

1. HTTP and HTTPS are both internet protocols that are used to transfer data over a network. HTTP stands for Hypertext transfer protocol and HTTPS stands for Hypertext transfer protocol Secure. HTTPS is a secure version of HTTP in that messages sent over the network are encrypted. HTTP messages can be intercepted by people and read as plain english. In HTTPS the messages are encrypted and if they are intercepted the message appears as random characters.
2. The server responded with a status code of 200. The content type is text/html. The message sent was an ok message letting the recipient know that their message was received.

858	82.76853000	93.184.216.34	10.0.2.15	HTTP	1061 HTTP/1.1 200 OK (text/html)	mininet@mininet-vm:~\$ date
861	82.80908800	10.0.2.15	93.184.216.34	HTTP	425 GET /favicon.ico HTTP/1.1	Tue Oct 19 22:46:28 PDT 2021
863	82.83629800	93.184.216.34	10.0.2.15	HTTP	1069 HTTP/1.1 404 Not Found (text/html)	mininet@mininet-vm:~\$

3. The web object is transferred from the server that is hosting the website.
4. The difference in this response is both the status code and message were different. In this case the server responded with a status code 301 and the message moved permanently.

2896	5055.522439	10.0.2.15	128.114.47.158	HTTP	457 GET / HTTP/1.1	mininet@mininet-vm:~\$ date
2898	5055.550601	128.114.47.158	10.0.2.15	HTTP	614 HTTP/1.1 301 Moved Permanently (text/html)	Tue Oct 19 23:54:01 PDT 2021
2964	5056.003990	10.0.2.15	91.199.212.52	HTTP	348 GET /COMMONORSAOrganizationValidationSecureS	mininet@mininet-vm:~\$

5. In a GET message the parameters for the request are contained within the URL. In a POST message the parameters for the request are contained within the body of the request. One advantage of using GET is that the message can be cached. One disadvantage for GET is it is less secure since it can only contain ASCII characters making it more readable. One advantage of POST is that other forms of data other than ASCII can be sent. One disadvantage of POST is that request cannot be bookmarked or cached.

(screenshot for 5)

52	64.78413000	10.0.2.15	93.184.216.34	HTTP	136 POST / HTTP/1.1
54	64.82355000	93.184.216.34	10.0.2.15	HTTP/XML	572 HTTP/1.1 411 Length Required


```
mininet@mininet-vm: ~  
File Edit Tabs Help  
mininet@mininet-vm:~$ date  
Wed Oct 20 01:02:39 PDT 2021  
mininet@mininet-vm:~$ curl -X POST http://www.example.com  
<?xml version="1.0" encoding="iso-8859-1"?>  
<!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.0 Transitional//EN"  
  "http://www.w3.org/TR/xhtml1/DTD/xhtml1-transitional.dtd">  
<html xmlns="http://www.w3.org/1999/xhtml" xml:lang="en" lang="en">  
  <head>  
    <title>411 - Length Required</title>  
  </head>  
  <body>  
    <h1>411 - Length Required</h1>  
  </body>  
</html>  
mininet@mininet-vm:~$
```

face 0
184.216.34)
: 1, Ack: 1, Len: 80

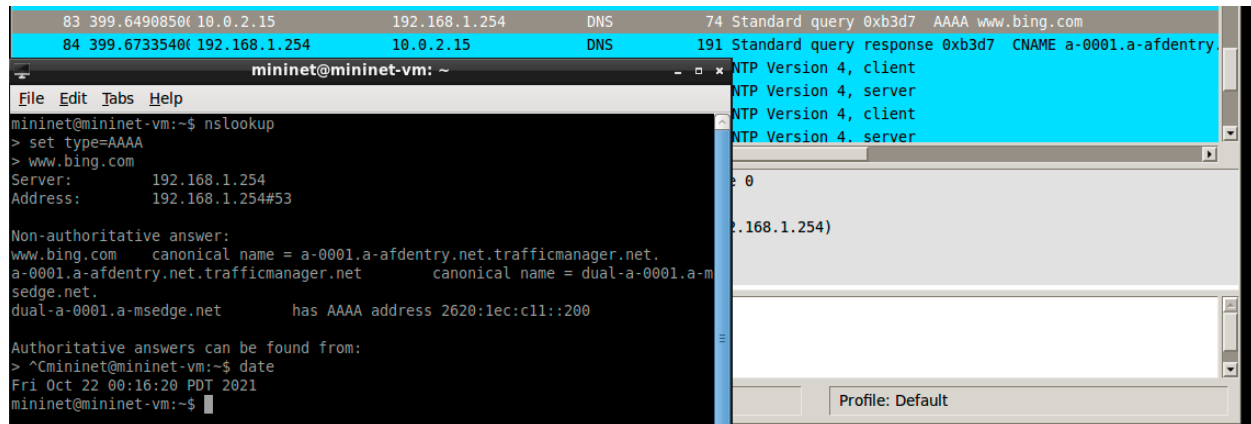
6. It appears my computer sends a DNS request to some server for the website example.com. I believe these are the packets that load example.com since the first one is my computer requesting for the url example.com and then the next message is the response from the server.

