Computer Networks
Chapter 2.2

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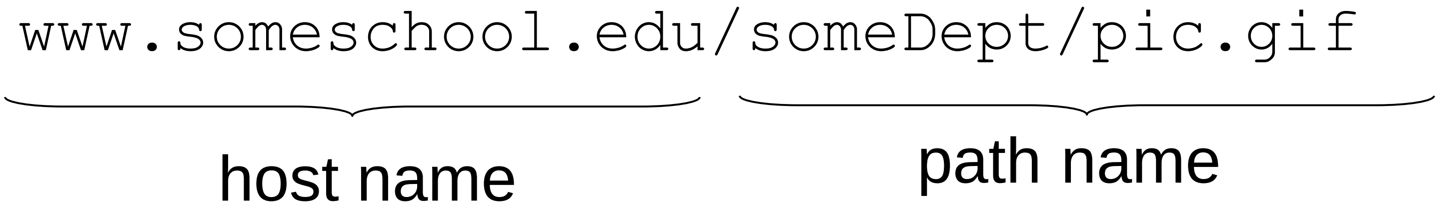
Chapter 2: Application layer

- ❒ 2.1 Principles of network applications
- ❒ 2.2 Web and HTTP
- ❒ 2.3 Electronic Mail (SMTP, POP3, IMAP)
- ❒ 2.4 DNS
- ❒ 2.5 P2P applications
- ❒ 2.6 Video streaming and content distribution networks (CDNs)
- ❒ 2.7 Socket programming with TCP and UDP

Web and HTTP

- *web page* consists of *objects*
  - object can be HTML file, JPEG image, Java applet, audio file,…
- web page consists of *base HTML-file* which includes *several referenced objects*
  - Hypertext/hypermedia system: information is organized as a set of documents (objects)
  - Each object is addressed by a uniform resource locator (URL)



```
www.someschool.edu/someDept/pic.gif
```

