


SWAMI SAHAJANAND COLLEGE OF COMPUTER SCIENCE

BCA Semester - V

Subject : Data Communication and Networking



UNIT 4

Network Applications

- ✓✓ **Domain Name System: DNS Basics, Characteristics,**
- ✓✓ **Working of DNS, DNS Hierarchy.**
- ✓✓ **File Transfer Protocol: FTP Basics, FTP Modes, FTP Commands.**
- ✓✓ **Email: Email Basics, Email Structure, How Email Works?**
- ✓✓ **Email Protocol :SMTP,IMAP, MIME and POP**
- ✓✓ **HTTP Protocol & UDP Protocol.**

DOMAIN NAME SYSTEM

DNS Basics

- DNS provides a **name to number** (IP address) mapping or translation, allowing internet users to use, easy to remember names, and not numbers to access resources on a network and the Internet.
- All computers that are connected to the Internet, Private network, or company network are identified by an IP address; **which is a number**.
- To make it easy for people to remember names (**host names**) are used to identify individual computers on a network.
 - ❖ Translate a hostname to an IP address
 - ❖ Translate an IP address to a hostname

DNS Characteristics

- The Domain Name System (DNS) is basically a large database which stores computers names and IP addresses of various hosts on the internet and various domains.
- The Domain Name System is used to provide information to the Domain Name Service to use when queries are made.
- DNS names are assigned through the Internet Registries by the Internet Assigned Number Authority (IANA).
- **For example:** mycollege.edu, microsoft.com and india.gov.
- DNS is hierarchical in structure. A domain is a sub-tree of the domain name space.
 - .GOV - Government body.
 - .EDU - Educational body.
 - .INT - International organization
 - .NET - Networks
 - .COM - Commercial entity.
 - .MIL - U. S. Military.
 - .ORG - Any other organization not previously listed.

DNS Services

- ❖ There are 2 ways to identify a host (1) Hostname and (2) IP address.
- ❖ People prefer to use hostname as identifier, while routers use structured IP addresses.
- ❖ A directory service is use to translates hostnames to IP addresses.
- ❖ The main task of the Internet's Domain Name System (DNS) is....
 - (1) Distributed database implemented in a hierarchy of DNS servers,
 - (2) Application-layer protocol that allows hosts to query the distributed database.
- ❖ The **DNS protocol runs over UDP and uses port 53**.
- ❖ DNS is commonly employed by other application-layer protocols- including HTTP, SMTP, and FTP - to translate user-supplied hostnames to IP addresses.

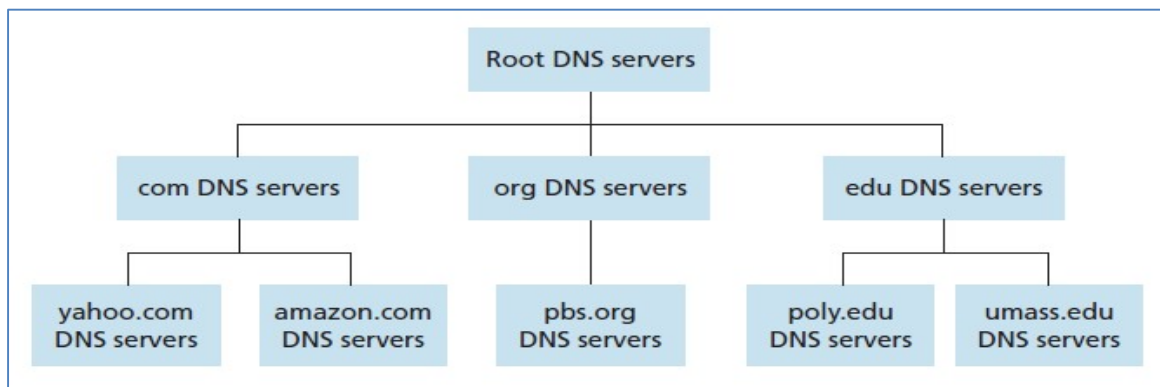
Working of DNS

- ❖ Applications like Web browser or a mail running in a user's host needs to translate a hostname to an IP address.
- ❖ DNS is a simple, straightforward translation service.
- ❖ The implementation of DNS service is complex, because it consist of large number of DNS servers distributed all over the world.

