UNIT V : INTERNETWORKING PROTOCOLS

Network Protocols

Email Architecture

Web server

Browsers

Domain Name System

IP protocol

IP addresses

IPv6.

Introduction to Wi-Fi & 4G technology.

NETWORK PROTOCOLS

Network Protocols are a set of guidelines governing the exchange of information in a simple, dependable and secure way.

Network protocols are formal standards and policies comprised of rules, methodology, and configurations that define communication between two or more devices over a network.

To effectively send and receive information, devices on the two sides of a communication exchange must follow protocols.

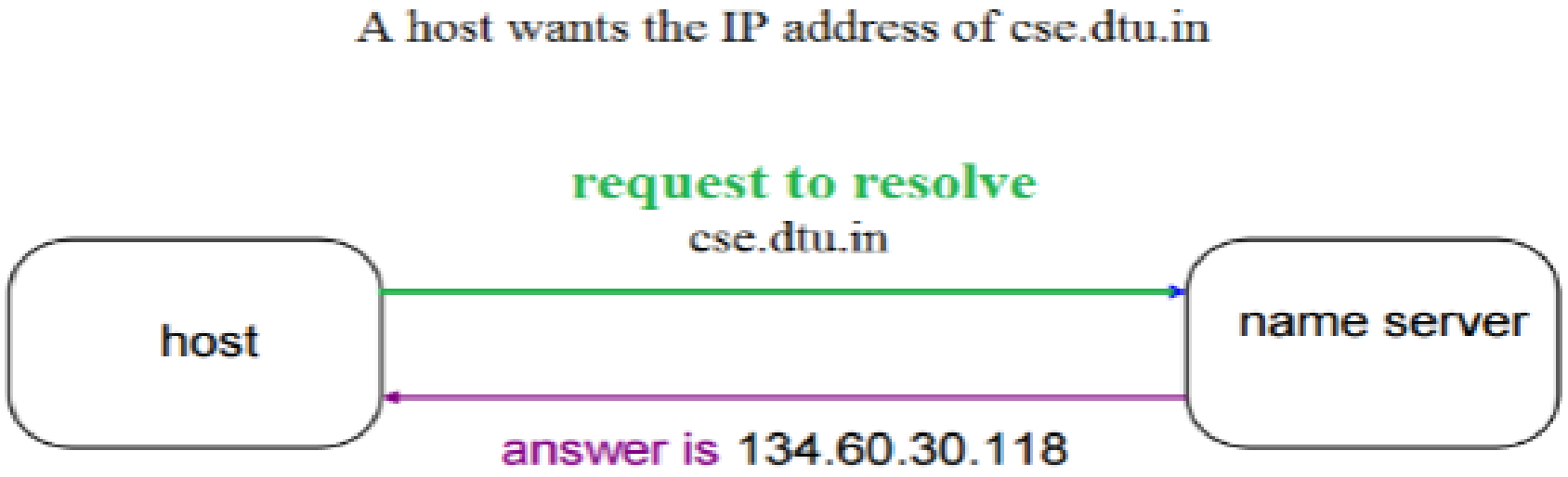
Network Time Protocol:

Network Time Protocol (NTP) is a protocol that synchronizes the clocks of computer systems over data networks. NTP was designed by David L. Mills. NTP permits network devices to synchronize their time settings with the NTP server. NTP is one of the most established internet protocols in current use.

Domain Name System:

DNS resolves a Uniform Resource Locator or website address to the IP address of the site.

When users type a web address into the address bar they rely on DNS servers to resolve the actual IP address of that destination. DNS translates domain names to IP addresses.



Routing Information Protocol:

It constrains the number of hops permitted in a path on a network from the source device to the destination. The maximum number of hops permitted for RIP is fifteen.

It is a routing protocol used to exchange routing information. It figures the best route based on hop count.

It actualizes the split horizon, route poisoning and, hold down mechanisms.

It is a dynamic routing protocol which uses hop count as a routing metric to find the best path between the source and the destination network

Dynamic Host Control Protocol:

Dynamic Host Control Protocol (DHCP) uses a server to allocate an IP address and other configuration information to network devices.

As a result, the device is getting a permission slip from the DHCP server to use the network.

DHCP enables users to send a request to the DHCP server whenever they connect to a network.

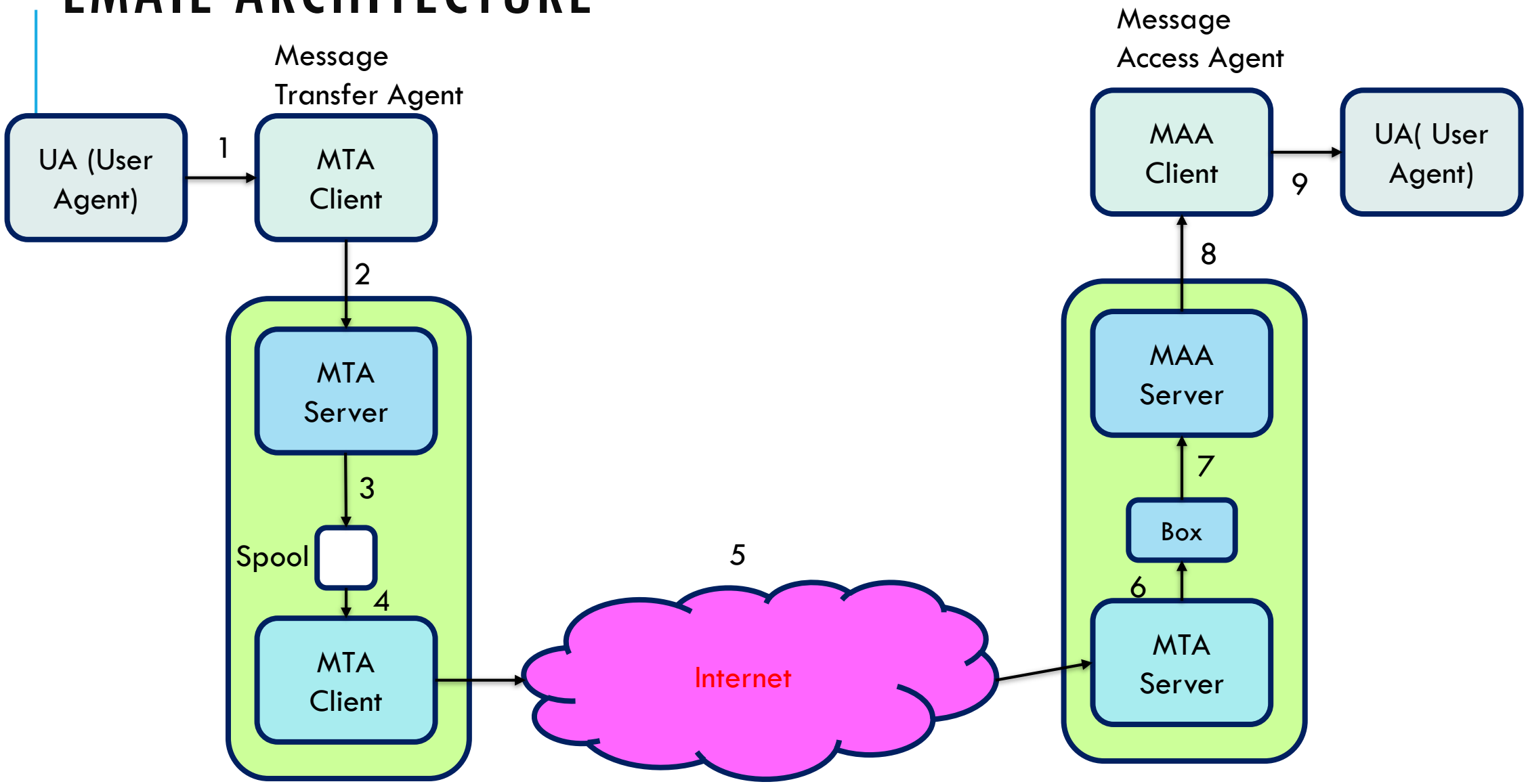
The server recognizes by providing an IP address to the user.

