Computer Network And Network Design(CNND) ITC402

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Module 5

Presentation Layer & Application Layer

Outline

Presentation layer :

- Compression: Comparison between Lossy Compression and Lossless Compression
- Huffman Coding
- Speech Compression
- LZW
- RLE
- Image Compression GIF,JPEG.

Application layer:

- Standard Client-Server Protocols: World Wide Web, HTTP, FTP, Electronic Mail, Domain Name System (DNS), SNMP

PRESENTATION LAYER

- Concerns with syntax and semantics of the information exchanged.
- Responsibilities:

1. Translation – ensures interoperability between different encodings
2. Encryption – ensures privacy of data
3. Compression – ensures optimization of data rate

COMPRESSION

Data Compression:

- Process of reducing , amount of data required to represent a given quantity of information.

Compression Properties:

1. Compression Ratio
2. Data Redundancy
3. Lossy Versus Lossless Compression

COMPRESSION RATIO

Consider

- n_1 – number of information carrying units before compression.
- n_2 - number of information carrying units after compression

$$\text{Compression Ratio} = C_R = \frac{n_1}{n_2}$$

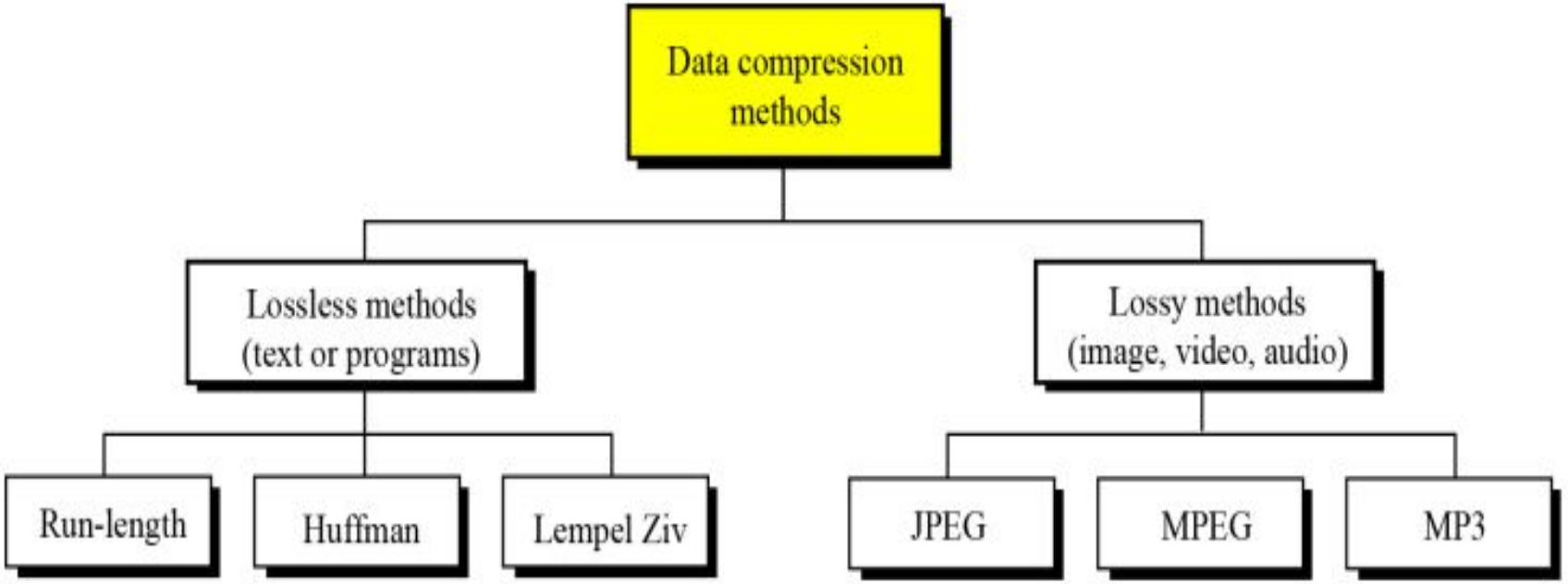
DATA REDUNDANCY

- Irrelevant or repeated data inside the information.

$$\text{Data Redundancy} = R_D = 1 - \frac{1}{C_R}$$

$$\text{In percentage} = R_D \times 100$$

COMPRESSION



LOSSLESS COMPRESSION

- In lossless compression the integrity of the data is preserved.
- Lossless compression methods are used when we cannot afford to lose any data.

RUN LENGTH ENCODING

- Run-length encoding is probably the simplest method of compression.
- It can be used to compress data made of any combination of symbols.
- Encoded data is in the form.

RUN LENGTH ENCODING

Consider the first two rows of data as given below. Encode using RLE.

2	2	2	5	5	5	5	5	5	5	5	6	6	6	6
4	4	8	8	8	8	8	8	8	1	1	1	1	1	7

Answer: 2 3 5 8 6 4 4 2 8 7 1 5 7 1

1	2	5	3	1	2	1	2	5	3	1	2	1	2	5
3	1	2	1	2	5	3	1	2	1	2	5	3	1	2

Answer: 1 1 2 1 5 1 3 1 1 1 2 1 1 1 2 1 5 1
3 1 1 1 2 1 1 1 2 1 5 1 3 1 1 1 2 1 1 1 2 1
5 1 3 1 1 1 2 1 1 1 2 1 5 1 3 1 1 1 2 1

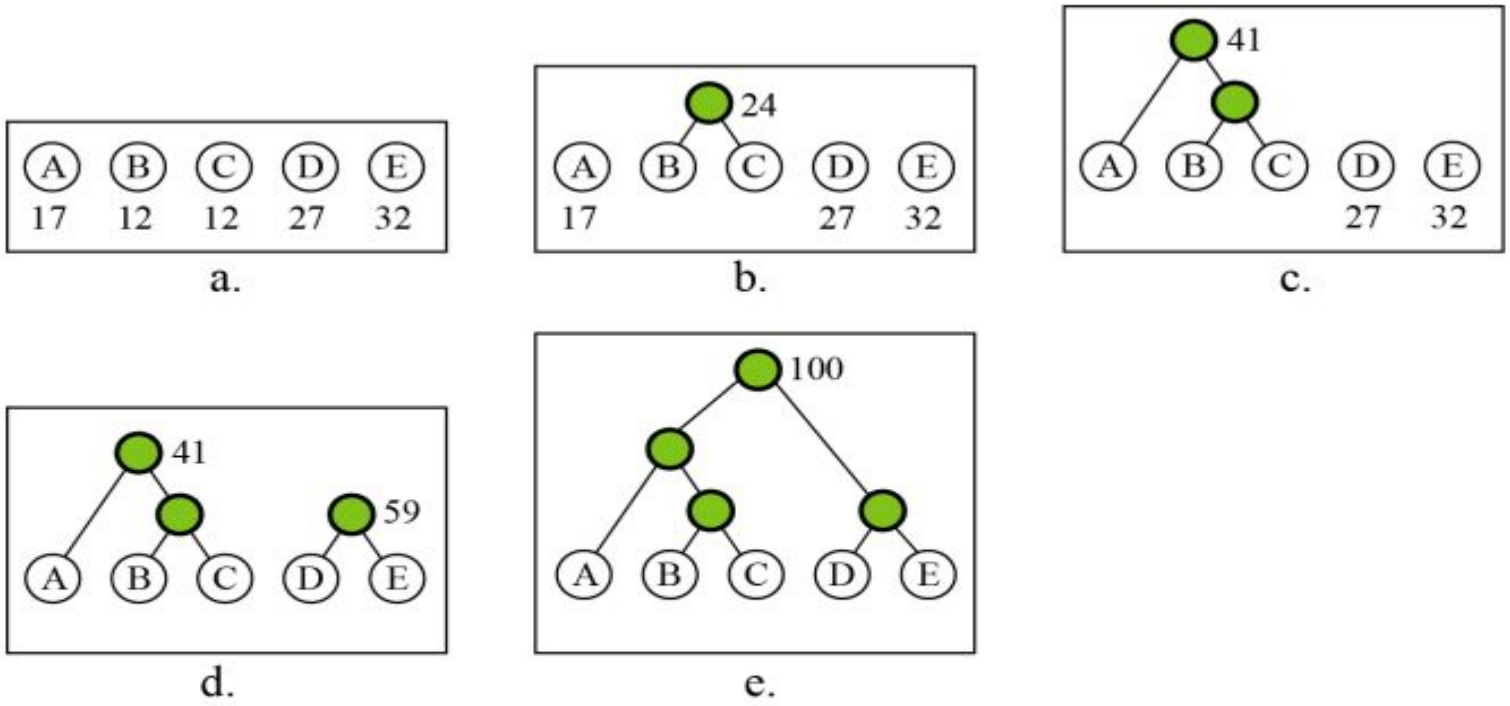
HUFFMAN CODING

- Huffman coding assigns shorter codes to symbols that occur more frequently and longer codes to those that occur less frequently.
- For example, imagine we have a text file that uses only five characters (A, B, C, D, E).

Table 15.1 Frequency of characters

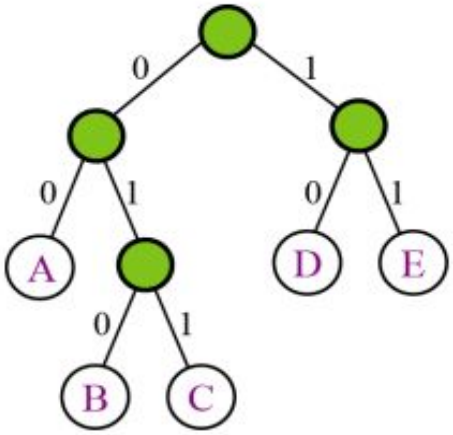
Character	A	B	C	D	E
Frequency	17	12	12	27	32

HUFFMAN CODING



Huffman coding

HUFFMAN CODING

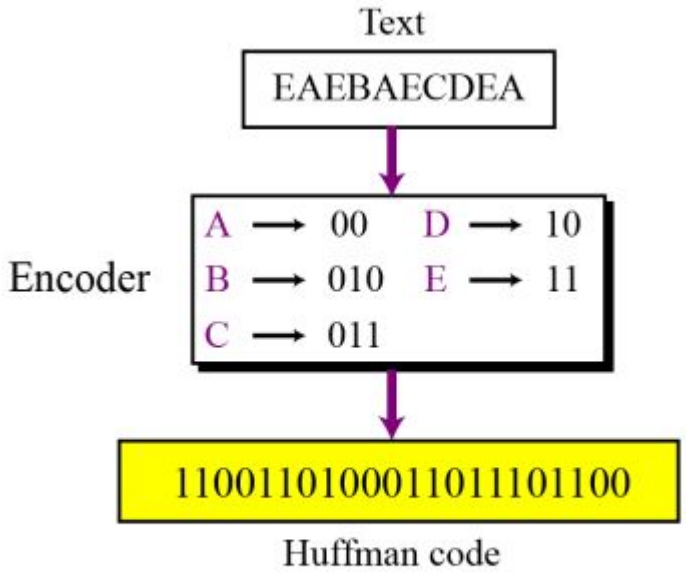


A: 00	D: 10
B: 010	E: 11
C: 011	

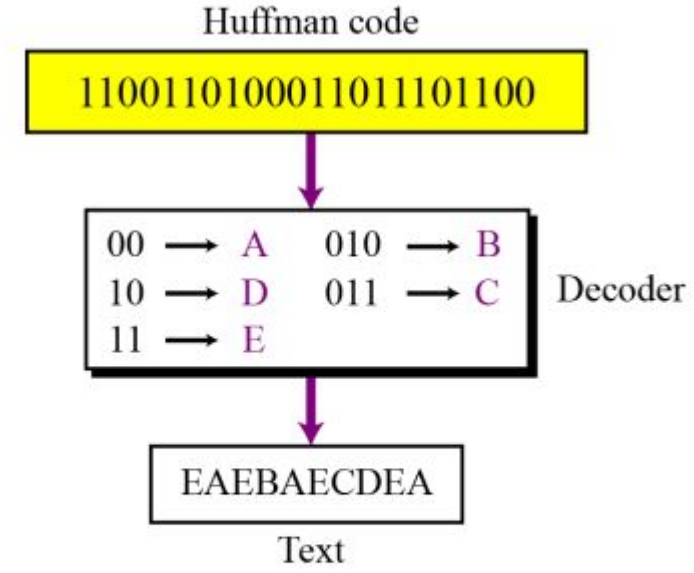
Code

Final tree and code

HUFFMAN CODING



Huffman encoding



Huffman decoding

HUFFMAN CODING

- Construct Huffman code for the given symbols (x_1, $x_2 \ldots x_8$) with probabilities P(x) = { 0.07, 0.08, 0.04, 0.26, 0.14, 0.09, 0.07, 0.25}. Find Coding efficiency.

Solution:

1. Arrange all probabilities in descending order
2. Add last 2 probabilities and push the value in the list of probabilities according to the order
3. Perform step 2 until only 2 probabilities are left
4. Start giving code values to the added probabilities, starting from right end.

HUFFMAN CODING

Symbol	P(x)	Codeword	Length
	0.26	01	2
	0.25	10	2
	0.14	001	3
	0.09	111	3
	0.08	0000	4
	0.07	0001	4
	0.07	1100	4
	0.04	1101	4

HUFFMAN CODING

Example 1: encode { 1 1 1 1 1 1 1 2 2 2 2 2 2 3 3 3 3 4 4 4 4 5 5 5 6 6 7}

Answer:

Symbol	Huffman code
1	10
2	01
3	000
4	100
5	011
6	0111
7	1111

$L_{avg} = 2.64$
Entropy = 2.603
Efficiency = 98.5%
Compression Ratio = 1.136

LEMPEL-ZIV-WELCH (LZW) CODES

- Assigns Fixed length codeword to a variable length sequence of source symbols.
- Dynamic dictionary technique (code table is generates simultaneously with data encoding).
- Used in images GIF, TIFF and PDF.

