. The architecture of the email system is shown in Figure below

# ELECTRONIC MAIL(e-mail)

## A. Architecture and Services





# ELECTRONIC MAIL(e-mail)

## A. Architecture and Services

It consists of two kinds of subsystems: **the user agents**, which allow people to read and send email, and **the message transfer agents**, which move the messages from the source to the destination. We will also refer to message transfer agents informally as **mail servers**.

# ELECTRONIC MAIL(e-mail)

## A. Architecture and Services

**The user agent is a program that provides a graphical interface, or sometimes a text- and command-based interface that lets users interact with the email system.**

It includes a means to compose messages and replies to messages, display incoming messages, and organize messages by filing, searching, and discarding them. The act of sending new messages into the mail system for delivery is called mail submission.

# ELECTRONIC MAIL(e-mail)

## A. Architecture and Services

The **message transfer agents** are typically **system processes**.

They run in the **background on mail server machines** and are intended to be always available.

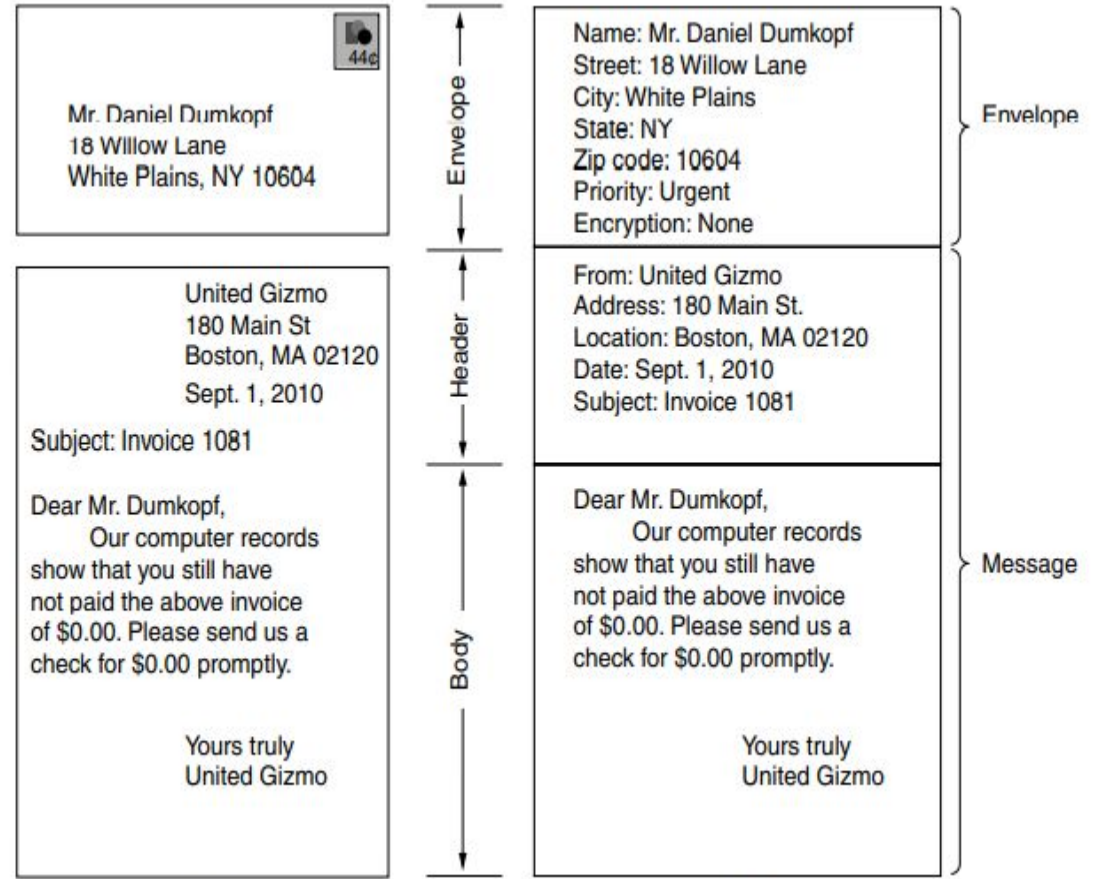
Their **job is to automatically move email through the system from the originator to the recipient with SMTP (Simple Mail Transfer Protocol)**.

This is the message transfer step. SMTP was originally specified as RFC. It sends mail over connections and reports back the delivery status and any errors.

# ELECTRONIC MAIL(e-mail)

## A. Architecture and Services

Structure of Paper mail and electronic mail is as shown which has header, body and envelope field.



# ELECTRONIC MAIL(e-mail)

## B. USER AGENT

A Mail User Agent (MUA), also referred to as an email client, is a computer application that allows you to send and retrieve email.

- ❖ A MUA is what you interact with, as opposed to an email server, which transports email.
- ❖ MUAs can be software applications, such as Outlook Express and Lotus notes, or they can be webmail services such as those provided by Yahoo!, Microsoft Outlook.com, and Gmail.
- ❖ MUAs are the component within the Simple Mail Transfer Protocol (SMTP) system responsible for creating email messages for transfer to a Mail Transfer Agent (MTA).

# ELECTRONIC MAIL(e-mail)

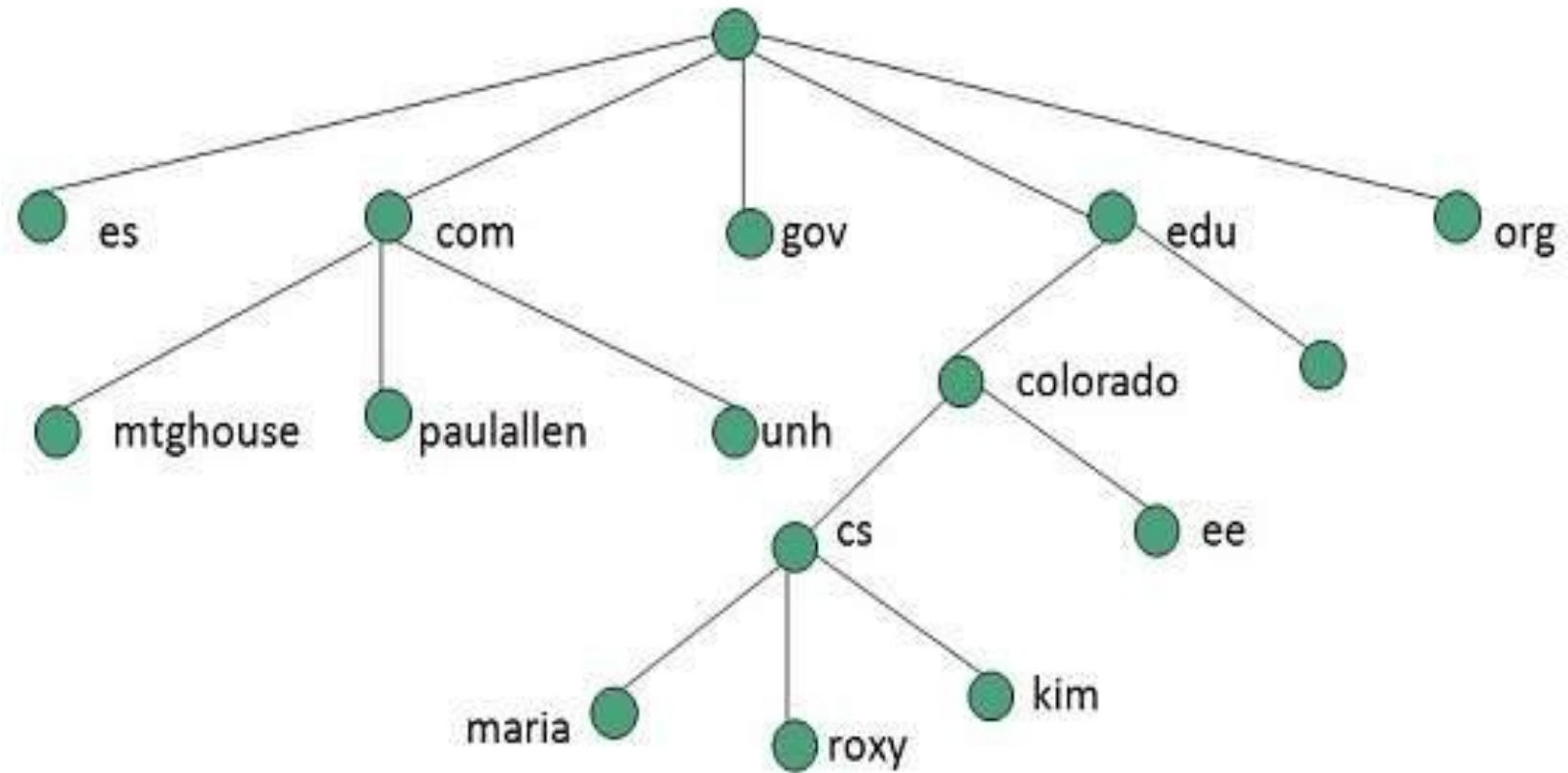
## B. USER AGENT

- ❖(MUA) The program that allows the user to compose and read **electronic mail** messages.
- ❖The MUA provides the interface between the user and the **Message Transfer Agent**.
- ❖Outgoing mail is eventually handed over to an MTA for delivery while the incoming messages are picked up from where the MTA left it (although MUA's running on single-user machines may pick up mail using **POP**).

