

Problem set -1

(1)

$$a) \text{ minimum RTT for link} = \frac{585000 \times 10^3 \times 2}{3 \times 10^8}$$

$$\text{minimum RTT} = 2.5667 \text{ sec}$$

$$b) \text{ Delay BW product} = \text{BW} \times \text{RTT}$$

$$= \cancel{2 \times 10^9} \times \cancel{2.5667} \text{ sec}$$

$$= 2 \times \cancel{10^9} \times 2.5667$$

$$= 5.133 \text{ Gbits}$$

c) significance of BDP in (b) is it tells us how many bits can be fit into the given link at a given time. In our case our link has capacity of 5.133 Gbits.

(d) Amount of time that lapse between the request

$$(i) \text{ Time for request} = \frac{1}{2} \text{ RTT}$$

$$(ii) \text{ Transfer time} = \frac{30 \times (1024)^2 \times 8}{2 \times (1024)^3} = 0.1171 \text{ sec}$$

$$(iii) \text{ Time for image to reach earth} = \frac{1}{2} \text{ RTT}$$

$$\text{Total time} = 2.5667 + \cancel{0.1171} = 2.684$$

Solution 2

$$BW = 1 \text{ Gbps} = (1024)^3$$

$$\text{File size} = 4 \times (1024)^2 \times 8 \text{ bits}$$

$$\text{Throughput} = \frac{\text{Trans. Size}}{\text{Tx time} + \text{RTT}}$$

(a) Time for request + file to travel = $\text{RTT} = 0.15$

$$\text{Throughput} = \frac{4 \times (1024)^2 \times 8}{\left(0.150 + \frac{4 \times (1024)^2 \times 8}{(1024)^3}\right)}$$

$$= \frac{4 \times (1024)^2 \times 8}{0.150 + 0.031}$$

$$= \underline{22.09 \text{ MB/sec}} = \underline{\underline{24.9 \text{ MB/s}}} = \underline{\underline{185.12 \text{ Mbits/sec}}}$$

(b)

$$\text{Throughput} = \frac{4 \times (1024)^2 \times 8}{(0.075 + 0.031)}$$

$$\underline{\underline{66.51 \text{ MB/sec}}}$$

$$= \underline{\underline{815.806 \text{ Mbits/sec}}}$$

$$= \underline{\underline{37.73 \text{ MB/sec}}}$$

Solution 3

$$RTT = 0.1 \text{ sec}, \text{ packet} = 1 \text{ KB}, \text{ Handshake} = 2RTT$$

$$(a) \text{ BW} = 1 \text{ mbps} = (1024)^2 \text{ bits/sec}$$

$$\text{Total time} = 2RTT + \frac{1}{2}RTT \text{ propagation delay}$$

$$+ \text{Time for } 2000 \text{ KB Tx}$$

$$= 2RTT + 0.5RTT + \frac{2000 \times 1024 \times 8}{(1024)^2}$$

$$= \underline{\underline{0.25 + 15.875 \text{ sec}}}$$

$$(b) \text{ BW} = 1.5 \text{ mbps} = 1.5 \times (1024)^2$$

$$\text{Time} = 2RTT + \text{Tx time for } 2000 \text{ KB} + \text{wait time after every } 1999 \text{ packet} + \frac{1}{2}RTT$$

$$= 2.5 \times 0.1 + 1999 \times 0.1 + \frac{2000 \times 1024 \times 8}{1.5 \times (1024)^2}$$

$$= 10.41 + 0.25 + 199.9$$

$$\text{Time} = 210.51 \text{ sec}$$

(c) Infinite BW, so 0 Transfer time.

$$\text{Total Time} = \text{Time to send } \frac{1968}{(49 \text{ RTT})} \text{ packets} + \text{last batch needs } 0.5 \text{ RTT} + 2 \text{ RTT}$$

$$= 51.5 \text{ RTT}$$

$$= 51.5 \times 0.1$$

$$= \underline{\underline{5.15 \text{ seconds}}}$$

(d) As the BW is infinite, transfer time is 0.

sequence to get 2000 packets from $\sum_{n=0}^{\infty} 2^{n-1}$

$$= 1 + 2 + 4 + 8 + 16 + 32 + 64 + 128 + 256 + 512 + 1024$$

$$= 2047$$

so, we need 11 RTT's to send entire sequence, but last batch only needs $\frac{1}{2}$ RTT.

so

$$\text{Total time} = 2 \text{ RTT} + 0.5 \text{ RTT} + 10 \text{ RTT}$$

$$= 12.5 \text{ RTT}$$

$$\boxed{\text{Total Time} = 1.25 \text{ seconds}}$$

Solution 4

$$\text{Width of bit} = \text{speed} / Bw$$

$$= \frac{2.3 \times 10^8}{20 \times (1024)^3}$$

~~$$= \frac{2.3 \times 10^8}{20 \times (1024)^3}$$~~

$$= 0.0107 \text{ m}$$

$$\boxed{\text{width} = 1.07 \text{ cm}}$$

Solution 5-

To maximize the rate at which frames are transmitted probability of successful transmission should be maximum.

$$Pr(\text{success}) = \left(\begin{array}{l} \text{Number of} \\ \text{stations} \end{array} \right) \times Pr(\text{one station transmits on one bus \& at next slot}) \\ \times Pr(\text{No other stations tx on same bus and at the next slot})$$

$$= 4 \times \frac{1}{2}P \times (1 - \frac{1}{2}P)^3$$

$$= 2P(1 - \frac{1}{2}P)^3$$

Taking derivative & equating to zero to get maximum value.

$$\frac{d}{dP} = 2(1 - \frac{1}{2}P)^3 - 3P(1 - \frac{1}{2}P)^2 = 0$$

$$\boxed{P = \frac{1}{2}}$$

~~Problem 6~~
Solution

$$\begin{aligned} \text{(a) propagation delay} &= \frac{\text{Distance}}{\text{Speed}} \\ &= \frac{36000 \times 10^3}{2.4 \times 10^8} \\ &= \underline{\underline{0.15 \text{ sec}}} \end{aligned}$$

$$\begin{aligned} \text{(b) Bandwidth delay product} &= 0.15 \times 10 \text{ } \cancel{\text{mb}} \\ &= 1.5 \text{ Mbits} \end{aligned}$$

(c) Minimum value of x (photo size)

$$\begin{array}{ccc} \cancel{10 \text{ mb}} & \text{in} & 1 \text{ sec} \\ x & \text{in} & 60 \text{ sec} \end{array}$$

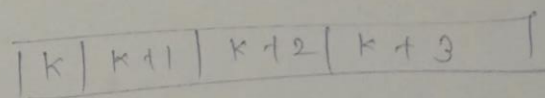
$$\boxed{x = 600 \text{ Mbits}}$$

⑦ Problem 7

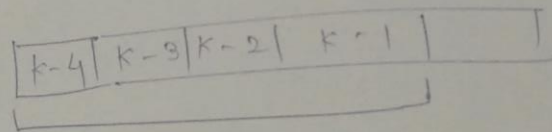
a) As the receiver is expecting packet k , it has received till $k-1$. And it has sent acknowledgements till $k-1$.

there are 3 possible sequences on sender's side.

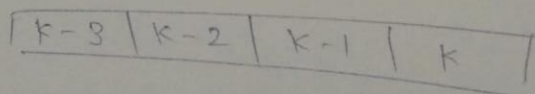
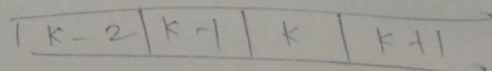
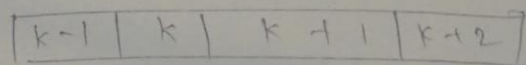
i) The sender has got all the Ack's till $k-1$. And the window starts at k till $k+3$. So window will look like



ii) Otherwise, the sender has not received any of the Ack's sent by Receiver. So window will have $k-4$ till $k-1$.



iii) There will be cases in the middle of above 2. Where the sender has received some of the Ack's & has not received some of them. So window might look like



(b) The receiver has received packets till $k-1$. & 4 packets before that.

