MODULE 5
Application Layer

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Application Layer

Human Computer Interaction Layer

- Enables any type of user to access network with ease.
- It provides protocols that allow software to send and receive information and present meaningful data to users.
- One widely-used application Layer protocol is HTTP

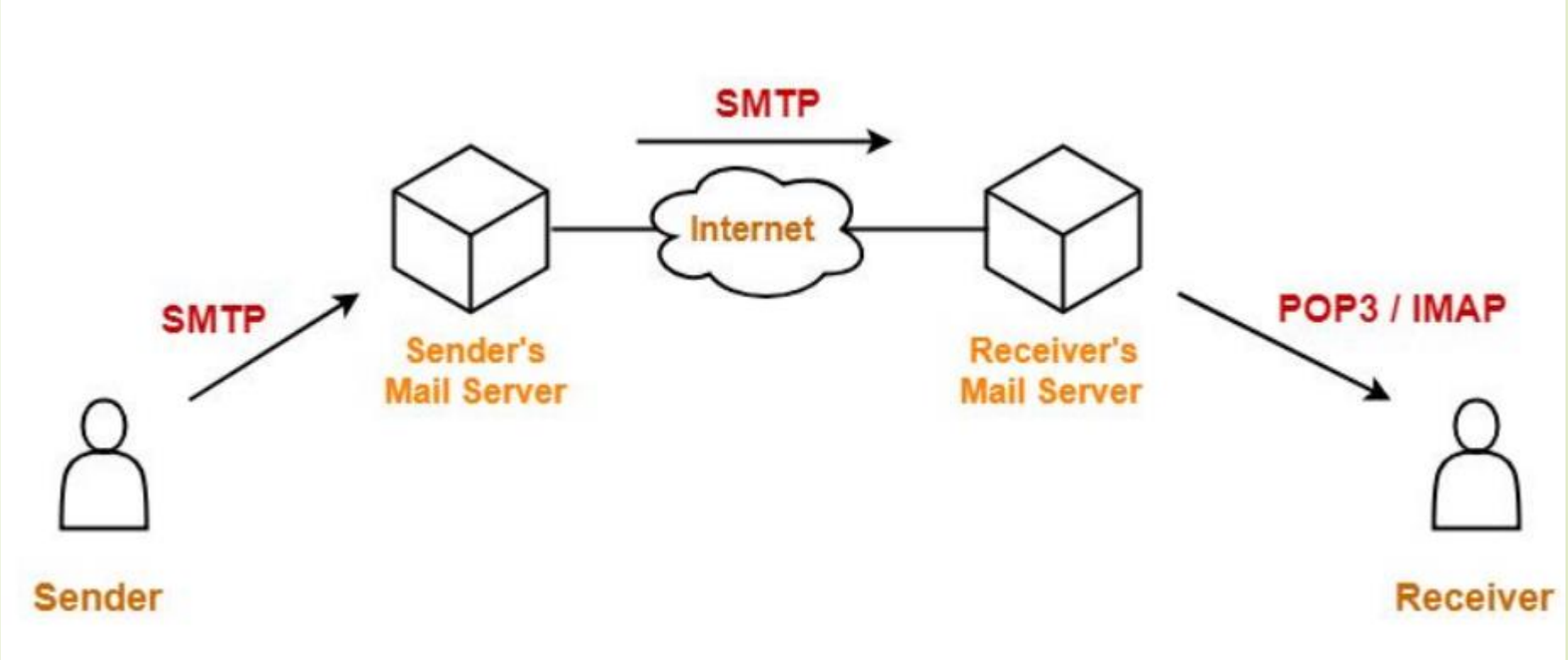
Application Layer Functions

1. Mail Services
2. Network Virtual Terminal
3. Directory Services
4. File Transfer, Access and Management

SMTP

- SMTP mainly stands for Simple Mail Transfer Protocol.
- The actual transfer of mail is done through the **message transfer agents(MTA).** Thus in order to send the mail, the system must have the **client MTA** and in order to receive the mail, the system must have a **server MTA**. In order to define the MTA client and server on the Internet, there is a formal way and it is known as Simple Mail Transfer Protocol(SMTP).
- SMTP is based on the client/server model uses ASCII encoding
- The original standard port for SMTP is **Port 25.**

- The client who wants to send the e-mail first opens a TCP connection to the SMTP server and then sends the e-mail across the TCP connection.
- It is important to note that the SMTP server is always in listening mode. As soon as it listens for the TCP connection from any client then the connection is initiated on port 25 and after the successful connection, the client sends the e-mail/message immediately.


