

Unit V

Application Layer

Introduction

- 1)The Application Layer of OSI (Open System Interconnection) model, is the top layer in this model and **takes care of network communication.**
- 2)The application layer **provides the functionality to send and receive data from users.**
- 3)It acts as the interface between the user and the application.
- 4)The application provides services like **file transmission, mail service, and many more.**

Functions of Application Layer

- ▶ Application Layer provides a facility by which users can forward several emails and it also provides a storage facility.
- ▶ This layer allows users to access, retrieve and manage files in a remote computer.
- ▶ It allows users to log on as a remote host.
- ▶ This layer provides access to global information about various services.
- ▶ This layer provides services which include: e-mail, transferring files, distributing results to the user, directory services, network resources and so on.

▶ **Working of Application Layer**

- ▶ At first, client sends a command to server and when server receives that command, it allocates port number to client.
- ▶ Thereafter, the client sends an initiation connection request to server and when server receives request, it gives acknowledgement (ACK) to client through which client has successfully established a connection with the server.
- ▶ Therefore, now client has access to server through which it may either ask server to send any types of files or other documents or it may upload some files or documents on server itself.

Protocols of Application Layer



```
graph TD; A[Protocols of Application Layer] --> B[HTTP]; A --> C[DNS]; A --> D[FTP]; A --> E[TFTP]; A --> F[SMTP]; A --> G[SNMP]; A --> H[TELNET]
```

HTTP

DNS

FTP

TFTP

SMTP

SNMP

TELNET

▶ **Application Layer Protocols**

- ▶ The application layer provides several protocols which allow any software to easily send and receive information and present meaningful data to its users. The following are some of the [application layer protocols](#).
- ▶ **TELNET:** [Telnet](#) stands for Telecommunications Network. This protocol is used for managing files over the Internet. It allows the Telnet clients to access the resources of Telnet server. Telnet uses port number 23.
- ▶ **DNS:** DNS stands for Domain Name System. The DNS service translates the domain name (selected by user) into the corresponding IP address. For example- If you choose the domain name as `www.abcd.com`, then DNS must translate it as `192.36.20.8` (random IP address written just for understanding purposes). DNS protocol uses the port number 53.

- ▶ **DHCP**: DHCP stands for Dynamic Host Configuration Protocol. It provides IP addresses to hosts. Whenever a host tries to register for an IP address with the DHCP server, DHCP server provides lots of information to the corresponding host. DHCP uses port numbers 67 and 68.
- ▶ **FTP**: FTP stands for File Transfer Protocol. This protocol helps to transfer different files from one device to another. FTP promotes sharing of files via remote computer devices with reliable, efficient data transfer. FTP uses port number 20 for data access and port number 21 for data control.

- ▶ **SMTP**: SMTP stands for Simple Mail Transfer Protocol. It is used to transfer electronic mail from one user to another user. SMTP is used by end users to send emails with ease. SMTP uses port numbers 25 and 587.
- ▶ **HTTP**: HTTP stands for Hyper Text Transfer Protocol. It is the foundation of the World Wide Web (WWW). HTTP works on the client server model. This protocol is used for transmitting hypermedia documents like HTML. This protocol was designed particularly for the communications between the web browsers and web servers, but this protocol can also be used for several other purposes. HTTP is a stateless protocol (network protocol in which a client sends requests to server and server responses back as per the given state), which means the server is not responsible for maintaining the previous client's requests. HTTP uses port number 80.

- ▶ **NFS**: NFS stands for Network File System. This protocol allows remote hosts to mount files over a network and interact with those file systems as though they are mounted locally. NFS uses the port number 2049.
- ▶ **SNMP**: SNMP stands for Simple Network Management Protocol. This protocol gathers data by polling the devices from the network to the management station at fixed or random intervals, requiring them to disclose certain information. SNMP uses port numbers 161 (TCP) and 162 (UDP).

1)Domain Name System(DNS)

- ▶ DNS help us to **get IP address from domain name and vice versa**
- ▶ **Google.com---→IP address of google.com**
- ▶ DNS uses **UDP protocol**
- ▶ You can have your own domain as my **websites:www.google.com**
- ▶ **IP address are dynamic so they can change with respect to time**
recently accessed domains are stored as entries for faster access to the domain.