# World Wide Web

- ❖ World Wide Web, which is also known as a Web, is a collection of websites or web pages stored in web servers and connected to local computers through the internet.
- ❖ These websites contain text pages, digital images, audios, videos, etc.
- ❖ Users can access the content of these sites from any part of the world over the internet using their devices such as computers, laptops, cell phones, etc.
- ❖ The WWW, along with internet, enables the retrieval and display of text and media to your device.
- ❖ In simple terms, The World Wide Web is a way of exchanging information between computers on the Internet, tying them together into a vast collection of interactive multimedia resources.
- ❖ **Internet** and **Web** is not the same thing: Web uses internet to pass over the information.

# World Wide Web





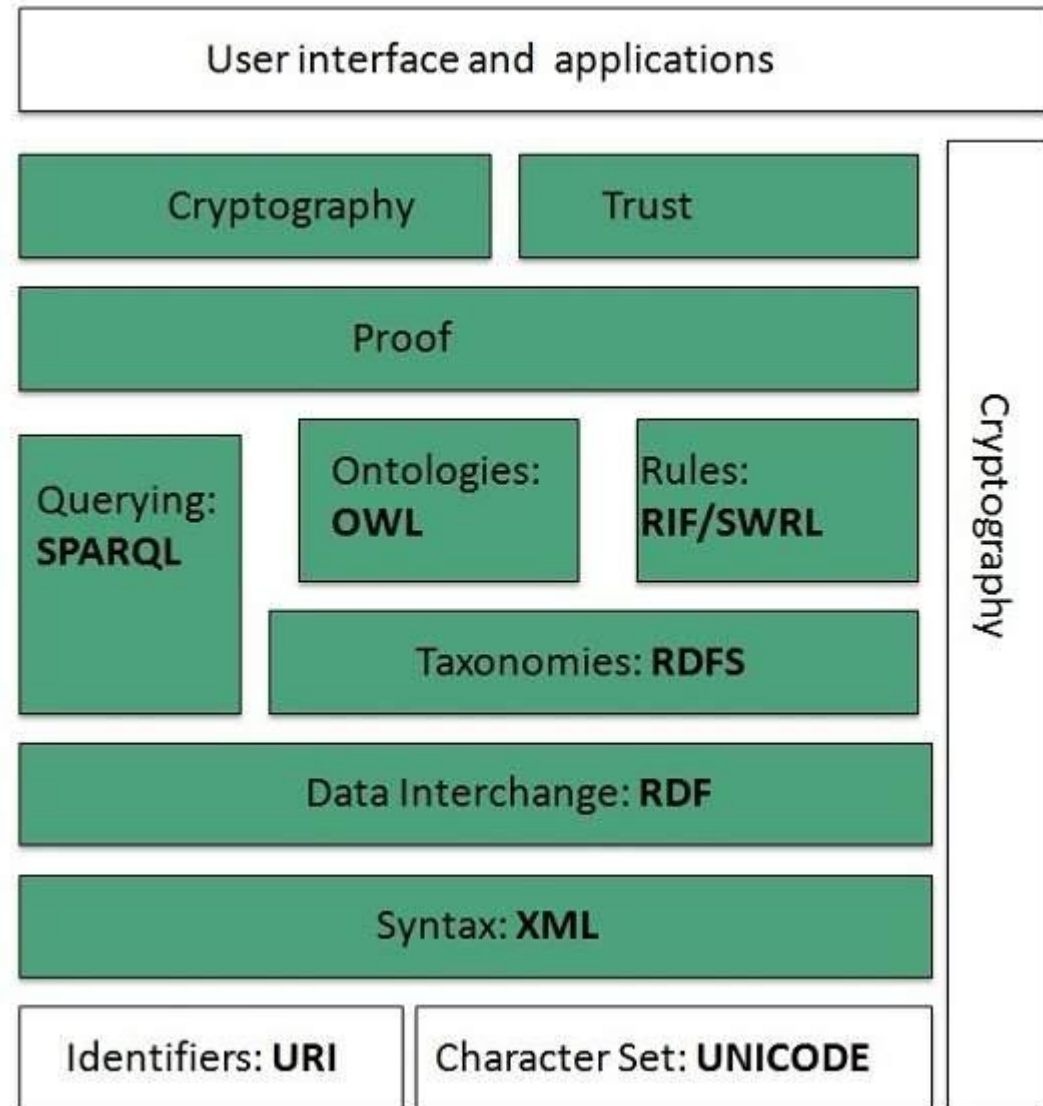
# World Wide Web

- Architectural overview
- Dynamic web document
- http

# World Wide Web

## Architectural overview:

WWW  
architecture is  
divided into  
several layers as  
shown in the  
following  
diagram:



# World Wide Web

## □ Architectural overview

### *Identifiers and Character Set*

**Uniform Resource Identifier (URI)** is used to uniquely identify resources on the web and **UNICODE** makes it possible to built web pages that can be read and write in human languages.

Syntax.

**XML (Extensible Markup Language)** helps to define common syntax in semantic web.

Data Interchange.

**Resource Description Framework (RDF)** framework helps in defining core representation of data for web. RDF represents data about resource in graph form.

### **Taxonomies**

**RDF Schema (RDFS)** allows more standardized description of **taxonomies** and other **ontological** constructs.

# World Wide Web

## Ontologies

**Web Ontology Language (OWL)** offers more constructs over RDFS. It comes in following three versions:

OWL Lite for taxonomies and simple constraints.

OWL DL for full description logic support.

OWL for more syntactic freedom of RDF

## Rules

**RIF** and **SWRL** offers rules beyond the constructs that are available from **RDFs** and **OWL**. Simple Protocol and **RDF Query Language (SPARQL)** is SQL like language used for querying RDF data and OWL Ontologies.

## Proof

All semantic and rules that are executed at layers below Proof and their result will be used to prove deductions.