SMTP
Internet
SMTP
Sender's
Mail Server
Receiver's
Mail Server
POP3 / IMAP
Sender
Receiver

Working of SMTP (IMP)

- Initially, the client establishes a reliable stream connection to the server and waits for the server to send a 220 READY FOR MAIL message.Upon receipt of the 220 message, the client sends a HELLO command. The server responds by identifying itself.
- Once communication has been established, the sender can transmit one or more mail messages, terminate the connection, or request the server to exchange the roles of sender and receiver so messages can flow in the opposite direction.
- The receiver must acknowledge each message. It can also abort the entire con- nection or abort the current message transfer.
- Mail transactions begin with a MAIL command that gives the sender identification as well as a FROM: field that contains the address to which errors should be reported.Response 250 means that all is well.

- After a successful MAIL command, the sender issues a series of RCPT commands that identilfy recipients of the mail message. The receiver must acknowledge each RCPT command by sending 250 OK or by sending the error message 550 No such user here.
- After all RCPT commands have been acknowledged, the sender issues a DATA command. In essence, a DATA command informs the receiver that the sender is ready to transfer a complete mail message.
- The receiver responds with message 354 Start mail input and specifies the sequence of characters used to terminate the mail message. The termination sequence consists of 5 characters: carriage return, line feed, period, carriage return, and line feed.

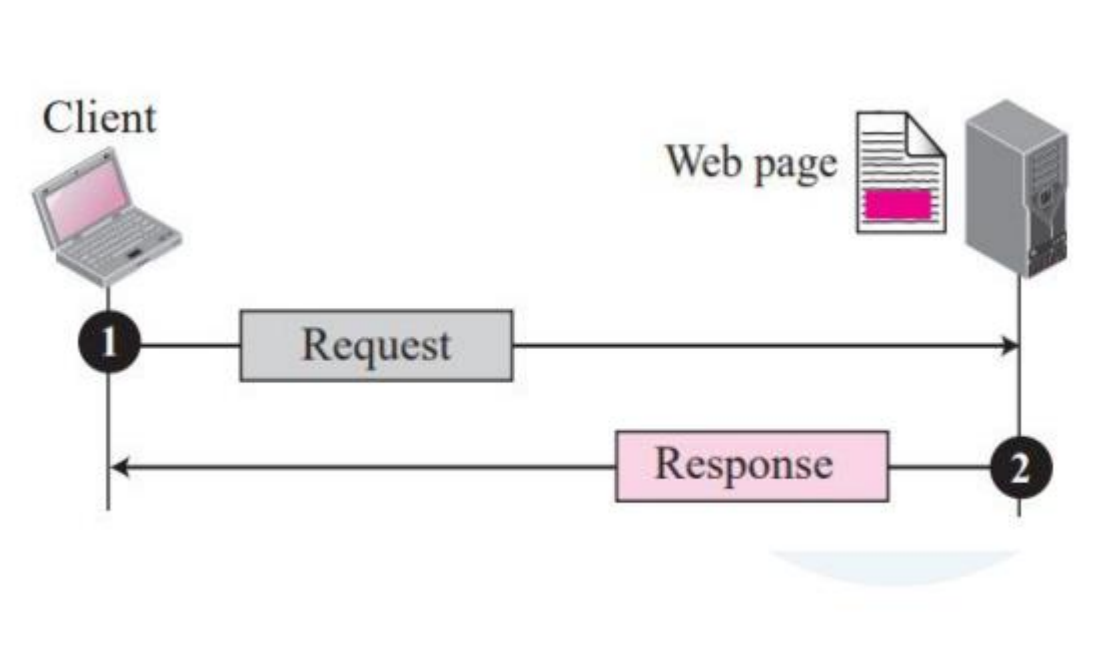
Characteristics of SMTP

- SMTP makes use of Port 25.
- It makes use of persistent TCP connections and thus can send multiple emails all at once (connection-oriented protocol)
- It is a push control protocol : SMTP is also known as PUSH protocol. POP3 is also known as POP protocol.
- Stateless protocol