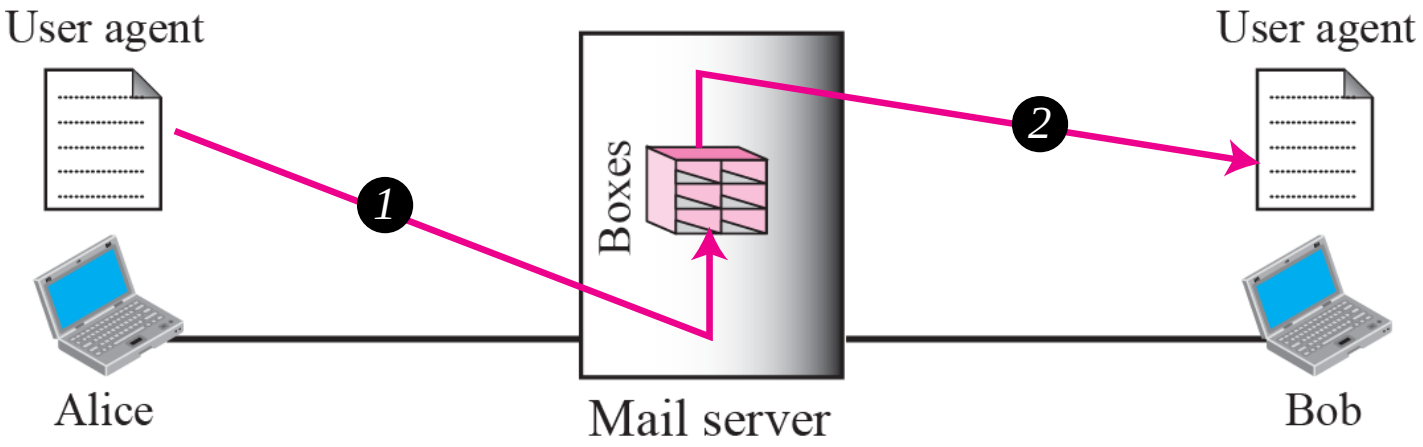
EMAIL ARCHITECTURE

The term “e-mail” applies both to the Internet e-mail system based on the Simple Mail Transfer Protocol (SMTP) and to intranet systems allowing users within one organization to e-mail each other.

Often workgroup collaboration organizations may use the Internet protocols for internal e-mail service. E-mail is often used to deliver bulk unwanted messages, or “spam”, but filter programs exist which can automatically delete most of these. E-mail systems based on RFC 822 are widely used.

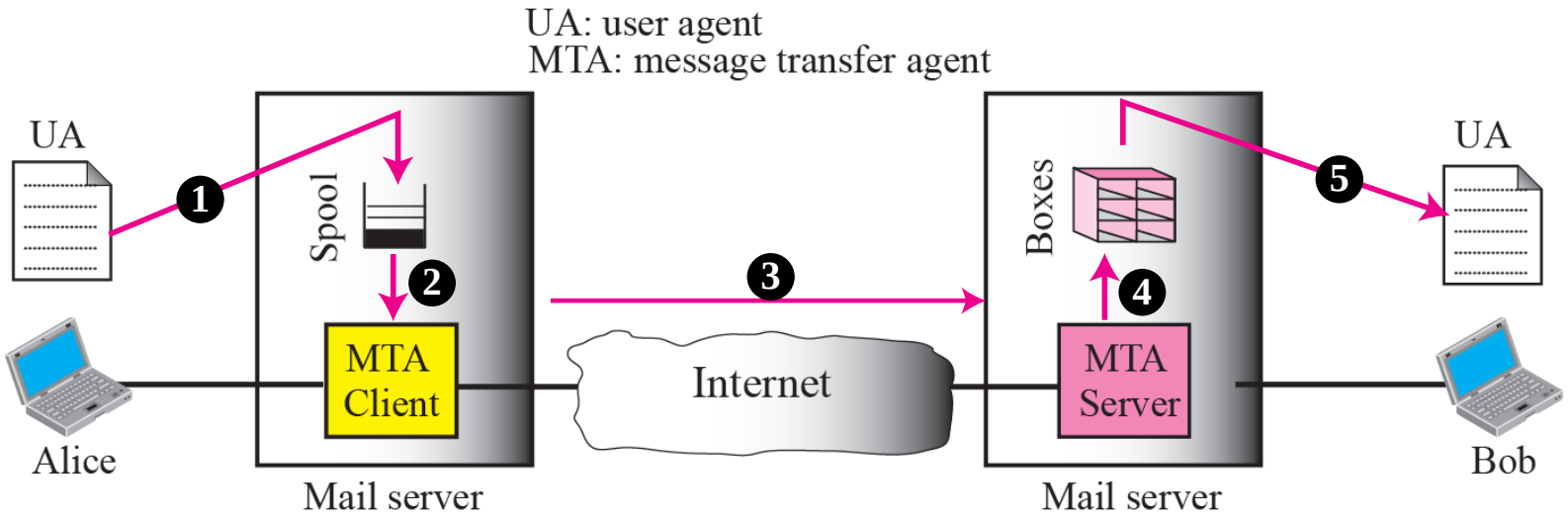
EMAIL ARCHITECTURE





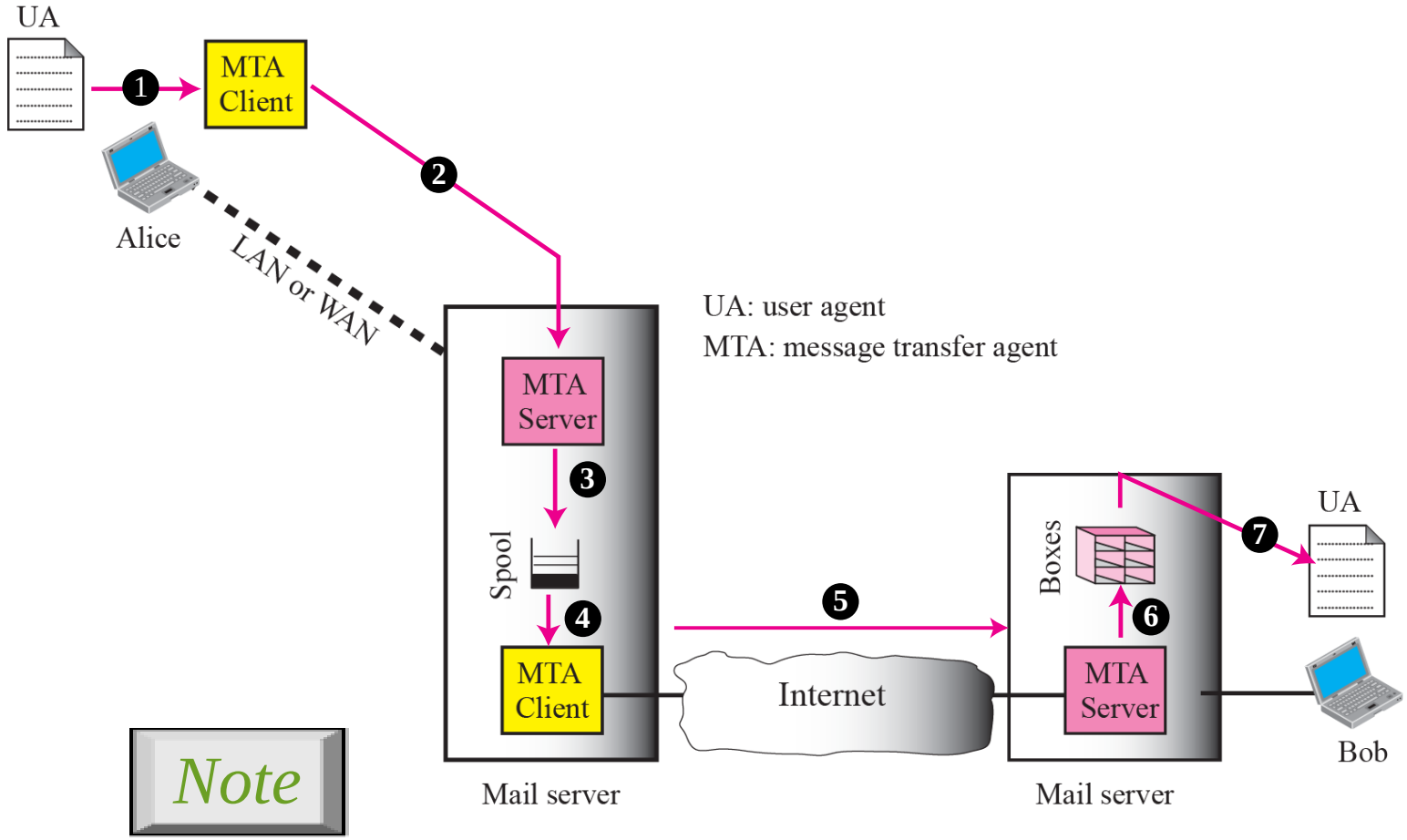
Note

When the sender and the receiver of an e-mail are on the same mail server, we need only two user agents.



