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Homework 1
10/6/17

1.

a. With packet switching, you don't need to reserve bandwidth on the network. This doesn't limit the number of users that can use the link.

b. A protocol dictates how a "conversation" between machines will occur in the network. If one machine receives a message in one format, the other machine will have a set number of possible responses to that message.

c. Transmission delay is the amount of time it takes for the router to gather all of the bits in the packet and send them out. IT depends on the size of packets, and the transmission rate of the router.

d. Propagation delay is the time it takes for a packet to go from one router to another after it has been transmitted. It depends on the amount of distance between the two routers.

e. The destination needs a port number to identify which process it should run to handle the message. The source needs a port number so the destination has a "return address" of the sending process, so the transport layer can demultiplex the message to the correct application layer socket.

f. One advantage is encapsulation. This allows the hiding of important implementation information that upper levels don't have to worry about. The modularity that layering allows, allows the system to update and modify individual components of the networking system.

2.

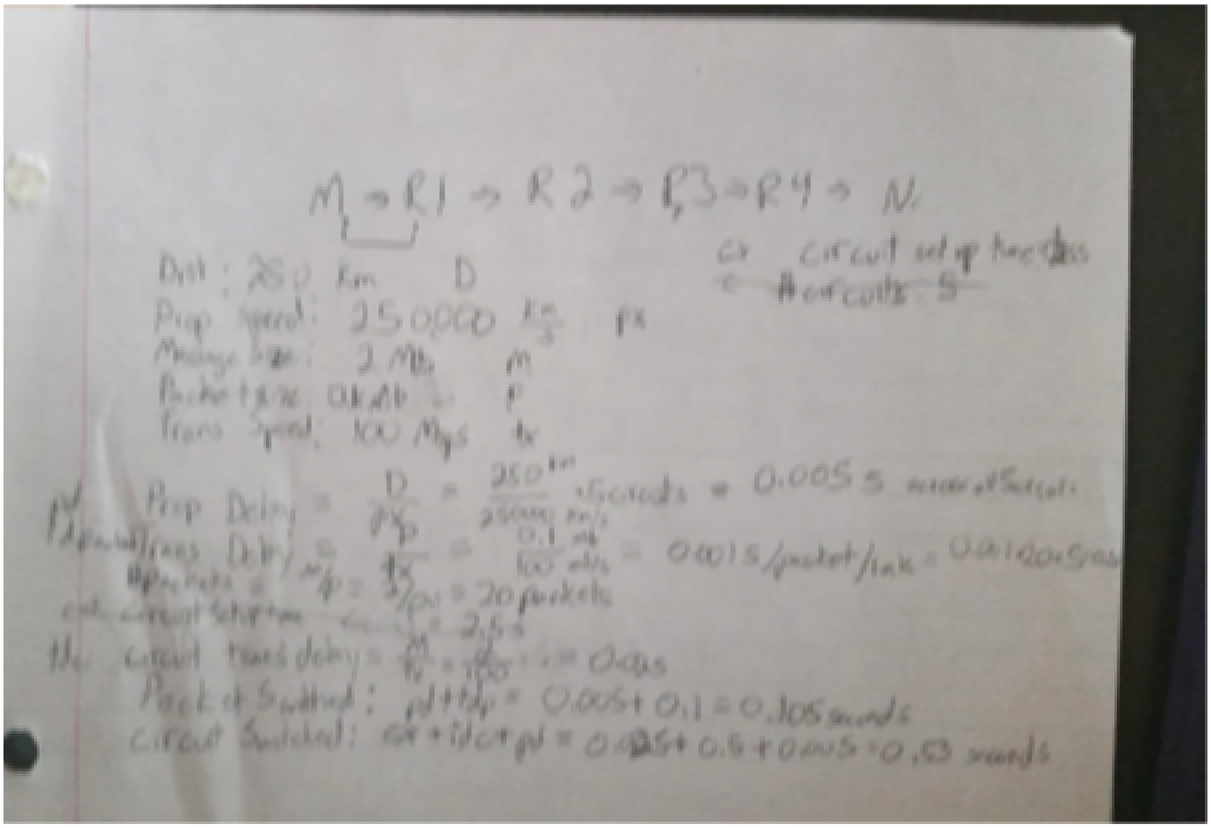
a. 3 Mbps / 150 kbps = 20
20 users

B. The user transmits 10% of the time
10%

C. $$\frac{120!}{n!\,(120-n)!} * 0.1^{n} * (0.9)^{120-n}$$

D. $$\sum_{n=21}^{120} \frac{120!}{n!\,(120-n)!} * 0.1^{n} * (0.9)^{120-n}$$ = 0.0079412=0.79412%

3.