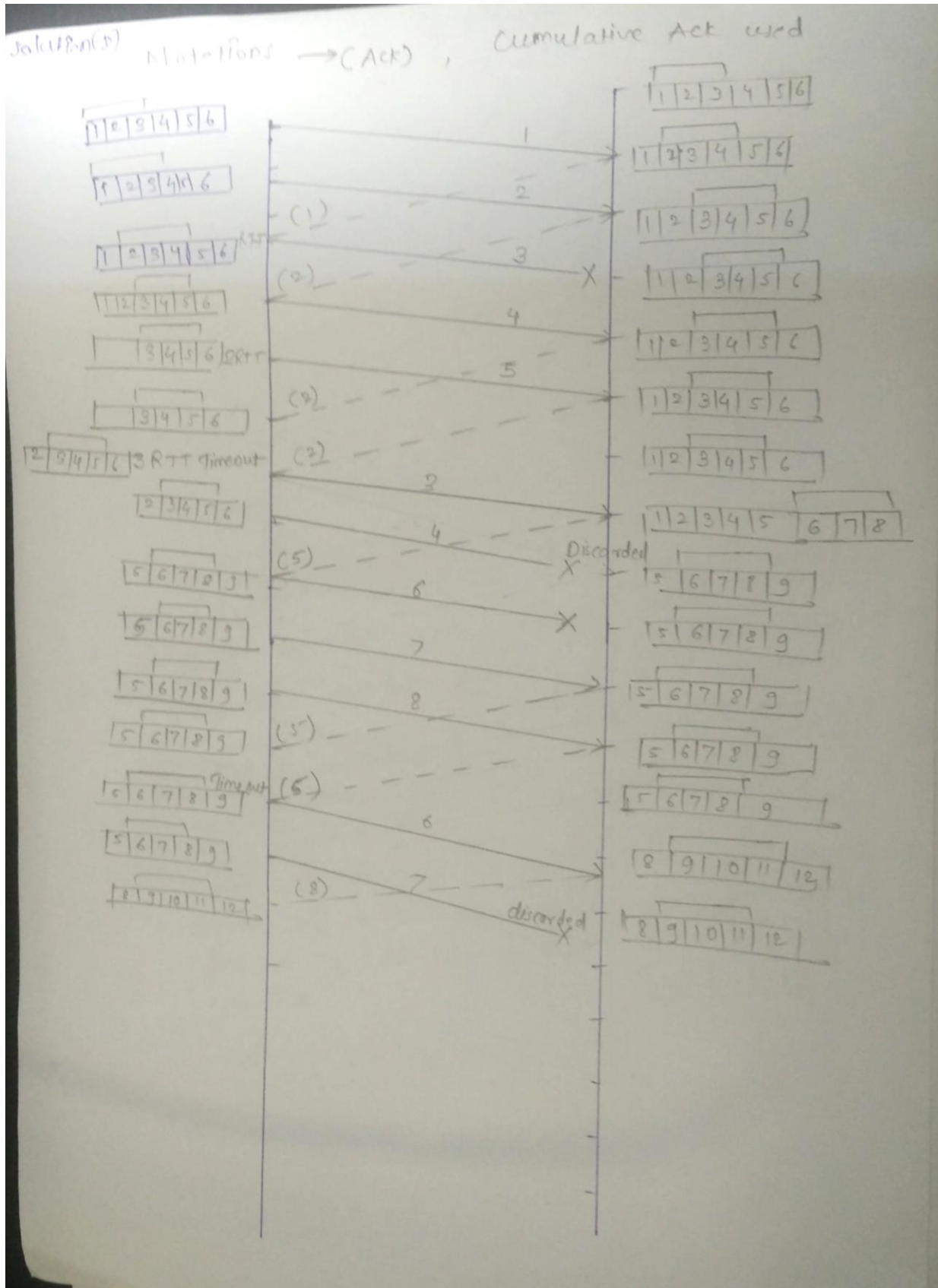
So considering ~~the~~ worst case scenario as all the Ack's are in the transit then all possible values in Ack field currently propagating are

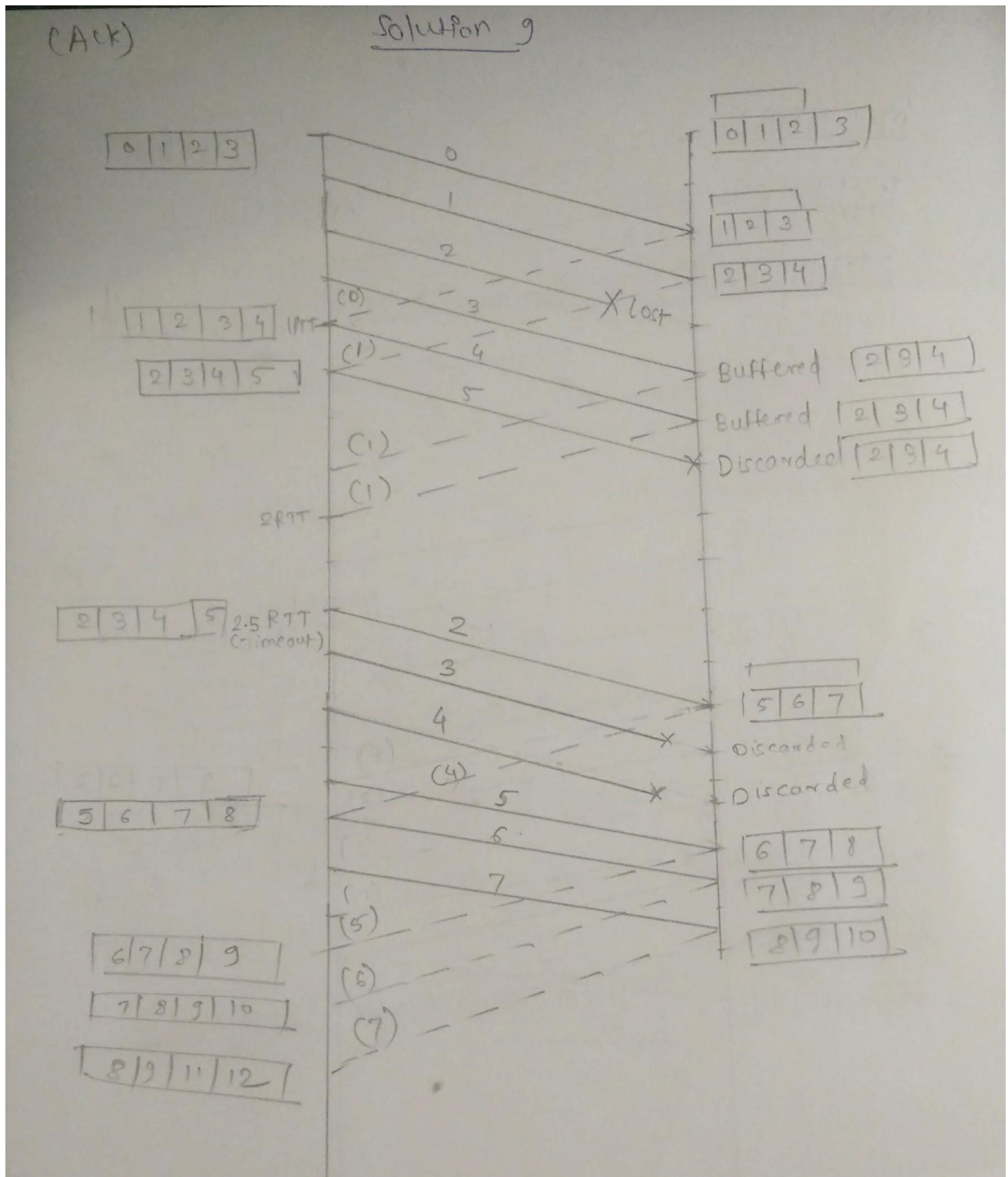
$k-4, k-3, k-2, k-1,$

(c) Yes it is possible.