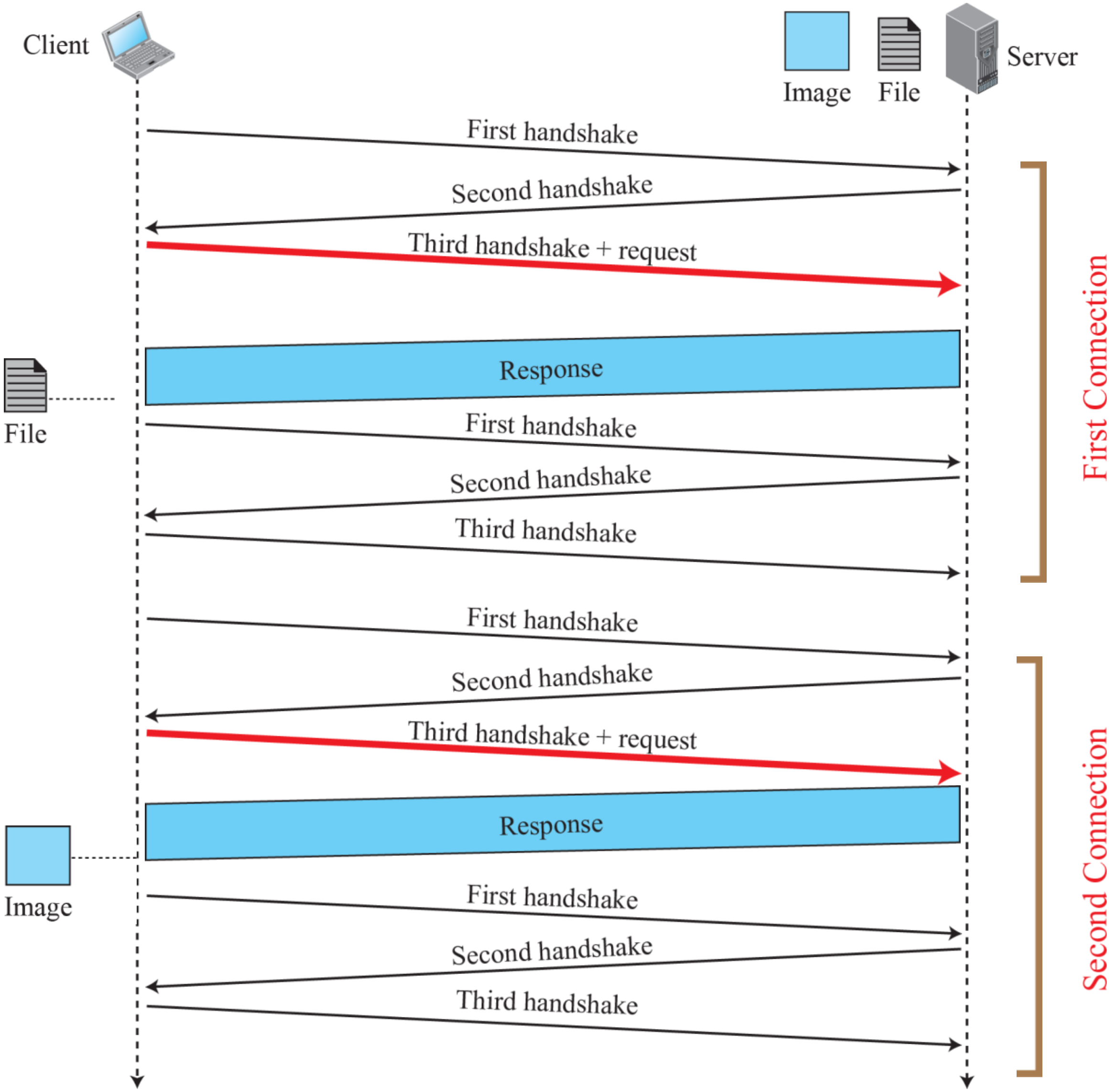
HyperText Transfer Protocol overview

- Web's application layer protocol
  - Defines how Web clients request pages from Web servers and how servers transfer Web pages to clients
- Client/Server model
  - *client:* browser that , receives, (using HTTP protocol) and "displays" Web objects
  - *server:* Web server sends (using HTTP protocol) objects in
- HTTP is
  - The server maintains no information of previous requests from the same client
- HTTP uses TCP as its underlying transport protocol.
- The port number for HTTP is .
- HTTP-TCP connection can be non-persistent or persistent
- HTTP 1.0: RFC 1945, HTTP 1.1: RFC 2068 (in 1998)
- HTTP 2.0: RFC 7540 (2015)