$M \to R1 \to R2 \to R3 \to R4 \to N$

Dist : 250 km   D

Prop speed: 250,000 km/s   ps

Message size: 2 Mb   m

Packet size: 0.1 Mb   p

Trans speed: 100 Mbps   tx

cs   circuit set up time 2.5s

~~c   # of circuits 5~~

pd   Prop Delay = D/ps = 250 km / 250000 km/s ·seconds = 0.005 s [illegible]

tdp   Trans Delay = p/tx = 0.1 Mb / 100 Mb/s = 0.001 s/packet/link = 0.001·20·5 [illegible]

#packets = m/p = 2/0.1 = 20 packets

cst   circuit setup time = [illegible] = 2.5 s

tdc   circuit trans delay = m/tx = 2/100 [illegible] = 0.025

Packet Switched: pd + tdp = 0.005 + 0.1 = 0.105 seconds

Circuit Switched: cst + tdc + pd = 0.025 + 0.5 + 0.005 = 0.53 seconds

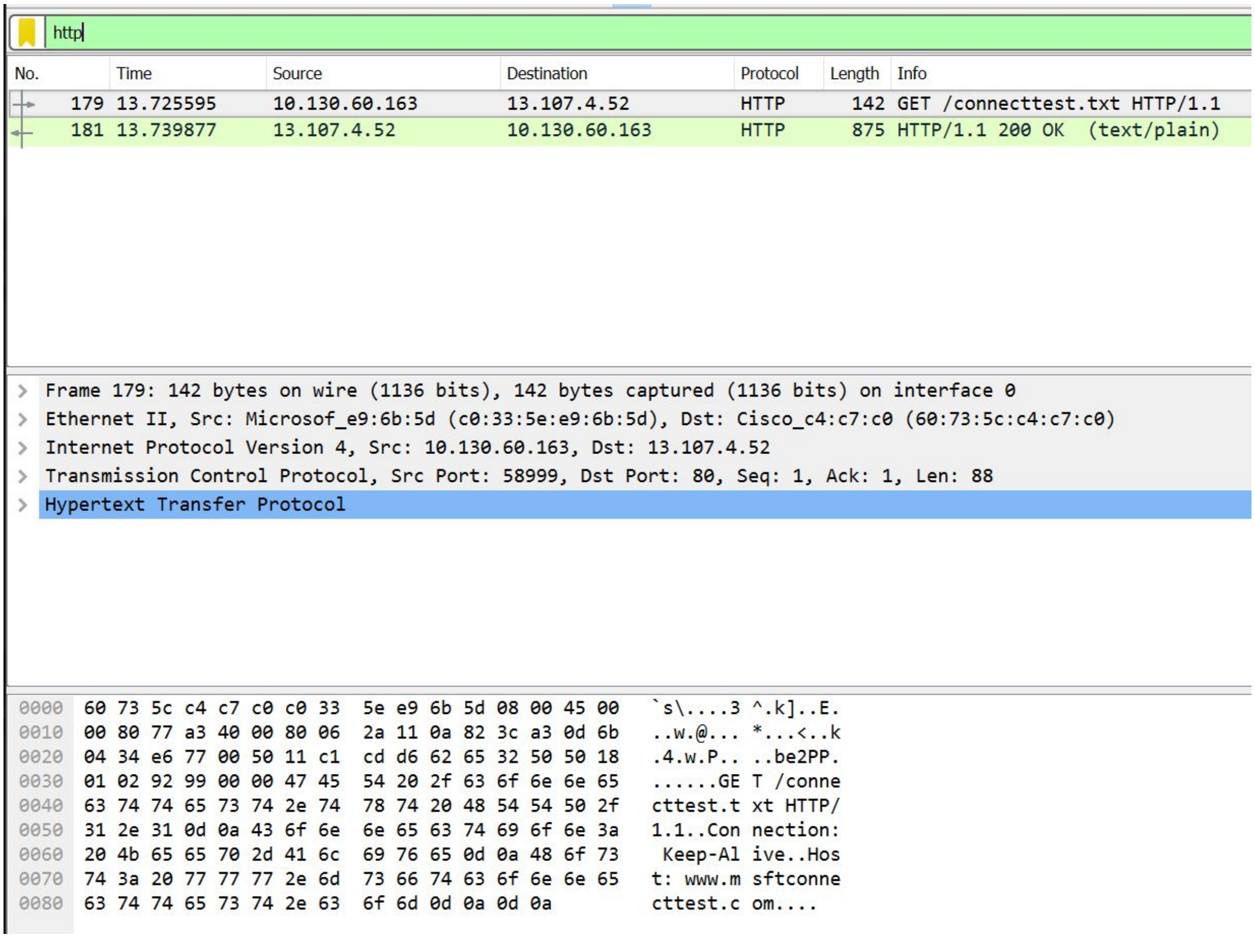
a. 0.53s
b. 0.105s
c. The delay would not change. Since we have uniform values for both sending and receiving messages at all nodes, no values values in our formulas would change, and the result wouldn't change.