LEMPEL-ZIV-WELCH (LZW) CODES

- LZW compression works by reading a sequence of symbols, grouping the symbols into strings, and converting the strings into codes.
- Because the codes take up less space than the strings they replace, we get compression.
- Characteristic features of LZW includes,

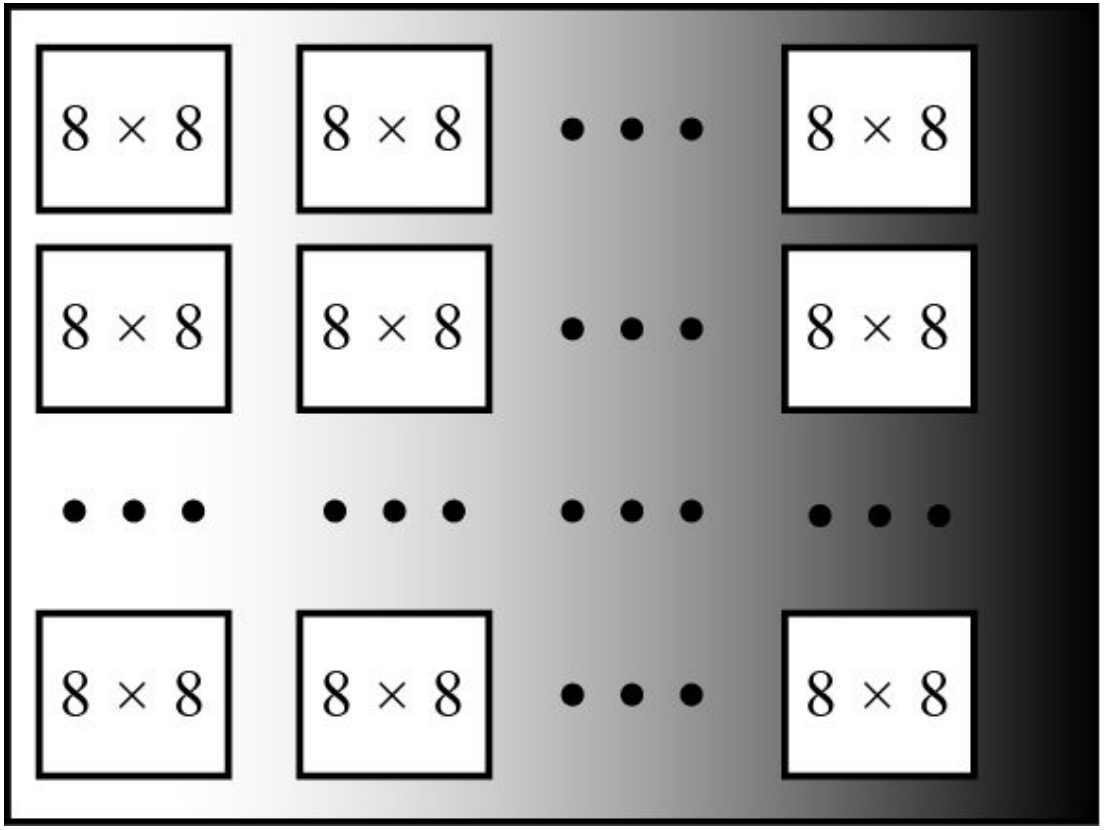
1. LZW compression uses a code table, with 4096 as a common choice for the number of table entries.
2. Codes 0-255 in the code table are always assigned to represent single bytes from the input file.
3. When encoding begins the code table contains only the first 256 entries, with the remainder of the table being blanks.
4. Compression is achieved by using codes 256 through 4095 to represent sequences of bytes.
5. As the encoding continues, LZW identifies repeated sequences in the data and adds them to the code table.
6. Decoding is achieved by taking each code from the compressed file and translating it through the code table to find what character or characters it represents.

LOSSY COMPRESSION

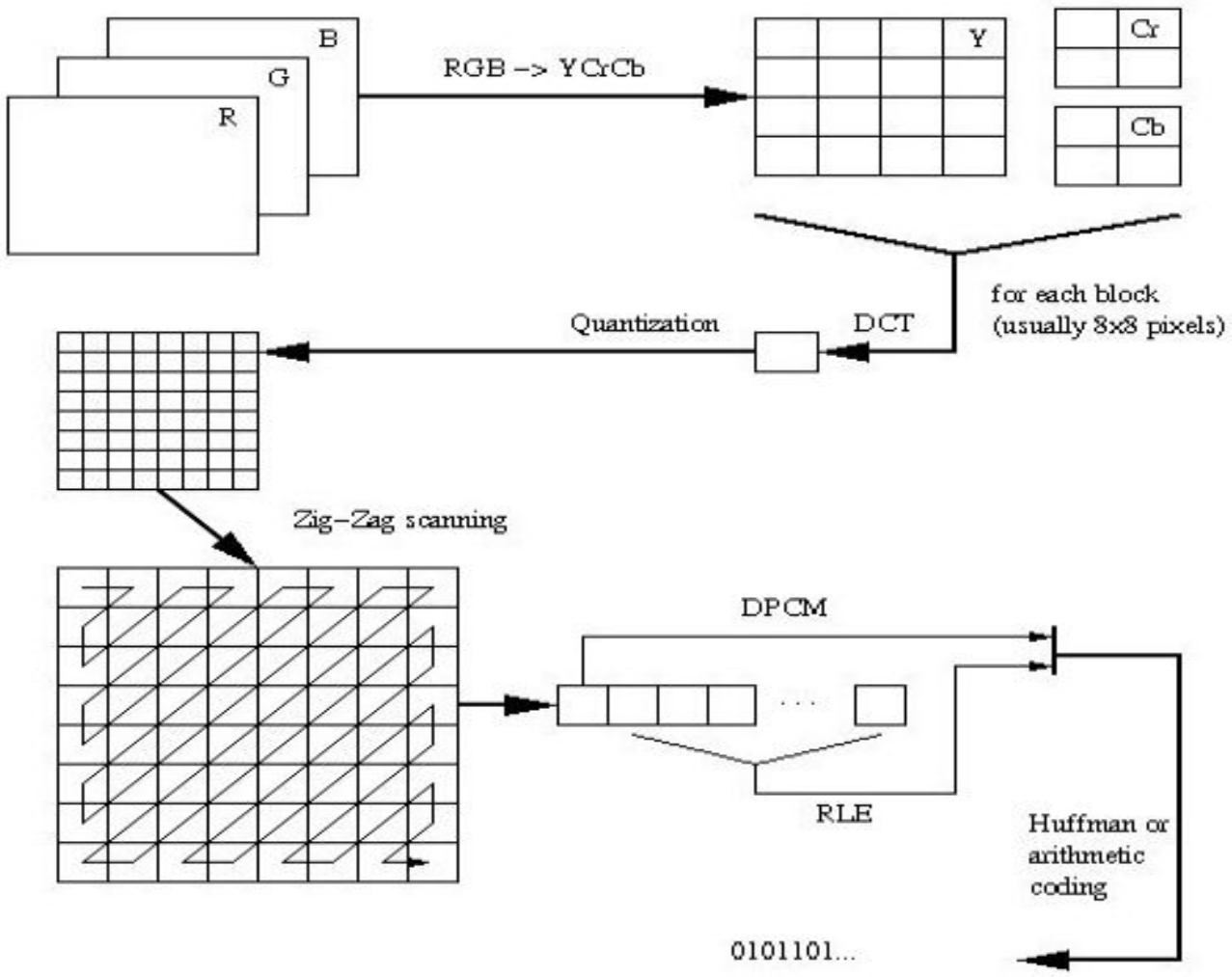
- Lossy file compression results in lost data and quality from the original version.

JPEG

- An image can be represented by a two-dimensional array (table) of picture elements (pixels).
- In JPEG, a grayscale picture is divided into blocks of 8 × 8 pixel blocks.

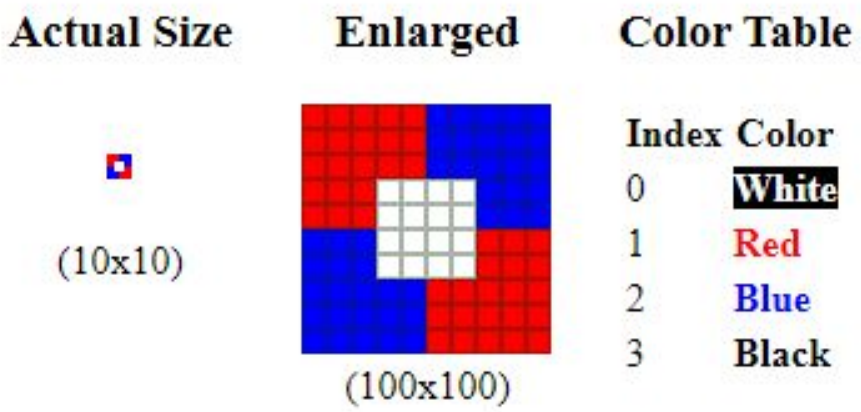


JPEG



GIF

- GIF, in full **Graphics Interchange Format**, digital file format devised in 1987 by the Internet service provider CompuServe as a means of reducing the size of images and short animations.
- Because GIF is a lossless data compression format, it quickly became a popular format for transmitting and storing graphic files.
- There are two versions of the GIF format; versions 87a and 89a.
- A GIF image can contain 2, 4, 8, 16, 32, 64, 128, or 256 colours which are stored in a colour palette or colour lookup table within the image file.
- Each colour in the GIF colour table is described in RGB values, with each value having a range of 0 to 255.



GIF

- The limited number of colours in GIF is used to limit the file size of images.
- GIF supports LZW compression.

Features of GIF:

1. Transparency
2. Interlacing
3. Animation

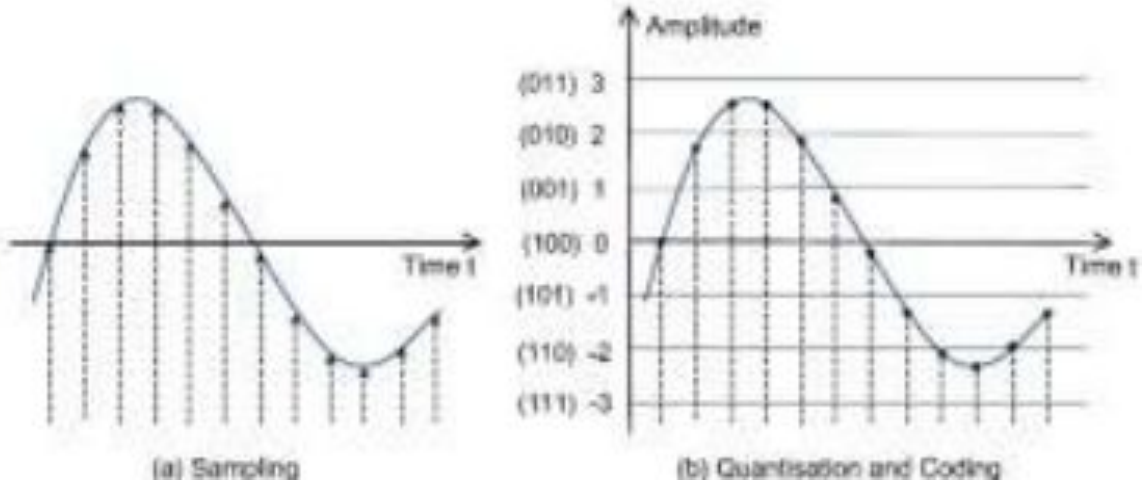
SPEECH COMPRESSION

- The aim of speech compression is to reduce the number of bits required to represent speech signals by removing the redundant bits so-that the less bandwidth is required for transmission.

SPEECH SIGNAL DIGITIZATION

- Speech signal digitization is the process to convert speech from analog signal to digital signal in order for digital processing and transmission.
- The main phases in speech signal digitization are :

a) Sampling
b) Quantization and coding



LOSSY vs LOSSLESS COMPRESSION

Lossy Compression	Lossless Compression
The technique involves some loss of information	Involves no loss of information.
Lossy compression is the family of data encoding method that utilizes imprecise estimates to represent the content.	Lossless compression is a group of data compression algorithms that permits the original data to be accurately rebuilt from the compressed data.
In Lossy compression, data's quality is compromised.	But Lossless Compression does not compromise the data's quality.
Lossy compression is used in Images, audio, video.	Lossless compression is used to compress text, images
After lossy compression, a file cannot be restored to its original form.	After lossless compression, a file can be restored to its original form.

