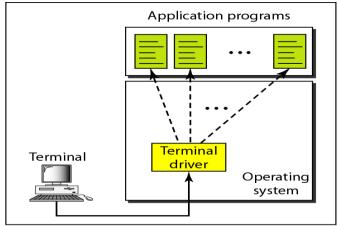
Application Layer Remote Login, Electronic mail and File transfer

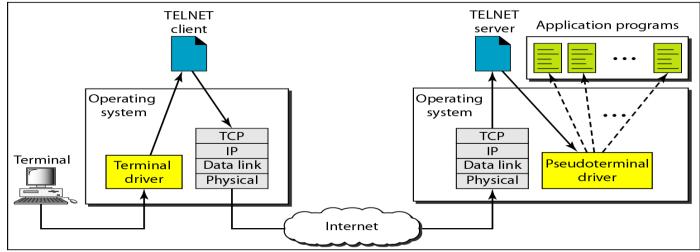
Remote Logging

- It would be impossible to write a specific client/server program for each demand. The better solution is a general-purpose client/server program that lets a user access any application program on a remote computer.
- TELNET is a general-purpose client/server application program.

Local and remote log-in

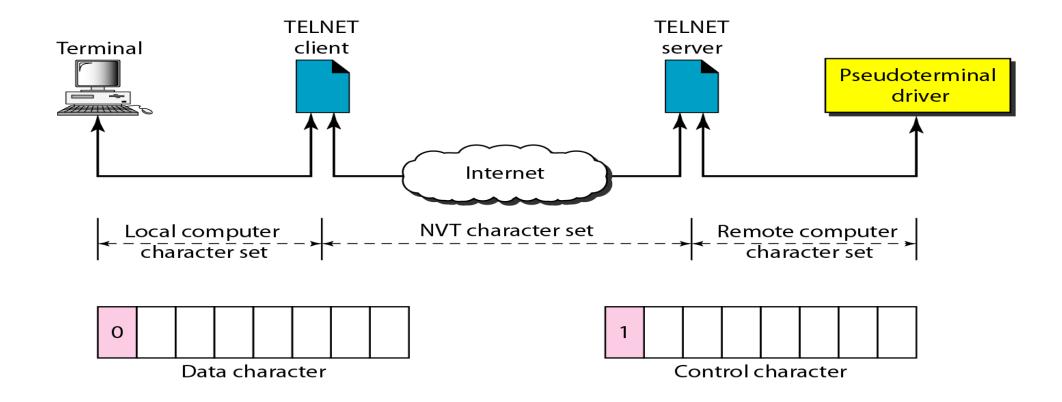


a. Local log-in



b. Remote log-in

Concept of NVT



Some NVT control characters

Character	Decimal	Binary	Meaning
EOF	236	11101100	End of file
EOR	239	11101111	End of record
SE	240	11110000	Suboption end
NOP	241	11110001	No operation
DM	242	11110010	Data mark
BRK	243	11110011	Break
IP	244	11110100	Interrupt process
AO	245	11110101	Abort output
AYT	246	11110110	Are you there?
EC	247	11110111	Erase character
EL	248	11111000	Erase line
GA	249	11111001	Go ahead
SB	250	11111010	Suboption begin
WILL	251	11111011	Agreement to enable option
WONT	252	11111100	Refusal to enable option
DO	253	11111101	Approval to option request
DONT	254	11111110	Denial of option request
IAC	255	11111111	Interpret (the next character) as control

Options

Code	Option	Meaning
0	Binary	Interpret as 8-bit binary transmission.
1	Echo	Echo the data received on one side to the other.
3	Suppress go ahead	Suppress go-ahead signals after data.
5	Status	Request the status of TELNET.
6	Timing mark	Define the timing marks.
24	Terminal type	Set the terminal type.
32	Terminal speed	Set the terminal speed.
34	Line mode	Change to line mode.

