Computer Network

Lecture-49

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Message Transfer Agent: SMTP

- SMTP is a message transfer agent.

- The actual mail transfer is done through message transfer agents.

- To send mail, a system must have the client MTA, and to receive mail, a system must have a server MTA.

- The protocol that defines the MTA client and server in the Internet is called the Simple Mail Transfer Protocol (SMTP).

SMTP

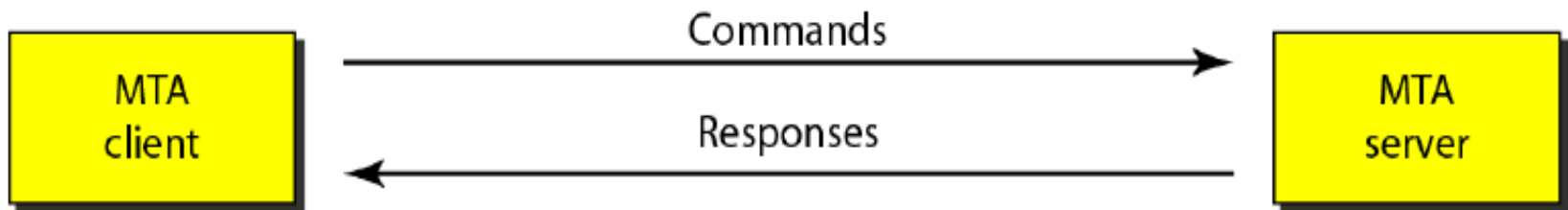Following figure shows the range of the SMTP protocol
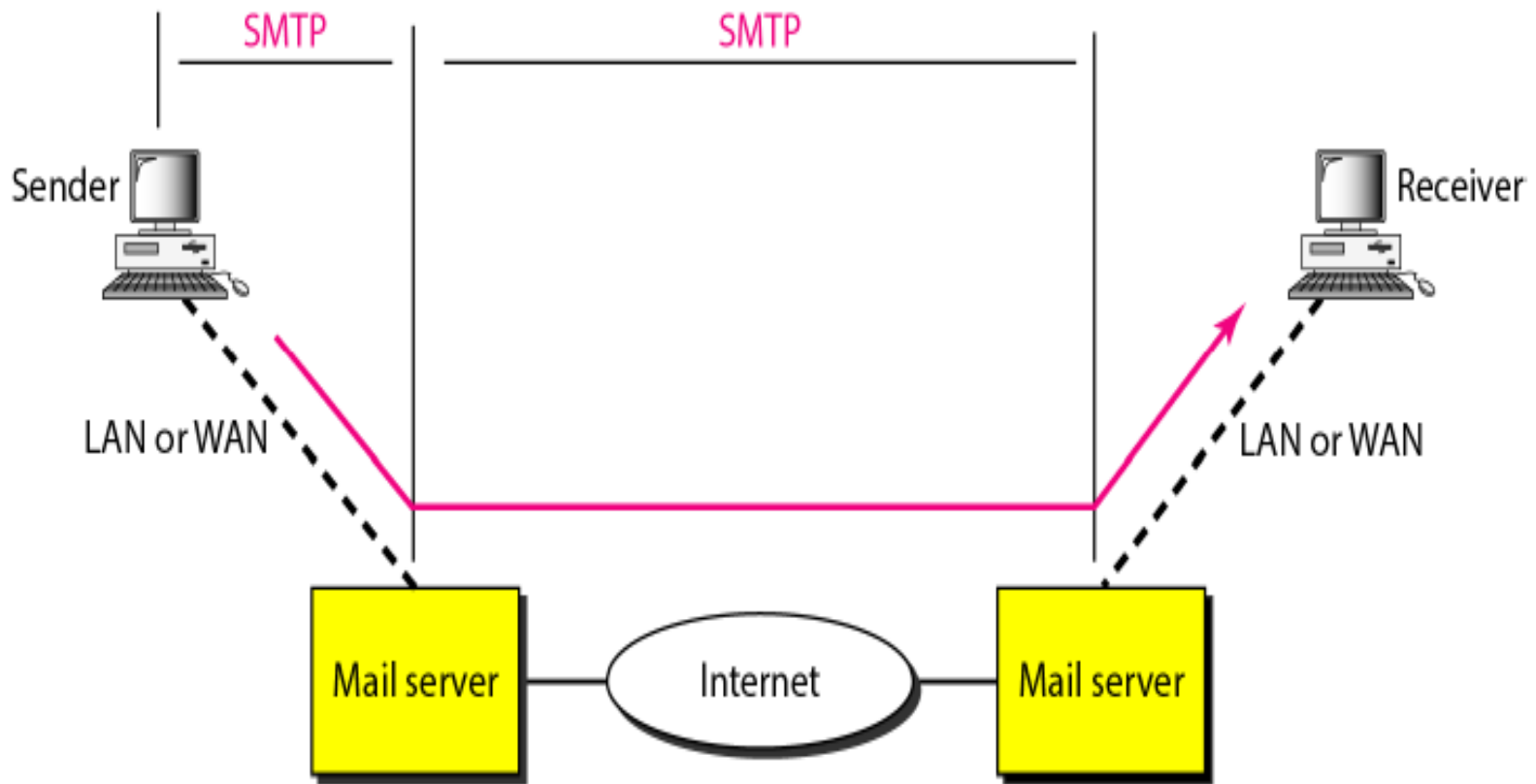
SMTP

