

CPSC 3600 Homework1

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Spring 2021 (50 points)

Due: 2/16/2021 before 9pm EST.

Instructions:

Can be done individually or in teams of two!!! If you are doing it in teams of two, please make sure that both of you know how to do all the exercises, and make only one submission per team. A great way to collaborate is to use a Zoom session and share screen while you work! You *cannot* talk to other students or teams, you can only talk to your teammate, teacher, or TA. Teammates share the grade. All the skills in this homework are very useful! When submitting your homework, clearly indicate the names on top of the file (no name, no grade). Your screenshots should be trimmed to remove the unneeded areas, so the images are clearly readable. ALL explanations should be in your own words, not copy-pasted from the Internet. This file is in the editable document format, so you can make space between questions and type your answers right there. Then save it as a pdf and submit to canvas. Please do not use red font!

Question 1 (15 points)

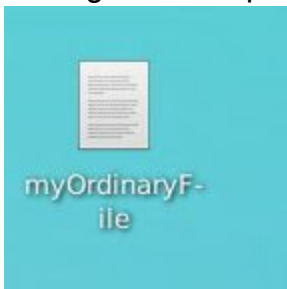
Read the paper “The Unix Time Sharing System” in the Files section of canvas. Based on the paper, and possibly with a bit more digging into additional material on Unix/Linux, answer the following questions.

1. Define a process. (1 point)

Process is a OS abstraction for code being executed by one or many different threads

2. Identify three types of files in Linux. Briefly describe each type in your own words. Find an example of each and paste it here along with its path. (3 points)

ordinary disk files - A file contains whatever information the user places on it
users/gav/Desktop/myOrdinaryFile (No Extension)



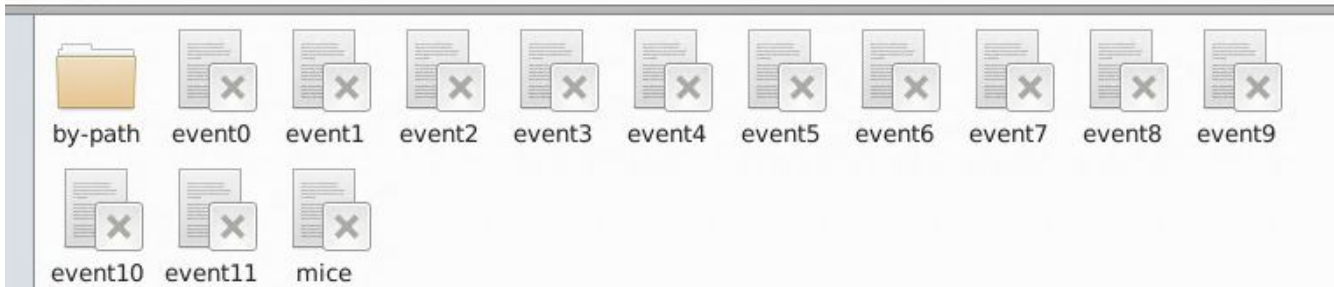
directories - Directories provide the “mapping” between the names of files and the files themselves
users/gav/Desktop



special files - Special files are read and written just like ordinary disk files, but requests to read or write result in activation of the associated device

/dev/input (special file assigned input devices such as mouse or keyboard)

/dev/input/



3. Summarize the access control system provided by Unix. (4 points)

Each user of the system is assigned a unique user identification number. When a file is created, it is marked with an ID unique to its creator. New files are given a set of seven protection bits. Six of these specify read, write, and execute permission for the owner/creator of the file and the rest for other users. If the seventh bit is flipped to true then system will temporarily change the user ID of the active user to the user ID of the file creator only during execution

4. What is an i-node? (1 point)

Contains an description of the file (information like it's size,owner, etc)

5. What is a shell? (1 point)

In essence the shell is a command line processor: it takes in lines typed by the user and reads them as requests to execute other programs

6. What is I/O redirection? Explain what standard input, standard output and standard error streams are. Please show an example or two of each. (5 points)

IO redirection is capturing the output of a file, script or anything with output and passing it as the input of another program

Standard Input - is the source of input data for command line programs

Example is scanf() in C, the input comes from standard input

Standard Output - refers to the standardized streams of data that are produced by command line programs

Example is `printf` in C, which prints out to STDOUT

Standard Error - is the default file descriptor where a process can write error messages

Example is `fprintf(stderr, "string",30)`, which outputs to `stderr`

Question 2 (9 points)

1. Explain the results you see when you run the two pipelines below. A pipeline is a sequence of commands/filters/programs each having its standard output redirected to the standard input of the next command in the sequence. (3 points)

```
head -c 5 /dev/urandom | wc
```

```
0      1      5
```

```
head -c 5 /dev/urandom | od -x --endian=big
```

```
0000000  9e03      3e18      0800      0000005
```

The first command displays the first 5 bytes of a file with the number of words lines and bytes on the first 5 bytes.