If the window size is 2 & sender sent packet 1, 2 at time t . The receiver received packets at $(t+k)$ & ~~But it~~ sends out Ack. But before the Ack reaches the sender, sender times out & retransmits packet 1 & 2. Then the sender receives first Ack & window moves ahead. But the receiver receives retransmitted packets ~~1 & 2~~ 1 and 2, and reacknowledge them.

So now sender window is at 3, 4 but it receives Ack's for 1, 2. These Ack's are outside its window.





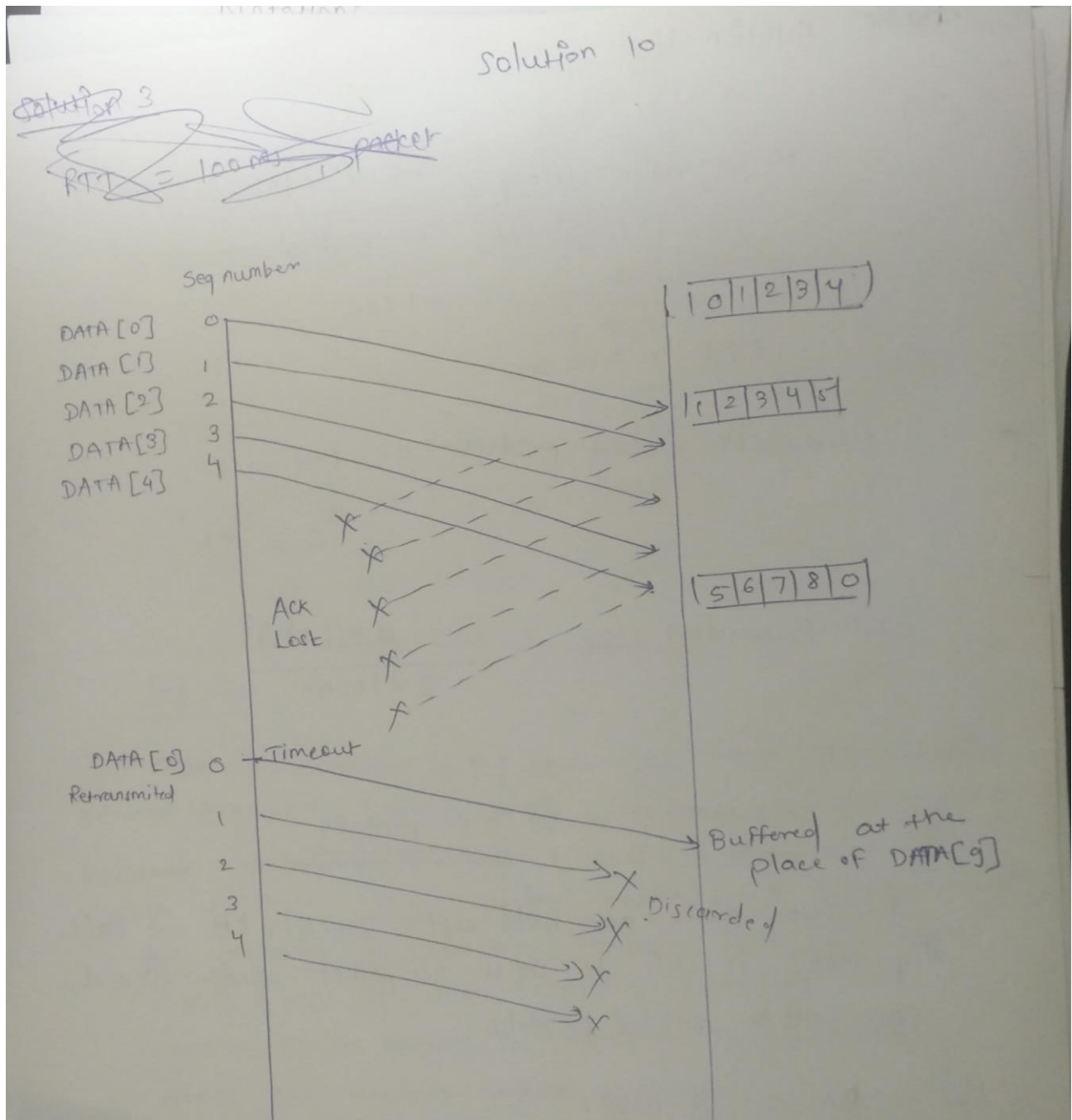
Solution 10

Max seq numbers = 9, meaning 0 to 8 seq numbers.
Sender transmits DATA [0 to 4] with sequence numbers 0 to 4.

Receiver receives all frames & sends a cumulative ACK which is lost. Then sender retransmits DATA [0 to 4].

But receiver is expecting frames with seq numbers 5, 6, 7, 8, 0. So when it receives DATA [0] with seq number 0 it accepts it ~~as~~ thinking "DATA [9]".

Hence the receiver makes an error.



~~Problem~~ Solution 11

$$(a) \quad \text{propagation delay} = \frac{5 \times 10^4 \times 10^3}{3 \times 10^8}$$

$$= 0.1 \text{ sec}$$

$$RTT = 0.2 \text{ sec}$$

$$\text{Bandwidth delay product} = 1 \times 0.2$$

$$= 0.2 \text{ mb}$$

$$\text{optimal window size} = \frac{0.2 \times (1024)^2}{8 \times 1024}$$

$$= 25.6$$

$$\approx \underline{\underline{25 \text{ packets}}}$$

Because pipe can hold upto ^{25.6} ~~0.444~~ kB & each packet is 1kB so with 25 packet window size the link will be utilized properly.