- SMTP is used two times, between the sender and the sender's mail server and between the two mail servers.

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.

SMTP

Commands

Commands are sent from the client to the server. The format of a command is shown in following figure:-

Keyword: argument(s)

- It consists of a keyword followed by zero or more arguments.

- SMTP defines 14 commands. The first five are mandatory; every implementation must support these five commands. The next three are often used and highly recommended. The last six are seldom used.

SMTP

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

SMTP

Responses

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

SMTP

Responses(continue)

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

➢ As the table shows, responses are divided into four categories. The leftmost digit of the code (2, 3, 4, and 5) defines the category.

SMTP

Mail Transfer Phases

The process of transferring a mail message occurs in three phases: connection establishment, mail transfer, and connection termination.

Example

Let us see how we can directly use SMTP to send an e-mail and simulate the commands and responses we described in this section. We use TELNET to log into port 25 (well known port for SMTP). We then use 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 below. We have shown the commands in black and the responses in color. Note that we have added, for clarification, some comment lines, designated by the "=" signs. These lines are not part of the e-mail procedure.

SMTP

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

```
================= Connection Establishment =================
    220 mta13.adelphia.net SMTP server ready Fri, 6 Aug 2004 . . .
HELO mail.adelphia.net
    250 mta13.adelphia.net
```

SMTP

```
==================    Mail Transfer    ==================
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.
  .
```

```
==================    Connection Termination    ==================
    250 Message received: adelphia.net@mail.adelphia.net
QUIT
    221 mta13.adelphia.net SMTP server closing connection
Connection closed by foreign host.
```

Message Access Agent: POP and IMAP

- 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 is from the server to the client. The third stage uses a message access agent.

