HTTP Overview

Roadmap

- The physical Internet
  - The Internet is a network of networks
  - Physically connected by cables and routers
- Internet Protocol (IP)
  - How routers move data through the Internet
  - Best effort basis
- Transport Control Protocol (TCP)
  - Transport information reliably through an unreliable network
  - Used by the client and server

Network Stack (A simplified view)

- Enter HTTP

Packet Structure
IP Headers
TCP Headers
HTTP Headers
Content

HTTP - Documentation

- HTTP/1.1 is defined by RFC2616 of the IETF
  - https://tools.ietf.org/html/rfc2616
  - This is THE document for all your questions about HTTP
  - Today we'll discus topics in sections 4, 5, and 6
- RFC
  - Request For Comments
  - Submit an RFC for public discussion or to publish information
- IETF
  - Internet Engineering Task Force
  - Adopts some RFC's as Internet standards

HyperText Transfer Protocol (HTTP)

- HTTP is an application layer protocol
  - Protocols used by our applications
  - Protocols that are not concerned with the transmission of data
- [Almost] Always uses TCP for reliable communication
  - Always in this course

- Today:
  - Overview of HTTP

HTTP

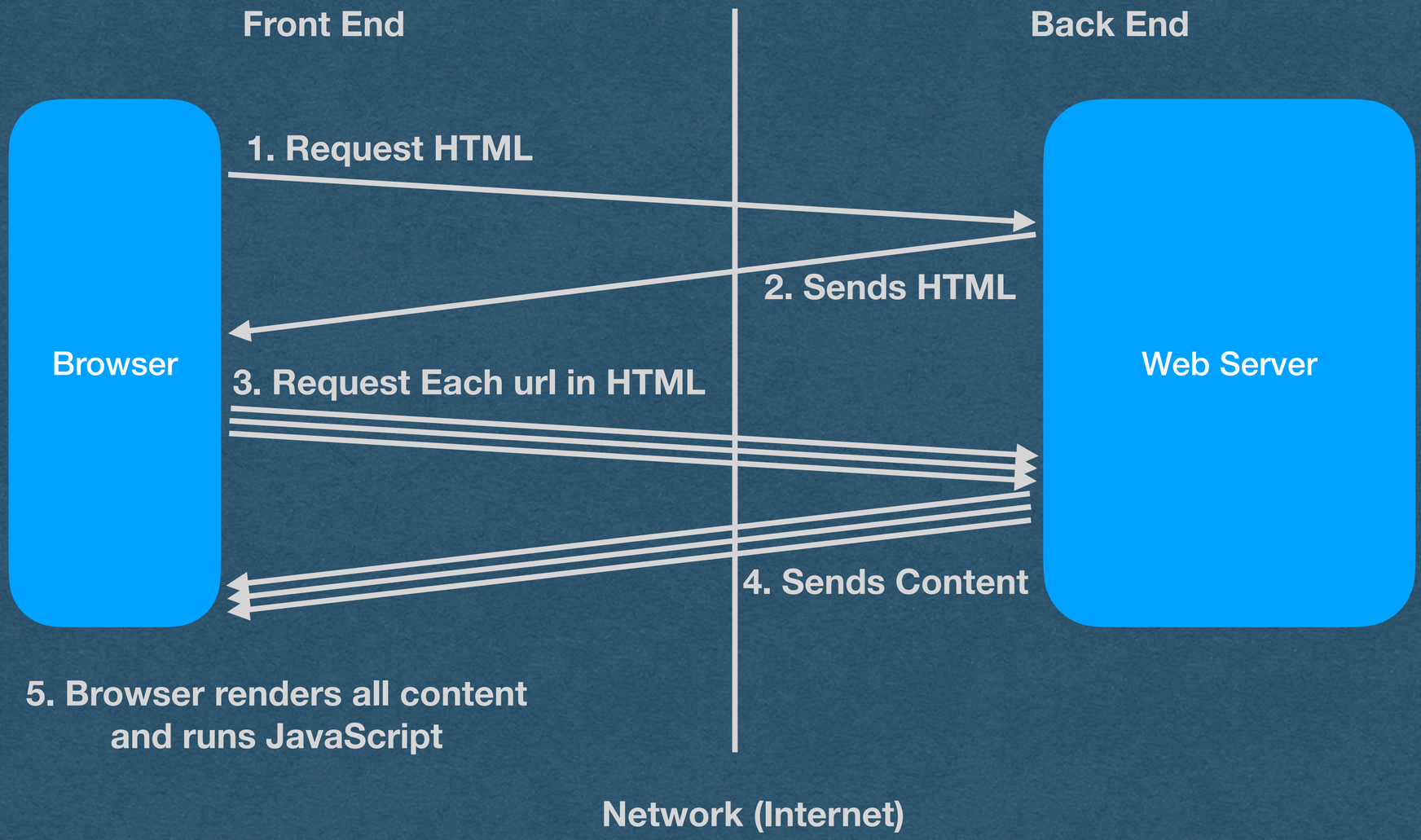
- HTTP is a protocol used to access content from a web server
- Protocol: An agreed upon set of rules
  - HTTP: Defines the format of messages sent to/from a web server
- HTTP is a Request - Response protocol
  - Client makes request to server
  - Server returns a response
  - Ex. Request The latest tweets from a user. Twitter server returns the tweets in its response
- Response may require more requests
  - Ex. Get HTML which requires CSS/JS/Images

