

חלק ג – קישור לגיט עבור ההקלטות pcap -

למרות ההשקעה המרובה שלנו בחלק ב וביצירת הקוד, לא הצלחנו ליצור קוד שעובד בצורה מלאה ולכן ביקשנו אישור מיוחד מהמרצה (פרופ עמית דביר) על מנת להשתמש בקוד של קבוצה אחרת כדי לעשות את חלק ג בצורה הטובה ביותר כדי שלא נאבד על כך נקודות. להלן חלק ג :

אציין כי עשינו את כל הקומבינציות האפשריות על מנת לקבל את הבונוס, בכל הסנפה ניתן לראות שפתיחת הקשר קורת באמצעות לחיצת יד משולשת ולאחר מכן הפקטות שנשלחות

```
asaf@asaf-VirtualBox:~/Desktop/NetworksEx3-master$ sudo tc qdisc change dev lo root netem loss 0%
```

```
Starting Receiver...

Waiting for RUDP connection...
Connected successfully. seqnum: 0
Finished receiving
Sent ACK for FIN
Sent ACK for FIN
Receiver finished successfully
Connected successfully. seqnum: 0
Finished receiving
Sent ACK for FIN
Sent ACK for FIN
Receiver finished successfully
Connected successfully. seqnum: 0
Finished receiving
Sent ACK for FIN
Sent ACK for FIN
Receiver finished successfully
Connected successfully. seqnum: 0
Finished receiving
Sent ACK for FIN
Sent ACK for FIN
Receiver finished successfully
-----
(*) Times and speeds summary:

(*) Run 1, Time: 37.549 ms, Speed: 53.264 MB/s
(*) Run 2, Time: 36.891 ms, Speed: 54.214 MB/s
(*) Run 3, Time: 99.459 ms, Speed: 20.109 MB/s
(*) Run 4, Time: 31.096 ms, Speed: 64.317 MB/s
(*) Run 5, Time: 62.901 ms, Speed: 31.796 MB/s

(*) Overall statistics:
(*) Number of runs: 5
(*) Average RTT: 53.579 ms
(*) Average throughput: 44.740 MB/s
(*) Total time: 267.896 ms
-----

127.0.0.1 -p 9878
Starting Sender...

Sent SYN 0
Received SYNACK 0
Handshake successful!
Connected successfully
time taken: 37.481 ms
Finished sending data. Closing connection
Sender finished successfully
would you like to send the file again? (0 to exit, 1 to resend)
1
Sent SYN 0
Received SYNACK 0
Handshake successful!
Connected successfully
time taken: 36.849 ms
Finished sending data. Closing connection
Sender finished successfully
would you like to send the file again? (0 to exit, 1 to resend)
1
Sent SYN 0
Received SYNACK 0
Handshake successful!
Connected successfully
time taken: 99.408 ms
Finished sending data. Closing connection
Sender finished successfully
would you like to send the file again? (0 to exit, 1 to resend)
1
Sent SYN 0
Received SYNACK 0
Handshake successful!
Connected successfully
time taken: 31.061 ms
Finished sending data. Closing connection
Sender finished successfully
would you like to send the file again? (0 to exit, 1 to resend)
1
Sent SYN 0
Received SYNACK 0
Handshake successful!
Connected successfully
time taken: 62.852 ms
Finished sending data. Closing connection
Sender finished successfully
would you like to send the file again? (0 to exit, 1 to resend)
0
```

```

• asaf@asaf-VirtualBox:~/Desktop/NetworksEx3-master$ sudo tc qdisc del dev lo root netem
[sudo] password for asaf:
• asaf@asaf-VirtualBox:~/Desktop/NetworksEx3-master$ sudo apt update
Hit:1 http://il.archive.ubuntu.com/ubuntu jammy InRelease
Hit:2 http://security.ubuntu.com/ubuntu jammy-security InRelease
Hit:3 http://il.archive.ubuntu.com/ubuntu jammy-updates InRelease
Hit:4 http://il.archive.ubuntu.com/ubuntu jammy-backports InRelease
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
61 packages can be upgraded. Run 'apt list --upgradable' to see them.
• asaf@asaf-VirtualBox:~/Desktop/NetworksEx3-master$ sudo apt install iproute2
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
iproute2 is already the newest version (5.15.0-1ubuntu2).
0 upgraded, 0 newly installed, 0 to remove and 61 not upgraded.
• asaf@asaf-VirtualBox:~/Desktop/NetworksEx3-master$ sudo tc qdisc add dev lo root netem loss 2%

```

Starting Sender...

```

Sent SYN 0
Timeout for SYN 0
Received SYNACK 0
Handshake successful!
Connected successfully
time taken: 344.159 ms
Finished sending data. Closing connection
Sender finished successfully
would you like to send the file again? (0 to exit, 1 to resend)
1
Sent SYN 0
Received SYNACK 0
Handshake successful!
Connected successfully
time taken: 391.562 ms
Finished sending data. Closing connection
Sender finished successfully
would you like to send the file again? (0 to exit, 1 to resend)
1
Sent SYN 0
Received SYNACK 0
Handshake successful!
Connected successfully
time taken: 252.382 ms
Finished sending data. Closing connection
Sender finished successfully
would you like to send the file again? (0 to exit, 1 to resend)
1
Sent SYN 0
Received SYNACK 0
Handshake successful!
Connected successfully
time taken: 291.331 ms
Finished sending data. Closing connection
Sender finished successfully
would you like to send the file again? (0 to exit, 1 to resend)
1
Sent SYN 0
Received SYNACK 0
Handshake successful!
Connected successfully
time taken: 324.570 ms
Finished sending data. Closing connection
Sender finished successfully
would you like to send the file again? (0 to exit, 1 to resend)
0

