APPLICATION LAYER

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.

The main task of the Internet is to provide services for users. Among the most popular applications are remote logging, electronic mail, and file transfer.

REMOTE LOGGING

In the Internet, users may want to run application programs at a remote site and create results that can be transferred to their local site. For example, students may want to connect to their university computer lab from their home to access application programs for doing homework assignments or projects. One way to satisfy that demand and others is to create a client/server application program for each desired service. Programs such as file transfer programs (FTPs), e-mail (SMTP), and so on are currently available. However, 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; in other words, allow the user to log on to a remote computer. After logging on, a user can use the services available on the remote computer and transfer the results back to the local computer.

TELNET

TELNET is a general-purpose client/server application program. TELNET is an abbreviation for TErminaL NETwork. It is the standard TCP/IP protocol for virtual terminal service as proposed by the International Organization for Standards (ISO). TELNET enables the establishment of a connection to a remote system in such a way that the local terminal appears to be a terminal at the remote system.

TELNET was designed at a time when most operating systems, such as UNIX, were operating in a timesharing environment. In such an environment, a large computer supports multiple users. The interaction between a user and the computer occurs through a terminal, which is usually a combination of keyboard, monitor, and mouse.

Logging

In a timesharing environment, users are part of the system with some right to access resources. To access the system, the user logs into the system with a user id or log-in name. The system also includes password checking to prevent an unauthorized user from accessing the resources.

When a user wants to access an application program or utility located on a remote machine, she performs remote log-in. Here the TELNET client and server programs come into use. The user sends the keystrokes to the terminal driver, where the local operating system accepts the characters but does not interpret them. The characters are sent to the TELNET client, which transforms the characters to a universal character set called network virtual terminal (NVT) characters and delivers them to the local TCP/IP protocol stack.

The commands or text, in NVT form, travel through the Internet and arrive at the TCP/IP stack at the remote machine. Here the characters are delivered to the operating system and passed to the TELNET server, which changes the characters to the corresponding characters understandable by the remote computer. However, the characters cannot be passed directly to the operating system because the remote operating system is not designed to receive characters from a TELNET server: It is designed to receive characters from a terminal driver. The solution is to add a piece of software called a *pseudoterminal driver* which pretends that the characters are coming from a terminal. The operating system then passes the characters to the appropriate application program.

Network Virtual Terminal

We are dealing with heterogeneous systems. If we want to access any remote computer in the world, we must first know what type of computer we will be connected to, and we must also install the specific terminal emulator used by that computer. TELNET solves this problem by defining a universal interface called the network virtual terminal (NVT) character set. Via this interface, the client TELNET translates characters (data or commands) that come from the local terminal into NVT form and delivers them to the network. The server TELNET, on the other hand, translates data and commands from NVT form into the form acceptable by the remote computer.

NVT Character Set

NVT uses two sets of characters, one for data and the other for control. Both are 8-bit bytes. For data, NVT is an 8-bit character set in which the 7 lowest-order bits are the same as ASCII and the highest-order bit is O. To send control characters between computers (from client to server or vice versa), NVT uses an 8-bit character set in which the highest-order bit is set to 1.

Embedding

TELNET uses only one TCP connection. The server uses the well-known port 23, and the client uses an ephemeral port. The same connection is used for sending both data and control characters. TELNET accomplishes this by embedding the control characters in the data stream. However, to distinguish data from control characters, each sequence of control characters is preceded by a special control character called *interpret as control* (IAC).

FILE TRANSFER PROTOCOL

File Transfer Protocol (FTP) is an application layer protocol which moves files between local and remote file systems. It runs on the top of TCP, like HTTP.

The two objectives of the protocol are to "promote the sharing of files" and "transfer data reliably and efficiently." To transfer a file, 2 TCP connections are used by FTP in parallel: control connection and data connection.

Control connection: This *TCP*-based connection is used to provide a communications channel for the delivery of commands and replies. This is effectively the mechanism that enables the user to tell the server which file is being requested, which directory it is in, and so forth.

Data connection: The second *TCP*-based connection is used for the actual transfer of user data. Once the Control connection has been used to exchange information on which file is required, the Data connection is used to transfer the file between the client and server.

The control connection remains connected during the entire interactive FTP session. The data connection is opened and then closed for each file transferred.

