APPLICATION LAYER

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Application Protocols covered till date:

- SMTP : Simple Mail Transfer Protocol
- POP : Post Office Protocol
- IMAP : Internet Message Access Protocol
- MIME : Multipurpose Internet Mail Extensions
- HTTP : HyperText Transport Protocol
- TELNET : TEminaL Network Protocol
- SSH : Secure Shell Protocol
- FTP: File Transfer Protocol

Web Applications

Email

WWW

BitTorrent

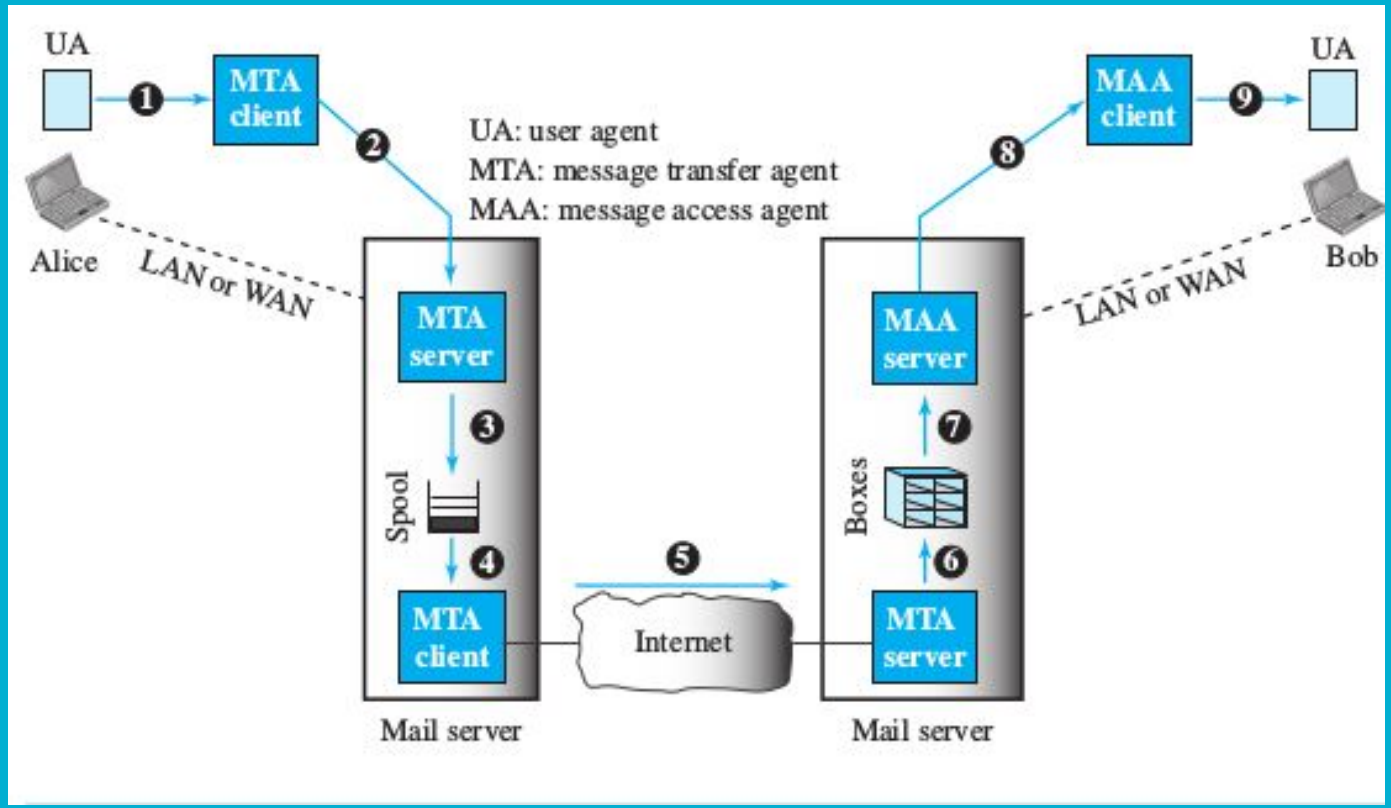
Skype

And so on..