Cryptography

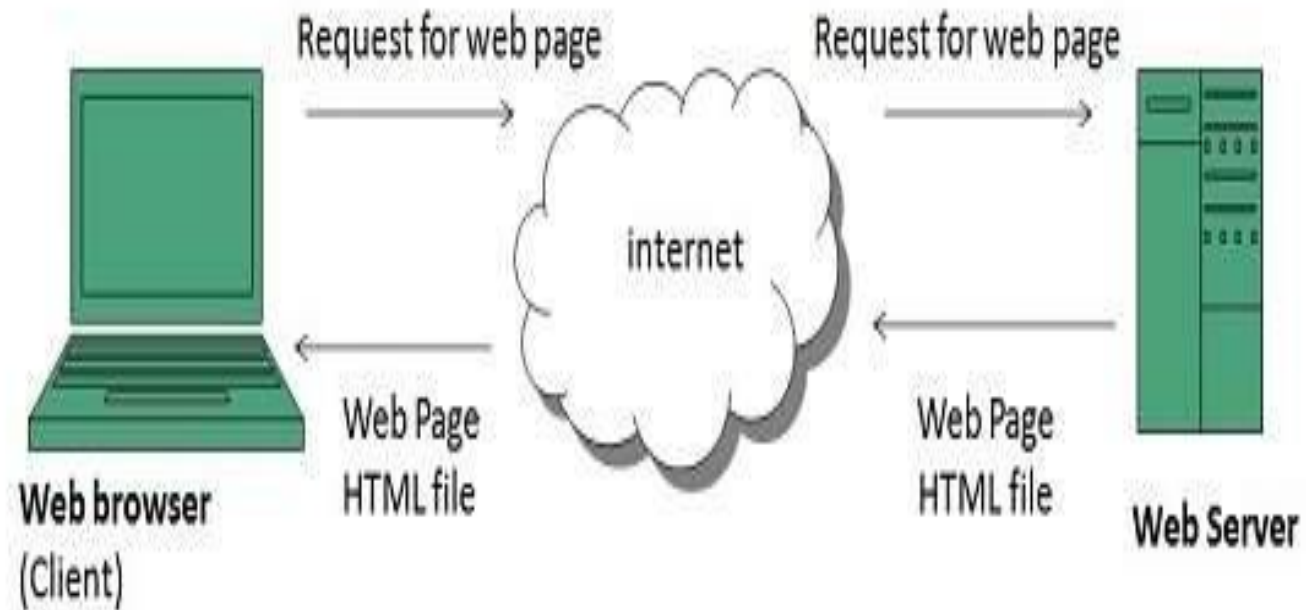
**Cryptography** means such as digital signature for verification of the origin of sources is used.

## User Interface and Applications

On the top of layer **User interface and Applications** layer is built for user interaction.

# World Wide Web

## WWW Operation



# World Wide Web

## □ Dynamic web Document

**Web page** is a document available on world wide web. Web Pages are stored on web server and can be viewed using a web browser.

A web page can contain huge information including text, graphics, audio, video and hyper links. These hyper links are the link to other web pages.

□ Static

□ Dynamic

# World Wide Web

## □ Dynamic web Document

❖ **Dynamic web page** shows different information at different point of time. It is possible to change a portion of a web page without loading the entire web page.

❖ It has been made possible using **Ajax** technology.

### *Server-side dynamic web page*

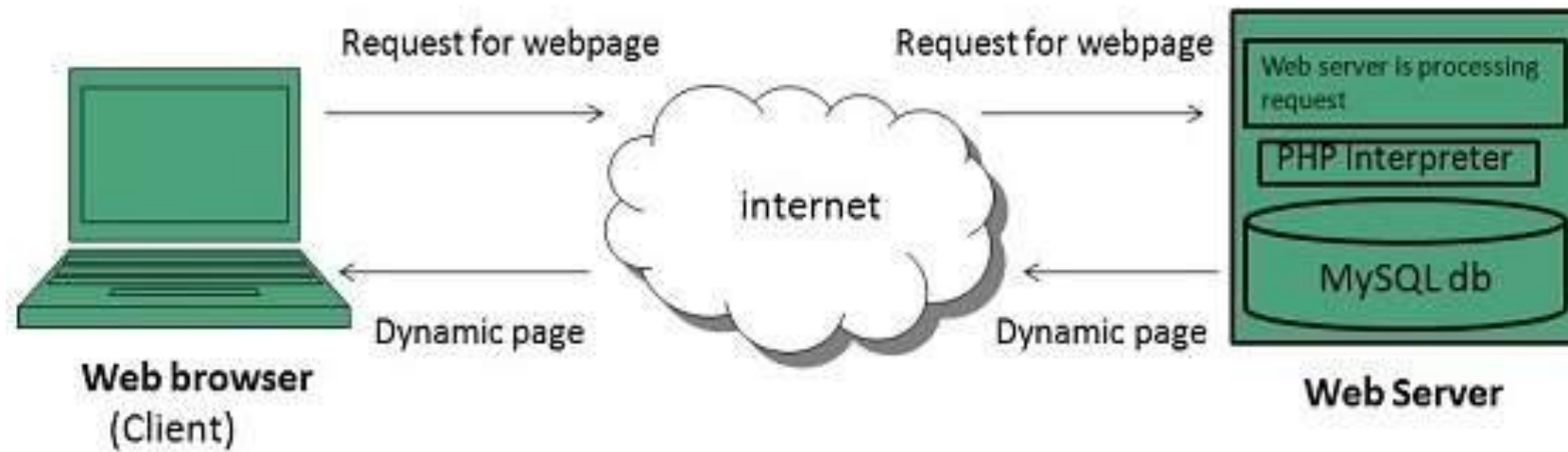
It is created by using server-side scripting. There are server-side scripting parameters that determine how to assemble a new web page which also include setting up of more client-side processing.

### *Client-side dynamic web page*

It is processed using client side scripting such as JavaScript. And then passed in to **Document Object Model (DOM)**.

# World Wide Web

## □Dynamic web Document





# World Wide Web

## □Dynamic web Document

### Scripting Languages:

Scripting languages are like programming languages that allow us to write programs in form of script. These scripts are interpreted not compiled and executed line by line.

Scripting language is used to create dynamic web pages.

- Client-Side
- Server-Side

# World Wide Web

## □ 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.

# World Wide Web

## □ HTTP

- 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.

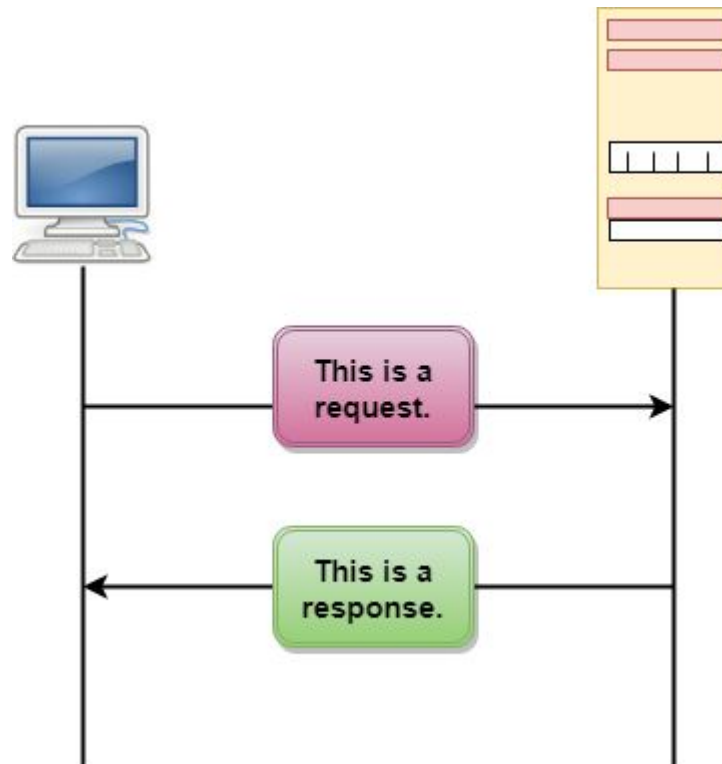
# World Wide Web

## □ HTTP

### Features of HTTP:

- Connectionless protocol
- Media independent
- Stateless

### HTTP Transactions



# World Wide Web

## □ HTTP

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.

