

2- Electronic Mail (SMTP), File Transfer (FTP), & Remote Logging (TELNET)

There are three popular applications for exchanging information. Electronic mail exchanges information between people and file transfer exchanges files between computers. Remote logging runs applications from a remote site.

2.1 ELECTRONIC MAIL

One of the most popular network services is electronic mail (email). Electronic mail is used for sending a single message that includes text, voice, or graphics to one or more recipients. **Simple Mail Transfer Protocol (SMTP)** is the standard mechanism for electronic mail in the Internet.

2.1.1 Sending email

To send mail, the user creates mail that looks very similar to postal mail. It has an **envelope** and a **message** (see Fig.2.1).

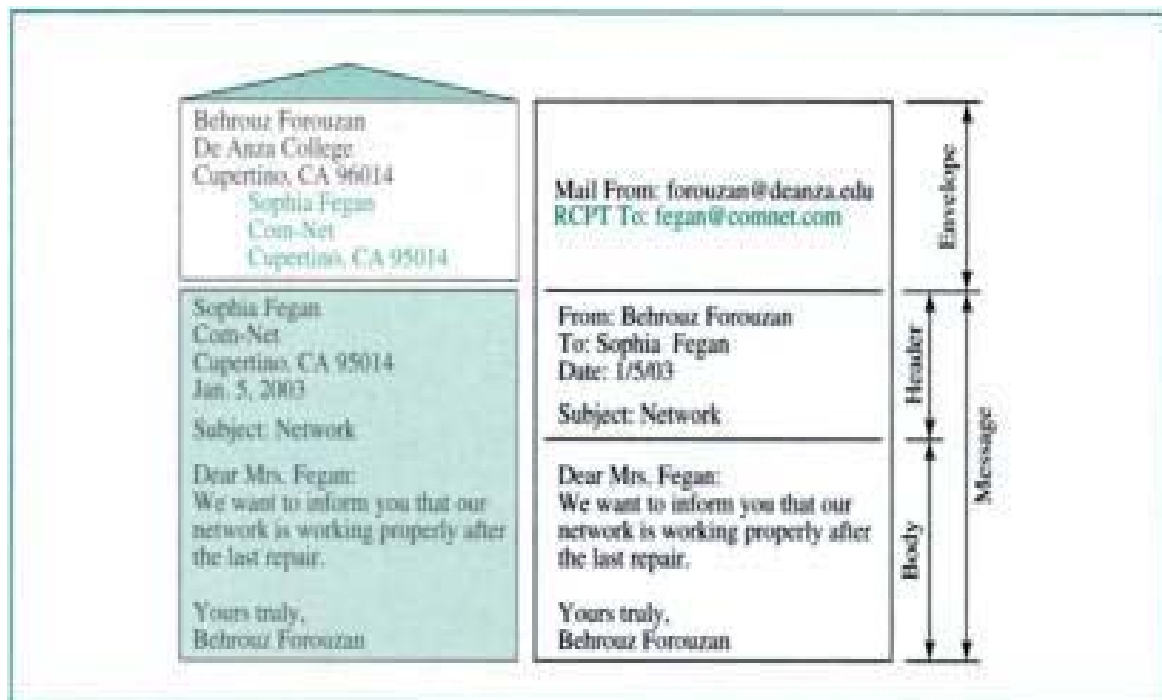


Fig.2.1 Format of an email

Envelope: The envelope usually contains the address, the receiver address, and other information.

Message: The message contains the *headers* and the *body*. The **headers** of the message define the sender, the receiver, the subject of the message, and other information. The body of the message contains the actual information to be read by the recipient.

2.1.2 Receiving Mail

The email system periodically checks the mailboxes. If a user has mail, it informs the user with a notice. If the user is ready to read the mail, a list is displayed in which each line contains a summary of the information about a particular message in the mailbox. The summary usually includes the sender mail address, the subject, and the time the mail was sent or received. The user can select any of the messages and display its contents on the screen.