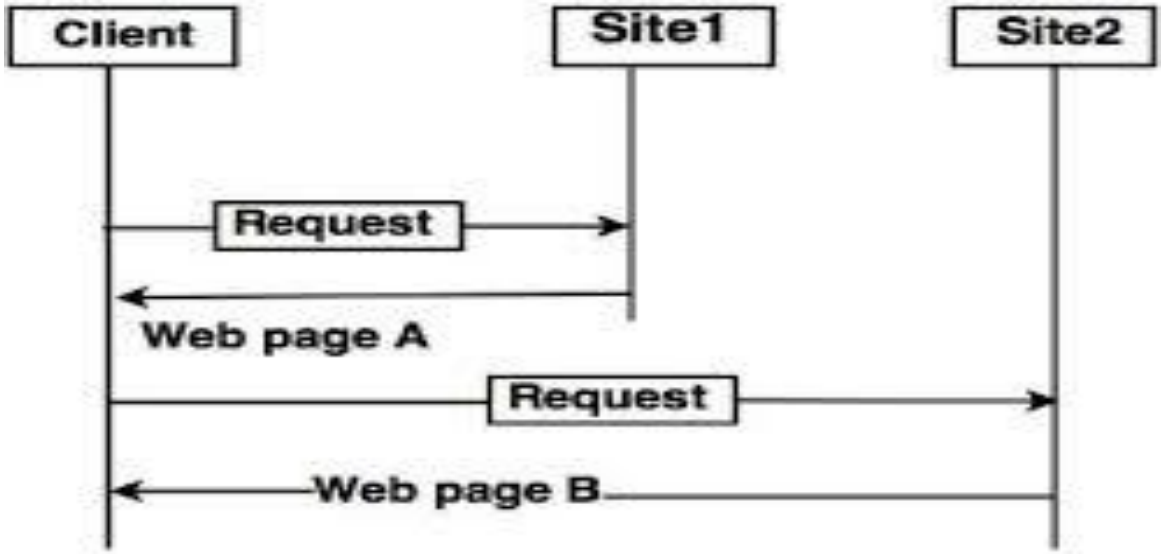
APPLICATION LAYER

INTRODUCTION

- The application layer enables the user, whether human or software, to access the network.
- It provides user interfaces and support for services such as electronic mail, file access and transfer, access to system resources, surfing the world wide web, and network management.

WORLD WIDE WEB

- Web is a repository of information in which the documents, called the web pages, are distributed all over the world and related documents are linked together.
- A web page can be simple or composite.



Architecture of WWW

WORLD WIDE WEB

Web Client (Browser)

- Browsers interpret and display a web page.

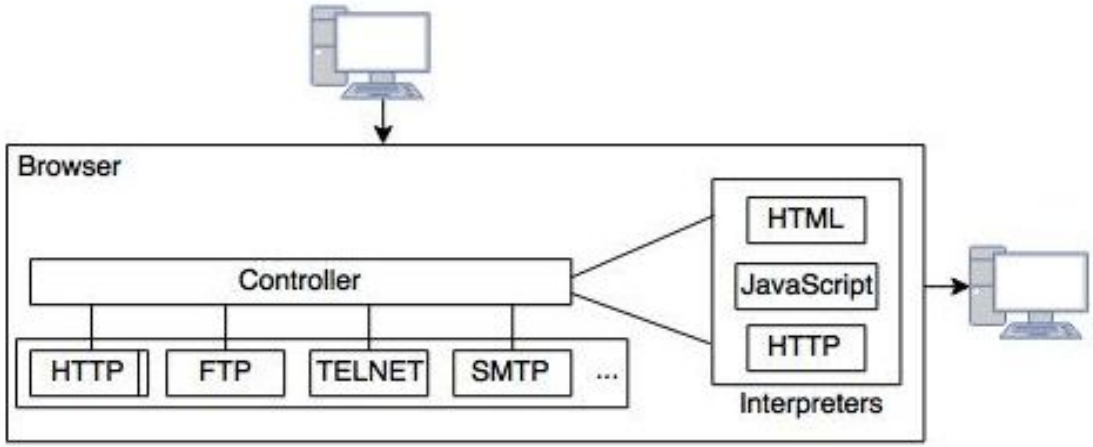


Fig: CIlient (Browser)

WORLD WIDE WEB

Web Server

- Server stores services in web pages.
- Each time a request arrives, the corresponding document is sent to the client.
- To improve efficiency , servers store requested files in a cache.
- Efficiency can be improved using multithreading and multi processing.
- Services can be accessed through URL.

WORLD WIDE WEB

Uniform Resource Locator

- A web page as a file must have a unique identifier to distinguish it from other web pages.

The identifiers are:

Protocol
Host
Port
Path

Syntax: protocol://host/path
protocol://host:port/path

Example: http://www.mhhe.com/compsci/forouzan

WORLD WIDE WEB

Web Documents:

Static Documents

- These are fixed content documents that are created and stored in a server.
- Static documents are prepared using one of the several languages: HTML,XML,XSL,XHTML

Dynamic Documents

- These document are created by a web server whenever a browser requests the document.
- Because a fresh document is created for each request, the contents of a dynamic document can vary from one request to another.
- The Common Gateway Interface (CGI) is a technology that creates and handles dynamic documents.
- The problem with CGI technology is the inefficiency that results if part of the dynamic document that is to be created is fixed and not changing from request to request.
- Scripting languages such as JSP, ASP etc. are used to retrieve dynamic document.

WORLD WIDE WEB

Active Documents

- For many applications we need a program or a script to be run at the client side.
- Java Applets are used to create to active documents.
- An applet is a program written in Java on the server. It is compiled and ready to be run.

HTTP

- HTTP is used to define how client –server programs can be written.
- HTTP client sends a request, and HTTP server returns a response .
- The server port number is 80 and client port number is temporary.
- HTTP use TCP protocol, i.e. before any transaction a connection needs to be established.
- Client and server need not worry about errors as TCP takes care of it.

HTTP

Non persistent connection

- In a Non persistent connection ,one TCP connection is made for each request/response.

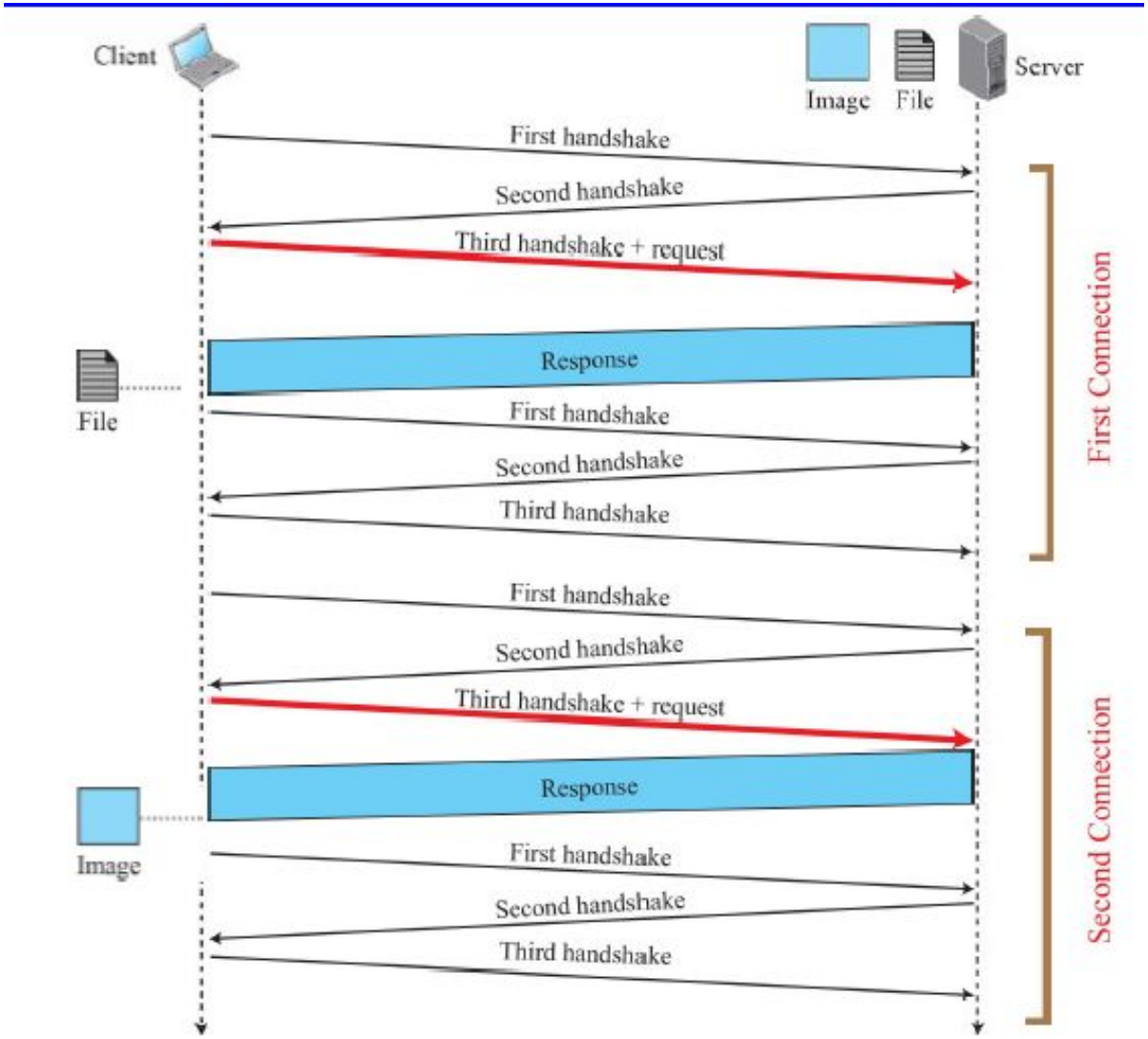
1. The client opens a TCP connection and sends a request.
2. The server sends the response and closes the connection.
3. The client reads the data until it encounters an end of file marker, it then closes the connection.

- In this method, if the file contains links to N different pictures in different files, the connection must be opened and closed N+1 times.

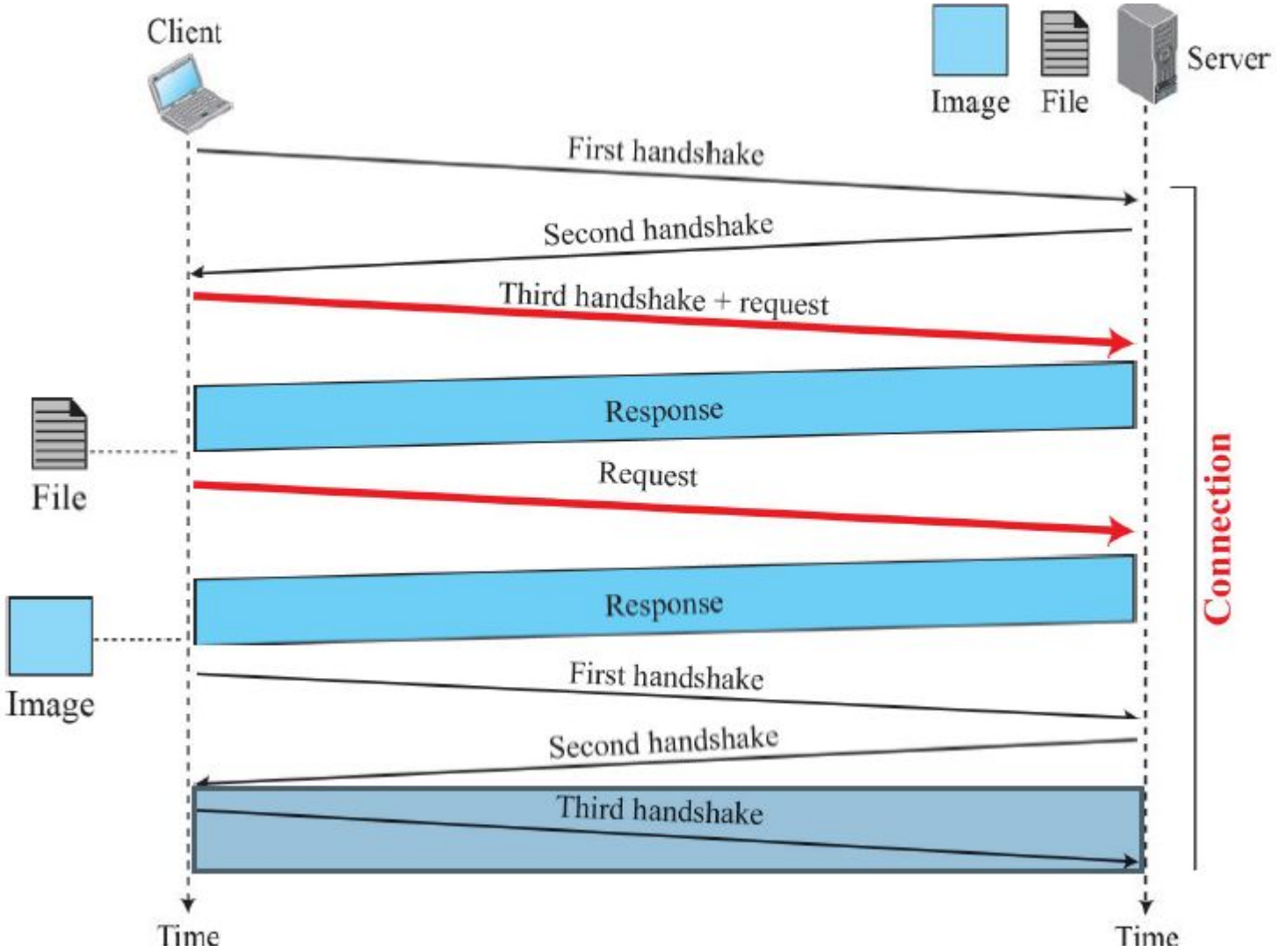
Persistent connection

- HTTP version 1.1 specifies a persistent connection by default.
- The server leaves the connection open for more requests after sending a response.