```

Starting Receiver...

```

Waiting for RUDP connection...
Connected successfully. seqnum: 0
Finished receiving
Sent ACK for FIN
Sent ACK for FIN
Receiver finished successfully
Connected successfully. seqnum: 0
Finished receiving
Sent ACK for FIN
Sent ACK for FIN
Receiver finished successfully
Connected successfully. seqnum: 0
Finished receiving
Sent ACK for FIN
Sent ACK for FIN
Receiver finished successfully
Connected successfully. seqnum: 0
Finished receiving
Sent ACK for FIN
Sent ACK for FIN
Receiver finished successfully

```

(*) Times and speeds summary:

```

(*) Run 1, Time: 344.748 ms, Speed: 5.801 MB/s
(*) Run 2, Time: 391.862 ms, Speed: 5.104 MB/s
(*) Run 3, Time: 252.441 ms, Speed: 7.923 MB/s
(*) Run 4, Time: 291.381 ms, Speed: 6.864 MB/s
(*) Run 5, Time: 324.693 ms, Speed: 6.160 MB/s

```

(*) Overall statistics:

```

(*) Number of runs: 5
(*) Average RTT: 321.025 ms
(*) Average throughput: 6.370 MB/s
(*) Total time: 1605.125 ms

```

RUDP: אחוזי איבוד 2


```
asaf@asaf-VirtualBox:~/Desktop/NetworksEx3-master$ sudo tc qdisc change dev lo root netem loss 5%
```

RUDP: אחוזי איבוד 5

```
Starting Sender...
Sent SYN 0
Received SYNACK 0
Handshake successful!
Connected successfully
time taken: 642.619 ms
Finished sending data. Closing connection
Sender finished successfully
would you like to send the file again? (0 to exit, 1 to resend)
1
Sent SYN 0
Received SYNACK 0
Handshake successful!
Connected successfully
time taken: 598.742 ms
Finished sending data. Closing connection
Sender finished successfully
would you like to send the file again? (0 to exit, 1 to resend)
1
Sent SYN 0
Received SYNACK 0
Handshake successful!
Connected successfully
time taken: 617.058 ms
Finished sending data. Closing connection
Sender finished successfully
would you like to send the file again? (0 to exit, 1 to resend)
1
Sent SYN 0
Received SYNACK 0
Handshake successful!
Connected successfully
time taken: 790.687 ms
Finished sending data. Closing connection
Sender finished successfully
would you like to send the file again? (0 to exit, 1 to resend)
1
Sent SYN 0
Timeout for SYN 0
Received SYNACK 0
Handshake successful!
Connected successfully
time taken: 743.850 ms
Finished sending data. Closing connection
Sender finished successfully
would you like to send the file again? (0 to exit, 1 to resend)
0

Starting Receiver...
Waiting for RUDP connection...
Connected successfully. seqnum: 0
Finished receiving
Sent ACK for FIN
Sent ACK for FIN
Receiver finished successfully
Connected successfully. seqnum: 0
Finished receiving
Sent ACK for FIN
Sent ACK for FIN
Receiver finished successfully
Connected successfully. seqnum: 0
Finished receiving
Sent ACK for FIN
Sent ACK for FIN
Receiver finished successfully
Connected successfully. seqnum: 0
Finished receiving
Sent ACK for FIN
Sent ACK for FIN
Receiver finished successfully
Connected successfully. seqnum: 0
Finished receiving
Sent ACK for FIN
Sent ACK for FIN
Receiver finished successfully
-----
(*) Times and speeds summary:
(*) Run 1, Time: 643.075 ms, Speed: 3.110 MB/s
(*) Run 2, Time: 598.833 ms, Speed: 3.340 MB/s
(*) Run 3, Time: 617.167 ms, Speed: 3.241 MB/s
(*) Run 4, Time: 790.729 ms, Speed: 2.529 MB/s
(*) Run 5, Time: 744.197 ms, Speed: 2.687 MB/s

(*) Overall statistics:
(*) Number of runs: 5
(*) Average RTT: 678.800 ms
(*) Average throughput: 2.981 MB/s
(*) Total time: 3394.001 ms
-----
```

```
asaf@asaf-VirtualBox:~/Desktop/NetworksEx3-master$ sudo tc qdisc change dev lo root netem loss 10%
```

RUDP: אחוזי איבוד 10

Starting Receiver...

```
Waiting for RUDP connection...
Connected successfully. seqnum: 0
Finished receiving
Sent ACK for FIN
Sent ACK for FIN
Receiver finished successfully
Connected successfully. seqnum: 0
Finished receiving
Sent ACK for FIN
Sent ACK for FIN
Receiver finished successfully
Connected successfully. seqnum: 0
Finished receiving
Sent ACK for FIN
Sent ACK for FIN
Receiver finished successfully
Connected successfully. seqnum: 0
Finished receiving
Sent ACK for FIN
Sent ACK for FIN
Receiver finished successfully
```

(*) Times and speeds summary:

```
(*) Run 1, Time: 1293.028 ms, Speed: 1.547 MB/s
(*) Run 2, Time: 1372.289 ms, Speed: 1.457 MB/s
(*) Run 3, Time: 1365.221 ms, Speed: 1.465 MB/s
(*) Run 4, Time: 1335.063 ms, Speed: 1.498 MB/s
(*) Run 5, Time: 1341.351 ms, Speed: 1.491 MB/s
```

(*) Overall statistics:

```
(*) Number of runs: 5
(*) Average RTT: 1341.390 ms
(*) Average throughput: 1.492 MB/s
(*) Total time: 6706.952 ms
```