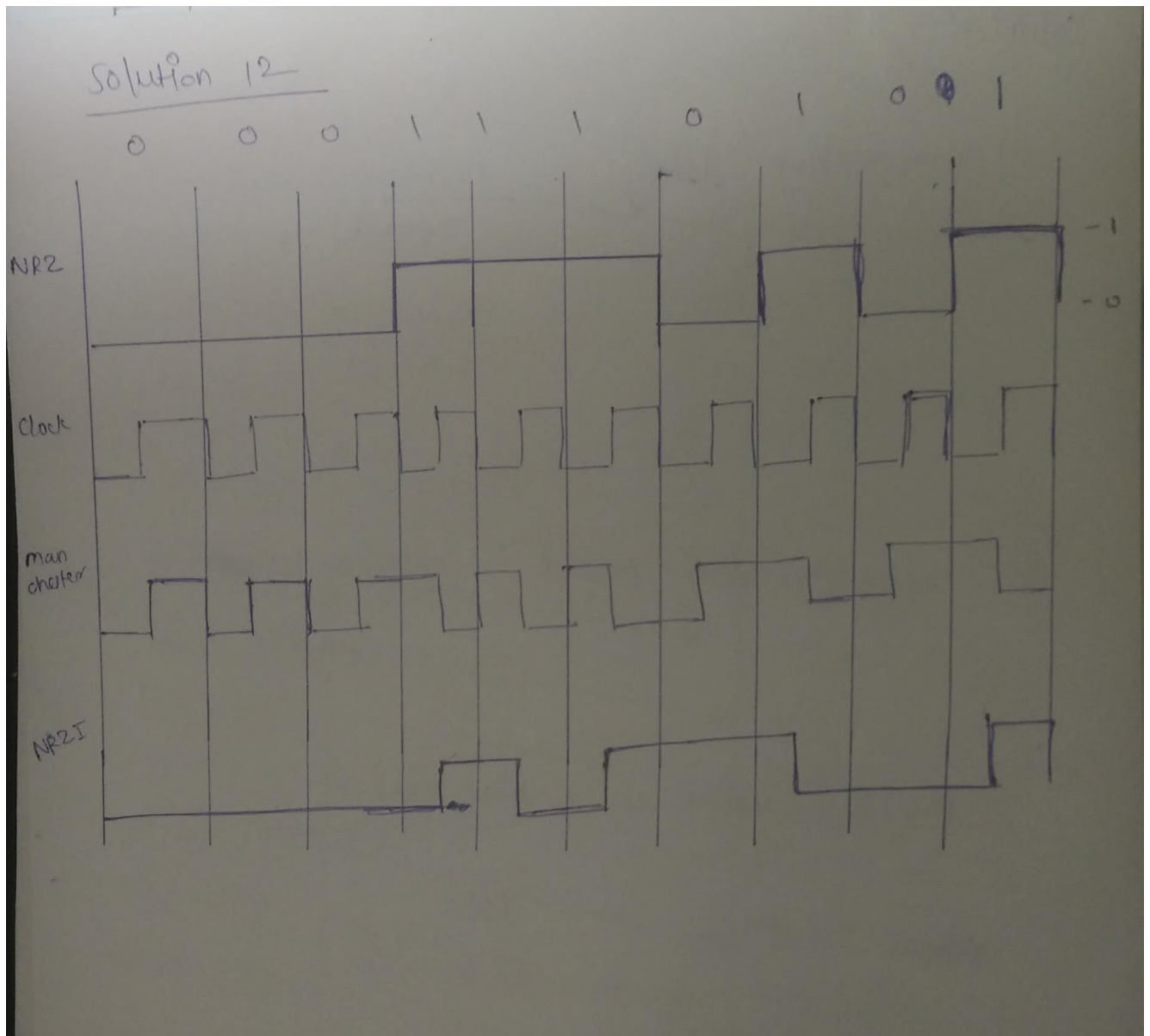
$$(b) \quad BW = 3 \text{ mbps}$$

$$BDP = 0.2 \times 3 = 0.6 \text{ mb}$$

$$\text{optimal window size} = \frac{0.6 \times (1024)^2}{1024 \times 8}$$

$$= 76.8 \approx 76$$

$$\boxed{\text{optimal window size} = 76 \text{ packets}}$$



Solution 13

$$BW = 4 \text{ mbps} = 4 \times (1024)^2 \text{ bits/sec}$$

$$\text{Dist} = 9 \times 10^4 \text{ km}, \quad \text{packet size} = 4 \text{ KB} \\ = 4 \times (1024) \times 8 \text{ bits}$$

$$\text{RTT} = \frac{9 \times 10^4 \times 10^3 \times 2}{3 \times 10^8} \\ = 6 \times 10^{-1} = 0.6 \text{ sec}$$

$$BDP = 0.6 \times 4 \times (1024)^2 = 2.4 \text{ Mb}$$

$$\text{Number of packets in the link at a time} = \frac{2.4 \times (1024)^2}{4 \times (1024) \times 8} \\ = 76.8 \approx 76 \text{ packets}$$

(a) $RWS = 1$, the necessary sequence number space 76, so 7 bits will be needed.

(b) $sws = RWS$, then the max seq number should be twice as sws. so it should be 152. So 8 bits will be needed