EMAIL

Email

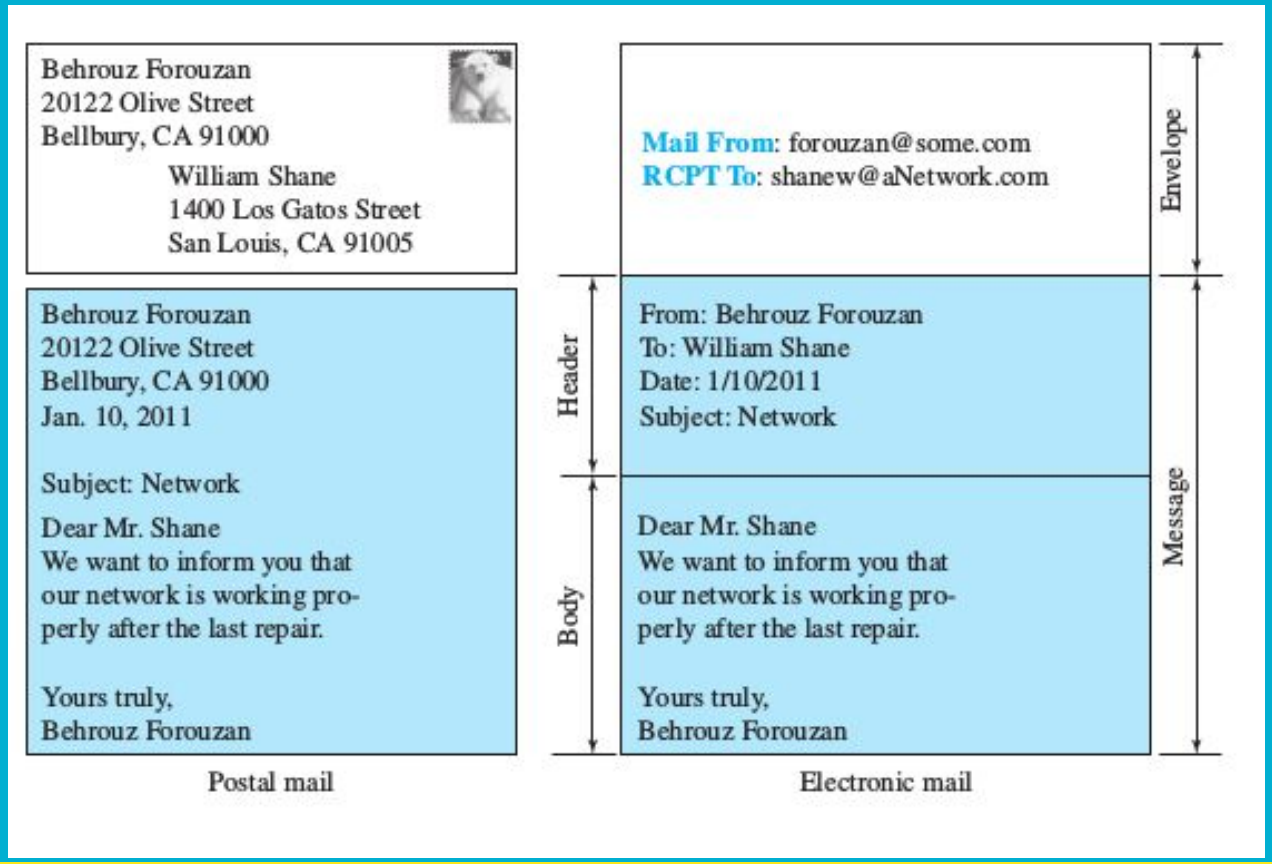
- Email System : Architecture



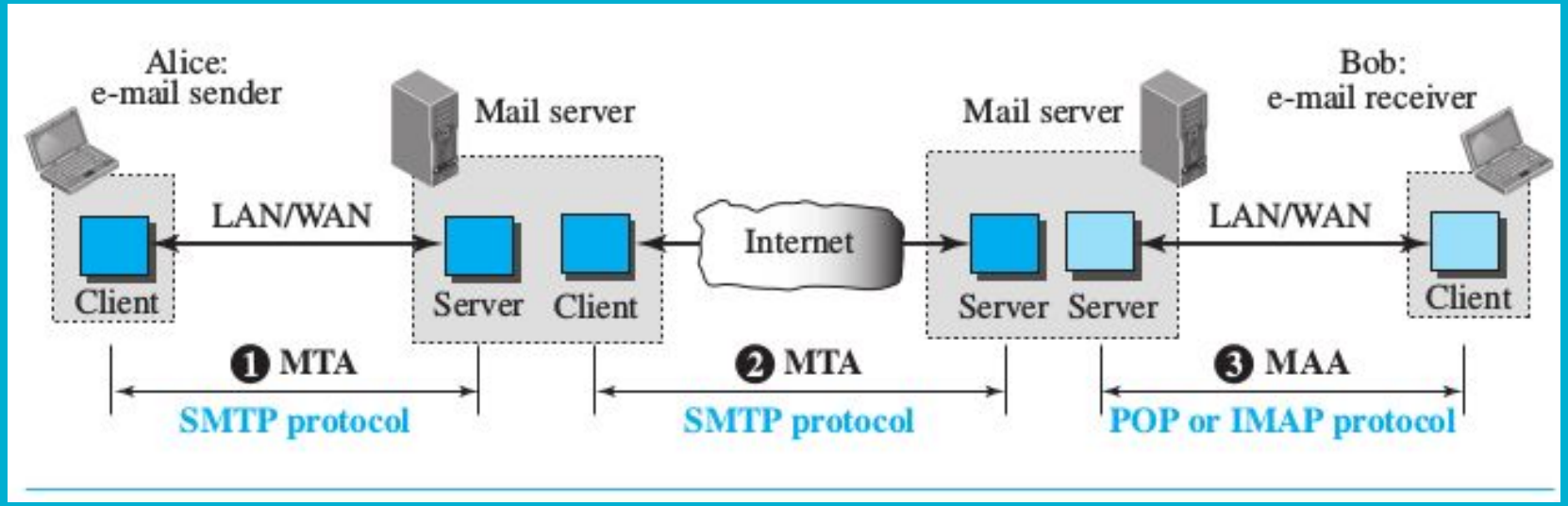
Three main components:

- User Agents
- Message Transfer Agent
- Message Access Agent

Format of an e-mail



Protocols used in e-mail



SMTP: Simple Mail Transfer Protocol

Commands:

Keyword	*Argument(s)*	*Description*
HELO	Sender's host name	Identifies itself
MAIL FROM	Sender of the message	Identifies the sender of the message
RCPT TO	Intended recipient	Identifies the recipient of the message
DATA	Body of the mail	Sends the actual message
QUIT		Terminates the message
RSET		Aborts the current mail transaction
VRFY	Name of recipient	Verifies the address of the recipient
NOOP		Checks the status of the recipient
TURN		Switches the sender and the recipient
EXPN	Mailing list	Asks the recipient to expand the mailing list
HELP	Command name	Asks the recipient to send information about the command sent as the argument
SEND FROM	Intended recipient	Specifies that the mail be delivered only to the terminal of the recipient, and not to the mailbox
SMOL FROM	Intended recipient	Specifies that the mail be delivered to the terminal *or* the mailbox of the recipient
SMAL FROM	Intended recipient	Specifies that the mail be delivered to the terminal *and* the mailbox of the recipient