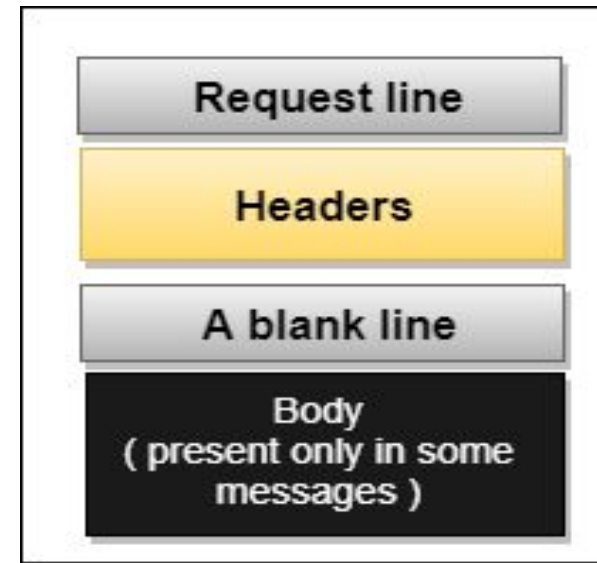
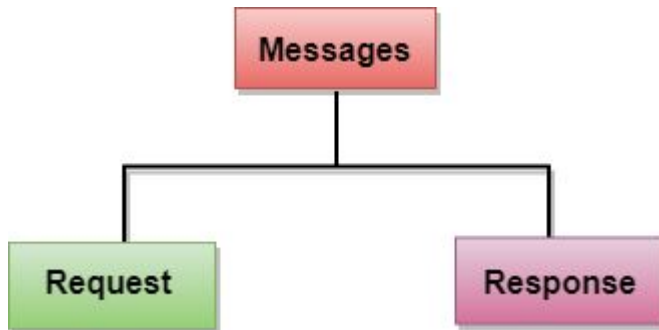
# World Wide Web

## □ HTTP

### Messages

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

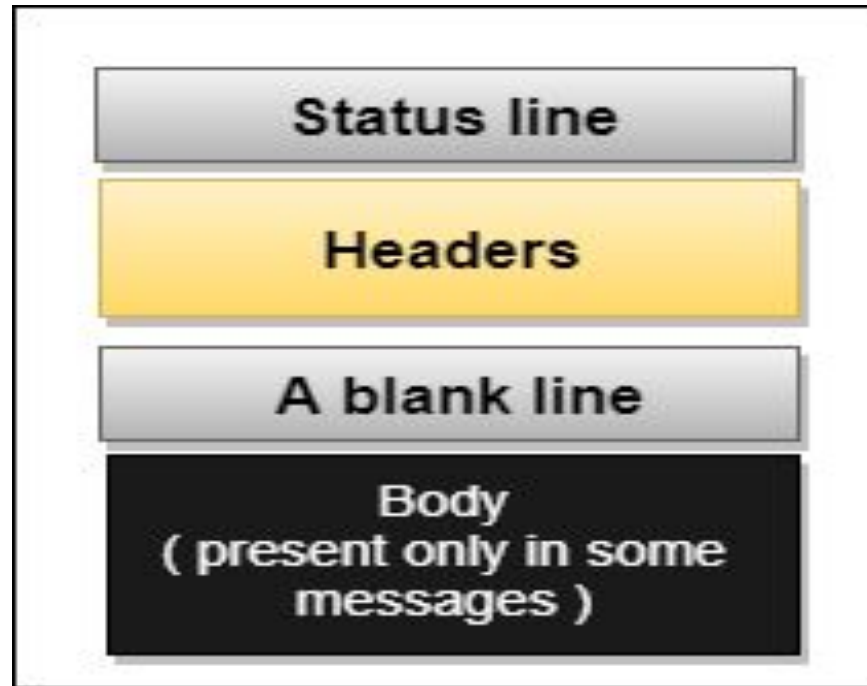
**Request Message:** The request message is sent by the client that consists of a request line, headers, and sometimes a body.



# World Wide Web

## □ HTTP

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



# World Wide Web

## □ HTTP

### 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.





# World Wide Web

## □ HTTP

**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.

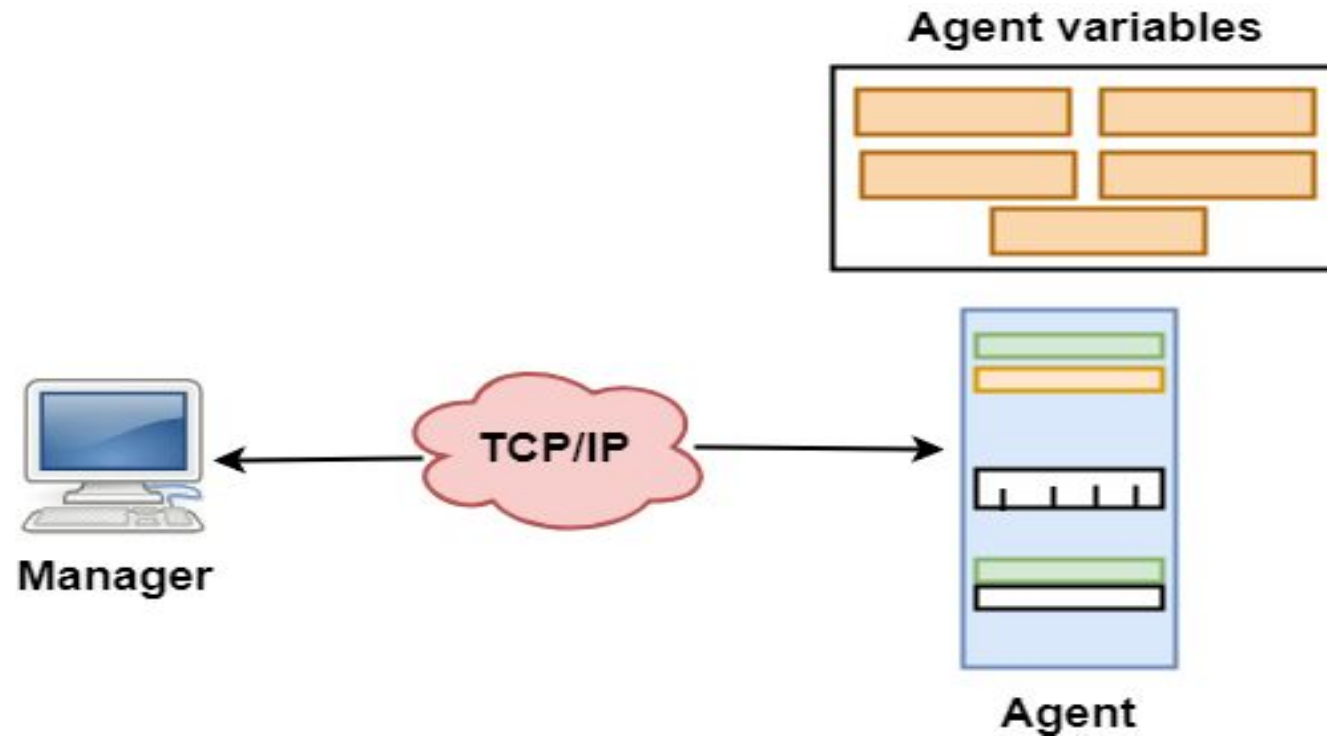
# APPLICATION LAYER PROTOCOLS:

## 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.

# APPLICATION LAYER PROTOCOLS:

## Simple Network Management Protocol:



# APPLICATION LAYER PROTOCOLS:

## Simple Network Management Protocol:

- ❖ 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.

# APPLICATION LAYER PROTOCOLS:

## Simple Network Management Protocol:

### 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.

# APPLICATION LAYER PROTOCOLS:

## Simple Network Management Protocol:

**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.

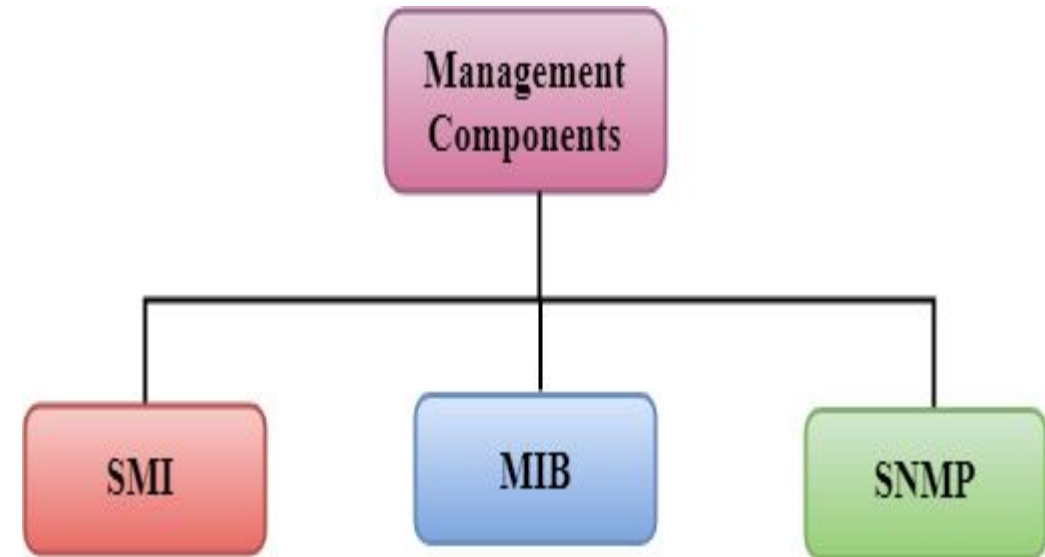
# APPLICATION LAYER PROTOCOLS:

## Simple Network Management Protocol:

### Management Components

#### 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.



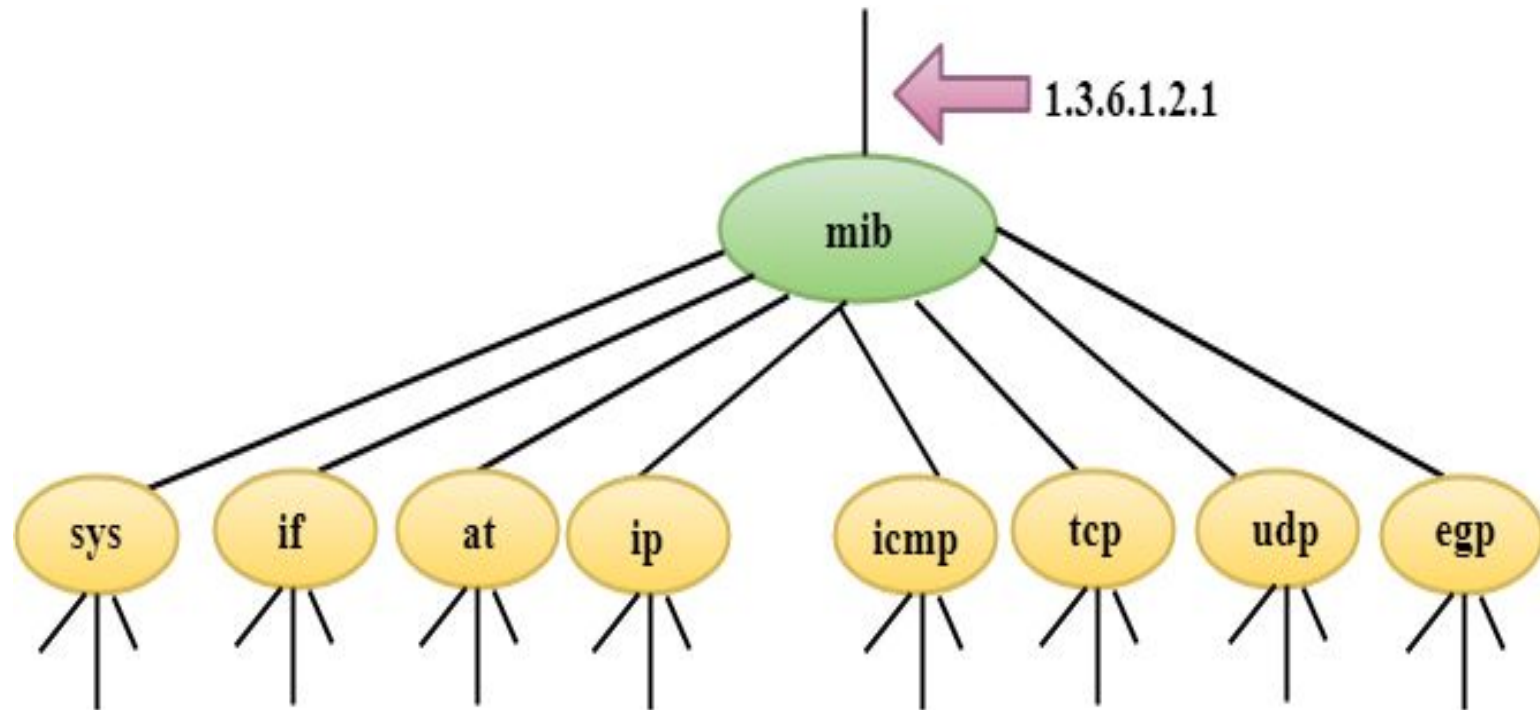
# APPLICATION LAYER PROTOCOLS:

## Simple Network Management Protocol:

### 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.





# APPLICATION LAYER PROTOCOLS:

## Simple Network Management Protocol:

SNMP defines five types of messages:

GetRequest, GetNextRequest, SetRequest, GetResponse, and Trap.

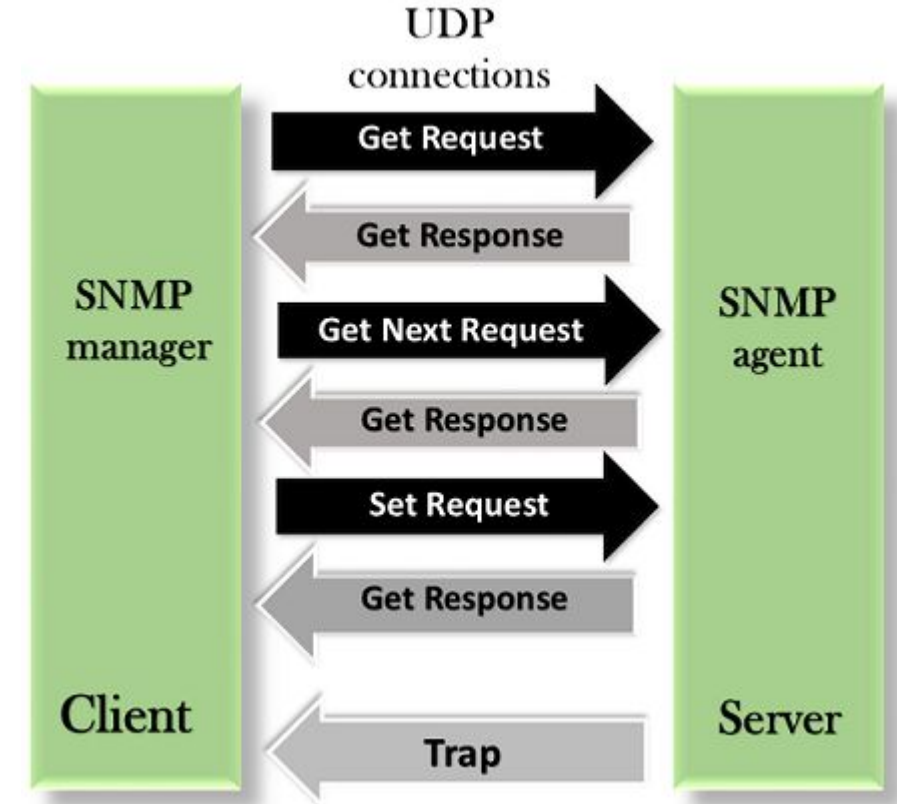
**GetRequest:** The GetRequest message is sent from a manager (client) to the agent (server) to retrieve the value of a variable.

**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.



# APPLICATION LAYER PROTOCOLS:

## File Transfer Protocol:

- ❖ 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.