Domain Name	IP	TTL
Google.com	XX	XX
Amazon.com	XX	XX
Flipkart.com	XX	XX



DNS

No.	Time	Source	Destination	Protocol	Length	Info
40274	480.840322	35.233.239.65	172.16.0.99	TLSv1.2	124	Application Data
40275	480.840350	172.16.0.99	35.233.239.65	TCP	54	53641 → 443 [ACK] Seq=6139 Ack=1427 Win=512 Len=0
40276	480.840981	172.16.0.99	35.233.239.65	TLSv1.2	96	Application Data
40277	480.843145	172.16.0.153	224.0.0.251	MDNS	182	Standard query 0x0000 SRV 401-7._smb._tcp.local, "QM" question AAAA 401-7.local, "QM" question A 401-7.local, "QM" qu
40278	480.843145	fe80::3ce5:86c7:f2bb:2eb9	ff02::fb	MDNS	186	Standard query 0x0000 SRV 401-7._smb._tcp.local, "QM" question AAAA 401-7.local, "QM" question A 401-7.local, "QM" qu
40279	480.843145	172.16.1.175	224.0.0.251	MDNS	182	Standard query 0x0000 SRV 401-7._smb._tcp.local, "QM" question AAAA 401-7.local, "QM" question A 401-7.local, "QM" qu
40280	480.844378	172.16.1.122	224.0.0.251	MDNS	60	Standard query response 0x0000
40281	480.844378	fe80::34ec:f5cb:dc2c:8522	ff02::fb	MDNS	74	Standard query response 0x0000
40282	480.844378	fe80::2997:f6c0:130d:8771	ff02::fb	MDNS	186	Standard query 0x0000 SRV 401-7._smb._tcp.local, "QM" question AAAA 401-7.local, "QM" question A 401-7.local, "QM" qu
40283	480.844378	172.16.1.122	224.0.0.251	MDNS	60	Standard query response 0x0000
40284	480.845257	fe80::34ec:f5cb:dc2c:8522	ff02::fb	MDNS	74	Standard query response 0x0000
40285	480.845281	172.16.0.233	224.0.0.251	MDNS	156	Standard query 0x0000 TXT 401-7._smb._tcp.local, "QM" question AAAA 401-7.local, "QM" question A 401-7.local, "QM" qu
40286	480.845281	fe80::7f3e:510b:67a8:82dc	ff02::fb	MDNS	160	Standard query 0x0000 TXT 401-7._smb._tcp.local, "QM" question AAAA 401-7.local, "QM" question A 401-7.local, "QM" qu
40287	480.846064	14.96.1.97	172.16.0.93	TCP	74	443 → 56912 [SYN, ACK] Seq=0 Ack=1 Win=31740 Len=0 MSS=1392 SACK_PERM TSval=723391349 TSecr=1446142645 WS=256
40288	480.846064	172.16.1.122	224.0.0.251	MDNS	60	Standard query response 0x0000
40289	480.846064	Fortinet_98:61:0e	Broadcast	ARP	60	Who has 172.16.0.237? Tell 172.16.0.1
40290	480.846064	fe80::34ec:f5cb:dc2c:8522	ff02::fb	MDNS	74	Standard query response 0x0000
40291	480.848827	216.239.36.223	172.16.0.125	UDP	210	443 → 53539 Len=168
40292	480.878434	LiteON_5c:da:b2	Broadcast	ARP	60	Who has 172.16.0.63? Tell 172.16.2.162

> Frame 40277: 182 bytes on wire (1456 bits), 182 bytes captured (1456 bits) on interface \Device\NPF_{A68F9A17-...}

> Ethernet II, Src: MicroStarINT_0e:7f:06 (d8:cb:8a:0e:7f:06), Dst: IPv4mcast_fb (01:00:5e:00:00:fb)

> Internet Protocol Version 4, Src: 172.16.0.153, Dst: 224.0.0.251

> User Datagram Protocol, Src Port: 5353, Dst Port: 5353

> Multicast Domain Name System (query)

> Transaction ID: 0x0000

> Flags: 0x0000 Standard query

Questions: 4

Answer RRs: 4

Authority RRs: 0

Additional RRs: 0

> Queries

> Answers

[\[Retransmitted request. Original request in: 39955\]](#)

[Retransmission: True]

```

0000 01 00 5e 00 00 fb d8 cb 8a 0e 7f 06 08 00 45 00  ..^.....E.
0010 00 a8 1f d5 40 00 ff 11 cd ca ac 10 00 99 e0 00  ....@.....
0020 00 fb 14 e9 14 e9 00 94 68 12 00 00 00 00 04  ....h.....
0030 00 04 00 00 00 05 34 30 31 2d 37 04 5f 73 6d  0004 000000053430312d37045f736d
0040 62 04 5f 74 63 70 05 6c 6f 63 61 6c 00 00 21 00  b._tcp.l ocal..!
0050 01 05 34 30 31 2d 37 c0 1c 00 1c 00 01 c0 27 00  ..401-7. ....'
0060 01 00 01 c0 0c 00 10 00 01 c0 0c 00 10 00 01 00  .....
0070 00 11 94 00 01 00 c0 27 00 01 00 01 00 00 00 78  .....x
0080 00 04 ac 10 01 09 c0 27 00 1c 00 01 00 00 00 78  .....x
0090 00 10 fe 80 00 00 00 00 00 00 82 27 4f c0 98 a1  .....O...
00a0 fd 07 c0 0c 00 21 00 01 00 00 00 78 00 08 00 00  .....!...x...
00b0 00 00 01 bd c0 27  .....
    
```

Microsoft Windows [Version 10.0.19045.4894]
(c) Microsoft Corporation. All rights reserved.

```
C:\Users\Lenovo>nslookup yahoo.com
Server: ns4.tataidc.co.in
Address: 103.8.46.5
```

Non-authoritative answer:

```
Name: yahoo.com
Addresses: 2001:4998:44:3507::8000
           2001:4998:24:120d::1:1
           2001:4998:44:3507::8001
           2001:4998:24:120d::1:0
           2001:4998:124:1507::f000
           2001:4998:124:1507::f001
           74.6.143.26
           98.137.11.164
           74.6.143.25
           74.6.231.20
           98.137.11.163
           74.6.231.21
```

```
C:\Users\Lenovo>
```



Type here to search



Closed road on Kore...