SMTP Responses

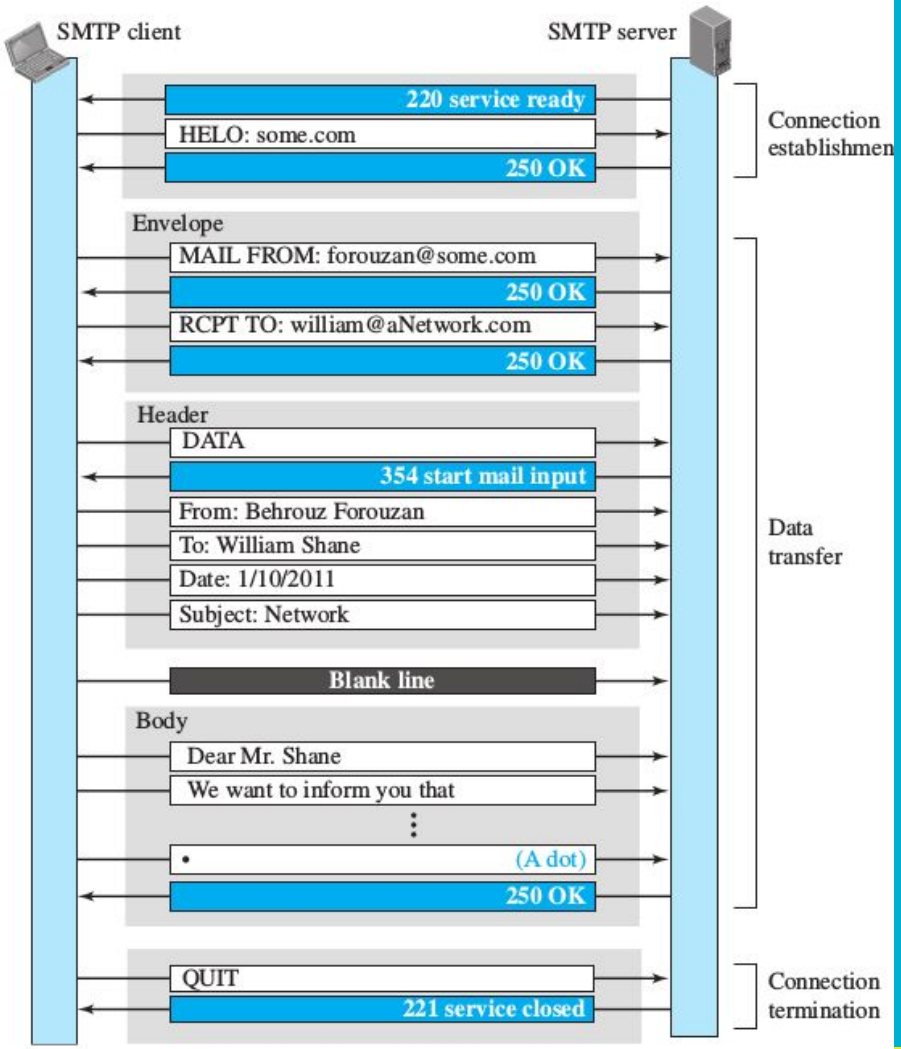
Code	*Description*
	Positive Completion Reply
211	System status or help reply
214	Help message
220	Service ready
221	Service closing transmission channel
250	Request command completed
251	User not local; the message will be forwarded
	Positive Intermediate Reply
354	Start mail input
	Transient Negative Completion Reply
421	Service not available
450	Mailbox not available
451	Command aborted: local error
452	Command aborted; insufficient storage
	Permanent Negative Completion Reply
500	Syntax error; unrecognized command

SMTP Responses

Code	*Description*
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

Mail Transfer Phases

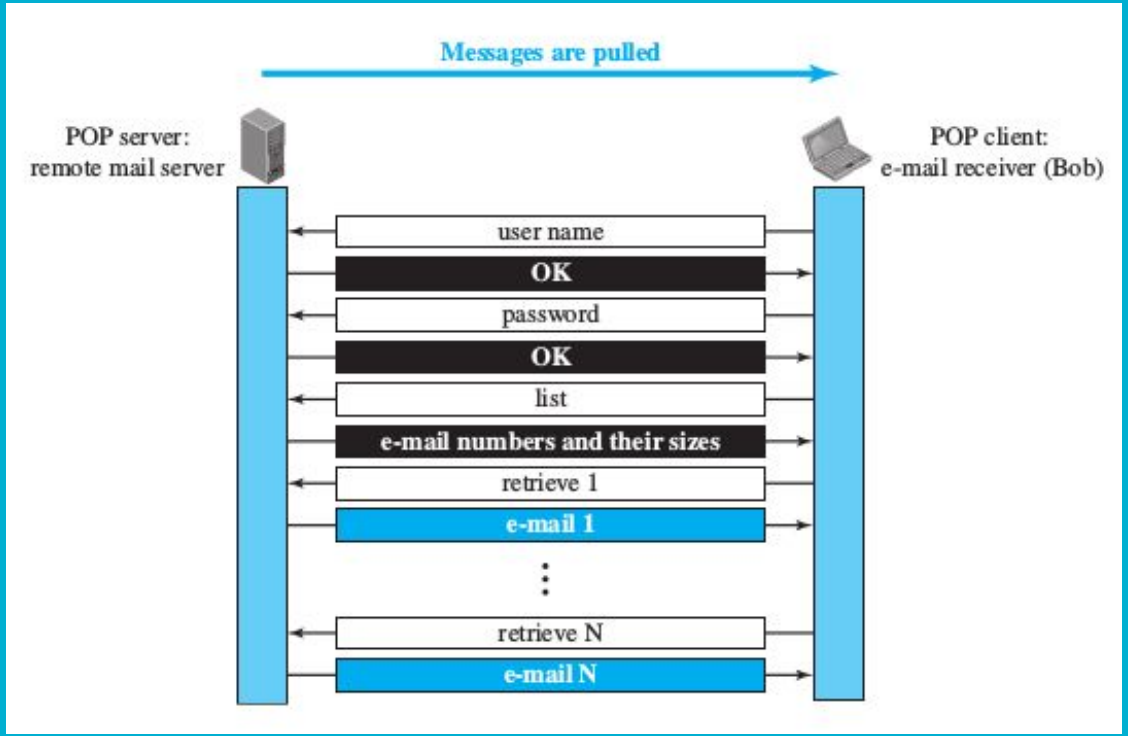
- Connection Establishment
- Message Transfer
- Connection Termination


SMTP client
SMTP server
220 service ready
HELO: some.com
250 OK
Connection establishmen
Envelope
MAIL FROM: forouzan@some.com
250 OK
RCPT TO: william@aNetwork.com
250 OK
Header
DATA
354 start mail input
From: Behrouz Forouzan
To: William Shane
Date: 1/10/2011
Subject: Network
Blank line
Body
Dear Mr. Shane
We want to inform you that
•
(A dot)
250 OK
Data transfer
QUIT
221 service closed
Connection termination

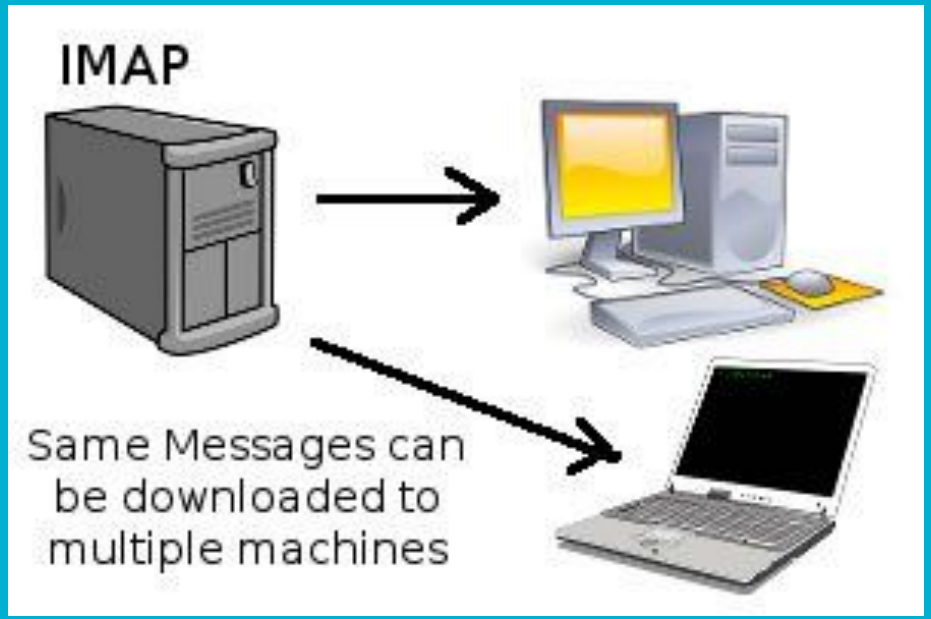
Message Access Agent: POP and IMAP

POP3 :