# APPLICATION LAYER PROTOCOLS:

## File Transfer Protocol:

### 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.

# APPLICATION LAYER PROTOCOLS:

## File Transfer Protocol:

### Why FTP?

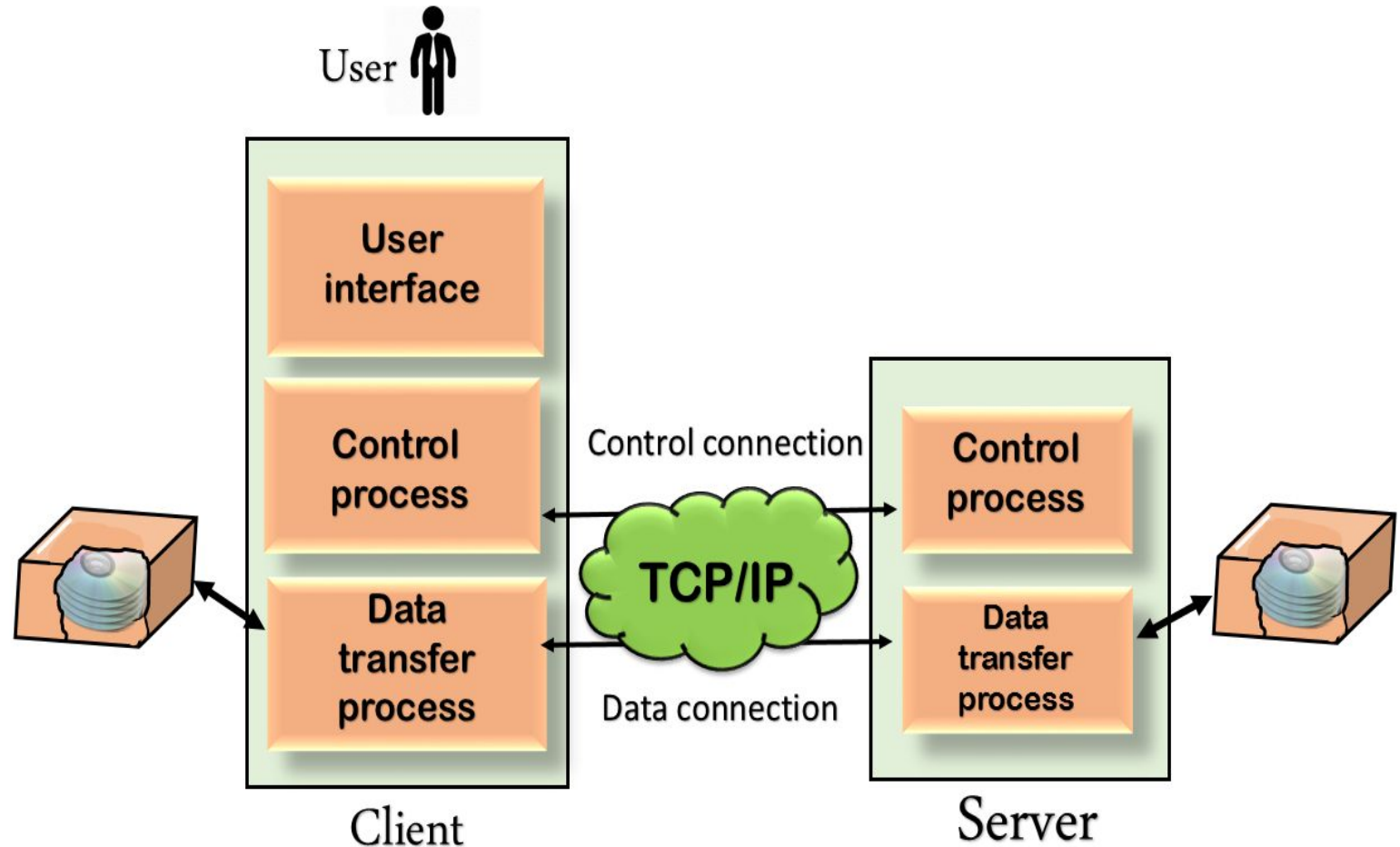
- ❖ Although transferring files from one system to another is very simple and straightforward, but sometimes it can cause problems.
- ❖ For example, two systems may have different file conventions.
- ❖ Two systems may have different ways to represent text and data. Two systems may have different directory 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.

# APPLICATION LAYER PROTOCOLS:

## File Transfer Protocol:

### Mechanism of FTP

The 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.



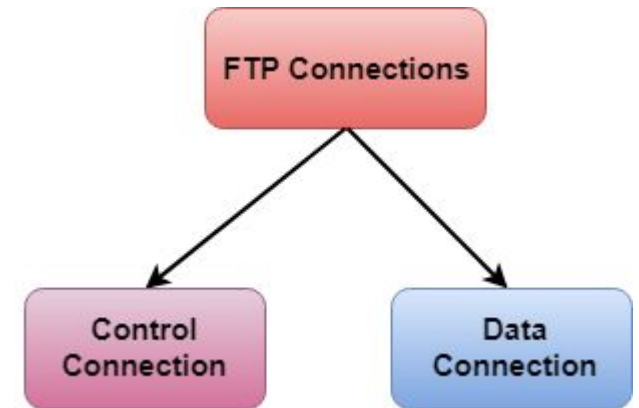
# APPLICATION LAYER PROTOCOLS:

## File Transfer Protocol:

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.



# APPLICATION LAYER PROTOCOLS:

## File Transfer Protocol:

### 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.

# APPLICATION LAYER PROTOCOLS:

## File Transfer Protocol:

### 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.



# APPLICATION LAYER PROTOCOLS:

## File Transfer Protocol:

### 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.

# APPLICATION LAYER PROTOCOLS:

## Simple Mail Transfer Protocol:

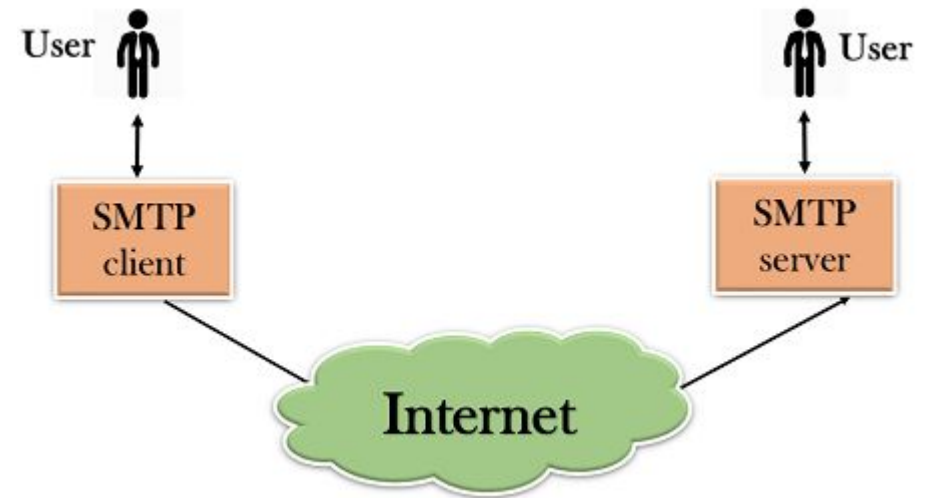
- SMTP stands for Simple Mail Transfer Protocol.
- SMTP is a set of communication guidelines that allow software to transmit an electronic mail over the internet is called **Simple Mail Transfer Protocol**.
- It is a program used for sending messages to other computer users based on e-mail addresses.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

# APPLICATION LAYER PROTOCOLS:

## Simple Mail Transfer Protocol:

### Components of SMTP

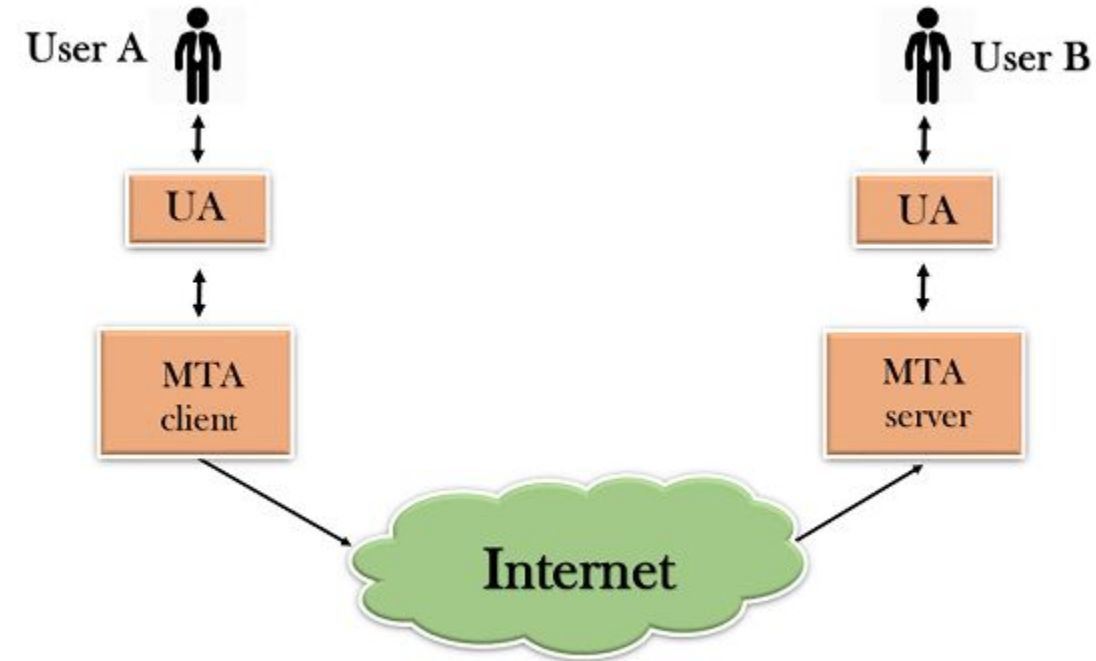
First, we will break the SMTP client and SMTP server into two components such as user agent (UA) and mail transfer agent (MTA). The user agent (UA) prepares the message, creates the envelope and then puts the message in the envelope. The mail transfer agent (MTA) transfers this mail across the internet.