2.1.3 Addresses

To deliver mail, a mail handling system must use an addressing system with unique address. The addressing system used by **SMTP** consists of two parts: a *local part* and a *domain name*, separated by an @ sign (see Fig.2.2).

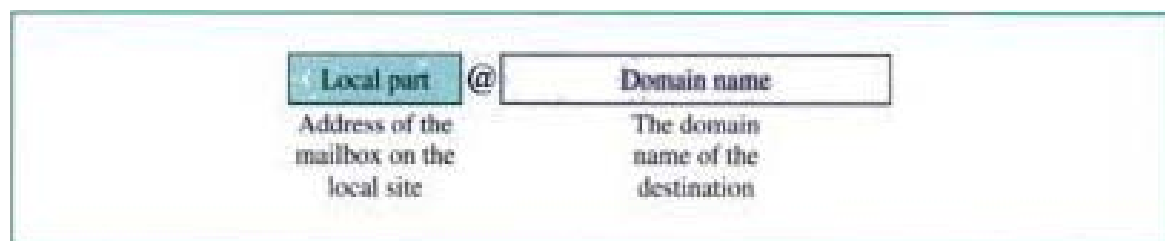


Fig.2.2 Email Address

Local Part: The local part defines the name of a special file, called the user mailbox, where all the mail received for a user is stored to be used by the user agent.

Domain Name: The second part of the address is the **domain name**. An organization usually selects one or more hosts to receive and send; they are called *mail exchangers*. The domain name assigned to each mail exchanger either comes from the DNS database or is a logical name (ex.: the name of the organization).

2.1.4 User Agent (UA)

The first component of an electronic mail system is the **user agent (UA)**. A user agent sometimes is called a *mail reader*.

User Agent Types: There are two types of user agents: command-driven and GUI-based.

1. **Command Driven:** Command –driven user agents belong to the early days of electronic mail. They are still present as the underlying user agents in servers. A command-driven user agent normally accepts a one-character command from the keyboard to perform its tasks.
2. **GUI – Based:** Modern user agents are **GUI**-based. They contain **Graphical User Interface (GUI)** components that allow the user to interact with the software by using both the keyboard and the mouse. They have graphical components such as icons, menu bars, and windows that make the services easy to access. Some examples of GUI-based user agents are Eudora, Microsoft’s Outlook, and Netscape.

Services provided by a User Agent: A user agent is a software package (program) that composes (new mail), reads, replies to, and forwards messages. It also handles mailboxes (See Fig.2.3).

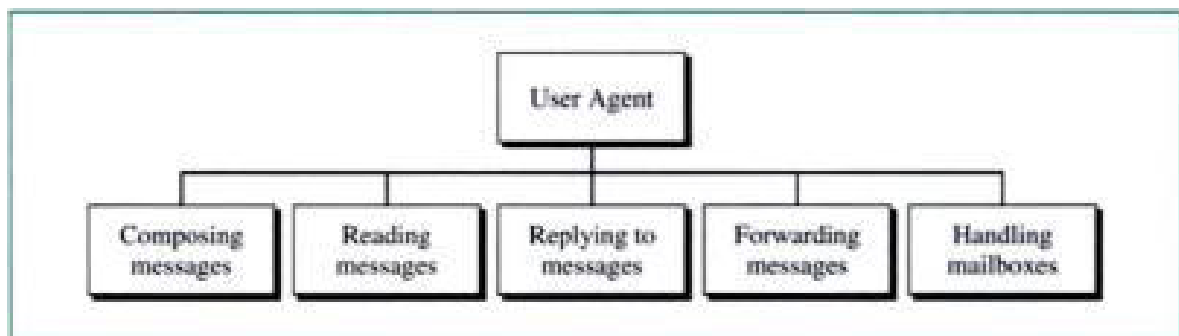


Fig.2.3 User agent

1. **Composing Messages:** A user is responsible for composing the email message to be sent out. Most user agents provide a template on the screen to be filled in by the user. Some even have a built-in editor that can do spell checking, grammar checking, and other tasks.
2. **Reading Messages:** The second duty of the user agent is to read the incoming messages. When a user invokes a user agent, it first checks the mail in the incoming mailbox. Most user agents show a one-line summary of each received mail which contain the following fields:
 1. A number field.