The second is doing the same thing but instead printing the first 5 bytes out in hexadecimal format in big endian notation

To understand what is going on on the command line, please first research and describe what *wc*, *head*, and *od* commands are and what their options (*-c -x -ending=big*) mean. (3 points)

a. *head* displays the first 5 bytes of a file inside `/dev/urandom` and *wc* displays the number of words, lines and bytes in each input file

b. *head* displays the first 5 bytes of a file inside `/dev/urandom` and *od -x* set output to hexadecimal shorts in big endian format

a. `head -c 5 /dev/urandom | wc`

b. `head -c 5 /dev/urandom | od -x --endian=big`

2. What is the purpose of the `/dev` directory in Unix/Linux? What is `/dev/urandom` and what is its purpose? (3 points)

`/dev` is the location of all special or device files. `/dev/urandom` serves as the files for pseudo random number generators. *Urandom* is used in industry standard cryptographic encryption. It's main job is to generate cryptographically secure numbers based on system "noise" collected from run time.

Question 3 (9 points)

Using your VM or a standalone Linux installation, please answer the following questions.

1. Issue the 'man man' command on the command line. What information did you find? How many sections does the manual have? Briefly summarize all the findings. (5 points)

man man searches the manual for the command man. It provides information about the manual itself such as sections, different options, as well as environmental variables that can be set. There are a total of 8 sections.

2. What is the difference between a 'man 1 printf' and 'man 3 printf' ? (1 point)

man 1 gives you the user command documentation for printf. Man 3 gives you the C documentation for printf

3. What does command *apropos* do? Give two examples of how to use it. What is the difference between *man* and *apropos*? (3 point)

apropos searches the whatis database for strings. Helpful for searching for commands without knowing the exact name. You could type apropos man or apropos mount if you wanted to search the what is database for it. apropos cat | less if you want to show less. Man is much more useful when you know the exact command name. Apropos can "suggest" what command you were searching for.

Question 4 (12 points)

1. Find out what *traceroute* command does and explain it in your own words. When will this command be useful? (2 points)

Print the route packets take to the network host. It's useful in network debugging when you want to see all the hops a packet takes and the total network delay.

On the *command line*, please issue a command
traceroute www.clemson.edu

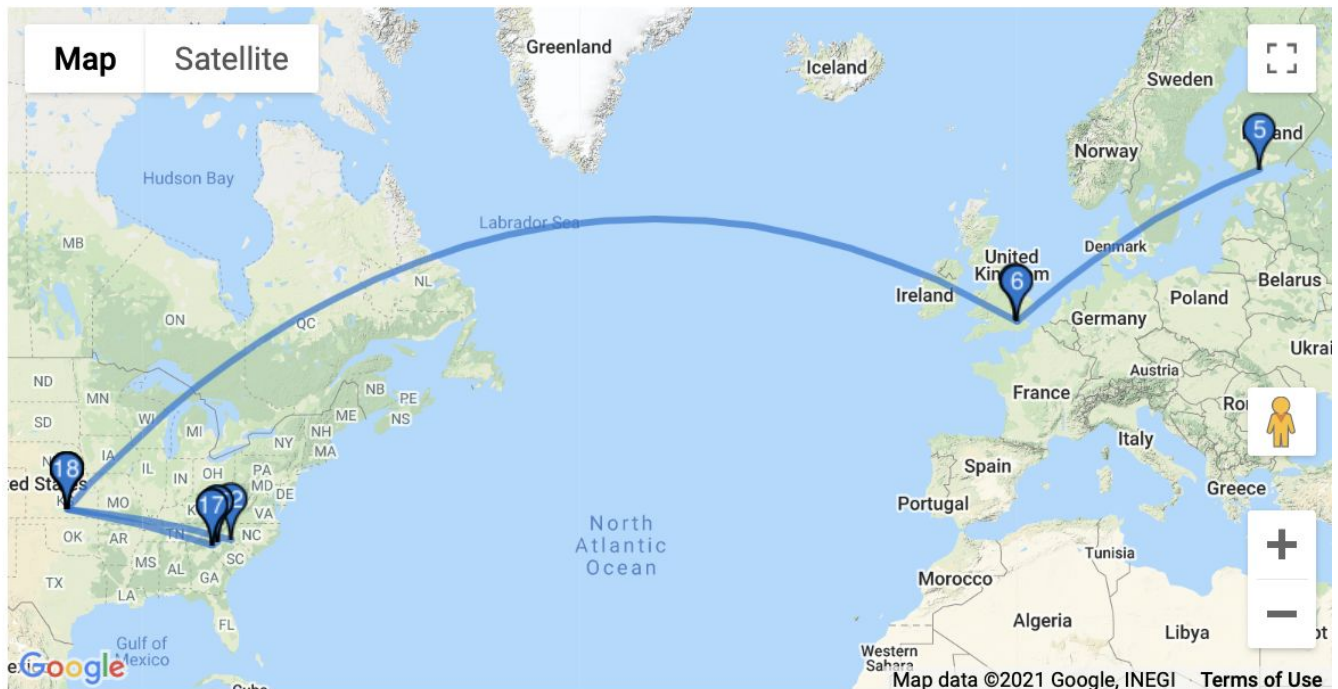
Paste a screenshot here. (Please edit it to trim the areas that are not needed, so that the output is readable) Explain every entry of the output. Did you see any asterisks? What do they mean? There are three sets of time on each line. What are those times? (4 points)