6133	171.2839060	10.0.2.15	192.168.1.254	DNS	77 Standard query 0x0785 A www.example.com
6134	171.2960120	192.168.1.254	10.0.2.15	DNS	93 Standard query response 0x0785 A 93.184.216.34


```
mininet@mininet-vm: ~  
File Edit Tabs Help  
mininet@mininet-vm:~$ date  
Thu Oct 21 21:38:35 PDT 2021  
mininet@mininet-vm:~$
```

Standard query 0x17c8 A www.iana.org
Standard query response 0x17c8 CNAME ianawww.vip.icann.org A 192.0.33.8
Standard query 0x23fc A safebrowsing.googleapis.com
Standard query response 0x23fc A 64.233.177.95
Standard query 0x0f81 A clients2.google.com
Standard query response 0x0f81 CNAME clients1.google.com A 142.251.40.78

7. From the second screenshot the IPV6 address seems to be 2620:1ec:c11::200



```
83 399.6490850f 10.0.2.15 192.168.1.254 DNS 74 Standard query 0xb3d7 AAAA www.bing.com
84 399.6733540f 192.168.1.254 10.0.2.15 DNS 191 Standard query response 0xb3d7 CNAME a-0001.a-afdentry.net
NTP Version 4, client
NTP Version 4, server
NTP Version 4, client
NTP Version 4, server
mininet@mininet-vm: ~
File Edit Tabs Help
mininet@mininet-vm:~$ nslookup
> set type=AAAA
> www.bing.com
Server: 192.168.1.254
Address: 192.168.1.254#53

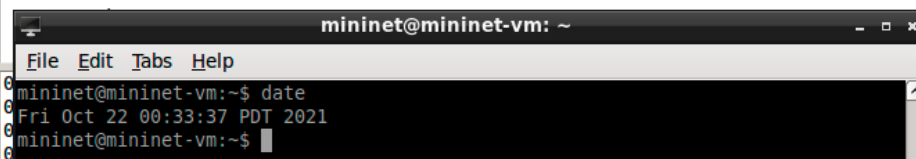
Non-authoritative answer:
www.bing.com canonical name = a-0001.a-afdentry.net.trafficmanager.net.
a-0001.a-afdentry.net.trafficmanager.net canonical name = dual-a-0001.a-msedge.net.
dual-a-0001.a-msedge.net has AAAA address 2620:1ec:c11::200

Authoritative answers can be found from:
> ^Cmininet@mininet-vm:~$ date
Fri Oct 22 00:16:20 PDT 2021
mininet@mininet-vm:~$
```

```
▷ www.bing.com: type CNAME, class IN, cname a-0001.a-afdentry.net.trafficmanager.net
▷ a-0001.a-afdentry.net.trafficmanager.net: type CNAME, class IN, cname dual-a-0001.a-msedge.net
▽ dual-a-0001.a-msedge.net: type AAAA, class IN, addr 2620:1ec:c11::200
  Name: dual-a-0001.a-msedge.net
  Type: AAAA (IPv6 address)
  Class: IN (0x0001)
  Time to live: 41 seconds
  Data length: 16
  Addr: 2620:1ec:c11::200
```