10:21

30-09-2024



How domain names are classified

- ▶ **Generic domain**

- ▶ .com

- ▶ .org

- ▶ .edu

- ▶ .net

- ▶ .mil

- ▶ **Country domain**

- ▶ .in

- ▶ .jp

- ▶ .uk

- ▶ .de

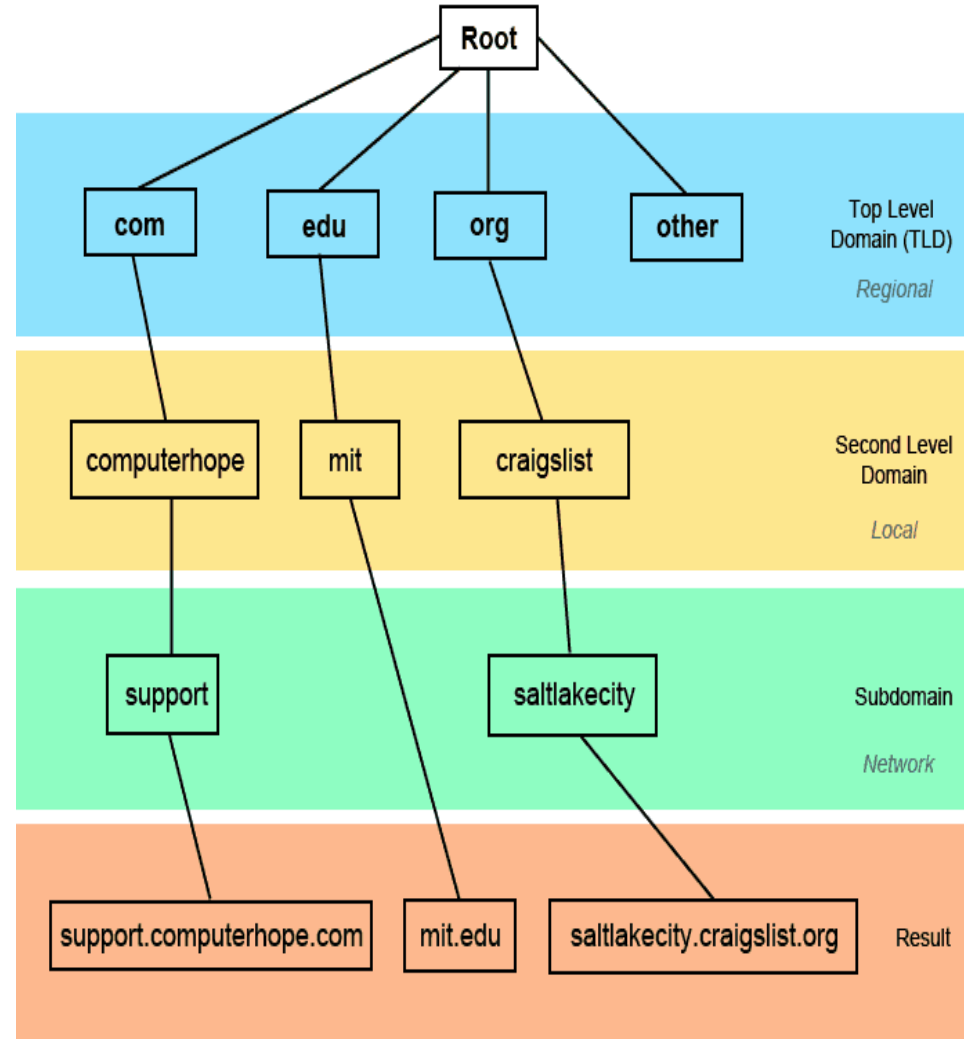
.org

.in

apex

apex.in.org

Domain Naming Hierarchy



DNS Database Organization

Root DNS Server

- 13 Root servers are there in the world to avoid

Name Server

- Name server means .com, .in, .org

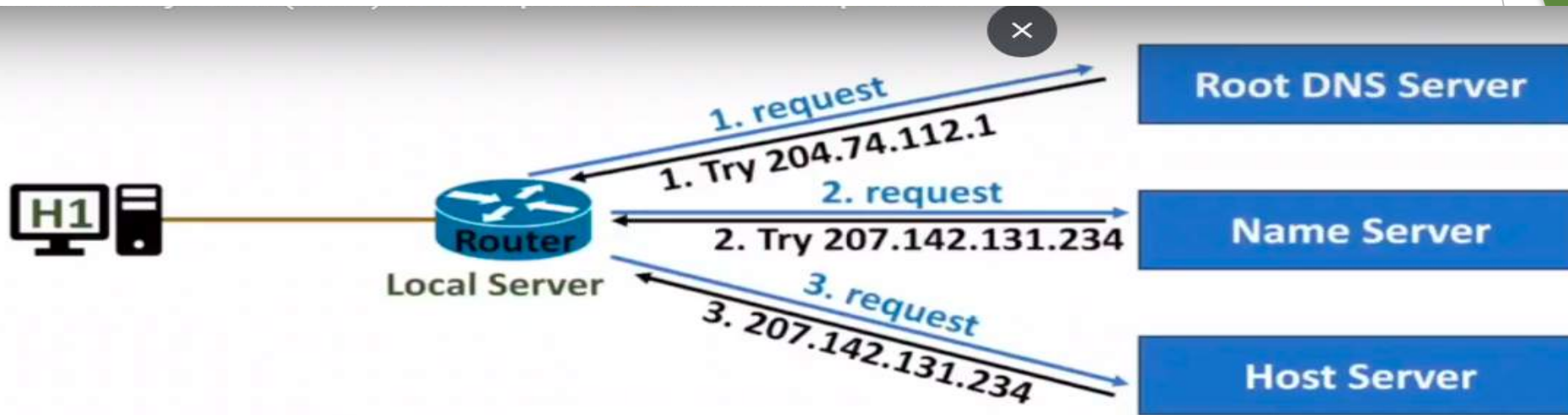
Host Server

- Host server hosts the database like YouTube

❖ DNS Entry

Domain Name	IP Address	Validity/TTL
Google.com	XX	XX
Amazon.co.in	XX	XX
XXX	XX	XX

