# HTTP: Hypertext Transfer Protocol



Lecture 12

# HTTP



- Hypertext Transfer Protocol
- History
  - Early 90's: developed at CERN, Tim Berners-Lee
  - 1996: version 1.0
  - 1999: version 1.1 (ubiquitous today!)
  - 2015: version 2
    - Performance improvements: binary, server push…
    - Backwards compatible
  - 2022: version 3
    - Performance improvements, same semantics

    w3techs.com/technologies/overview/site_element
- Simple request/response (client/server)
  - Client sends request to (web) server
  - (Web) server responds
  - Protocol itself is stateless

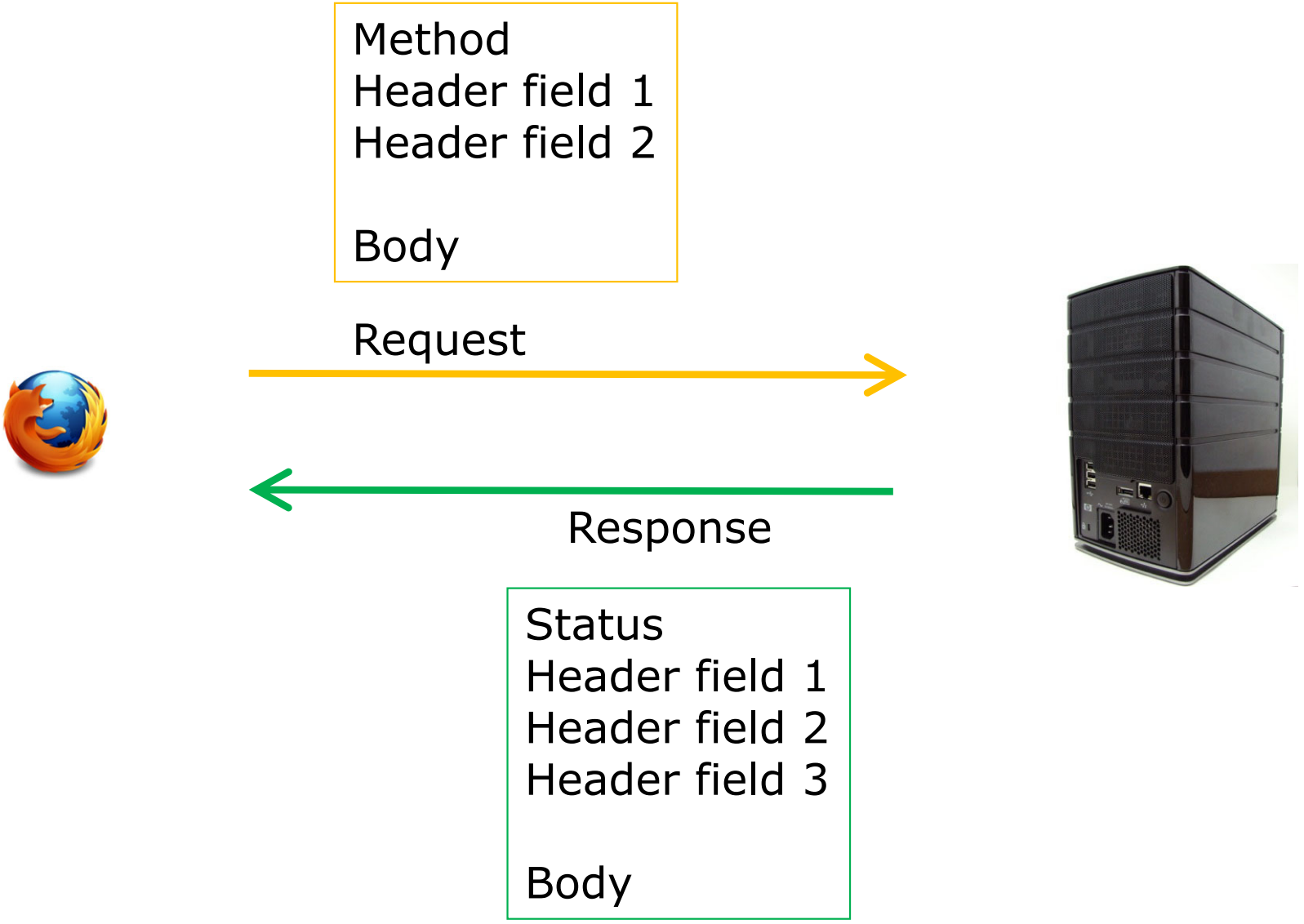
# Anatomy of a Request/Response



- An HTTP request/response consists of
  1. Method (request) / status (response)
  2. Header fields: meta information
  3. A blank line
  4. Body (sometimes): payload
- The header (parts 1-3) is ASCII text
  - Newline is CRLF (typical of IETF protocols)
  - Method/status is 1 line
  - Each header field is on its own line
  - Blank line separates header from body

# Protocol: Request, Response





# Request Header: Method



- Syntax of first line:

  ***verb path version***

  - Verb: **GET, HEAD, POST, PUT, DELETE,…**
  - Path: part of URL (path and query)

    **scheme://FQDN:port/path?query#fragment**
  - Version: **HTTP/1.1, HTTP/2, HTTP/3**
- Example:
  - For URL

    **http://www.osu.edu/academics#content**
  - First line of HTTP request is

    **GET /academics HTTP/1.1**

# Request Header: Header Fields



- Each field is on its own line:

  ***name*: *value***

- Examples

```
Host: cse.ohio-state.edu
Accept: text/*,image/apng
Accept-Language: en-US,en;q=0.9
If-Modified-Since: Sat, 12 May 2021
19:43:31 GMT
Content-Length: 349
User-Agent: Mozilla/5.0 (X11; Linux
x86_64) Chrome116.0.0.0 Safari/537.36
```

- Header names are case insensitive

# Some Common Header Fields



- Host
  - The only required field
  - Q: Why is host field even needed?
- Accept, Accept-Language, Accept-Encoding
  - List of browser preferences for response
  - MIME types, language locales, transfer encodings
  - Priority based on order and q-value weight (0-1)
- User-Agent
  - Identifies application making request
- If-Modified-Since
  - Send payload only if changed since date
  - Date must be GMT
- Content-Length
  - Required if request has a body
  - Number of bytes in body
- Referer (misspelled in spec)
  - Previous web page, ie source of this request

# "Nobody knows you're a dog"



```
GET / HTTP/1.1
Host: www.osu.edu
User-Agent: Mozilla/5.0 (X11; Ubuntu;…etc
```

Request

# "Nobody knows you're a dog"



```
$ telnet
```

```
GET / HTTP/1.1
Host: www.osu.edu
User-Agent: Mozilla/5.0 (X11; Ubuntu;…etc
```

Request

```
$ curl -A "Mozilla/5.0" http://www.osu.edu
```


```
require 'mechanize'
agent = Mechanize.new
page = agent.get 'http://www.osu.edu'
```

# Demo: HTTP Request with telnet



- Example URL
  - web.cse.ohio-state.edu/~sivilotti.1/
- At console

```
$ telnet web.cse.ohio-state.edu 80
```