HTTP -Hyper Text Transfer Protocol

- The Hypertext Transfer Protocol (HTTP) is a Application layer protocol used mainly to access data on the World Wide Web.
- Unlike SMTP, the HTTP messages are not destined to be read by humans; they are read and interpreted by the HTTP server and HTTP client (browser).
- SMTP messages are stored and forwarded, but HTTP messages are delivered immediately.
- The commands from the client to the server are embedded in a request message. The contents of the requested file or other information are embedded in a response message.
- HTTP uses the services of TCP on well-known port 80.

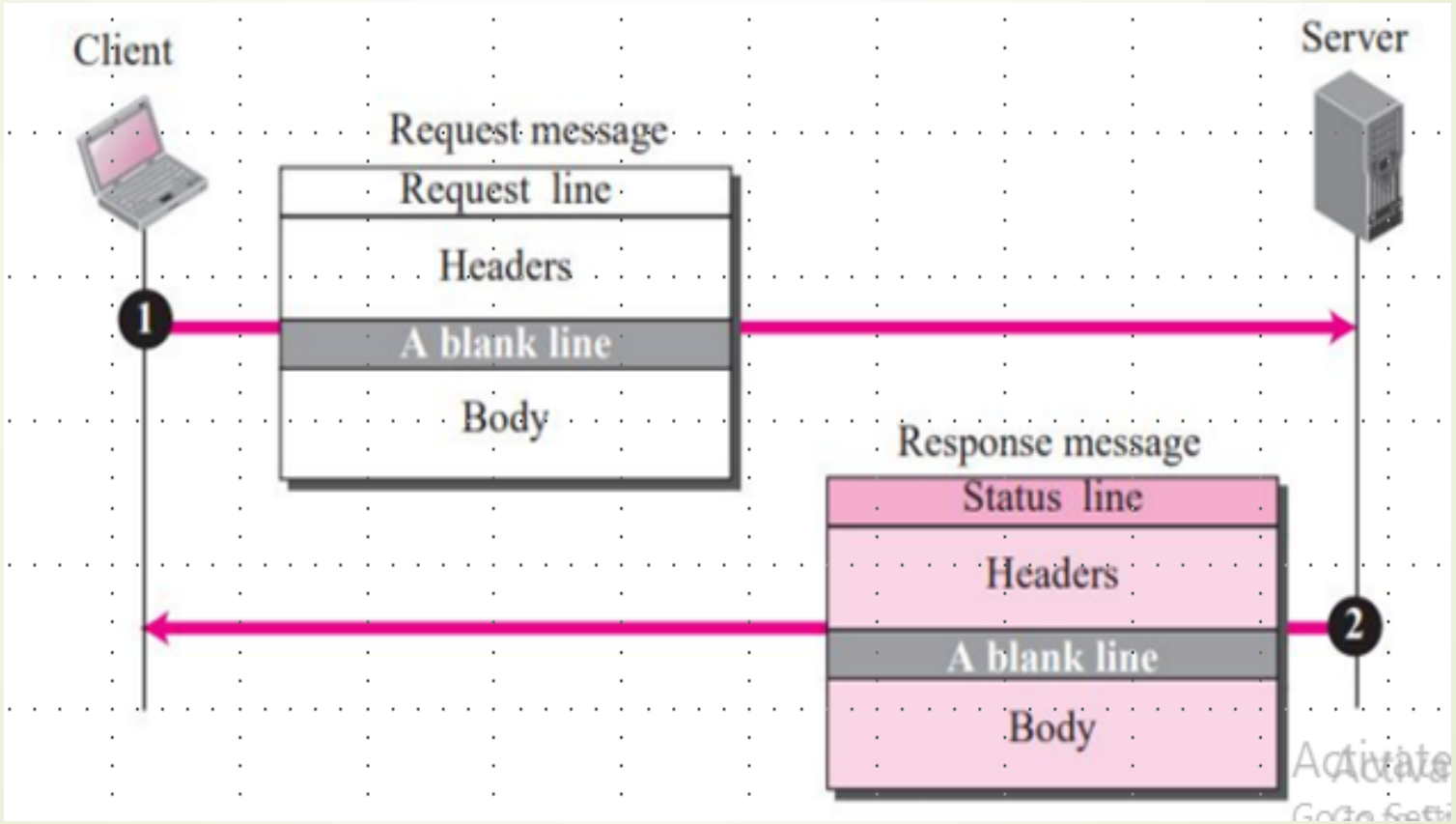
HTTP



HTTP has the following set of characteristics:

- **Application Layer.** HTTP operates at the application layer. It assumes a reliable, connection-oriented transport protocol such as TCP, but does not provide reliability or retransmission itself.
- **Request / Response**. Once a transport session has been established, one side (usually a browser) must send an HTTP request to which the other side responds.
- **Stateless.** Each HTTP request is self-contained; the server does not keep a history of previous requests or previous sessions