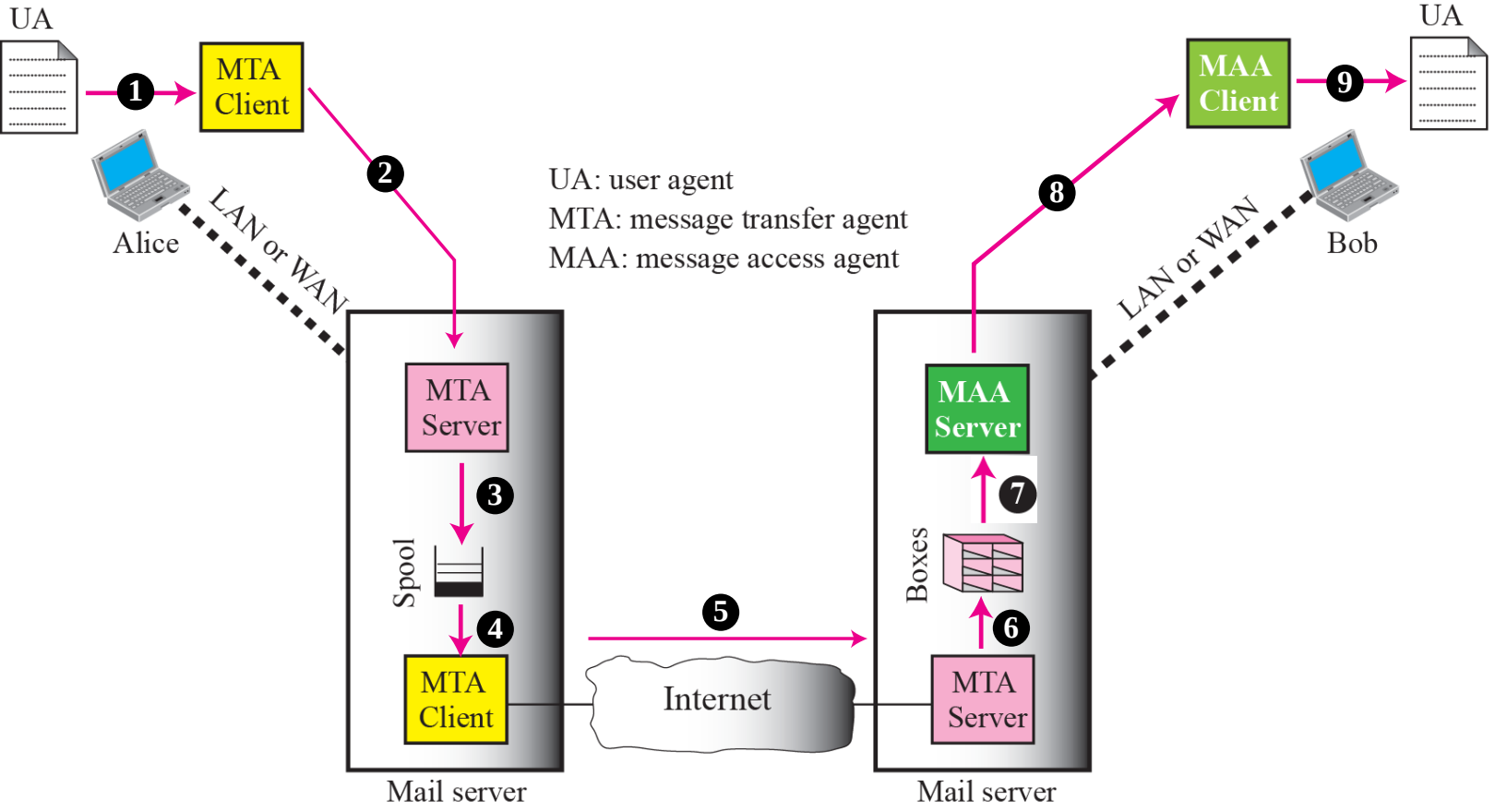
Note

When the sender and the receiver of an e-mail are on different mail servers, we need two UAs and a pair of MTAs (client and server).



Note

When the sender is connected to the mail server via a LAN or a WAN, we need two UAs and two pairs of MTAs (client and server).



23-2 USER AGENT

The first component of an electronic mail system is the user agent (UA). It provides service to the user to make the process of sending and receiving a message easier.

1 Architecture :

E-mail system normally consists of two sub systems

1. the user agents

2. the message transfer agents

The user agents allow people to read and send e-mails. The message transfer agents move the messages from source to destination. The user agents are local programs that provide a command based, menu-based, or graphical method for interacting with e-mail system. The message transfer agents are daemons, which are processes that run in background. Their job is to move datagram e-mail through system.

A key idea in e-mail system is the distinction between the envelope and its contents. The envelope encapsulates the message. It contains all the information needed for transporting the message like destinations address, priority, and security level, all of which are distinct from the message itself.

The Header:

The header contains control information for the user agents. It is structured into fields such as summary, sender, receiver, and other information about the e-mail.

· Body:

The body is entirely for human recipient. The message itself as unstructured text; sometimes containing a signature block at the end

2 Header format

The header is separated from the body by a blank line.

consists of following fields

· From: The e-mail address, and optionally name, of the sender of the message.

· To: one or more e-mail addresses, and optionally name, of the receiver's of the message.

· Subject: A brief summary of the contents of the message.

· Date: The local time and date when the message was originally sent.

E-mail system based on RFC 822 contains the message header as shown in figure 8.2. The figure gives the fields along with their meaning.

Mail From: abc@xyz.com **Recpt To:** **LMN@xyz.com**	**Envelop**	
From: abc@xyz.com To: lmn@xyz.com Date: 5/2/2020 Subject: CN Notes	Header	Message
Dear Friend, I want CN Notes Unit2 Yours Truly, abc@xyz.com	Body	

Mailbox address of the recepient

The domain name of the mail server

23-3 MESSAGE TRANSFER AGENT

The actual mail transfer is done through message transfer agents (MTAs). To send mail, a system must have the client MTA, and to receive mail, a system must have a server MTA. The formal protocol that defines the MTA client and server in the Internet is called Simple Mail Transfer Protocol (SMTP). As we said before, two pairs of MTA client-server programs are used in the most common situation (fourth scenario). Figure 23.8 shows the range of the SMTP protocol in this scenario.

23-4 MESSAGE ACCESS AGENT

The first and the second stages of mail delivery use SMTP. However, SMTP is not involved in the third stage because SMTP is a push protocol; it pushes the message from the client to the server. In other words, the direction of the bulk data (messages) is from the client to the server. On the other hand, the third stage needs a pull protocol; the client must pull messages from the server. The direction of the bulk data are from the server to the client. The third stage uses a message access agent.

WEB SERVER

Web server is a computer where the web content is stored. Basically web server is used to host the web sites but there exists other web servers also such as gaming, storage, FTP, email etc.

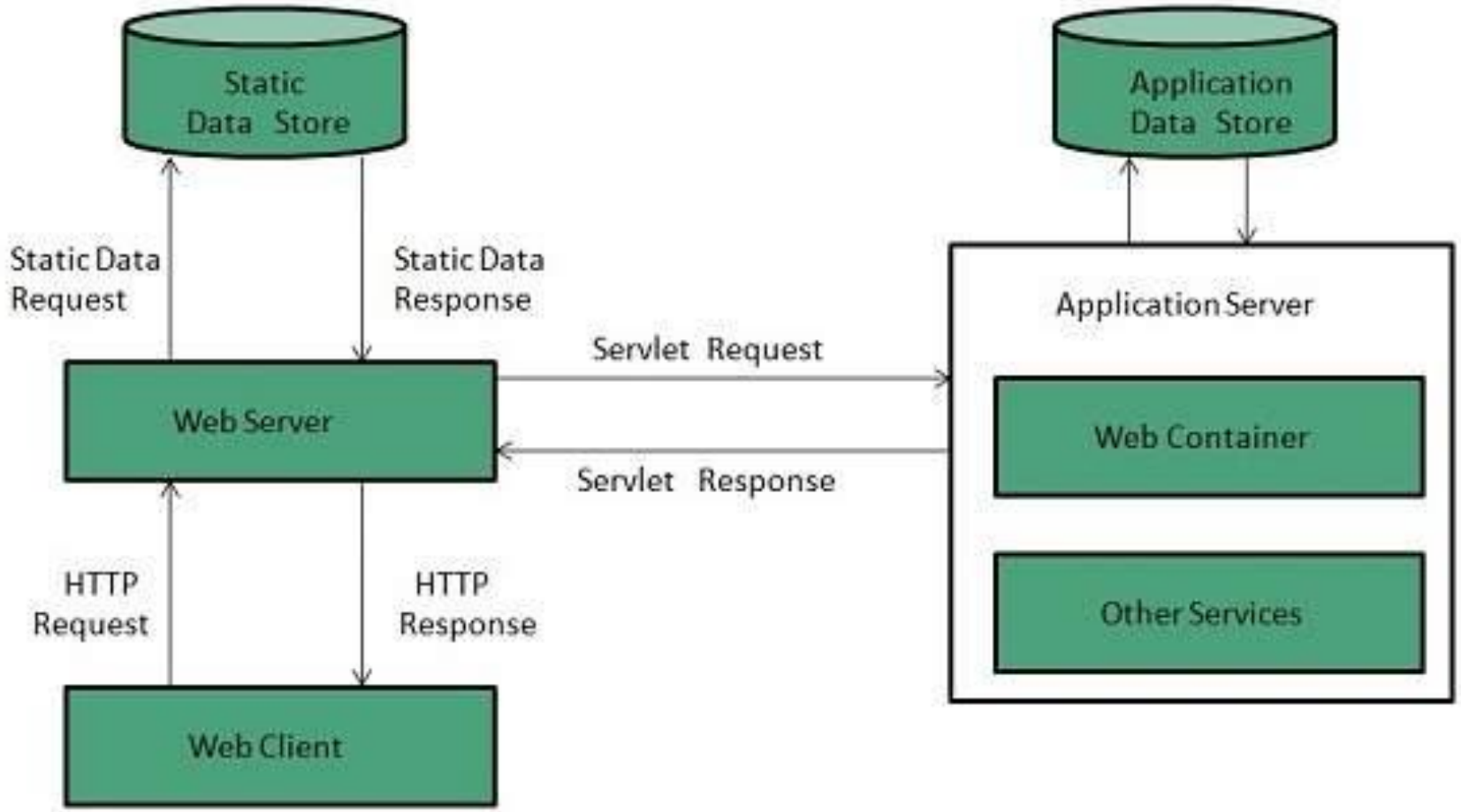
Web site is collection of web pages while web server is a software that respond to the request for web resources.