Post Office Protocol



IMAP4 : Internet Message Access Protocol



MIME: Multipurpose Internet Mail Extensions

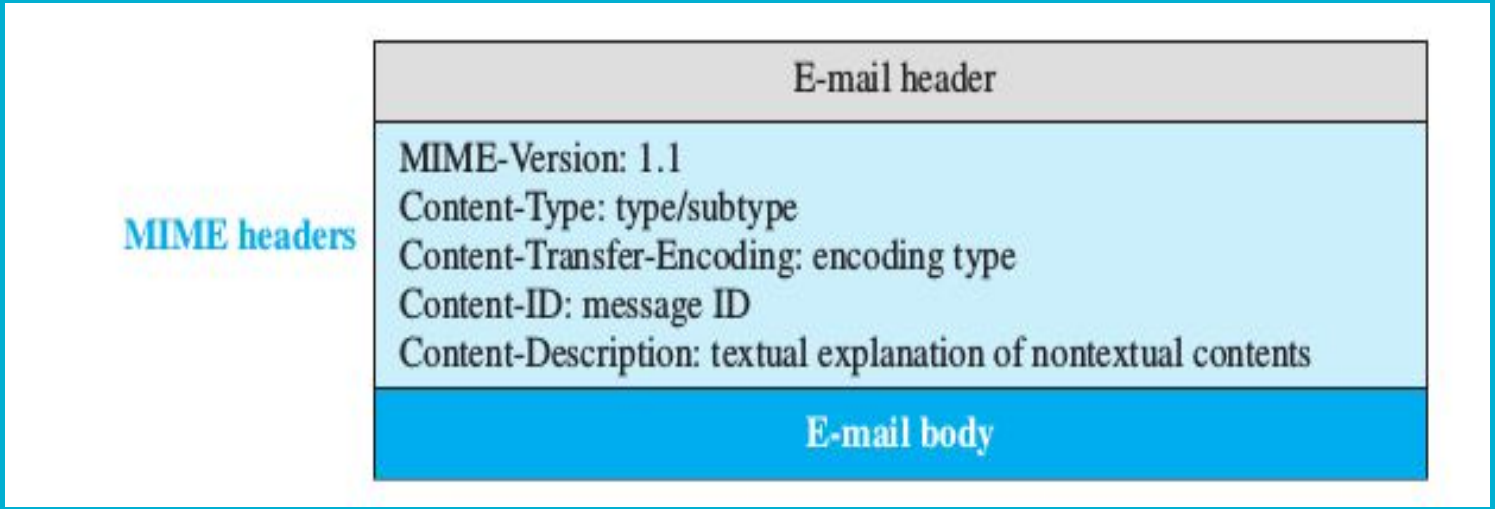
Limitations of e-mail:

- It cannot be used for languages other than English.
- It cannot send binary files or video or audio.

So MIME is a companion protocol for defining format of the email message.

It allows non-ASCII data to be sent through e-mail.

MIME Headers



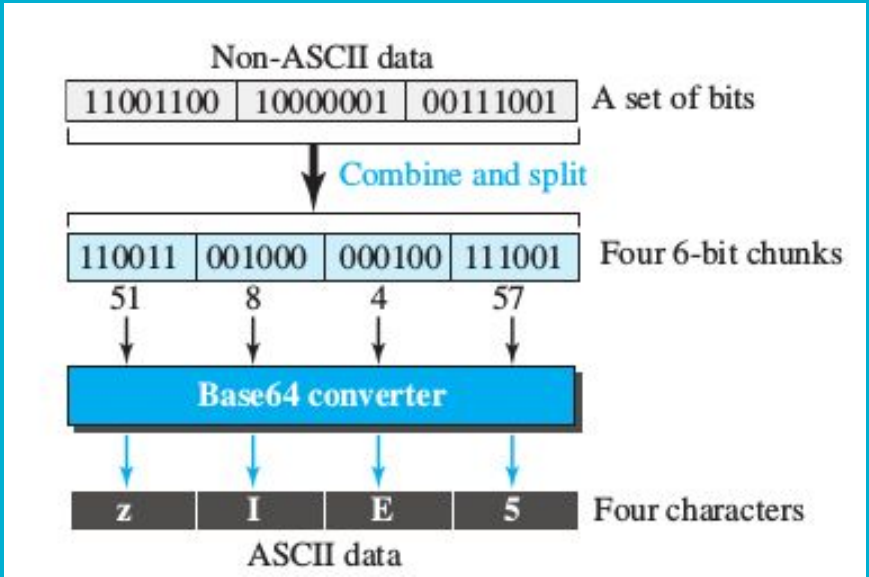
MIME Content Type

Type	*Subtype*	*Description*
Text	Plain	Unformatted
	HTML	HTML format (see Appendix C)
Multipart	Mixed	Body contains ordered parts of different data types
	Parallel	Same as above, but no order
	Digest	Similar to Mixed, 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 (eight-bit bytes)

Content Transfer Encoding

Type	*Description*
7-bit	NVT ASCII characters with each line less than 1000 characters
8-bit	Non-ASCII characters with each line less than 1000 characters
Binary	Non-ASCII characters with unlimited-length lines
Base64	6-bit blocks of data encoded into 8-bit ASCII characters
Quoted-printable	Non-ASCII characters encoded as an equal sign plus an ASCII code