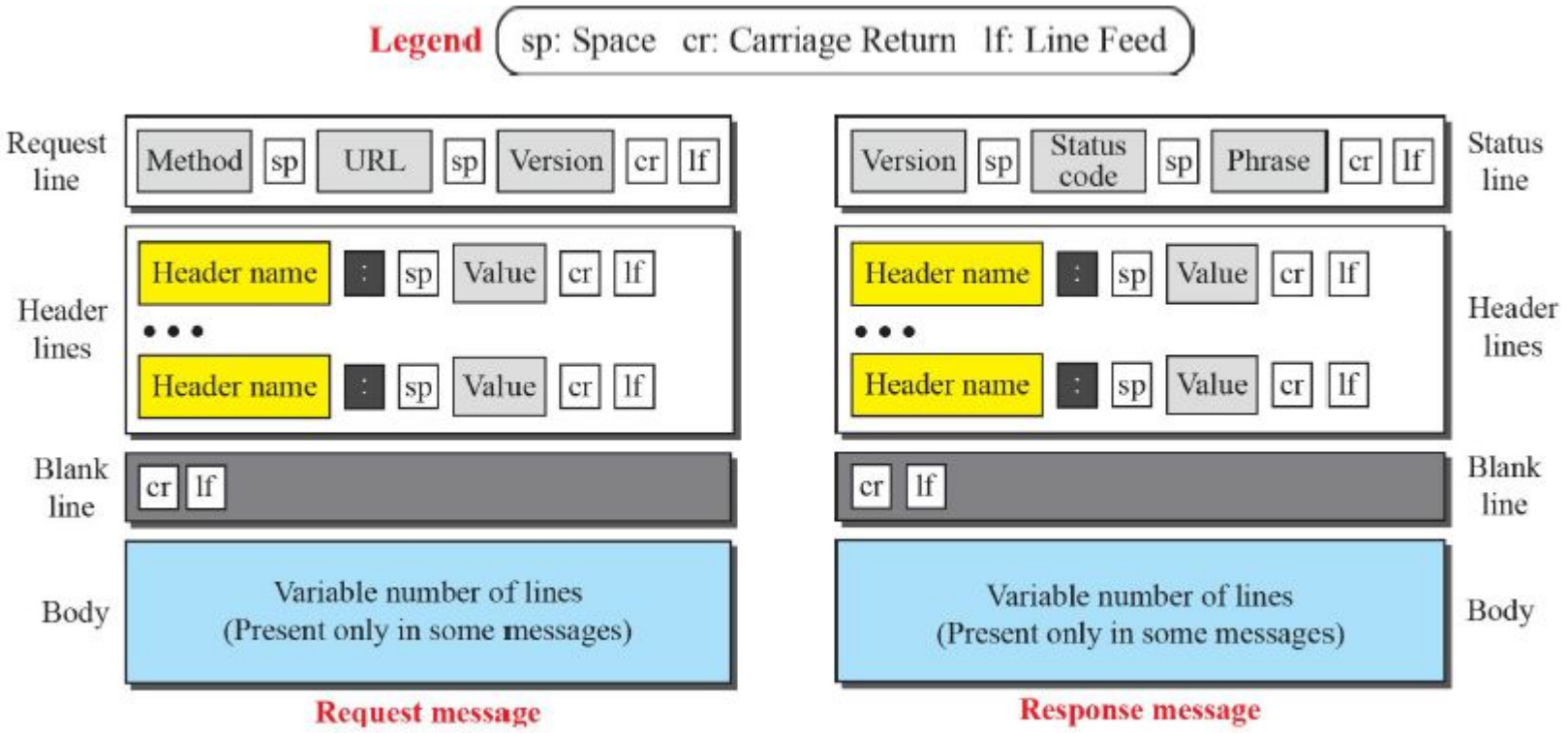
NON PERSISTENT HTTP



PERSISTENT HTTP



HTTP MESSAGE FORMATS



HTTP METHODS

Method	*Action*
GET	Requests a document from the server
HEAD	Requests information about a document but not the document itself
PUT	Sends a document from the client to the server
POST	Sends some information from the client to the server
TRACE	Echoes the incoming request
DELETE	Removes the web page
CONNECT	Reserved
OPTIONS	Inquires about available options

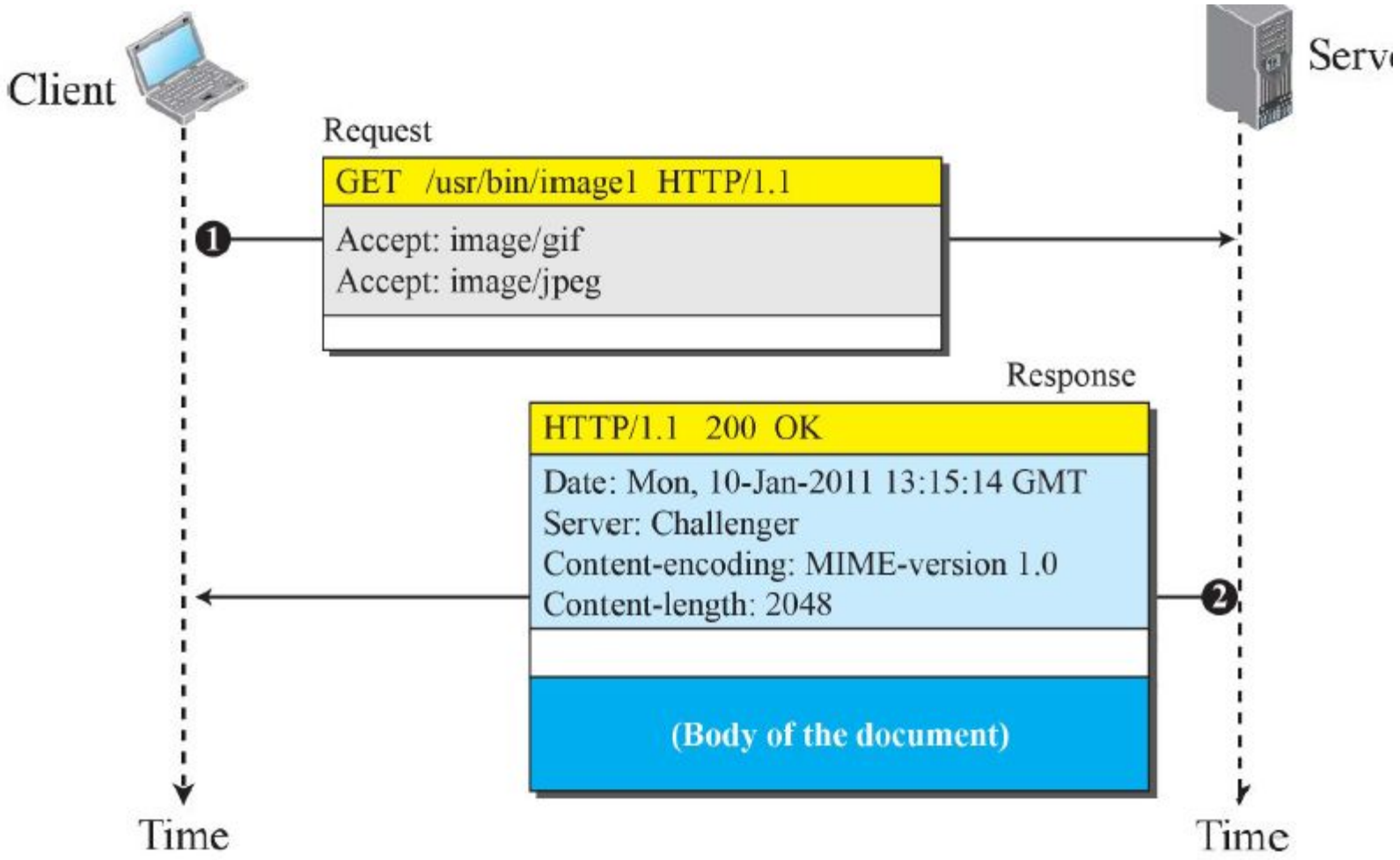
HTTP REQUEST HEADER NAMES

Header	*Description*
User-agent	Identifies the client program
Accept	Shows the media format the client can accept
Accept-charset	Shows the character set the client can handle
Accept-encoding	Shows the encoding scheme the client can handle
Accept-language	Shows the language the client can accept
Authorization	Shows what permissions the client has
Host	Shows the host and port number of the client
Date	Shows the current date
Upgrade	Specifies the preferred communication protocol
Cookie	Returns the cookie to the server (explained later)
If-Modified-Since	If the file is modified since a specific date

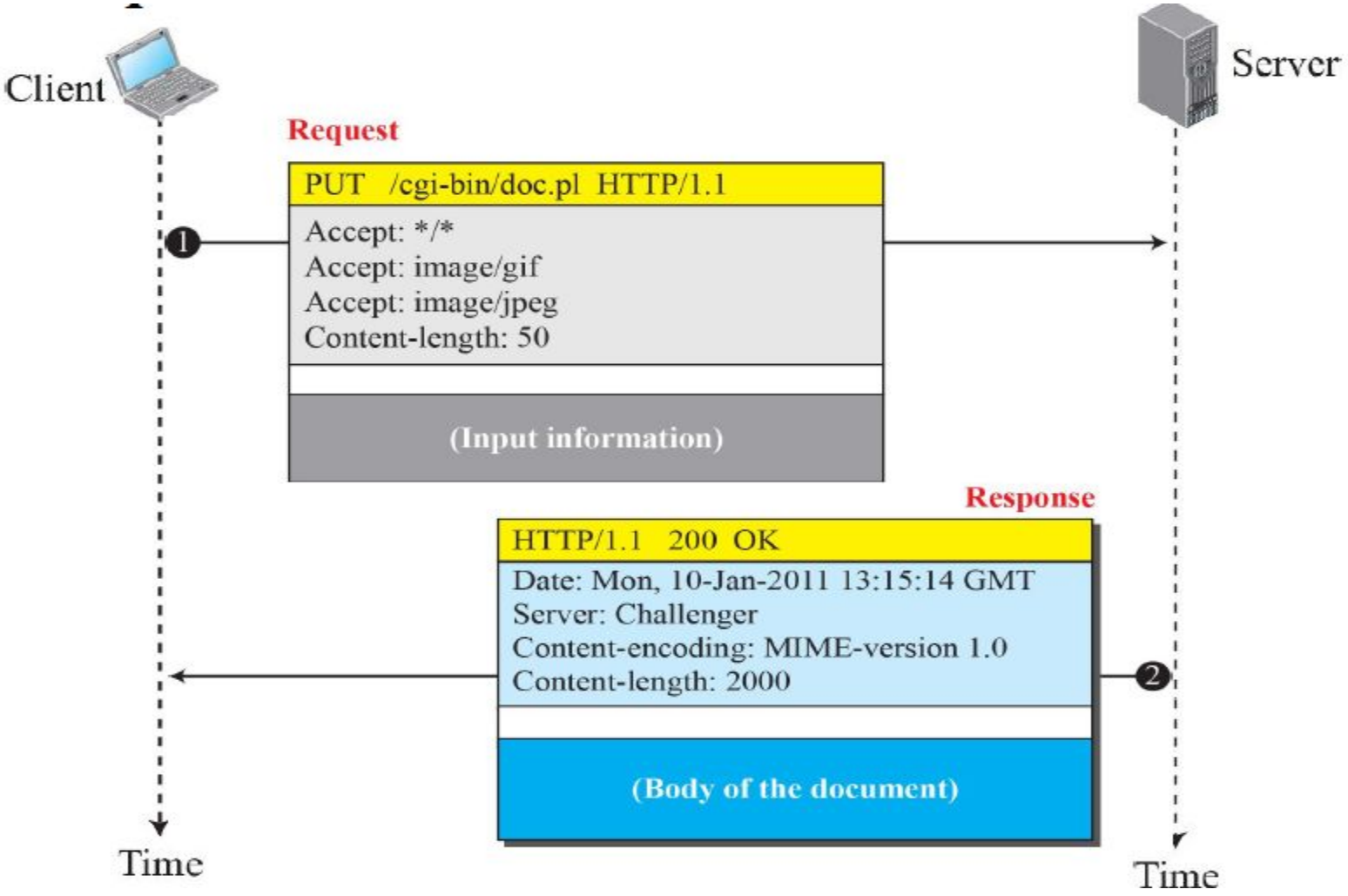
HTTP RESPONSE HEADER NAMES

Header	*Description*
Date	Shows the current date
Upgrade	Specifies the preferred communication protocol
Server	Gives information about the server
Set-Cookie	The server asks the client to save a cookie
Content-Encoding	Specifies the encoding scheme
Content-Language	Specifies the language
Content-Length	Shows the length of the document
Content-Type	Specifies the media type
Location	To ask the client to send the request to another site
Accept-Ranges	The server will accept the requested byte-ranges
Last-modified	Gives the date and time of the last change

HTTP



HTTP



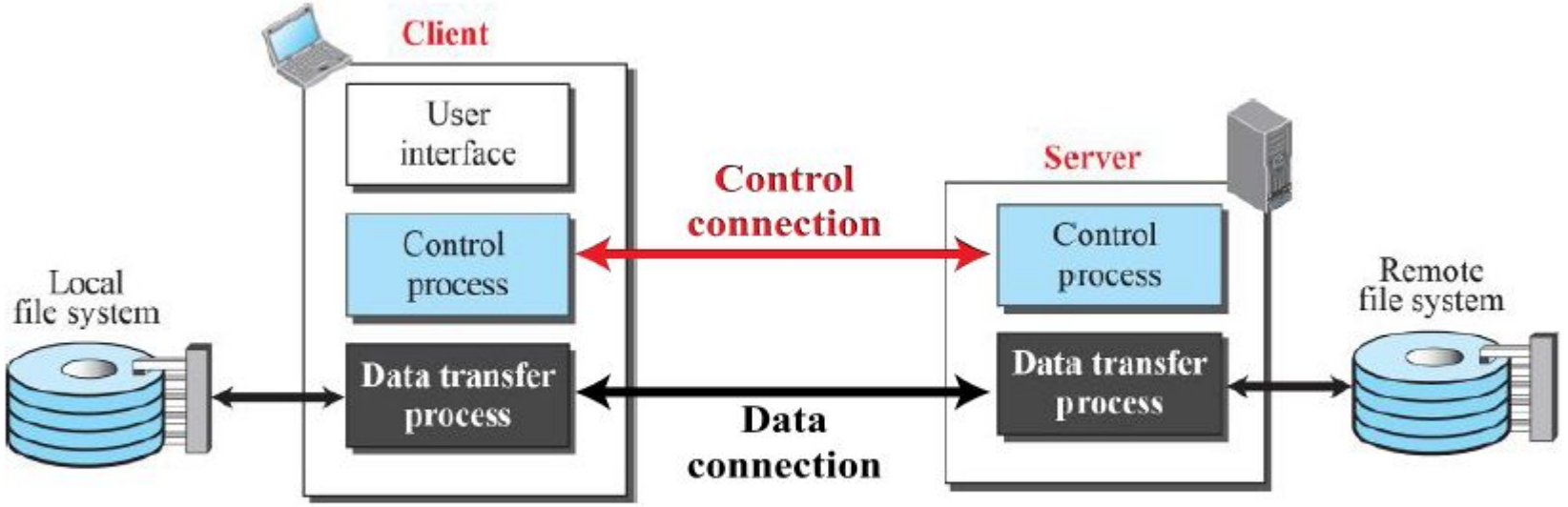
FTP

- File Transfer Protocol (FTP) is the standard protocol provided by TCP/IP for copying a file from one host to another.
- Transferring files from one system to another seems simple and straightforward, some problems must be dealt.
- For example,

1. Two systems may use different file name conventions.
2. Two systems may have different ways to represent data.

- FTP uses two well-known TCP ports: Port 21 is used for the control connection, and port 20 is used for the data connection.