WEB SERVER WORKING

Web server respond to the client request in either of the following two ways:

Sending the file to the client associated with the requested URL.

Generating response by invoking a script and communicating with database


Static
Data Store
Application
Data Store
Static Data
Request
Static Data
Response
Application Server
Servlet Request
Web Server
Web Container
Servlet Response
HTTP
Request
HTTP
Response
Other Services
Web Client

KEY POINTS

When client sends request for a web page, the web server search for the requested page if requested page is found then it will send it to client with an HTTP response.

If the requested web page is not found, web server will the send an **HTTP response:Error 404 Not found.**

If client has requested for some other resources then the web server will contact to the application server and data store to construct the HTTP response.

ARCHITECTURE

Web Server Architecture follows the following two approaches:

1. Concurrent Approach
2. Single-Process-Event-Driven Approach.

1. **Concurrent Approach**

Concurrent approach allows the web server to handle multiple client requests at the same time. It can be achieved by following methods:

1. Multi-process
2. Multi-threaded
3. Hybrid method.

Multi-processing

In this a single process (parent process) initiates several single-threaded child processes and distribute incoming requests to these child processes. Each of the child processes are responsible for handling single request.

It is the responsibility of parent process to monitor the load and decide if processes should be killed or forked.

Multi-threaded

Unlike Multi-process, it creates multiple single-threaded process.

Hybrid

It is combination of above two approaches. In this approach multiple process are created and each process initiates multiple threads. Each of the threads handles one connection. Using multiple threads in single process results in less load on system resources.

S.N.	Web Server Descriptino
1	**Apache HTTP Server** This is the most popular web server in the world developed by the Apache Software Foundation. Apache web server is an open source software and can be installed on almost all operating systems including Linux, UNIX, Windows, FreeBSD, Mac OS X and more. About 60% of the web server machines run the Apache Web Server.
2.	**Internet Information Services (IIS)** The Internet Information Server (IIS) is a high performance Web Server from Microsoft. This web server runs on Windows NT/2000 and 2003 platforms (and may be on upcoming new Windows version also). IIS comes bundled with Windows NT/2000 and 2003; Because IIS is tightly integrated with the operating system so it is relatively easy to administer it.
3.	**Lighttpd** The lighttpd, pronounced lighty is also a free web server that is distributed with the FreeBSD operating system. This open source web server is fast, secure and consumes much less CPU power. Lighttpd can also run on Windows, Mac OS X, Linux and Solaris operating systems.
4.	**Sun Java System Web Server** This web server from Sun Microsystems is suited for medium and large web sites. Though the server is free it is not open source. It however, runs on Windows, Linux and UNIX platforms. The Sun Java System web server supports various languages, scripts and technologies required for Web 2.0 such as JSP, Java Servlets, PHP, Perl, Python, and Ruby on Rails, ASP and Coldfusion etc.
5.	**Jigsaw Server** Jigsaw (W3C's Server) comes from the World Wide Web Consortium. It is open source and free and can run on various platforms like Linux, UNIX, Windows, and Mac OS X etc. Jigsaw has been written in Java and can run CGI scripts and PHP programs.

BROWSERS

web Browser is an application software that allows us to view and explore information on the web. User can request for any web page by just entering a URL into address bar.

Web browser can show text, audio, video, animation and more. It is the responsibility of a web browser to interpret text and commands contained in the web page.

Earlier the web browsers were text-based while now a days graphical-based or voice-based web browsers are also available. Following are the most common web browser available today:

EXAMPLES OF BROWSERS

Browser	Vendor
Internet Explorer	Microsoft
Google Chrome	Google
Mozilla Firefox	Mozilla
Netscape Navigator	Netscape Communications Corp.
Opera	Opera Software
Safari	Apple
Sea Monkey	Mozilla Foundation
K-meleon	K-meleon

ARCHITECTURE

There are a lot of web browser available in the market. All of them interpret and display information on the screen however their capabilities and structure varies depending upon implementation. But the most basic component that all web browser must exhibit are listed below:

Controller/Dispatcher

Interpreter

Client Programs

Controller works as a control unit in CPU. It takes input from the keyboard or mouse, interpret it and make other services to work on the basis of input it receives.

Interpreter receives the information from the controller and execute the instruction line by line. Some interpreter are mandatory while some are optional For example, HTML interpreter program is mandatory and java interpreter is optional.

Client Program describes the specific protocol that will be used to access a particular service. Following are the client programs that are commonly used:

HTTP

SMTP

FTP

NNTP

POP

DOMAIN NAME SYSTEM

DNS is like a phone book for the internet. If you know a person's name but don't know their telephone number, you can simply look it up in a phone book. DNS provides this same service to the internet.

When you visit https://dyn.com in a browser, your computer uses DNS to retrieve the website's IP address of 50.16.85.103. Without DNS, you would only be able to visit our website (or any website) by visiting its IP address directly, such as http://50.16.85.103.

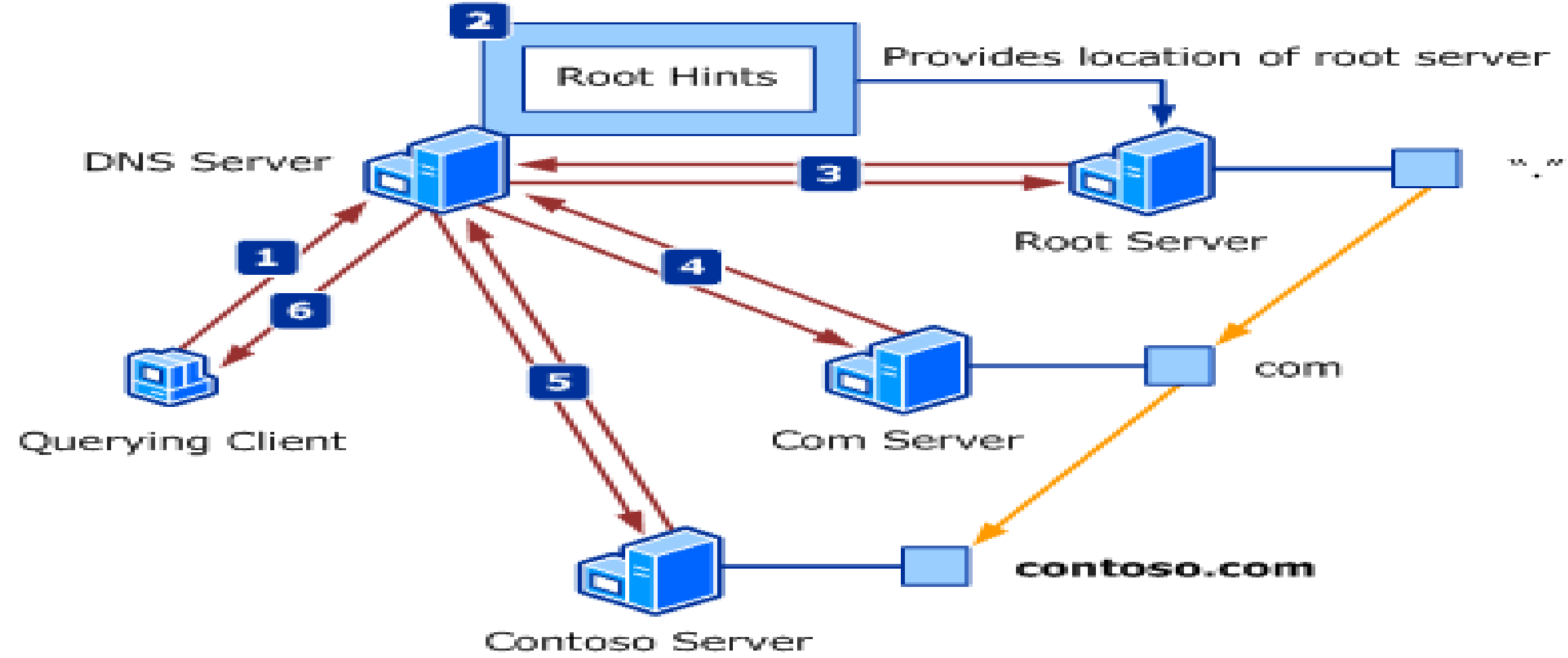
DNS stands for **Domain Name System.** A domain is a unique string (Gingernameclub.com) associated with an IP address.