2. A flag field that shows if the mail is new, already read but not replied to, read and replied to, and so on.
3. The size of the message.
4. The sender.
5. The subject field if the subject line in the message is not empty.

3. Replying to Messages: After reading a message, a user can use the user agent to reply to a message. Normally, a user agent allows the user to reply to the original sender or to reply to all recipients of the message. The reply message normally contains the original message (for quick reference) and the new message side receives the **ASCII** data and delivers them to **MIME** to be transformed to the original data. **MIME** is a set of software functions that transform **non-ASCII** data to **ASCII** data and vice versa (See fig.2.4).

MIME: Electronic mail can send messages only in (**Network Virtual Terminal**) **NVT 7-bit ASCII** format so it has some limitations and it cannot be used for languages that are not supported by **7-bit ASCII** characters (such as French, German) Also, it cannot be used to send binary files or video or audio data. **Multipurpose Internet Mail Extensions** is a supplementary protocol that allows **non-ASCII** data to be sent through e-mail. **MIME** transforms **non-ASCII** data at the sender site to **NVT ASCII** data and delivers them to the client **MTA** to be sent through the Internet. The message at the receiving side is transformed back to the original data.

MIME defines five headers that can be added to the original **SMTP** header section to define the transformation parameters:

1. MIME-Version.
2. Content - Type.
3. Content – Transfer – Encoding.
4. Content – ID.
5. Content – Description.

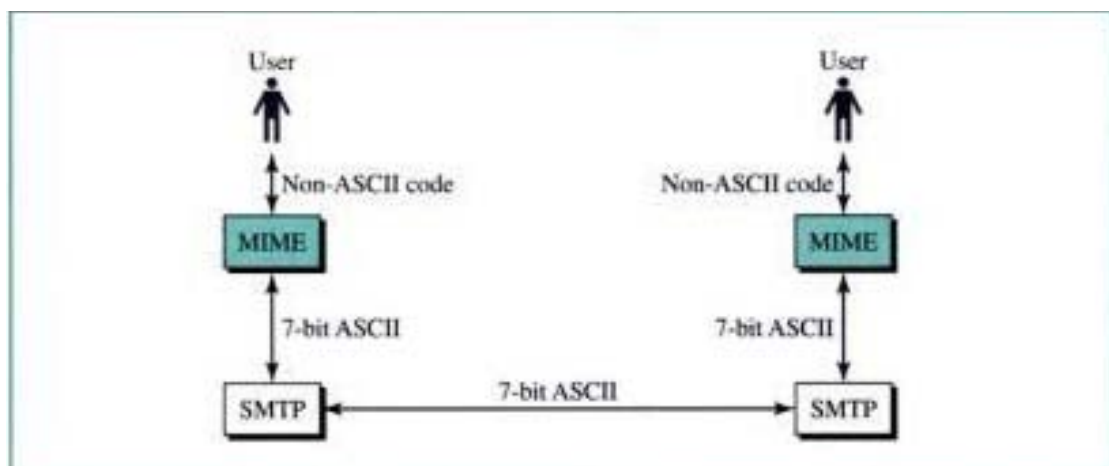


Fig.2.4 MIME

Fig.2.5 shows the original header and the extended header.