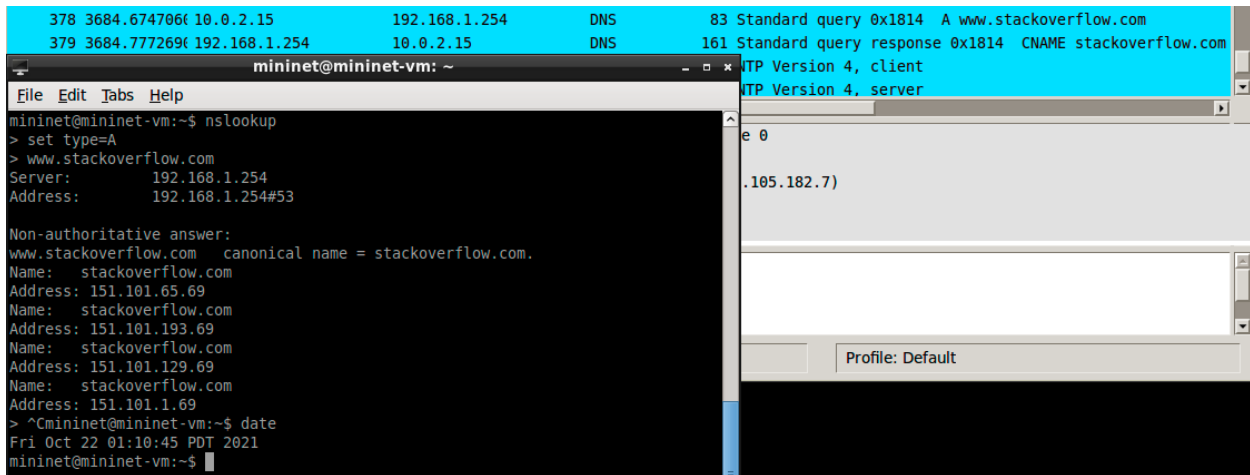
8. Based on the flags of the response it appears that my computer completed the request recursively and not iteratively. This is because in the flags, there's the line "Recursion desired: Do query recursively" then the next line confirms the use of recursion.

```
▽ Flags: 0x8180 Standard query response, No error
 1... .. = Response: Message is a response
.000 0... .. = Opcode: Standard query (0)
... .0.. .. = Authoritative: Server is not an authority for domain
... ..0. .... = Truncated: Message is not truncated
... ..1 .... = Recursion desired: Do query recursively
... ..1... .. = Recursion available: Server can do recursive queries
... ..0.. .... = Z: reserved (0)
... ..0. .... = Answer authenticated: Answer/authority portion was not authenticated by the server
... ..0 .... = Non-authenticated data: Unacceptable
... ..0000 = Reply code: No error (0)
```



```
mininet@mininet-vm: ~
File Edit Tabs Help
mininet@mininet-vm:~$ date
Fri Oct 22 00:33:37 PDT 2021
mininet@mininet-vm:~$
```

9. I was given 4 ip Addresses: 151.101.665.69, 151.101.193.69, 151.101.129.69, 151.101.1.69.

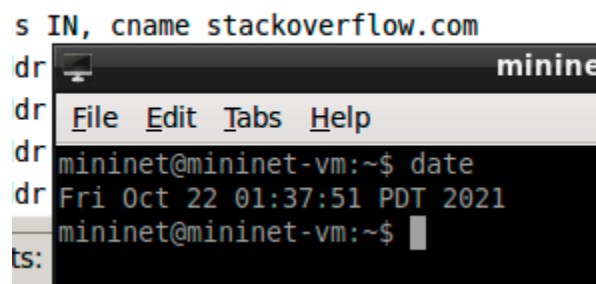


```
378 3684.674706 10.0.2.15 192.168.1.254 DNS 83 Standard query 0x1814 A www.stackoverflow.com
379 3684.777269 192.168.1.254 10.0.2.15 DNS 161 Standard query response 0x1814 CNAME stackoverflow.com

mininet@mininet-vm: ~
File Edit Tabs Help
mininet@mininet-vm:~$ nslookup
> set type=A
> www.stackoverflow.com
Server: 192.168.1.254
Address: 192.168.1.254#53

Non-authoritative answer:
www.stackoverflow.com canonical name = stackoverflow.com.
Name: stackoverflow.com
Address: 151.101.65.69
Name: stackoverflow.com
Address: 151.101.193.69
Name: stackoverflow.com
Address: 151.101.129.69
Name: stackoverflow.com
Address: 151.101.1.69
> ^Cmininet@mininet-vm:~$ date
Fri Oct 22 01:10:45 PDT 2021
mininet@mininet-vm:~$
```