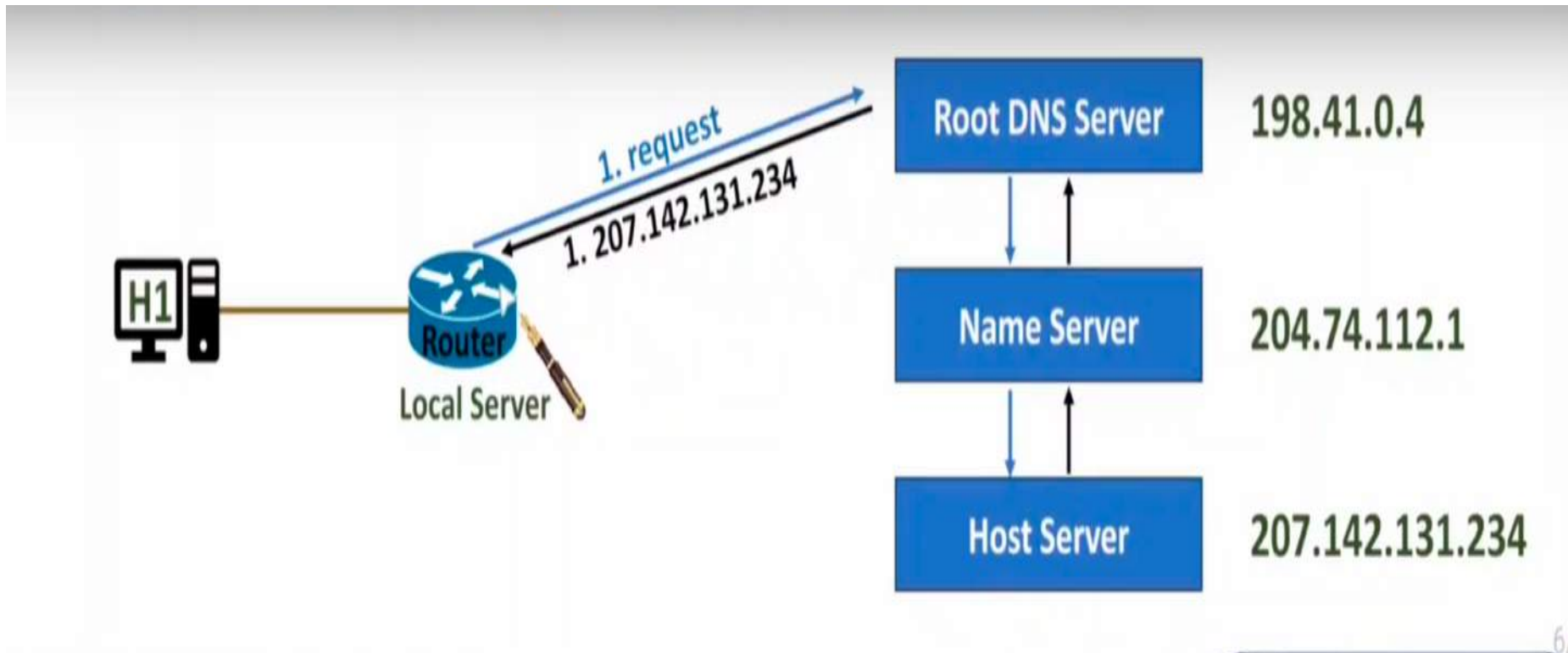
Address resolution using iterative method



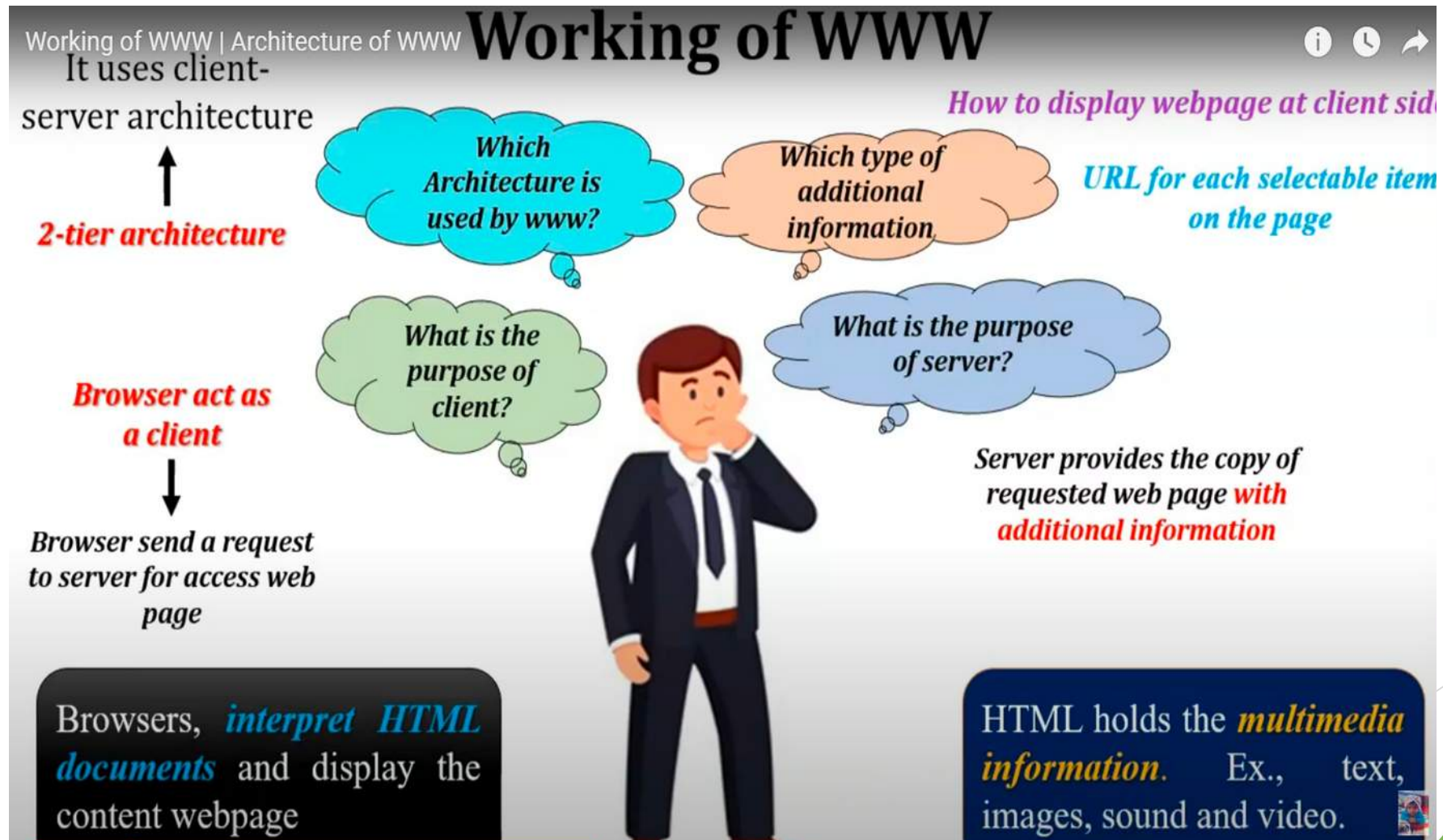
❖ Address Resolution using the Recursive method in DNS

