ECE 435 – Network Engineering
Lecture 4

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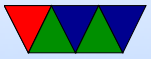
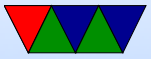
Announcements

- HW#1 was due.
- HW#2 will be posted. Write a mini-webserver.



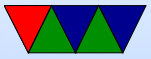
http

- HyperText Transfer Protocol
  RFC 2068 (1997), RFC 2616 (1999), RFC 7230 (2016)
- Make ASCII request, get a MIME-like response
- Connect with TCP socket
- Plain text request, followed by text headers
- Expects carriage returns in addition to linefeeds

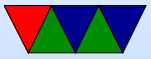


http Commands

- GET filename HTTP/1.1
  get file
- HEAD
  get header (can check timestamp. why? see if cache up to date)
- PUT
  send a file
- POST
  append to a file (send form data)

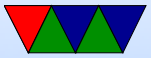


- DELETE
  remove file (not used much)
- TRACE
  debugging
- CONNECT, OPTIONS



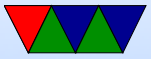
http three digit status codes

- 1xx – informational – not used much
- 2xx – Success – 200 = page is OK
- 3xx – Redirect – 303 = page moved
- 4xx – Client Error – 403 = forbidden, 404 = not found
- 5xx – Server Error – 500 = internal, 503 = try again



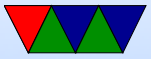
Selected http request headers (included after GET)

- User-Agent (browser info). Can you lie? Can you leak info?
- Referer [sic] URL that referred to here
- Accept-*: type of documents can accept, compression, character set
- Host: server you are requesting
  Can configure browser to open up helper util for this (for example, run Office if it's a word file)



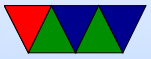
- Authorization: if you need special permissions/login
- Cookie: deals with cookies

  Statelessness – how do you remember setting, logins, shopping cart, etc. “cookies”. Expire. Can be misused.
- If-Modified-Since – caching



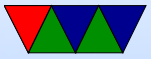
Selected http response headers

- Content-Encoding,Language,Length,Type
- Last-Modified: helps with caching
- Location: used when redirecting
- Accept-Ranges: partial downloads (downloading a large file, interrupted, can restart where left off)
- Content-Length: length of file being sent
- Content-type: type of data
- Date: current date
- Server: Name of webserver



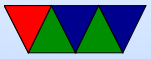
http 1.0/1.1

- HTTP 1.0, single request was set and single response. Each file/image requested was separate TCP connection
- HTTP 1.1 (1997) supports persistent connections, allowing multiple requests to happen with one TCP connection (lowering overhead). How do you know when to close? (timeout after 60s?)
- For improved performance, open multiple simultaneous connections instead? Yes, but frowned upon (server/network load)

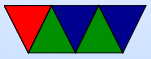


HTTP/2

- 2015. RFC 7540
- `https://http2.github.io/faq/`
- Google push through, extension of their SPDY (speedy) Microsoft and Facebook giving feedback
- Why does google care about (relatively) small increases in web performance?
- Leaves a lot of high level things the same. Negotiate what level to use.
- Decrease latency of rendering web pages:

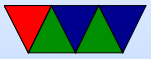


- compress headers
- Server can push data the browser didn't request yet but it knows it will need (like images, etc)
- pipeline requests
  Send multiple requests without waiting for response
  good on high-latency links (FIFO on 1.1, new makes it asynchronous)
- multiplex multiple requests over one TCP connection
- head-of-line blocking problem?
  line of packets held up by processing of first
  FIFO first requests waits until done until next, can't



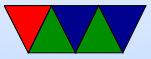
run in parallel

- Page load time 10-50% faster
- While can use w/o encryption, most browsers say will only do with encryption
- Criticism: was rushed through. Is way complex. Does own flow control (has own TCP inside of TCP) Re-implements transport layer at application layer
- Can check if your web-browser implements HTTP by going to `https://http2.golang.org/`

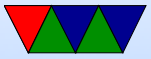


HTTP/3 or H3

- Web browsers have support but as of Feb 2021 still disabled by default
- `https://blog.erratasec.com/2018/11/some-notes-a html`
- Uses QUIC – runs sort of custom network congestion protocol in userspace over top of UDP
- HTTP/3 started as HTTP/2 over QUIC but has developed more
- QUIC is almost more of a TCP replacement

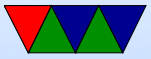


- HTTPS only
- Can handle better roaming around switching IP addresses w/o losing connection
- Interface is no longer a sockets interface



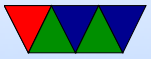
Do you need a browser? (old)

```
telnet www.maine.edu 80
GET / HTTP/1.1
Host: www.maine.edu
(enter)(enter)
control-]
close
```



Do you need a browser? (https)

```
openssl s_client -connect www.maine.edu:443
GET / HTTP/1.1
Host: www.maine.edu
(enter)(enter)
```



Do you need a browser? (HTTP2)

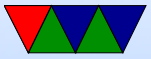
```
openssl s_client -connect http2.akamai.com:443
GET / HTTP/1.1
Host: http2.akamai.com
```

Does not work.