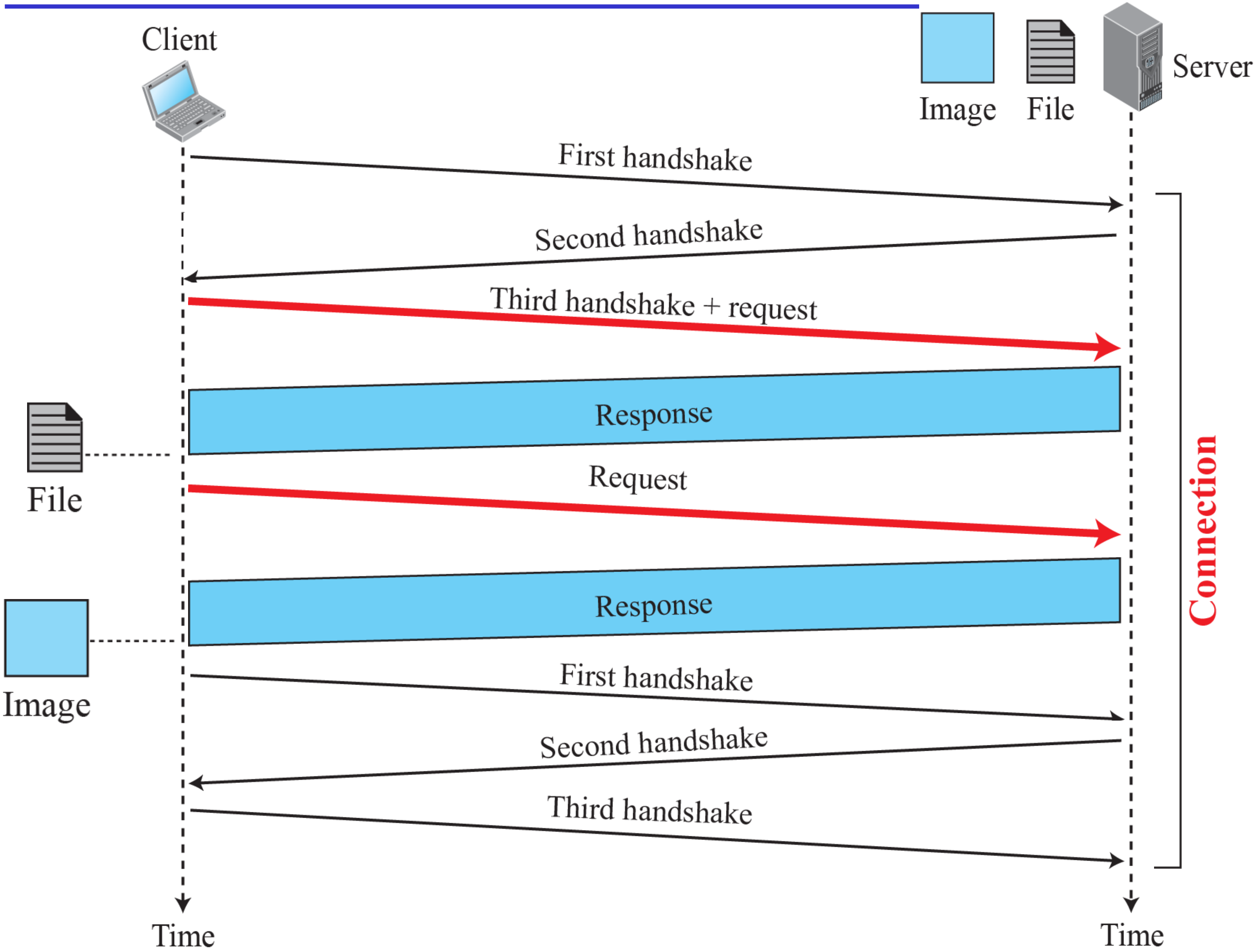
HTTP connections

- HTTP
  - At most one object is sent over a TCP connection.
  - HTTP/1.0 uses non-persistent
  - but browsers often open parallel TCP connections to fetch referenced objects
- HTTP
  - Multiple objects can be sent over single TCP connection between client and server.
    - server leaves connection open after sending response
    - subsequent HTTP messages between the same client/server are sent over the same connection
  - HTTP/1.1 uses persistent connections in default mode