NVT character set for option negotiation

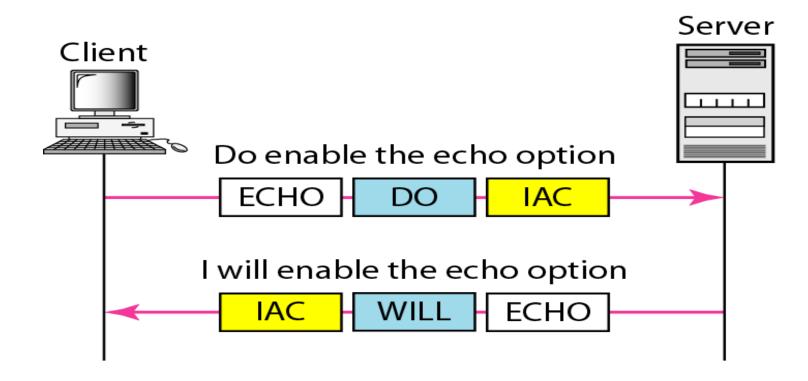
Character	Decimal	Binary	Meaning
WILL	251	11111011	1. Offering to enable
			2. Accepting a request to enable
WONT	252	11111100	1. Rejecting a request to enable
			2. Offering to disable
			3. Accepting a request to disable
DO	253	11111101	1. Approving an offer to enable
			2. Requesting to enable
DONT	254	11111110	1. Disapproving an offer to enable
			2. Approving an offer to disable
			3. Requesting to disable



Example 26.1

Figure 26.4 shows an example of option negotiation. In this example, the client wants the server to echo each character sent to the server. The echo option is enabled by the server because it is the server that sends the characters back to the user terminal. Therefore, the client should request from the server the enabling of the option using DO. The request consists of three characters: IAC, DO, and ECHO. The server accepts the request and enables the option. It informs the client by sending the three-character approval: IAC, WILL, and ECHO.

Example 26.1: Echo option



Character set for suboptions

Character	Decimal	Binary	Meaning
SE	240	11110000	Suboption end
SB	250	11111010	Suboption begin

Electronic Mail

One of the most popular Internet services is electronic mail (e-mail). The designers of the Internet probably never imagined the popularity of this application program. Its architecture consists of several components that we discuss in this chapter.

