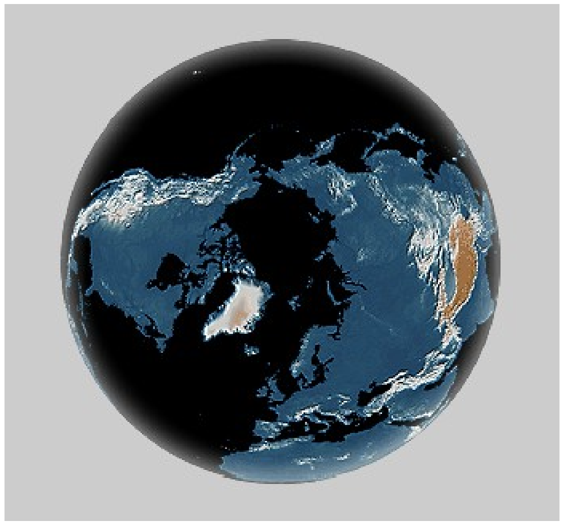


HTTP

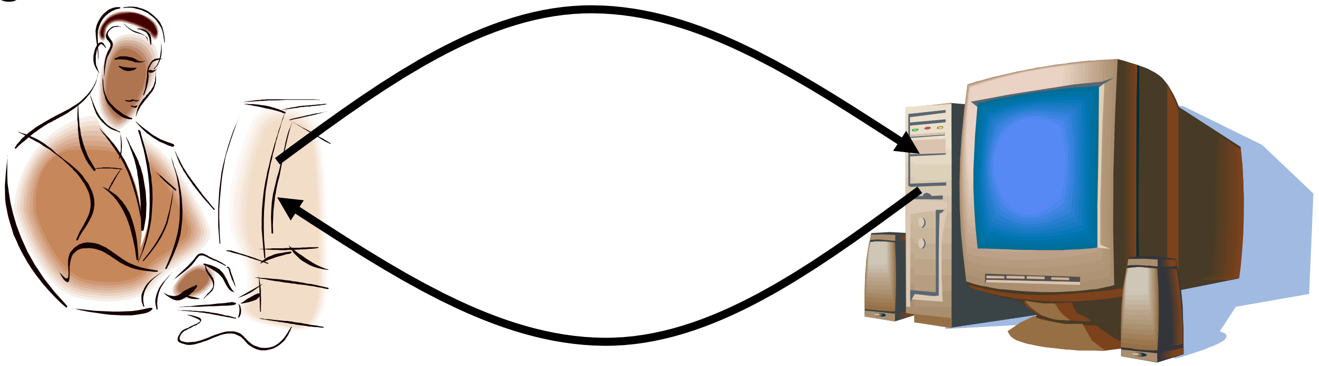
Reading: Section 9.1.2 and 9.4.3

COS 461: Computer Networks
Spring 2013

Recap: Client-Server Communication

- Client "sometimes on"
  - Initiates a request to the server when interested
  - E.g., Web browser on your laptop or cell phone
  - Doesn't communicate directly with other clients
  - Needs to know server's address

- Server is "always on"
  - Handles services requests from many client hosts
  - E.g., Web server for the www.cnn.com Web site
  - Doesn't initiate contact with the clients
  - Needs fixed, known address