Non-Persistent HTTP connections



Persistent HTTP connections

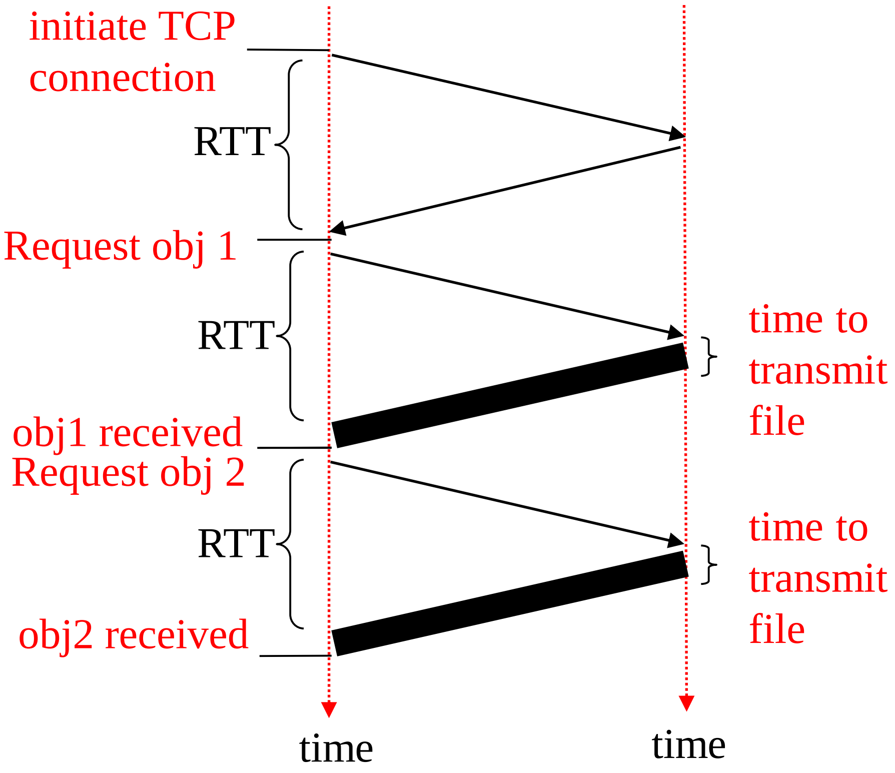


Persistent HTTP connections

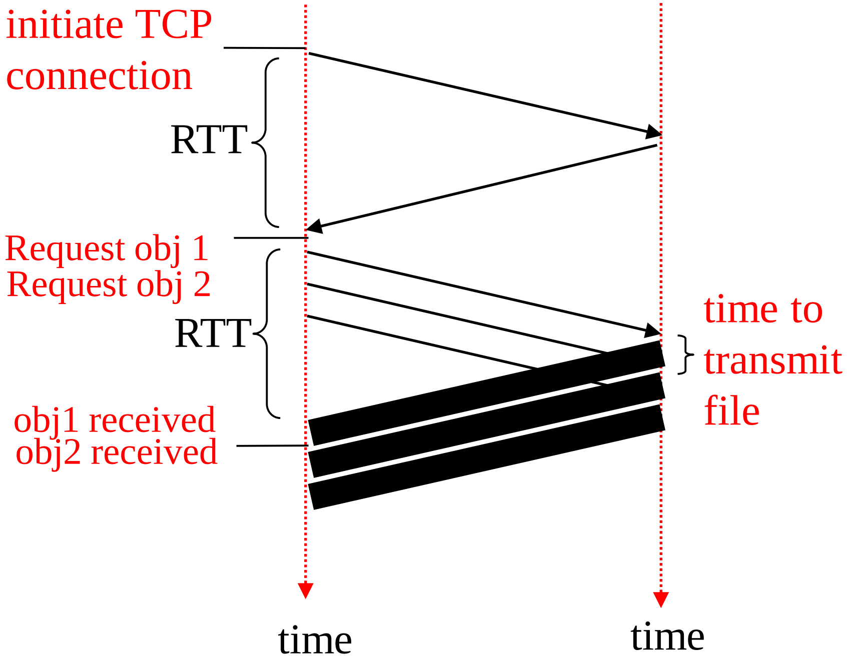
- Persistent without pipelining
  - client issues new request only when previous response has been received
  - one RTT for each referenced object
- Persistent with pipelining
  - default in HTTP/1.1 (maybe not…)
  - client sends requests as soon as it encounters a referenced object
  - as little as one RTT for all the referenced objects