4.

$$\left(\sum_{i=1}^{n} RTT_i\right) + RTT_0 + RTT_0$$

It is the sum of all of the round trip times to the DNS server and two of the round trip times to the web server (one to establish the connect, and another to get the HTML object).

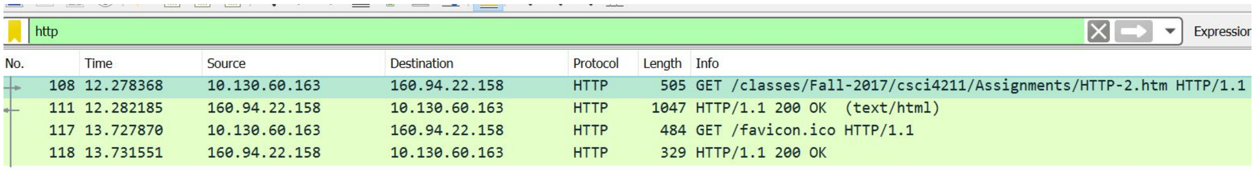
5.



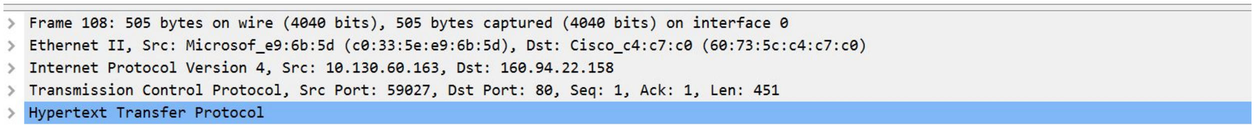
```
No.     Time        Source          Destination     Protocol  Length  Info
  179  13.725595   10.130.60.163   13.107.4.52     HTTP       142    GET /connecttest.txt HTTP/1.1
  181  13.739877   13.107.4.52     10.130.60.163   HTTP       875    HTTP/1.1 200 OK  (text/plain)
```

```
> Frame 179: 142 bytes on wire (1136 bits), 142 bytes captured (1136 bits) on interface 0
> Ethernet II, Src: Microsof_e9:6b:5d (c0:33:5e:e9:6b:5d), Dst: Cisco_c4:c7:c0 (60:73:5c:c4:c7:c0)
> Internet Protocol Version 4, Src: 10.130.60.163, Dst: 13.107.4.52
> Transmission Control Protocol, Src Port: 58999, Dst Port: 80, Seq: 1, Ack: 1, Len: 88
> Hypertext Transfer Protocol
```