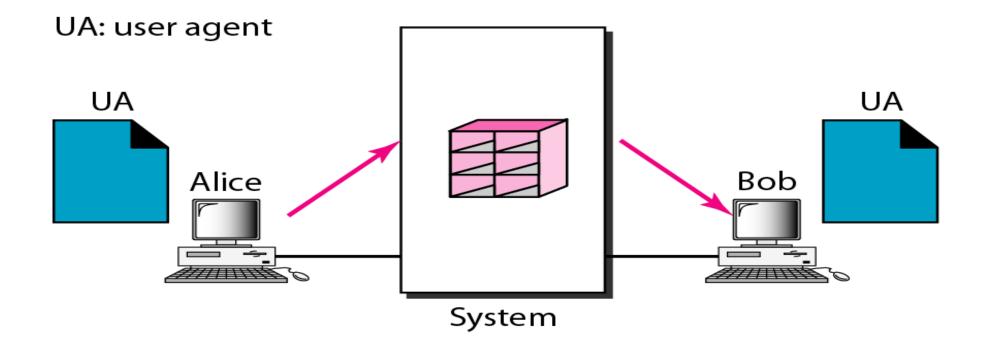
Architecture User Agent

Message Transfer Agent: SMTP

Message Access Agent: POP and IMAP

Web-Based Mail

First scenario in electronic mail



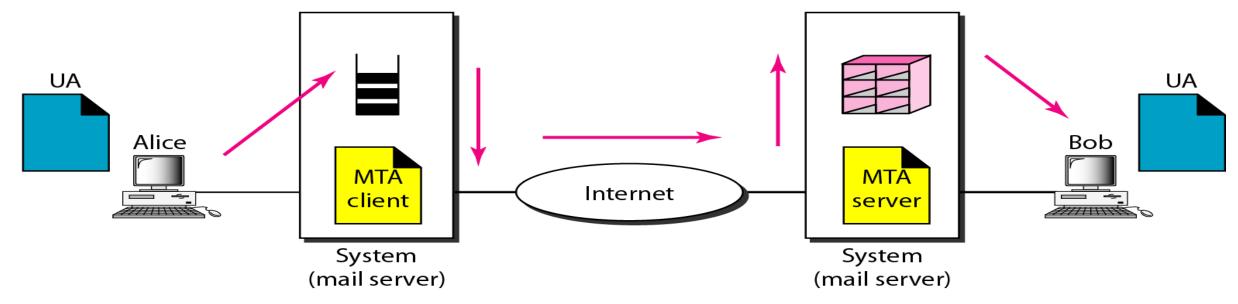
Note

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

Second scenario in electronic mail

UA: user agent

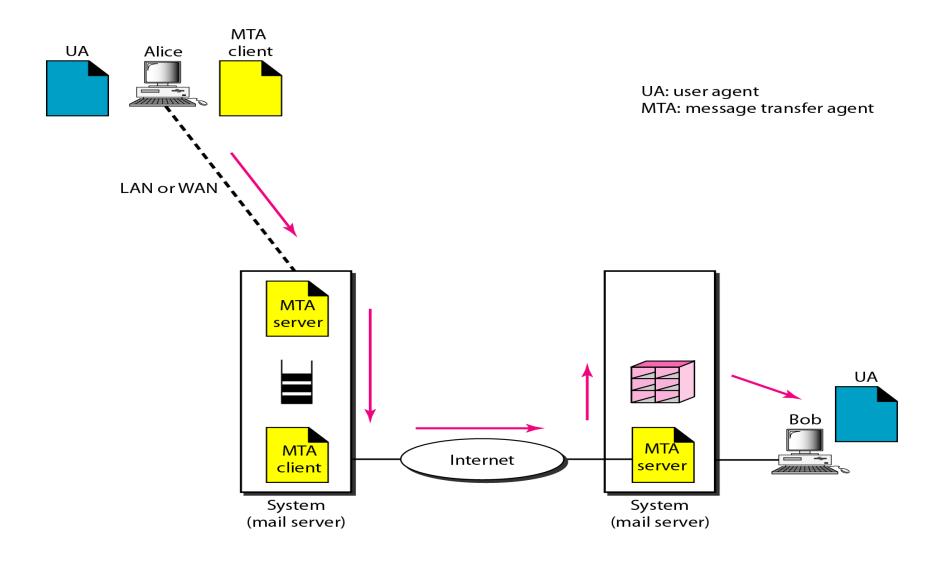
MTA: message transfer agent



Note

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

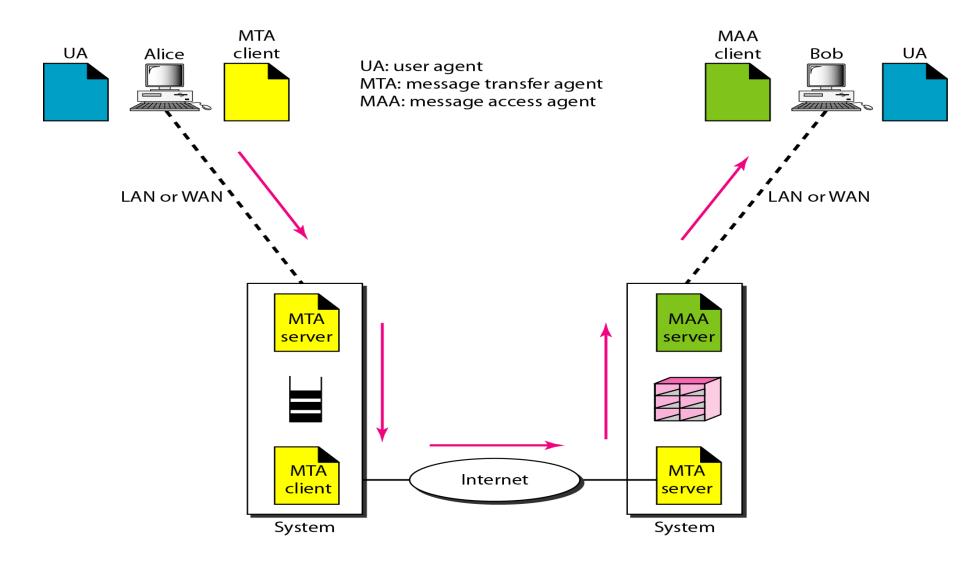
Third scenario in electronic mail



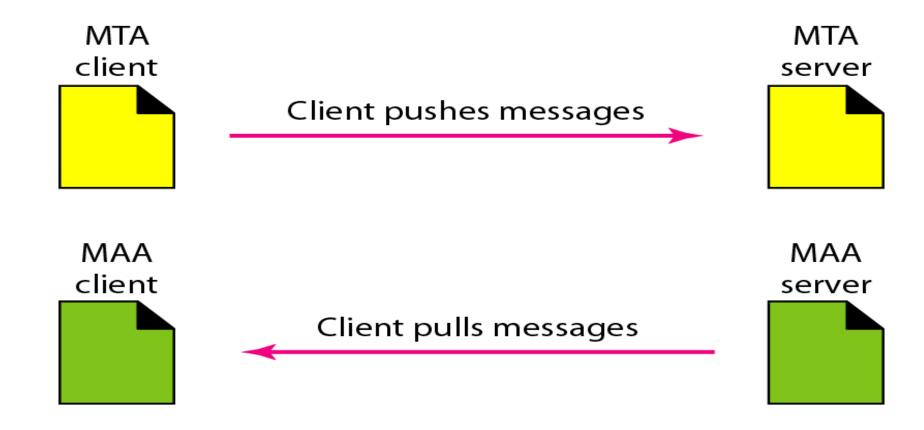
Note

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).

Fourth scenario in electronic mail



Push versus pull in electronic email