Persistent HTTP connections

Without pipelining

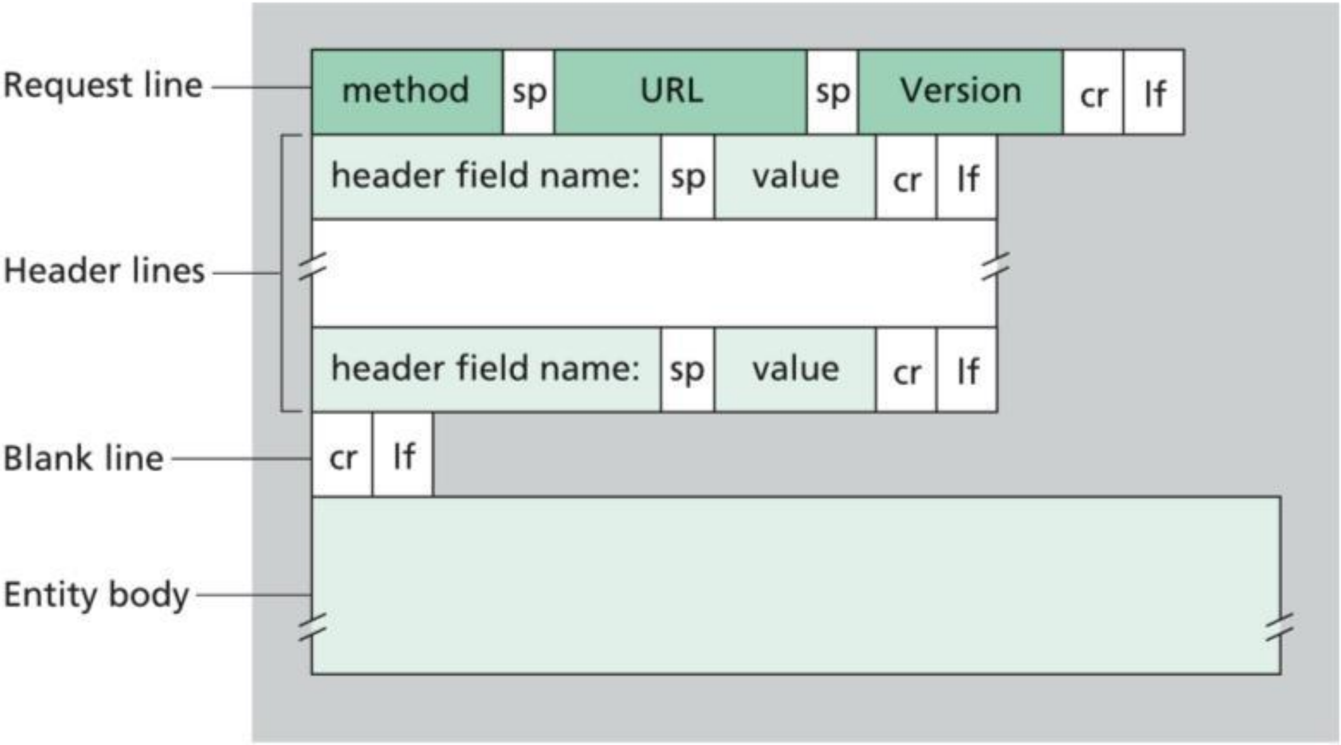


With pipelining



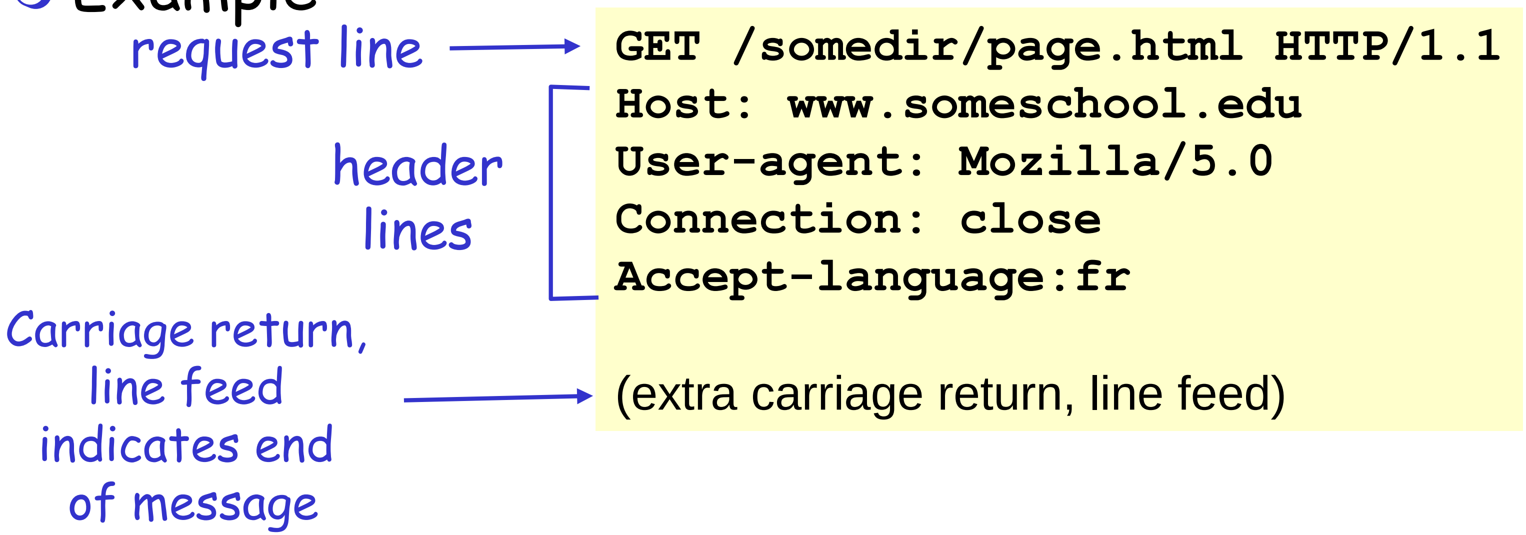
HTTP Message

- two types of HTTP messages: *request, response*
- General format of Request message