See `http://www.chmod777self.com/2013/07/http2-status-update.html`

But need to first send a binary SETTINGS frame.

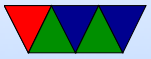
```
50 52 49 20 2a 20 48 54 54 50
2f 32 2e 30 0d 0a 0d 0a 53 4d
```



```
0d 0a 0d 0a 00 00 04 00 00 00
00 00
```

Then HEADERS frame, then compressed HEADERS.

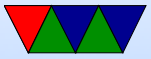
Response is compressed HEADERS and DATA frames.



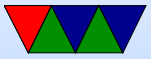
How simple can a server be?

- My Apple II webserver project

  `http://www.deater.net/weave/vmwprod/apple2_eth/`

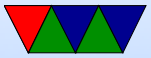


High-Level WWW Concerns



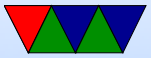
What if Server Overloaded?

- Slashdot effect (modern: HackerNews?)
- caching/proxy – squid
- Content Delivery Network – akami
- Server farms



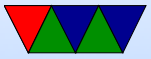
Web Security

- SSL – Secure Socket Layer
- Replaced by TLS (Transport Layer Security)
- Port 443 for https (we'll talk about soon)
- Public key encryption.



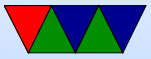
Web Privacy

- Cookies
- Cross-device tracing
- Browser Fingerprinting



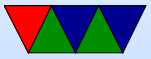
Setting Up a Web-server

- Apache
- Easy to do, more difficult to secure



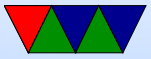
Web Seach

- Web-bots index the web. robots.txt file
- Altavista, Hotbot, Excite, Inktomi, etc.
- Curated search like Yahoo (people organize links rather than automatically search)
- Google (1996 some machine in Stanford, 1997-1998)
- MSN search 1999, rebranded Microsoft Bing 2009



HW#2 Hints

- Get the header printing first, then worry about correctness of headers (dates, length))



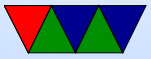
HW#2 – Parsing for filename

- Know how to search for a string and point to location after it?
  - Find a string and point to beginning of it.

```
char *pointer;
pointer=strstr(haystack,needle);
```

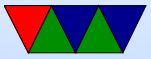
  - Look for `"GET "`

    Actually points to beginning of GET. How to skip ahead?
  - pointer+=4 is one way. (pointer math, ugh)
  - How to get to first space?



- `strtok(pointer," ");`
  Will split the string into chunks, put 0 at end.
- Also can do this manually;

```
pointer2=pointer;
while(*pointer) {
   if (pointer==' ') {
      *pointer=0;
      break;
   }
   pointer++;
}
printf("%s\n",pointer2);
```

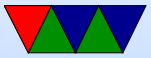


HW#2 – Constructing the Headers

- Know how to construct a string on the fly? `strcat()`, `sprintf()`
  `strcpy()` first bit in.
  `strcat()` additional strings.
  If you want formatting you can do things like

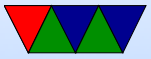
```
sprintf(temp_string,"File size=%d\r\n",filesize);
strcat(out_string,temp_string);
```

  Create big enough buffer.



HW#2 – Calculating Content-length

- How to find size of a file?
- Can read it in, and count. Note: don't use strlen() for this as a binary file might have zeros in it
- Might be better to use `stat()` (`man stat.2`) need .2 (or `man -a`) as there's a command line tool called stat that comes ip first.

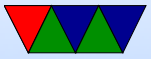


HW#2 – Reading/Writing File

- How to read/write file. There are a large number of ways to do this. `open()/read()/write()/close` `fopen()/fread/fwrite/fclose` (careful! Buffered! And maybe need fdopen() to print to file descriptor).

```
fd=open(filename,O_RDONLY);
if (fd<0) fprintf(stderr,"Error opening %s\n",filename);
while(1) {
    result=read(fd,buffer,256);
    if (result<=0) break;
    write(network_fd,buffer,result);
}
```

  Be sure to close afterward.



HW#2 – Getting Filetype

- Easiest way is calculating based on extension
- Take filename, look for . and compare after it
- Can use strstr() again, but think of corner cases
  What if multiple dots? What if no dots?