An IP address is a string of numbers used to identify a computer or resource on a network or internet.

The Domain Name System (DNS) is a network of directories on the internet used to resolve host names (e.g., www.gingernameclub.com) into machine-readable IP addresses (e.g., 192.168.106.81).

HOW DOES DNS WORK?

When you visit a domain such as dyn.com, your computer follows a series of steps to turn the human-readable web address into a machine-readable IP address. This happens every time you use a domain name, whether you are viewing websites, sending email or listening to internet radio stations



Legend

- Zone
- Delegation
- Queries and Responses
- Server Hosts Zone

DOMAIN NAME SYSTEM

In the internet computers identified by unique numbers called as IP addresses. They do not understand human languages.

If computer do not understand human language then how they load website when we type a URL in browser. That's the space where DNS comes in.

Computers and Browsers understand IP address and we understand our language that is English.

DNS Acts as a translator between Human and Internet and web browser

DNS maintains a table where Names are mapped with Numbers. i.e. Website domain name is mapped with their IP addresses.

When we type web address on web browsers then DNS translates these domain name in IP address and gives it to web browsers. Here browsers understand which web site we want.

Then browser communicate to internet for the requested web site. And load that specific web site on our computers browsers.

Here DNS acts as phone book of a Internet where a names are searched by numbers.

DNS SERVERS

Servers are the systems where HTML files, Text, Audio, Video information is stored.

DNS Servers are the systems that provide IP address of the web site.

There are 4 types of DNS Servers.

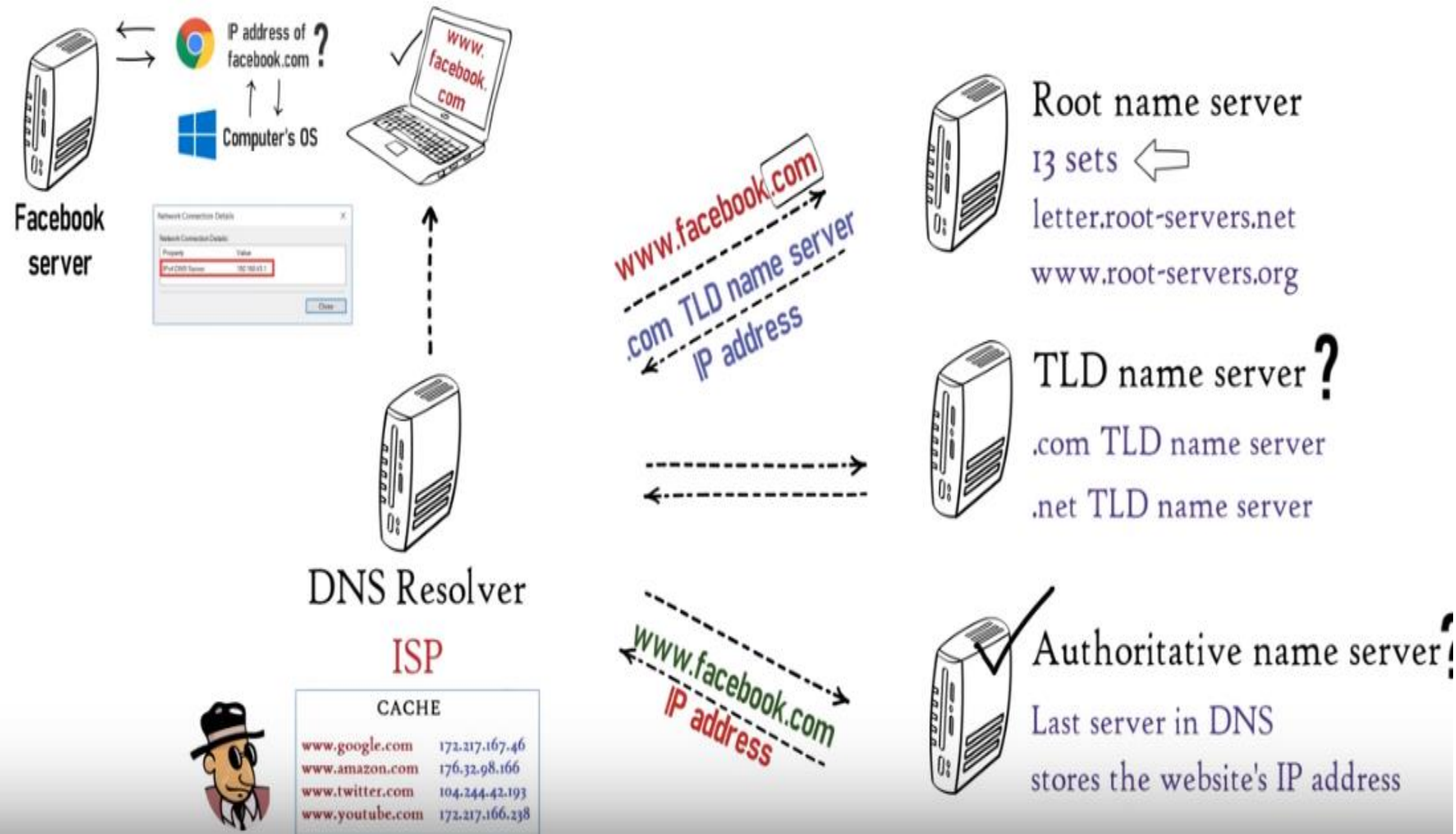
- DNS recursive resolver/ DNS resolver
- Root Name Server
- Top Level Domain/ TLD server
- Authoritative name server.

DNS resolver are the Internet service provider that connect to the computer through internet.

DNS Name servers: There are 13 sets of servers. Named as A to M except G where g is used to store home page. Logically it is represented by letter.root.server.net These servers are operated by 12 organizations

TLD name servers holds the all domain name like .com, .net, .in, .edu etc. eg. .com TLD name server tolds the web browsers about all the websites who ends with .com

Authoritative name server is the last server who tolds the IP address of the web site


IP address of facebook.com ?
Computer's OS
www. facebook. com
Facebook server
Network Connection Details
Property
Value
Close
DNS Resolver
ISP
CACHE
www.google.com 172.217.167.46
www.amazon.com 176.32.98.166
www.twitter.com 104.244.42.193
www.youtube.com 172.217.166.238
www.facebook.com
.com TLD name server
IP address
Root name server
13 sets
letter.root-servers.net
www.root-servers.org
TLD name server ?
.com TLD name server
.net TLD name server
www.facebook.com
IP address
Authoritative name server
Last server in DNS
stores the website's IP address

IP ADDRESSING

In Computer network there are two types of addressing

1. Physical Addressing (MAC Address it is of 48 bits
2. Logical Addressing

   It is of two type

   1. IPv4
      a. Public IPv4
      b. Private IPv4
   2. IPv6

IPV4

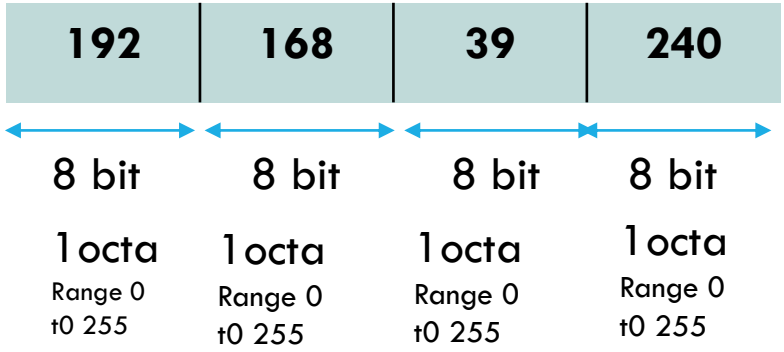
Class	From	to
Class A	1.0.0.0	126.0.0.0
Class B	128.0.0.0	191.255.0.0
Class C	192.0.0.0	223.255.255.0
Class D	224	239
Class E	240	255