- **Bi-Directional Transfer.** In most cases, a browser requests a web page, and the server transfers a copy to the browser. HTTP also allows transfer from a browser to a server (e.g., when a user supplies data).

- **Capability Negotiation.** HTTP allows browsers and servers to negotiate details such as the character set to be used during transfers. A sender can specify the capabilities it offers, and a receiver can specify the capabilities it accepts.
- **Support For Caching**. To improve response time, a browser caches a copy of each web page it retrieves. If a user requests a page again, the browser can interrogate the server to determine whether the contents of the page has changed since the copy was cached.
- **Support For Intermediaries.** HTTP allows a machine along the path between a browser and a server to act as a proxy server that caches web pages and answers a browser's request from its cache.


Client
Server
Request message
Request line
Headers
A blank line
Body
1
Response message
Status line
Headers
A blank line
Body
2

Request Message

A request message consists of

- Request line
- Header
- body.

1. Request Line :

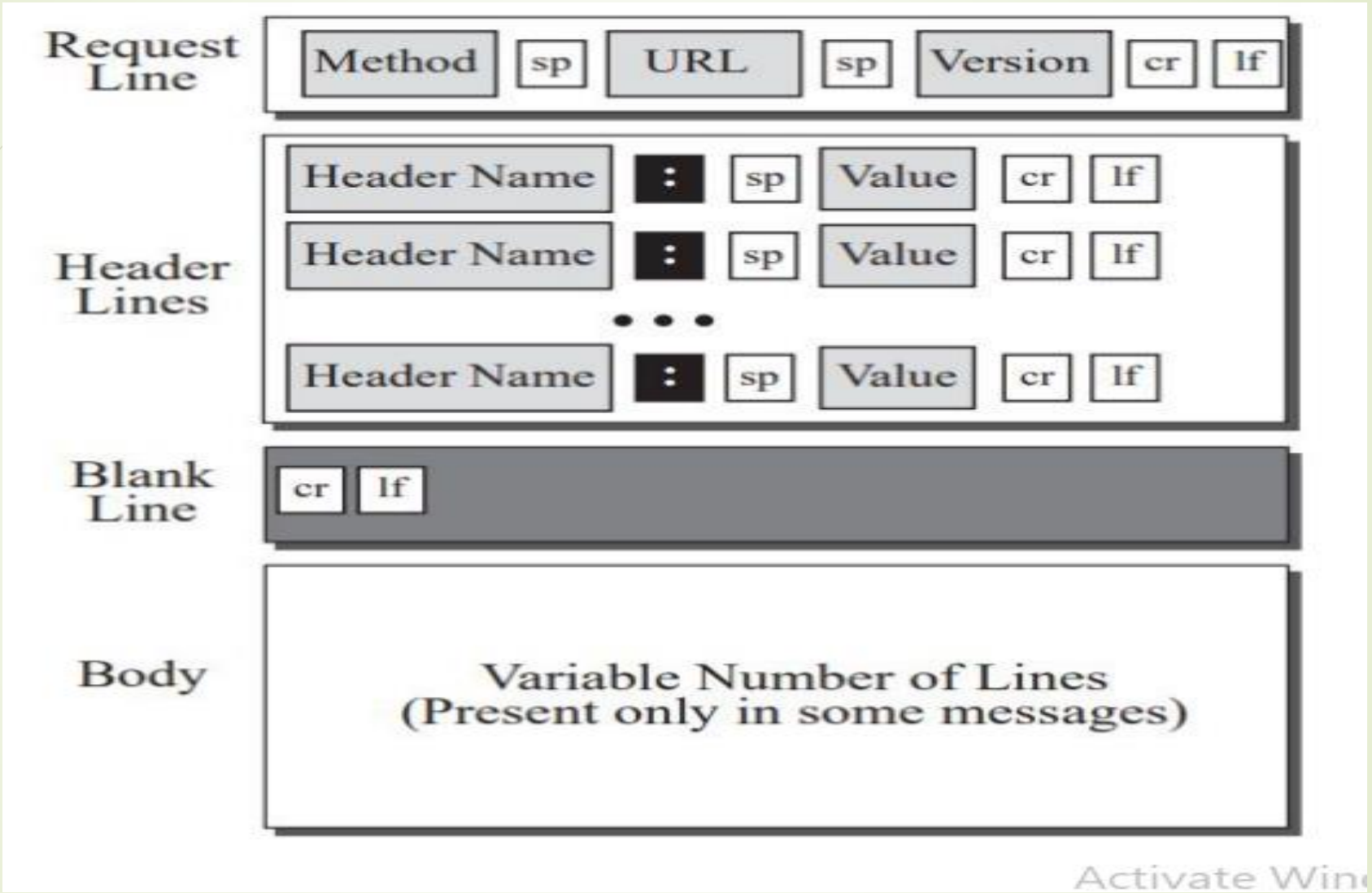
● These three should be separated by a space character. At the end two characters, a **carriage return** followed by a **line feed** terminate the line