HTTP Request Message

- HTTP request message:
  - ASCII (human-readable format)
  - Example



request line

header lines

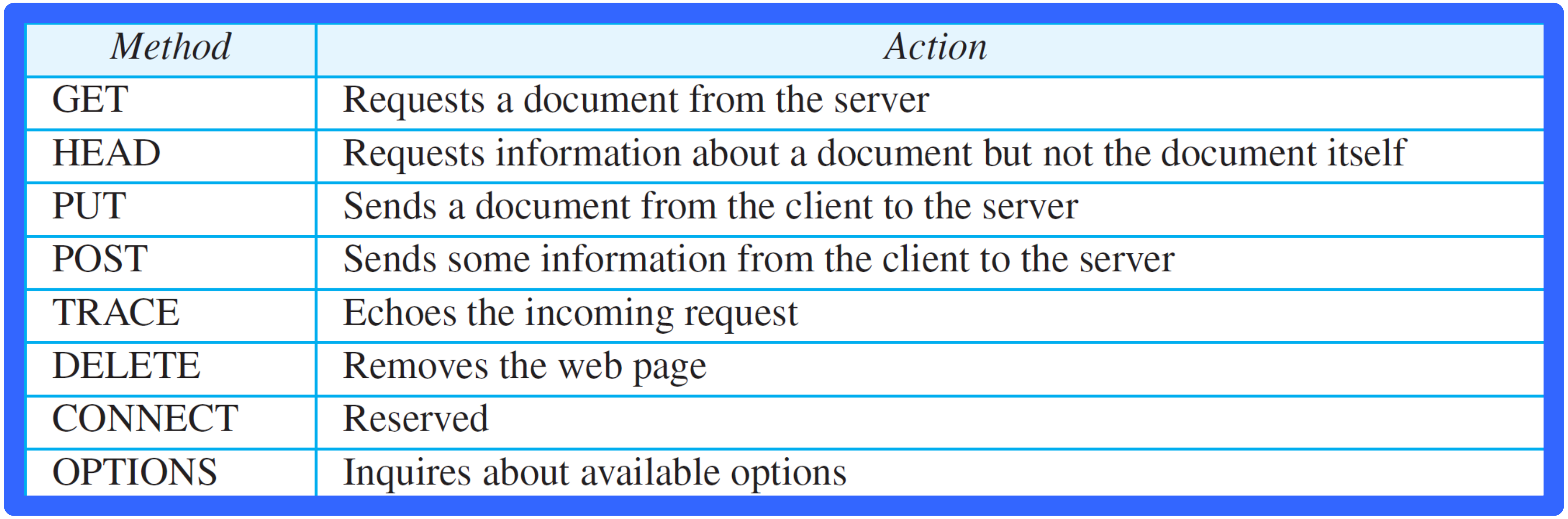
Carriage return, line feed indicates end of message

```
GET /somedir/page.html HTTP/1.1
Host: www.someschool.edu
User-agent: Mozilla/5.0
Connection: close
Accept-language:fr

(extra carriage return, line feed)
```

HTTP Request Message

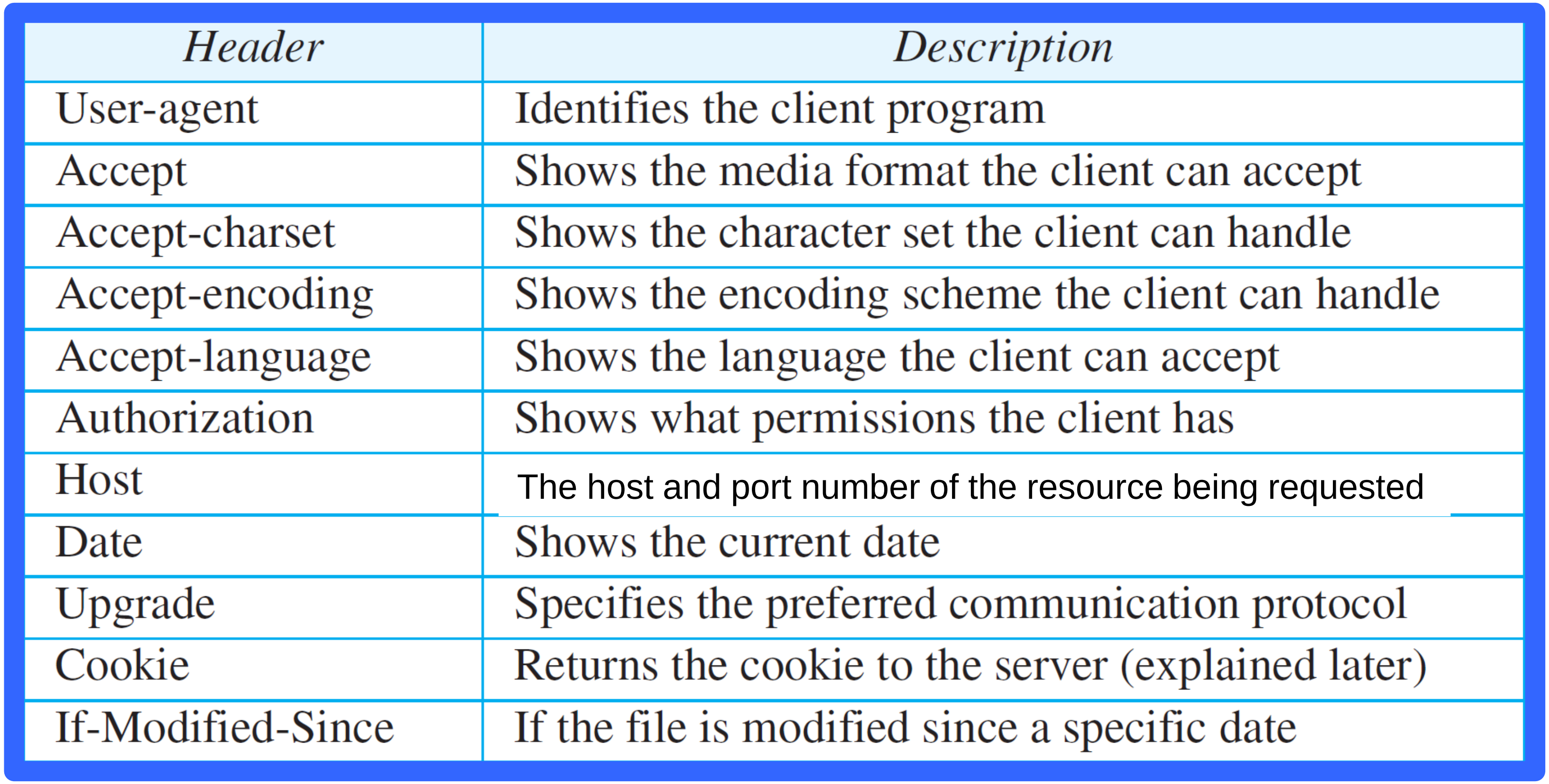
- Methods of Request line in a request message