32 bit logical address

4 Octa

0 to 255 rage in Octa

IP Address -> Network ID + Host ID



Using IPv4 it is possible to form 4,294,967,296 (2^{32})unique address

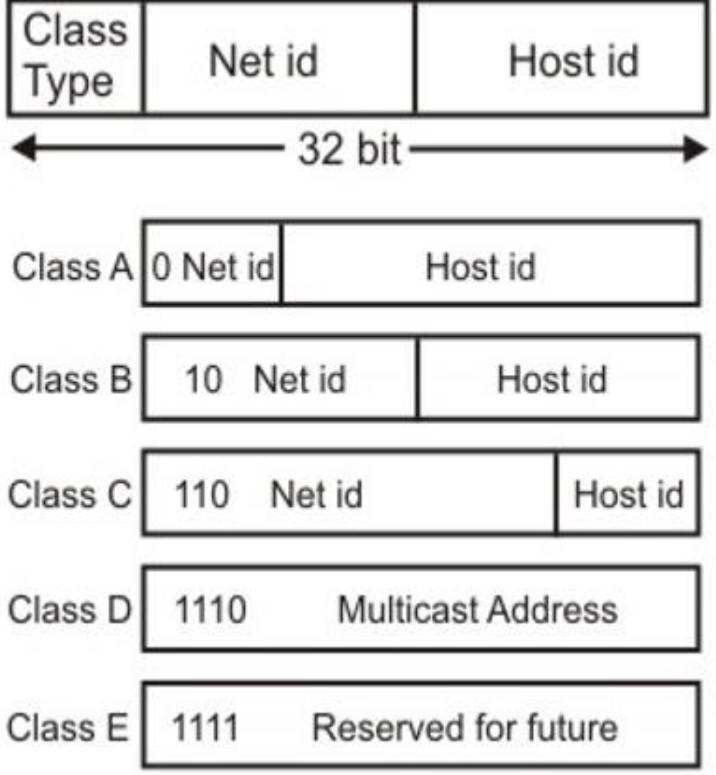
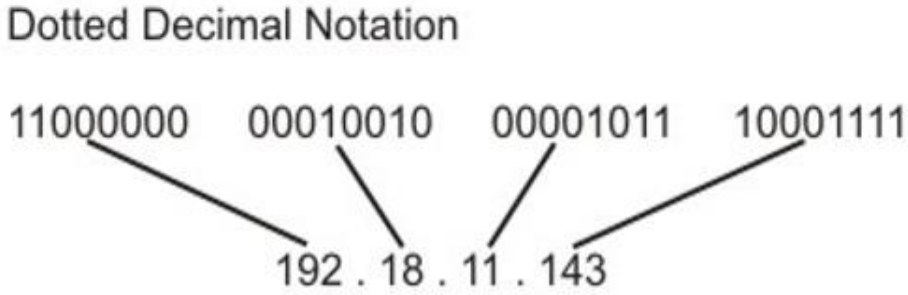


Figure 6.2.2 IP address formats



Class	From	to
Class A	1.0.0.0	126.0.0.0
Class B	128.0.0.0	191.255.0.0
Class C	192.0.0.0	223.255.255.0
Class D	224	239
Class E	240	255

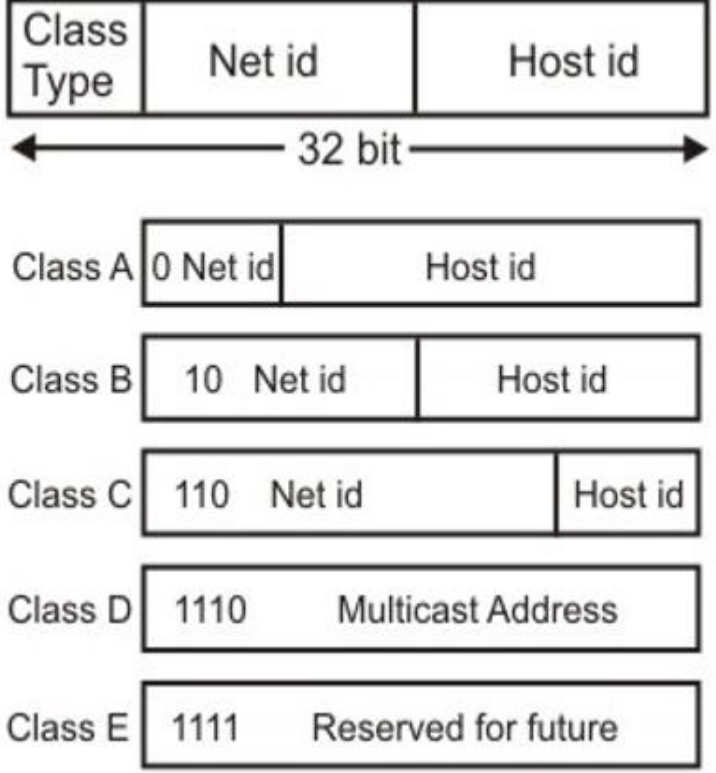
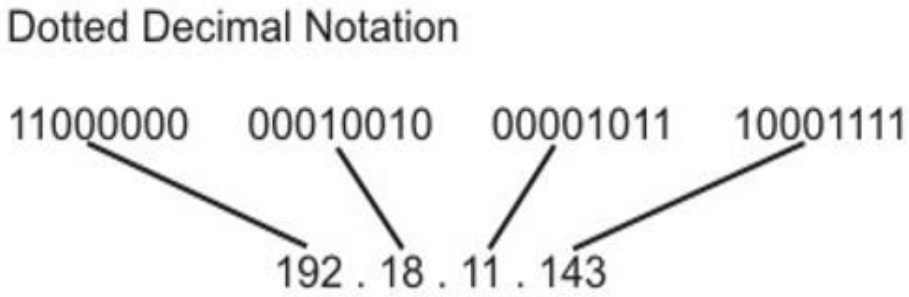


Figure 6.2.2 IP address formats

In **class A** 128 different networks and 16 Million Host computers can be connected in a network.Class A is used by NASA or such a big organization

In **Class B** 16384 networks and 65536 Host Computers can be connected in a network. Such type of class is used in Banking Sectors.

In **Class C** 2 Million Networks and Host computers are 256 such type of class is used in small organizations like school colleges etc.



DETERMINING THE NETWORK ID AND HOST ID PART

E.g. 23.10.5.26

23	10	5	26

The Above IP Address is from Class A

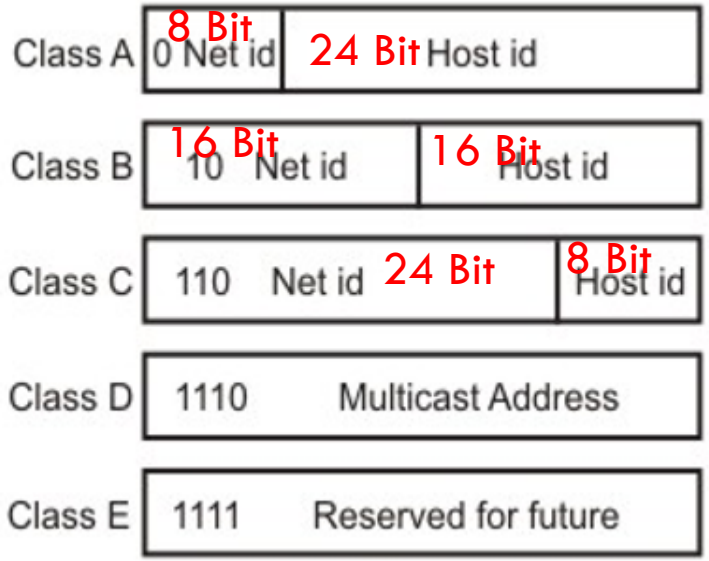
Network ID

Host ID

E.g. 192.168.1.40

192	168	1	40

Class	From	to
Class A	1.0.0.0	126.0.0.0
Class B	128.0.0.0	191.255.0.0
Class C	192.0.0.0	223.255.255.0
Class D	224	239
Class E	240	255



IPV6.

The network layer that is present in use in commonly referred to as IPv4. Although IPv4 is well designed and has helped the internet to grow rapidly, it has some deficiencies, These deficiencies has made it unsuitable for the fast growing internet. To overcome these deficiencies, Internet Protocol, Version 6 protocol has been proposed and it has evolved into a standard.