Starting Sender...

```
Sent SYN 0
Received SYNACK 0
Handshake successful!
Connected successfully
time taken: 1292.960 ms
Finished sending data. Closing connection
Sender finished successfully
would you like to send the file again? (0 to exit, 1 to resend)
1
Sent SYN 0
Received SYNACK 0
Handshake successful!
Connected successfully
time taken: 1371.737 ms
Finished sending data. Closing connection
Sender finished successfully
would you like to send the file again? (0 to exit, 1 to resend)
1
Sent SYN 0
Timeout for SYN 0
Received SYNACK 0
Handshake successful!
Connected successfully
time taken: 1365.180 ms
Finished sending data. Closing connection
Sender finished successfully
would you like to send the file again? (0 to exit, 1 to resend)
1
Sent SYN 0
Received SYNACK 0
Handshake successful!
Connected successfully
time taken: 1335.023 ms
Finished sending data. Closing connection
Sender finished successfully
would you like to send the file again? (0 to exit, 1 to resend)
1
Sent SYN 0
Received SYNACK 0
Handshake successful!
Connected successfully
time taken: 1341.301 ms
Finished sending data. Closing connection
Sender finished successfully
would you like to send the file again? (0 to exit, 1 to resend)
0
```

```
asaf@asaf-VirtualBox:~/Desktop/NetworksEx3-master$ sudo tc qdisc change dev lo root netem loss 0%
```

Cubic cubic 0%

```
Starting Receiver...

Waiting for TCP connection...
Sender connected, beginning to receive file...

File transfer completed.

Waiting for Sender response...
File transfer completed.

Waiting for Sender response...
File transfer completed.

Waiting for Sender response...
File transfer completed.

Waiting for Sender response...
File transfer completed.

Waiting for Sender response...
Sender sent exit message.

-----
(*) Times and speeds summary:

(*) Run 1, Time: 8.615 ms, Speed: 348.230 MB/s
(*) Run 2, Time: 2.481 ms, Speed: 1209.190 MB/s
(*) Run 3, Time: 1.253 ms, Speed: 2394.254 MB/s
(*) Run 4, Time: 2.203 ms, Speed: 1361.779 MB/s
(*) Run 5, Time: 2.255 ms, Speed: 1330.377 MB/s

(*) Overall statistics:
(*) CC Algorithm: cubic
(*) Number of runs: 5
(*) Average RTT: 3.361 ms
(*) Average throughput: 1328.766 MB/s
(*) Total time: 16.807 ms
-----
```

```
Starting Sender...

sending file
file sent
time taken: 8.098 ms
Press 1 to resend the file, press 0 to exit.
1
time taken: 2.359 ms
Press 1 to resend the file, press 0 to exit.
1
time taken: 1.245 ms
Press 1 to resend the file, press 0 to exit.
1
time taken: 1.856 ms
Press 1 to resend the file, press 0 to exit.
1
time taken: 2.268 ms
Press 1 to resend the file, press 0 to exit.
0
```



```
● asaf@asaf-VirtualBox:~/Desktop/NetworksEx3-master$ sudo tc qdisc change dev lo root netem loss 2%
```

```
Starting Receiver...
```

```
Waiting for TCP connection...
```

```
Sender connected, beginning to receive file...
```

```
File transfer completed.
```

```
Waiting for Sender response...
```

```
File transfer completed.
```

```
Waiting for Sender response...
```

```
File transfer completed.
```

```
Waiting for Sender response...
```

```
File transfer completed.
```

```
Waiting for Sender response...
```

```
File transfer completed.
```

```
Waiting for Sender response...
```

```
Sender sent exit message.
```

```
-----  
(* ) Times and speeds summary:
```

```
(* ) Run 1, Time: 2.236 ms, Speed: 1341.682 MB/s
```

```
(* ) Run 2, Time: 2.085 ms, Speed: 1438.849 MB/s
```

```
(* ) Run 3, Time: 1.353 ms, Speed: 2217.295 MB/s
```

```
(* ) Run 4, Time: 1.597 ms, Speed: 1878.522 MB/s
```

```
(* ) Run 5, Time: 1.765 ms, Speed: 1699.717 MB/s
```

```
(* ) Overall statistics:
```

```
(* ) CC Algorithm: cubic
```

```
(* ) Number of runs: 5
```

```
(* ) Average RTT: 1.807 ms
```

```
(* ) Average throughput: 1715.213 MB/s
```

```
(* ) Total time: 9.036 ms  
-----
```

Cubic cubic
2%

```
Starting Sender...
```

```
sending file
```

```
file sent
```

```
time taken: 1.674 ms
```

```
Press 1 to resend the file, press 0 to exit.
```

```
1
```

```
time taken: 1.535 ms
```

```
Press 1 to resend the file, press 0 to exit.
```

```
1
```

```
time taken: 1.352 ms
```

```
Press 1 to resend the file, press 0 to exit.
```

```
1
```

```
time taken: 1.527 ms
```

```
Press 1 to resend the file, press 0 to exit.
```

```
1
```

```
time taken: 1.323 ms
```

```
Press 1 to resend the file, press 0 to exit.
```

```
0
```

```
asaf@asaf-VirtualBox:~/Desktop/NetworksEx3-master$ sudo tc qdisc change dev lo root netem loss 5%
```

```
Starting Receiver...
```

```
Waiting for TCP connection...
```

```
Sender connected, beginning to receive file...
```

```
File transfer completed.
```

```
Waiting for Sender response...
```

```
File transfer completed.
```

```
Waiting for Sender response...
```

```
File transfer completed.
```

```
Waiting for Sender response...
```

```
File transfer completed.
```

```
Waiting for Sender response...
```

```
File transfer completed.
```

```
Waiting for Sender response...
```

```
Sender sent exit message.
```

```
Starting Sender...
```

```
sending file
```

```
file sent
```

```
time taken: 2.352 ms
```

```
Press 1 to resend the file, press 0 to exit.
```

```
1
```

```
time taken: 1.159 ms
```

```
Press 1 to resend the file, press 0 to exit.
```

```
1
```

```
time taken: 1.178 ms
```

```
Press 1 to resend the file, press 0 to exit.
```

```
1
```

```
time taken: 1.460 ms
```

```
Press 1 to resend the file, press 0 to exit.
```

```
1
```

```
time taken: 1.319 ms
```

```
Press 1 to resend the file, press 0 to exit.
```

```
0
```

```
-----  
(*) Times and speeds summary:
```

```
(*) Run 1, Time: 6.997 ms, Speed: 428.755 MB/s
```

```
(*) Run 2, Time: 1.369 ms, Speed: 2191.381 MB/s
```

```
(*) Run 3, Time: 1.521 ms, Speed: 1972.387 MB/s
```

```
(*) Run 4, Time: 1.645 ms, Speed: 1823.708 MB/s
```

```
(*) Run 5, Time: 9.086 ms, Speed: 330.178 MB/s
```

```
(*) Overall statistics:
```

```
(*) CC Algorithm: cubic
```

```
(*) Number of runs: 5
```

```
(*) Average RTT: 4.124 ms
```

```
(*) Average throughput: 1349.282 MB/s
```

```
(*) Total time: 20.618 ms  
-----
```