- ❖ All DNS query and reply messages are sent within UDP datagrams to port 53.
- ❖ A simple design for DNS would have one DNS server that contains all the mappings.
- ❖ In Centralized design, clients simply direct all queries to the single DNS server, and the DNS server responds directly to the querying clients.
- ❖ The problems with a centralized design include:
 - ❖ **A single point of failure.** If the DNS server crashes, so does the entire Internet
 - ❖ **Traffic volume.** A single DNS server would have to handle all DNS queries.
 - ❖ **Distant centralized database.** A single DNS server can-not be “close to” all the querying clients. If we put the single DNS server in MUMBAI, then all queries from USA must travel around the world.
 - ❖ **Maintenance.** Single DNS server would have to keep records for all Internet hosts.

DNS Hierarchy

- ❖ The DNS uses large number of servers, organized in a hierarchical method and distributed around the world. No single DNS server has all of mappings for all of hosts in the Internet.
- ❖ The mappings are distributed across the DNS servers.
- ❖ There are 3 classes of DNS servers
 - (1) **Root DNS servers**
 - (2) **Top-level domain (TLD) DNS servers**
 - (3) **Authoritative DNS servers.**
- ❖ The client first contacts one of the root servers, which returns IP addresses for TLD servers for the top-level_domain.com.
- ❖ The client then contacts one of these TLD servers, which returns the IP address of an authoritative server for requested site. (www.google.com).
- ❖ Finally, the client contacts one of the authoritative servers for amazon.com, which returns the IP address for the hostname **www.google.com**



Explain DNS servers Hierarchy (3 classes of DNS Servers) :

1. Root DNS servers:

There are 13 root DNS servers. The 13 root DNS servers work as if it were a single server, each “server” is network of replicated servers, for both security and reliability purposes..

2. Top-level domain (TLD) servers:-

These servers are responsible for top-level domains such as **.com .org, .net, .edu and .gov** and all of the country level top-level domains such **.in .uk, .fr, .us.**

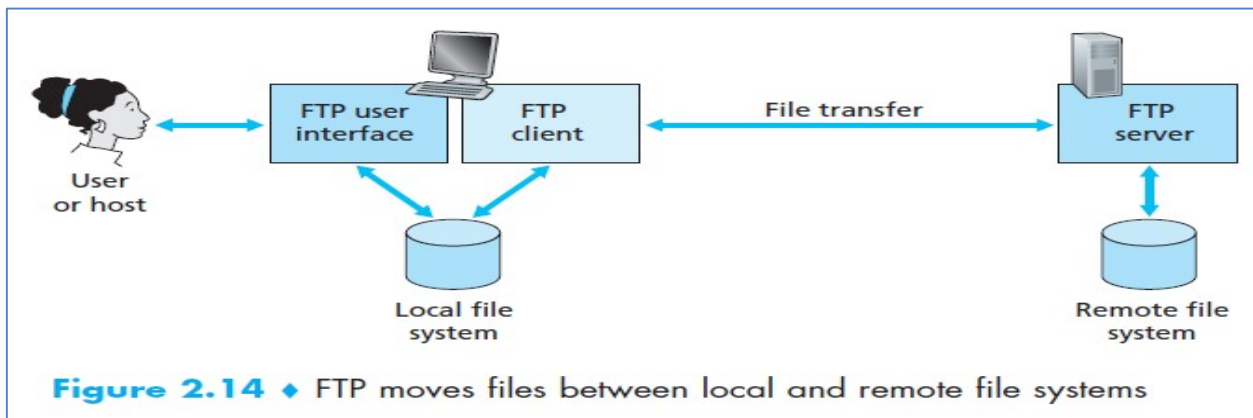
3. Authoritative DNS servers.

- Every organization with publically accessible hosts (such as Web servers and mail servers) on Internet must provide publicly accessible DNS records that map the names of those hosts to IP addresses.
- The above Figure shows, the root, TLD, and authoritative and local DNS servers all belong to the hierarchy of DNS servers.
- When host connects to an ISP, the ISP provides the host with the IP addresses of one or more of its local DNS servers.
- A host's local DNS server is typically "close to" the host.
 - ❖ The local DNS server then resends the query message to one of these TLD servers.
 - ❖ The TLD server responds with the IP address of the authoritative DNS server.
 - ❖ Finally, the local DNS server resends the query message directly.

File Transfer Protocol: FTP Basics, FTP Modes, FTP Commands.