Outline

- HTTP overview
- Proxies

Two Forms of Header Formats

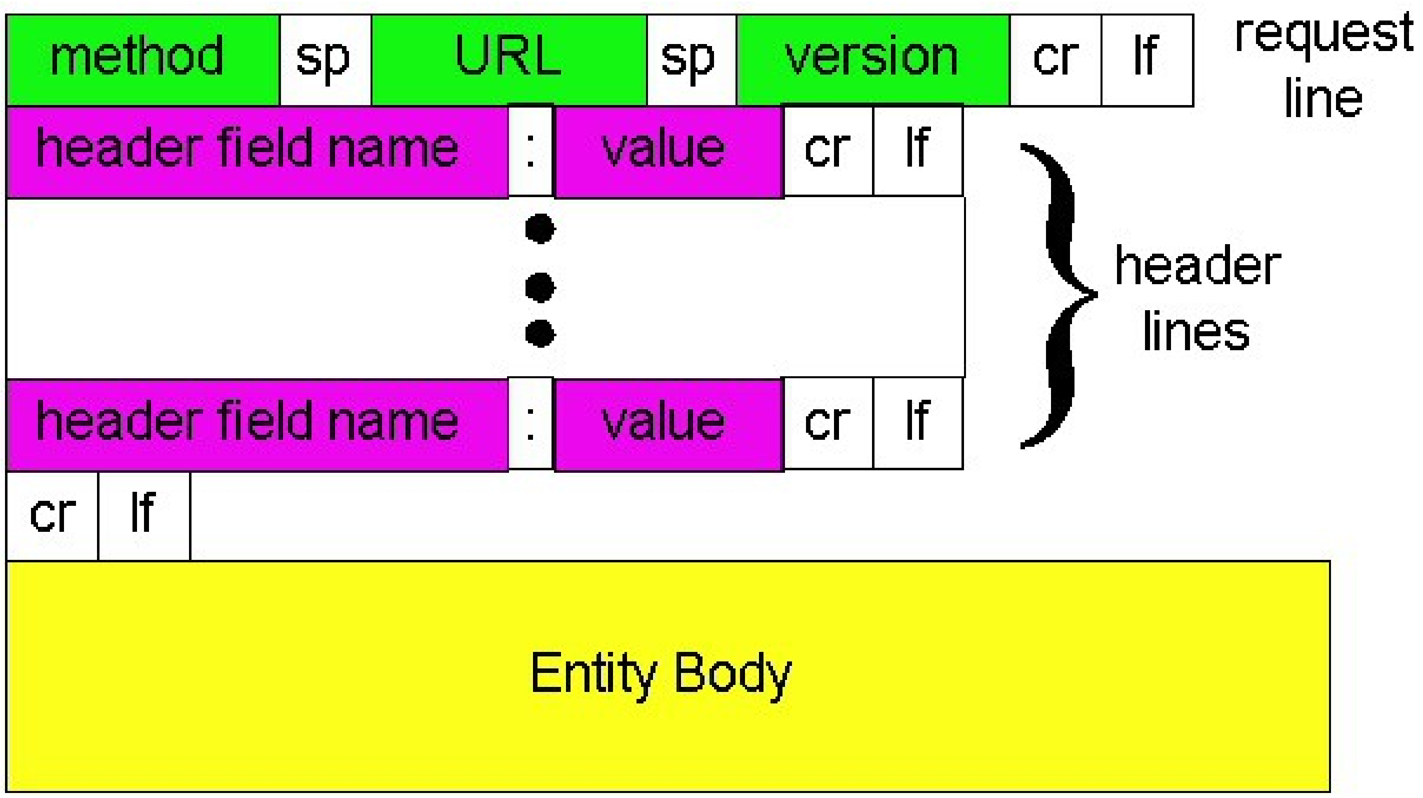
- **Fixed: Every field (type, length) defined**
  - Fast parsing (good for hardware implementations)
  - Not human readable
  - Fairly static (IPv6 ~20 years to deploy)
  - E.g., Ethernet, IP, TCP headers

- **Variable length headers**
  - Slower parsing (hard to implement in hardware)
  - Human readable
  - Extensible
  - E.g., HTTP (Web), SMTP (Email), XML

HTTP Basics (Overview)

- HTTP over bidirectional byte stream (e.g. TCP)
- Interaction
  - Client looks up host (DNS)
  - Client sends request to server
  - Server responds with data or error
  - Requests/responses are encoded in text
- Stateless
  - HTTP maintains no info about past client requests
  - HTTP "Cookies" allow server to identify client and associate requests into a client session

HTTP Request



"cr" is \r **"lf" is \n**

sp is " "