Web Server

- Software that "speaks" HTTP
- Listens for HTTP requests and responds with HTTP responses
- We want to host our web pages/apps on the Internet using HTTP

- Terminology:
  - Front End - The part a web app that runs in the browser (HTML/CSS/JS)
  - Back End - The web server and all software that does not run on the user's machine

Loading a Web Site



HTTP Request

- Each HTTP request will contain the request type:
  - GET: Request information from a server
  - POST: Send information to a server
  - PUT: Add information to a service
  - DELETE: Delete information from a service
  - HEAD: Request only the headers of a response
- To start, we'll focus on GET and POST

HTTP Request

- HTTP GET Request
  - Used when requesting content from a server
  - [Typically] Only contains a URL and HTTP *headers*
  - When you click a link, your browser makes a GET request
  - Requesting HTML/CSS/Javascript/Images/etc are GET requests
- HTTP POST Request
  - Used when sending data to a website
  - Contains a URL and a body [And HTTP headers]
  - When you submit a form, your browser [typically] makes a POST request
  - The contents of the form are sent in the *body* of the request

HTTP Request

Protocol://host:port/path?query_string#fragment

- Each request is made for a specific URL (Uniform Resource Location)
  - A URL uniquely identifies a resource and has the following parts
- Protocol - The protocol being used (ex. file, HTTP, HTTPS, FTP)
- Host - The IP address or domain name of the server
  - Used to route the request to the appropriate machine
- Port - The TCP port number of the host server
  - Defaults to 80/443 for HTTP/HTTPS respectively
- Path - Specifies the specific resource being requested from the server

HTTP Request

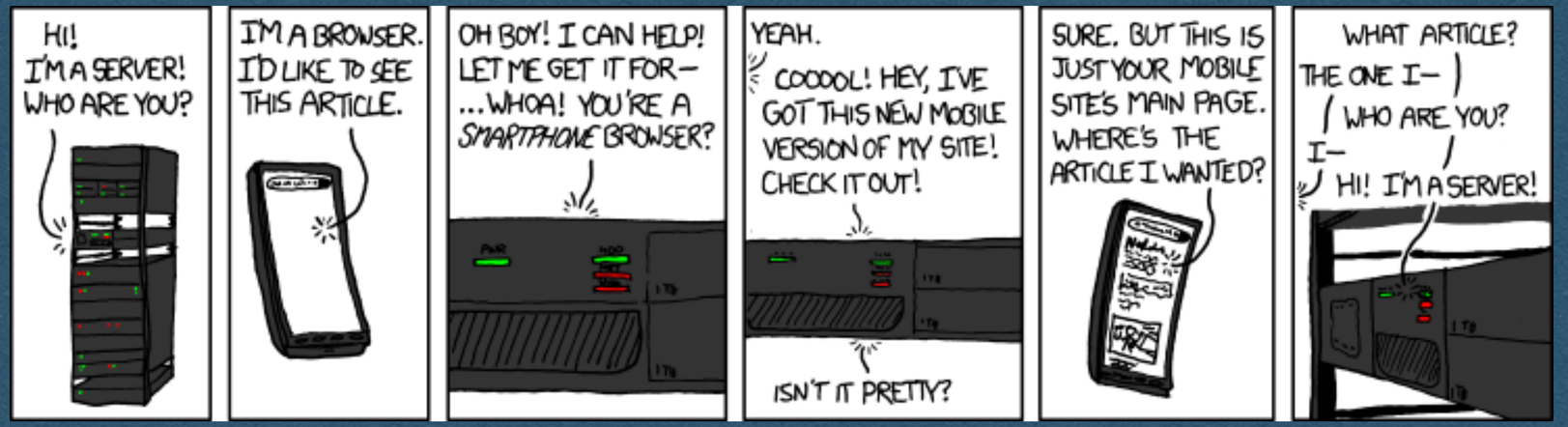
Protocol://host:port/path?query_string#fragment