Write Short Note on:-FTP OR How FTP Works?

- ❖ FTP session is use to transfer files to or from a remote host.

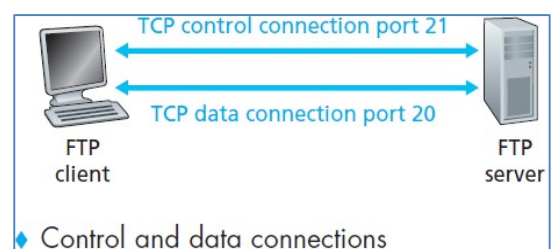


- ❖ To access remote account, user must provide username and password.
- ❖ User can transfer files from local file system to the remote file system and vice versa.
- ❖ The user first provides the hostname, to establish a TCP connection with FTP server process in the remote host.
- ❖ The user then provides the user name and password, which are sent over the TCP connection as part of FTP commands.
- ❖ After authorized the user, the user copies one or more files stored in the local file system into the remote file system (or vice versa).
- ❖ HTTP and FTP are both File transfer protocols and uses TCP Connection

FTP uses 2 parallel TCP connections to transfer file,

(1) Control Connection (2) Data Connection.

- ❖ **The control connection** is used for sending control information between the 2 hosts such as user id., password, commands to change remote directory, and commands to "put" and "get" files.
- ❖ **The data connection** is used to send a file.
- ❖ When a user starts an FTP session with a remote host, the client of FTP (user) first initiates a control TCP connection with the server (remote host) Port Number **21**.
- ❖ The client FTP sends the user name and



password over control connection.

- ❖ The client FTP also sends commands to change the remote directory.
- ❖ FTP sends exactly one file over the data connection and then closes the data connection.
- ❖ If, during the same session, the user wants to transfer another file, FTP opens another data connection. (So, data connections are non-persistent).
- ❖ The FTP server must maintain state about the user.





Explain FTP Commands?

- ❖ The commands, from client to server, and replies, from server to client, are sent across the control connection in 7-bit ASCII format.
- ❖ FTP commands are readable by people. In order to describe successive commands, a carriage return and line feed at the end of each command.
- ❖ Each command consists of 4 uppercase ASCII characters, some with optional arguments.
- ❖ Some of the more common commands are given below:

Sr. No.	Command	Use
1	User	Sends the user identification to the server.
2	Pass	Sends the user password to the server
3	retr: filename	To retrieve (get) a file from current directory of the remote host
4	stor: filename	To store (put) a file into the current directory of the remote host
5	ls	list contents of remote directory
6	pwd	print working directory on remote machine
7	chmod	Change file permissions of remote file
8	bye	Terminate ftp session and exit
9	quit	
10	exit	
11	close	Terminate FTP session
12	disconnect	
13	get	receive one file
14	put	send one file
15	Help	display local help information
16	cd	Change remote working directory
17	cdup	change remote working directory to parent directory
18	mkdir	make directory on remote machine
19	rmdir	remove directory on remote machine
20	rename	rename file
21	size	show size of remote file
22	status	show current status

- ❖ There is 1:1 communication between the command that user issues and the FTP command sent across the control connection.
- ❖ Each command is followed by a reply, sent from server to client.
- ❖ The replies are 3-digit numbers, with an optional message following the number.

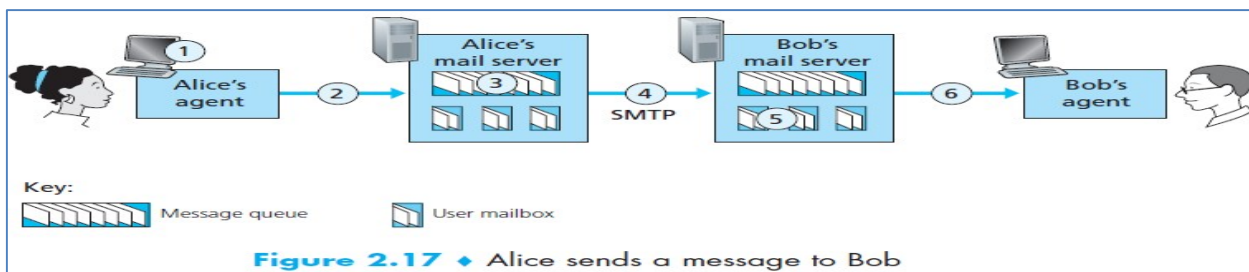
- ❖ Some typical replies, with their possible messages, are

-  **331** Username OK, password required
-  **125** Data connection already open; transfer starting
-  **425** Can't open data connection
-  **452** Error writing file

Email: Email Basics, Email Structure, How Email Works?

