

רשתות תקשורת מטלה 3
מגישים:

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נוסיף את החלק הראשון של המטלה:

Part A

Algorithm: Reno - sender & receiver

0% packet loss

```

barye@barye-VirtualBox:~/from git/CN_EX3/communications_network
• k_EX3$ sudo tc qdisc change dev lo root netem loss 0%
barye@barye-VirtualBox:~/from git/CN_EX3/communications_network
• k_EX3$ ./TCP_Receiver -p 5060 -algo reno
Stating Receiver...
Waiting for TCP connection...
Sender 127.0.0.1:45026 connected, beginning to receive file...
File transfer completed.
File transfer completed.
File transfer completed.
File transfer completed.
File transfer completed.
Sender 127.0.0.1:45026 disconnected
-----
- * Statistics * -
Run #1 Data: Time=1.568000 S ; Speed=1275.510204 MB/S
Run #2 Data: Time=0.534000 S ; Speed=3745.318352 MB/S
Run #3 Data: Time=0.785000 S ; Speed=2547.770701 MB/S
Run #4 Data: Time=0.697000 S ; Speed=2869.440459 MB/S
Run #5 Data: Time=0.651000 S ; Speed=3072.196621 MB/S
Average time: 0.847000 S
Average speed: 2702.047267 S
Sender 127.0.0.1:45026 disconnected
Receiver finished!
barye@barye-VirtualBox:~/from git/CN_EX3/communications_network
• k_EX3$

barye@barye-VirtualBox:~/from git/CN_EX3/communications_network
• rk_EX3$ ./TCP_Sender -ip 127.0.0.1 -p 5060 -algo reno
Connecting to 127.0.0.1:5060...
Successfully connected to the receiver!
Sending message to the receiver:
Sent 2097153 bytes to the receiver!
Do you want to send the file again?
No - press 0
Yes- press 1
1
Sent 2097153 bytes to the receiver!
Do you want to send the file again?
No - press 0
Yes- press 1
1
Sent 2097153 bytes to the receiver!
Do you want to send the file again?
No - press 0
Yes- press 1
1
Sent 2097153 bytes to the receiver!
Do you want to send the file again?
No - press 0
Yes- press 1
1
Sent 2097153 bytes to the receiver!
Do you want to send the file again?
No - press 0
Yes- press 1
0
Connection closed!