Cubic cubic 5%


```
asaf@asaf-VirtualBox:~/Desktop/NetworksEx3-master$ sudo tc qdisc change dev lo root netem loss 10%
```

Cubic cubic 10%

```
Starting Receiver...
```

```
Waiting for TCP connection...
```

```
Sender connected, beginning to receive file...
```

```
File transfer completed.
```

```
Waiting for Sender response...
```

```
File transfer completed.
```

```
Waiting for Sender response...
```

```
File transfer completed.
```

```
Waiting for Sender response...
```

```
File transfer completed.
```

```
Waiting for Sender response...
```

```
File transfer completed.
```

```
Waiting for Sender response...
```

```
Sender sent exit message.
```

```
Starting Sender...
```

```
sending file
```

```
file sent
```

```
time taken: 7.289 ms
```

```
Press 1 to resend the file, press 0 to exit.
```

```
1
```

```
time taken: 217.376 ms
```

```
Press 1 to resend the file, press 0 to exit.
```

```
1
```

```
time taken: 1.037 ms
```

```
Press 1 to resend the file, press 0 to exit.
```

```
1
```

```
time taken: 1.113 ms
```

```
Press 1 to resend the file, press 0 to exit.
```

```
1
```

```
time taken: 1.200 ms
```

```
Press 1 to resend the file, press 0 to exit.
```

```
0
```

```
-----  
(*) Times and speeds summary:
```

```
(*) Run 1, Time: 647.262 ms, Speed: 4.635 MB/s
```

```
(*) Run 2, Time: 383.482 ms, Speed: 7.823 MB/s
```

```
(*) Run 3, Time: 284.181 ms, Speed: 10.557 MB/s
```

```
(*) Run 4, Time: 476.897 ms, Speed: 6.291 MB/s
```

```
(*) Run 5, Time: 6.571 ms, Speed: 456.552 MB/s
```

```
(*) Overall statistics:
```

```
(*) CC Algorithm: cubic
```

```
(*) Number of runs: 5
```

```
(*) Average RTT: 359.679 ms
```

```
(*) Average throughput: 97.171 MB/s
```

```
(*) Total time: 1798.393 ms  
-----
```

```
asaf@asaf-VirtualBox:~/Desktop/NetworksEx3-master$ sudo tc qdisc change dev lo root netem loss 0%
```

Starting Receiver...

Waiting for TCP connection...

Sender connected, beginning to receive file...

File transfer completed.

Waiting for Sender response...

File transfer completed.

Waiting for Sender response...

File transfer completed.

Waiting for Sender response...

File transfer completed.

Waiting for Sender response...

File transfer completed.

Waiting for Sender response...

Sender sent exit message.

Starting Sender...

sending file

file sent

time taken: 4.292 ms

Press 1 to resend the file, press 0 to exit.

1

time taken: 1.528 ms

Press 1 to resend the file, press 0 to exit.

1

time taken: 1.321 ms

Press 1 to resend the file, press 0 to exit.

1

time taken: 1.119 ms

Press 1 to resend the file, press 0 to exit.

1

time taken: 1.221 ms

Press 1 to resend the file, press 0 to exit.

0

(*) Times and speeds summary:

(*) Run 1, Time: 4.406 ms, Speed: 680.890 MB/s

(*) Run 2, Time: 1.536 ms, Speed: 1953.125 MB/s

(*) Run 3, Time: 1.396 ms, Speed: 2148.997 MB/s

(*) Run 4, Time: 2.056 ms, Speed: 1459.144 MB/s

(*) Run 5, Time: 1.819 ms, Speed: 1649.258 MB/s

(*) Overall statistics:

(*) CC Algorithm: reno

(*) Number of runs: 5

(*) Average RTT: 2.243 ms

(*) Average throughput: 1578.283 MB/s

(*) Total time: 11.213 ms

Reno reno 0%


```
asaf@asaf-VirtualBox:~/Desktop/NetworksEx3-master$ sudo tc qdisc change dev lo root n
tem loss 2%
```

Starting Receiver...

Waiting for TCP connection...

Sender connected, beginning to receive file...

File transfer completed.

Waiting for Sender response...

File transfer completed.

Waiting for Sender response...

File transfer completed.

Waiting for Sender response...

File transfer completed.

Waiting for Sender response...

File transfer completed.

Waiting for Sender response...

Sender sent exit message.

Starting Sender...

sending file

file sent

time taken: 1.347 ms

Press 1 to resend the file, press 0 to exit.

1

time taken: 1.549 ms

Press 1 to resend the file, press 0 to exit.

1

time taken: 1.482 ms

Press 1 to resend the file, press 0 to exit.

1

time taken: 1.959 ms

Press 1 to resend the file, press 0 to exit.

1

time taken: 1.388 ms

Press 1 to resend the file, press 0 to exit.