- **HTTP METHODS** : HTTP request methods specify the action to perform through the request.
- The **URL** typically functions as a name for the resource being requested
- The **HTTP version** being used The only HTTP versions in common use on the Internet are 1.0 and 1.1, and most browsers use version 1.1 by default.

- 2. Header Line :

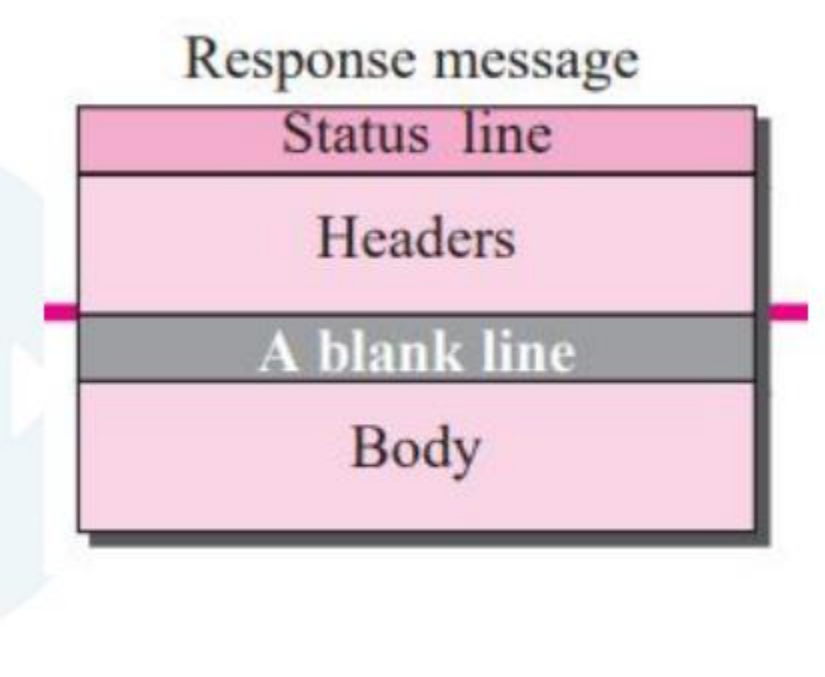
- After the request line, we can have zero or more request header lines.