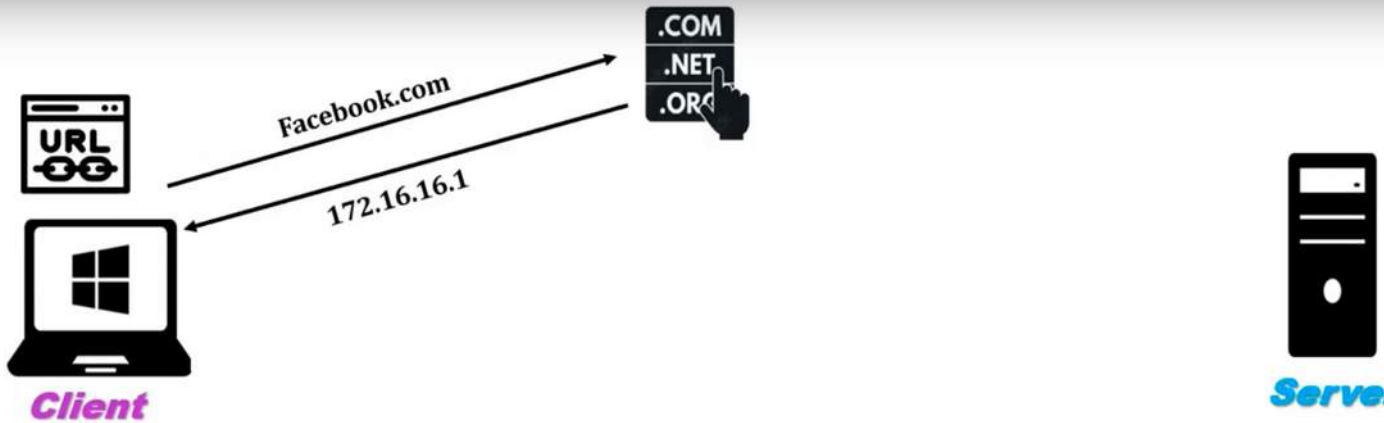


Address resolution using recursive method

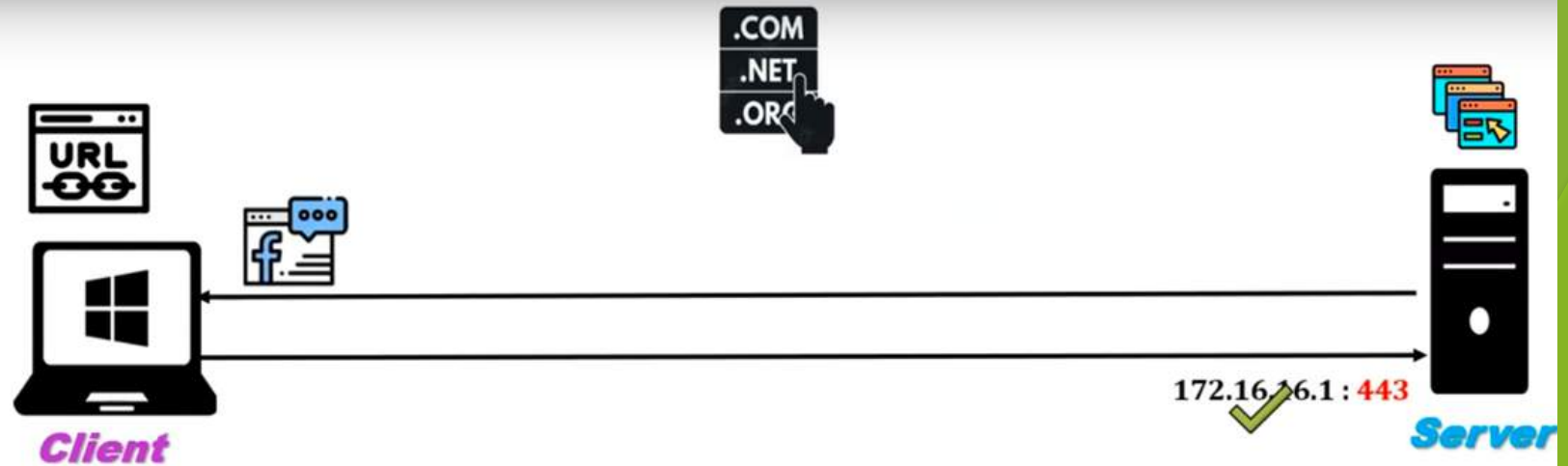


2) World wide web



DNS Server

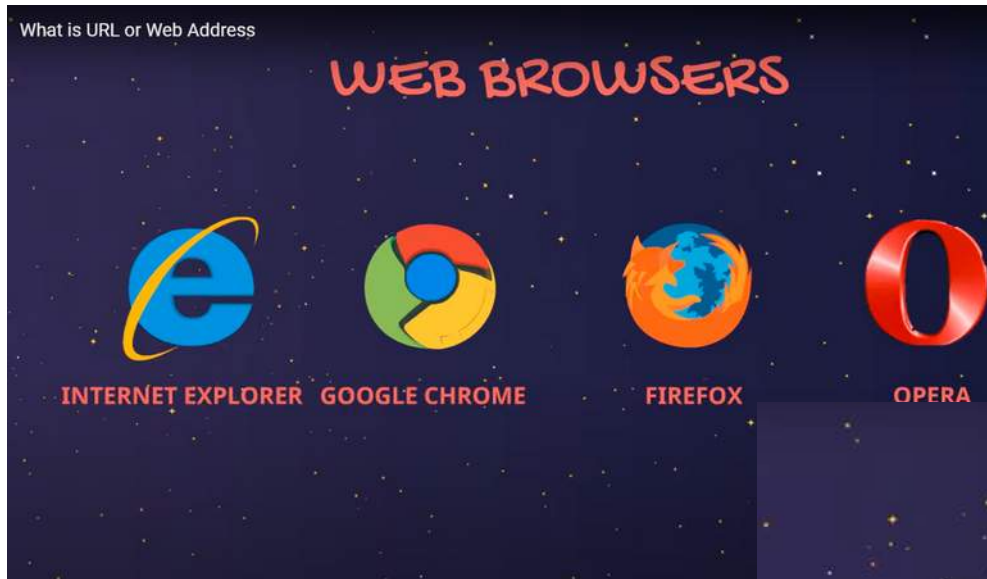
- User enter an URL in Browser. Ex., **www.facebook.com**
- The browser asks DNS for the **IP address of URL**
- DNS **replies with IP Address** ex., 172.16.16.1

DNS Server

- User enter an URL in Browser. Ex., **www.facebook.com**
- The browser asks DNS for the **IP address of URL**
- DNS **replies with IP Address** ex., 172.16.16.1
- The browser make a **TCP connection to port 443** on 172.16.16.1
- **Sends a request to server** for Webpage
- Client **receive** the requested file

- **Accept a TCP connection** from a client browser.
- Get the **name of the file** required.
- **Search the requested file** from stored files.
- **Get the requested file** from directory.
- **Return the file** to the client.

3) Web Browser Uniform resource locator(URL)



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URL



Subdomain

Top Level
Domain

Directory/
File Path

HTTP://WWW.MYSITE.COM.IN/ACADEMICS/STAR.HTML

Protocol

Domain

Geographical
Domain

⤴ Pull up for p



4) Web Documents

▶ 1) Static Web document

▶ The content of static web document are fix.

▶ These content are created & stored in a server .

▶ If required the client can get a copy of static document

▶ Ex-HTML

▶ 2) Dynamic Web document:

▶ The dynamic document are not present in a predefined format like static documents.

▶ A dynamic documents is created by a server on the request for document from browser

What Is a Static Site?



5)HTTP

- ▶ **HTTP** stands for **HyperText Transfer Protocol**.
- ▶ It is a protocol **can be used to transfer the data on world wide web**
- ▶ **What is HyperText?**
- ▶ The **protocol used to transfer hypertext between two computers is known as HyperText Transfer Protocol**.