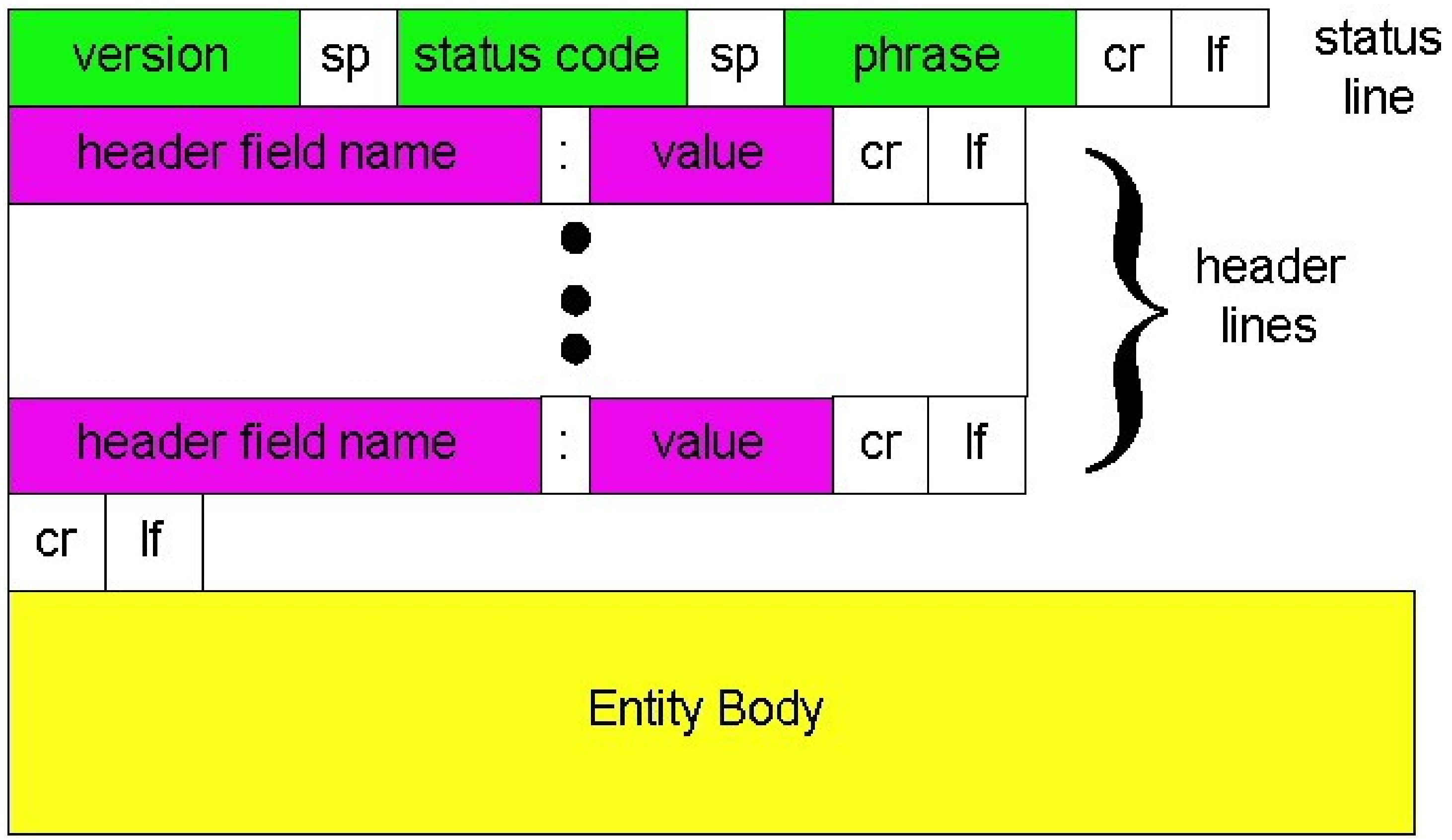
HTTP Request

- Request line
  - Method
    - GET – return URI
    - HEAD – return headers only of GET response
    - POST – send data to the server (forms, etc.)
  - URL (relative)
    - E.g., /index.html
  - HTTP version

HTTP Request (cont.)