Message Access Agent: POP and IMAP

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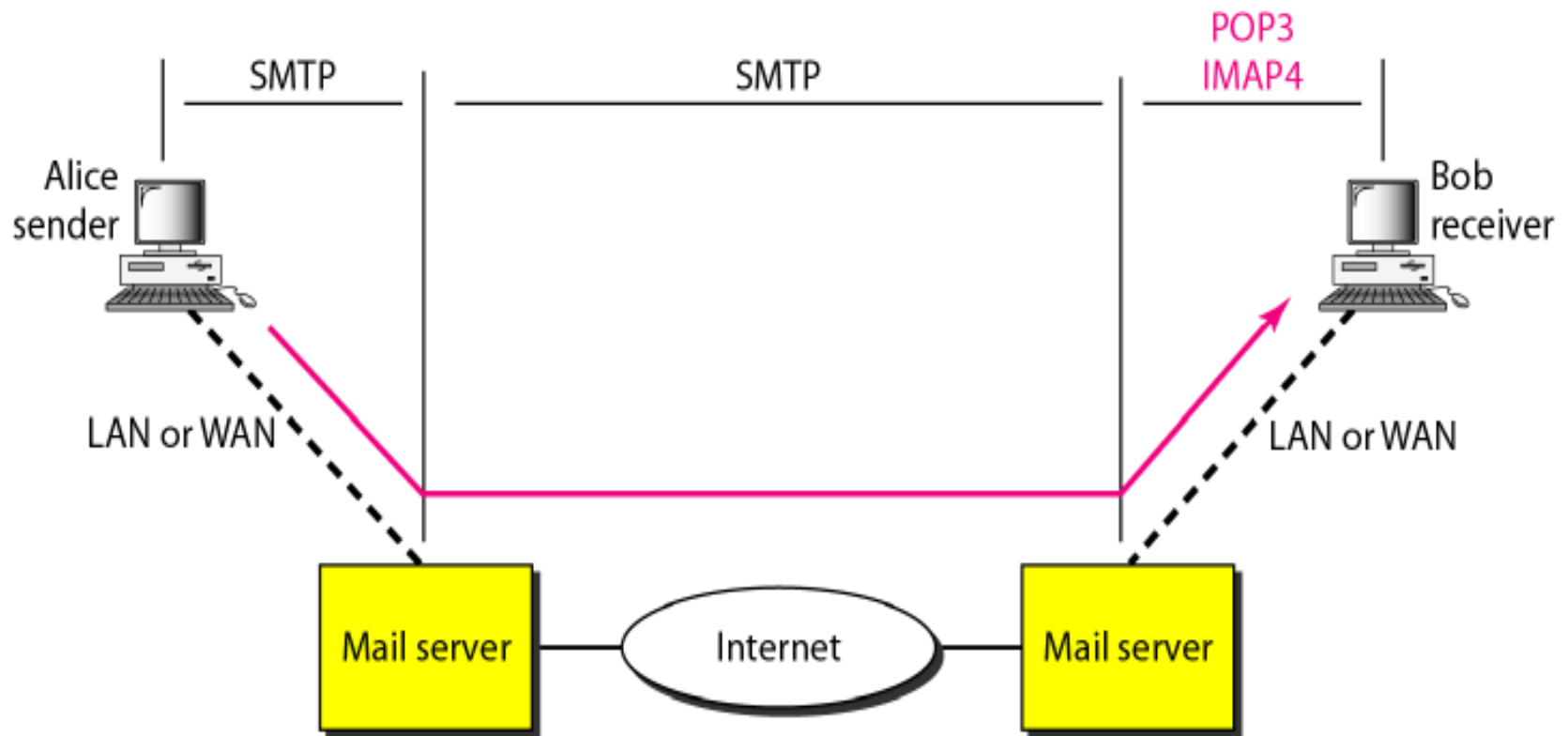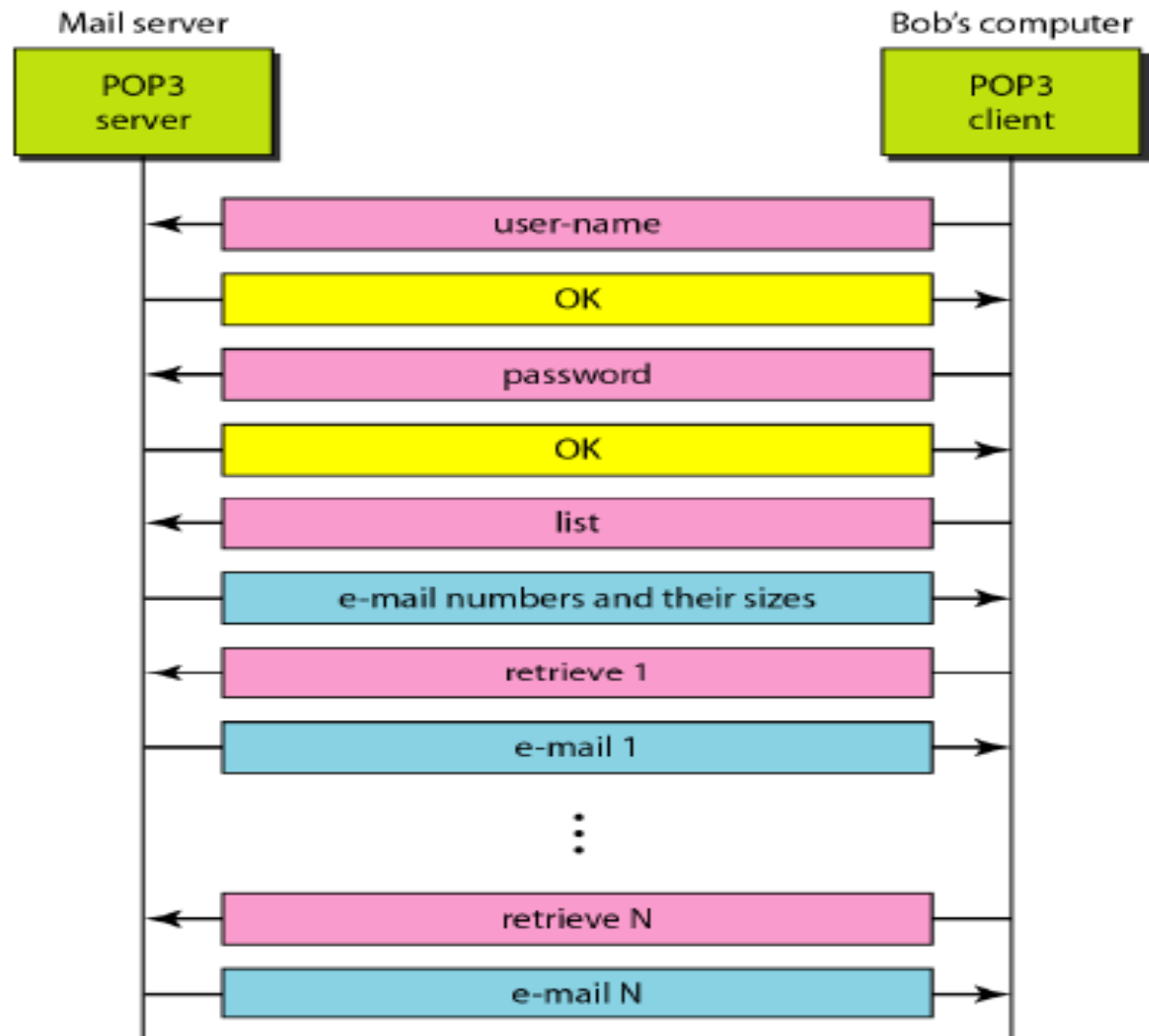
POP3