- 3.Body In Request Message :
- The body can be present in a request message. Usually, it contains the comment to be sent.


Request Line
Method
sp
URL
sp
Version
cr
lf
Header Lines
Header Name
:
sp
Value
cr
lf
Header Name
:
sp
Value
cr
lf
Header Name
:
sp
Value
cr
lf
Blank Line
cr
lf
Body
Variable Number of Lines
(Present only in some messages)

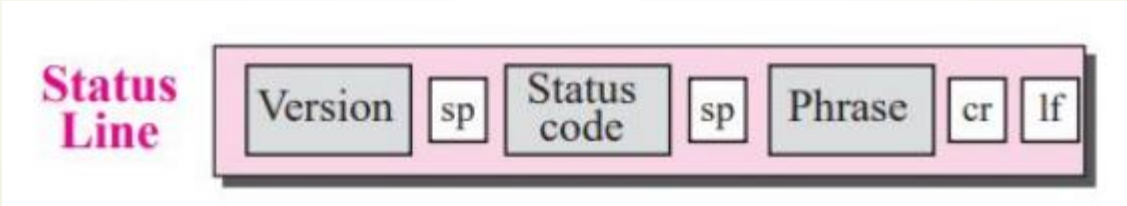
Response Message A response message consists of

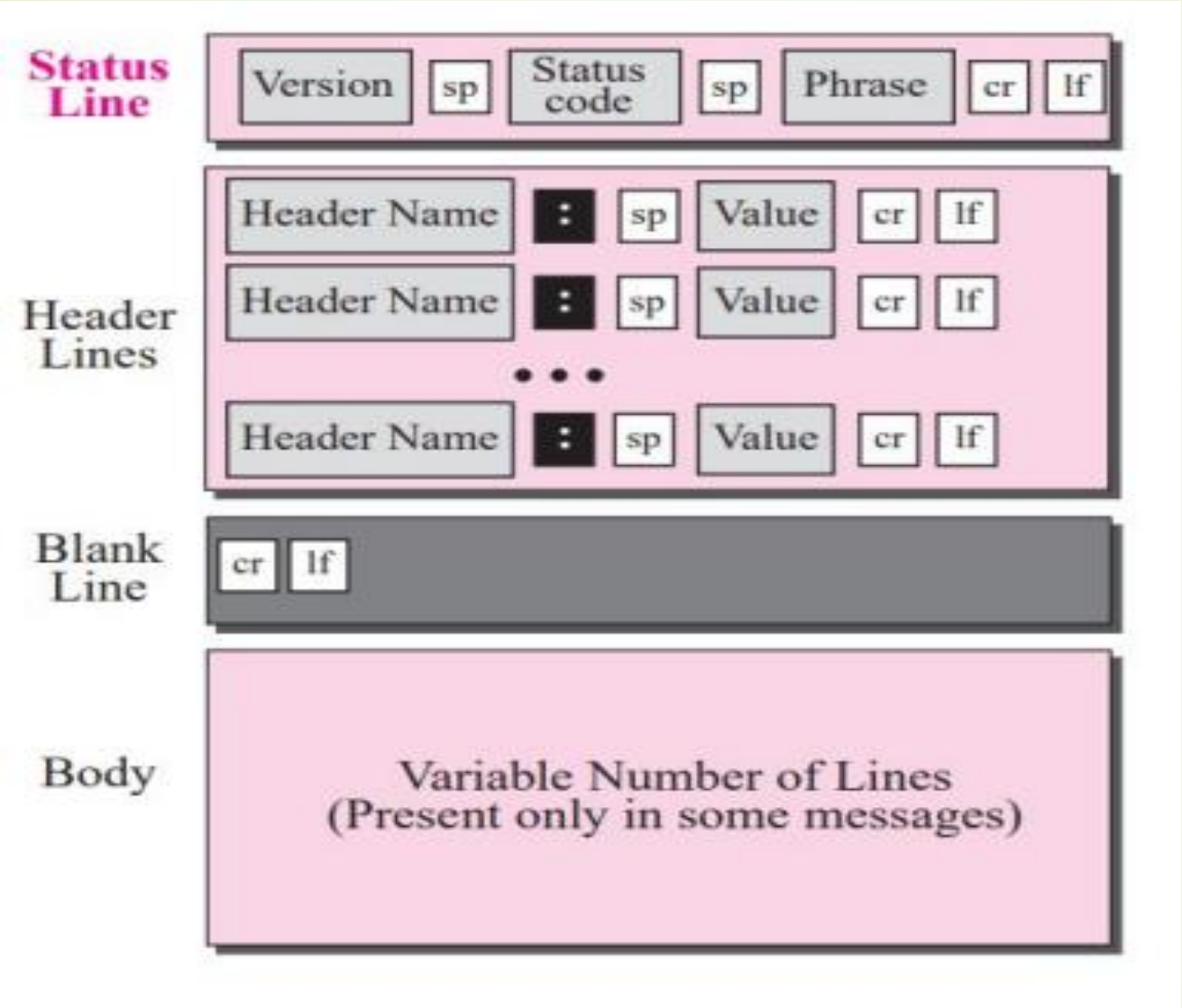
- 1. Status line 2. Header lines 3. body



