CNT 5106
Spring 2023

Homework Assignment 1

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1.
Solution: A circuit switched network is a better choice, because the end-to-end communication quality of a circuit-switched network is reliably guaranteed because of the agreed communication resources, it is highly efficient for continuous transmission of large amounts of data.

2.
Solution: Application Layer, Transport Layer, Network Layer, Link Layer, Physical Layer.

3.
Solution: The transmission time=100000/ (2.5×10^8) =0.0004 s
The maximum number of bits=0.0004* 1Mbps=400 bits.

4.
Solution: The delay components are processing delays, transmission delays, propagation delays, and queuing delays, and all these delays are constant, except queuing delays which are variable.

5.

```
xinhaodu@xinhaodeMacBookPro ~ % traceroute –n www.google.com
traceroute to www.google.com (142.250.64.228), 64 hops max, 52 byte packets
 1  * 10.136.0.2  31.262 ms  3.696 ms
 2  128.227.236.212  13.006 ms  5.740 ms  5.044 ms
 3  128.227.79.242  10.229 ms  3.799 ms  3.032 ms
 4  128.227.79.243  11.365 ms  3.679 ms  4.351 ms
 5  128.227.79.219  9.041 ms  4.082 ms  4.556 ms
 6  128.227.236.179  13.343 ms  4.425 ms  4.654 ms
 7  128.227.69.36  10.571 ms  4.260 ms  6.529 ms
 8  128.227.69.51  10.622 ms  4.282 ms  5.095 ms
 9  108.59.28.114  13.398 ms  8.837 ms  8.965 ms
10  108.59.31.150  32.068 ms  24.741 ms  27.091 ms
11  108.59.31.158  43.380 ms  23.365 ms  26.606 ms
12  108.59.31.156  36.171 ms  26.769 ms  24.530 ms
13  108.59.31.154  46.602 ms  26.307 ms  24.409 ms
14  108.59.28.49  37.402 ms  22.995 ms  25.065 ms
15  * * *
16  108.170.253.1  89.362 ms  27.623 ms
    142.251.68.236  35.169 ms
17  108.170.225.183  28.816 ms
    108.170.253.19  37.838 ms
    108.170.253.2  31.392 ms
18  142.250.211.238  31.203 ms
    142.250.64.228  29.368 ms  22.842 ms
```

```
[xinhaodu@xinhaodeMacBookPro ~ % traceroute -n www.google.com
traceroute to www.google.com (142.250.64.228), 64 hops max, 52 byte packets
 1  * 10.136.0.2  30.969 ms  3.239 ms
 2  128.227.236.212  10.319 ms  3.422 ms  3.520 ms
 3  128.227.79.242  9.306 ms  3.290 ms  3.027 ms
 4  128.227.79.243  9.342 ms  5.216 ms  3.849 ms
 5  128.227.79.219  12.029 ms  4.179 ms  5.250 ms
 6  128.227.236.179  15.456 ms  4.690 ms  4.971 ms
 7  128.227.69.36  8.867 ms  4.916 ms  6.085 ms
 8  128.227.69.51  12.468 ms  4.686 ms  4.456 ms
 9  108.59.28.114  14.106 ms  8.601 ms  7.604 ms
10  108.59.31.150  31.686 ms  24.999 ms  24.510 ms
11  108.59.31.158  33.580 ms  23.295 ms  26.454 ms
12  108.59.31.156  36.140 ms  25.449 ms  24.082 ms
13  108.59.31.154  55.450 ms  25.369 ms  23.909 ms
14  108.59.28.49  38.871 ms  23.254 ms  23.977 ms
15  * * *
16  108.170.253.1  53.477 ms
    216.239.50.108  32.651 ms  23.918 ms
17  108.170.225.183  35.701 ms
    108.170.253.18  34.492 ms
    108.170.253.19  31.791 ms
18  216.239.54.71  29.636 ms
    142.250.64.228  30.271 ms  21.677 ms


[xinhaodu@xinhaodeMacBookPro ~ % traceroute -n www.google.com
traceroute to www.google.com (142.250.64.228), 64 hops max, 52 byte packets
 1  10.136.0.2  21.144 ms  6.433 ms  5.367 ms
 2  128.227.236.212  12.882 ms  4.019 ms  4.034 ms
 3  128.227.79.242  17.574 ms  3.452 ms  3.732 ms
 4  128.227.79.243  8.186 ms  4.004 ms  8.457 ms
 5  128.227.79.219  13.401 ms  4.608 ms  4.969 ms
 6  128.227.236.179  9.605 ms  7.310 ms  4.887 ms
 7  128.227.69.36  11.562 ms  4.866 ms  4.931 ms
 8  128.227.69.51  11.943 ms  5.395 ms  6.009 ms
 9  108.59.28.114  14.300 ms  8.037 ms  8.513 ms
10  108.59.31.150  34.426 ms  26.811 ms  25.190 ms
11  108.59.31.158  47.608 ms  23.496 ms  114.778 ms
12  108.59.31.156  53.140 ms  37.202 ms  24.313 ms
13  108.59.31.154  35.286 ms  24.581 ms  24.431 ms
14  108.59.28.49  34.032 ms  23.091 ms  25.757 ms
15  * * *
16  209.85.242.132  45.646 ms
    108.170.253.1  31.828 ms
    209.85.244.152  30.237 ms
17  74.125.37.157  28.562 ms
    108.170.253.18  31.070 ms
    108.170.253.19  32.702 ms
18  216.239.54.71  33.024 ms
    142.250.64.228  28.807 ms  23.123 ms
```