- Post Office Protocol, version 3 (POP3) is simple and 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 e-mail from the mailbox on the mail server. The client opens a connection to 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.

POP3

Following figure shows an example of downloading using POP3

POP3

- POP3 has two modes: the delete mode and the keep mode.
- In the delete mode, the mail is deleted from the mailbox after each retrieval.
- In the keep mode, the mail remains in the mailbox after retrieval.
- The delete mode is normally used when the user is working at her permanent computer and can save and organize the received mail after reading or replying.
- The keep mode is normally used when the user accesses her mail away from her primary computer (e.g., a laptop). The mail is read but kept in the system for later retrieval and organizing.

POP3

Deficiencies:

- It does not allow the user to organize her mail on the server.

- The user cannot have different folders on the server.

- In addition, POP3 does not allow the user to partially check the contents of the mail before downloading.

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.

- 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.

IMAP4

- 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.

Web-Based Mail

- E-mail is such a common application that some websites today provide this service to anyone who accesses the site.

- Suppose the mail is transferred from Alice to Bob.
  - Mail transfer from Alice's browser to her 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.

- In the last phase, instead of POP3 or IMAP4, HTTP is normally used.

File Transfer Protocol (FTP)

- File Transfer Protocol (FTP) is the standard mechanism provided by TCP/IP for copying a file from one host to another.

- FTP differs from other client/server applications in that it establishes two connections between the hosts. One connection is used for data transfer, the other for control information (commands and responses). Separation of commands and data transfer makes FTP more efficient.

- The control connection uses very simple rules of communication. We need to transfer only a line of command or a line of response at a time.

- The data connection, on the other hand, needs more complex rules due to the variety of data types transferred.

- However, the difference in complexity is at the FTP level, not TCP.

- For TCP, both connections are treated the same.

File Transfer Protocol (FTP)

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

- Following figure shows the basic model of FTP:-
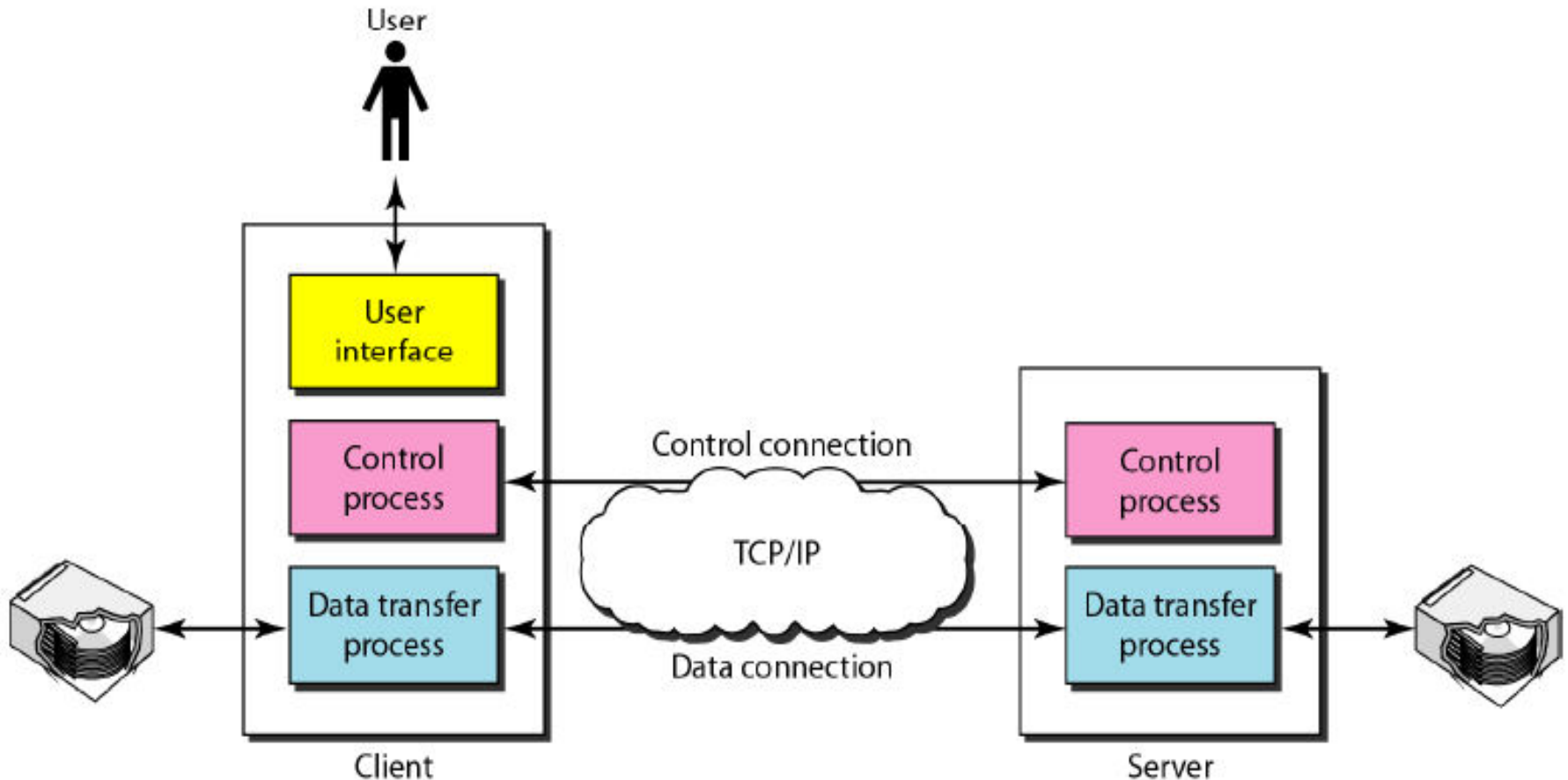
File Transfer Protocol (FTP)