FTP



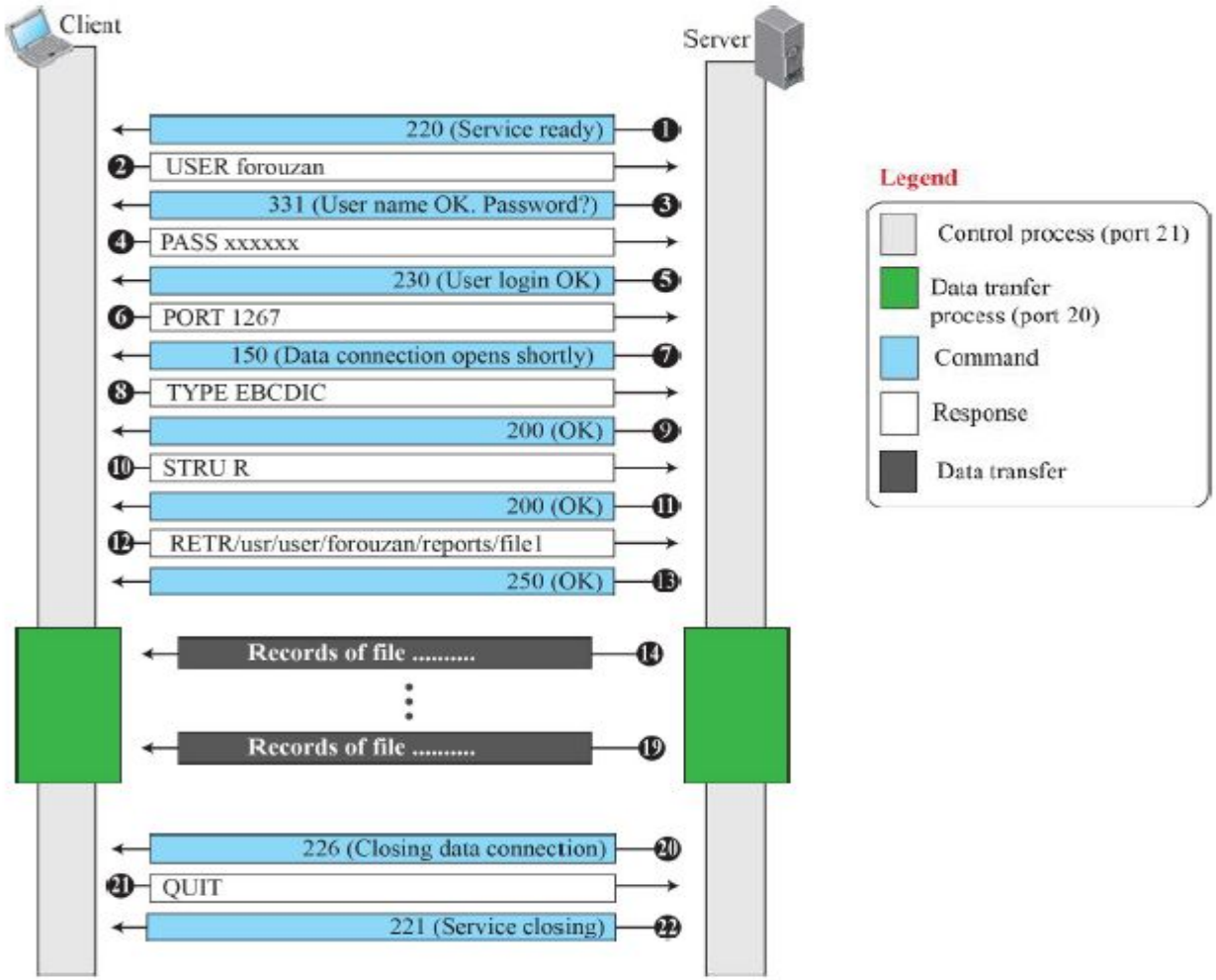
FTP COMMANDS

Command	*Argument(s)*	*Description*
ABOR		Abort the previous command
CDUP		Change to parent directory
CWD	Directory name	Change to another directory
DELE	File name	Delete a file
LIST	Directory name	List subdirectories or files
MKD	Directory name	Create a new directory
PASS	User password	Password
PASV		Server chooses a port
PORT	port identifier	Client chooses a port
PWD		Display name of current directory
QUIT		Log out of the system
RETR	File name(s)	Retrieve files; files are transferred from server to client
RMD	Directory name	Delete a directory
RNFR	File name (old)	Identify a file to be renamed

FTP RESPONSES

Code	*Description*	*Code*	*Description*
125	Data connection open	**250**	Request file action OK
150	File status OK	**331**	User name OK; password is needed
200	Command OK	**425**	Cannot open data connection
220	Service ready	**450**	File action not taken; file not available
221	Service closing	**452**	Action aborted; insufficient storage
225	Data connection open	**500**	Syntax error; unrecognized command
226	Closing data connection	**501**	Syntax error in parameters or arguments
230	User login OK	**530**	User not logged in

FTP



FTP

Communication over Data Connection

- File transfer occurs over the data connection under the control of the commands sent over the control connection.

File transfer in FTP means one of three things:

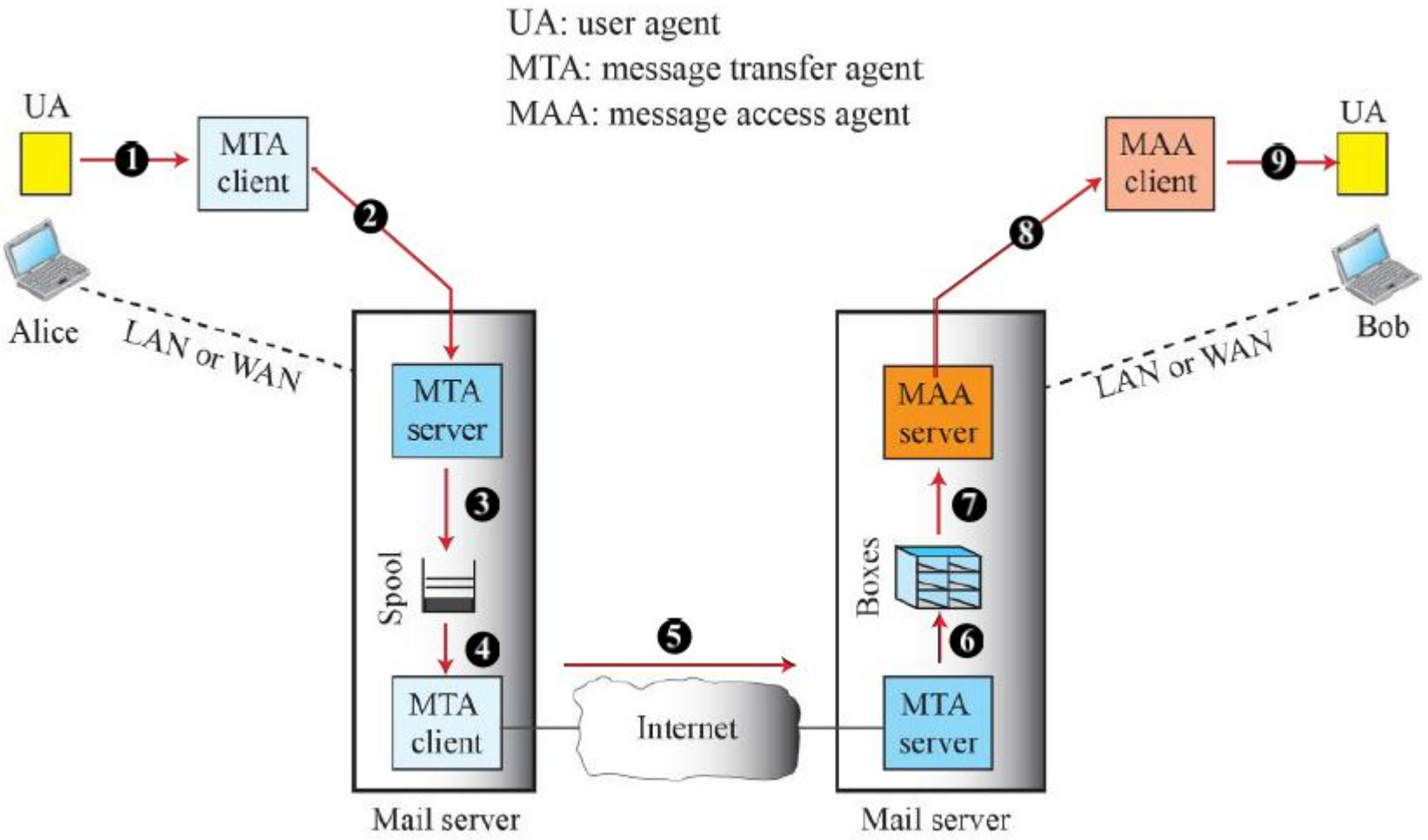
1. A file is to be copied from the server to the client. This is called retrieving a file.
2. A file is to be copied from the client to the server. This is called storing a file.
3. A list of directory or file names is to be sent from the server to the client.

- The client must define the type of file to be transferred, the structure of the data, and the transmission mode.
- Before sending the file through the data connection, we prepare for transmission through the control connection.

ELECTRONIC MAIL

- Electronic mail (or e-mail) allows users to exchange messages.
- In an application such as HTTP or FTP, the server program is running all the time, waiting for a request from a client.
- When the request arrives, the server provides the service. In the case of electronic mail, the situation is different.
- E-mail is considered a one-way transaction.

ELECTRONIC MAIL



ELECTRONIC MAIL

USER AGENT

- It provides service to the user to make the process of sending and receiving a message easier.
- A user agent is a software package that composes , reads , replies to , Handling Mailboxes and forwards messages.
- Types of user agents:

1. Command driven
2. GUI based

ELECTRONIC MAIL

Message Transfer Agent: SMTP

- The protocol that defines the MTA client and server in the internet is called as Simple Mail Transfer Protocol(SMTP)
- SMTP uses commands and responses to transfer messages between an MTA client and MTA server.
- Commands: Keyword: argument(s)

Table 26.7 *Commands*

Keyword	*Argument(s)*
HELO	Sender's host name
MAIL FROM	Sender of the message
RCPTTO	Intended recipient of the message
DATA	Body of the mail

ELECTRONIC MAIL

- Responses are sent from the server to the client.
- A response is a three digit code that may be followed by additional textual information.