Solution:
a). The average of the three round-trip delays is 27.80 ms, 27.19 ms and 28.32 ms, respectively. The standard deviation of the three round-trip delays is 3.58ms, 3.91ms, 4.05ms, respectively.

b). The number of routers is 18 routers in the path at each of the three hours. No, the paths didn't change.

c). Packets passed through 4 ISPs. Yes, the largest delays occur at the peering interfaces between adjacent ISPs, such as 10 to 14.

d).
```
xinhaodu@xinhaodeMacBookPro ~ % traceroute www.sina.com
traceroute: Warning: www.sina.com has multiple addresses; using 8.38.121.228
traceroute to ww1.sinaimg.cn.w.alikunlun.com (8.38.121.228), 64 hops max, 52 byte packets
 1  10.20.0.1 (10.20.0.1)  21.688 ms  3.166 ms  1.979 ms
 2  10.15.128.1 (10.15.128.1)  21.381 ms  9.301 ms  9.019 ms
 3  100.122.94.88 (100.122.94.88)  39.183 ms  10.978 ms  38.912 ms
 4  100.122.93.64 (100.122.93.64)  17.577 ms  13.067 ms  20.173 ms
 5  mtc3dsrj01-ge708.103.rd.ok.cox.net (68.1.2.29)  32.121 ms  127.713 ms  18.982 ms
 6  atl-b24-link.ip.twelve99.net (62.115.167.68)  45.633 ms  82.719 ms  35.476 ms
 7  level3-ic366139-atl-b24.ip.twelve99-cust.net (62.115.58.99)  59.200 ms  18.535 ms  18.567 ms
 8  * * *
[9  * * 4.15.156.194 (4.15.156.194)  62.671 ms
10  * * *
11  8.38.121.228 (8.38.121.228)  189.835 ms  32.290 ms  39.440 ms


traceroute to 8.38.121.232 (8.38.121.232), 64 hops max, 52 byte packets
 1  10.20.0.1 (10.20.0.1)  70.054 ms  2.312 ms  1.741 ms
 2  10.15.128.1 (10.15.128.1)  18.803 ms  8.418 ms  10.327 ms
 3  100.122.94.88 (100.122.94.88)  21.003 ms  15.189 ms  27.633 ms
 4  100.122.93.64 (100.122.93.64)  66.308 ms  13.809 ms  9.468 ms
 5  mtc3dsrj01-ge708.103.rd.ok.cox.net (68.1.2.29)  28.290 ms  39.205 ms  115.118 ms
 6  atl-b24-link.ip.twelve99.net (62.115.167.68)  158.786 ms  21.611 ms  17.602 ms
 7  level3-ic366139-atl-b24.ip.twelve99-cust.net (62.115.58.99)  28.098 ms  18.306 ms  40.809 ms
 8  * * *
 9  4.15.156.194 (4.15.156.194)  64.440 ms  31.300 ms  34.307 ms
10  * * *
11  8.38.121.232 (8.38.121.232)  60.812 ms  45.255 ms  45.951 ms

traceroute to 8.38.121.232 (8.38.121.232), 64 hops max, 52 byte packets
 1  10.20.0.1 (10.20.0.1)  206.150 ms  2.356 ms  1.690 ms
 2  10.15.128.1 (10.15.128.1)  16.294 ms  362.622 ms  11.534 ms
 3  100.122.94.88 (100.122.94.88)  65.494 ms  18.818 ms  95.358 ms
 4  100.122.93.64 (100.122.93.64)  19.932 ms  10.232 ms  100.703 ms