- The client has three components: user interface, client control process, and the client data transfer process.

- The server has two components: the server control process and the server data transfer process.

- The control connection is made between the control processes. The data connection is made between the data transfer processes.

File Transfer Protocol (FTP)

- The control connection remains connected during the entire interactive FTP session.

- The data connection is opened and then closed for each file transferred. It opens each time commands that involve transferring files are used, and it closes when the file is transferred.

- In other words, when a user starts an FTP session, the control connection opens. While the control connection is open, the data connection can be opened and closed multiple times if several files are transferred.
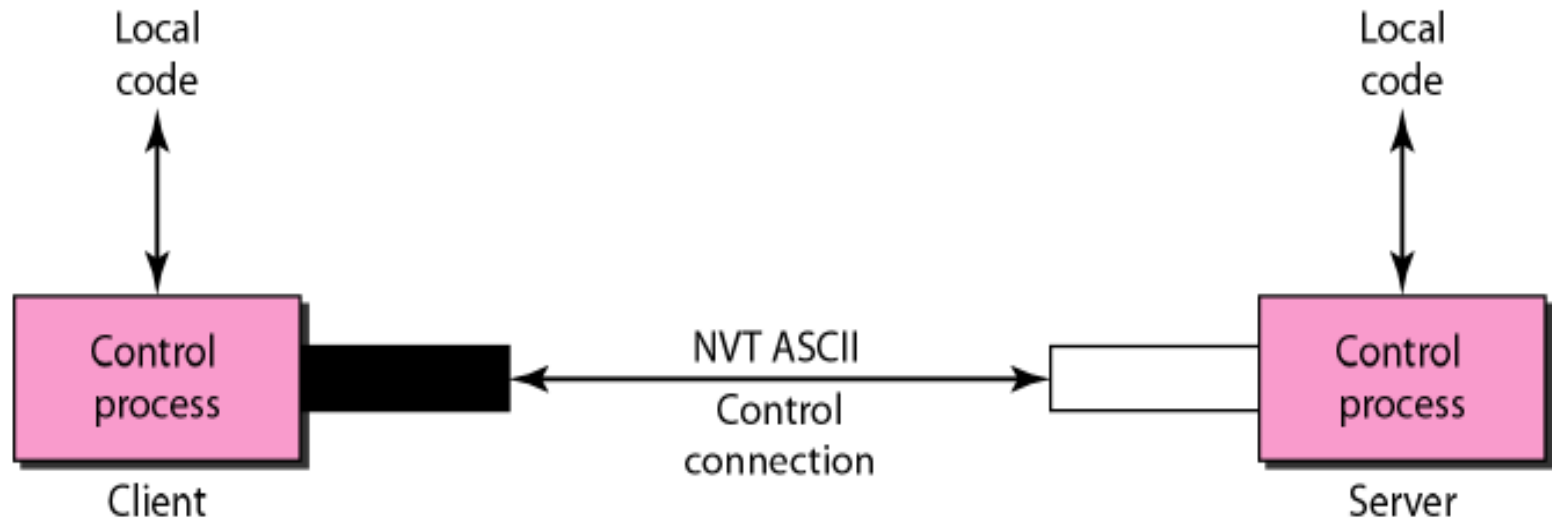
File Transfer Protocol (FTP)

Communication over Control Connection

- FTP uses the same approach as SMTP to communicate across the control connection.