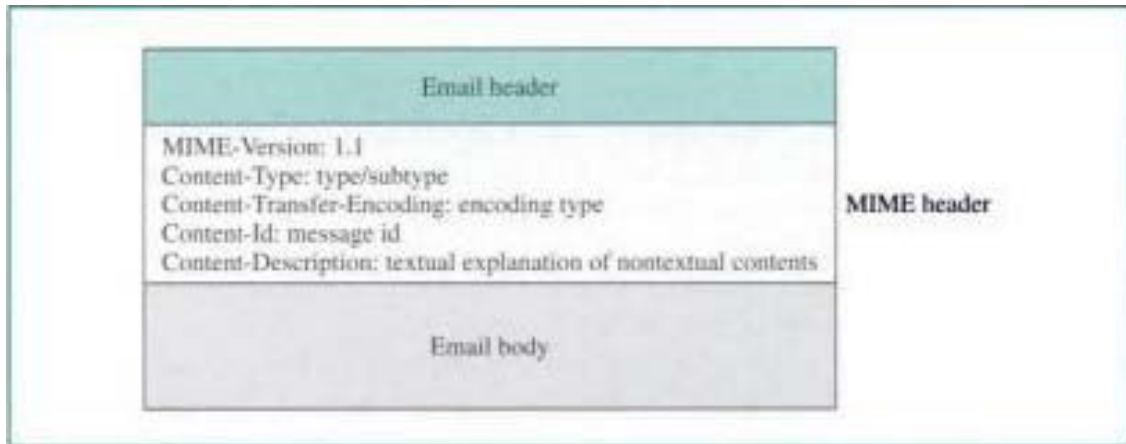


Fig.2.5 MIME header

- **MIME – Version:** This header defines the version of MIME used. The current version is 1.1.
- **Content – Type:** This header defines the type of data used in the body of the message. The content type and the content subtype are separated by a slash. Depending on the subtype, the header may contain other parameters. MIME allows seven different types of data. These are listed in table 2.1.

<i>Type</i>	<i>Subtype</i>	<i>Description</i>
Text	Plain	Unformatted
	HTML	HTML format (see Chapter 27)
Multipart	Mixed	Body contains ordered parts of different data types
	Parallel	Same as above, but no order
	Digest	Similar to mixed subtypes, but the default is message/RFC822
	Alternative	Parts are different versions of the same message
Message	RFC822	Body is an encapsulated message
	Partial	Body is a fragment of a bigger message
	External-Body	Body is a reference to another message
Image	JPEG	Image is in JPEG format
	GIF	Image is in GIF format
Video	MPEG	Video is in MPEG format
Audio	Basic	Single-channel encoding of voice at 8 kHz
Application	PostScript	Adobe PostScript
	Octet-stream	General binary data (8-bit bytes)

Table 2.1 MIME types and Subtypes

- **Content-Transfer-Encoding:** This header defines the method used to encode the messages into 0s and 1s for transport. The 5 types of encoding methods are listed in table 2.2.

<i>Type</i>	<i>Description</i>
7-bit	NVT ASCII characters and short lines
8-bit	Non-ASCII characters and short lines
Binary	Non-ASCII characters with unlimited-length lines
Base-64	6-bit blocks of data encoded into 8-bit ASCII characters
Quoted-printable	Non-ASCII characters encoded as an equals sign followed by an ASCII code

Tables 2.2 Content-Transfer-Encoding

- **Content-Id:** This header uniquely identifies the whole message in a multiple-message environment.
 - **Content-Description:** This header defines if the body is image, audio, or video.
4. **Forwarding Messages:** Replying is defined as sending a message to the sender or recipients of the copy, or sending it to third party. A user agent allows the receiver to forward the message, with or without extra comments, to a third party.
 5. **Handling Mailboxes:** A user agent normally two mailboxes: inbox and outbox. Each box is a file with a special format that can be handled by the user agent. The inbox keeps all the received e-mails until they are deleted by the user. The outbox keeps all the sent e-mail until the user deletes them. Most user agents today are capable of creating customized mailboxes.

2.1.5 Message

In the message type, the body is itself a whole mail message, a part of a mail message, or a pointer to a message. Three subtypes are currently used: *RFC822*, *partial*, or *external-body*. The subtype RFC`822 is used if the body is encapsulating another message (including header and the body). The subtype partial is used if the original message has been fragmented into different mail messages and this mail message is one of the fragments. The fragments must be reassembled at the destination by **MIME**. Three parameters must be added: *id*, *number*, and the *total*. The id identifies the message and is present in all the fragments. The number defines the sequence order of the fragment. The total defines the number of fragments that comprise the original message. The following is an example of a message with three fragments:

```
Content-Type: message/partial;  
id="forouzan@challenger.atc.fhda.edu";  
number=1;  
total=3;
```

```
.....  
.....
```