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

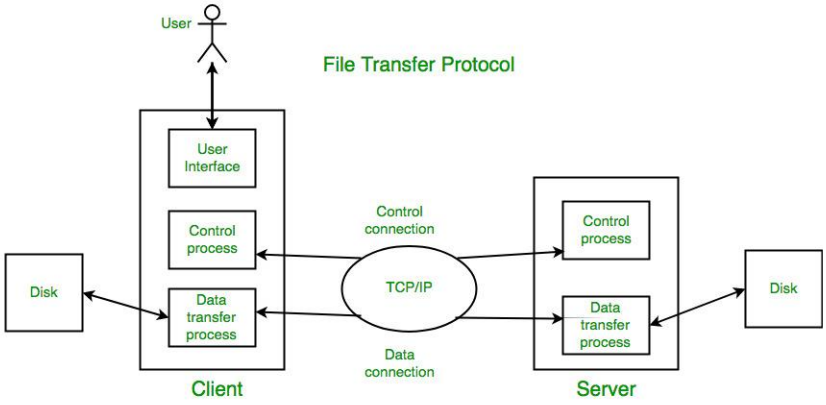


Figure shows the basic model of FTP. The client has three components: user interface, client control process, and the client data transfer process. The server has two components: the server control process and the server data transfer process. The control connection is made between the control processes. The data connection is made between the data transfer processes.

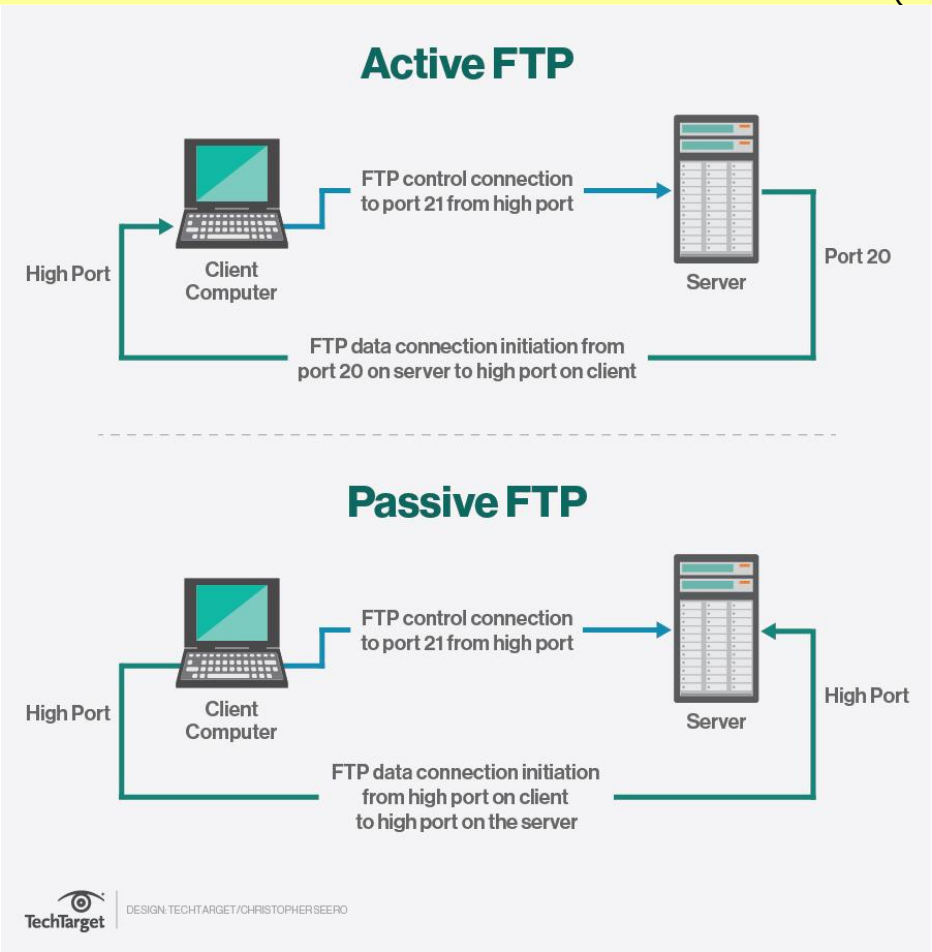
Using these two communication connections, two distinct modes of operation determine in which direction the connections are established: Active mode and Passive mode.

Active Mode *FTP*

In active mode, after a client initiates a session via a command channel request, the server initiates a data connection back to the client and begins transferring data.

Passive Mode *FTP*

In passive mode, the server instead uses the command channel to send the client the information it needs to open a data channel. Because passive mode has the client initiating all connections, it works well across firewalls and Network Address Translation (NAT) gateways.



FTP Session

When a FTP session is started between a client and a server, the client initiates a control TCP connection with the server side. The client sends the control information over this. When the server receives this, it initiates a data connection to the client side. Only one file can be sent over one data connection. But the control connection remains active throughout the user session. As we know HTTP is stateless i.e. it does not have to keep track of any user state. But FTP needs to maintain a state about its user throughout the session.