- ▶ HTTP provides a standard between a **web browser and a web server to establish communication**.
- ▶ It is a set of rules for transferring data from one computer to another. Data such as **text, images, and other multimedia files** are shared on the World Wide Web.

Features Of HTTP

Key Features of HTTP:



Protocol Without
Connection



Media
Independent



Stateless

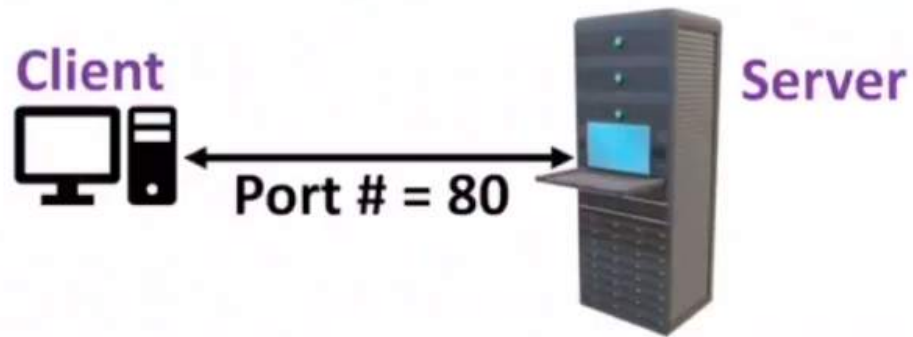


Lengthy
Links

HTTP:

❖ Basics of HTTP/HTTPs

- ❑ HTTP is Hypertext Transfer Protocol.
- ❑ Port Number for HTTP is 80.
- ❑ At the transport Layer, HTTP usually uses TCP for reliable service.



- ❑ Server stays stateless. Many clients are connected to the server, but the server does not maintain the state of each client.
- ❑ Client state is maintained using cookies.
- ❑ HTTP is an In-Band protocol. {Command and Data are on the same connection}

Types of HTTP:

- ▶ **HTTP 1.0(Non-Persistent Connection)**
- ▶ **TCP** connection is established for each HTTP request
- ▶ **After the server sends the response back to the client connection is closed**
- ▶ If the client needs to make another request it has to **establish a new TCP connection.**
- ▶ **HTTP 1.1(Persistent Connection)**
- ▶ The **client and server maintain the connection open after the information exchange**
- ▶ So no need to established a new connection.

❖ HTTP Methods

- ❑ GET: The GET method is used to retrieve data from the server.
- ❑ HEAD: It is similar to the GET method, but it requests only the headers of the resource and not the actual content.
- ❑ POST: Post is used in filling forms on the server. In the POST method, the client fills forms back to the server.
- ❑ PUT: PUT method is used for uploading the object on the server. {Upload file on server}
- ❑ DELETE: The DELETE method is used to request the removal of an object on the server.
- ❑ CONNECT: The CONNECT method is used by HTTPS to enable secure connections.