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

HTTP Request Message

- Header names of Request line in a request message



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	The host and port number of the resource being requested
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

Uploading form of input

POST method:

- Web page often includes form input
- Input is uploaded to server in entity body

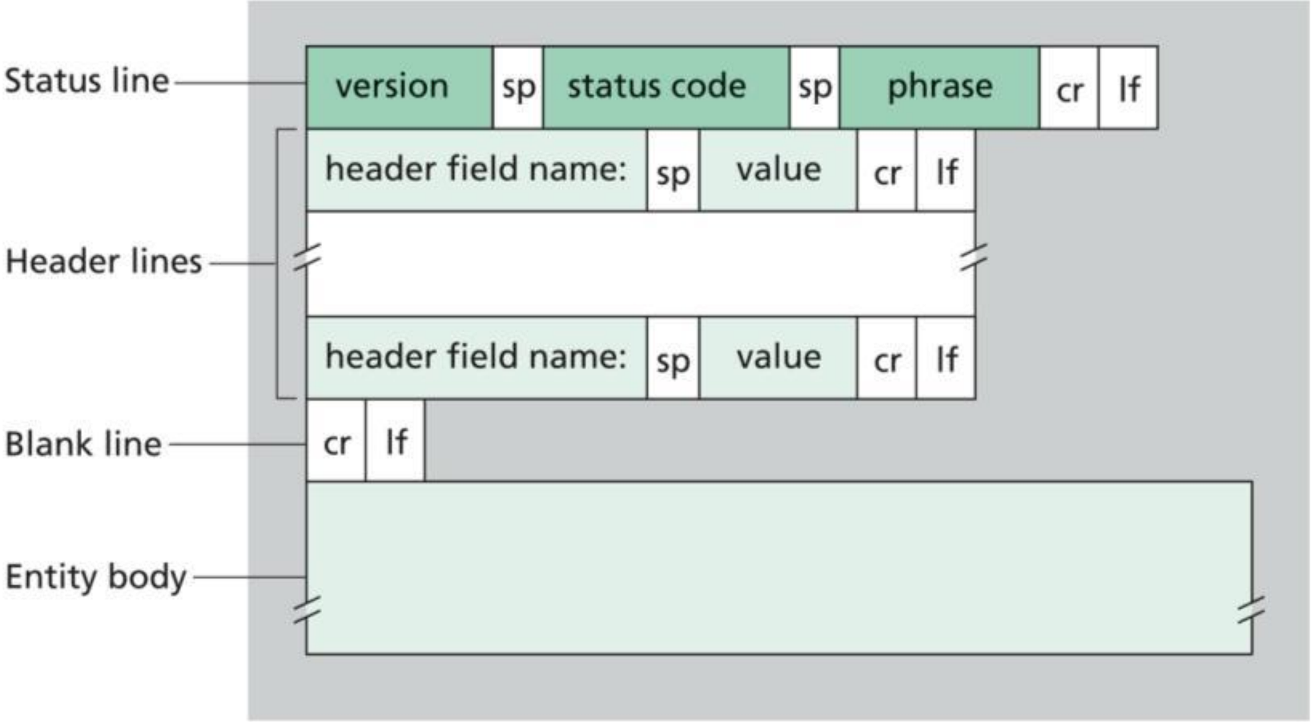
URL method:

- Uses GET method
- Input is uploaded in URL field of request line:

```
www.somesite.com/animalsearch?monkeys&banana
```