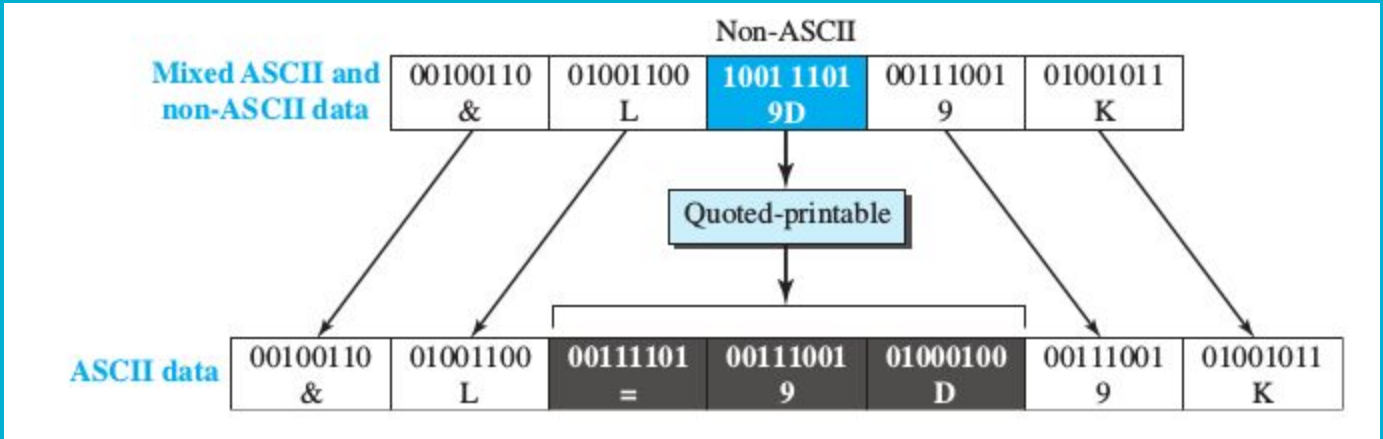
Example of Base64 conversion



Base64 Converting Table

Value	*Code*	*Value*	*Code*	*Value*	*Code*	*Value*	*Code*	*Value*	*Code*	*Value*	*Code*
0	**A**	11	**L**	22	**W**	33	**h**	44	**s**	55	**3**
1	**B**	12	**M**	23	**X**	34	**i**	45	**t**	56	**4**
2	**C**	13	**N**	24	**Y**	35	**j**	46	**u**	57	**5**
3	**D**	14	**O**	25	**Z**	36	**k**	47	**v**	58	**6**
4	**E**	15	**P**	26	**a**	37	**l**	48	**w**	59	**7**
5	**F**	16	**Q**	27	**b**	38	**m**	49	**x**	60	**8**
6	**G**	17	**R**	28	**c**	39	**n**	50	**y**	61	**9**
7	**H**	18	**S**	29	**d**	40	**o**	51	**z**	62	**+**
8	**I**	19	**T**	30	**e**	41	**p**	52	**0**	63	**/**
9	**J**	20	**U**	31	**f**	42	**q**	53	**1**		
10	**K**	21	**V**	32	**g**	43	**r**	54	**2**		

Quoted Printable encoding example:



GATE 2019

Which of the following protocol pairs can be used to send and retrieve e-mails (in that order)?

- A) IMAP POP3
- B) SMTP, POP3
- C) SMTP, MIME
- D) IMAP, SMTP

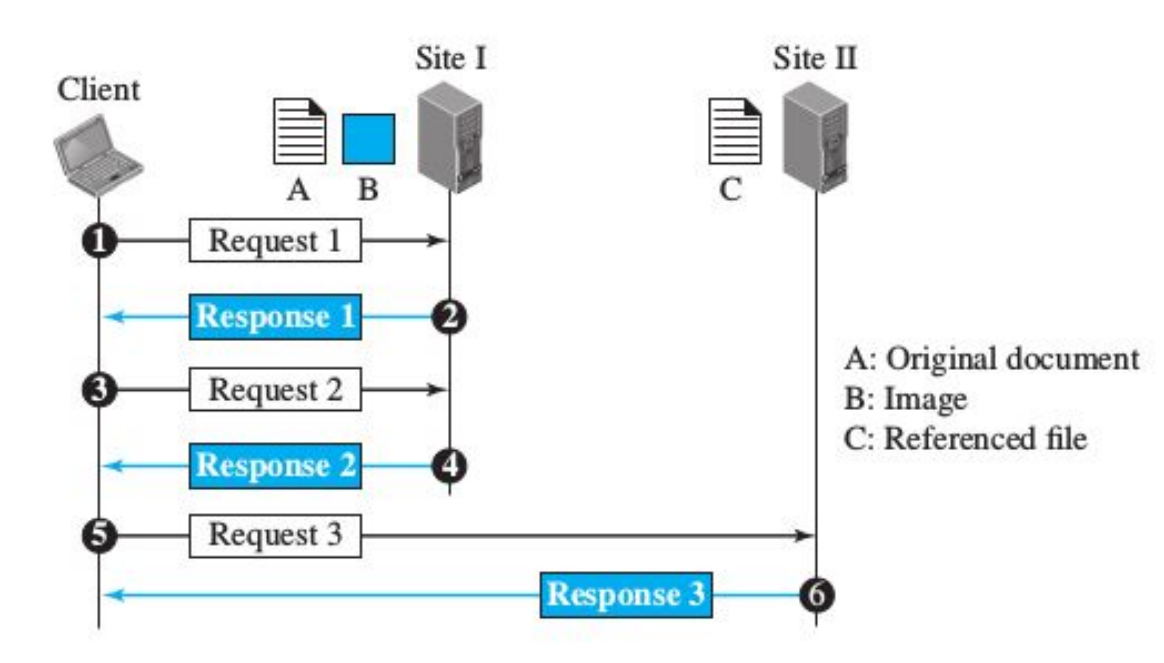
WWW : World Wide Web

- WWW is a well known web service provided by the Internet.
- It is a repository of information.
- HTTP is a application layer protocol to retrieve information from the Web

WWW and HTTP

- Web has a set of clients and servers.
- They speak a common language : HTTP
- How do you access Web?
- What is URL?
- Web page and Web site?
- Domain?
- Hypertext?
- Hypermedia?