The external-body subtype indicates that the body does not contain the actual message but is only a reference (pointer) to the original message. The parameters following the subtype define how to access original message. The following is an example:

```
Content-Type: message/external-body;  
name="report.txt";  
site="fhda.edu";  
access-type="ftp";
```

```
.....  
.....
```

2.1.6 Mail (or Message) Transfer Agent (MTA)

The actual mail transfer is done through **Mail Transfer Agents (MTAs)**. To send mail, a system must have a client MTA: and to receive mail, a system must have a server MTA. In the Internet, message transfer is done through a protocol (and software) named **Simple Mail Transfer Protocol (SMTP)**. To send a message, we need a client **SMTP** and a server **SMTP**, In Fig.2.7 we show Alice sending an email to Bob with the **SMTP** clients and servers needed. Note that mail transfer occurs between the two mail servers, one at Alice's site and the other at Bob's site. The mail servers can belong to the ISPs to which Alice and Bob are subscribers, or they can belong to the companies where Alice and Bob work.

Commands and Responses: **SMTP** uses commands and responses to transfer messages between an **MTA** client and an **MTA** server. Each command or reply is terminated by a two-character (carriage return and line feed) end-of-line token.

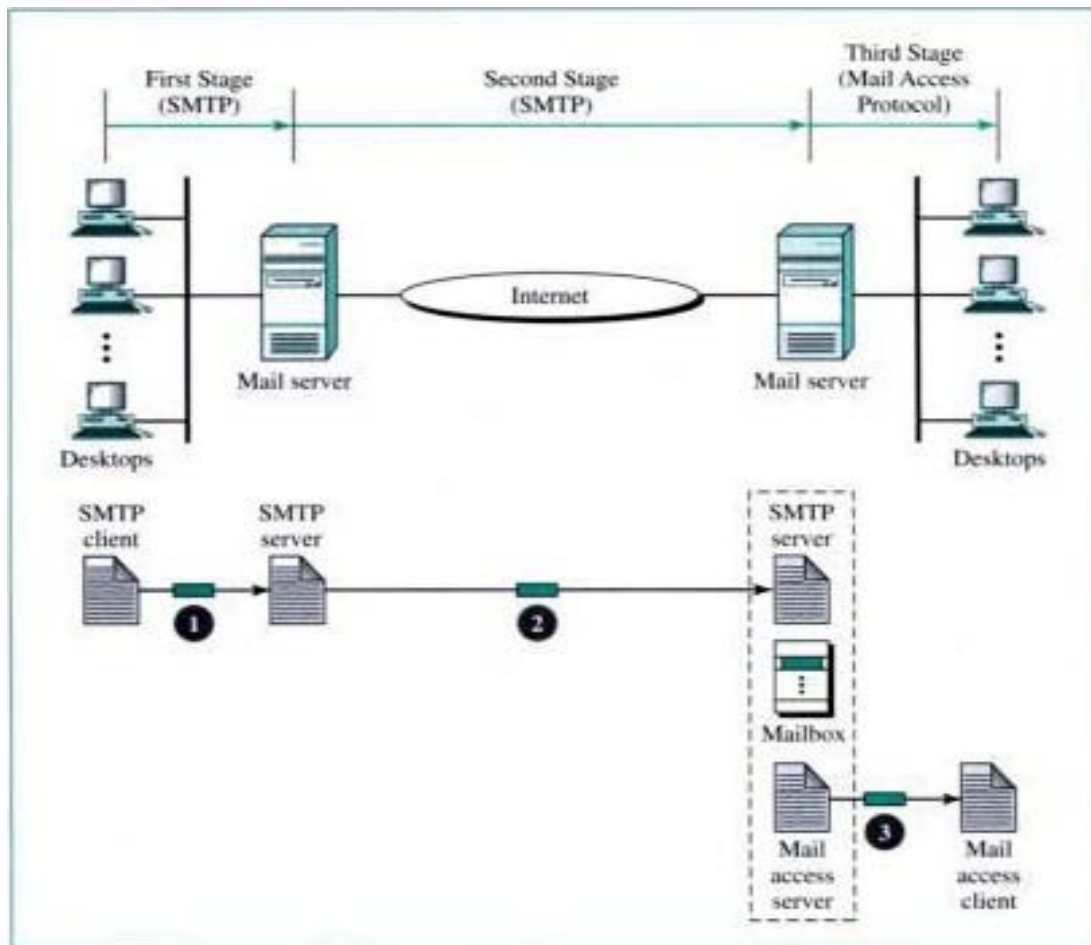


Fig.2.7 Email Delivery

- **First Stage:** Here, the email goes from the user agent to the local server. The mail does not go directly to the remote server because the remote server may not be available at all times. Therefore, the mail is stored in the local server until it can be sent. The user agent uses **SMTP** client software, and the local server uses **SMTP** server software.