0

(*) Times and speeds summary:

(*) Run 1, Time: 1.913 ms, Speed: 1568.217 MB/s

(*) Run 2, Time: 1.750 ms, Speed: 1714.286 MB/s

(*) Run 3, Time: 2.113 ms, Speed: 1419.782 MB/s

(*) Run 4, Time: 10.074 ms, Speed: 297.796 MB/s

(*) Run 5, Time: 1.607 ms, Speed: 1866.833 MB/s

(*) Overall statistics:

(*) CC Algorithm: reno

(*) Number of runs: 5

(*) Average RTT: 3.491 ms

(*) Average throughput: 1373.383 MB/s

(*) Total time: 17.457 ms

Reno reno
2%


```
asaf@asaf-VirtualBox:~/Desktop/NetworksEx3-master$ sudo tc qdisc change dev lo root netem loss 5%
```

```
Starting Receiver...
```

```
Waiting for TCP connection...
```

```
Sender connected, beginning to receive file...
```

```
File transfer completed.
```

```
Waiting for Sender response...
```

```
File transfer completed.
```

```
Waiting for Sender response...
```

```
File transfer completed.
```

```
Waiting for Sender response...
```

```
File transfer completed.
```

```
Waiting for Sender response...
```

```
File transfer completed.
```

```
Waiting for Sender response...
```

```
Sender sent exit message.
```

```
5 -algo reno  
Starting Sender...
```

```
sending file
```

```
file sent
```

```
time taken: 8.301 ms
```

```
Press 1 to resend the file, press 0 to exit.
```

```
1
```

```
time taken: 1.517 ms
```

```
Press 1 to resend the file, press 0 to exit.
```

```
1
```

```
time taken: 1.382 ms
```

```
Press 1 to resend the file, press 0 to exit.
```

```
1
```

```
time taken: 2.034 ms
```

```
Press 1 to resend the file, press 0 to exit.
```

```
1
```

```
time taken: 1.621 ms
```

```
Press 1 to resend the file, press 0 to exit.
```

```
0
```

```
-----  
(*) Times and speeds summary:
```

```
(*) Run 1, Time: 8.254 ms, Speed: 363.460 MB/s
```

```
(*) Run 2, Time: 1.685 ms, Speed: 1780.415 MB/s
```

```
(*) Run 3, Time: 45.868 ms, Speed: 65.405 MB/s
```

```
(*) Run 4, Time: 10.113 ms, Speed: 296.648 MB/s
```

```
(*) Run 5, Time: 3.167 ms, Speed: 947.269 MB/s
```

```
(*) Overall statistics:
```

```
(*) CC Algorithm: reno
```

```
(*) Number of runs: 5
```

```
(*) Average RTT: 13.817 ms
```

```
(*) Average throughput: 690.639 MB/s
```

```
(*) Total time: 69.087 ms  
-----
```

Reno reno
5%

```
asaf@asaf-VirtualBox:~/Desktop/NetworksEx3-master$ sudo tc qdisc change dev lo root netem loss 10%
```

```
Starting Receiver...
```

```
Waiting for TCP connection...
```

```
Sender connected, beginning to receive file...
```

```
File transfer completed.
```

```
Waiting for Sender response...
```

```
File transfer completed.
```

```
Waiting for Sender response...
```

```
File transfer completed.
```

```
Waiting for Sender response...
```

```
File transfer completed.
```

```
Waiting for Sender response...
```

```
File transfer completed.
```

```
Waiting for Sender response...
```

```
Sender sent exit message.
```

```
Starting Sender...
```

```
sending file
```

```
file sent
```

```
time taken: 215.387 ms
```

```
Press 1 to resend the file, press 0 to exit.
```

```
1
```

```
time taken: 1.514 ms
```

```
Press 1 to resend the file, press 0 to exit.
```

```
1
```

```
time taken: 1.644 ms
```

```
Press 1 to resend the file, press 0 to exit.
```

```
1
```

```
time taken: 1.129 ms
```

```
Press 1 to resend the file, press 0 to exit.
```

```
1
```

```
time taken: 1.325 ms
```

```
Press 1 to resend the file, press 0 to exit.
```

```
0
```

```
-----  
(*) Times and speeds summary:
```

```
(*) Run 1, Time: 280.558 ms, Speed: 10.693 MB/s
```

```
(*) Run 2, Time: 988.250 ms, Speed: 3.036 MB/s
```

```
(*) Run 3, Time: 2.784 ms, Speed: 1077.586 MB/s
```

```
(*) Run 4, Time: 2.061 ms, Speed: 1455.604 MB/s
```

```
(*) Run 5, Time: 1.697 ms, Speed: 1767.826 MB/s
```

```
(*) Overall statistics:
```

```
(*) CC Algorithm: reno
```

```
(*) Number of runs: 5
```

```
(*) Average RTT: 255.070 ms
```

```
(*) Average throughput: 862.949 MB/s
```

```
(*) Total time: 1275.350 ms  
-----
```

Reno reno
10%

```
asaf@asaf-VirtualBox:~/Desktop/NetworksEx3-master$ sudo tc qdisc change dev lo root n
tem loss 0%
```