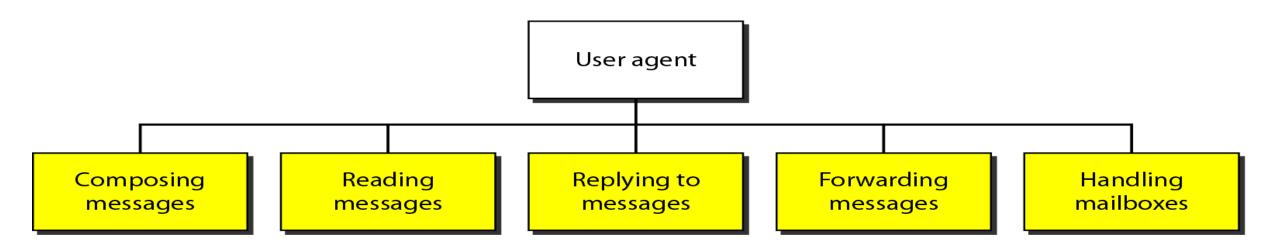
Note

When both sender and receiver are connected to the mail server via a LAN or a WAN, we need two

UAs, two pairs of MTAs and a pair of MAAs.

This is the most common situation today.

Services of user agent



Note

Some examples of command-driven user agents are *mail*, *pine*, and *elm*.

Some examples of GUI-based user agents are *Eudora*, *Outlook*, and *Netscape*

Format of an e-mail

Behrouz Forouzan De Anza College Cupertino, CA 96014

> Sophia Fegan Com-Net Cupertino, CA 95014

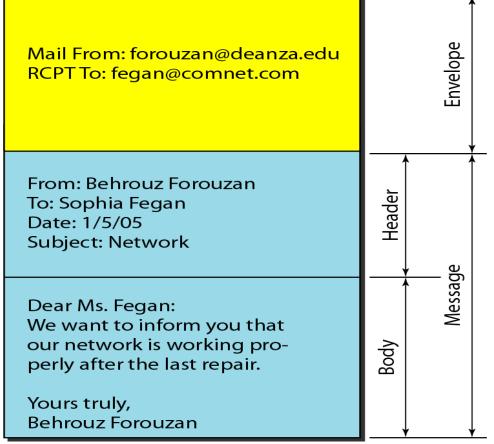
Sophia Fegan Com-Net Cupertino, CA 95014 Jan. 5, 2005

Subject: Network

Dear Ms. Fegan: We want to inform you that our network is working properly after the last repair.