```

- * Statistics * -

Run #1 Data: Time=1.568000 S ; Speed=1275.510204 MB/S

Run #2 Data: Time=0.534000 S ; Speed=3745.318352 MB/S

Run #3 Data: Time=0.785000 S ; Speed=2547.770701 MB/S

Run #4 Data: Time=0.697000 S ; Speed=2869.440459 MB/S

Run #5 Data: Time=0.651000 S ; Speed=3072.196621 MB/S

Average time: 0.847000 S

Average speed: 2702.047267 S

Sender 127.0.0.1:45026 disconnected

!Receiver finished

2% packet loss

```

barye@barye-VirtualBox:~/from git/CN_EX3/communications_network
• k_EX3$ sudo tc qdisc change dev lo root netem loss 2%
barye@barye-VirtualBox:~/from git/CN_EX3/communications_network
• k_EX3$ ./TCP_Receiver -p 5060 -algo reno
Starting Receiver...
Waiting for TCP connection...
Sender 127.0.0.1:34156 connected, beginning to receive file...
File transfer completed.
File transfer completed.
File transfer completed.
File transfer completed.
File transfer completed.
Sender 127.0.0.1:34156 disconnected
-----
- * Statistics * -
Run #1 Data: Time=1.731000 S ; Speed=1155.401502 MB/S
Run #2 Data: Time=0.599000 S ; Speed=3338.898164 MB/S
Run #3 Data: Time=0.764000 S ; Speed=2617.801047 MB/S
Run #4 Data: Time=4.465000 S ; Speed=447.928331 MB/S
Run #5 Data: Time=0.524000 S ; Speed=3816.793893 MB/S
Average time: 1.616600 S
Average speed: 2275.364587 S
Sender 127.0.0.1:34156 disconnected
Receiver finished!
barye@barye-VirtualBox:~/from git/CN_EX3/communications_network
• k_EX3$

barye@barye-VirtualBox:~/from git/CN_EX3/communications_network
• rk_EX3$ ./TCP_Sender -ip 127.0.0.1 -p 5060 -algo reno
Connecting to 127.0.0.1:5060...
Successfully connected to the receiver!
Sending message to the receiver:
Sent 2097153 bytes to the receiver!
Do you want to send the file again?
No - press 0
Yes- press 1
1
Sent 2097153 bytes to the receiver!
Do you want to send the file again?
No - press 0
Yes- press 1
1
Sent 2097153 bytes to the receiver!
Do you want to send the file again?
No - press 0
Yes- press 1
1
Sent 2097153 bytes to the receiver!
Do you want to send the file again?
No - press 0
Yes- press 1
1
Sent 2097153 bytes to the receiver!
Do you want to send the file again?
No - press 0
Yes- press 1
0
Connection closed!

```

Statistics

Run #1 Data: Time=1.731000 S ; Speed=1155.401502 MB/S

Run #2 Data: Time=0.599000 S ; Speed=3338.898164 MB/S

Run #3 Data: Time=0.764000 S ; Speed=2617.801047 MB/S

Run #4 Data: Time=4.465000 S ; Speed=447.928331 MB/S

Run #5 Data: Time=0.524000 S ; Speed=3816.793893 MB/S

Average time: 1.616600 S

Average speed: 2275.364587 S

Sender 127.0.0.1:34156 disconnected

!Receiver finished

5% packet loss

```

barye@barye-VirtualBox:~/from git/CN_EX3/communications_network
• k_EX3$ sudo tc qdisc change dev lo root netem loss 5%
barye@barye-VirtualBox:~/from git/CN_EX3/communications_network
• k_EX3$ ./TCP_Receiver -p 5060 -algo reno
Stating Receiver...
Waiting for TCP connection...
Sender 127.0.0.1:46214 connected, beginning to receive file...
File transfer completed.
File transfer completed.
File transfer completed.
File transfer completed.
File transfer completed.
Sender 127.0.0.1:46214 disconnected
-----
- * Statistics * -
Run #1 Data: Time=2.574000 S ; Speed=777.000777 MB/S
Run #2 Data: Time=0.471000 S ; Speed=4246.284501 MB/S
Run #3 Data: Time=0.419000 S ; Speed=4773.269690 MB/S
Run #4 Data: Time=1.180000 S ; Speed=1694.915254 MB/S
Run #5 Data: Time=0.530000 S ; Speed=3773.584906 MB/S
Average time: 1.034800 S
Average speed: 3053.011026 S
Sender 127.0.0.1:46214 disconnected
Receiver finished!
barye@barye-VirtualBox:~/from git/CN_EX3/communications_network
• k_EX3$

barye@barye-VirtualBox:~/from git/CN_EX3/communications_network
• rk_EX3$ ./TCP_Sender -ip 127.0.0.1 -p 5060 -algo reno
Connecting to 127.0.0.1:5060...
Successfully connected to the receiver!
Sending message to the receiver:
Sent 2097153 bytes to the receiver!
Do you want to send the file again?
No - press 0
Yes- press 1
1
Sent 2097153 bytes to the receiver!
Do you want to send the file again?
No - press 0
Yes- press 1
1
Sent 2097153 bytes to the receiver!
Do you want to send the file again?
No - press 0
Yes- press 1
1
Sent 2097153 bytes to the receiver!
Do you want to send the file again?
No - press 0
Yes- press 1
1
Sent 2097153 bytes to the receiver!
Do you want to send the file again?
No - press 0
Yes- press 1
0
Connection closed!