Email Basics

- ❖ Email Stands for Electronic Mail.
- ❖ Email is the most popular application.
- ❖ Email Uses Application Layer Protocol.
- ❖ E-mail is an asynchronous communication medium - people send and read messages when it is convenient for them, without having to coordinate with other people's schedules.

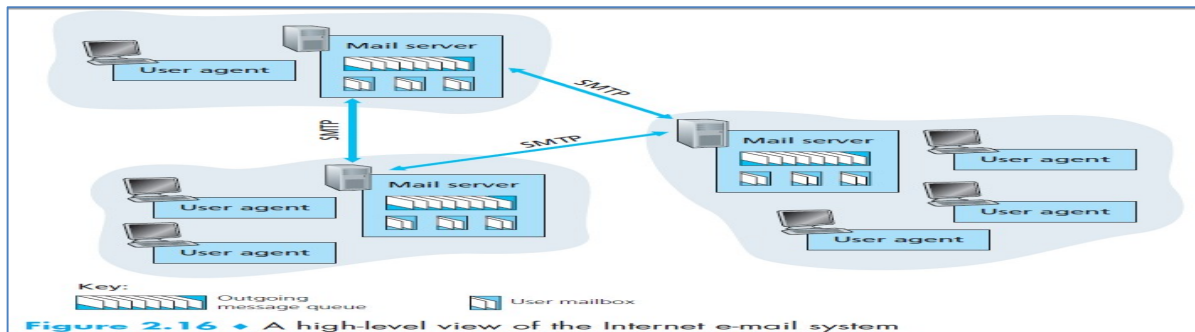


- ❖ E-mail is fast, easy to distribute, and inexpensive.
- ❖ E-mail has many features, like messages with attachments, hyperlinks, formatted text, and embedded photos.

Email Structure

The E-Mail system has 3 major components: **user agents, mail servers, and the Simple Mail Transfer Protocol (SMTP).**

- ❖ User1 sending an e-mail message to recipient User2.
- ❖ User agents allow users to read, reply to, forward, save, and compose messages.



How E-Mail Works?

- ❖ When User1 is finished composing her message, the user agent sends the message to mail server, where the message is placed in the mail server's outgoing message queue.
- ❖ When User2 wants to read a message, his user agent retrieves the message from his mailbox in his mail server.
- ❖ Each recipient has a mail-box located in one of the mail servers.
- ❖ User2's mailbox manages and maintains the messages that have been sent to him.

- ❖ A typical message starts its journeying the sender's user agent, travels to the sender's mail server, and travels to the recipient's mail server, where it is deposited in recipient's mailbox.
- ❖ SMTP is application-layer protocol for Internet electronic mail. It uses the reliable data transfer service of TCP to transfer mail from the sender's to recipient's mail server.
- ❖ SMTP has 2 sides: a client side, which executes on the sender's mail server, and server side, which executes on the recipient's mail server.
- ❖ Both the client and server sides of SMTP run on every mail server.
- ❖ When a mail server sends mail to other mail servers, it acts as an SMTP client. When a mail server receives mail from other mail servers, it acts as an SMTP server.

Email Protocol: SMTP, IMAP, MIME and POP

Explain SMTP

- ❖ SMTP is at the heart of Internet Electronic mail service.
- ❖ SMTP transfers messages from senders' mail servers to the recipients 'mail servers'.
- ❖ SMTP restricts the body of all mail messages to simple 7-bit ASCII.
- ❖ Suppose **User1 (Alice)** wants to send **User2 (Bob)** a simple ASCII message
 1. **Alice** invokes her user agent for e-mail, provides Bob e-mail address (like, `alice@svccs.edu`), composes a message, and instructs the user agent to send the message.
 2. Alice's user agent sends message to her mail server, where it is placed in message queue.
 3. The client side of SMTP, running on Alice's mail server, sees the message in the message queue. It opens a TCP connection to an SMTP server, running on Bob's mail server.
 4. After initial SMTP handshaking, SMTP client sends Alice's message into the TCP connection.
 5. At Bob's mail server, the server side of SMTP receives the message. Bob's mail server then places the message in Bob's mailbox.
 6. Bob invokes his user agent to read the message at his convenience.
- ❖ From above diagram, SMTP does not use intermediate mail servers for sending mail.
- ❖ The TCP connection is a direct connection between the Mail servers.
- ❖ If the server is down, the client tries again later.
- ❖ There are many mail access protocols, like Post Office Protocol-Version 3 (POP3), Internet Mail Access Protocol (IMAP), and HTTP.
- ❖ SMTP is also used to transfer mail from the sender's user agent to the sender's mail server.
- ❖ A mail access protocol, such as POP3, is used to transfer mail from the recipient's mail server to the recipient's user agent