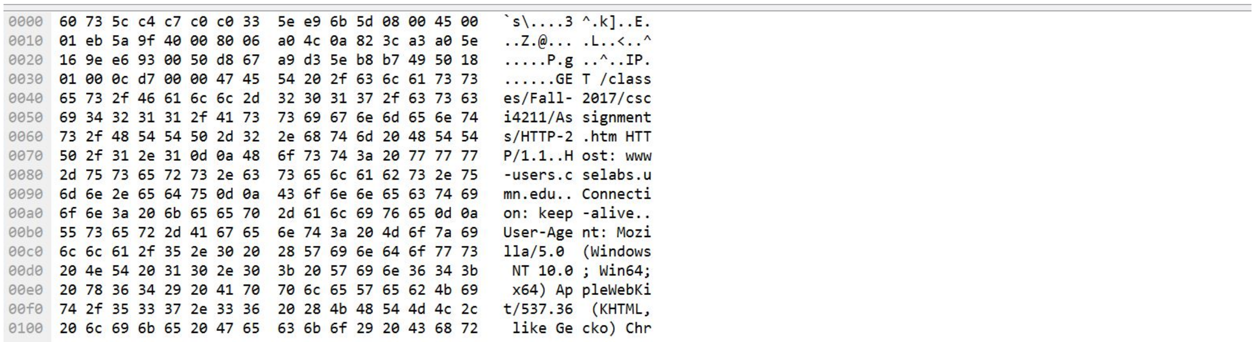
```
0000  60 73 5c c4 c7 c0 c0 33  5e e9 6b 5d 08 00 45 00   `s\....3 ^.k]..E.
0010  00 80 77 a3 40 00 80 06  2a 11 0a 82 3c a3 0d 6b   ..w.@... *...<..k
0020  04 34 e6 77 00 50 11 c1  cd d6 62 65 32 50 50 18   .4.w.P.. ..be2PP.
0030  01 02 92 99 00 00 47 45  54 20 2f 63 6f 6e 6e 65   ......GE T /conne
0040  63 74 74 65 73 74 2e 74  78 74 20 48 54 54 50 2f   cttest.t xt HTTP/
0050  31 2e 31 0d 0a 43 6f 6e  6e 65 63 74 69 6f 6e 3a   1.1..Con nection:
0060  20 4b 65 65 70 2d 41 6c  69 76 65 0d 0a 48 6f 73    Keep-Al ive..Hos
0070  74 3a 20 77 77 77 2e 6d  73 66 74 63 6f 6e 6e 65   t: www.m sftconne
0080  63 74 74 65 73 74 2e 63  6f 6d 0d 0a 0d 0a         cttest.c om....
```



```
No.     Time        Source          Destination     Protocol Length Info
    108 12.278368   10.130.60.163   160.94.22.158   HTTP      505 GET /classes/Fall-2017/csci4211/Assignments/HTTP-2.htm HTTP/1.1
    111 12.282185   160.94.22.158   10.130.60.163   HTTP     1047 HTTP/1.1 200 OK  (text/html)
    117 13.727870   10.130.60.163   160.94.22.158   HTTP      484 GET /favicon.ico HTTP/1.1
    118 13.731551   160.94.22.158   10.130.60.163   HTTP      329 HTTP/1.1 200 OK
```



```
> Frame 108: 505 bytes on wire (4040 bits), 505 bytes captured (4040 bits) on interface 0
> Ethernet II, Src: Microsof_e9:6b:5d (c0:33:5e:e9:6b:5d), Dst: Cisco_c4:c7:c0 (60:73:5c:c4:c7:c0)
> Internet Protocol Version 4, Src: 10.130.60.163, Dst: 160.94.22.158
> Transmission Control Protocol, Src Port: 59027, Dst Port: 80, Seq: 1, Ack: 1, Len: 451
> Hypertext Transfer Protocol
```



```
0000  60 73 5c c4 c7 c0 c0 33  5e e9 6b 5d 08 00 45 00   `s\....3 ^.k]..E.
0010  01 eb 5a 9f 40 00 80 06  a0 4c 0a 82 3c a3 a0 5e   ..Z.@... .L..<..^
0020  16 9e e6 93 00 50 d8 67  a9 d3 5e b8 b7 49 50 18   .....P.g ..^..IP.
0030  01 00 0c d7 00 00 47 45  54 20 2f 63 6c 61 73 73   ......GE T /class
0040  65 73 2f 46 61 6c 6c 2d  32 30 31 37 2f 63 73 63   es/Fall- 2017/csc
0050  69 34 32 31 31 2f 41 73  73 69 67 6e 6d 65 6e 74   i4211/As signment
0060  73 2f 48 54 54 50 2d 32  2e 68 74 6d 20 48 54 54   s/HTTP-2 .htm HTT
0070  50 2f 31 2e 31 0d 0a 48  6f 73 74 3a 20 77 77 77   P/1.1..H ost: www
0080  2d 75 73 65 72 73 2e 63  73 65 6c 61 62 73 2e 75   -users.c selabs.u
0090  6d 6e 2e 65 64 75 0d 0a  43 6f 6e 6e 65 63 74 69   mn.edu.. Connecti
00a0  6f 6e 3a 20 6b 65 65 70  2d 61 6c 69 76 65 0d 0a   on: keep -alive..
00b0  55 73 65 72 2d 41 67 65  6e 74 3a 20 4d 6f 7a 69   User-Age nt: Mozi
00c0  6c 6c 61 2f 35 2e 30 20  28 57 69 6e 64 6f 77 73   lla/5.0  (Windows
00d0  20 4e 54 20 31 30 2e 30  3b 20 57 69 6e 36 34 3b    NT 10.0 ; Win64;
00e0  20 78 36 34 29 20 41 70  70 6c 65 57 65 62 4b 69    x64) Ap pleWebKi
00f0  74 2f 35 33 37 2e 33 36  20 28 4b 48 54 4d 4c 2c   t/537.36  (KHTML,
0100  20 6c 69 6b 65 20 47 65  63 6b 6f 29 20 43 68 72    like Ge cko) Chr
```

a. 1.1, 1.1

b. Computer: 10.130.60.163
Server: 160.94.22.158

C. 2 GET requests

D. 2

E. HTTP/1.1 200 OK

6.

a. Since the server did not receive an acknowledgement back, it will resend the exact same message to the client. Since the client did not receive an acknowledgement back either, it will resend its original message. The server will realize that the client's new message is a duplicate, and probably ignore it.

b. Yes, this can happen. If the connection gets closed, after the duplicate message gets sent, but before it gets received by the client. The client probably would probably have to deal with an error, as the message is destined for a client that has already closed the socket.