IMPORTANT FEATURES OF IPV6 ARE HIGHLIGHTED BELOW

IPv6 uses 128-bit address instead of 32-bit address to provide larger address space

Uses more flexible header format, which simplifies and speeds up the routing process

Basic header followed by extended header

Resource Allocation options, which was not present in IPv4

Provision of new/future protocol options

Support for security with the help of encryption and authentication

Support for fragmentation at source

IPV6 ADDRESSING METHOD

It is made up of 128 bits

Divided into 8 octa of 16bit blocks

Each block is then converted into 4-digit Hexadecimal numbers separated by colon (:) symbol

Eg. Of IPv6 IP Address

2001:0000:3238:DEF1:0063:0000:0000:FEFB

2001:0:3238:DEF1:63::FEFB

0010010101000001000:1000110111011110:0011110001011111:0111010110010100:

0010010101000001000:1000110111011110:0011110001011111:0111010110010100:

8	4	2	1		hex
0	0	0	0		0
0	0	0	1		1
0	0	1	0	0010	2
0	0	1	1		3
0	1	0	0		4
0	1	0	1		5
0	1	1	0		6
0	1	1	1		7
1	0	0	0		8
1	0	0	1		9
1	0	1	0		A
1	0	1	1		B
1	1	0	0		C
1	1	0	1		D
1	1	1	0		E
1	1	1	1		F

2504:8CCE:3C5F:____:____:____:____:____

Converting 128 bit binary IPV6 Address in Hexadecimal Number system is

Version (4-bits): It represents the version of Internet Protocol, i.e. 0110.

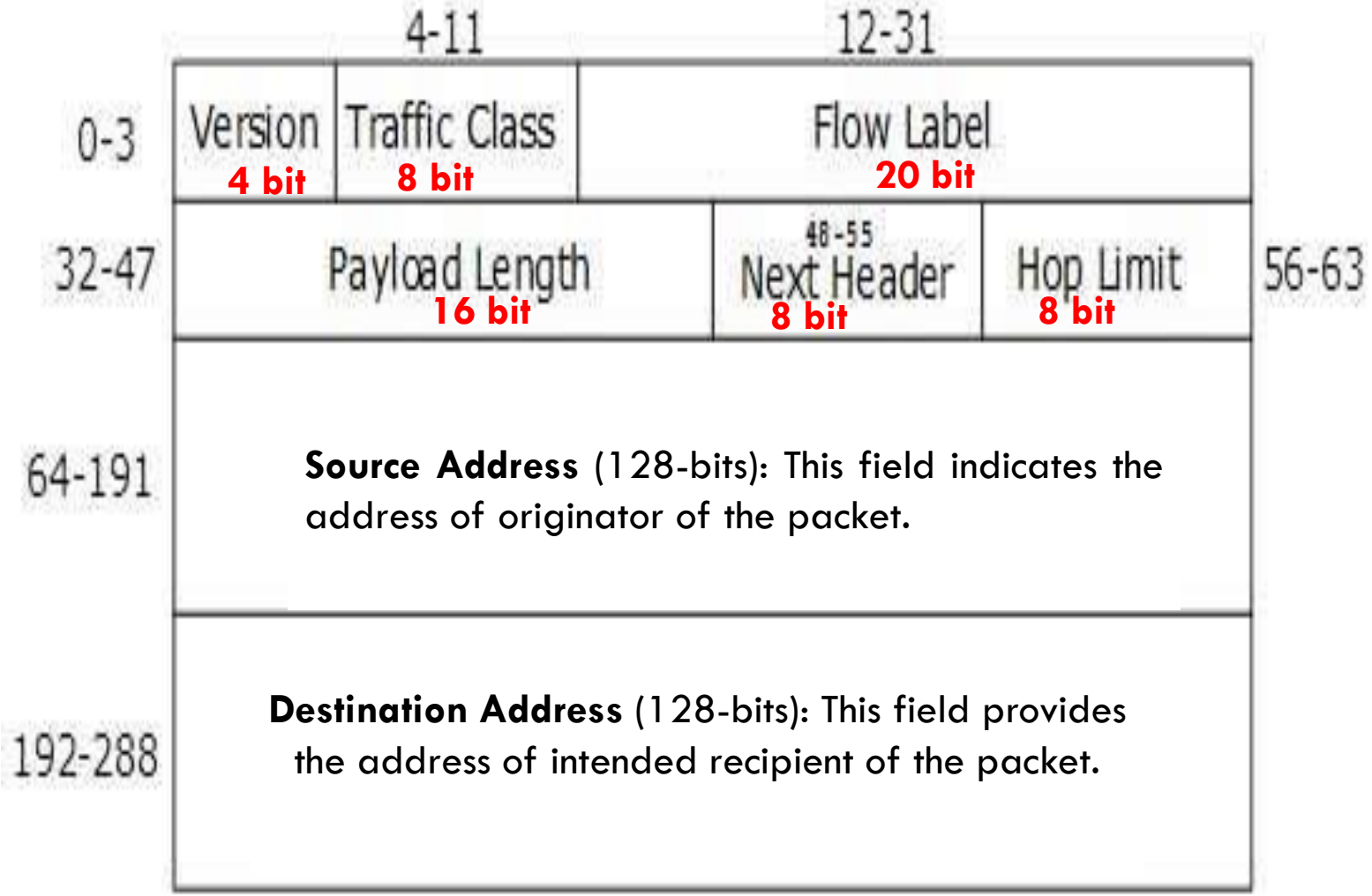
Next Header (8-bits): This field is used to indicate either the type of Extension Header, or if the Extension Header is not present then it indicates the Upper Layer PDU

Traffic Class (8-bits): These 8 bits are divided into two parts. The most significant 6 bits are used for Type of Service to let the Router Known what services should be provided to this packet. The least significant 2 bits are used for Explicit Congestion Notification (ECN).

Payload Length (16-bits): This field is used to tell the routers how much information a particular packet contains in its payload. Payload is composed of Extension Headers and Upper Layer data. With 16 bits, up to 65535 bytes can be indicated

Hop Limit (8-bits): This field is used to stop packet to loop in the network infinitely.

Flow Label (20-bits): This label is used to maintain the sequential flow of the packets belonging to a communication



IPV 6 HEADER FORMAT 40 BYTES (320 BITS)

WIFI TECHNOLOGY

WiFi stands for **Wi**reless **Fi**delity. WiFilt is based on the IEEE 802.11 family of standards and is primarily a local area networking (LAN) technology designed to provide in-building broadband coverage.

Current WiFi systems support a peak physical-layer data rate of 54 Mbps and typically provide indoor coverage over a distance of 100 feet.

WiFi has become the *de facto* standard for *last mile* broadband connectivity in homes, offices, and public hotspot locations. Systems can typically provide a coverage range of only about 1,000 feet from the access point.

RADIO SIGNALS

Radio Signals are the keys, which make WiFi networking possible. These radio signals transmitted from WiFi antennas are picked up by WiFi receivers, such as computers and cell phones that are equipped with WiFi cards.

Whenever, a computer receives any of the signals within the range of a WiFi network, which is usually 300 — 500 feet for antennas, the WiFi card reads the signals and thus creates an internet connection between the user and the network without the use of a cord.

WIFI CARDS

You can think of WiFi cards as being invisible cords that connect your computer to the antenna for a direct connection to the internet.

WiFi cards can be **external** or **internal**. If a WiFi card is not installed in your computer, then you may purchase a USB antenna attachment and have it externally connect to your USB port, or have an antenna-equipped expansion card installed directly to the computer (as shown in the figure given above). For laptops, this card will be a PCMCIA card which you insert to the PCMCIA slot on the laptop.

INTRODUCTION TO WI-FI & 4G TECHNOLOGY.

WiFi Technology is a proficient used by mobiles, workplaces, home and computer systems all around the world.

Newest entrenched wireless fidelity representations are outfitted by real time operating systems that allow communication by means of serial ports so we can say that WiFi Technology is a standard of communication among wireless devices and computers all over the world.

The world's leading WiFi Technology network is simply a name of freedom which permits you to connect your computer with any device as PDA without any expense of wires.

Just imagine you are sitting in a coffee shop and chatting with your friend for fun, traveling with airport and in touch with your business, working in a office or taking tea in company cafeteria and checking your today business status Now you can use internet share your files making conference with your client and these all thing possible yes your work and outing both are going and it is possible only with WiFi Technology.

There are several specifications in the 802.11 family −

802.11 − This pertains to wireless LANs and provides 1 - or 2-Mbps transmission in the 2.4-GHz band using either frequency-hopping spread spectrum (FHSS) or direct-sequence spread spectrum (DSSS).

802.11a − This is an extension to 802.11 that pertains to wireless LANs and goes as fast as 54 Mbps in the 5-GHz band. 802.11a employs the orthogonal frequency division multiplexing (OFDM) encoding scheme as opposed to either FHSS or DSSS.

802.11b − The 802.11 high rate WiFi is an extension to 802.11 that pertains to wireless LANs and yields a connection as fast as 11 Mbps transmission (with a fallback to 5.5, 2, and 1 Mbps depending on strength of signal) in the 2.4-GHz band. The 802.11b specification uses only DSSS. Note that 802.11b was actually an amendment to the original 802.11 standard added in 1999 to permit wireless functionality to be analogous to hard-wired Ethernet connections.