1.The Status line

- Status Line of every HTTP response consists of three items, separated by spaces:
  - The HTTP version being used.
  - A numeric status code indicating the result of the request.
  - A textual "reason phrase" further describing the status of the response. This can have any value and is not used for any purpose by current browsers.




Status Line
Version
sp
Status code
sp
Phrase
cr
lf
Header Lines
Header Name
:
sp
Value
cr
lf
Header Name
:
sp
Value
cr
lf
Header Name
:
sp
Value
cr
lf
Blank Line
cr
lf
Body
Variable Number of Lines
(Present only in some messages)

Persistence

HTTP, prior to version 1.1, specified a nonpersistent connection, while a persistent connection is the default in version 1.1.

- **a. Nonpersistent Connection**:

In a nonpersistent connection, one TCP connection is made for each request/response. The following lists the steps in this strategy:

1. The client opens a TCP connection and sends a request.
2. 2. The server sends the response and closes the connection.
3. 3. The client reads the data until it encounters an end-of-file marker; it then closes the connection

- **b. Persistent Connection**

● HTTP version 1.1 specifies a persistent connection by default. In a persistent connection, the server leaves the connection open for more requests after sending a response.

● The server can close the connection at the request of a client or if a time-out has been reached.

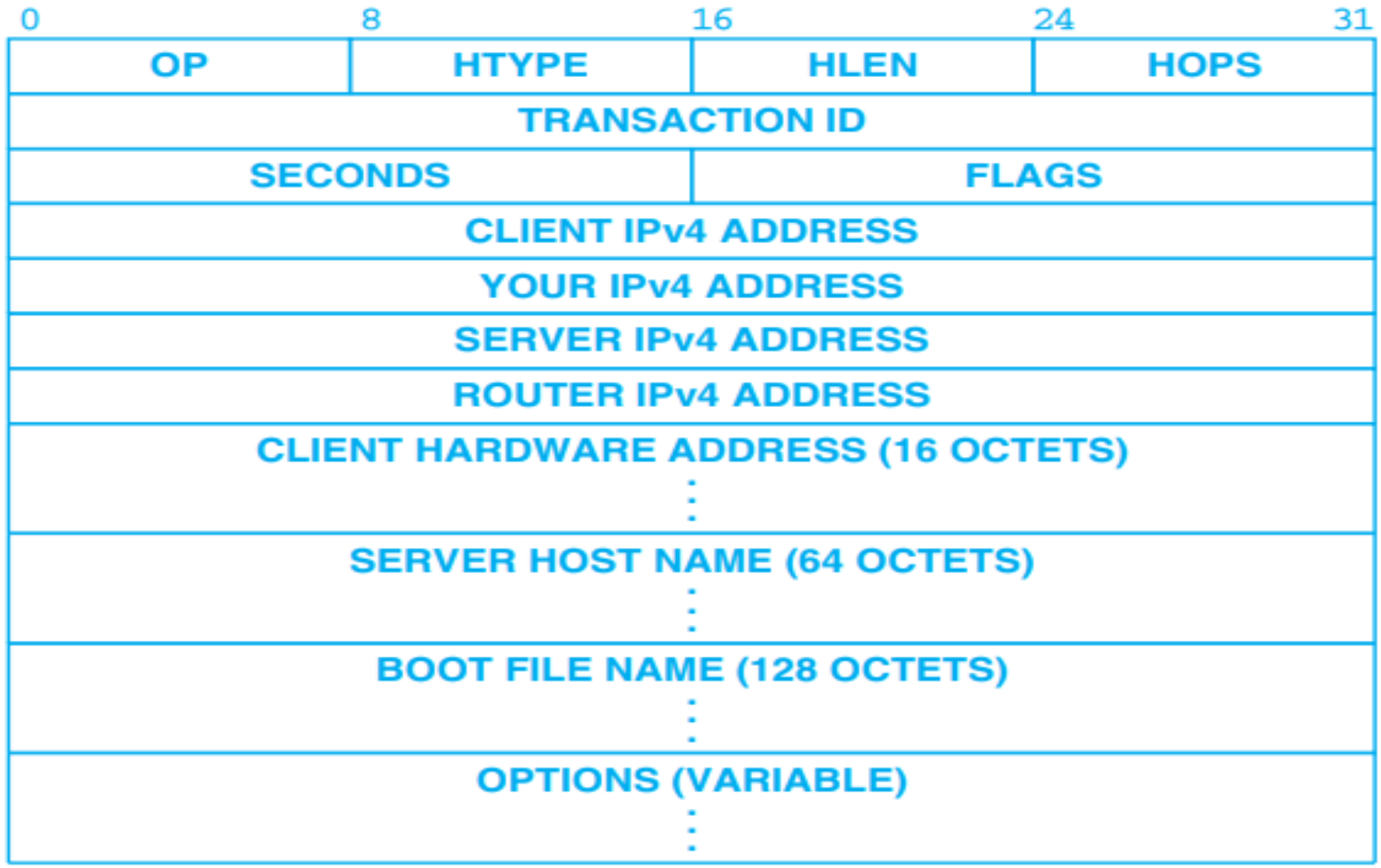
Cookies:

Cookie allow sites to keep track of users. Most major commercial Web sites use cookies today.

- cookie technology has four components:
- (1) a cookie header line in the HTTP response message;