10. The other name for www.stackoverflow.com is indicated by the “cname” part of the response. In the case of this request the cname is stackoverflow.com. The DNS record that identifies the “other name” is a canonical Name Record.



```
s IN, cname stackoverflow.com
dr mininet
dr File Edit Tabs Help
dr mininet@mininet-vm:~$ date
dr Fri Oct 22 01:37:51 PDT 2021
ts: mininet@mininet-vm:~$
```

11. The mx records for `www.stackoverflow.com` are listed in the screenshot below. These are correct since this is the response received from a `nslookup` with type `mx` on the corresponding domain. The mail exchange with the highest preference is `aspmx.l.google.com`.

```
Additional RRs: 0
Queries
  www.stackoverflow.com: type MX, class IN
Answers
  www.stackoverflow.com: type CNAME, class IN, cname stackoverflow.com
  stackoverflow.com: type MX, class IN, preference 5, mx alt1.aspmx.l.google.com
  stackoverflow.com: type MX, class IN, preference 10, mx alt3.aspmx.l.google.com
  stackoverflow.com: type MX, class IN, preference 1, mx aspmx.l.google.com
  stackoverflow.com: type MX, class IN, preference 5, mx alt2.aspmx.l.google.com
  stackoverflow.com: type MX, class IN, preference 10, mx alt4.aspmx.l.google.com

mininet@mininet-vm: ~
File Edit Tabs Help
mininet@mininet-vm:~$ date
Fri Oct 22 01:42:06 PDT 2021
mininet@mininet-vm:~$
```