```

- * Statistics * -

Run #1 Data: Time=2.574000 S ; Speed=777.000777 MB/S

Run #2 Data: Time=0.471000 S ; Speed=4246.284501 MB/S

Run #3 Data: Time=0.419000 S ; Speed=4773.269690 MB/S

Run #4 Data: Time=1.180000 S ; Speed=1694.915254 MB/S

Run #5 Data: Time=0.530000 S ; Speed=3773.584906 MB/S

Average time: 1.034800 S

Average speed: 3053.011026 S

Sender 127.0.0.1:46214 disconnected

!Receiver finished

10% packet loss

```

barye@barye-VirtualBox:~/from git/CN_EX3/communications_network
• k_EX3$ sudo tc qdisc change dev lo root netem loss 10%
barye@barye-VirtualBox:~/from git/CN_EX3/communications_network
• k_EX3$ ./TCP Receiver -p 5060 -algo reno
Starting Receiver...
Waiting for TCP connection...
Sender 127.0.0.1:59202 connected, beginning to receive file...
File transfer completed.
File transfer completed.
File transfer completed.
File transfer completed.
File transfer completed.
Sender 127.0.0.1:59202 disconnected
-----
- * Statistics * -
Run #1 Data: Time=1.165000 S ; Speed=1716.738197 MB/S
Run #2 Data: Time=0.473000 S ; Speed=4228.329810 MB/S
Run #3 Data: Time=0.838000 S ; Speed=2386.634845 MB/S
Run #4 Data: Time=0.833000 S ; Speed=2400.960384 MB/S
Run #5 Data: Time=0.757000 S ; Speed=2642.007926 MB/S
Average time: 0.813200 S
Average speed: 2674.934232 S
Sender 127.0.0.1:59202 disconnected
Receiver finished!
barye@barye-VirtualBox:~/from git/CN_EX3/communications_network
• k_EX3$

barye@barye-VirtualBox:~/from git/CN_EX3/communications_network
• rk_EX3$ ./TCP Sender -ip 127.0.0.1 -p 5060 -algo reno
Connecting to 127.0.0.1:5060...
Successfully connected to the receiver!
Sending message to the receiver!
Sent 2097153 bytes to the receiver!
Do you want to send the file again?
No - press 0
Yes- press 1
1
Sent 2097153 bytes to the receiver!
Do you want to send the file again?
No - press 0
Yes- press 1
1
Sent 2097153 bytes to the receiver!
Do you want to send the file again?
No - press 0
Yes- press 1
1
Sent 2097153 bytes to the receiver!
Do you want to send the file again?
No - press 0
Yes- press 1
1
Sent 2097153 bytes to the receiver!
Do you want to send the file again?
No - press 0
Yes- press 1
0
Connection closed!