Data Structures :

FTP allows three types of data structures :

1. **File Structure –** In file-structure there is no internal structure and the file is considered to be a continuous sequence of data bytes.
2. **Record Structure –** In record-structure the file is made up of sequential records.
3. **Page Structure –** In page-structure the file is made up of independent indexed pages.

Anonymous FTP

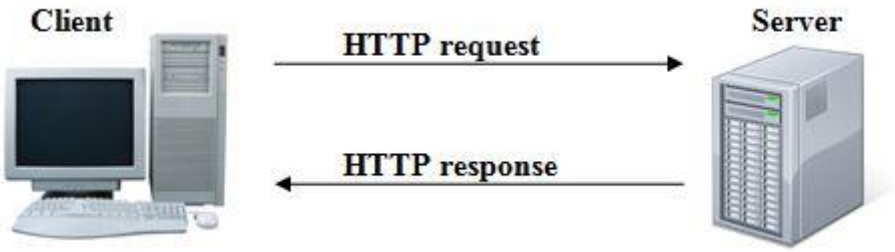
Anonymous FTP is enabled on some sites whose files are available for public access. A user can access these files without having any username or password. Instead, username is set to anonymous and password to guest by default. Here, the user access is very limited. For example, the user can be allowed to copy the files but not to navigate through directories.

HYPERTEXT TRANSFER PROTOCOL (*HTTP*)

The HyperText Transfer Protocol, or *HTTP* is the most widely used Application layer protocol in the world today. It forms the basis of what most people understand the Internet to be—the World Wide Web. Its purpose is to provide a lightweight protocol for the retrieval of HyperText Markup Language (*HTML*) and other documents from Web sites throughout the Internet. Each time you open a Web browser to surf the Internet, you are using *HTTP* over *TCP*/*IP*.

HTTP (Hypertext Transfer Protocol) is the set of rules for transferring files (text, graphic images, sound, video, and other multimedia files) on the World Wide Web. As soon as a Web user opens their Web browser, the user is indirectly making use of HTTP. HTTP is an application protocol that runs on top of the TCP/IP suite of protocols (the foundation protocols for the Internet).

This protocol defines how messages are formatted and transmitted, and what actions Web servers and browsers should take in response to various commands.



For example, when you enter a URL in your browser, this actually sends an HTTP command to the Web server directing it to fetch and transmit the requested Web page

Basic *HTTP* Page Retrieval

Think of the process, taking place in the following order:

1. Client sends a request for the required page to the Web server.
2. The server analyzes the request and sends back an acknowledgment to the client along with the *HTML* code required to make the page.

3. The client will begin interpreting the *HTML* and building the page.
4. The client, in subsequent requests, will retrieve any embedded objects, such as images or other multimedia sources.
5.

Once all elements of the page have been retrieved, the client browser will display the completed Web page.

E-MAIL

E-mail Protocols are set of rules that help the client to properly transmit the information to or from the mail server.

SMPTP

SMTP stands for **Simple Mail Transfer Protocol**. It was first proposed in 1982. It is a standard protocol used for sending e-mail efficiently and reliably over the internet.

Key Points:

- SMTP is application level protocol.
- SMTP is connection oriented protocol.
- SMTP is text based protocol.
- It handles exchange of messages between e-mail servers over TCP/IP network.
- Apart from transferring e-mail, SMPT also provides notification regarding incoming mail.
- When you send e-mail, your e-mail client sends it to your e-mail server which further contacts the recipient mail server using SMTP client.
- These SMTP commands specify the sender's and receiver's e-mail address, along with the message to be send.
- The exchange of commands between servers is carried out without intervention of any user.
- In case, message cannot be delivered, an error report is sent to the sender which makes SMTP a reliable protocol.

IMAP

IMAP stands for **Internet Mail Access Protocol.** It was first proposed in 1986. There exist five versions of IMAP as follows:

1. Original IMAP
2. IMAP2
3. IMAP3
4. IMAP2bis
5. IMAP4

Key Points:

- IMAP allows the client program to manipulate the e-mail message on the server without downloading them on the local computer.
- The e-mail is hold and maintained by the remote server.

- It enables us to take any action such as downloading, delete the mail without reading the mail.It enables us to create, manipulate and delete remote message folders called mail boxes.
- IMAP enables the users to search the e-mails.
- It allows concurrent access to multiple mailboxes on multiple mail servers.

POP

POP stands for Post Office Protocol. It is generally used to support a single client. There are several versions of POP but the POP 3 is the current standard.

Key Points

- POP is an application layer internet standard protocol.
- Since POP supports offline access to the messages, thus requires less internet usage time.
- POP does not allow search facility.
- In order to access the messaged, it is necessary to download them.
- It allows only one mailbox to be created on server.
- It is not suitable for accessing non mail data.
- POP commands are generally abbreviated into codes of three or four letters. Eg. STAT.