- Request headers
  - Variable length, human-readable
  - Uses:
    - Authorization – authentication info
    - Acceptable document types/encodings
    - From – user email
    - If-Modified-Since
    - Referrer – what caused this page to be requested
    - User-Agent – client software
- Blank-line
- Body

HTTP Response



HTTP Response

- Status-line
  - HTTP version (now "1.1")
  - 3 digit response code
    - 1XX – informational
    - 2XX – success
      - 200 OK
    - 3XX – redirection
      - 301 Moved Permanently
      - 303 Moved Temporarily
      - 304 Not Modified
    - 4XX – client error
      - 404 Not Found
    - 5XX – server error
      - 505 HTTP Version Not Supported
  - Reason phrase

HTTP Response (cont.)

- Headers
  - Variable length, human-readable
  - Uses:
    - Location – for redirection
    - Server – server software
    - WWW-Authenticate – request for authentication
    - Allow – list of methods supported (get, head, etc)
    - Content-Encoding – E.g x-gzip
    - Content-Length
    - Content-Type
    - Expires (caching)
    - Last-Modified (caching)
- Blank-line
- Body

HTTP Response Example

```
HTTP/1.1 200 OK
Date: Tue, 27 Mar 2001 03:49:38 GMT
Server: Apache/1.3.14 (Unix)  (Red-Hat/Linux) mod_ssl/2.7.1
    OpenSSL/0.9.5a DAV/1.0.2 PHP/4.0.1pl2 mod_perl/1.24
Last-Modified: Mon, 29 Jan 2001 17:54:18 GMT
Accept-Ranges: bytes
Content-Length: 4333
Keep-Alive: timeout=15, max=100
Connection: Keep-Alive
Content-Type: text/html
…..
```

How to Mark End of Message?

- **Close connection**
  - Only server can do this
  - One request per TCP connection. Hurts performance.
- **Content-Length**
  - Must know size of transfer in advance
- **No body content. Double CRLF marks end**
  - E.g., 304 never have body content
- **Transfer-Encoding: chunked (HTTP/1.1)**
  - After headers, each chunk is content length in hex, CRLF, then body. Final chunk is length 0.

Example: Chunked Encoding

```
HTTP/1.1 200 OK <CRLF>
Transfer-Encoding: chunked <CRLF>
<CRLF>
25 <CRLF>
This is the data in the first chunk <CRLF>
1A <CRLF>
and this is the second one <CRLF>
0 <CRLF>
```

- Especially useful for dynamically-generated content, as length is not a priori known
  - Server would otherwise need to cache data until done generating, and then go back and fill-in length header before transmitting