HTTP Response Message

- General format of Response message



HTTP Response Message

- Example

status line

header lines

```
HTTP/1.1 200 OK
Connection: close
Date: Thu, 06 Aug 1998 12:00:15 GMT
Server: Apache/1.3.0 (Unix)
Last-Modified: Mon, 22 Jun 1998 …...
Content-Length: 6821
Content-Type: text/html

data data data data data ...
```

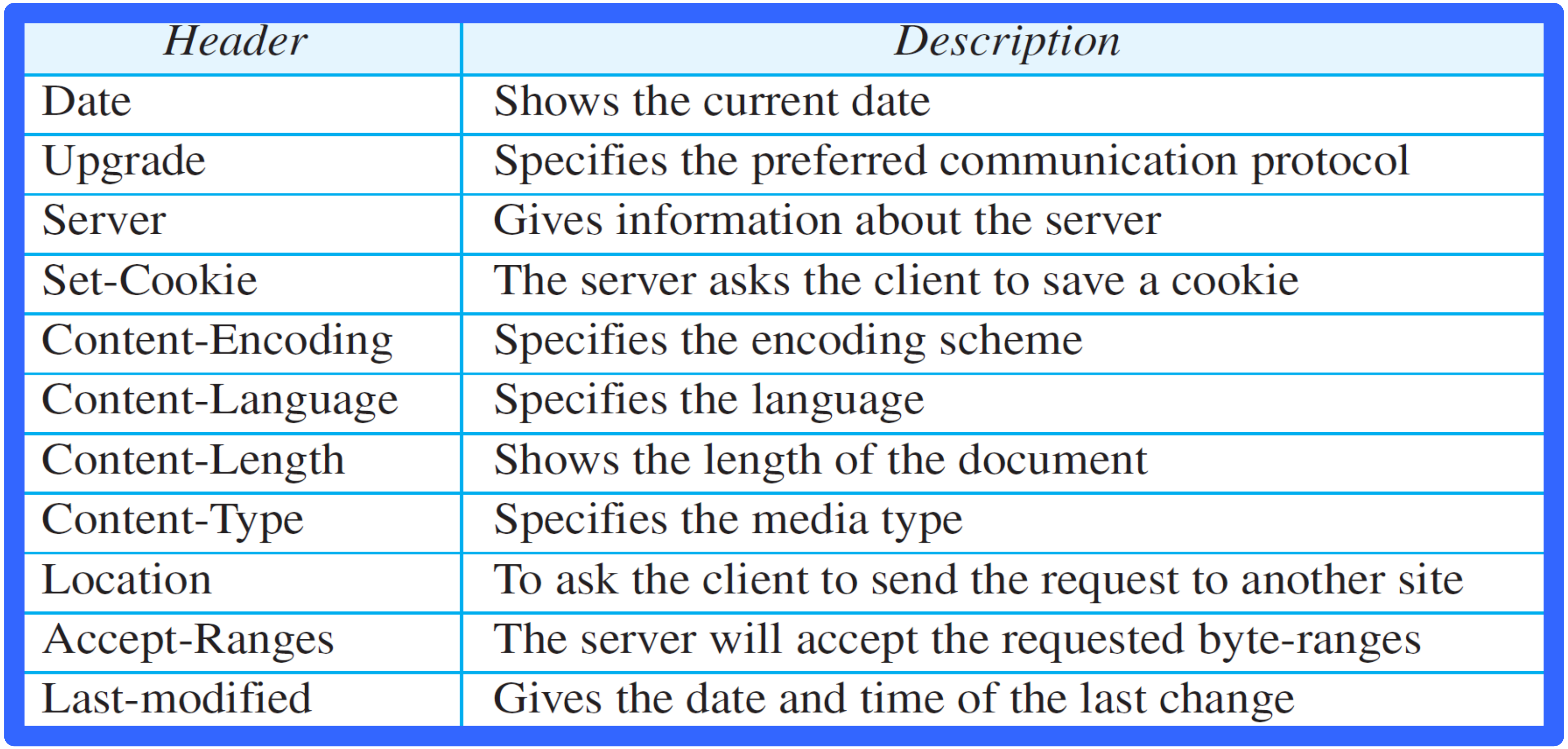
data, e.g., requested HTML file

HTTP Response Message

- Status code in Response Message
  - 3-digit integer that indicates the response to a received request
    - Status phrase gives short textual explanation of the status code
  - 200 OK: request succeeded, information returned
  - 301 Moved Permanently: requested object moved, new location specified later in this message (Location:)
  - 400 Bad Request: syntax error in request
  - 404 Not Found: requested document does not exist on this server
  - 505 Version Not Supported:

HTTP Response Message

- Header names in Response Message



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