$$(c) \text{ Maximum efficiency} = \frac{1}{76} = 0.013$$

Traceroute Solution

```

18
19
20 afternoon
21
22 traceroute to www.berkeley.edu (128.32.203.137), 30 hops max, 60 byte packets
23 1 gateway (128.138.201.65) 0.912 ms 0.845 ms 0.824 ms
24 2 hut-spssc.colorado.edu (128.138.81.2) 0.445 ms 0.445 ms 0.422 ms
25 3 fw-hut.colorado.edu (128.138.81.250) 0.444 ms 0.563 ms 0.416 ms
26 4 juniper-fw.colorado.edu (128.138.81.193) 1.235 ms 1.231 ms 0.741 ms
27 5 tcommx-compmx.colorado.edu (128.138.81.254) 1.139 ms 1.106 ms 1.063 ms
28 6 frgpl3-re-ucb.colorado.edu (198.59.55.2) 2.063 ms 1.895 ms 1.863 ms
29 7 lax-hpr2--frgp-10ge.cenic.net (137.164.26.1) 32.219 ms 32.144 ms 32.293 ms
30 8 hpr-svl-hpr3--lax-hpr3-100ge.cenic.net (137.164.25.74) 39.928 ms 40.360 ms 40.285 ms
31 9 hpr-ucb--svl-hpr-10g.cenic.net (137.164.27.133) 42.187 ms 42.268 ms 42.368 ms
32 10 tl-3.inr-201-sut.berkeley.edu (128.32.0.65) 42.437 ms tl-3.inr-202-reccev.berkeley.edu (128.32.0.67) 42.250 ms tl-3.inr-201-sut.berkeley.edu (128.32.0.65) 42.250 ms
33 11 et3-48.inr-311-ewdc.berkeley.edu (128.32.0.101) 42.201 ms 42.501 ms et3-47.inr-311-ewdc.berkeley.edu (128.32.0.103) 42.139 ms
34 12 calweb-farm-prod.ist.berkeley.edu (128.32.203.137) 42.119 ms 42.265 ms 42.224 ms
35
36
37
38 Morning
39
40 traceroute to www.berkeley.edu (128.32.203.137), 30 hops max, 60 byte packets
41 1 gateway (128.138.201.65) 1.038 ms 1.016 ms 1.022 ms
42 2 hut-spssc.colorado.edu (128.138.81.2) 0.434 ms 0.431 ms 0.417 ms
43 3 fw-hut.colorado.edu (128.138.81.250) 0.509 ms 0.430 ms 0.413 ms
44 4 juniper-fw.colorado.edu (128.138.81.193) 0.784 ms 0.757 ms 0.919 ms
45 5 tcommx-compmx.colorado.edu (128.138.81.254) 0.899 ms 0.876 ms 0.859 ms
46 6 frgpl3-re-ucb.colorado.edu (198.59.55.2) 2.032 ms 1.781 ms 1.745 ms
47 7 lax-hpr2--frgp-10ge.cenic.net (137.164.26.1) 32.153 ms 32.346 ms 32.117 ms
48 8 hpr-svl-hpr3--lax-hpr3-100ge.cenic.net (137.164.25.74) 39.930 ms 40.076 ms 40.059 ms
49 9 hpr-ucb--svl-hpr-10g.cenic.net (137.164.27.133) 42.204 ms 42.147 ms 42.272 ms
50 10 tl-3.inr-201-sut.berkeley.edu (128.32.0.65) 42.288 ms tl-3.inr-202-reccev.berkeley.edu (128.32.0.67) 42.279 ms 42.402 ms
51 11 et3-47.inr-311-ewdc.berkeley.edu (128.32.0.103) 42.300 ms et3-48.inr-311-ewdc.berkeley.edu (128.32.0.101) 42.331 ms et3-47.inr-311-ewdc.berkeley.edu (128.32.0.103) 42.331 ms
52 12 calweb-farm-prod.ist.berkeley.edu (128.32.203.137) 42.446 ms 42.268 ms 42.197 ms
53
54

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1 evening
2
3 traceroute to www.berkeley.edu (128.32.203.137), 30 hops max, 60 byte packets
4 1 gateway (128.138.201.65) 0.650 ms 0.768 ms 0.895 ms
5 2 hut-spssc.colorado.edu (128.138.81.2) 0.428 ms 0.449 ms 0.427 ms
6 3 fw-hut.colorado.edu (128.138.81.250) 0.432 ms 0.420 ms 0.576 ms
7 4 juniper-fw.colorado.edu (128.138.81.193) 0.721 ms 0.929 ms 0.746 ms
8 5 tcommx-compmx.colorado.edu (128.138.81.254) 20.501 ms 20.557 ms 20.525 ms
9 6 frgpl3-re-ucb.colorado.edu (198.59.55.2) 1.748 ms 1.689 ms 1.662 ms
10 7 lax-hpr2--frgp-10ge.cenic.net (137.164.26.1) 32.291 ms 32.670 ms 32.597 ms
11 8 hpr-svl-hpr3--lax-hpr3-100ge.cenic.net (137.164.25.74) 40.460 ms 40.315 ms 40.288 ms
12 9 hpr-ucb--svl-hpr-10g.cenic.net (137.164.27.133) 42.314 ms 42.298 ms 42.267 ms
13 10 tl-3.inr-202-reccev.berkeley.edu (128.32.0.67) 42.281 ms 42.380 ms tl-3.inr-201-sut.berkeley.edu (128.32.0.65) 42.213 ms
14 11 et3-47.inr-311-ewdc.berkeley.edu (128.32.0.103) 42.365 ms et3-48.inr-311-ewdc.berkeley.edu (128.32.0.101) 42.396 ms 42.375 ms
15 12 calweb-farm-prod.ist.berkeley.edu (128.32.203.137) 42.367 ms 42.660 ms 42.766 ms
16
17
18
19

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Solution → Tracemate

- a) ~~Find~~ the average & standard deviation of RTT at 3 different hours.

$$\text{Average RTT} = \frac{42.224 + 42.766 + 42.197}{3} = 42.39 \text{ ms}$$

~~Standard deviation~~

$$\text{Average RTT Morning} = \frac{42.446 + 42.268 + 42.197}{3} = 42.30 \text{ ms}$$

$$\text{Afternoon} = \frac{42.199 + 42.265 + 42.224}{3} = 42.22 \text{ ms}$$

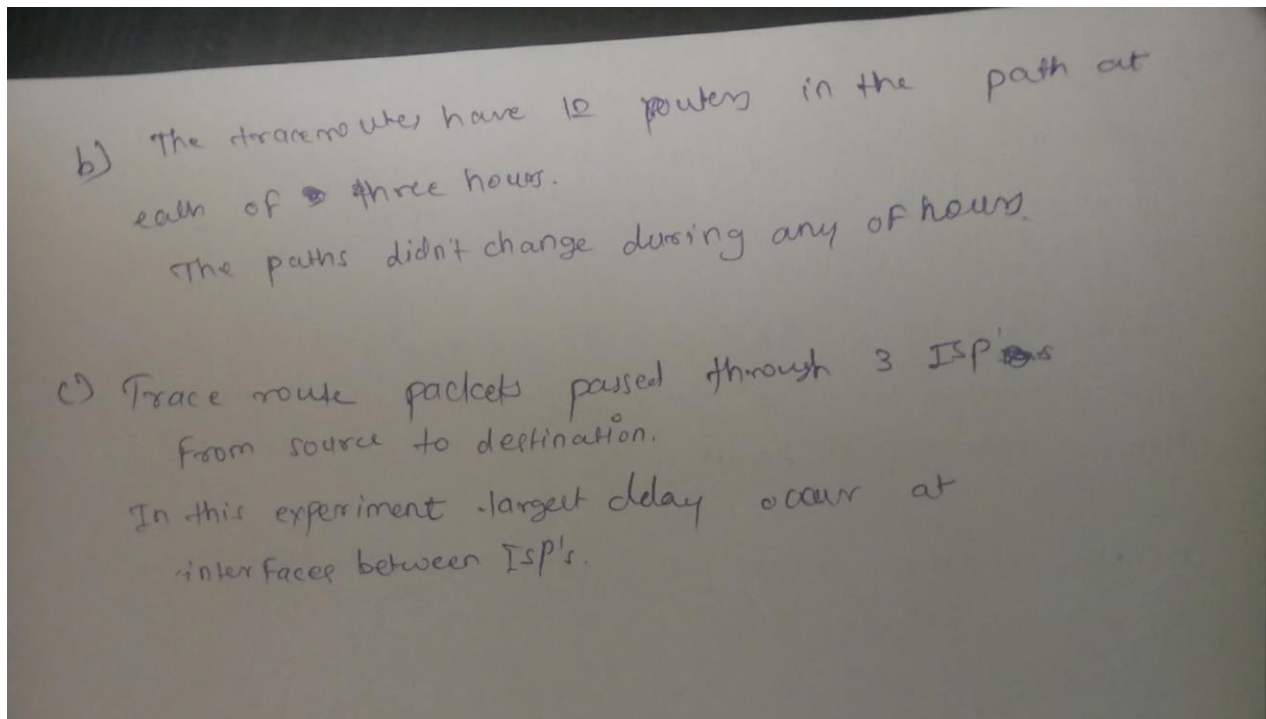
$$\text{Evening} = \frac{42.367 + 42.660 + 42.766}{3} = 42.59 \text{ ms}$$

standard deviation

$$\text{Morning} = \cancel{0.074 \text{ ms}} 0.139 \text{ ms}$$

$$\text{Afternoon} = 0.033 \text{ ms}$$

$$\text{Evening} = 0.2066 \text{ ms}$$



Solution 2

Server of choice:

Local: csel.cs.colorado.edu

National: www.berkley.edu

International: www.vit.edu (India)

Average RTT	Local	National	International
Morning	0.319 ms	42.29 ms	242.950 ms
Afternoon	0.321 ms	42.344 ms	237.2 ms
Late Night	0.347 ms	42.42 ms	237.3 ms

Average Packet Loss	Local	National	International
Morning	0	0	0
Afternoon	0	0	0
Late Night	0	0	0

2)

a) There was not significant variation of average RTT over the course of the day for local & national servers.

There was some deviation on international server in RTT during the whole day. It might happen because different amount of traffic at different time of the day.

b) The average packet loss was 0 at different times of the day.

c) There was a significant variation of average RTT with respect to geographic location. This is because of the difference in propagation delay. International servers ~~are~~ are the farthest, so it has the maximum RTT because of maximum propagation delay.

Screen Shots

```
gaga2284@elra-01:~$ ping -c 20 -s 200 www.vit.edu
PING www.vit.edu (202.38.172.240) 200(228) bytes of data.
200 bytes from 202.38.172.240: icmp_seq=1 ttl=48 time=243 ms
200 bytes from 202.38.172.240: icmp_seq=2 ttl=48 time=242 ms
200 bytes from 202.38.172.240: icmp_seq=3 ttl=48 time=242 ms
200 bytes from 202.38.172.240: icmp_seq=4 ttl=48 time=242 ms
200 bytes from 202.38.172.240: icmp_seq=5 ttl=48 time=243 ms
200 bytes from 202.38.172.240: icmp_seq=6 ttl=48 time=243 ms
200 bytes from 202.38.172.240: icmp_seq=7 ttl=48 time=243 ms
200 bytes from 202.38.172.240: icmp_seq=8 ttl=48 time=243 ms
200 bytes from 202.38.172.240: icmp_seq=9 ttl=48 time=242 ms
200 bytes from 202.38.172.240: icmp_seq=10 ttl=48 time=243 ms
200 bytes from 202.38.172.240: icmp_seq=11 ttl=48 time=243 ms
200 bytes from 202.38.172.240: icmp_seq=12 ttl=48 time=243 ms
200 bytes from 202.38.172.240: icmp_seq=13 ttl=48 time=243 ms
200 bytes from 202.38.172.240: icmp_seq=14 ttl=48 time=242 ms
200 bytes from 202.38.172.240: icmp_seq=15 ttl=48 time=242 ms
200 bytes from 202.38.172.240: icmp_seq=16 ttl=48 time=242 ms
200 bytes from 202.38.172.240: icmp_seq=17 ttl=48 time=242 ms
200 bytes from 202.38.172.240: icmp_seq=18 ttl=48 time=242 ms
200 bytes from 202.38.172.240: icmp_seq=19 ttl=48 time=242 ms
200 bytes from 202.38.172.240: icmp_seq=20 ttl=48 time=243 ms

--- www.vit.edu ping statistics ---
20 packets transmitted, 20 received, 0% packet loss, time 19027ms
rtt min/avg/max/mdev = 242.528/242.973/243.610/0.323 ms
```