IMAP (Internet Message Access Protocol)

- ❖ Once User2 has downloaded his messages to the local machine, he can create mail folders and move the downloaded messages into the folders.
- ❖ User2 can then delete messages, move messages across folders, and search for messages. This is not possible with POP3.
- ❖ POP3 protocol does not provide any means for a user to create remote folders and assign messages to folders.

- ❖ To solve this and other problems, the IMAP protocol was invented.
- ❖ IMAP is a mail access protocol. It has many more features, but it is also more complex.
- ❖ An IMAP server will associate each message with a folder; when a message first arrives at the server, it is associated with the recipient's INBOX folder.
- ❖ The recipient can then move the message into a new, user-created folder, read the message, delete the message, and so on.
- ❖ The IMAP protocol provides commands to allow users to create folders and move messages from one folder to another.
- ❖ IMAP also provides commands that allow users to search remote folders for messages matching specific criteria.
- ❖ IMAP has commands that permit a user agent to obtain components of messages.

MIME

- ❖ MIME (Multi-Purpose Internet Mail Extensions) is an extension of the original Internet e-mail protocol.
- ❖ It allows exchanging different kinds of data files on the Internet: audio, video, images, application programs, and ASCII text handled in the SMTP.
- ❖ As a result, new file types were added to "mail" as a supported Internet Protocol file type.
- ❖ Servers insert the MIME header at the beginning of any Web transmission.
- ❖ Clients use this header to select an appropriate "player" application for the type of data the header indicates.
- ❖ Some of these players are built into the Web client or browser.
- ❖ **Example:** all browsers come with GIF and JPEG image players as well as the ability to handle HTML files. Other players may need to be downloaded.
- ❖ New MIME data types are registered with IANA (Internet Assigned Numbers Authority).
- ❖ MIME is specified in detail in Internet Request for Comments 1521 and 1522.

Explain Post Office Protocol (POP3) OR How POP3 Works?

- ❖ POP3 is simple mail access protocol.
- ❖ It is short, Simple, readable and so its functionality is limited.
- ❖ POP3 begins when the user agent (client) opens a TCP connection to mail server (server) on port 110. When TCP connection established, POP3 progresses through 3 phases: Authorization, Transaction, and Update.
 - (1) The user agent sends a username and a password to **authenticate the user**.
 - (2) **Transaction**, the user agent **retrieves messages**. The user agent obtains mail statistics.
 - (3) **Update**, occurs after the client has issued the quit command, **ending the POP3 session**.
- ❖ User agent issues commands, and the server responds to each command with a reply.
- ❖ There are 2 possible responses: **+OK** (followed by server-to-client data), used by the server to indicate that the previous command was fine; and **-ERR**, used by the server to indicate that something was wrong with the previous command.
- ❖ **Authorization phase** has 2 principal commands: **user <username>** and **pass<password>**.
- ❖ If you apply a wrong command, POP3 server will reply with an **-ERR** message.
- ❖ **Transaction phase:** -
 - ✓ A user agent using POP3 can often be configured to "download and delete" or to "download and keep."

- ✓ The sequence of commands issued by a POP3 user agent depends on which of these 2 modes the user agent is operating in.
- ✓ In the download-and-delete mode, the user agent will issue the list, **retr**, and **dele** commands.

Example:-suppose the user has two messages in his or her mail-box.