- ❑ DELETE: The DELETE method is used to request the removal of an object on the server.
- ❑ CONNECT: The CONNECT method is used by HTTPS to enable secure connections.
- ❑ OPTIONS: The OPTIONS method is used to request information about the communication options available for a particular URL.
- ❑ TRACE: The TRACE method is used to see what are the intermediate servers have received and how they interpret the request.
- ❑ PATCH: The PATCH method is used to apply partial modifications to a resource.

▶ **Advantages of HTTP**

- ▶ Memory usage and CPU usage are low because of fewer simultaneous connections.
- ▶ Since there are few TCP connections hence network congestion is less.
- ▶ Since handshaking is done at the initial connection stage, then latency is reduced because there is no further need for handshaking for subsequent requests.
- ▶ The error can be reported without closing the connection.
- ▶ HTTP allows HTTP pipe-lining of requests or responses.

▶ **Disadvantages of HTTP**

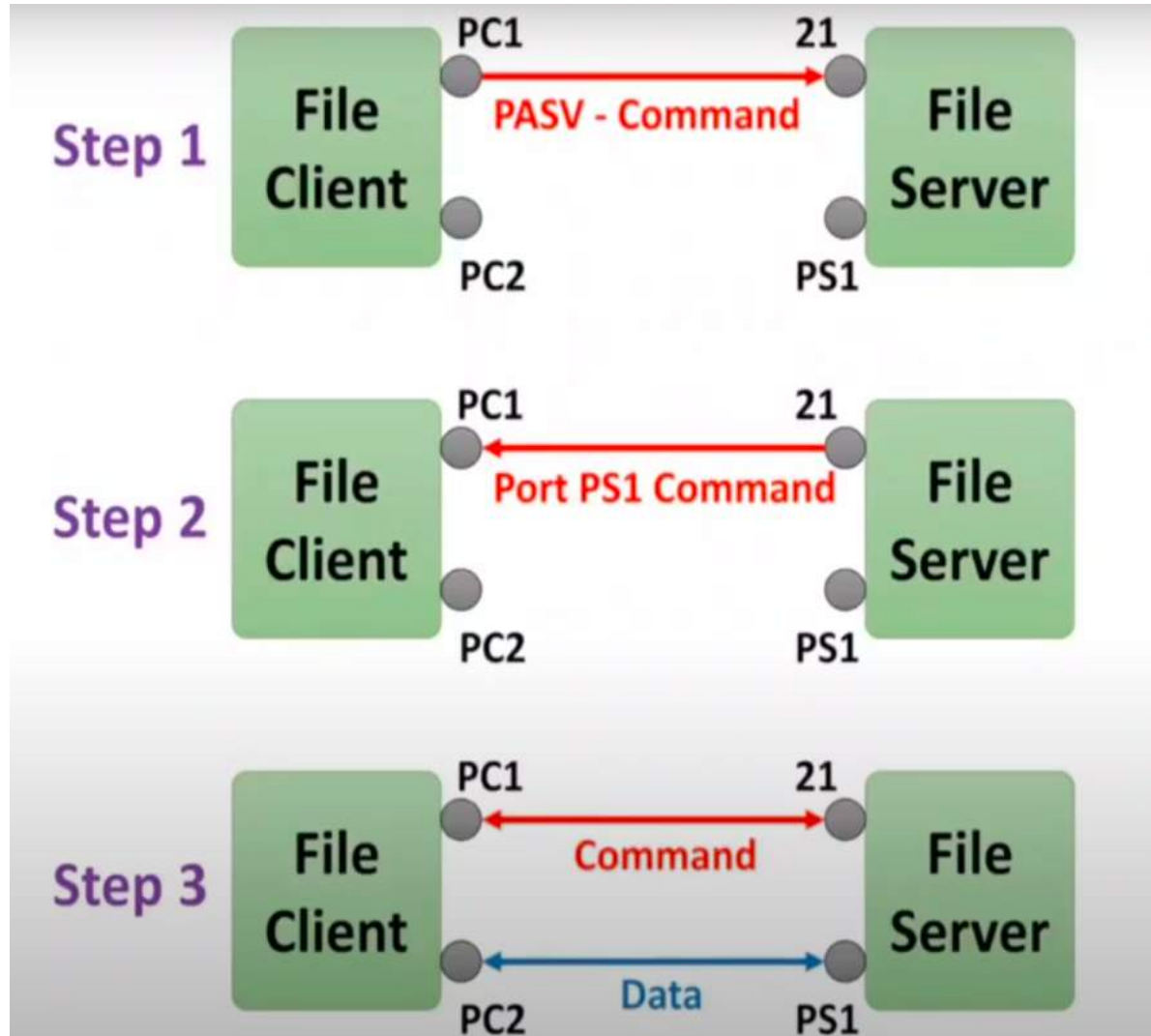
- ▶ HTTP requires high power to establish communication and transfer data.
- ▶ HTTP is less secure because it does not use any encryption method like HTTPS and uses TLS to encrypt regular HTTP requests and responses.
- ▶ HTTP is not optimized for cellular phones and it is too gabby.
- ▶ HTTP does not offer a genuine exchange of data because it is less secure.
- ▶ The client does not close the connection until it receives complete data from the server; hence, the server needs to wait for data completion and cannot be available for other clients during this time.

Basics of FTP ,SFTP,TFTP(FILE transfer protocol)

❖ Basics of FTP, SFTP & TFTP

- ❑ FTP, SFTP & TFTP are used to transfer files over the computer network.
- ❑ FTP – File Transfer Protocol (Port Number = 21)
 - It has two channels, one is for data and the second is for command. (Out-of-band protocol)
 - It has no encryption, so data tempering is possible.
 - It uses TCP for data communication.
- ❑ SFTP – SSH (Secure Shell) File Transfer Protocol (Port Number = 22)
 - It has a single channel for data and command. (In-Band Protocol)
 - Both data and command are encrypted in SFTP.
 - It uses TCP for data communication.
- ❑ TFTP – Trivial File Transfer Protocol (Port Number = 69)
 - It doesn't require authentication, making it less secure than FTP and SFTP.
 - It uses UDP for data communication.
 - It is not used over the internet, it is mainly used for transferring files within LAN.