The three sets of time on each line is the time for each probe sent to receive a reply.

Asterisk signals no reply after 5 seconds. The entry is the private network device sending a packet to the router then that packet arriving towards its destination and continually being routed through. It's hard to explain exactly what lines 3-10 are doing but they are routing the packet through different routers until it reaches the last entry which is www.clemson.edu

```
Gavins-MacBook-Pro:~ gavintaylorlormcroy$ man traceroute
Gavins-MacBook-Pro:~ gavintaylorlormcroy$ traceroute www.clemson.edu
traceroute to www.l.clemson.edu (130.127.204.30), 64 hops max, 52 byte packets
 1  192.168.1.1 (192.168.1.1)  1.834 ms  1.482 ms  6.518 ms
 2  209.37.123.254 (209.37.123.254)  4.913 ms  6.642 ms  3.128 ms
 3  12.124.145.13 (12.124.145.13)  17.488 ms  7.503 ms  9.370 ms
 4  cr1.attga.ip.att.net (12.122.141.222)  8.750 ms  7.051 ms
    12.122.141.162 (12.122.141.162)  10.015 ms
 5  12.122.29.209 (12.122.29.209)  16.607 ms
    gar9.attga.ip.att.net (12.122.96.81)  77.290 ms
    12.122.29.209 (12.122.29.209)  61.655 ms
 6  12.86.186.10 (12.86.186.10)  44.177 ms  11.949 ms  17.714 ms
 7  205-186-63-36.generic.c-light.net (205.186.63.36)  9.747 ms  11.152 ms  14.9
23 ms
 8  205-186-62-17.generic.c-light.net (205.186.62.17)  9.088 ms  8.220 ms  12.39
2 ms
 9  130.127.3.186 (130.127.3.186)  9.604 ms
    130.127.3.185 (130.127.3.185)  11.413 ms
    130.127.3.186 (130.127.3.186)  10.839 ms
10  130.127.3.74 (130.127.3.74)  12.798 ms
    130.127.3.72 (130.127.3.72)  10.293 ms
    130.127.3.74 (130.127.3.74)  11.185 ms
11  130.127.204.30 (130.127.204.30)  12.804 ms  12.742 ms  9.807 ms
Gavins-MacBook-Pro:~ gavintaylorlormcroy$
```

2. Using your favorite search engine, find a visual *traceroute* tool online. (no need to download/install anything, you can use it on the website). Use a known website, other than amazon.com or google.com to run the trace. What information did you find? Does this provide more information than the command-line traceroute? Paste a trimmed screenshot here. (5 points)



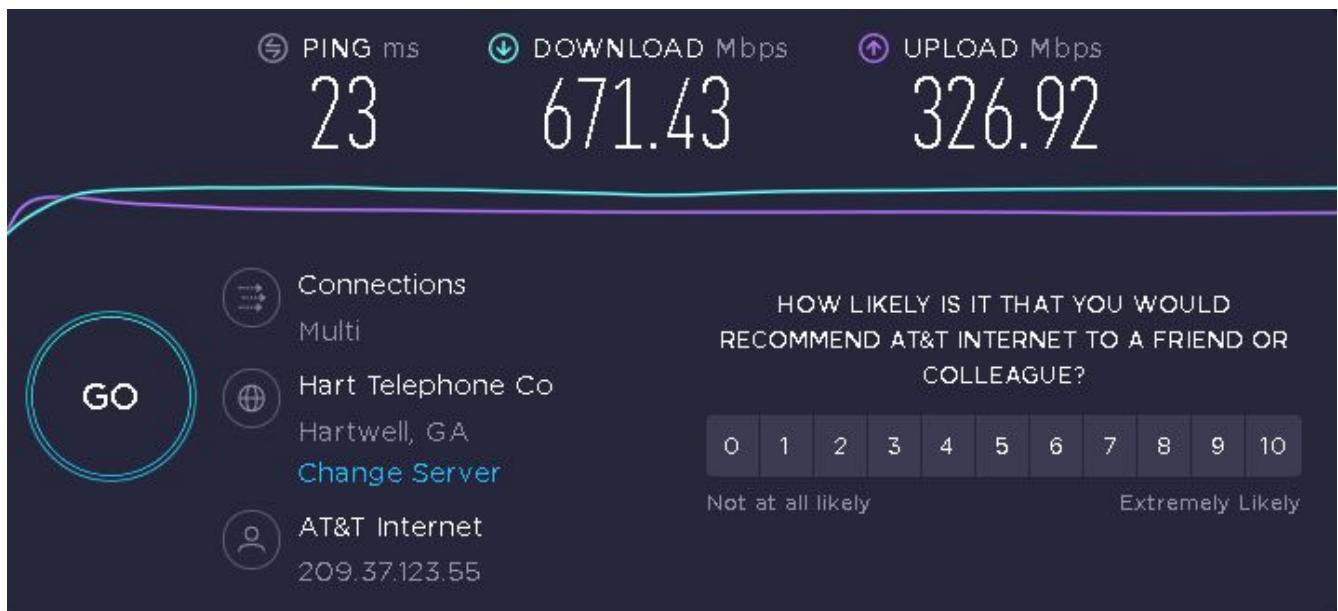
traceroute to www.l.clemson.edu (**130.127.204.30**), 30 hops max

