

Machine Problem 1

Handed Out: February 6th, 2022

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TA: Federico Cifuentes-Urtubey

Abstract

This machine problem introduces you to a bare-bones HTTP client that can get data from any web server. This is the kind of code that is running in your browser. You will also create a HTTP server that can serve data to other clients much like how a real server would function.

1 Introduction

In this assignment, you will implement a simple HTTP client and server. The client will be able to GET correctly from standard web servers, and browsers will be able to GET correctly from your server. The test setup will be two VMs, one server and one client. Each test will use your client or wget, and your server or tthttpd. Your client doesn't have to support caching or recursively retrieving embedded objects. HTTP uses TCP – you can use Beej's client.c and server.c as a base.

Your server must support concurrent connections: if one client is downloading a 10MB object, another client that comes looking for a 10KB object shouldn't have to wait for the first to finish.

2 What is expected in this MP?

2.1 HTTP Client

Your client should run as

```
./http_client http://hostname[:port]/path/to/file
```

e.g.

```
./http_client http://127.0.0.1/index.html
```

```
./http_client http://illinois.edu/index.html
```

```
./http_client http://12.34.56.78:8888/somefile.txt
```

```
./http_client http://localhost:5678/somedir/anotherfile.html
```

If there is no :port, assume port 80 – the standard HTTP port. **You should write the file that you receive to a file called “output” (no file extension, like txt or html).** Here’s the very simple HTTP GET that wget uses:

```
GET /test.txt HTTP/1.1
User-Agent: Wget/1.12 (linux-gnu)
Host: localhost:3490
Connection: Keep-Alive
```

The GET /test.txt instructs the server to return the file called test.txt in the server’s top-level web directory. User-Agent identifies the type of client. Host is the URL that the client was originally told to get from – exactly what the user typed. This is useful in case a single server has multiple domain names resolving to it (maybe cs.illinois.edu and math.illinois.edu), and each domain name actually refers to different content. This could be a bare IP address, if that’s what the user had typed. The 3490 is the port – this server was listening on 3490, so I called “wget localhost:3490/test.txt”. Finally, Connection: Keep-Alive refers to TCP connection reuse, which will be discussed in class.

Note that the newlines are technically supposed to be CRLF – so, “\r\n” on a Unix machine.

Only the first line is essential for a server to know what file to give back, so **your HTTP GETs can be just that first line.** HTTP specifies that the end of a request should be marked by a blank line — so **be sure to have two newlines at the end.** (This is necessary because TCP presents you with a stream of **bytes**, rather than **packets**.)

2.2 HTTP Server

Now for the HTTP response. Here’s what Google returns for a simple GET of /index.html:

```
HTTP/1.0 200 OK
Date: Wed, 21 May 2014 17:39:46 GMT
Expires: -1
Cache-Control: private, max-age=0
Content-Type: text/html; charset=ISO-8859-1
Set-Cookie: PREF=ID=d985d415c1aaf0cc:FF=0:TM=1400693986:LM=1400693986:S=jbOFRLMuiYWpB6sl;
expires=Fri, 20-May-2016 17:39:46 GMT; path=/; domain=.google.com
Set-Cookie: NID=67=UEN1ApahELM_UhkJDWgHbwLmw1thhjwfucoYpC2E-
UpqH6bwR8Rq9YAqY1ptRu3qCeljkHLBwY867JmRn4fzFQzJpgld1TLzXhBhLjAKCpGx0DQpVSDFjAPByCQo37
K4; expires=Thu, 20-Nov-2014 17:39:46 GMT; path=/; domain=.google.com; HttpOnly
P3P: CP="This is not a P3P policy! See http://www.google.com/support/accounts/bin/answer.py?
hl=en&answer=151657 for more info."
Server: gws
X-XSS-Protection: 1; mode=block
X-Frame-Options: SAMEORIGIN
Alternate-Protocol: 80:quic
<!doctype html><html:itemscope="" much more of the document follows...
```

Your server’s headers will be much simpler (but still correct and complete): only include the response code. When correctly returning the requested document, use HTTP/1.1 200 OK, like this example. When the client requests a non-existent file, return HTTP/1.1 404 Not Found. Note

that you can still have document text on a 404 – allowing for nicely formatted or more informative “whoops, file not found!” messages. For any other errors, you may simply return 400 Bad Request.

An important note: see how there’s a blank line between the header and document text in the Google response? That’s a well-defined part of the protocol, marking the end of the header. Your server must include this blank line. Again, HTTP newlines are CRLF. Your server should take the port to run on as a command line argument, and should treat all filepaths it’s asked for as being relative to its current working directory. (Meaning just pass the client’s request directly to `fopen`: if the client asks for `GET /somedir/somefile.txt`, the correct argument to `fopen` is `somedir/somefile.txt`). Your server executable should be called `http_server`, e.g.:

```
sudo ./http_server 80
```

```
./http_server 8888
```

(The `sudo` is there because using any port < 1024 requires root access.)