```
gaga2284@elra-01:~$ ping -c 20 -s 200 csel-www.cs.colorado.edu
PING csel-www.cs.colorado.edu (128.138.201.90) 200(228) bytes of data.
200 bytes from csel-www.cs.colorado.edu (128.138.201.90): icmp_seq=1 ttl=64 time=0.351 ms
200 bytes from csel-www.cs.colorado.edu (128.138.201.90): icmp_seq=2 ttl=64 time=0.277 ms
200 bytes from csel-www.cs.colorado.edu (128.138.201.90): icmp_seq=3 ttl=64 time=0.335 ms
200 bytes from csel-www.cs.colorado.edu (128.138.201.90): icmp_seq=4 ttl=64 time=0.402 ms
200 bytes from csel-www.cs.colorado.edu (128.138.201.90): icmp_seq=5 ttl=64 time=0.261 ms
200 bytes from csel-www.cs.colorado.edu (128.138.201.90): icmp_seq=6 ttl=64 time=0.327 ms
200 bytes from csel-www.cs.colorado.edu (128.138.201.90): icmp_seq=7 ttl=64 time=0.245 ms
200 bytes from csel-www.cs.colorado.edu (128.138.201.90): icmp_seq=8 ttl=64 time=0.283 ms
200 bytes from csel-www.cs.colorado.edu (128.138.201.90): icmp_seq=9 ttl=64 time=0.252 ms
200 bytes from csel-www.cs.colorado.edu (128.138.201.90): icmp_seq=10 ttl=64 time=0.397 ms
200 bytes from csel-www.cs.colorado.edu (128.138.201.90): icmp_seq=11 ttl=64 time=0.327 ms
200 bytes from csel-www.cs.colorado.edu (128.138.201.90): icmp_seq=12 ttl=64 time=0.258 ms
200 bytes from csel-www.cs.colorado.edu (128.138.201.90): icmp_seq=13 ttl=64 time=0.223 ms
200 bytes from csel-www.cs.colorado.edu (128.138.201.90): icmp_seq=14 ttl=64 time=0.320 ms
200 bytes from csel-www.cs.colorado.edu (128.138.201.90): icmp_seq=15 ttl=64 time=0.325 ms
200 bytes from csel-www.cs.colorado.edu (128.138.201.90): icmp_seq=16 ttl=64 time=0.251 ms
200 bytes from csel-www.cs.colorado.edu (128.138.201.90): icmp_seq=17 ttl=64 time=0.334 ms
200 bytes from csel-www.cs.colorado.edu (128.138.201.90): icmp_seq=18 ttl=64 time=0.389 ms
200 bytes from csel-www.cs.colorado.edu (128.138.201.90): icmp_seq=19 ttl=64 time=0.448 ms
200 bytes from csel-www.cs.colorado.edu (128.138.201.90): icmp_seq=20 ttl=64 time=0.429 ms

--- csel-www.cs.colorado.edu ping statistics ---
20 packets transmitted, 20 received, 0% packet loss, time 18998ms
rtt min/avg/max/mdev = 0.223/0.321/0.448/0.067 ms
```

```
gaga2284@elra-01:~$ ping -c 20 -s 200 www.berkeley.edu
PING www.w3.berkeley.edu (128.32.203.137) 200(228) bytes of data.
200 bytes from calweb-farm-prod.ist.berkeley.edu (128.32.203.137): icmp_seq=1 ttl=52 time=42.6 ms
200 bytes from calweb-farm-prod.ist.berkeley.edu (128.32.203.137): icmp_seq=2 ttl=52 time=42.3 ms
200 bytes from calweb-farm-prod.ist.berkeley.edu (128.32.203.137): icmp_seq=3 ttl=52 time=42.6 ms
200 bytes from calweb-farm-prod.ist.berkeley.edu (128.32.203.137): icmp_seq=4 ttl=52 time=42.6 ms
200 bytes from calweb-farm-prod.ist.berkeley.edu (128.32.203.137): icmp_seq=5 ttl=52 time=42.0 ms
200 bytes from calweb-farm-prod.ist.berkeley.edu (128.32.203.137): icmp_seq=6 ttl=52 time=42.2 ms
200 bytes from calweb-farm-prod.ist.berkeley.edu (128.32.203.137): icmp_seq=7 ttl=52 time=42.1 ms
200 bytes from calweb-farm-prod.ist.berkeley.edu (128.32.203.137): icmp_seq=8 ttl=52 time=42.1 ms
200 bytes from calweb-farm-prod.ist.berkeley.edu (128.32.203.137): icmp_seq=9 ttl=52 time=42.3 ms
200 bytes from calweb-farm-prod.ist.berkeley.edu (128.32.203.137): icmp_seq=10 ttl=52 time=42.7 ms
200 bytes from calweb-farm-prod.ist.berkeley.edu (128.32.203.137): icmp_seq=11 ttl=52 time=42.2 ms
200 bytes from calweb-farm-prod.ist.berkeley.edu (128.32.203.137): icmp_seq=12 ttl=52 time=42.2 ms
200 bytes from calweb-farm-prod.ist.berkeley.edu (128.32.203.137): icmp_seq=13 ttl=52 time=42.4 ms
200 bytes from calweb-farm-prod.ist.berkeley.edu (128.32.203.137): icmp_seq=14 ttl=52 time=42.5 ms
200 bytes from calweb-farm-prod.ist.berkeley.edu (128.32.203.137): icmp_seq=15 ttl=52 time=42.1 ms
200 bytes from calweb-farm-prod.ist.berkeley.edu (128.32.203.137): icmp_seq=16 ttl=52 time=42.4 ms
200 bytes from calweb-farm-prod.ist.berkeley.edu (128.32.203.137): icmp_seq=17 ttl=52 time=42.2 ms
200 bytes from calweb-farm-prod.ist.berkeley.edu (128.32.203.137): icmp_seq=18 ttl=52 time=42.2 ms
200 bytes from calweb-farm-prod.ist.berkeley.edu (128.32.203.137): icmp_seq=19 ttl=52 time=42.3 ms
200 bytes from calweb-farm-prod.ist.berkeley.edu (128.32.203.137): icmp_seq=20 ttl=52 time=42.7 ms

--- www.w3.berkeley.edu ping statistics ---
20 packets transmitted, 20 received, 0% packet loss, time 19028ms
rtt min/avg/max/mdev = 42.094/42.388/42.792/0.236 ms
```

```
rtt min/avg/max/mdev = 237.003/237.403/238.109/0.382 ms
gaga2284@elra-01:~$ ping -c 20 -s 200 www.vit.edu
PING www.vit.edu (202.38.172.240) 200(228) bytes of data.
208 bytes from 202.38.172.240: icmp_seq=1 ttl=48 time=237 ms
208 bytes from 202.38.172.240: icmp_seq=2 ttl=48 time=236 ms
208 bytes from 202.38.172.240: icmp_seq=3 ttl=48 time=237 ms
208 bytes from 202.38.172.240: icmp_seq=4 ttl=48 time=237 ms
208 bytes from 202.38.172.240: icmp_seq=5 ttl=48 time=237 ms
208 bytes from 202.38.172.240: icmp_seq=6 ttl=48 time=237 ms
208 bytes from 202.38.172.240: icmp_seq=7 ttl=48 time=237 ms
208 bytes from 202.38.172.240: icmp_seq=8 ttl=48 time=237 ms
208 bytes from 202.38.172.240: icmp_seq=9 ttl=48 time=237 ms
208 bytes from 202.38.172.240: icmp_seq=10 ttl=48 time=237 ms
208 bytes from 202.38.172.240: icmp_seq=11 ttl=48 time=237 ms
208 bytes from 202.38.172.240: icmp_seq=12 ttl=48 time=237 ms
208 bytes from 202.38.172.240: icmp_seq=13 ttl=48 time=237 ms
208 bytes from 202.38.172.240: icmp_seq=14 ttl=48 time=237 ms
208 bytes from 202.38.172.240: icmp_seq=15 ttl=48 time=237 ms
208 bytes from 202.38.172.240: icmp_seq=16 ttl=48 time=237 ms
208 bytes from 202.38.172.240: icmp_seq=17 ttl=48 time=237 ms
208 bytes from 202.38.172.240: icmp_seq=18 ttl=48 time=237 ms
208 bytes from 202.38.172.240: icmp_seq=19 ttl=48 time=236 ms
208 bytes from 202.38.172.240: icmp_seq=20 ttl=48 time=237 ms