Table 26.8 *Responses*

Code	*Description*
Positive Completion Reply	
211	System status or help reply
214	Help message
220	Service ready
221	Service closing transmission channel
250	Request command completed
251	User not local; the message will be forwarded

ELECTRONIC MAIL

MAIL TRANSFER PHASES

1. Connection Establishment
2. Message transfers
3. Connection Termination

ELECTRONIC MAIL

MESSAGE ACCESS AGENT: POP & IMAP

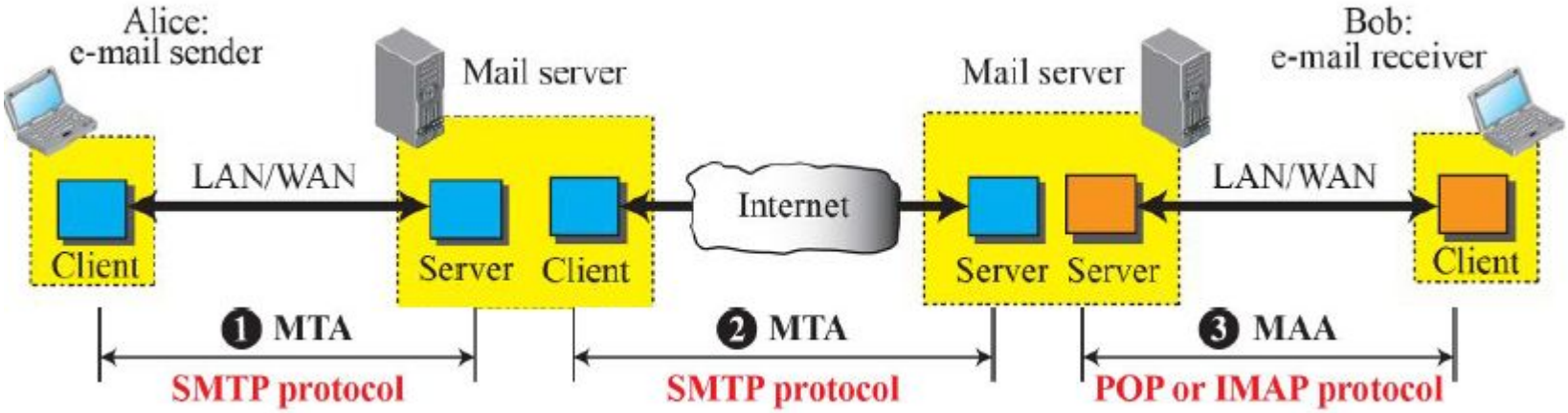
POP3 – Post Office Protocol

- The client POP3 software is installed on the recipient computer; the server POP3 software is installed on the mail server.
- POP3 allows you to download email messages on your local computer and read them even when you are offline.
- POP3 has 2 modes: Delete mode and Keep mode

IMAP4-Internet Mail Access Protocol

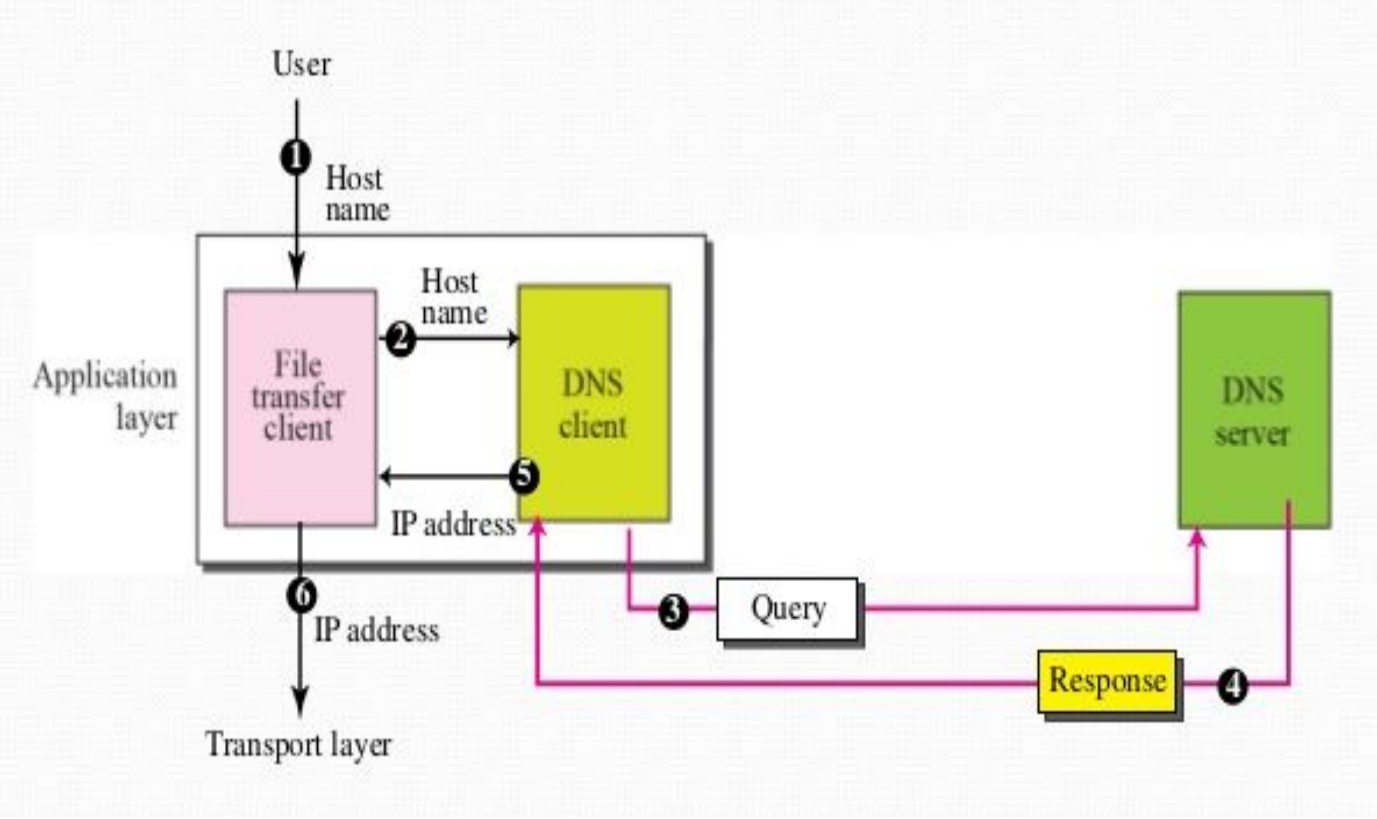
- A user can check the email header prior to downloading.
- A user can search the contents of the e-mail for a specific string of characters prior to downloading.
- A user can create, delete, or rename mailboxes on the mail server.
- Messages are synced and accessed across multiple devices.

ELECTRONIC MAIL



DOMAIN NAME SYSTEM (DNS)

- To identify an entity, TCP/IP protocols use the IP address, which uniquely identifies the connection of a host to the Internet.
- However, people prefer to use names instead of numeric addresses.
- Therefore, the Internet needs to have a directory system that can map a name to an address.



DOMAIN NAME SYSTEM (DNS)

NAMESPACE

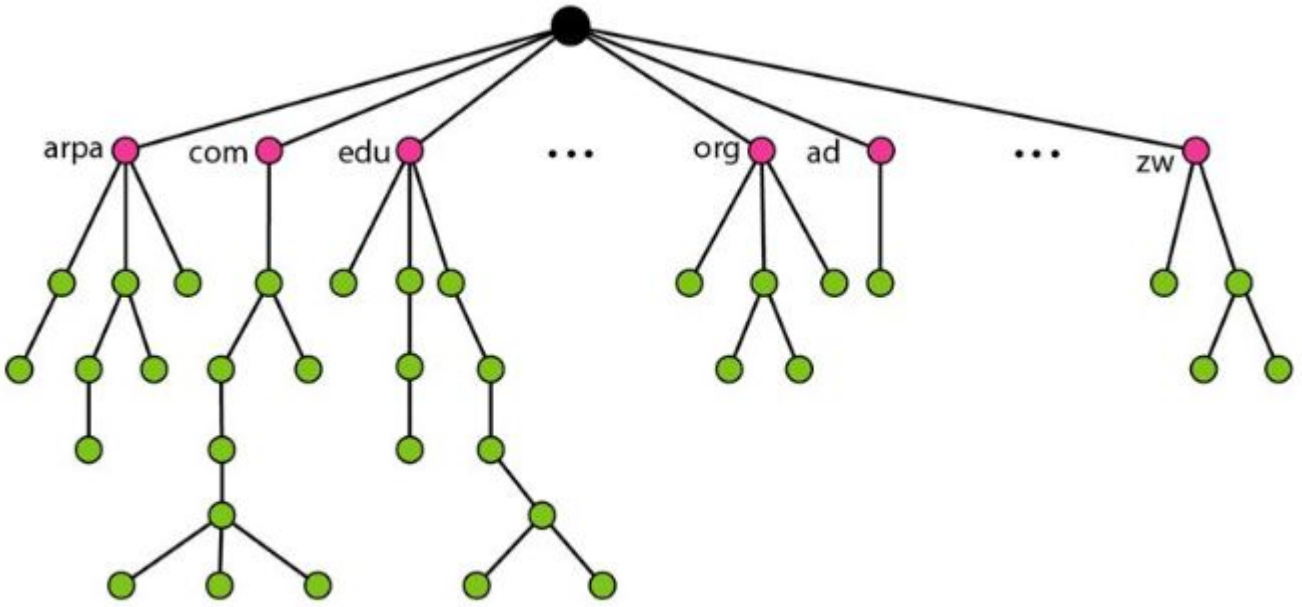
- The names assigned to machines must be unique because the addresses are unique.
- A namespace is organized in two ways:

1. Flat
2. Hierarchical

DOMAIN NAME SYSTEM (DNS)

DOMAIN NAME SPACE

- To have a hierarchical name space, a domain name space was designed.
- In this design the names are defined in an inverted-tree structure with the root at the top.
- The tree can have only 128 levels: level 0 (root) to level 127



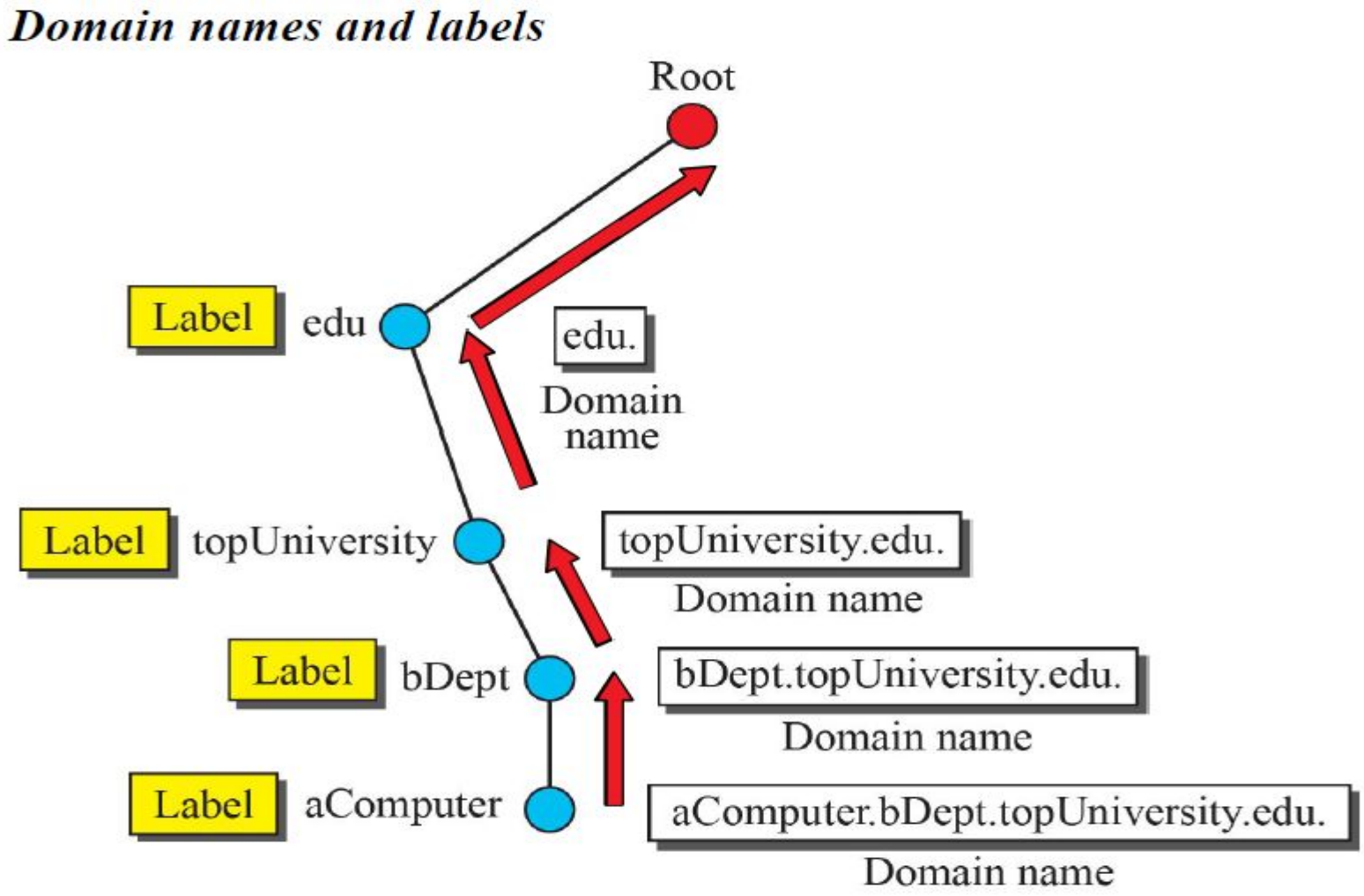
DOMAIN NAME SYSTEM (DNS)

Label : Each node in the tree has a label which is a string with a maximum of 63 characters. The root label is a null string (empty string).

Domain name: A full domain name is a sequence of labels separated by dots(.). The domain names are always read from the node up to the root.

Domain: A domain is a subtree of the domain name space.

