15-213

"The course that gives CMU its Zip!"

Web Services
Nov 26, 2002

Topics

- HTTP

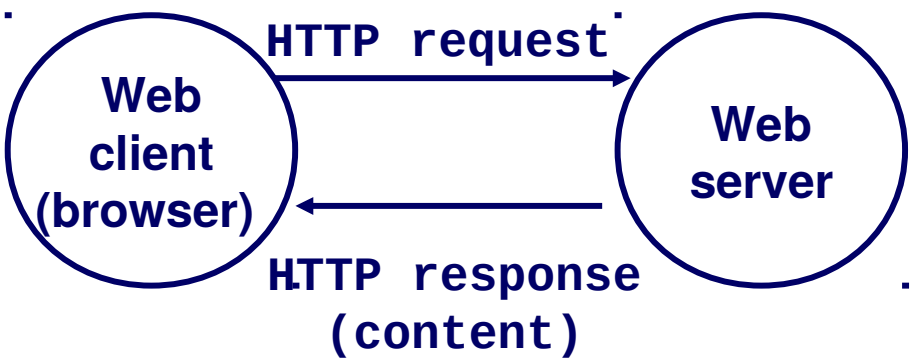
Web Servers

Clients and servers communicate using the HyperText Transfer Protocol (HTTP)

- Client and server establish TCP connection
- Client requests content
- Server responds with requested content
- Client and server close connection (usually)

Current version is HTTP/1.1

- RFC 2616, June, 1999.



Web Content

Web servers return *content* to clients

- *content:* a sequence of bytes with an associated MIME (Multipurpose Internet Mail Extensions) type

Example MIME types

`text/html`	HTML document
`text/plain`	Unformatted text
`application/postscript`	Postcript document
`image/gif`	Binary image encoded in GIF format
`image/jpeg`	Binary image encoded in JPEG format

Static and Dynamic Content

The content returned in HTTP responses can be either *static* or *dynamic*.

- **Static content: content stored in files and retrieved in response to an HTTP request**
  - **Examples: HTML files, images, audio clips.**
- **Dynamic content: content produced on-the-fly in response to an HTTP request**
  - **Example: content produced by a program executed by the server on behalf of the client.**

Bottom line: *All Web content is associated with a file that is managed by the server.*

URLs

Each file managed by a server has a unique name called a URL (Universal Resource Locator)

URLs for static content:

- `http://www.cs.cmu.edu:80/index.html`
- `http://www.cs.cmu.edu/index.html`
- `http://www.cs.cmu.edu`
  - Identifies a file called `index.html`, managed by a Web server at `www.cs.cmu.edu` that is listening on port 80.

URLs for dynamic content:

- `http://www.cs.cmu.edu:8000/cgi-bin/adder?15000&213`
  - Identifies an executable file called `adder`, managed by a Web server at `www.cs.cmu.edu` that is listening on port 8000, that should be called with two argument strings: `15000` and `213`.

How Clients and Servers Use URLs

Example URL: `http://www.aol.com:80/index.html`

Clients use *prefix* (`http://www.aol.com:80`) to infer:

- What kind of server to contact (Web server)
- Where the server is (`www.aol.com`)
- What port it is listening on (80)

Servers use *suffix* (`/index.html`) to:

- Determine if request is for static or dynamic content.
  - No hard and fast rules for this.
  - Convention: executables reside in `cgi-bin` directory
- Find file on file system.
  - Initial "`/`" in suffix denotes home directory for requested content.
  - Minimal suffix is "`/`", which all servers expand to some default home page (e.g., `index.html`).

Anatomy of an HTTP Transaction

```
unix> telnet www.aol.com 80          Client: open connection to server
Trying 205.188.146.23...             Telnet prints 3 lines to the terminal
Connected to aol.com.
Escape character is '^]'.
GET / HTTP/1.1                       Client: request line
host: www.aol.com                    Client: required HTTP/1.1 HOST header
                                     Client: empty line terminates headers.
HTTP/1.0 200 OK                      Server: response line
MIME-Version: 1.0                    Server: followed by five response headers
Date: Mon, 08 Jan 2001 04:59:42 GMT
Server: NaviServer/2.0 AOLserver/2.3.3
Content-Type: text/html              Server: expect HTML in the response body
Content-Length: 42092                Server: expect 42,092 bytes in the resp body
                                     Server: empty line ("\r\n") terminates hdrs
<html>                               Server: first HTML line in response body
...                                  Server: 766 lines of HTML not shown.
</html>                              Server: last HTML line in response body
Connection closed by foreign host.   Server: closes connection
unix>                                Client: closes connection and terminates
```

HTTP Requests

HTTP request is a *request line*, followed by zero or more *request headers*

Request line: `<method> <uri> <version>`

- `<version>` is HTTP version of request (`HTTP/1.0` or `HTTP/1.1`)
- `<uri>` is typically URL for proxies, URL suffix for servers.
- `<method>` is either `GET`, `POST`, `OPTIONS`, `HEAD`, `PUT`, `DELETE`, or `TRACE`.