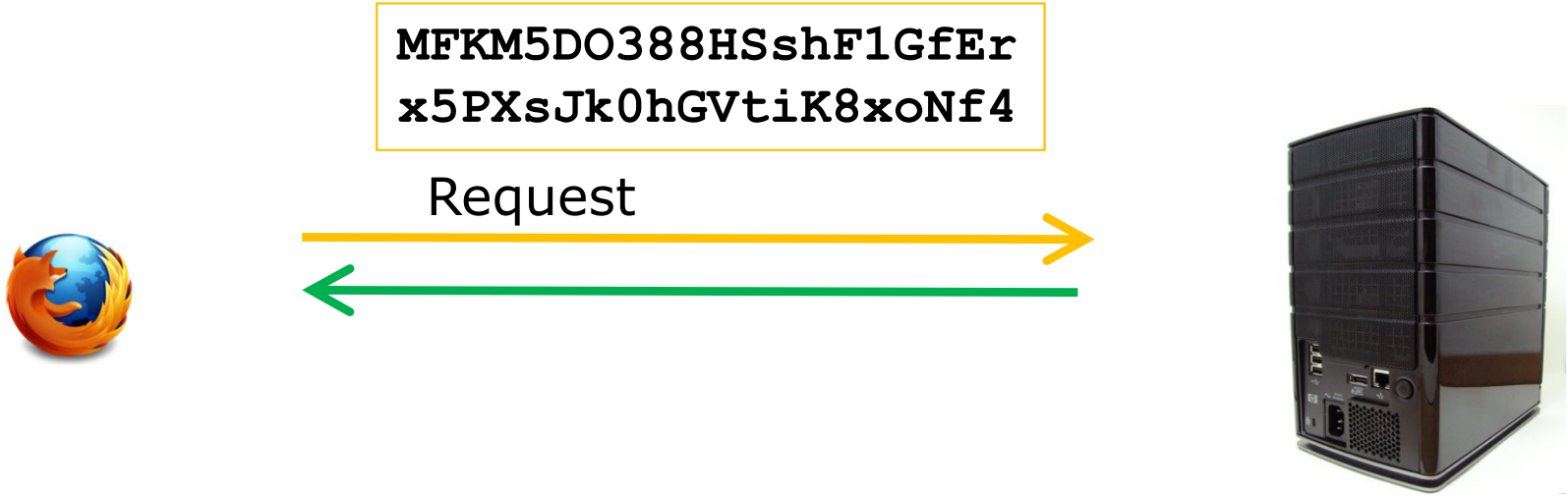
  - Opens connection to port 80, where a web server is listening
- Send the following HTTP request:

```
GET /~sivilotti.1/ HTTP/1.1
Host: web.cse.ohio-state.edu
<blank line>
```

# HTTP Traffic Transparency



- Everything is visible to an eavesdropper
  - HTTP headers are plain text
  - HTTP payload may be binary
- To protect communication, use encryption
  - SSL, TLS: protocols to create secure channel
  - Initial handshake between client and server
  - Subsequent communication is encrypted
- HTTP over secure channel = HTTPS
  - Default port: 443



# Demo: HTTPS with openssl



- Use openssl instead of telnet
  - Negotiates initial handshake with server
  - Handles encryption/decryption of traffic
- Example URL
  - https://www.osu.edu/
- At console

```
$ openssl s_client -connect www.osu.edu:443
```

  - Note connection to port 443 (ie https)
- Syntax of subsequent request is the same
- Send the following HTTP request:

```
GET / HTTP/1.1
Host: www.osu.edu
<blank line>
```

# HTTP Response Anatomy



- Recall, four parts
  1. Status (one line)
  2. Header fields (separated by newlines)
  3. Blank line
  4. Body (*i.e.*, payload)
- Parts 1-2 collectively are the header
- Status line syntax:

  ***http-version status-code text***

  - Examples

```
HTTP/1.1 200 OK
HTTP/1.1 301 Moved Permanently
HTTP/1.1 404 Not Found
```

# Taxonomy of Status Codes



| Code | Meaning |
|---|---|
| 1xx | Informational |
| 2xx | Success |
| 3xx | Redirection |
| 4xx | Client Error |
| 5xx | Server Error |

# Some Common Status Codes



- 200 Success/OK
  - All is good!
  - Response body is the requested document
- 301 Permanent Redirect / 302 Temporary Redirect
  - Requested resource is found somewhere else
  - 301 means please go to new location in the future
- 304 Not Modified
  - Document hasn't changed since date/time in If-Modified-Since field of request
  - No response body
- 404 Not Found
  - Server could not satisfy the request
  - It is the client's fault (design-by-contract?)
- 500 Internal Server Error
  - Server could not satisfy the request
  - It is the server's fault (design-by-contract?)