Outline

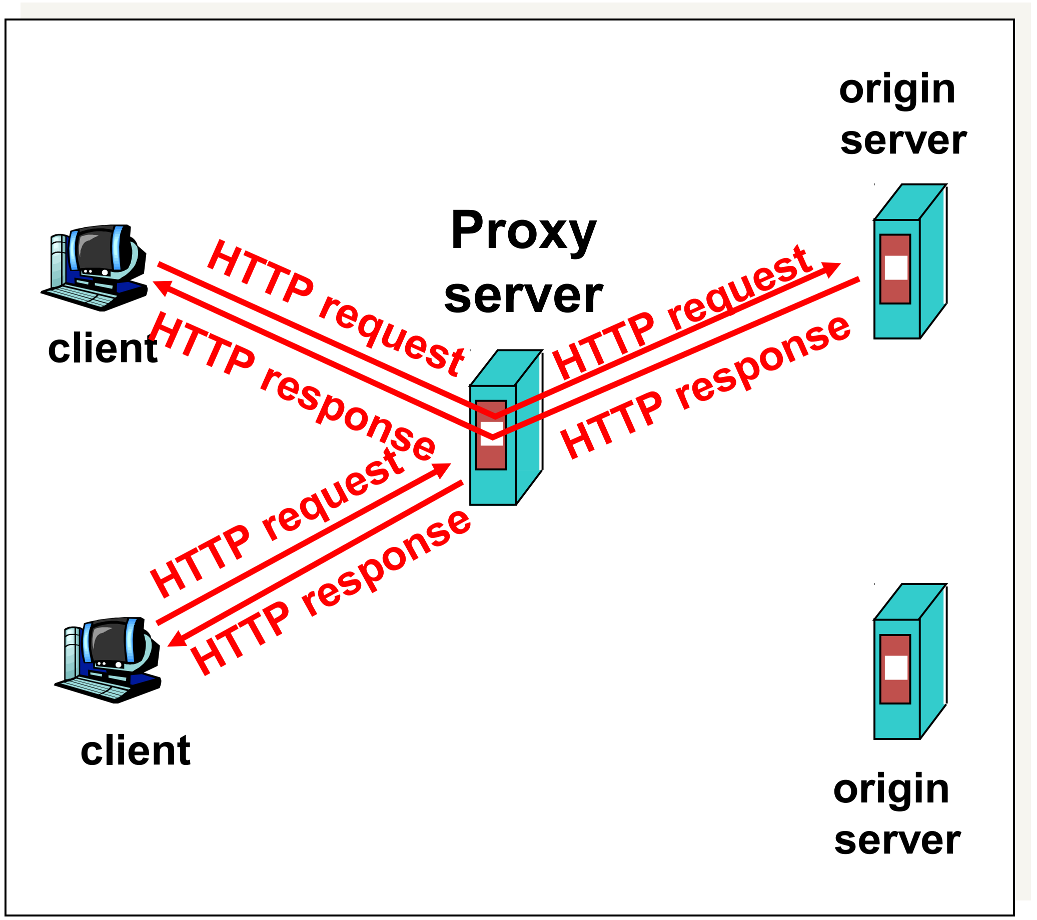
- HTTP overview
- Proxies

Proxies

- End host that acts a broker between client and server
  - Speaks to server on client’s behalf
- Why?
  - Privacy
  - Content filtering
  - Can use caching (coming up)

Proxies (Cont.)

- Accept requests from multiple clients
- Takes request and reissues it to server
- Takes response and forwards to client



Assignment 1: Requirements

- Non-caching, HTTP 1.0 proxy
  - Support only GET requests
  - No persistent connections: 1 HTTP request per TCP connection
- Multi-process: use fork()
- Simple binary that takes a port number
  - ./proxy 12345 (proxy listens on port 12345)
- Work in Firefox & Chrome
  - Use settings to point browser to your proxy

Assignment 1: Requirements

- **What you need from a client request: host, port, and URI path**
  - `GET http://www.princeton.edu:80/ HTTP/1.0`

- What you send to a remote server:

  -
    ```
    GET / HTTP/1.0
    Host: www.princeton.edu:80
    Connection: close
    ```

- Check request line and header format

- Forward the response to the client

Why Absolute vs. Relative URLs?

- First there was one domain per server
  - GET /index.html
- Then proxies introduced
  - Need to specify which server
  - GET http://www.cs.princeton.edu/index.hml
- Then virtual hosting: multiple domains per server
  - GET /index.html
  - Host: www.cs.princeton.edu
- Absolute URL still exists for historical reasons and backward compatibility

Assignment 1: Requirements

- Non-GET request?
  - return “Not Implemented” (code 501)
- Unparseable request?
  - return “Bad Request” (code 400)
- Use provided parsing library

Advice

- Networking is hard
  - Hard to know what’s going on in network layers
  - Start out simple, test often
- Build in steps
  - Incrementally add pieces
  - Make sure they work
  - Will help reduce the effect of “incomplete” information
- Assume teaching staff is non malicious or trying to trick you

Assignment 1 – Getting Started

- Modify Assn 0 to have server respond
  - Simple echo of what client sent
- Modify Assn 0 to handle concurrent clients
  - Use fork()
- Create “proxy” server
  - Simply “repeats” client msg to a server, and “repeats” server msg back
- Client sends HTTP requests, proxy parses

Summary

- HTTP: Simple text-based file exchange protocol
  - Support for status/error responses, authentication, client-side state maintenance, cache maintenance
- How to improve performance
  - Proxies
  - Caching
  - Persistent connections (more later)

Pop Quiz!

- Advantage of “fast retransmit” over timeouts?
- When are fast retransmits possible?
- When are timeouts particularly expensive?