- Query String - [Optional] Contains key-value pairs set by the client
- https://www.google.com/search?q=web+development
  - HTTPS request to Google search for the phrase "web development"
- https://duckduckgo.com/?q=web+development&ia=images
  - An HTTPS request to Duck Duck Go image search for the phrase "web development"

- Fragment - [Optional] Specifies a single value commonly used for navigation
- https://en.wikipedia.org/wiki/Uniform_Resource_Identifier
  - HTTPS Request for the URI Wikipedia page
- https://en.wikipedia.org/wiki/Uniform_Resource_Identifier#Definition
  - HTTPS Request for the URI Wikipedia page that will scroll to the definition of URI

HTTP

- HTTP is a stateless protocol
- Each request is handled in isolation even if a client just made another request
- If state is desired (ex. Login), the state must be sent with each request
  - Cookies
- When handling an HTTP request, do not have to care who sent it



https://xkcd.com/869/

New Lines

- A new line character in an HTTP request/response must be:
  - **"\r\n"**
    - Carriage return (From the days of typewriters)
    - New line
  - In the documentation this is referred to as a CRLF
  - CRLF == Carriage Return Line Feed

- Be aware of this while parsing
- Use "\r\n" for new lines when preparing your responses

HTTP GET Request

GET Request

- We'll use this simple request as an example

GET / HTTP/1.1
Host: cse312.com

GET Request

- More accurately, it will be this

GET / HTTP/1.1\r\nHost: cse312.com\r\n\r\n

- For the example, we'll show "\r\n" as a new line

- Note that there is a blank line at the end of the request

The Request Line

- The first line of the request is always the request line
- The request line has 3 values separated by spaces
  - The request type (GET/POST/PUT/DELETE/etc)
  - The path of the request (ex. "/") - Everything after the port in the requested url
  - The HTTP Version
    - We'll always use HTTP/1.1 in this course
    - You can assume the request uses HTTP/1.1 in your assignments without checking this string

GET / HTTP/1.1
Host: cse312.com

The Request Line

- Parse the request line by looking for the 2 space characters
  - Separate the values and check the strings
- Typically: When the root path "/" is requested, serve the HTML of your home page
  - By convention, web servers look for index.html to serve
- If the url contains a different path, it will appear in the request line

GET / HTTP/1.1
Host: cse312.com

GET /lecture HTTP/1.1
Host: cse312.com

Headers

- Following the request line are any number of headers
- HTTP Headers
  - Key-Value pairs
  - Key and value separated by a colon ":"
- Each header will be on a new line
- To parse, look for the colon ":" and read the key and value
  - There is an optional space after the colon which should be removed if present

GET / HTTP/1.1
Host: cse312.com

HTTP Response

Response

- Your web server will listen for HTTP requests over the TCP sockets and respond with HTTP responses
- Send this response back to the client to serve them the requested content

HTTP/1.1 200 OK
Content-Type: text/plain
Content-Length: 5

hello

Response

- Or, more accurately

HTTP/1.1 200 OK\r\nContent-Type: text/plain\r\nContent-Length: 5\r\n\r\nhello

Status Line

- The first line of the response must be the status line
- Status line contains 3 values separated by spaces
  - The HTTP version
  - The status code
  - The status message (Reason phrase in docs)

```
HTTP/1.1 200 OK
Content-Type: text/plain
Content-Length: 5

hello
```