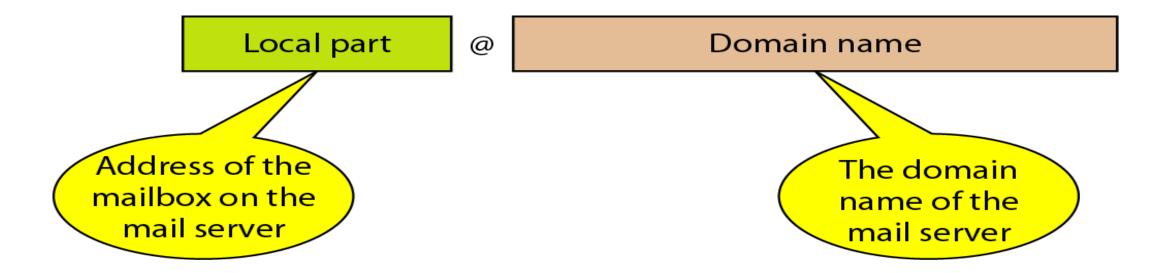
Yours truly, Behrouz Forouzan

a. Postal mail

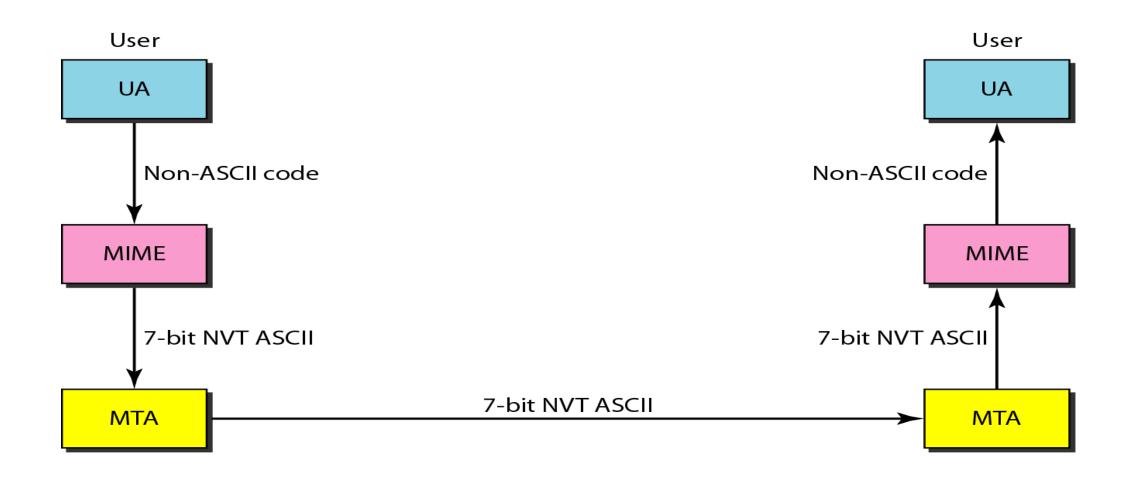


b. Electronic mail

E-mail address



MIME



MIME header

E-mail header

MIME-Version: 1.1

Content-Type: type/subtype

Content-Transfer-Encoding: encoding type

Content-Id: message id

Content-Description: textual explanation of nontextual contents

E-mail body

MIME headers

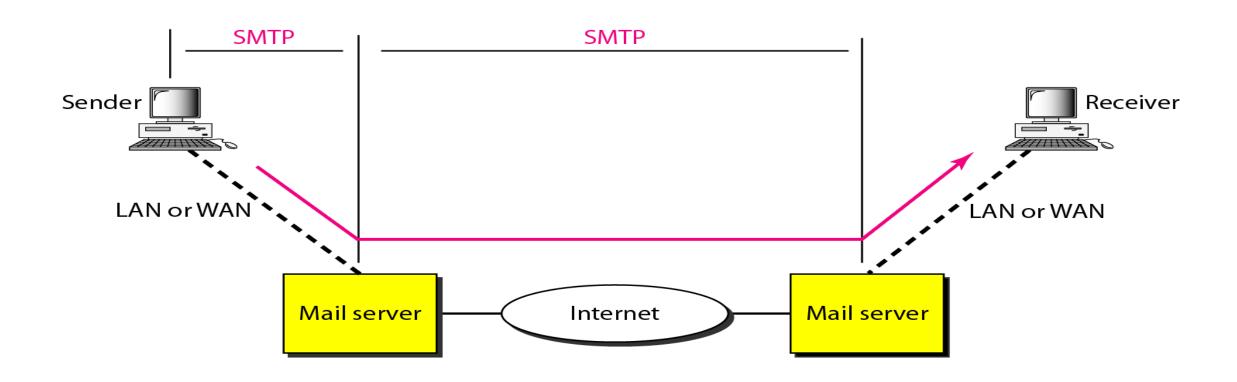
Data types and subtypes in MIME

Туре	Subtype	Description
Text	Plain	Unformatted
	HTML	HTML format (see Chapter 27)
	Mixed	Body contains ordered parts of different data types
Multipart	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
	RFC822	Body is an encapsulated message
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)