RENO – receiver, cubic-sender, 0%

```
Starting Receiver...
```

```
Waiting for TCP connection...
```

```
Sender connected, beginning to receive file...
```

```
File transfer completed.
```

```
Waiting for Sender response...
```

```
File transfer completed.
```

```
Waiting for Sender response...
```

```
File transfer completed.
```

```
Waiting for Sender response...
```

```
File transfer completed.
```

```
Waiting for Sender response...
```

```
File transfer completed.
```

```
Waiting for Sender response...
```

```
Sender sent exit message.
```

```
-----  
(*) Times and speeds summary: 0
```

```
(*) Run 1, Time: 1.882 ms, Speed: 1594.049 MB/s
```

```
(*) Run 2, Time: 1.535 ms, Speed: 1954.397 MB/s
```

```
(*) Run 3, Time: 1.348 ms, Speed: 2225.519 MB/s
```

```
(*) Run 4, Time: 1.421 ms, Speed: 2111.189 MB/s
```

```
(*) Run 5, Time: 1.297 ms, Speed: 2313.030 MB/s
```

```
(*) Overall statistics:
```

```
(*) CC Algorithm: reno
```

```
(*) Number of runs: 5
```

```
(*) Average RTT: 1.497 ms
```

```
(*) Average throughput: 2039.637 MB/s
```

```
(*) Total time: 7.483 ms
```



```
asaf@asaf-VirtualBox:~/Desktop/NetworksEx3-master$ sudo tc qdisc change dev lo root n
tem loss 2%
```

RENO – receiver, cubic-sender, 2%

```
Starting Receiver...
Waiting for TCP connection...
Sender connected, beginning to receive file...

File transfer completed.
Waiting for Sender response...
File transfer completed.
Waiting for Sender response...
File transfer completed.
Waiting for Sender response...
File transfer completed.
Waiting for Sender response...
File transfer completed.
Waiting for Sender response...
Sender sent exit message.

Starting Sender...
sending file
file sent
time taken: 3.890 ms
Press 1 to resend the file, press 0 to exit.
1
time taken: 1.312 ms
Press 1 to resend the file, press 0 to exit.
1
time taken: 2.293 ms
Press 1 to resend the file, press 0 to exit.
1
time taken: 1.585 ms
Press 1 to resend the file, press 0 to exit.
1
time taken: 1.285 ms
Press 1 to resend the file, press 0 to exit.
0

-----
(*) Times and speeds summary:

(*) Run 1, Time: 3.681 ms, Speed: 814.996 MB/s
(*) Run 2, Time: 8.655 ms, Speed: 346.620 MB/s
(*) Run 3, Time: 2.947 ms, Speed: 1017.984 MB/s
(*) Run 4, Time: 1.749 ms, Speed: 1715.266 MB/s
(*) Run 5, Time: 1.326 ms, Speed: 2262.443 MB/s

(*) Overall statistics:
(*) CC Algorithm: reno
(*) Number of runs: 5
(*) Average RTT: 3.672 ms
(*) Average throughput: 1231.462 MB/s
(*) Total time: 18.358 ms
-----
```

```
asaf@asaf-VirtualBox:~/Desktop/NetworksEx3-master$ sudo tc qdisc change dev lo root netem loss 5%
```

RENO – receiver, cubic-sender, 5%

```
Starting Receiver...
```

```
Waiting for TCP connection...
```

```
Sender connected, beginning to receive file...
```

```
File transfer completed.
```

```
Starting Sender...
```

```
Waiting for Sender response... sending file
```

```
File transfer completed. file sent
```

```
time taken: 426.572 ms
```

```
Press 1 to resend the file, press 0 to exit.
```

```
Waiting for Sender response... 1
```

```
File transfer completed. time taken: 1.326 ms
```

```
Press 1 to resend the file, press 0 to exit.
```

```
Waiting for Sender response... 1
```

```
File transfer completed. time taken: 1.129 ms
```

```
Press 1 to resend the file, press 0 to exit.
```

```
Waiting for Sender response... 1
```

```
File transfer completed. time taken: 1.878 ms
```

```
Press 1 to resend the file, press 0 to exit.
```

```
Waiting for Sender response... 1
```

```
Sender sent exit message. time taken: 1.103 ms
```

```
Press 1 to resend the file, press 0 to exit.
```

```
0
```

```
-----  
(*) Times and speeds summary:
```

```
(*) Run 1, Time: 649.062 ms, Speed: 4.622 MB/s
```

```
(*) Run 2, Time: 1.647 ms, Speed: 1821.494 MB/s
```

```
(*) Run 3, Time: 1.843 ms, Speed: 1627.781 MB/s
```

```
(*) Run 4, Time: 2.099 ms, Speed: 1429.252 MB/s
```

```
(*) Run 5, Time: 1.898 ms, Speed: 1580.611 MB/s
```

```
(*) Overall statistics:
```

```
(*) CC Algorithm: reno
```

```
(*) Number of runs: 5
```

```
(*) Average RTT: 131.310 ms
```

```
(*) Average throughput: 1292.752 MB/s
```

```
(*) Total time: 656.549 ms  
-----
```



```
asaf@asaf-VirtualBox:~/Desktop/NetworksEx3-master$ sudo tc qdisc change dev lo root netem loss 10%
```

RENO – receiver, cubic-sender, 10%

```
Starting Receiver...
```

```
Waiting for TCP connection...
```

```
Sender connected, beginning to receive file...
```

```
File transfer completed.
```

```
Waiting for Sender response...
```

```
File transfer completed.
```

```
Waiting for Sender response...
```

```
File transfer completed.
```

```
Waiting for Sender response...
```

```
File transfer completed.
```

```
Waiting for Sender response...
```

```
File transfer completed.
```

```
Waiting for Sender response...
```

```
Sender sent exit message.
```

```
-----  
(*) Times and speeds summary:
```

```
(*) Run 1, Time: 10.488 ms, Speed: 286.041 MB/s
```

```
(*) Run 2, Time: 8.364 ms, Speed: 358.680 MB/s
```

```
(*) Run 3, Time: 57.419 ms, Speed: 52.248 MB/s
```

```
(*) Run 4, Time: 208.923 ms, Speed: 14.359 MB/s
```

```
(*) Run 5, Time: 209.740 ms, Speed: 14.303 MB/s
```

```
(*) Overall statistics:
```

```
(*) CC Algorithm: reno
```

```
(*) Number of runs: 5
```

```
(*) Average RTT: 98.987 ms
```

```
(*) Average throughput: 145.126 MB/s
```

```
(*) Total time: 494.934 ms  
-----
```

```
Starting Sender...
```

```
sending file
```

```
file sent
```

```
time taken: 1.715 ms
```

```
Press 1 to resend the file, press 0 to exit
```

```
1
```

```
time taken: 1.181 ms
```

```
Press 1 to resend the file, press 0 to exit
```

```
1
```

```
time taken: 1.185 ms
```

```
Press 1 to resend the file, press 0 to exit
```

```
1
```

```
time taken: 1.349 ms
```

```
Press 1 to resend the file, press 0 to exit
```

```
1
```

```
time taken: 1.602 ms
```

```
Press 1 to resend the file, press 0 to exit
```

```
0
```



```
● asaf@asaf-VirtualBox:~/Desktop/NetworksEx3-master$ sudo tc qdisc change dev lo root n
tem loss 0%
```