802.11g − This pertains to wireless LANs and provides 20+ Mbps in the 2.4-GHz band.

APPLICATIONS

Mobile Applications

Business Applications

Home Applications

Computerized Applications

Automotive Segment

Browsing Internet

Video Conference

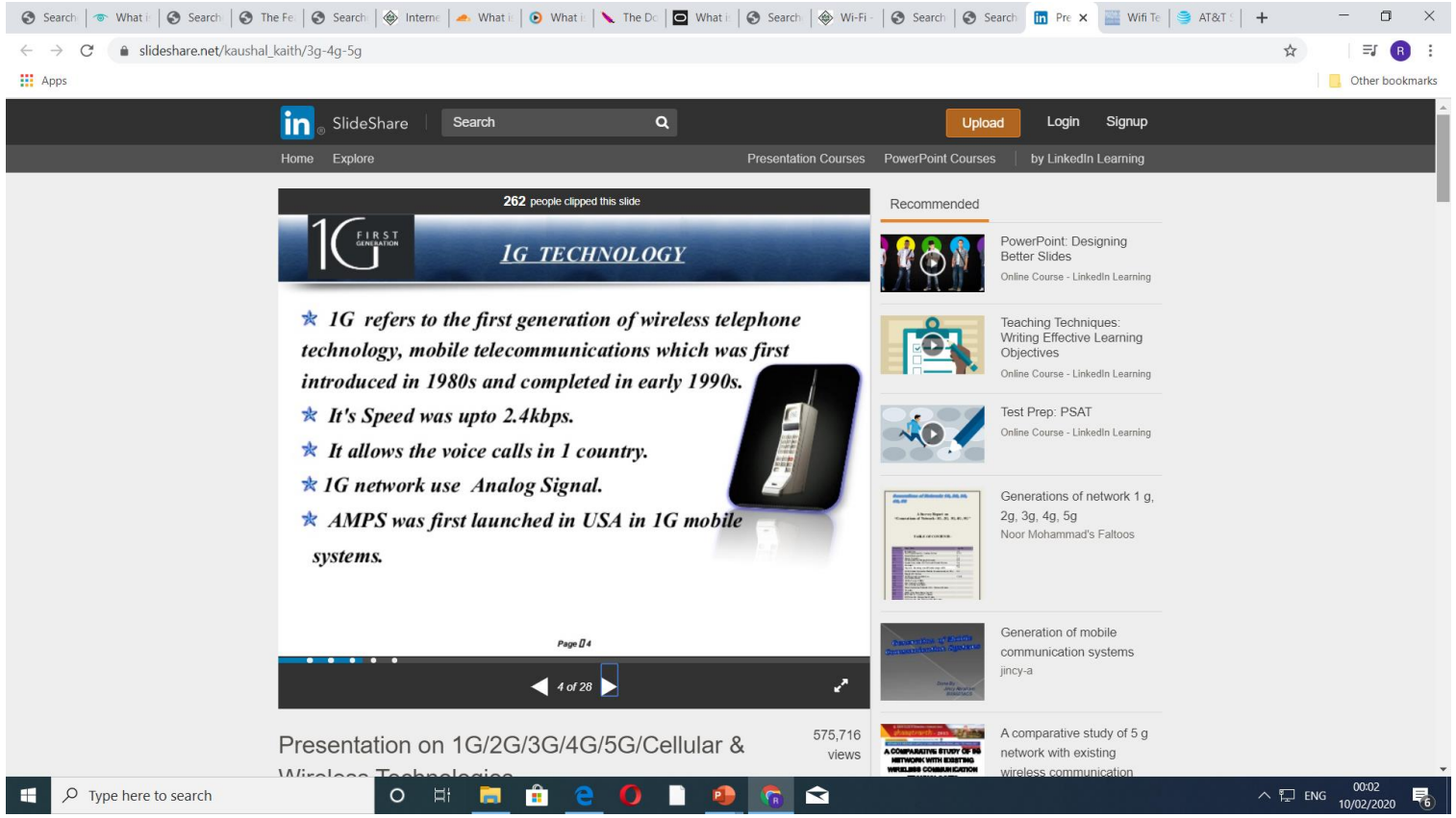
WHAT IS WIRELESS ?

The word wireless is dictionary defined "having no wires ".

In networking terminology , wireless is the term used to describe any computer network where there is no physical wired connection between sender and receiver, but rather the network is connected by radio waves and or microwaves to maintain communications.

Wireless networking utilizes specific equipment such as NICs and Routers in place of wires (copper or optical fibre).

1 G TECHNOLOGY



DISADVANTAGES

- ***Poor Voice Quality***
- ***Poor Battery Life***
- ***Large Phone Size***
- ***No Security***
- ***Limited Capacity***
- ***Poor Handoff Reliability***

1G Wireless System

2 G TECHNOLOGY

- *2G technology refers to the 2nd generation which is based on GSM.*
- *It was launched in Finland in the year 1991.*
- *2G network use digital signals.*
- *It's data speed was upto 64kbps.*

Features Includes:

- ✓ *It enables services such as text messages, picture messages and MMS (multi media message).*
- ✓ *It provides better quality and capacity .*

DISADVANTAGES

- *2G requires strong digital signals to help mobile phones work. If there is no network coverage in any specific area , digital signals would weak.*

- *These systems are unable to handle complex data such as Videos.*

2G Wireless System

3 G TECHNOLOGY

- *3G technology refer to third generation which was introduced in year 2000s.*

- *Data Transmission speed increased from 144kbps- 2Mbps.*

- *Typically called Smart Phones and features increased its bandwidth and data transfer rates to accommodate web-based applications and audio and video files.*

FEATURES OF 3G TECHNOLOGY

- ✓ *Providing Faster Communication*
- ✓ *Send/Receive Large Email Messages*
- ✓ *High Speed Web / More Security*

Video Conferencing / 3D Gaming

- ✓ *TV Streaming/ Mobile TV/ Phone Calls*
- ✓ *Large Capacities and Broadband Capabilities*
- ✓ *11 sec – 1.5 min. time to download a 3 min Mp3 song.*

DISADVANTAGES

- *Expensive fees for 3G Licenses Services*
- *It was challenge to build the infrastructure for 3G*
- *High Bandwidth Requirement*
- *Expensive 3G Phones.*
- *Large Cell Phones*

4 G TECHNOLOGY

- *4G technology refer to or short name of fourth Generation which was started from late 2000s.*
- *Capable of providing 100Mbps – 1Gbps speed.*
- *One of the basic term used to describe 4G is MAGIC.*

MAGIC:

- *Mobile Multimedia*
- *Anytime Anywhere*
- *Global Mobility Support*
- *Integrated Wireless Solution*
- *Customized Personal Services*

Also known as Mobile Broadband Everywhere.

4 G TECHNOLOGY

- *The next generations of wireless technology that promises higher data rates and expanded multimedia services.*
- *Capable to provide speed 100Mbps-1Gbps.*
- *High QOS and High Security*
- *Provide any kind of service at any time as per user requirements, anywhere.*

Features Include:

- *More Security*
- *High Speed*
- *High Capacity*
- *Low Cost Per-bit etc.*

DISADVANTAGES

- *Battery uses is more*
- *Hard to implement*
- *Need complicated hardware*
- *Expensive equipment required to implement next generation network.*

5G TECHNOLOGY

- *5G technology refer to short name of fifth Generat which was started from late 2010s.*

- *Complete wireless communication with almost no limitations.*

- *It is highly supportable to WWWW (Wireless World Wide Web).*

FEATURES OF 5G TECHNOLOGY

- *High Speed, High Capacity*
- *5G technology providing large broadcasting of data in Gbps .*
- *Multi - Media Newspapers, watch T.V prog... with the clarity as to that of an HD Quality.*
- *Faster data transmission that of the previous generations.*
- *Large Phone Memory, Dialing Speed, clarity in Audio/Video.*
- *Support interactive multimedia , voice, streaming video, Internet and other*
- *5G is More Effective and More Attractive.*

WIRELESS APPLICATIONS

- *Wireless applications are those which we use free space as the transmission medium & do not involve cabling like fibre or copper cables.*

WIRELESS SERVICES

Wireless solution for:

- *Business and Industry*
- *Schools , Colleges*
- *Doctors , Pilots*
- *Police and Vehicles etc.*

- ***All totally the best way to help all users is to use 5G as the next wireless system and in totally it is safety and secure for public, this the need that demands the solution.***
- ***Today's wired society is going wireless and if it has problem, 5G is answer.***
- ***5G technology is going to give tough competition to Computers and Laptops.***
- ***It will be available in the market 2020 at affordable cost with more reliability than previous mobiles.***