C : (client) is the user agent

S: (server) is the mail server

The transaction will look something like:

- ❖ The user agent first asks the mail server to list the size of each of the stored messages.
- ❖ The user agent then retrieves and deletes each message from the server.
- ❖ After processing the quit command, the POP3 server enters the **update phase** and removes messages 1 and 2 from the mailbox.
- ❖ During a POP3 session between a user agent and the mail server, it keeps track of which user messages have been marked deleted.

```
C: list
S: 1 498
S: 2 912
S: .
C: retr 1
S: Hello hi ...
S: .....hi.....
S: .....Bye
C: quit
S: +OK POP3 server signing off
```

USER DATAGRAM PROTOCOL

- ✚ UDP is a connection - less protocol.
- ✚ It means that one program can send lots of packets to another.
- ✚ UDP is an unreliable protocol, because it does not give any acknowledgement (ACK or N-ACK) for datagram delivery. UDP does not perform any error checking method.
- ✚ UDP protocol used in message transport or transfer.
- ✚ UDP is faster than TCP, because there is no error-checking.
- ✚ UDP is suitable for applications that need fast, efficient transmission, such as games.
- ✚ Services like DNS, DHCP, SNMP, VOIP are UDP based Protocols.
- ✚ UDP is lightweight. There is no ordering of messages, No tracking connections, etc.
- ✚ The User Datagram Protocol gives application programs direct access to a datagram delivery service, like the delivery service that IP provides.
- ✚ This allows applications to exchange messages over the network with a minimum of protocol overhead.
- ✚ UDP uses 16-bit *Source Port* and *Destination Port* numbers in word 1 of the message header, to deliver data to the correct applications process. Figure shows the UDP message format.

Features

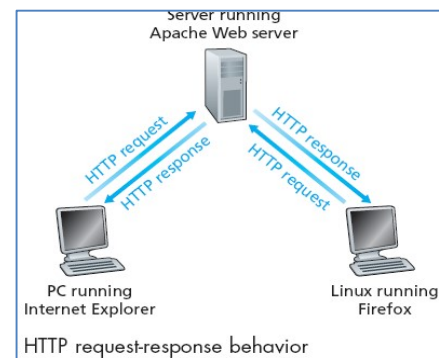
- ✓ UDP is used when acknowledgement of data does not hold any importance.
- ✓ UDP is good protocol for data flowing in one direction.
- ✓ UDP is simple and suitable for query based communications.
- ✓ UDP is not connection oriented. It is Connection Less Protocol.
- ✓ UDP does not provide congestion control mechanism.
- ✓ UDP does not guarantee ordered delivery of data.
- ✓ UDP is stateless.
- ✓ UDP is suitable protocol for streaming applications such as VoIP, multimedia streaming.

UDP Application - Here are few applications where UDP is used to transmit data

- ✓ Domain Name Services (DNS)
- ✓ Simple Network Management Protocol(SNMP)
- ✓ Trivial File Transfer Protocol(TFTP)
- ✓ Routing Information Protocol(RIP)

HTTP Protocol

- ❖ Hyper Text Transfer Protocol (HTTP) is Web's application-layer protocol.
- ❖ HTTP is implemented in 2 programs: Client program and Server program.
- ❖ Both of these programs, executing on different end systems, communicate each other by exchanging HTTP messages.
- ❖ Most Web pages consist as HTML files and objects such as HTML text and JPEG images.
- ❖ HTML file references the other objects using URLs.
- ❖ **Each URL has 2 components: the hostname** of the server that houses the object and the **object's path name**. For example, the URL ***http://www.svccs.edu/bcadept/picture.gif***
- ❖ Web Servers are Apache and Microsoft Internet Information Server (IIS).
- ❖ HTTP defines how Web clients request Web pages from Web servers and how servers transfer Web pages to clients.



- ❖ Figure shows
 - ✓ When a user requests Web page, the browser send HTTP request messages for objects in page to server.
 - ✓ The server receives the requests and responds with HTTP response messages that contain the objects.
- ❖ HTTP uses TCP as its transport protocol.
 - ✓ The HTTP client first initiates a TCP connection with the server.
 - ✓ Then client and the server processes access TCP through their socket interfaces.
 - ✓ The client sends HTTP request messages into its socket interface and receives HTTP response messages from its socket interface.
 - ✓ Similarly, HTTP server receives request messages from its socket interface and sends response messages into its socket interface.
- ❖ Each HTTP response message sent by the server process arrives intact at the client.
- ❖ HTTP server does not maintain information about the clients, so HTTP is stateless protocol.