- It uses the 7-bit ASCII character set.

- Communication is achieved through commands and responses.

- This simple method is adequate for the control connection because we send one command (or response) at a time.

File Transfer Protocol (FTP)

- Each command or response is only one short line, so we need not worry about file format or file structure.

- Each line is terminated with a two-character (carriage return and line feed) end-of-line token.
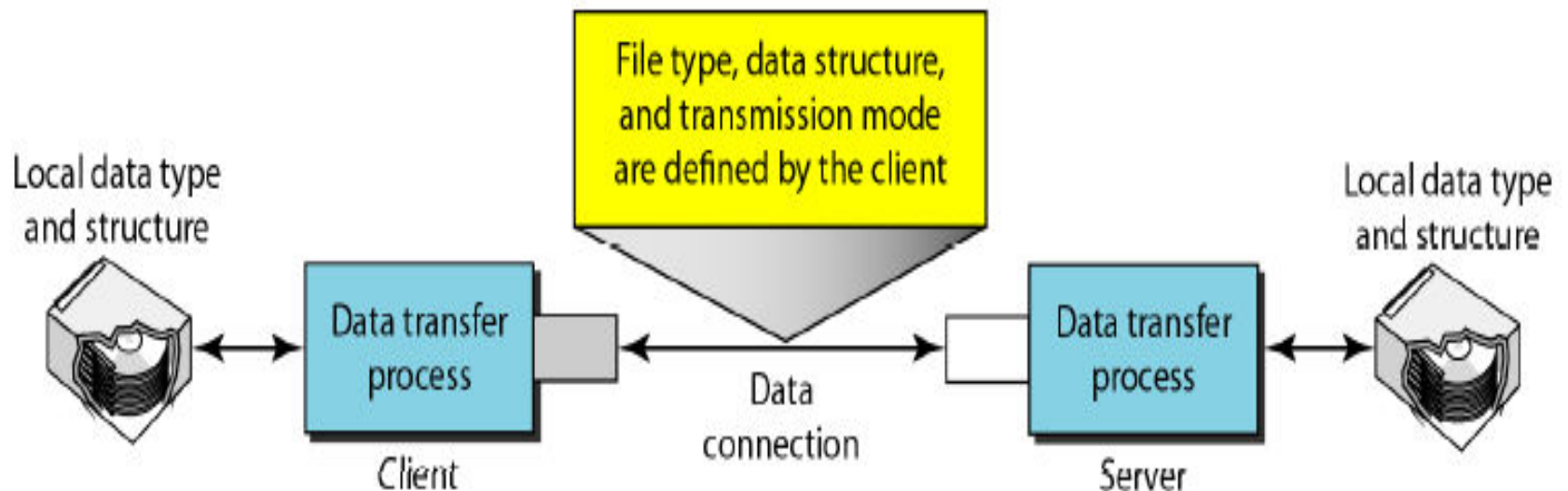
File Transfer Protocol (FTP)

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:
  - A file is to be copied from the server to the client. This is called retrieving a file. It is done under the supervision of the **RETR** command.
  - A file is to be copied from the client to the server. This is called storing a file. It is done under the supervision of the **STOR** command.
  - A list of directory or file names is to be sent from the server to the client. This is done under the supervision of the **LIST** command.

File Transfer Protocol (FTP)

- The client must define the type of file to be transferred, the structure of the data, and the transmission mode.

File Transfer Protocol (FTP)

File Type

FTP can transfer one of the following file types across the data connection: an ASCII file, EBCDIC file, or image file.

- The ASCII file is the default format for transferring text files. Each character is encoded using 7-bit ASCII. The sender transforms the file from its own representation into ASCII characters, and the receiver transforms the ASCII characters to its own representation.

- If one or both ends of the connection use EBCDIC encoding (the file format used by IBM), the file can be transferred using EBCDIC encoding.

- The image file is the default format for transferring binary files. The file is sent as continuous streams of bits without any interpretation or encoding. This is mostly used to transfer binary files such as compiled programs.