- **Second Stage:** In the second stage, the email is relayed by the local server, which now acts as the **SMTP** client, to the remote server, which is the **SMTP** server in this stage. The email is delivered to the remote server, not to the remote user agent. The reason is that **SMTP** messages must be received by a server that is always running since mail can arrive at any time. However, people often turn off their computers at the end of the day, and those with laptops or mobile computers do not normally have on all the time. So usually an organization (or **ISP**) assigns a computer to be the email server and run the SMTP server program. The email is received by this mail server and stored in the mailbox of the user for later retrieval.
- **Third Stage:** In the third stage, the remote uses a mail access protocol such as **POP3** or **IMAP4** to access the mailbox and obtain the mail.

2.1.7 Mail Access Protocols

The first and 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 sender to the receiver even if the receiver does not want it.

The operation of **SMTP** starts with the sender, not the receiver. On the other hand, the third stage needs a *pull* protocol; the operation must start with the recipient. The mail must stay in the mail server mailbox until the recipient retrieves it.

The third stage uses a **mail access protocol**.

Currently two mail access protocols are available: Post Office Protocol, version 3 (**POP3**) and Internet Mail Access Protocol, version 4 (**IMAP4**). Fig.2.8 shows the position of these two protocols in the most common situation.

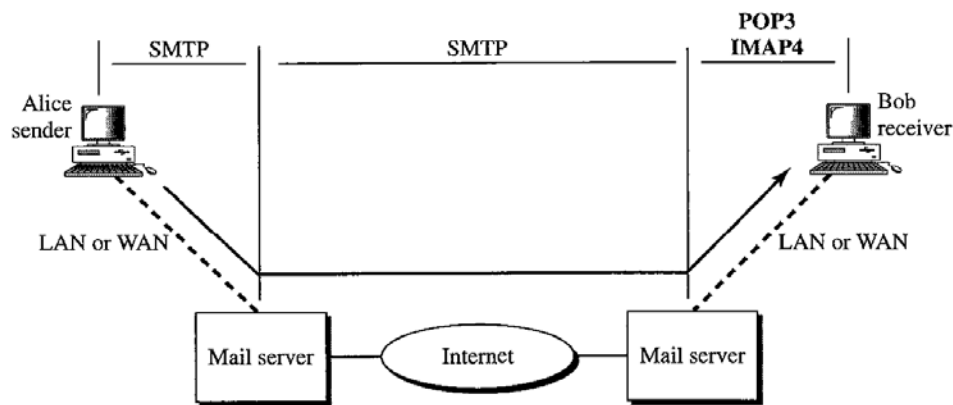


Fig.2.8 POP3 & IMAP4

Post Office Protocol, version 3 (POP3): It's simple, but it's limited in functionality. The client POP3 software is installed on the recipient computer; the server POP3 software is installed on the mail server. Mail access starts with the client when the user needs to download email from the mailbox on the mail server. The client (user agent) opens a connection with the server on TCP port 110. It then sends its user name and password to access the mailbox. The user can then list and retrieve the mail messages, one by one. As shown in Fig.2.9.