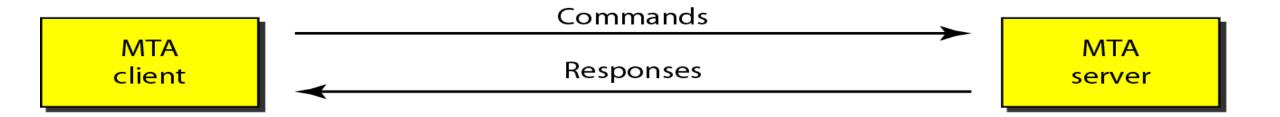
Table 26.6 Content-transfer-encoding

Туре	Description
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

SMTP range



Commands and responses



Command format

Keyword: argument(s)

Commands

Keyword	Argument(s)
HELO	Sender's host name
MAIL FROM	Sender of the message
RCPT TO	Intended recipient of the message
DATA	Body of the mail
QUIT	
RSET	
VRFY	Name of recipient to be verified
NOOP	
TURN	
EXPN	Mailing list to be expanded
HELP	Command name
SEND FROM	Intended recipient of the message
SMOL FROM	Intended recipient of the message
SMAL FROM	Intended recipient of the message

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		
	Positive Intermediate Reply		
354	Start mail input		
	Transient Negative Completion Reply		
421	Service not available		
450	Mailbox not available		
451	Command aborted: local error		
452	Command aborted: insufficient storage		

Responses (continued)

Code	Description		
	Permanent Negative Completion Reply		
500	Syntax error; unrecognized command		
501	Syntax error in parameters or arguments		
502	Command not implemented		
503	Bad sequence of commands		
504	Command temporarily not implemented		
550	Command is not executed; mailbox unavailable		
551	User not local		
552	Requested action aborted; exceeded storage location		
553	Requested action not taken; mailbox name not allowed		
554	Transaction failed		

we can directly use SMTP to how e-mail and simulate the commands and responses we described in this section. We use TELNET to log into port 25 (the well-known port for SMTP). We then the commands directly to send an e-mail. In this example, forouzanb@adelphia.net is sending an e-mail to himself. The first few lines show TELNET trying to connect to the Adelphia mail server. After connection, we can type the SMTP commands and then receive the responses, as shown on the next slide. Note that we have added, for clarification, some comment lines, designated by the "=" signs. These lines are not part of the e-mail procedure.



```
$ telnet mail.adelphia.net 25
Trying 68.168.78.100 . . .
Connected to mail.adelphia.net (68.168.78.100).
```

220 mta13.adelphia.net SMTP server ready Fri, 6 Aug 2004 . . .

HELO mail.adelphia.net

250 mta13.adelphia.net



MAIL FROM: forouzanb@adelphia.net

250 Sender <forouzanb@adelphia.net> Ok

RCPT TO: forouzanb@adelphia.net

250 Recipient <forouzanb@adelphia.net> Ok

DATA

354 Ok Send data ending with <CRLF>.<CRLF>

From: Forouzan

TO: Forouzan

This is a test message to show SMTP in action.