# APPLICATION LAYER PROTOCOLS:

## Simple Mail Transfer Protocol:

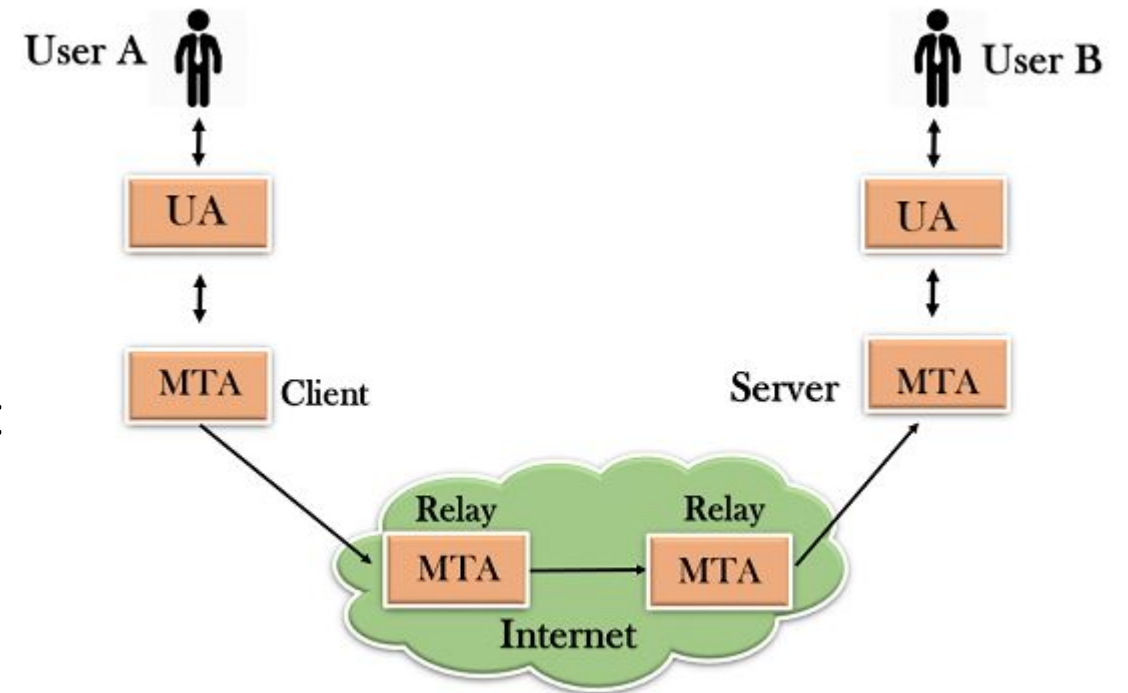
SMTP allows a more complex system by adding a relaying system. Instead of just having one MTA at sending side and one at receiving side, more MTAs can be added, acting either as a client or server to relay the email.



# APPLICATION LAYER PROTOCOLS:

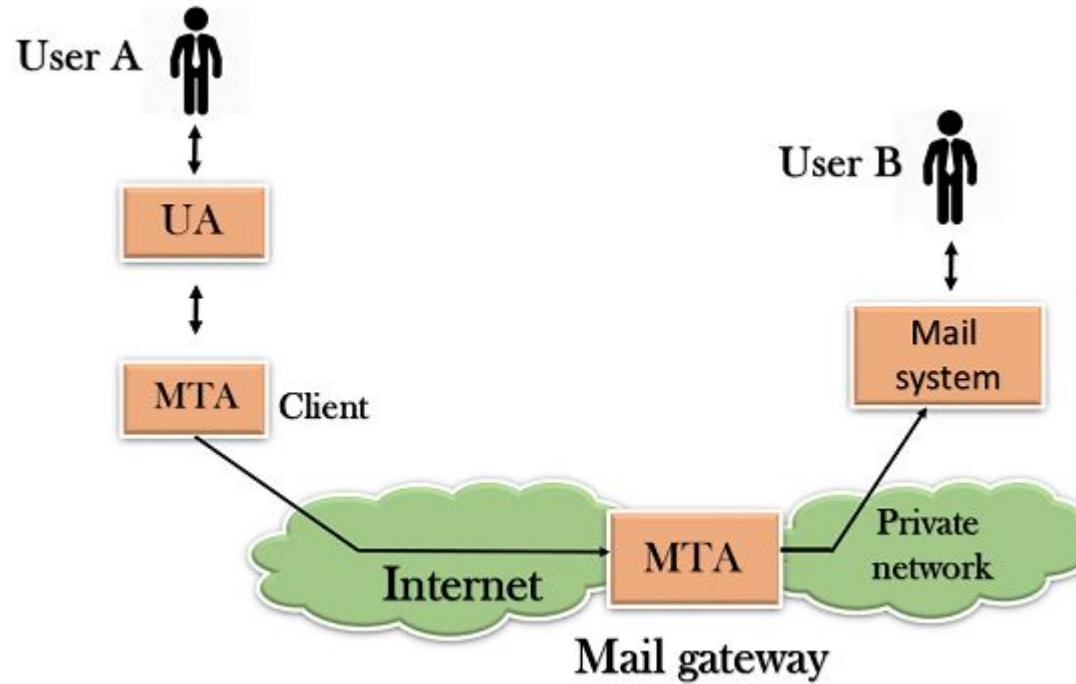
## Simple Mail Transfer Protocol:

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.



# APPLICATION LAYER PROTOCOLS:

## Simple Mail Transfer Protocol:



# APPLICATION LAYER PROTOCOLS:

## Simple Mail Transfer Protocol:

**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.

**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.

# APPLICATION LAYER PROTOCOLS:

## Simple Mail Transfer Protocol:

**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.

**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.

**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.



# APPLICATION LAYER PROTOCOLS:

## 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.

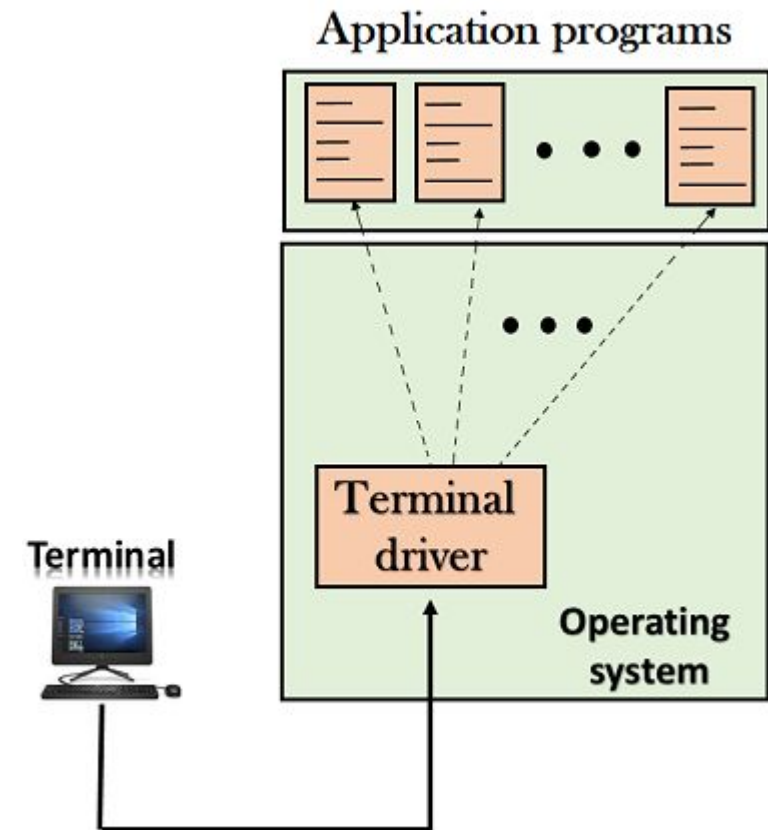
# APPLICATION LAYER PROTOCOLS:

## Telnet:

**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.

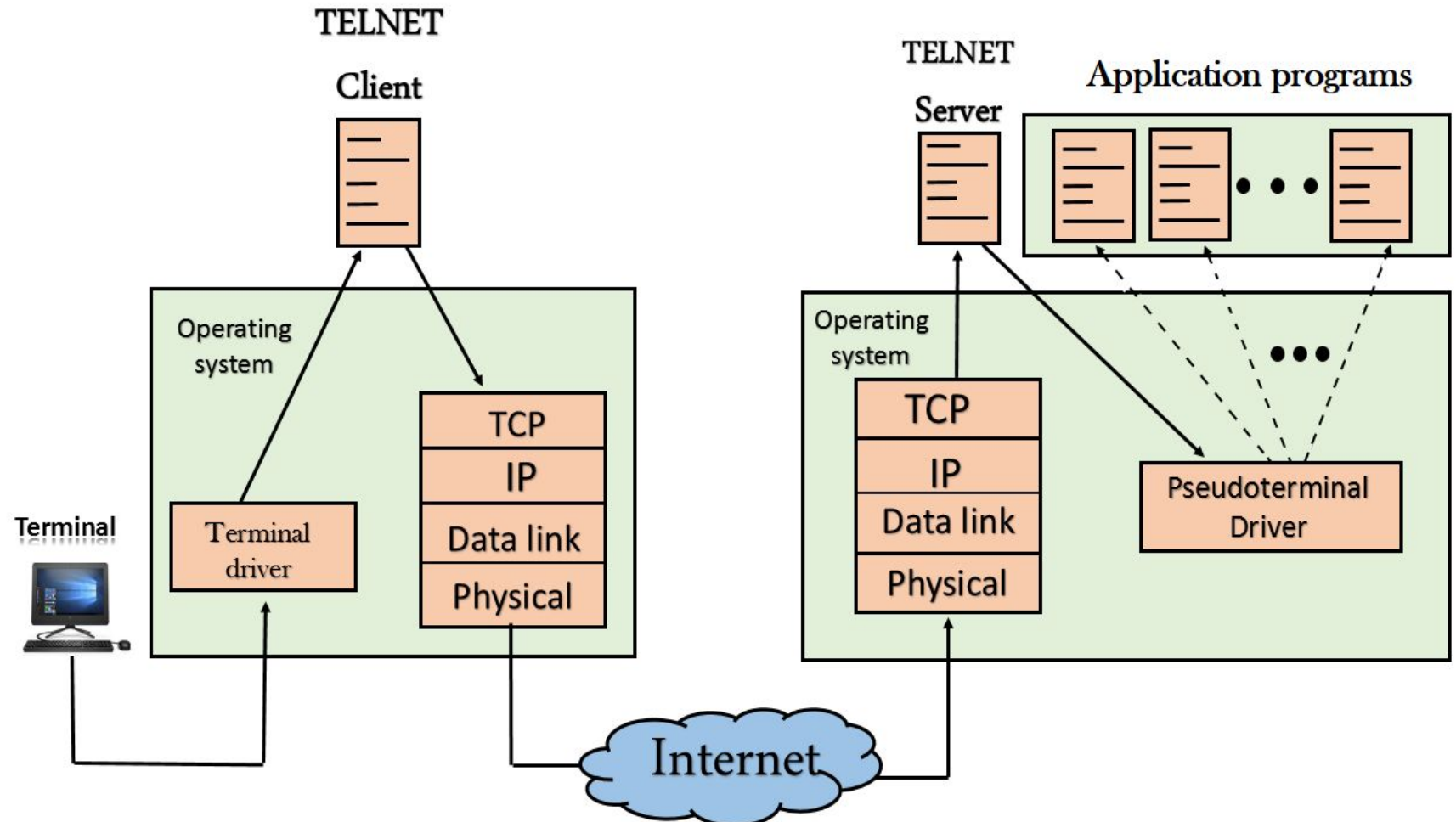


# APPLICATION LAYER PROTOCOLS:

**Telnet:**

**Remote login**

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



# APPLICATION LAYER PROTOCOLS:

## Telnet:

### 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.

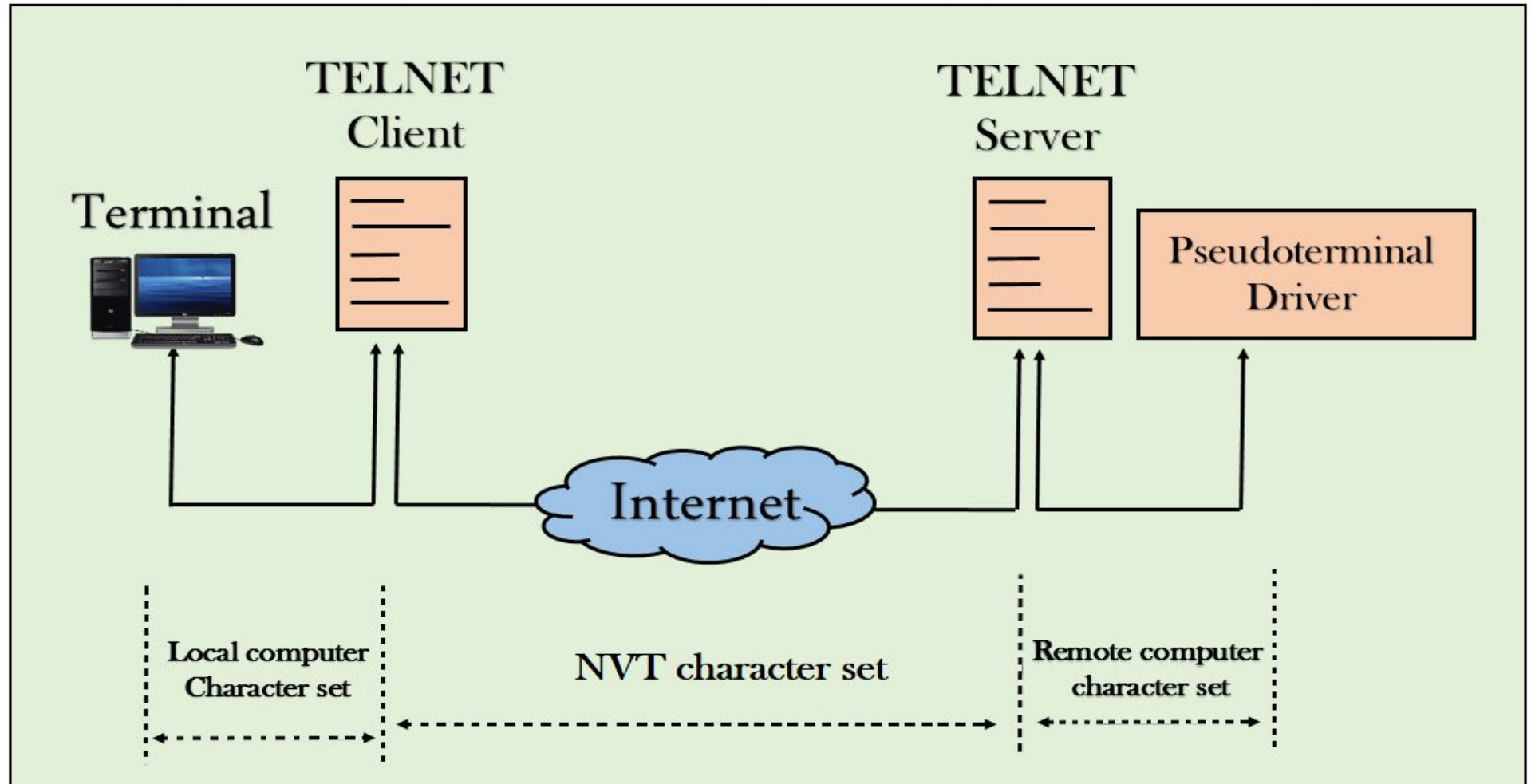
#### At the remote site

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.

# APPLICATION LAYER PROTOCOLS:

Telnet:

Network Virtual Terminal (NVT)



# APPLICATION LAYER PROTOCOLS:

## Telnet:

- ❖ 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.