12. My computer advertised a window of 29200, and the server responded with a window size of 65535.

```
260 1472.672558 10.0.2.15 80.249.99.148 TCP 76 50578 > http [SYN] Seq=0 Win=29200 Len=0 MSS=1460 SACK_PERM=1 TSval=319355 TSecr=0 WS=128
261 1472.819042 80.249.99.148 10.0.2.15 TCP 62 http > 50578 [SYN, ACK] Seq=0 Ack=1 Win=65535 Len=0 MSS=1460
262 1472.819066 10.0.2.15 80.249.99.148 TCP 56 50578 > http [ACK] Seq=1 Ack=1 Win=29200 Len=0
263 1472.819327 10.0.2.15 80.249.99.148 HTTP 194 GET /10MB.zip HTTP/1.1
264 1472.819553 80.249.99.148 10.0.2.15 TCP 62 http > 50578 [ACK] Seq=1 Ack=139 Win=65535 Len=0

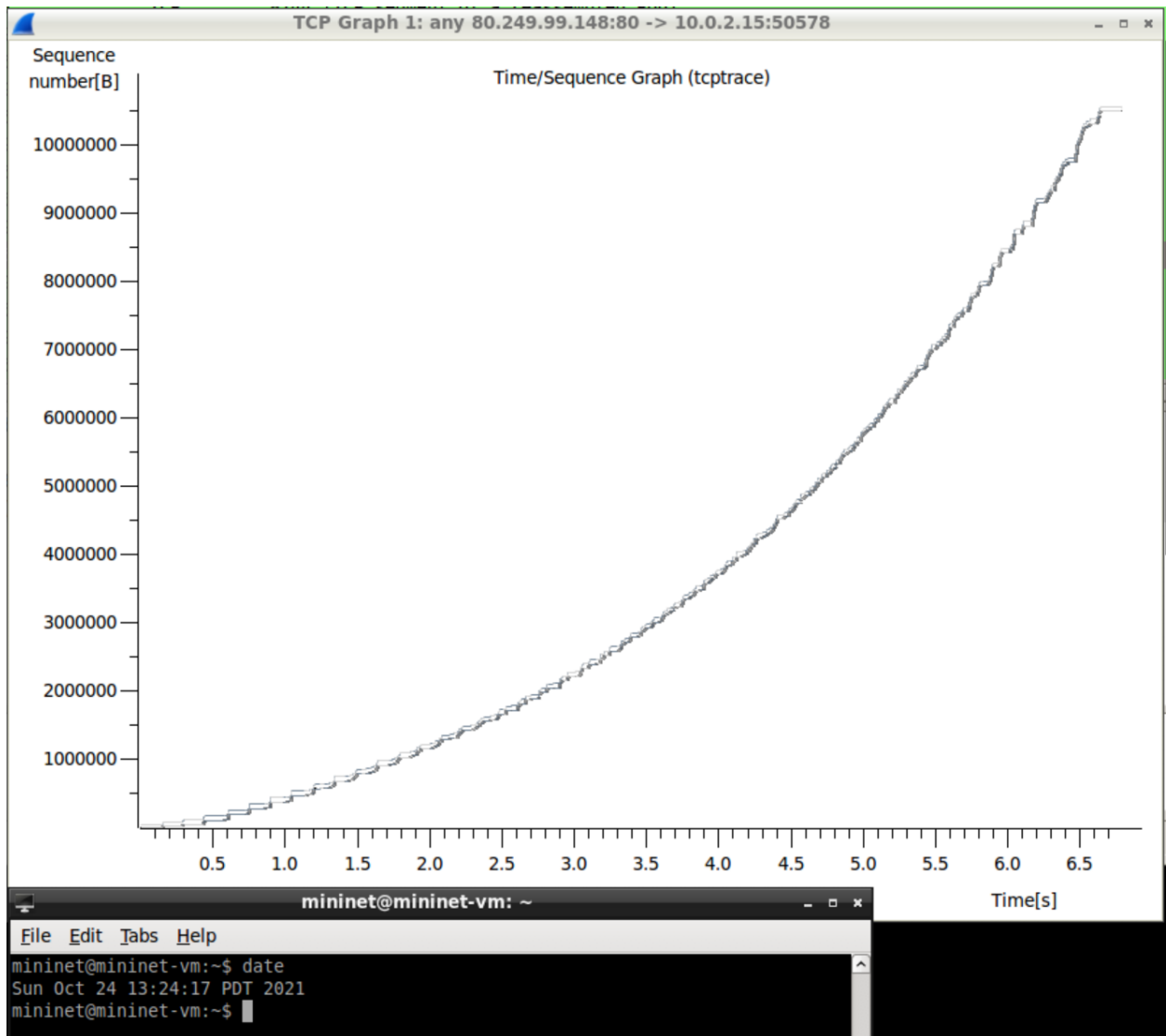
mininet@mininet-vm: ~
File Edit Tabs Help
mininet@mininet-vm:~$ date
Sun Oct 24 11:18:42 PDT 2021
mininet@mininet-vm:~$ wget http://ipv4.download.thinkbroadband.com/10MB.zip
--2021-10-24 11:37:55-- http://ipv4.download.thinkbroadband.com/10MB.zip
Resolving ipv4.download.thinkbroadband.com (ipv4.download.thinkbroadband.com)...
80.249.99.148
Connecting to ipv4.download.thinkbroadband.com (ipv4.download.thinkbroadband.com) [80.249.99.148]:80... connected.
HTTP request sent, awaiting response... 200 OK
Length: 10485760 (10M) [application/zip]
Saving to: '10MB.zip'