 5  mtc3dsrj01-ge708.103.rd.ok.cox.net (68.1.2.29)  31.565 ms  48.227 ms  19.531 ms
 6  atl-b24-link.ip.twelve99.net (62.115.167.68)  28.325 ms  18.646 ms  17.514 ms
 7  level3-ic366139-atl-b24.ip.twelve99-cust.net (62.115.58.99)  37.595 ms  21.282 ms  18.381 ms
 8  * * *
 9  * 4.15.156.194 (4.15.156.194)  146.215 ms  153.433 ms
10  * * *
11  8.38.121.232 (8.38.121.232)  68.720 ms  33.188 ms  31.067 ms
```

Traceroute from 10.20.0.1 (US) to www.sina.com (China)
The average of the three round-trip delays is 87.19 ms, 50.67 ms and 44.32 ms, respectively.
The standard deviation of the three round-trip delays is 72.64ms, 7.17ms, 17.27 ms, respectively.
The number of routers is 11 routers in the path at each of the three hours. No, the paths didn't change.
Packets passed through 4 ISPs. Yes, the largest delays occur at the peering interfaces between adjacent ISPs, such as 3 to 4.

6.

Solution:

The throughput is min $\{Rs, Rc, R/M\}$.

7.

Solution:

a). Time to move the message from the source host to the first packet switch $= 8* \ 10^6/(2*10^6)=4\text{sec}$
The total time to move the message from source host to destination host $=4*3=12\text{sec}$.

b). Time to move the first packet from source host to the first switch $=10000/(2*10^6)=5\text{ms}$
Time to second packet be fully received at the first switch $=2*5=10\text{ms}$

c). Time when 1st packet received $= 5*3 = 15$ ms.
Time when last packet received $=15+(800-1)*5=4010\text{ms}=4.01\text{sec}$.
Message segmentation helps reduce time to send the file because store-and-forward packet switching uses more time.

d).
- **In the case of no message segmentation, when an error occurs in the transmission of a bit of data, all data is to be re-transmitted.**
- **With message segmentation, which could reduce requirements for packet switch buffers.**

e).
- **With message segmentation, which could increase processing latency due to segmentation and recovery**
- **With message segmentation, data groups must be ordered.**
- **With message segmentation, which could increase the amount of data headers.**

8.

Solution: Skype uses a communication protocol like VoIP, which requires a professional voice gateway for signaling conversion. When a Skype user makes a phone call, the user's voice data is sent to the gateway and grouped, after which the data is reassembled at the gateway and then transmitted over the circuit to the ordinary phone.