--- www.vit.edu ping statistics ---
20 packets transmitted, 20 received, 0% packet loss, time 19023ms
rtt min/avg/max/mdev = 236.821/237.273/237.614/0.259 ms
```

```
gaga2284@elra-01:~$ ping -c 20 -s 200 www.berkeley.edu
PING www.w3.berkeley.EDU (128.32.203.137) 200(228) bytes of data.
208 bytes from calweb-farm-prod.ist.berkeley.edu (128.32.203.137): icmp_seq=1 ttl=52 time=42.4 ms
208 bytes from calweb-farm-prod.ist.berkeley.edu (128.32.203.137): icmp_seq=2 ttl=52 time=42.4 ms
208 bytes from calweb-farm-prod.ist.berkeley.edu (128.32.203.137): icmp_seq=3 ttl=52 time=42.4 ms
208 bytes from calweb-farm-prod.ist.berkeley.edu (128.32.203.137): icmp_seq=4 ttl=52 time=42.5 ms
208 bytes from calweb-farm-prod.ist.berkeley.edu (128.32.203.137): icmp_seq=5 ttl=52 time=42.4 ms
208 bytes from calweb-farm-prod.ist.berkeley.edu (128.32.203.137): icmp_seq=6 ttl=52 time=42.3 ms
208 bytes from calweb-farm-prod.ist.berkeley.edu (128.32.203.137): icmp_seq=7 ttl=52 time=42.2 ms
208 bytes from calweb-farm-prod.ist.berkeley.edu (128.32.203.137): icmp_seq=8 ttl=52 time=42.6 ms
208 bytes from calweb-farm-prod.ist.berkeley.edu (128.32.203.137): icmp_seq=9 ttl=52 time=42.3 ms
208 bytes from calweb-farm-prod.ist.berkeley.edu (128.32.203.137): icmp_seq=10 ttl=52 time=42.5 ms
208 bytes from calweb-farm-prod.ist.berkeley.edu (128.32.203.137): icmp_seq=11 ttl=52 time=42.4 ms
208 bytes from calweb-farm-prod.ist.berkeley.edu (128.32.203.137): icmp_seq=12 ttl=52 time=42.5 ms
208 bytes from calweb-farm-prod.ist.berkeley.edu (128.32.203.137): icmp_seq=13 ttl=52 time=42.4 ms
208 bytes from calweb-farm-prod.ist.berkeley.edu (128.32.203.137): icmp_seq=14 ttl=52 time=42.2 ms
208 bytes from calweb-farm-prod.ist.berkeley.edu (128.32.203.137): icmp_seq=15 ttl=52 time=42.9 ms
208 bytes from calweb-farm-prod.ist.berkeley.edu (128.32.203.137): icmp_seq=16 ttl=52 time=42.3 ms
208 bytes from calweb-farm-prod.ist.berkeley.edu (128.32.203.137): icmp_seq=17 ttl=52 time=42.6 ms
208 bytes from calweb-farm-prod.ist.berkeley.edu (128.32.203.137): icmp_seq=18 ttl=52 time=42.3 ms
208 bytes from calweb-farm-prod.ist.berkeley.edu (128.32.203.137): icmp_seq=19 ttl=52 time=42.2 ms
208 bytes from calweb-farm-prod.ist.berkeley.edu (128.32.203.137): icmp_seq=20 ttl=52 time=42.1 ms

--- www.w3.berkeley.EDU ping statistics ---
20 packets transmitted, 20 received, 0% packet loss, time 19028ms
rtt min/avg/max/mdev = 42.116/42.440/42.933/0.286 ms
```

```
gaga2284@elra-01:~$ ping -c 20 -s 200 csel.cs.colorado.edu
PING csel-www.cs.colorado.edu (128.138.201.90) 200(228) bytes of data.
208 bytes from csel-www.cs.colorado.edu (128.138.201.90): icmp_seq=1 ttl=64 time=0.465 ms
208 bytes from csel-www.cs.colorado.edu (128.138.201.90): icmp_seq=2 ttl=64 time=0.294 ms
208 bytes from csel-www.cs.colorado.edu (128.138.201.90): icmp_seq=3 ttl=64 time=0.414 ms
208 bytes from csel-www.cs.colorado.edu (128.138.201.90): icmp_seq=4 ttl=64 time=0.395 ms
208 bytes from csel-www.cs.colorado.edu (128.138.201.90): icmp_seq=5 ttl=64 time=0.325 ms
208 bytes from csel-www.cs.colorado.edu (128.138.201.90): icmp_seq=6 ttl=64 time=0.335 ms
208 bytes from csel-www.cs.colorado.edu (128.138.201.90): icmp_seq=7 ttl=64 time=0.381 ms
208 bytes from csel-www.cs.colorado.edu (128.138.201.90): icmp_seq=8 ttl=64 time=0.366 ms
208 bytes from csel-www.cs.colorado.edu (128.138.201.90): icmp_seq=9 ttl=64 time=0.381 ms
208 bytes from csel-www.cs.colorado.edu (128.138.201.90): icmp_seq=10 ttl=64 time=0.417 ms
208 bytes from csel-www.cs.colorado.edu (128.138.201.90): icmp_seq=11 ttl=64 time=0.413 ms
208 bytes from csel-www.cs.colorado.edu (128.138.201.90): icmp_seq=12 ttl=64 time=0.415 ms
208 bytes from csel-www.cs.colorado.edu (128.138.201.90): icmp_seq=13 ttl=64 time=0.404 ms
208 bytes from csel-www.cs.colorado.edu (128.138.201.90): icmp_seq=14 ttl=64 time=0.455 ms
208 bytes from csel-www.cs.colorado.edu (128.138.201.90): icmp_seq=15 ttl=64 time=0.341 ms
208 bytes from csel-www.cs.colorado.edu (128.138.201.90): icmp_seq=16 ttl=64 time=0.279 ms
208 bytes from csel-www.cs.colorado.edu (128.138.201.90): icmp_seq=17 ttl=64 time=0.376 ms
208 bytes from csel-www.cs.colorado.edu (128.138.201.90): icmp_seq=18 ttl=64 time=0.334 ms
208 bytes from csel-www.cs.colorado.edu (128.138.201.90): icmp_seq=19 ttl=64 time=0.326 ms
208 bytes from csel-www.cs.colorado.edu (128.138.201.90): icmp_seq=20 ttl=64 time=0.412 ms

--- csel-www.cs.colorado.edu ping statistics ---
20 packets transmitted, 20 received, 0% packet loss, time 18999ms
rtt min/avg/max/mdev = 0.279/0.376/0.465/0.052 ms
```