# Response Header: Header Fields



- Each field on its own line, syntax:

  ***name*: *value***

- Examples

```
Date: Tue, 19 Sep 2023 17:31:18 GMT
Server: Apache/2.4.6 (Red Hat)
Content-Type: text/html; charset=UTF-8
Content-Encoding: gzip
Content-Length: 333
```

- Blank line indicates end of headers

# Demo: Using Terminal



- Telnet is cumbersome
  - Requesting the following by telnet fails (why?)

```
http://web.cse.ohio-state.edu/~paolo/
```

  - Try:

```
http://web.cse.ohio-state.edu/~sivilotti.1/
```

  - Body is incomplete (no images)
  - Body is chunked
- Better command-line tool: cURL
  - Handles redirection, chunking, https, headers, …

```
$ curl -Li web.cse.ohio-state.edu/~paolo
```

  - Can explicitly set request headers (-H)

```
$ curl https://www.osu.edu \
    -A "Mozilla/5.0"
    -H "accept: text/html"
```

# Demo: Chrome Developer Tools



- Powerful inspection tool for the web
  - Kabob > More Tools… > Developer Tools, then see the Network tab
- One GET results in many requests

  **`http://web.cse.ohio-state.edu/~paolo`**
- For each request, see:
  - Request method, headers
  - Response status code, and headers
  - Response body (and preview)
- To reproduce a request:
  - Right click, Copy > Copy as cURL

# Demo: Using Ruby



- Mechanize: A Ruby gem for HTTP

```
require 'mechanize'
```

- Create an agent to send requests

```
agent = Mechanize.new do |a|
  a.user_agent_alias = 'Mac Safari'
end
```

- Use agent to issue a request

```
page = agent.get 'https://news.osu.edu'
```

- Follow links, submit forms, etc

```
h = page.link_with(text: /Top/).click
f = page.forms[0]
f.field_with(name: 'q').value = 'CSE'
s = f.submit
```

# Request Methods



- GET, HEAD
  - Request: should be *safe* (no side effects)
  - Request has header only (no body)
- PUT
  - Update (or create): should be *idempotent*
- DELETE
  - Delete: should be *idempotent*
- POST
  - Create (or update): changes server state
  - Beware re-sending!
- HTTP does not enforce these semantics

# HTTP is Stateless



- Every request looks the same
- But maintaining state between requests is really useful:
  - User logs in, then can GET account info
  - Shopping cart "remembers" contents
- Solution: Keep a shared secret
  - Server's first response contains a unique session identifier (a long random value)
  - Subsequent requests from this client include this secret value
  - Server recognizes the secret value, request must have come from original client

# HTTP Session



Request

# HTTP Session



Request

Store secret

`38afes7a8`

# HTTP Session



Request

Response
Secret: `38afes7a8`

Store secret

`38afes7a8`

# HTTP Session



Request

Store secret

Response
Secret: `38afes7a8`

Request
id: `38afes7a8`

`38afes7a8`

Check id

Response

Request
id: `38afes7a8`

Check id

Response

# HTTP Cookies



- Popular mechanism for session manag'nt
- Set in *response* header field

  **Set-Cookie: session=38afes7a8**

  - Any name/value is ok
  - Options: expiry, require https
- Client then includes cookie(s) in any subsequent request to that domain
- Sent in *request* header field:

  **Cookie: session=38afes7a8**
- Cookies also used for
  - Tracking/analytics: What path did they take?
  - Personalization

# Summary



- HTTP: request/response
- Anatomy of request
  - Methods: GET, PUT, DELETE, POST
  - Headers
  - Body: arguments of POST
- Anatomy of response
  - Status Codes: 200, 301, 404, etc
  - Headers
  - Body: payload
- Tools
  - Curl, Developer Tools, Mechanize