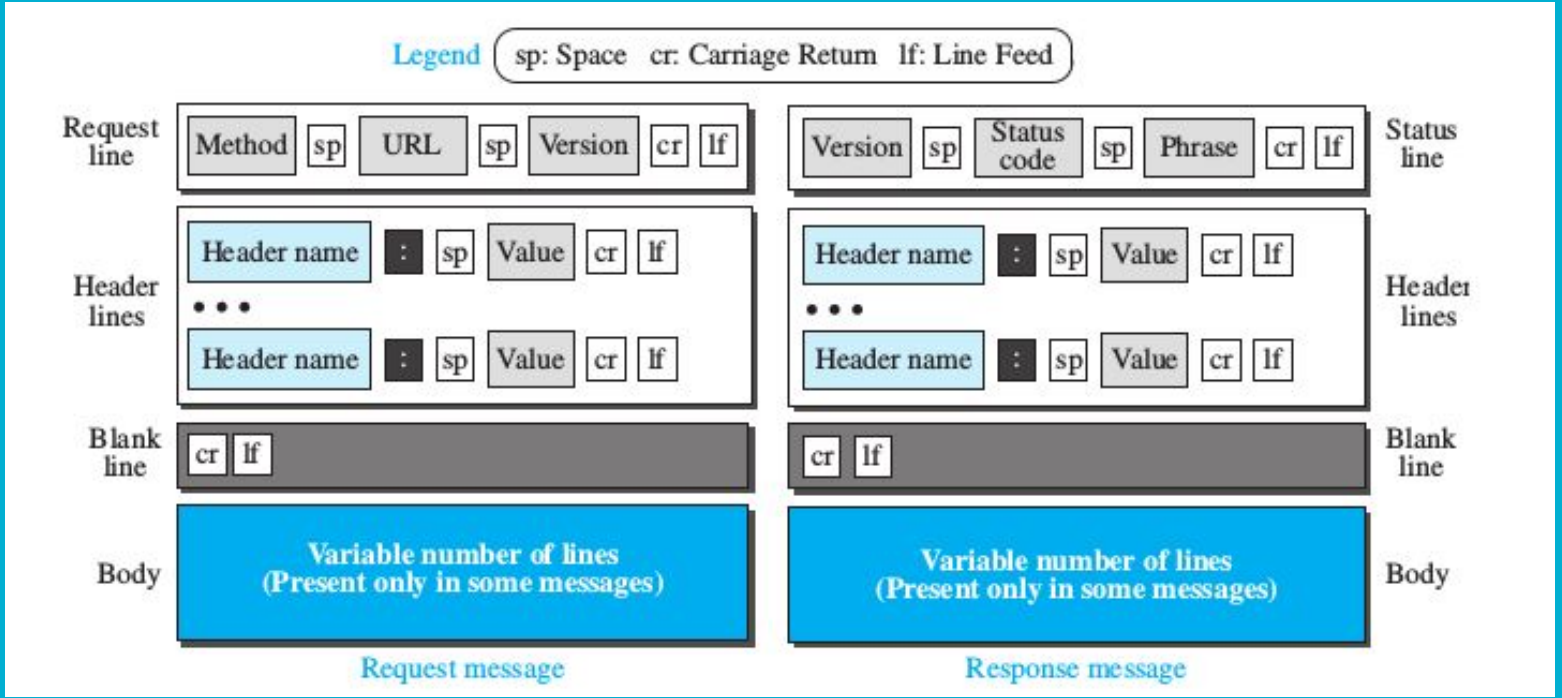
WWW Architecture:



HyperText Transfer Protocol : HTTP

- It is a text oriented protocol that has a general format.
- It is a stateless application protocol.
- Runs over TCP.
- Three parts to understand : HyperText, Transfer, Protocol.
- It defines how client server programs can be written to retrieve web pages from the web.
- HTTP messages are read and interpreted by the HTTP client and Servers.

Request and Response message formats:



Request Message

Request Line : Method, URL and Version

Method	*Action*
GET	Requests a document from the server
HEAD	Requests information about a document but not the document itself
PUT	Sends a document from the client to the server
POST	Sends some information from the client to the server
TRACE	Echoes the incoming request
DELETE	Removes the web page
CONNECT	Reserved
OPTIONS	Inquires about available options

Request Message

Request Header:

Header	*Description*
User-agent	Identifies the client program
Accept	Shows the media format the client can accept
Accept-charset	Shows the character set the client can handle
Accept-encoding	Shows the encoding scheme the client can handle
Accept-language	Shows the language the client can accept
Authorization	Shows what permissions the client has
Host	Shows the host and port number of the client
Date	Shows the current date
Upgrade	Specifies the preferred communication protocol
Cookie	Returns the cookie to the server (explained later)
If-Modified-Since	If the file is modified since a specific date

Response Message

Status Line: Version, Status code and Status Phrase.