```
rtt min/avg/max/mdev = 230.841/237.1340/238.919/0.745 ms
gaga2284@elra-01:~$ ping -c 20 -s 200 www.vit.edu
PING www.vit.edu (202.38.172.240) 200(228) bytes of data.
208 bytes from 202.38.172.240: icmp_seq=1 ttl=48 time=237 ms
208 bytes from 202.38.172.240: icmp_seq=2 ttl=48 time=237 ms
208 bytes from 202.38.172.240: icmp_seq=3 ttl=48 time=237 ms
208 bytes from 202.38.172.240: icmp_seq=4 ttl=48 time=236 ms
208 bytes from 202.38.172.240: icmp_seq=5 ttl=48 time=237 ms
208 bytes from 202.38.172.240: icmp_seq=6 ttl=48 time=237 ms
208 bytes from 202.38.172.240: icmp_seq=7 ttl=48 time=237 ms
208 bytes from 202.38.172.240: icmp_seq=8 ttl=48 time=237 ms
208 bytes from 202.38.172.240: icmp_seq=9 ttl=48 time=237 ms
208 bytes from 202.38.172.240: icmp_seq=10 ttl=48 time=237 ms
208 bytes from 202.38.172.240: icmp_seq=11 ttl=48 time=237 ms
208 bytes from 202.38.172.240: icmp_seq=12 ttl=48 time=236 ms
208 bytes from 202.38.172.240: icmp_seq=13 ttl=48 time=237 ms
208 bytes from 202.38.172.240: icmp_seq=14 ttl=48 time=237 ms
208 bytes from 202.38.172.240: icmp_seq=15 ttl=48 time=236 ms
208 bytes from 202.38.172.240: icmp_seq=16 ttl=48 time=237 ms
208 bytes from 202.38.172.240: icmp_seq=17 ttl=48 time=237 ms
208 bytes from 202.38.172.240: icmp_seq=18 ttl=48 time=237 ms
208 bytes from 202.38.172.240: icmp_seq=19 ttl=48 time=237 ms
208 bytes from 202.38.172.240: icmp_seq=20 ttl=48 time=237 ms

--- www.vit.edu ping statistics ---
20 packets transmitted, 20 received, 0% packet loss, time 19023ms
rtt min/avg/max/mdev = 236.931/237.251/237.599/0.540 ms
```

```
rtt min/avg/max/mdev = 42.110/42.440/42.535/0.280 ms
gaga2284@elra-01:~$ ping -c 20 -s 200 www.berkeley.edu
PING www.w3.berkeley.edu (128.32.203.137) 200(228) bytes of data.
208 bytes from calweb-farm-prod.ist.berkeley.edu (128.32.203.137): icmp_seq=1 ttl=52 time=42.1 ms
208 bytes from calweb-farm-prod.ist.berkeley.edu (128.32.203.137): icmp_seq=2 ttl=52 time=42.2 ms
208 bytes from calweb-farm-prod.ist.berkeley.edu (128.32.203.137): icmp_seq=3 ttl=52 time=42.9 ms
208 bytes from calweb-farm-prod.ist.berkeley.edu (128.32.203.137): icmp_seq=4 ttl=52 time=41.9 ms
208 bytes from calweb-farm-prod.ist.berkeley.edu (128.32.203.137): icmp_seq=5 ttl=52 time=42.1 ms
208 bytes from calweb-farm-prod.ist.berkeley.edu (128.32.203.137): icmp_seq=6 ttl=52 time=42.6 ms
208 bytes from calweb-farm-prod.ist.berkeley.edu (128.32.203.137): icmp_seq=7 ttl=52 time=42.8 ms
208 bytes from calweb-farm-prod.ist.berkeley.edu (128.32.203.137): icmp_seq=8 ttl=52 time=42.2 ms
208 bytes from calweb-farm-prod.ist.berkeley.edu (128.32.203.137): icmp_seq=9 ttl=52 time=42.3 ms
208 bytes from calweb-farm-prod.ist.berkeley.edu (128.32.203.137): icmp_seq=10 ttl=52 time=42.2 ms
208 bytes from calweb-farm-prod.ist.berkeley.edu (128.32.203.137): icmp_seq=11 ttl=52 time=42.6 ms
208 bytes from calweb-farm-prod.ist.berkeley.edu (128.32.203.137): icmp_seq=12 ttl=52 time=42.2 ms
208 bytes from calweb-farm-prod.ist.berkeley.edu (128.32.203.137): icmp_seq=13 ttl=52 time=42.1 ms
208 bytes from calweb-farm-prod.ist.berkeley.edu (128.32.203.137): icmp_seq=14 ttl=52 time=42.4 ms
208 bytes from calweb-farm-prod.ist.berkeley.edu (128.32.203.137): icmp_seq=15 ttl=52 time=42.4 ms
208 bytes from calweb-farm-prod.ist.berkeley.edu (128.32.203.137): icmp_seq=16 ttl=52 time=42.4 ms
208 bytes from calweb-farm-prod.ist.berkeley.edu (128.32.203.137): icmp_seq=17 ttl=52 time=42.3 ms
208 bytes from calweb-farm-prod.ist.berkeley.edu (128.32.203.137): icmp_seq=18 ttl=52 time=42.4 ms
208 bytes from calweb-farm-prod.ist.berkeley.edu (128.32.203.137): icmp_seq=19 ttl=52 time=42.8 ms
208 bytes from calweb-farm-prod.ist.berkeley.edu (128.32.203.137): icmp_seq=20 ttl=52 time=42.4 ms

--- www.w3.berkeley.edu ping statistics ---
20 packets transmitted, 20 received, 0% packet loss, time 19028ms
rtt min/avg/max/mdev = 41.987/42.415/42.947/0.343 ms
```

```
gaga2284@elra-01:~$ ping -c 20 -s 200 csel.cs.colorado.edu
PING csel-www.cs.colorado.edu (128.138.201.90) 200(228) bytes of data.
208 bytes from csel-www.cs.colorado.edu (128.138.201.90): icmp_seq=1 ttl=64 time=0.267 ms
208 bytes from csel-www.cs.colorado.edu (128.138.201.90): icmp_seq=2 ttl=64 time=0.237 ms
208 bytes from csel-www.cs.colorado.edu (128.138.201.90): icmp_seq=3 ttl=64 time=0.263 ms
208 bytes from csel-www.cs.colorado.edu (128.138.201.90): icmp_seq=4 ttl=64 time=0.261 ms
208 bytes from csel-www.cs.colorado.edu (128.138.201.90): icmp_seq=5 ttl=64 time=0.307 ms
208 bytes from csel-www.cs.colorado.edu (128.138.201.90): icmp_seq=6 ttl=64 time=0.235 ms
208 bytes from csel-www.cs.colorado.edu (128.138.201.90): icmp_seq=7 ttl=64 time=0.210 ms
208 bytes from csel-www.cs.colorado.edu (128.138.201.90): icmp_seq=8 ttl=64 time=0.230 ms
208 bytes from csel-www.cs.colorado.edu (128.138.201.90): icmp_seq=9 ttl=64 time=0.299 ms
208 bytes from csel-www.cs.colorado.edu (128.138.201.90): icmp_seq=10 ttl=64 time=0.272 ms
208 bytes from csel-www.cs.colorado.edu (128.138.201.90): icmp_seq=11 ttl=64 time=0.329 ms
208 bytes from csel-www.cs.colorado.edu (128.138.201.90): icmp_seq=12 ttl=64 time=0.424 ms
208 bytes from csel-www.cs.colorado.edu (128.138.201.90): icmp_seq=13 ttl=64 time=0.199 ms
208 bytes from csel-www.cs.colorado.edu (128.138.201.90): icmp_seq=14 ttl=64 time=0.275 ms
208 bytes from csel-www.cs.colorado.edu (128.138.201.90): icmp_seq=15 ttl=64 time=0.362 ms
208 bytes from csel-www.cs.colorado.edu (128.138.201.90): icmp_seq=16 ttl=64 time=0.373 ms
208 bytes from csel-www.cs.colorado.edu (128.138.201.90): icmp_seq=17 ttl=64 time=0.349 ms
208 bytes from csel-www.cs.colorado.edu (128.138.201.90): icmp_seq=18 ttl=64 time=0.375 ms
208 bytes from csel-www.cs.colorado.edu (128.138.201.90): icmp_seq=19 ttl=64 time=0.306 ms
208 bytes from csel-www.cs.colorado.edu (128.138.201.90): icmp_seq=20 ttl=64 time=0.235 ms

--- csel-www.cs.colorado.edu ping statistics ---
20 packets transmitted, 20 received, 0% packet loss, time 18999ms
rtt min/avg/max/mdev = 0.199/0.290/0.424/0.062 ms
```