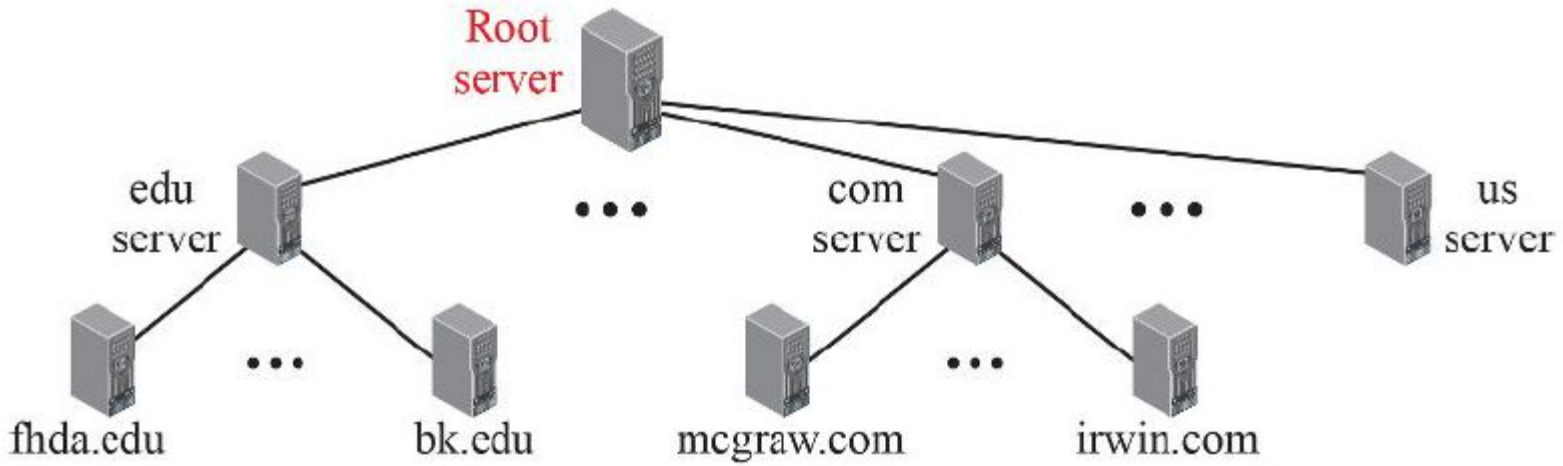
DOMAIN NAME SYSTEM (DNS)



DOMAIN NAME SYSTEM (DNS)

HIERARCHY OF NAME SERVERS

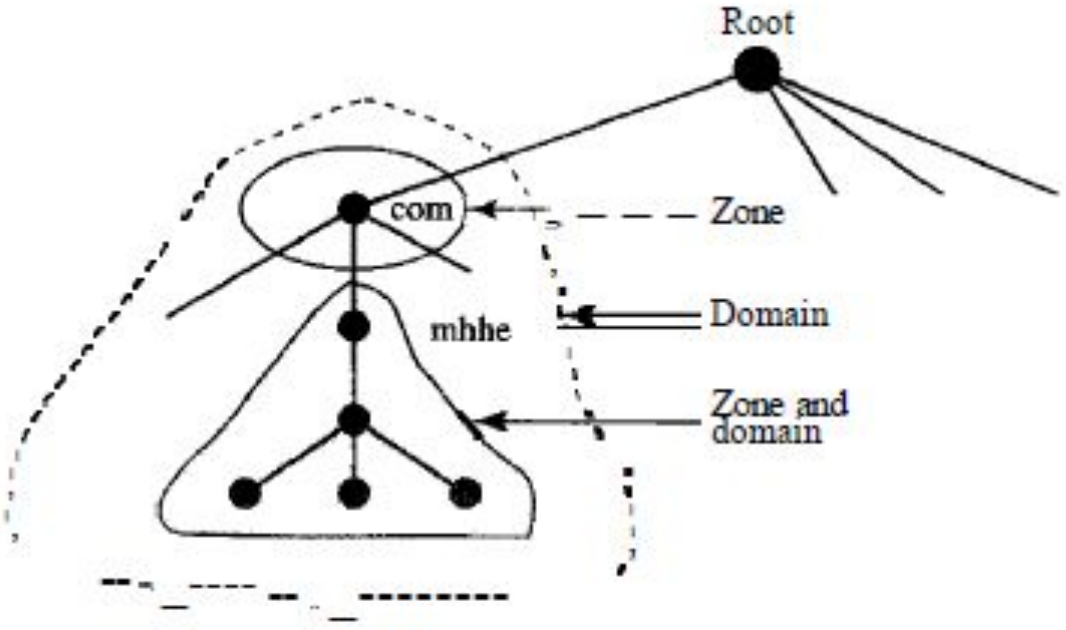
- One way of dividing the entire information among many computers is to divide the whole space into many domains based on the first level.



DOMAIN NAME SYSTEM (DNS)

Zone

- Since the complete domain name hierarchy cannot be stored on a single server, it is divided among many servers.
- What a server is responsible for or has authority over is called a **zone**.



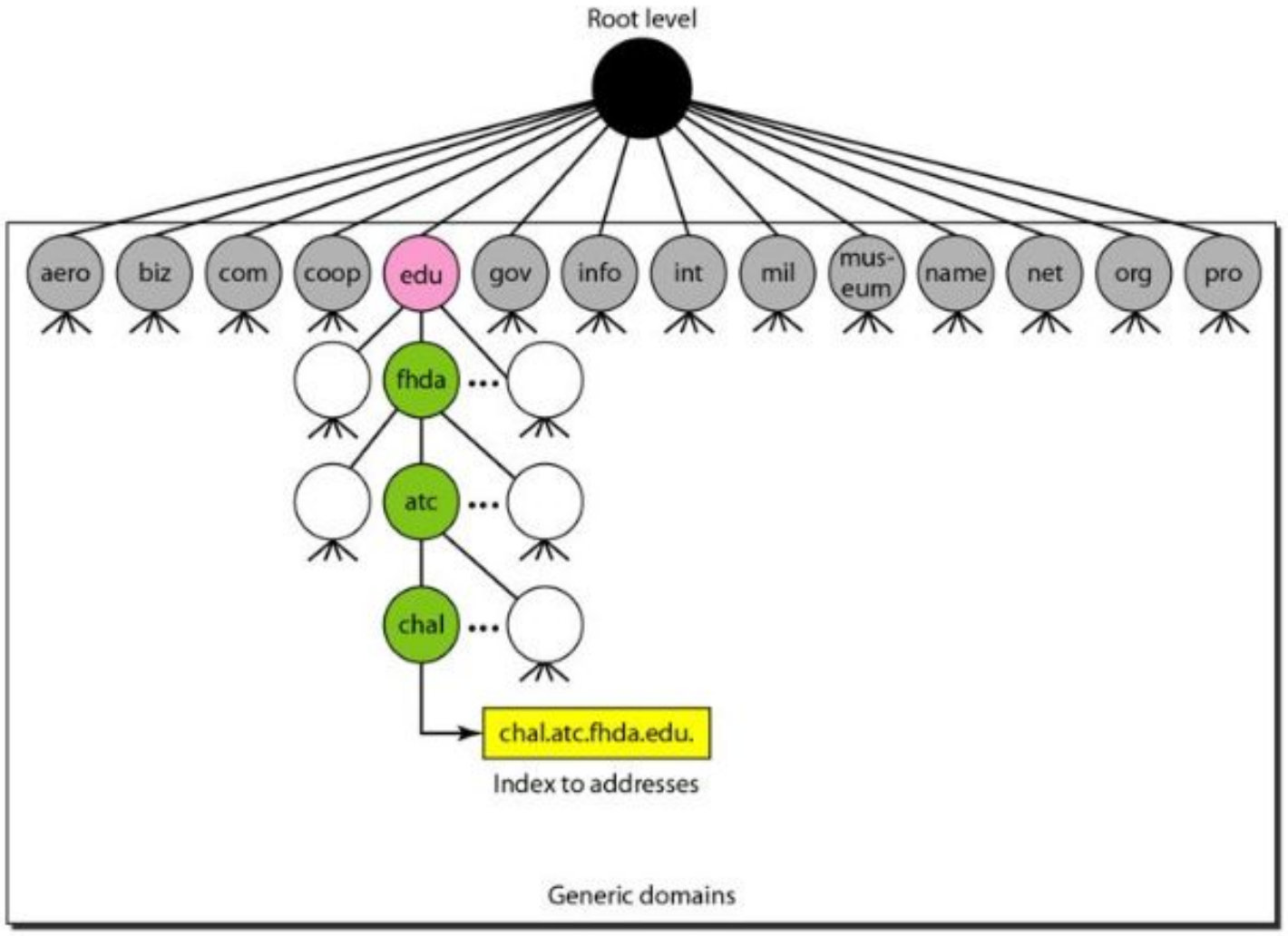
DOMAIN NAME SYSTEM (DNS)

DNS IN THE INTERNET

- The domain name space was originally divided into 3 different sections:

1. Generic domain
2. Country domain
3. Inverse domain

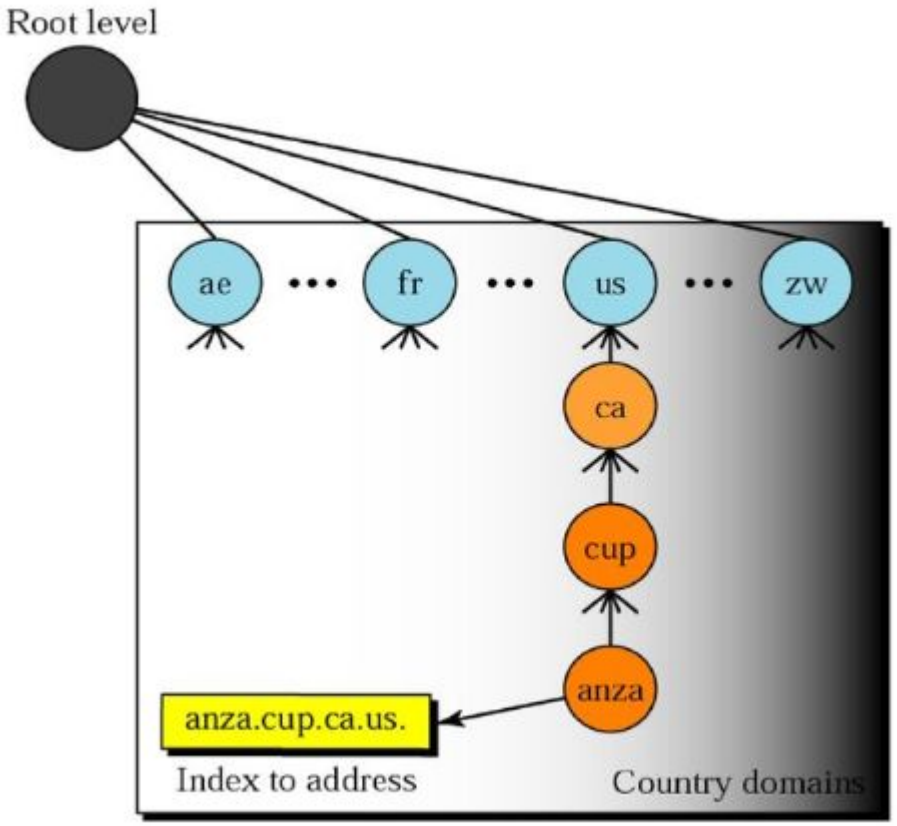
DOMAIN NAME SYSTEM (DNS)



DOMAIN NAME SYSTEM (DNS)

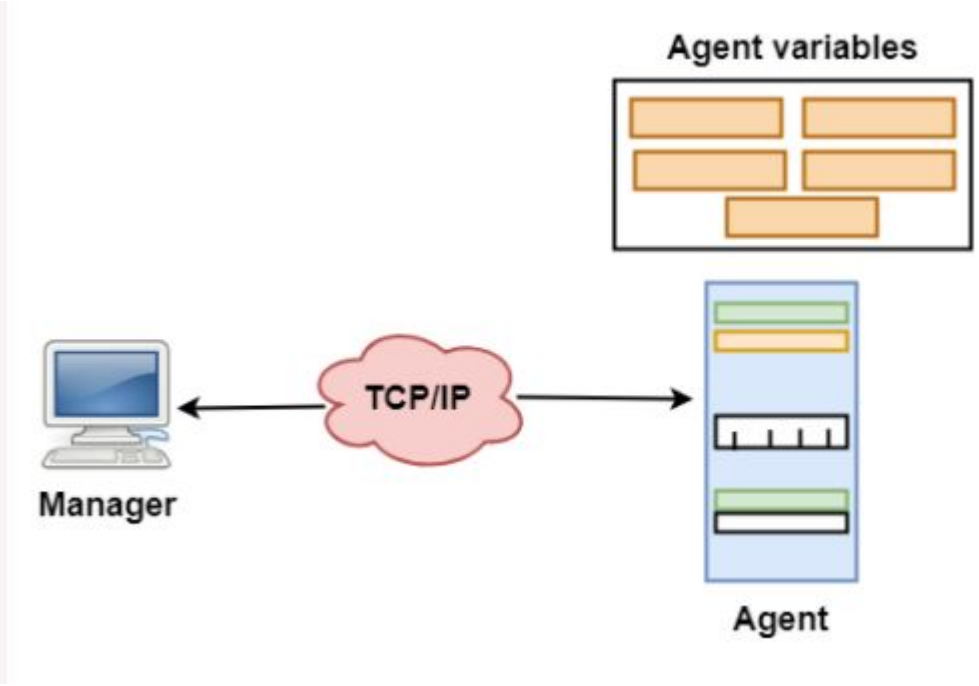
Country Domain

- The country domains section uses two-character country abbreviations (e.g., us for United States).



SIMPLE NETWORK MANAGEMENT PROTOCOL

- The Simple Network Management Protocol (SNMP) is a framework for managing devices in an internet using the TCP/IP protocol suite.
- It provides a set of fundamental operations for monitoring and maintaining an internet.
- SNMP uses the concept of manager and agent.



SNMP

Managers and Agents

- A management station, called a manager, is a host that runs the SNMP client program.
- A managed station, called an agent, is a router (or a host) that runs the SNMP server program.
- Management is achieved through simple interaction between a manager and an agent.
- The agent keeps performance information in a database. The manager has access to the values in the database.
- The manager can also make the router perform certain actions. For example, a router periodically checks the value of a reboot counter to see when it should reboot itself.
- Agents can also contribute to the management process. The server program running on the agent can check the environment, and if it notices something unusual, it can send a warning message, called a trap, to the manager.