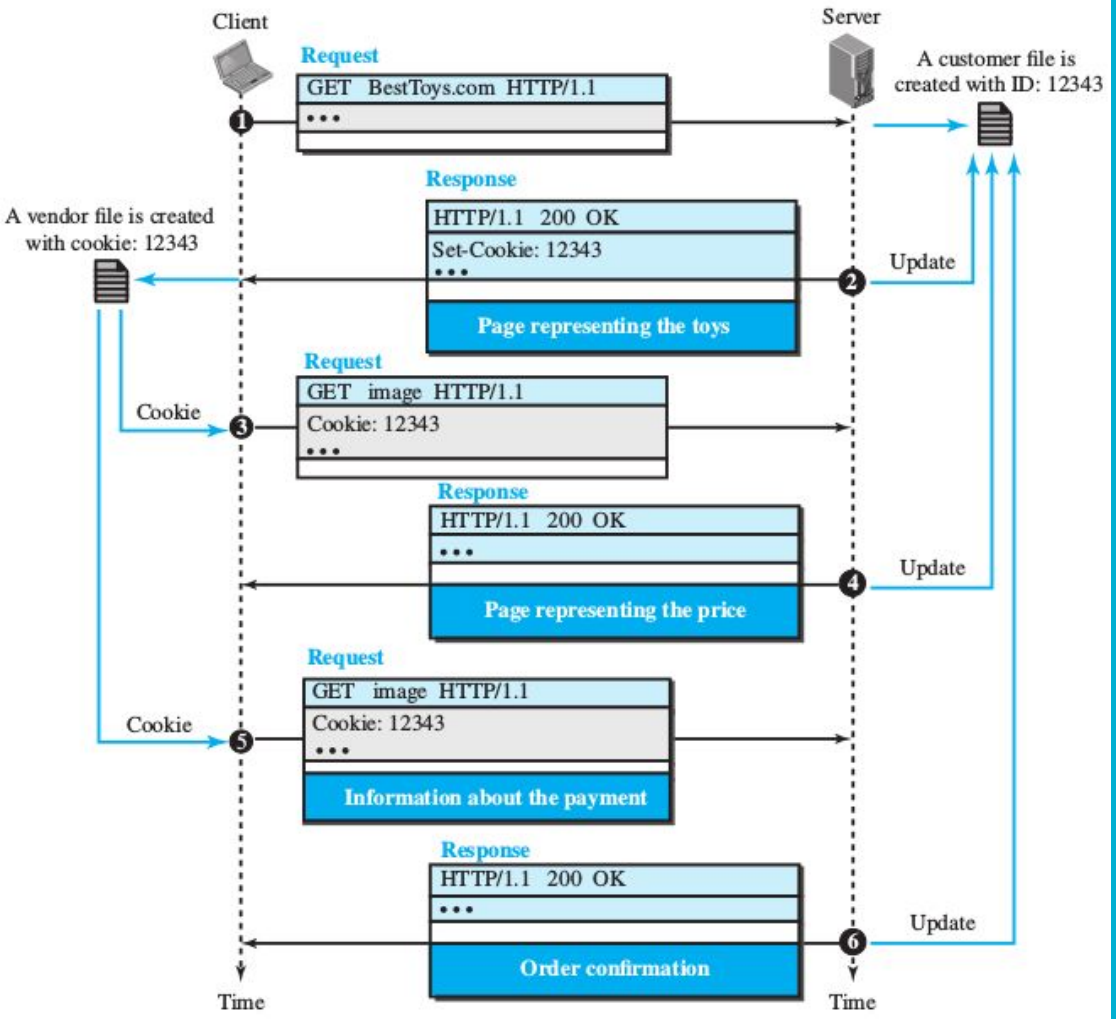
Version is HTTP version : 1.1 or 2.0

Status code: 100 range, 200 range, 300 range, 400 range, 500 range

Response Message

Response Header:

Header	*Description*
Date	Shows the current date
Upgrade	Specifies the preferred communication protocol
Server	Gives information about the server
Set-Cookie	The server asks the client to save a cookie
Content-Encoding	Specifies the encoding scheme
Content-Language	Specifies the language
Content-Length	Shows the length of the document
Content-Type	Specifies the media type
Location	To ask the client to send the request to another site
Accept-Ranges	The server will accept the requested byte-ranges
Last-modified	Gives the date and time of the last change

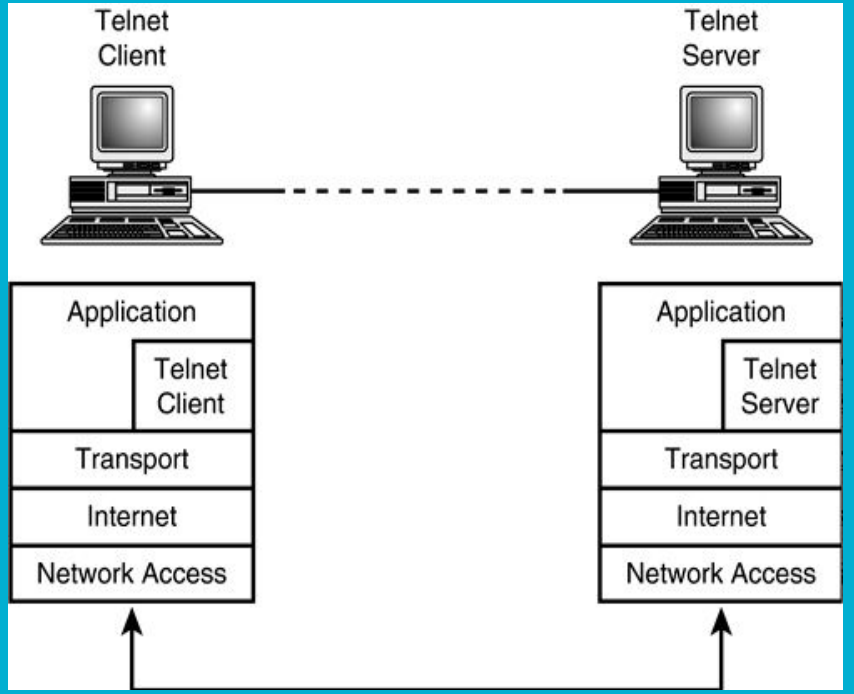

Client
Server
Request
GET BestToys.com HTTP/1.1
A customer file is created with ID: 12343
Response
HTTP/1.1 200 OK
Set-Cookie: 12343
A vendor file is created with cookie: 12343
Update
Page representing the toys
Request
GET image HTTP/1.1
Cookie: 12343
Cookie
Response
HTTP/1.1 200 OK
Update
Page representing the price
Request
GET image HTTP/1.1
Cookie: 12343
Cookie
Information about the payment
Response
HTTP/1.1 200 OK
Update
Order confirmation
Time
Time