- (2) a cookie header line in the HTTP request message;
- (3) a cookie file kept on the user's end system and managed by the user's browser; and
- (4) a back-end database at the Web site.

DHCP(Dynamic Host Configuration Protocol)

- The DHCP **port number** for the **server is 67** and for the **client is 68.**
- DHCP stands for Dynamic Host Configuration Protocol. It is the critical feature on which the users of an enterprise network communicate. DHCP helps enterprises to smoothly manage the allocation of IP addresses to the end-user clients' devices such as desktops, laptops, cellphones, etc. is an application layer protocol that is used to provide


0
8
16
24
31
OP
HTYPE
HLEN
HOPS
TRANSACTION ID
SECONDS
FLAGS
CLIENT IPv4 ADDRESS
YOUR IPv4 ADDRESS
SERVER IPv4 ADDRESS
ROUTER IPv4 ADDRESS
CLIENT HARDWARE ADDRESS (16 OCTETS)
SERVER HOST NAME (64 OCTETS)
BOOT FILE NAME (128 OCTETS)
OPTIONS (VARIABLE)

- Field OP specifies whether the message is a request (1) or a reply (2).
- HTYPE and HLEN specify the network hardware type and length of the hardware address (e.g., Ethernet has type 1 and address length 6)†.
- The client places 0 in the HOPS field. If it receives the request and decides to pass the request on to another machine (e.g., to allow bootstrapping across multiple routers), the DHCP server increments the HOPS count
- The TRANSACTION ID field contains an integer that clients use to match responses with requests.
- The SECONDS field reports the number of seconds since the client started to boot.

- DHCP Options And Message Type

TYPE FIELD	Corresponding DHCP Message Type
1	DHCPDISCOVER
2	DHCPOFFER
3	DHCPREQUEST
4	DHCPDECLINE
5	DHCPACK
6	DHCPNACK
7	DHCPRELEASE
8	DHCPINFORM