Response Codes

- Tells the browser the nature of the response
  - 200-level codes: Everything went well
  - 300-level codes: Redirect the request
  - 400-level codes: Error caused by the client
  - 500-level codes: Error caused by the server
- Include a human readable message

```
HTTP/1.1 200 OK
Content-Type: text/plain
Content-Length: 5

hello
```

Response Headers

- The headers in the response follow the same format as request headers
- Should have at least two headers
  - Content-Type - Tells the browser how to parse this content
  - Content-Length - How many **bytes** should be read from the body of the response

HTTP/1.1 200 OK
Content-Type: text/plain
Content-Length: 5

hello

Body

- The headers are followed by 2 new lines "\r\n\r\n" to indicate the beginning of the body
- The body contains the content that is being served

HTTP/1.1 200 OK
Content-Type: text/plain
Content-Length: 5

hello

404 Not Found

- If a path is requested that your server does not handle
  - Respond with a 404 Not Found
  - Note: Spaces are allowed in your reason message
- The response format is the same as a 200 response
  - Include content type and length
  - Include a body that will be displayed to the client

HTTP/1.1 404 Not Found
Content-Type: text/plain
Content-Length: 36

The requested content does not exist

301 Moved Permanently

- Respond with 301 to redirect the user to a new path
  - Ex. When the server is updated with new paths, redirect the old paths to the new paths instead of maintaining both
  - Ex. Redirect HTTP requests to HTTPS requests

HTTP/1.1 301 Moved Permanently
Content-Length: 0
Location: /new-path

301 Moved Permanently

- A 301 response must contain a Location header
  - This is the path of the redirect
- The client will make a second request for the Location path

HTTP/1.1 301 Moved Permanently
Content-Length: 0
Location: /new-path

301 Moved Permanently

- If the Location is not a full url, it will be treated as a relative path
- New request is made with the same protocol/host/port as the original request
- Example:
  - First request was for "http://cse312.com:8080/old-path"
  - Second request is "http://cse312.com:8080/new-path"

HTTP/1.1 301 Moved Permanently
Content-Length: 0
Location: /new-path

301 Moved Permanently

- If the location is a full url, the user can be redirected to a different server
- Example:
  - First request was for "http://cse312.com:8080/old-path"
  - Second request is "https://google.com/"

HTTP/1.1 301 Moved Permanently
Content-Length: 0
Location: https://google.com/

301 Moved Permanently

- Add a Content-Length of 0 since there are no bytes to read from the body
  - This is technically optional. The lack of a Content-Length header should assume a length of 0
  - However, this confuses Firefox.. so we'll add the header

HTTP/1.1 301 Moved Permanently
Content-Length: 0
Location: /new-path

HTTP POST Request

POST Request

- A POST request, or any request containing a body, will be formatted similar to your HTTP responses

```
POST /path HTTP/1.1
Content-Type: text/plain
Content-Length: 5

hello
```

POST Request

- More accurately

POST /path HTTP/1.1\r\nContent-Type: text/plain\r\nContent-Length: 5\r\n\r\nhello

POST Request

- When parsing, look for the Content-Length and Content-Type headers
  - It is strongly recommended that you write general header parsing code that you can use for all requests

POST /path HTTP/1.1\r\nContent-Type: text/plain\r\nContent-Length: 5\r\n\r\nhello

POST Request

- Look for the blank line that separates the headers from the body
  - "\r\n\r\n"
- Read everything after this blank line
- Make sure you've read "Content-Length" number of bytes
  - It's possible to only receive part of a request and have to read the rest from the TCP socket

POST /path HTTP/1.1\r\nContent-Type: text/plain\r\nContent-Length: 5\r\n\r\nhello

POST Request

- When you read the content from the body:
  - Do whatever your server does based on it's feature for this path
  - Send a response to the client

POST /path HTTP/1.1\r\nContent-Type: text/plain\r\nContent-Length: 5\r\n\r\nhello