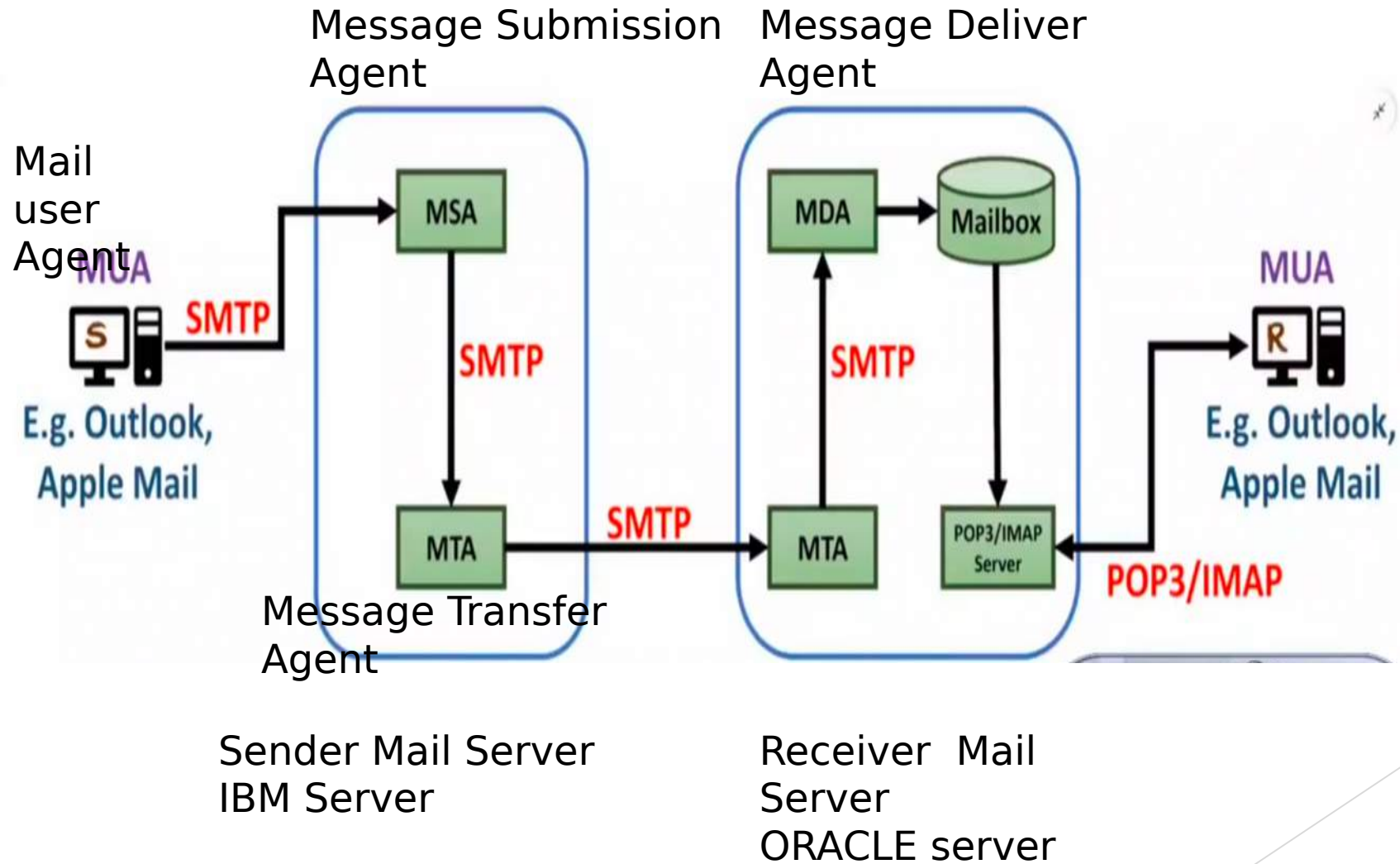
Working of FTP(Upload,Download,Access file)



PASV command to initiate file transfer

Port PS1 command to give the location of the port for data transfer

SMTP, POP & IMAP in Computer N/W (Mail Protocol)



Parameters	SMTP	POP	IMAP
Full Form	Simple Mail Transfer Protocol	Post Office Protocol	Internet Message Access Protocol
Transfer Type	Send Mail (Push Mail)	Retrieve Mail (Pop Mail)	Retrieve Mail (Pop Mail)
Port Number	25	110 (Default) & 995 (SSL)	143 (Default) & 993 (SSL)
Transport Layer	TCP	TCP	TCP

Examples on Application Layer Protocols

Example 1 – Which of the following protocol pairs can be used to send and retrieve emails (in that order)?

- a. IMAP, POP3
- b. SMTP, POP3
- c. SMTP, MIME
- d. IMAP, SMTP

✓ SMTP, POP
✓ SMTP, IMAP

Example 2 – Which one of the following protocols is NOT used to resolve one form of address to another one?

- a. DNS ✗
- b. ARP ✗
- c. DHCP ✓
- d. RARP ✗

Example 3 – Which of the following is/are examples of stateful application layer protocols?

- a. HTTP ✗
- b. FTP ✓
- c. TCP ✗
- d. POP3 ✓

Example 4 – Which of the following statements is NOT correct about HTTP cookies?

- a. A cookie is a piece of code that has the potential to compromise the security of an Internet user.
- b. A cookie gains entry to the user's work area through an HTTP header.
- c. A cookie has an expiry date and time.
- d. A cookie can be used to track the browsing pattern of a user at a particular site.