Hop	Host	IP	Time (ms)
1	dgw1-wan-uk-lon1.ipv4.upcloud.com	83.136.248.1	0.089ms
2	100.69.3.17	100.69.3.17	0.259ms
3	172.17.255.241	172.17.255.241	0.240ms
4	172.17.255.253	172.17.255.253	0.218ms
5	r2-lon1-po1.uk.net.upcloud.com	94.237.0.121	0.229ms
6	te0-3-1-4.rcr51.lon17.atlas.cogentco.com	149.11.141.9	0.501ms
7	be2971.ccr42.lon13.atlas.cogentco.com	154.54.39.81	1.168ms
8	be12489.ccr42.par01.atlas.cogentco.com	154.54.57.70	80.488ms
9	be3628.ccr42.jfk02.atlas.cogentco.com	154.54.27.169	78.504ms
10	be2807.ccr42.dca01.atlas.cogentco.com	154.54.40.110	80.266ms
11	be2656.rcr21.clt01.atlas.cogentco.com	154.54.41.46	86.597ms
12	38.140.175.114	38.140.175.114	84.501ms
13	*	*	*
14	205-186-62-91.generic.c-light.net	205.186.62.91	87.799ms
15	205-186-62-90.generic.c-light.net	205.186.62.90	89.519ms
16	130.127.3.185	130.127.3.185	88.442ms
17	130.127.3.98	130.127.3.98	90.051ms
18	130.127.204.30	130.127.204.30	87.818ms

I used clemson.edu out of curiosity and was surprised to see many of the packets traveled to Finland then to the UK only to go back to the US. I never thought a simple clemson.edu search would send information all the way to Europe and back in the snap of a finger. I would say this provides more information since you can visualize where the packet travels + most of the host names are resolved with the IP addresses beside it.

Question 5 (6 points)

1. Search for an online speed test to determine your network bandwidth. Measure your asymmetrical bandwidth upstream and downstream. Which one is higher and why? Run the test 4 times and calculate the average upload and download rates. Paste one of the screenshots with test results here. (3 points)



Ping: 23	Download: 671.43	Upload: 326.92
Ping: 7	Download: 737.29	Upload: 326.20
Ping: 19	Download: 742.64	Upload: 378.86
Ping: 7	Download: 766.83	Upload: 402.69
AVERAGE		
Ping: 14	Download: 729.55	Upload: 358.67

Download on average was about 2x faster than upload. Normally this is by design of the ISP as more people are downloading information than uploading to the internet so it's more beneficial to optimize download over upload for consumer usage.

2. Now find another online speed test. Repeat the same. Get the average of the 4 tests again. Are the results consistent between the two different speed tests, or are there variations? Explain why it would be so. (3 points)

(Google Download Speed)

Ping: 5	Download: 685.7	Upload: 112.2
Ping: 5	Download: 715.5	Upload: 57.6
Ping: 4	Download: 740.8	Upload: 895.2
Ping: 5	Download: 706.1	Upload: 122.5
AVERAGE		

Ping: 4.75 Download: 712.03 Upload: 296.88

There are some pretty severe variations which I would believe come from the actual ISP throttling the internet. There is a lot of internet usage between all my roommates and during the night upload speeds fluctuate like crazy.

Extra Credit (3 points)

Using your VM or Linux installation machine, find out how to obtain information about your computer's network interface using command line utilities. Which file/s in Linux contain your machine's IP address and other network info. Show a screenshot of the command you ran that showed this info and a screenshot of a file you found.

/etc/sysconfig/**network**-scripts