3 VM Setup

You’ll need 2 VMs to test your client and server together. Unfortunately, VirtualBox’s default setup does not allow its VMs to talk to the host or each other. There is a simple fix, but then that prevents them from talking to the Internet. So, be sure you have done all of your `apt-get` installs before doing the following! To be sure, just run:

```
sudo apt-get install gcc make gdb valgrind iperf tcpdump
```

You may create the 2nd VM by cloning the one from MP0. If you do this instead of a fresh install, change the MAC address policy to ‘*Generate new MAC addresses for all network adapters.*’

After making your second VM,

- Make sure the VMs are fully shut down.
- For each, go to Settings > Network. Switch the Adapter Type from NAT to “Host-only”, and click ok.
- When you start them, you should be able to `ssh` to them from the host, and each should be able to ping the other VM.

You can use `ip a` to find out the VMs’ IP addresses. If they get the same IP address, run `sudo dhclient -v` to get a new IP address on one of the VMs.

4 Autograder and Submission

Similar to the MP0, checkout your MP1 directory from the class repository:

```
git pull
```

```
git fetch release
```

```
git merge release/main -m “Merging release repository (MP1)”
```

The contents of the checked out mp1 folder will be similar to mp0 when you first checked it out. Use those programs as a starting point and make the modifications required for this assignment.

Modify the Makefile such that a simple `make` command in your mp1 folder creates the required executables. The autograder does just that. Be careful about the executable filenames and output filenames.

A new script (`inc_and_push.sh`) has been added for your convenience. It increments the version, commits the modified tracked files in git, and then pushes everything.

You have also been provided a text file, `partners.txt`. It should have the following format:

| |
|--------|
| NetID1 |
| NetID2 |

where the NetIDs belong to you and your partner. One student's submission suffices for both teammates to get their grade. If both partners submit, their grade will be the maximum of the two grades.

Follow the git instructions from MP0 to submit your code. Once the autograder is enabled, you will be able to run the `./see_results.sh` script to get the results.

Tests generally take 1-4 minutes, and there may be a queue of students. You can see where you are in the queue at

http://mobius03.cs.illinois.edu:4380/queue/queue_mp1.html

This is an Illinois private IP address. If your device is not accessing it through the campus network, please use the Illinois VPN to get a private IP address.

Caution: During the hours leading up to the submission deadline the queues could be multiple hours long. So it is advisable to get your work done early.

PLEASE do not fall into the trap of “debugging on the autograder”. If you submit a new version every time you make some change that might help pass an extra test, you are going to waste a lot of time waiting for results. Rather, only submit when you have made major progress or have definitively figured out what you were previously doing wrong. If you aren't genuinely surprised that your most recent submission didn't increase your score, you are submitting too often.

Your grade is the highest score that the autograder gives you across your submissions for MP1.

5 Grade Breakdown

- 25%: you submitted your assignment correctly and it compiles correctly on the autograder (You must have at least successfully committed your files into git to benefit from this.)
- 25%: `wget` can retrieve files from your HTTP server
- 25%: your client can retrieve files from your HTTP server
- 25%: your server does concurrency correctly: 1 very long download does not block many smaller downloads from starting immediately.

We will use `diff` to compare the server's copy with the downloaded copy, and you should do the same. If `diff` produces any output, you aren't transferring the file correctly.

6 Notes

- You must use C or C++.
common mistake: libraries must go at the end of the compile command.
- Your program must have a Makefile; running "make" should build all executables.
- **5% penalty:** Do not put compiled binary files (*.o, the final executable) into git
- Do not use a public github repo. You will be held partially responsible for any resultant plagiarism.
- Your code must be your own. You can discuss very general concepts with others, but if you find yourself looking at a screenful/whiteboard of pseudocode (let alone real code), you're going too far.
- Refer to the class slides and official student handbook for academic integrity policy. In summary, the standard for guilt is "more probable than not probable", and penalties range from warnings to recommending suspension/expulsion, based entirely on the instructor's impression of the situation.
- The College of Engineering has some guidelines for penalties that we think are reasonable, but we reserve the right to ignore them when appropriate.
- You can use libraries from wherever for data structures. You **MUST** acknowledge the source in a README. Algorithms (e.g. Dijkstra's) should be your own.
- Your code must run on the autograder setup, which are Ubuntu 20.04.3 LTS Server VMs running on VirtualBox.
- We will not look at your program on your laptop or EWS.
- Input files on the grader are READ-ONLY. Do not use the "rb+" mode to read them; the "+" asks for write permission. (In general, you shouldn't use "rb+" unless you need it, which should be rare.)
- Input files on the grader are general binary data, NOT text.
- If you run the `see_results.sh` file on mp1 before the autograder has been activated, your directory will move to the `_grades` branch. You will have to manually execute `git checkout master` to get back to your working branch. **DO NOT** work on the `_grades` branch!
- All of your source files will be checked for plagiarism. So do not use pieces of code outside of what has been provided in `_release`.