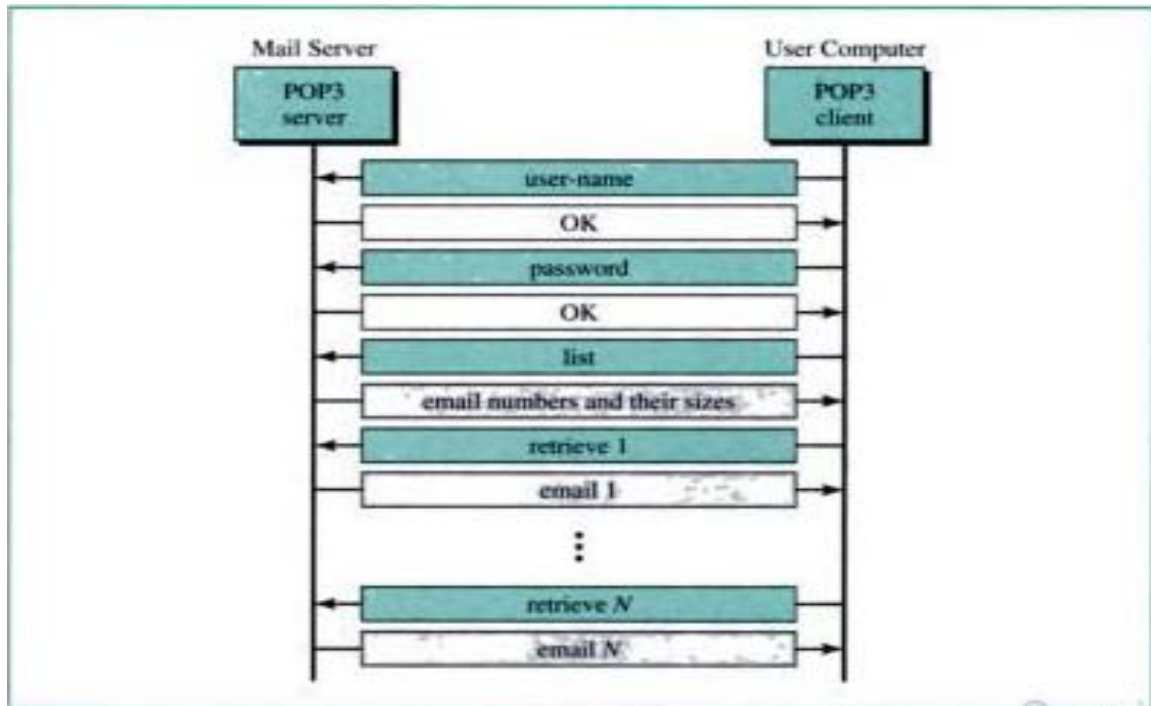


Fig.2.9 POP3

IMAP4: Another mail access protocol is Internet Mail Access Protocol, Version 4 (IMAP4). IMAP4 is similar to POP3, but it has more features; IMAP4 is more powerful and more complex. POP3 is deficient in several ways. It does not allow the user to organize mail on the server; the user cannot have different folders on the server. IMAP4 provides the following extra functions:

- A user can check the e-mail 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 partially download e-mail. This is especially useful if bandwidth is limited and the e-mail contains multimedia with high bandwidth requirements.
- A user can create, delete or rename mailboxes on the mail server.
- A user can create a hierarchy of mailboxes in a folder for e-mail storage.

2.1.8 Web-Based Mail

E-mail is such a common application that some website today provides this service to anyone who accesses the site. Two common sites are Hotmail and Yahoo. The idea is very simple. Mail transfer from John's browser to his mail server is done through **HTTP**. The transfer of the message from the sending mail server to the

receiving mail server is still through **SMTP**. Finally, the message from the receiving server (the Web server) to Bob's browser is done through **HTTP**.

The last phase is very interesting. Instead of **POP3** or **IMAP4**, **HTTP** is normally used. When Bob needs to retrieve his e-mail, he sends a message to the website (Hotmail, for ex.). The website sends a form to be filled in by Bob, which includes the log-in name and the password. If the log-in name and password match, the e-mail is transferred from the Web server to Bob's browser in **HTML** format.