File Transfer Protocol (FTP)

Data Structure

FTP can transfer a file across the data connection by using one of the following interpretations about the structure of the data: file structure, record structure, and page structure.

- In the **file structure** format, the file is a continuous stream of bytes.

- In the **record structure**, the file is divided into records. This can be used only with text files.

- In the **page structure**, the file is divided into pages, with each page having a page number and a page header. The pages can be stored and accessed randomly or sequentially.

File Transfer Protocol (FTP)

Transmission Mode

FTP can transfer a file across the data connection by using one of the following three transmission modes: stream mode, block mode, and compressed mode.

- The **stream mode** is the default mode. Data are delivered from FTP to TCP as a continuous stream of bytes. TCP is responsible for chopping data into segments of appropriate size. If the data are simply a stream of bytes (file structure), no end-of-file is needed. End-of-file in this case is the closing of the data connection by the sender. If the data are divided into records (record structure), each record will have a 1-byte end-of-record (EOR) character and the end of the file will have a 1-byte end-of-file (EOF) character.

File Transfer Protocol (FTP)

Transmission Mode(continue)

- In **block mode**, data can be delivered from FTP to TCP in blocks. In this case, each block is preceded by a 3-byte header. The first byte is called the block descriptor; the next 2 bytes define the size of the block in bytes.

- In **the compressed mode**, if the file is big, the data can be compressed. The compression method normally used is run-length encoding. In this method, consecutive appearances of a data unit are replaced by one occurrence and the number of repetitions.

File Transfer Protocol (FTP)

Example

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.

File Transfer Protocol (FTP)

```
$ 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.
```

File Transfer Protocol (FTP)

1. After the control connection is created, the FIP server sends the 220 (service ready) response on the control connection.

2. The client sends its name.

3. The server responds with 331 (user name is OK, password is required).

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 (ls reports) to find the list of files on the directory named reports.

7. Now, the server responds with 150 and opens the data connection.

8. The server then sends the list of the files or directories (as a file) on the data connection. When the whole list (file) is sent, the server responds with 226 (closing data connection) over the control connection.

9. The client now has two choices. It can use the QUIT command to request the closing of the control connection, or it can send another command to start another activity (and eventually open another data connection). In our example, the client sends a QUIT command.

10. After receiving the QUIT command, the server responds with 221 (service closing) and then closes the control connection.

File Transfer Protocol (FTP)

AKTU Examination Questions

1. Mention the use of HTTP.

2. List out few email gateways.

3. Elaborate about TELNET and its working procedure.

4. How does FTP work? Differentiate between passive and active FTP.

5. Explain the SNMP protocols in detail.

6. How is TFTP different from FTP?

7. What three functions can SNMP perform to manage network devices?

8. How is the BOOTP different from DHCP?

9. What is the purpose of the Domain Name System? Discuss the three main divisions of the domain name space.

10. Write short notes on any two: (i) SMTP (ii) TELNET (iii) HTTP

AKTU Examination Questions

11. Elaborate about TELNET and its working procedure.

12. Write short notes on any two of the following:
    i.   DNS in the internet
    ii.   Voice Over IP
    iii.   File Transfer Protocol

13. Explain the SNMP protocols in detail.

14. What do you mean by DNS?

15. The symbols & their frequencies are given below

Symbol	A	B	C	D	E	F	G	H
Frequency	20	28	16	15	15	10	4	2

Construct Huffman codes.

16. Encrypt "EXTRANETPLANETSOURCE" using a transposition cipher with the following key: 3 5 2 1 4

17. Explain the following:

   (i)   Telnet

   (ii) FTP

   (iii) SNMP

   (iv) HTTP

   (v)   MIME

18. How does DNS perform data name resolution? What are the different types of name servers? Mention the DNS message format for query and reply messages.

19. Write short notes on any three of the following:

   (i)   DNS in the Internet

   (ii)   Voice Over IP

   (iii)   SNMP

   (iv)   Electronic mail

   (v)   File Transfer Protocol