cubic – receiver, reno-sender, 0%

```
Starting Receiver...
Waiting for TCP connection...
Sender connected, beginning to receive file...

File transfer completed.
Waiting for Sender response..
File transfer completed.
Waiting for Sender response..
File transfer completed.
Waiting for Sender response..
File transfer completed.
Waiting for Sender response..
File transfer completed.
Waiting for Sender response..
Sender sent exit message.

-----
(*) Times and speeds summary:

(*) Run 1, Time: 2.602 ms, Speed: 1152.959 MB/s
(*) Run 2, Time: 1.459 ms, Speed: 2056.203 MB/s
(*) Run 3, Time: 1.339 ms, Speed: 2240.478 MB/s
(*) Run 4, Time: 1.504 ms, Speed: 1994.681 MB/s
(*) Run 5, Time: 1.638 ms, Speed: 1831.502 MB/s

(*) Overall statistics:
(*) CC Algorithm: cubic
(*) Number of runs: 5
(*) Average RTT: 1.708 ms
(*) Average throughput: 1855.165 MB/s
(*) Total time: 8.542 ms
-----
```

```
asaf@asaf-VirtualBox:~/Desktop/NetworksEx3-master$ sudo tc qdisc change dev lo root netem loss 2%
```

cubic – receiver, reno-sender, 2%

```
Starting Receiver...
Waiting for TCP connection...
Sender connected, beginning to receive file...
File transfer completed.
Starting Sender...
sending file
File transfer completed. file sent
time taken: 1.788 ms
Press 1 to resend the file, press 0 to exit.
1
File transfer completed. time taken: 1.278 ms
Press 1 to resend the file, press 0 to exit.
1
File transfer completed. time taken: 1.094 ms
Press 1 to resend the file, press 0 to exit.
1
File transfer completed. time taken: 1.341 ms
Press 1 to resend the file, press 0 to exit.
1
File transfer completed. time taken: 1.154 ms
Press 1 to resend the file, press 0 to exit.
0
-----
(*) Times and speeds summary:

(*) Run 1, Time: 1.763 ms, Speed: 1701.645 MB/s
(*) Run 2, Time: 1.550 ms, Speed: 1935.484 MB/s
(*) Run 3, Time: 1.255 ms, Speed: 2390.438 MB/s
(*) Run 4, Time: 1.624 ms, Speed: 1847.291 MB/s
(*) Run 5, Time: 2.270 ms, Speed: 1321.586 MB/s

(*) Overall statistics:
(*) CC Algorithm: cubic
(*) Number of runs: 5
(*) Average RTT: 1.692 ms
(*) Average throughput: 1839.289 MB/s
(*) Total time: 8.462 ms
-----
```



```
asaf@asaf-VirtualBox:~/Desktop/NetworksEx3-master$ sudo tc qdisc change dev lo root netem loss 5%
```

cubic – receiver, reno-sender, 5%

```
Starting Receiver...
Waiting for TCP connection...
Sender connected, beginning to receive file...
File transfer completed.
Waiting for Sender response...
File transfer completed.
Waiting for Sender response...
File transfer completed.
Waiting for Sender response...
File transfer completed.
Waiting for Sender response...
File transfer completed.
Waiting for Sender response...
Sender sent exit message.

-----
(*) Times and speeds summary:

(*) Run 1, Time: 441.917 ms, Speed: 6.789 MB/s
(*) Run 2, Time: 52.709 ms, Speed: 56.916 MB/s
(*) Run 3, Time: 208.244 ms, Speed: 14.406 MB/s
(*) Run 4, Time: 1.657 ms, Speed: 1810.501 MB/s
(*) Run 5, Time: 1.772 ms, Speed: 1693.002 MB/s

(*) Overall statistics:
(*) CC Algorithm: cubic
(*) Number of runs: 5
(*) Average RTT: 141.260 ms
(*) Average throughput: 716.323 MB/s
(*) Total time: 706.299 ms
-----
```



```
asaf@asaf-VirtualBox:~/Desktop/NetworksEx3-master$ sudo tc qdisc change dev lo root netem loss 10%
```

cubic – receiver, reno-sender 10%

```
Starting Receiver...
Waiting for TCP connection...
Sender connected, beginning to receive file...
File transfer completed.
Starting Sender...
Waiting for Sender response.. sending file
File transfer completed. file sent
time taken: 11.702 ms
Press 1 to resend the file, press 0 to exit.
1
Waiting for Sender response.. time taken: 1.780 ms
File transfer completed. Press 1 to resend the file, press 0 to exit.
1
Waiting for Sender response.. time taken: 1.271 ms
File transfer completed. Press 1 to resend the file, press 0 to exit.
1
Waiting for Sender response.. time taken: 1.400 ms
File transfer completed. Press 1 to resend the file, press 0 to exit.
1
Waiting for Sender response.. time taken: 1.289 ms
Sender sent exit message. Press 1 to resend the file, press 0 to exit.
0

-----
(*) Times and speeds summary:

(*) Run 1, Time: 715.459 ms, Speed: 4.193 MB/s
(*) Run 2, Time: 443.643 ms, Speed: 6.762 MB/s
(*) Run 3, Time: 8.288 ms, Speed: 361.969 MB/s
(*) Run 4, Time: 1.996 ms, Speed: 1503.006 MB/s
(*) Run 5, Time: 95.216 ms, Speed: 31.507 MB/s

(*) Overall statistics:
(*) CC Algorithm: cubic
(*) Number of runs: 5
(*) Average RTT: 252.920 ms
(*) Average throughput: 381.488 MB/s
(*) Total time: 1264.602 ms
-----
```