•

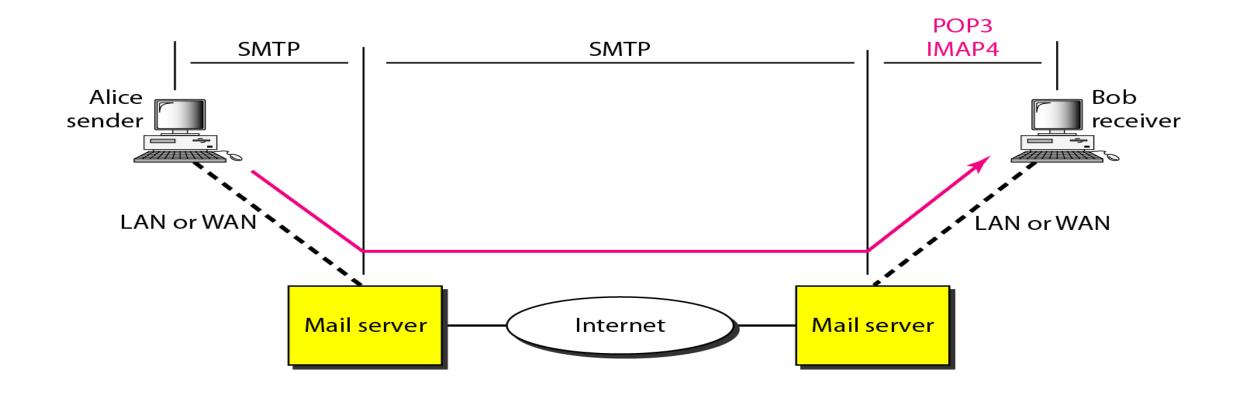




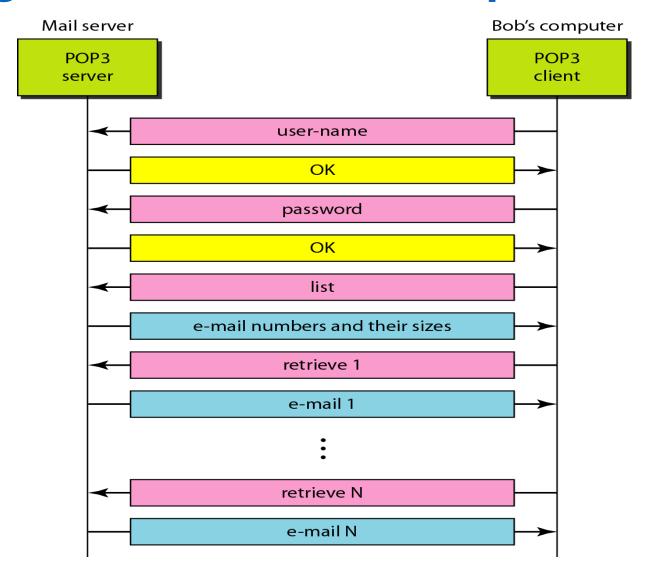
250 Message received: adelphia.net@mail.adelphia.net QUIT

221 mta13.adelphia.net SMTP server closing connection Connection closed by foreign host.

POP3 and IMAP4(mail Pull Protocol)



The exchange of commands and responses in POP3



FILE TRANSFER

Transferring files from one computer to another is one of the most common tasks expected from a networking or internetworking environment. As a matter of fact, the greatest volume of data exchange in the Internet today is due to file transfer.

Topics discussed in this section:

File Transfer Protocol (FTP) Anonymous FTP

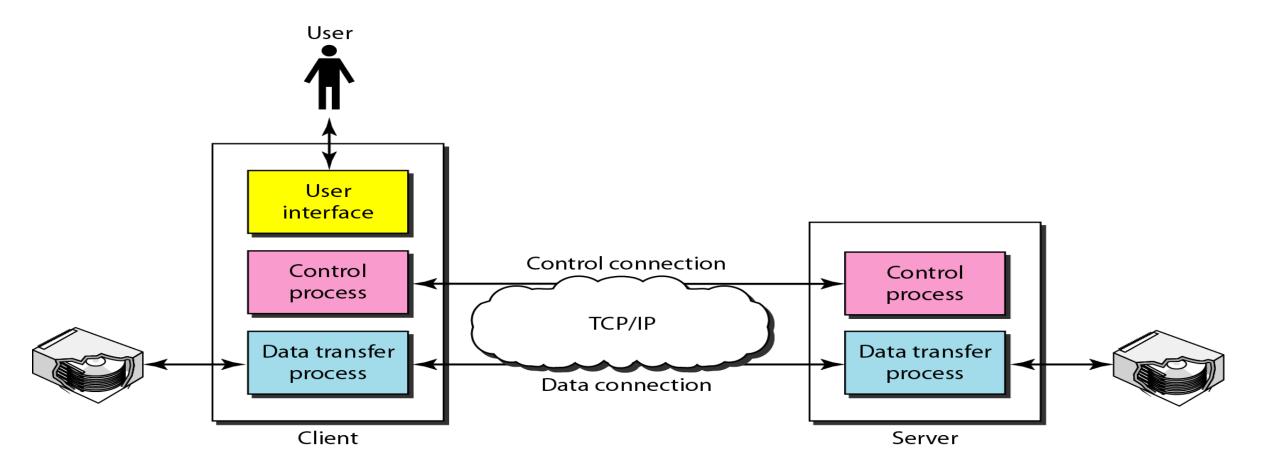
26.41



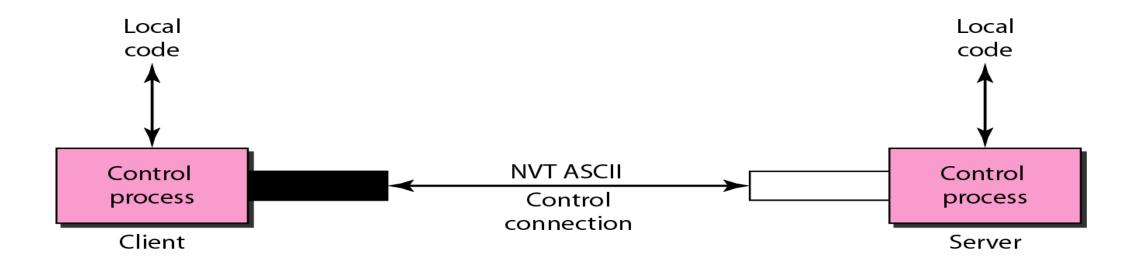
FTP uses the services of TCP. It needs two TCP connections.

The well-known port 21 is used for the control connection and the well-known port 20 for the data connection.

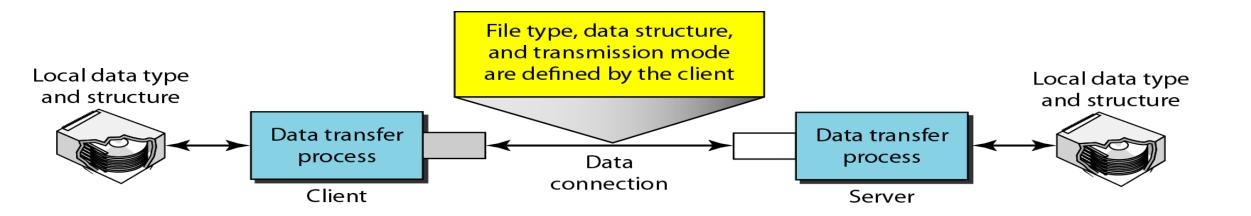
FTP



Using the control connection



Using the data connection





The following shows an actual FTP session for retrieving a list of items in a directory. The colored lines show the responses from the server control connection; the black lines show the commands sent by the client. The lines in white with a black background show data transfer.

- 1. After the control connection is created, the FTP server sends the 220 response.
- 2. The client sends its name.
- 3. The server responds with 331.



- 4. The client sends the password (not shown).
- 5. The server responds with 230 (user log-in is OK).
- 6. The client sends the list command (Is reports) to find the list of files on the directory named report.
- 7. Now the server responds with 150 and opens the data connection.
- 8. The server then sends the list of the files or directories on the data connection.
- 9. The client sends a QUIT command.
- 10. The server responds with 221.

\$ ftp voyager.deanza.fhda.edu

Connected to voyager.deanza.fhda.edu.

220 (vsFTPd 1.2.1)

530 Please login with USER and PASS.

Name (voyager.deanza.fhda.edu:forouzan): forouzan

331 Please specify the password.

Password:

230 Login successful.

Remote system type is UNIX.

Using binary mode to transfer files.

ftp> ls reports

227 Entering Passive Mode (153,18,17,11,238,169)

150 Here comes the directory listing.

 drwxr-xr-x
 2 3027
 411
 4096 Sep 24 2002 business

 drwxr-xr-x
 2 3027
 411
 4096 Sep 24 2002 personal

 drwxr-xr-x
 2 3027
 411
 4096 Sep 24 2002 school

226 Directory send OK.

ftp> quit

221 Goodbye.



We show an example of anonymous FTP. We assume that some public data are available at internic.net.

\$ ftp internic.net

Connected to internic.net

220 Server ready

Name: anonymous

331 Guest login OK, send "guest" as password

Password: guest

continued on next slide

```
ftp > pwd
257 '/' is current directory
ftp > ls
200 OK
150 Opening ASCII mode
bin
ftp > close
221 Goodbye
ftp > quit
```