REMOTE LOGGING

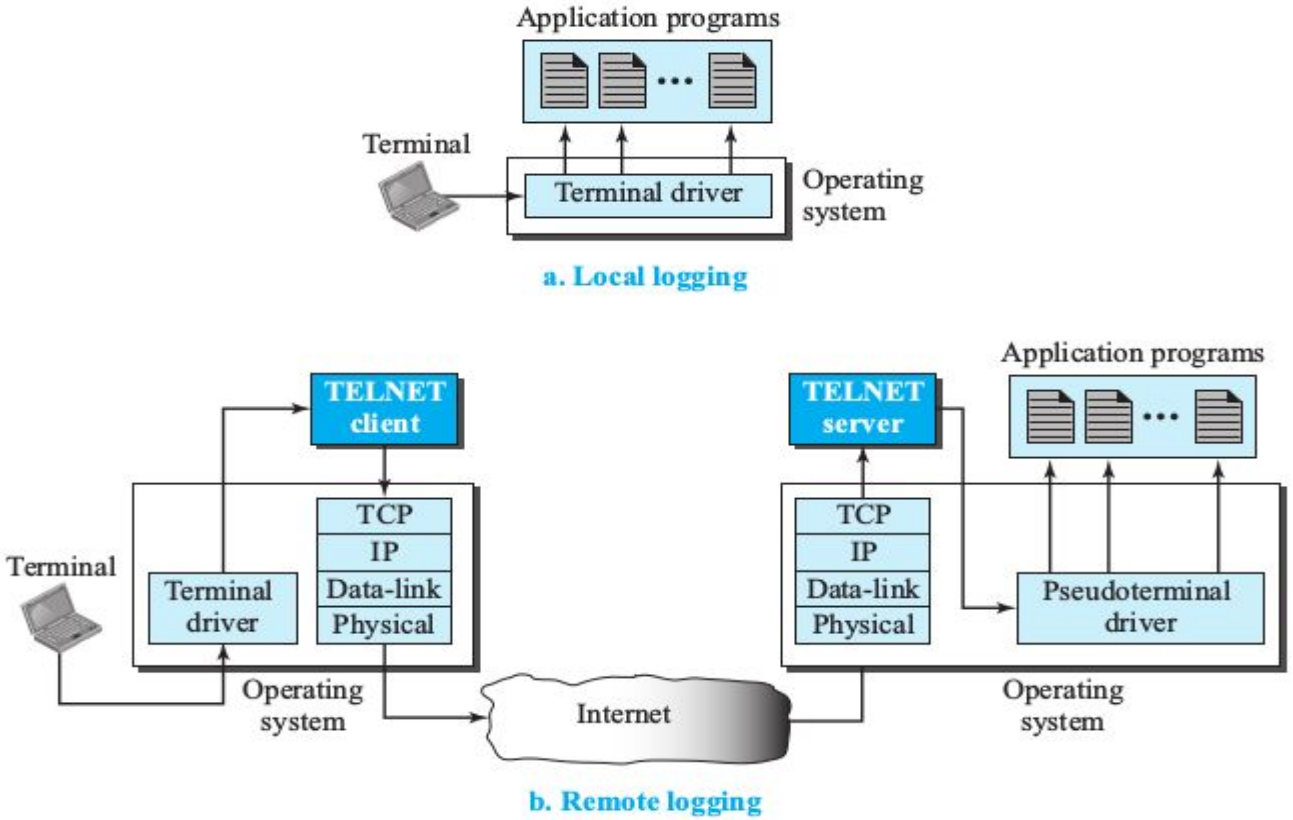
- TELNET
- SSH

TELNET : TErminaL NETwork

- Allows Remote logging
- Original protocol for remote login
- But now replaced by SSH (not fully)
- Problem : no encryption of data

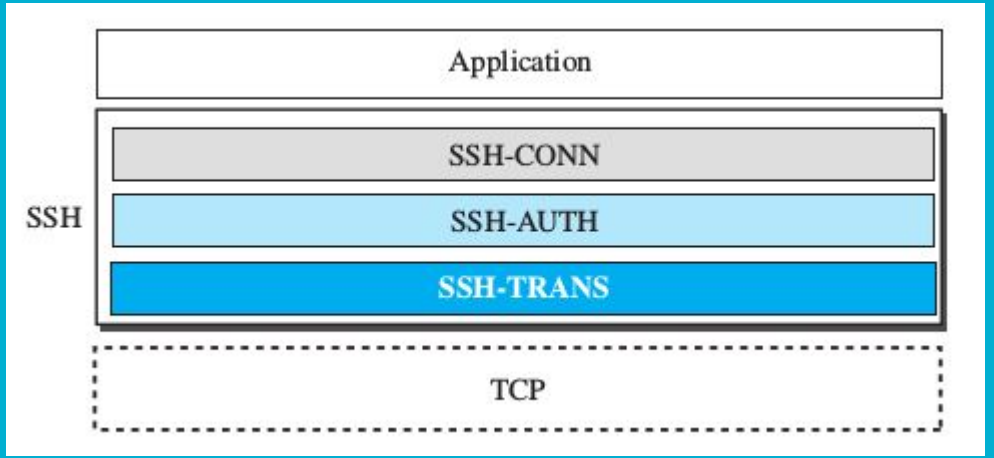


TELNET: Working



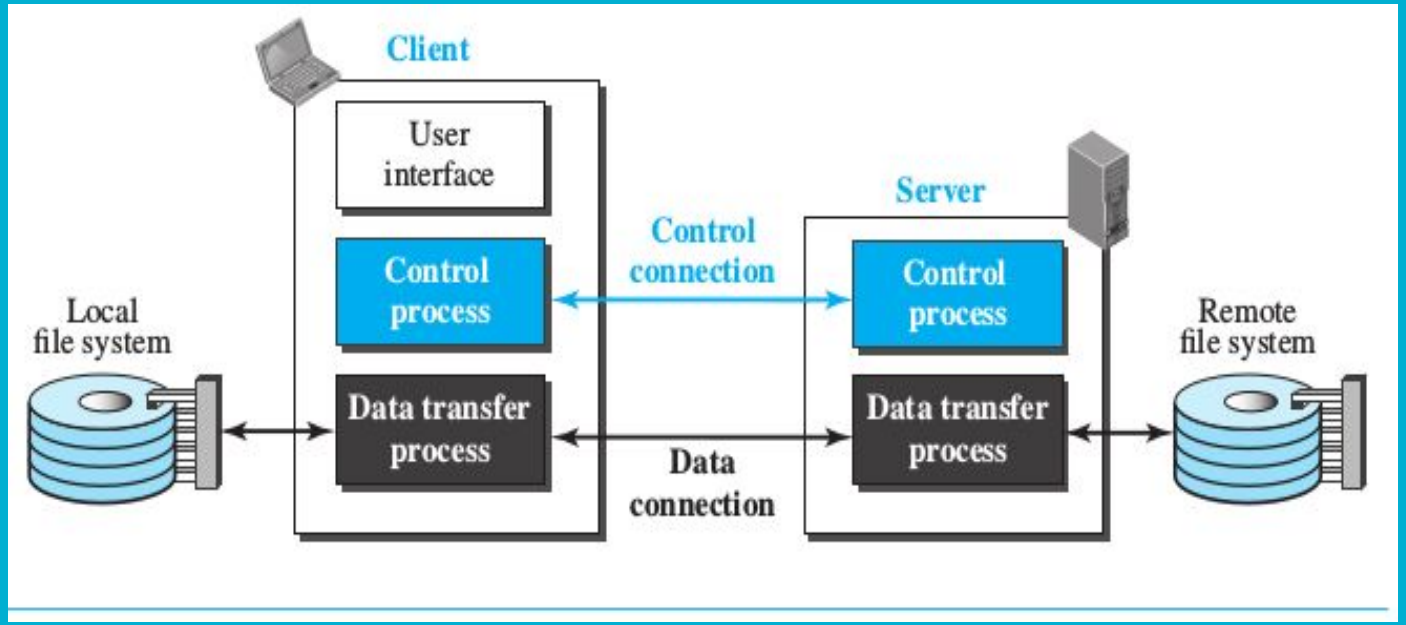
SSH: Secure Shell

- It is a secure application layer protocol
- It has three main components:
  - SSH Transport Layer Protocol
  - SSH Authentication Protocol
  - SSH Connection Protocol
- Applications :
  - Remote logging
  - Port Forwarding



FILE TRANSFER PROTOCOL

- File Transfer means copying, retrieving or directory listing.
- Major concern is Heterogeneity : file type, file system, data representation
- It has three major components :
  - User Interface
  - Control Process
  - Data Transfer Process


Client
User interface
Control process
Data transfer process
Server
Control process
Data transfer process
Control connection
Data connection
Local file system
Remote file system