שאלות המחקר :

1: בtcp כאשר ה packet loss היה באחוזים נמוכים אז לא היה הבדל משמעותי בין ה cubic לבין ה renson אך כאשר עלו אחוזי ה packet loss היה ניתן לראות שהcubic משפר משמעותית את מהירות השליחה מכיוון שהוא אלגוריתם מורכב יותר לא כמו ה renson שגדל באופן ליניארי.

2. ב RUDP כפי שכבר ציינתי השתמשתי בקוד של קבוצה אחרת שמימשה על ידי wait and stop, כלומר נחכה שכל פקטה תגיע ונקבל אישור כדי להמשיך להעביר נתונים (לא יעיל בכלל כאשר יש packet loss גבוה) ולכן הRUDP הוא הרבה יותר איטי מהTCP. אם נבחין בזמן ובמהירות הממוצעת בין הRUDP ל TCP נוכל לראות שהRUDP הרבה יותר איטי ולכן נעדיף את השימוש ב tcp

3. יש לציין כי התוצאות שלנו שונות מהדרך המקובלת שכן עבור התוצאות שקיבלנו עדיף להשתמש בtcp תמיד וזה בגלל שהקוד עליו הרצנו ממומש בצורה שבה המהירות היא מאוד איטית. אך באופן כללי בקוד שבנוי בצורה אופטימלית אנו נרצה להשתמש ב rudp במקרים כמו אפליקציות שיכולות להתמודד עם פספוס מידע וכן באפליקציות שיודעות להתמודד עם שגיאות בזמן אמת, לדוגמא משחקי גיימינג, RUDP נותן חשיבות גדולה יותר למהירות על הגעה מושלמת של הפקטה, אז כמובן שRUDP כאשר צריך להעביר מידע בצורה אמינה בדחיפות ובאותו הרגע הוא ייתן לנו תוצאות הרבה יותר טובות ונרצה להשתמש בו. ובTCP נרצה להשתמש אם אנו צריכים שכל המידע יגיע ולא נוכל להסתפק בחלק מהמידע וכן במקרים בהם סדר הפקטות הוא חשוב, לדוגמא: web browsing.

תשובות לשאלות בעברית :

תשובה לשאלה 1-

בחרנו במקרה 1: בקשר ארוך על גבי רשת אמינה עם RTT גדול.

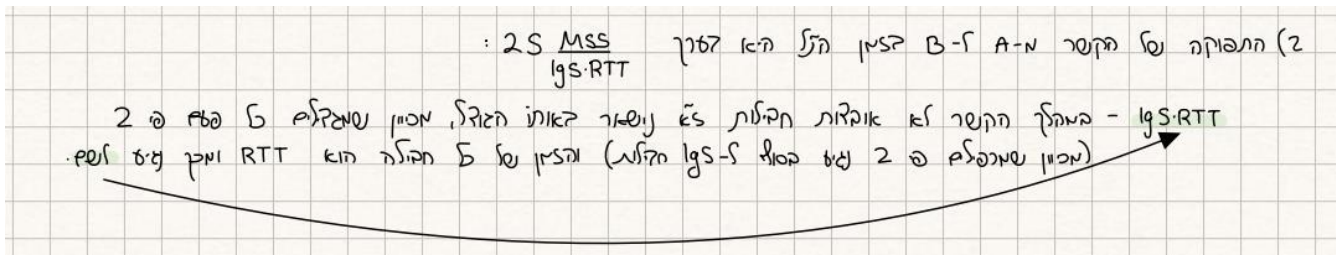
נחלק את התשובה לשלושת היתרונות שהם הרשת האמינה, RTT גדול וקשר ארוך

הרשת האמינה מובילה לכך שפחות חבילות יאבדו או יאבדו בקצב נמוך יחסית. זה מאפשר לנו להעלות את ערך ה-SSThreshold בתחילת הקשר מבלי לחשוש מאיבוד חבילות מיותר.

RTT גדול מסמן על כך שלפקטות לוקח הרבה זמן ל"סיבוב" שכל פקטה עושה ליעד ובחזרה כלומר על ידי הגבהת הסף אנו מבצעים כמה שיותר פעולות במקביל ויכולים לשלוח כמה שיותר פקטות לפני שאנחנו מחכים לאישור מה שיכול להגביר את הביצועים של הרשת

קשר ארוך - העלאת ערך ה-SSThreshold בתחילת הקשר מאפשרת לנו לשלוח הרבה מידע בו זמנית, מה שמסייע לנו להעביר מידע במהירות גבוהה יותר באופן יעיל. בקשר ארוך, שבו נתונים עוברים באופן ממושך לאורך זמן, נרוויח מכך שאפשר לבצע מספר פעולות במקביל, מבלי לדרוש תגובות או לנהל את החבילות. כתוצאה מכך, זמן ההעברה יתקצר והתקשורת תהיה יעילה יותר. הגדלת ערך ה-SSThreshold מאפשרת לשפר את ביצועי התקשורת ולאפשר העברת נתונים בצורה יעילה ובמהירות גבוהה לאורך כל תקופת הקשר.

תשובה לשאלה 2 -



תשובה לשאלה 3 -