100%[=====] 10,485,760 2.27MB/s in 6.5s

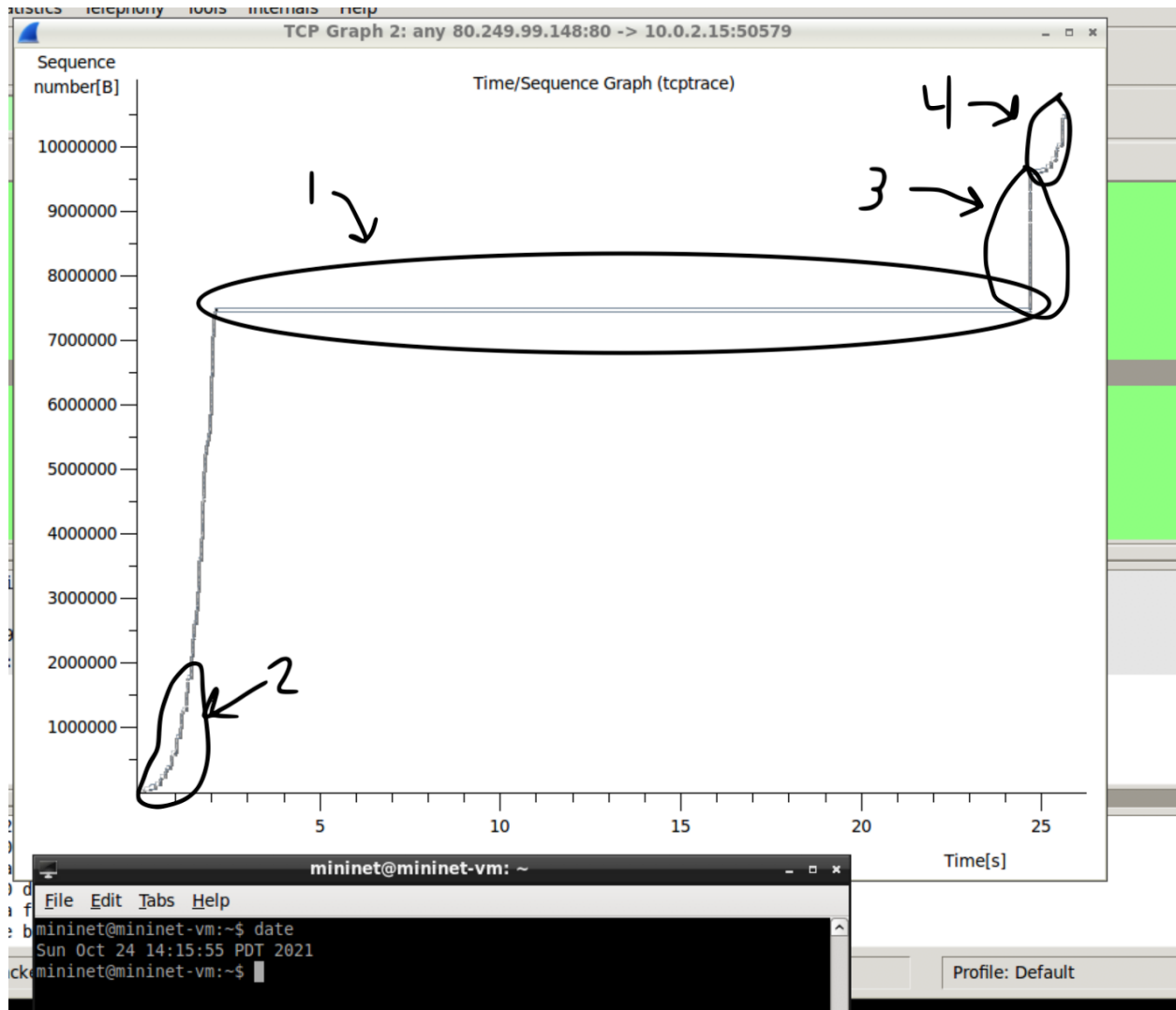
2021-10-24 11:38:03 (1.54 MB/s) - '10MB.zip' saved [10485760/10485760]

mininet@mininet-vm:~$
```

13. This graph is showing the data transmission between the client and the server. Each of the black lines going upward represents the data being sent, the gap between each of the data lines is the time between each data transfer, which is one clock cycle.



14. Parts 1-4 denoted on screenshot



14 part 5-8

5. The average throughput with packet loss is 0 and the average throughput without packet loss is roughly 1 megabit per second. There is a large discrepancy between these two because when there is 100% packet loss nothing is being transmitted thus the throughput is 0.

6. If this transfer were to occur with UDP the average throughput without packet loss would be faster since UDP is a faster communication protocol than TCP. With 100% packet loss I would expect the throughput to be the same and also be zero since no data would be transmitted.

7. I would expect the end to end delay to be shorter using UDP with and without packet loss.

8. In regards to TCP I would expect the end to end delay to be longer with and without packet loss.