SNMP

Management Components

- To do management tasks, SNMP uses two other protocols: Structure of Management Information (SMI) and Management Information Base (MIB).

Role of SNMP

- SNMP has some very specific roles in network management.
- It defines the format of the packet to be sent from a manager to an agent and vice versa.
- It also interprets the result and creates statistics (often with the help of other management software).
- The packets exchanged contain the object (variable) names and their status (values).
- SNMP is responsible for reading and changing these values.

SNMP

Role of SMI

- To use SNMP, we need rules. We need rules for naming objects. This is particularly important because the objects in SNMP form a hierarchical structure .
- We also need rules to define the type of the objects. What types of objects are handled by SNMP? Can SNMP handle simple types or structured types? How many simple types are available? What are the sizes of these types? What is the range of these types? In addition, how are each of these types encoded?
- We need these universal rules because we do not know the architecture of the computers that send, receive, or store these values. The sender may be a powerful computer in which an integer is stored as 8-byte data; the receiver may be a small computer that stores an integer as 4-byte data.
- SMI is a protocol that defines these rules. However, we must understand that SMI only defines the rules; it does not define how many objects are managed in an entity or which object uses which type.
- SMI is a collection of general rules to name objects and to list their types. The association of an object with the type is not done by SMI.

SNMP

Role of MIB

- For each entity to be managed, this protocol must define the number of objects, name them according to the rules defined by SMI, and associate a type to each named object.
- This protocol is MIB. MIB creates a set of objects defined for each entity similar to a database.

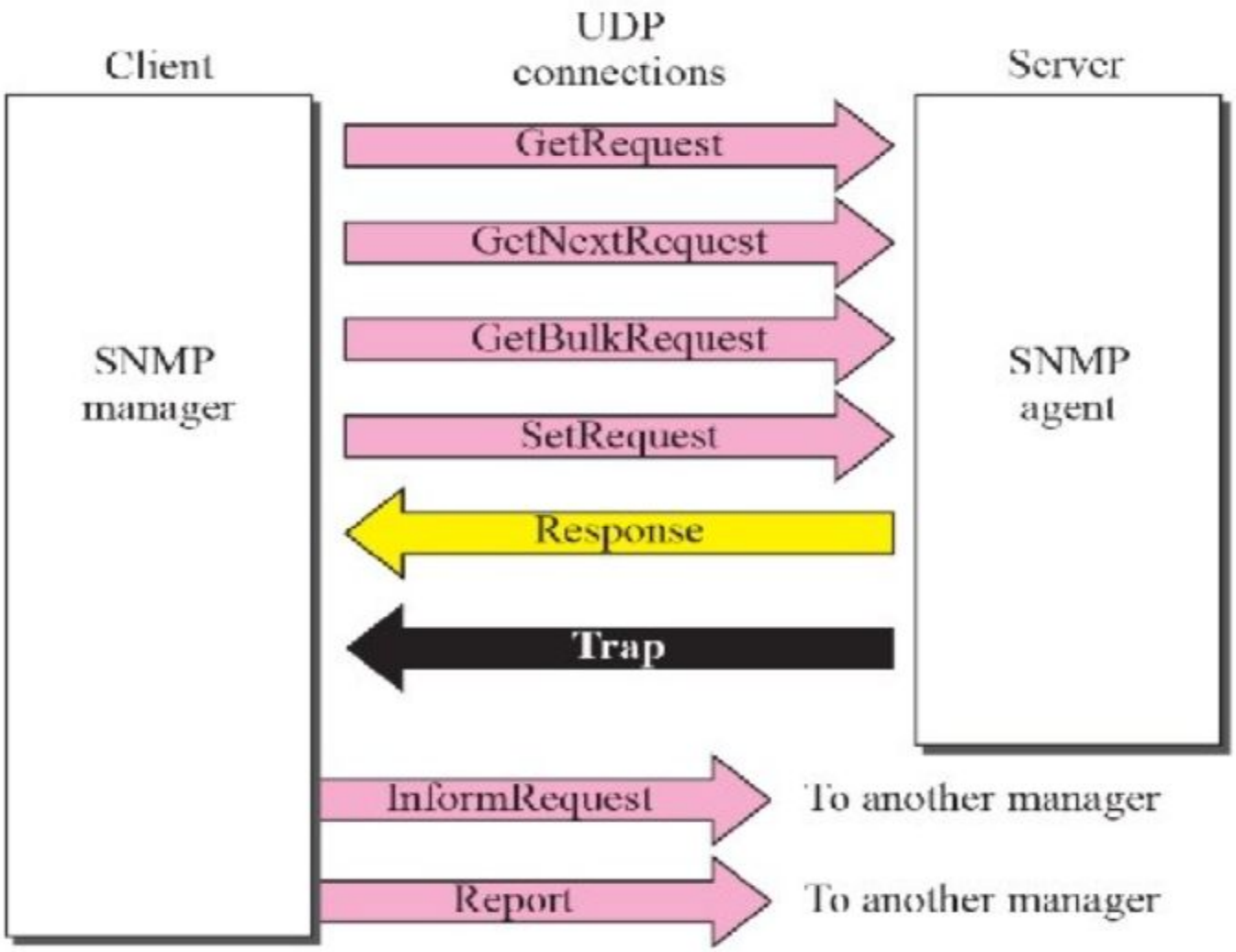
SNMP

- SNMP uses both SMI and MIB in Internet network management. It is an application program that allows

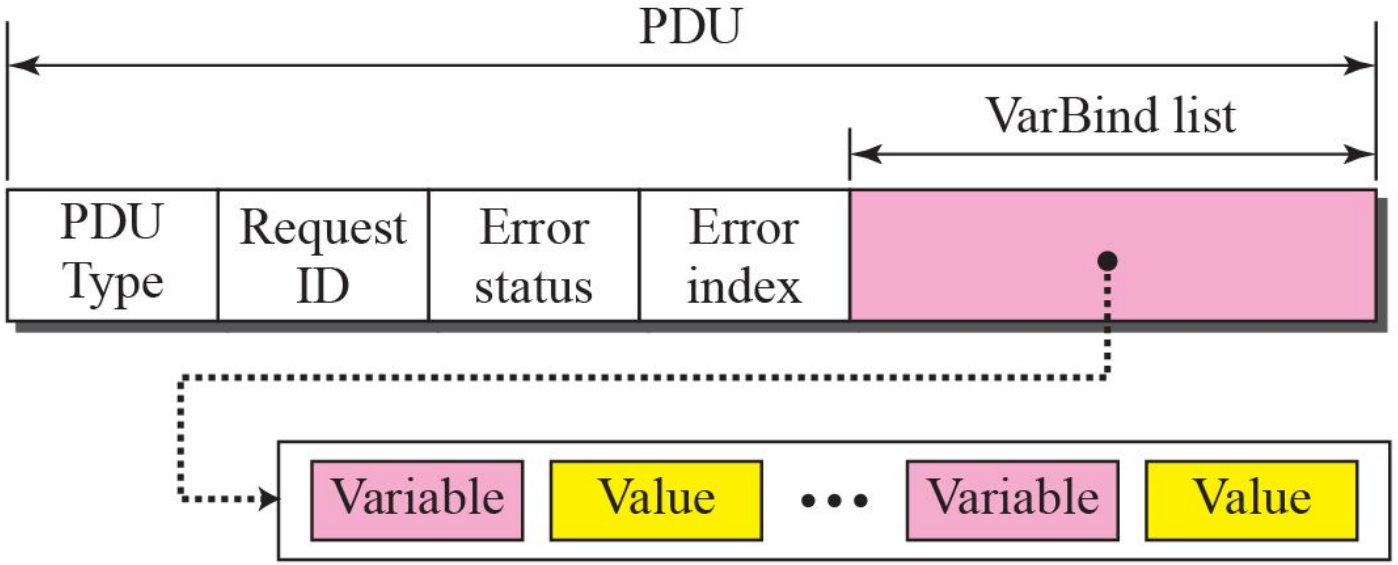
1. A manager to retrieve the value of an object defined in an agent
2. A manager to store a value in an object defined in an agent
3. An agent to send an alarm message about an abnormal situation to the manager

- SNMPv3 defines eight types of packets (or PDUs).

SNMP



SNMP



Differences:

1. Error status and error index values are zeros for all request messages except GetBulkRequest.
2. Error status field is replaced by non-repeater field and error index field is replaced by max-repetitions field in GetBulkRequest.

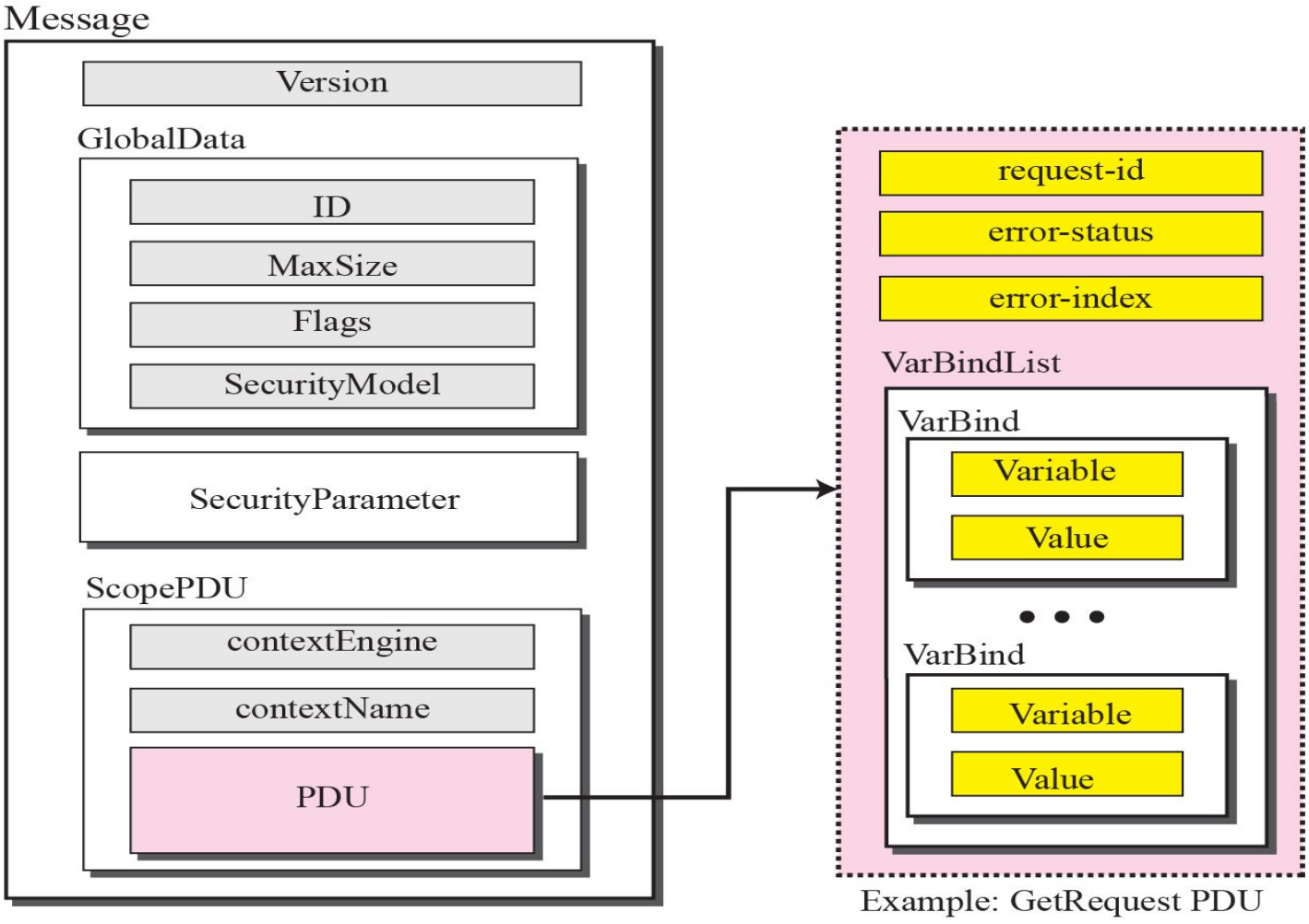
SNMP

Table 24.4 *Types of Errors*

Status	*Name*	*Meaning*
0	noError	No error
1	tooBig	Response too big to fit in one message
2	noSuchName	Variable does not exist
3	badValue	The value to be stored is invalid
4	readOnly	The value cannot be modified
5	genErr	Other errors

SNMP

- SNMP does not send only a PDU, it embeds the PDU in a message. A message in SNMPv3 is made of four elements: version, header, security parameters, and data.



SNMP

- SNMP uses the services of UDP on two well-known ports, 161 and 162.
- The well known port 161 is used by the server (agent), and the well-known port 162 is used by the client (manager).
- The agent (server) issues a passive open on port 161. It then waits for a connection from a manager (client).
- A manager (client) issues an active open, using an ephemeral port, The request messages are sent from the client to the server, using the ephemeral port as the source port and the well-known port 161 as the destination port.
- The response messages are sent from the server to the client, using the well-known port 161 as the source port and the ephemeral port as the destination port.
- The manager (client) issues a passive open on port 162. It then waits for a connection from an agent (server).
- Whenever it has a Trap message to send, an agent (server) issues an active open, using an ephemeral port. This connection is only one-way, from the server to the client.

SNMP

a. Passive open by both client and server

b. Exchange of request and response messages

c. Server sends trap message

Thank you …