HTTP Requests (cont)

HTTP methods:

- `GET`: Retrieve static or dynamic content
  - Arguments for dynamic content are in URI
  - Workhorse method (99% of requests)
- `POST`: Retrieve dynamic content
  - Arguments for dynamic content are in the request body
- `OPTIONS`: Get server or file attributes
- `HEAD`: Like `GET` but no data in response body
- `PUT`: Write a file to the server!
- `DELETE`: Delete a file on the server!
- `TRACE`: Echo request in response body
  - Useful for debugging.

HTTP Requests (cont)

Request headers: `<header name>: <header data>`

- Provide additional information to the server.

Major differences between HTTP/1.1 and HTTP/1.0

- HTTP/1.0 uses a new connection for each transaction.
- HTTP/1.1 also supports *persistent connections*
  - multiple transactions over the same connection
  - `Connection: Keep-Alive`
- HTTP/1.1 requires `HOST` header
  - `Host: kittyhawk.cmcl.cs.cmu.edu`
- HTTP/1.1 adds additional support for caching

HTTP Responses

HTTP response is a *response line* followed by zero or more *response headers*.

Response line:

`<version> <status code> <status msg>`

- `<version>` is HTTP version of the response.
- `<status code>` is numeric status.
- `<status msg>` is corresponding English text.
  - 200 OK — Request was handled without error
  - 403 Forbidden — Server lacks permission to access file
  - 404 Not found — Server couldn't find the file.

Response headers: `<header name>: <header data>`

- Provide additional information about response
- `Content-Type:` MIME type of content in response body.
- `Content-Length:` Length of content in response body.

GET Request to Apache Server From IE Browser

```
GET /test.html HTTP/1.1
Accept: */*
Accept-Language: en-us
Accept-Encoding: gzip, deflate
User-Agent: Mozilla/4.0 (compatible; MSIE 4.01; Windows 98)
Host: euro.ecom.cmu.edu
Connection: Keep-Alive
CRLF (\r\n)
```

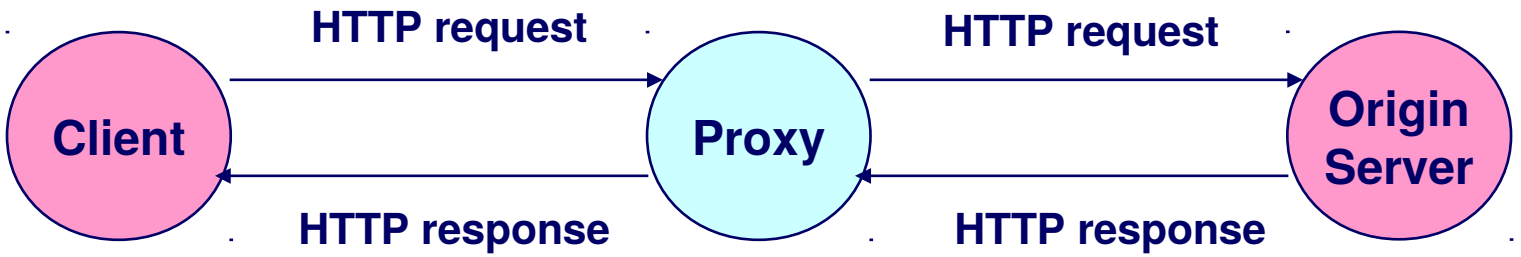
GET Response From Apache Server

```
HTTP/1.1 200 OK
Date: Thu, 22 Jul 1999 04:02:15 GMT
Server: Apache/1.3.3 Ben-SSL/1.28 (Unix)
Last-Modified: Thu, 22 Jul 1999 03:33:21 GMT
ETag: "48bb2-4f-37969101"
Accept-Ranges: bytes
Content-Length: 79
Keep-Alive: timeout=15, max=100
Connection: Keep-Alive
Content-Type: text/html
CRLF
<html>
<head><title>Test page</title></head>
<body>
<h1>Test page</h1>
</html>
```

Proxies

A *proxy* is an intermediary between a client and an *origin server*.

- **To the client, the proxy acts like a server.**
- **To the server, the proxy acts like a client.**



Why Proxies?

Can perform useful functions as requests and responses pass by

- Examples: Caching, logging, anonymization