```

- * Statistics * -

Run #1 Data: Time=1.165000 S ; Speed=1716.738197 MB/S

Run #2 Data: Time=0.473000 S ; Speed=4228.329810 MB/S

Run #3 Data: Time=0.838000 S ; Speed=2386.634845 MB/S

Run #4 Data: Time=0.833000 S ; Speed=2400.960384 MB/S

Run #5 Data: Time=0.757000 S ; Speed=2642.007926 MB/S

Average time: 0.813200 S

Average speed: 2674.934232 S

Sender 127.0.0.1:59202 disconnected

!Receiver finished

Algorithm: cubic - sender & receiver

0% packet loss

```

noamco@noamco-VirtualBox:~/CN_EX3/communications_network_EX3$ sudo
o tc qdisc change dev lo root netem loss 0%
noamco@noamco-VirtualBox:~/CN_EX3/communications_network_EX3$ ./T
CP Receiver -p 5060 -algo cubic
Starting Receiver...
Waiting for TCP connection...
Sender 127.0.0.1:39974 connected, beginning to receive file...
File transfer completed.
File transfer completed.
File transfer completed.
File transfer completed.
Sender 127.0.0.1:39974 disconnected
- * Statistics * -
Run #1 Data: Time=0.520000 S ; Speed=3846.153846 MB/S
Run #2 Data: Time=0.631000 S ; Speed=3169.572108 MB/S
Run #3 Data: Time=0.719000 S ; Speed=2781.641168 MB/S
Run #4 Data: Time=1.110000 S ; Speed=1801.801802 MB/S
Run #5 Data: Time=0.692000 S ; Speed=2890.173410 MB/S
Average time: 0.734400 S
Average speed: 2897.868467 S
Sender 127.0.0.1:39974 disconnected
Receiver finished!
noamco@noamco-VirtualBox:~/CN_EX3/communications_network_EX3$

noamco@noamco-VirtualBox:~/CN_EX3/communications_network_EX3$ ./
TCP-Sender -ip 127.0.0.1 -p 5060 -algo cubic
Connecting to 127.0.0.1:5060...
Successfully connected to the receiver!
Sending message to the receiver:
Sent 2097153 bytes to the receiver!
Do you want to send the file again?
No - press 0
Yes - press 1
1
Sent 2097153 bytes to the receiver!
Do you want to send the file again?
No - press 0
Yes - press 1
1
Sent 2097153 bytes to the receiver!
Do you want to send the file again?
No - press 0
Yes - press 1
1
Sent 2097153 bytes to the receiver!
Do you want to send the file again?
No - press 0
Yes - press 1
0
Connection closed!
noamco@noamco-VirtualBox:~/CN_EX3/communications_network_EX3$

```

- * Statistics * -

Run #1 Data: Time=0.520000 S ; Speed=3846.153846 MB/S

Run #2 Data: Time=0.631000 S ; Speed=3169.572108 MB/S

Run #3 Data: Time=0.719000 S ; Speed=2781.641168 MB/S

Run #4 Data: Time=1.110000 S ; Speed=1801.801802 MB/S

Run #5 Data: Time=0.692000 S ; Speed=2890.173410 MB/S

Average time: 0.734400 S

Average speed: 2897.868467 S

Sender 127.0.0.1:39974 disconnected

Receiver finished

2% packet loss

```

noamco@noamco-VirtualBox:~/CN_EX3/communications_network_EX3$ sudo ./TCP_Receiver -p 5060 -algo rdo
[sudo] password for noamco:
noamco@noamco-VirtualBox:~/CN_EX3/communications_network_EX3$ ./TCP_Sender -p 5060 -algo cubic
CP Receiver -p 5060 -algo cubic
Starting Receiver...
Waiting for TCP connection...
Sender 127.0.0.1:49516 connected, beginning to receive file...
File transfer completed.
File transfer completed.
File transfer completed.
File transfer completed.
Sender 127.0.0.1:49516 disconnected
Receiver finished!

- * Statistics * -
Run #1 Data: Time=0.658000 S ; Speed=3039.513678 MB/S
Run #2 Data: Time=3.764000 S ; Speed=531.349628 MB/S
Run #3 Data: Time=0.690000 S ; Speed=2898.550725 MB/S
Run #4 Data: Time=0.434000 S ; Speed=4608.294931 MB/S
Run #5 Data: Time=0.690000 S ; Speed=2898.550725 MB/S
Average time: 1.247200 S
Average speed: 2795.251937 S
Sender 127.0.0.1:49516 disconnected
Receiver finished!

noamco@noamco-VirtualBox:~/CN_EX3/communications_network_EX3$

```

- * Statistics * -

Run #1 Data: Time=0.658000 S ; Speed=3039.513678 MB/S

Run #2 Data: Time=3.764000 S ; Speed=531.349628 MB/S

Run #3 Data: Time=0.690000 S ; Speed=2898.550725 MB/S

Run #4 Data: Time=0.434000 S ; Speed=4608.294931 MB/S

Run #5 Data: Time=0.690000 S ; Speed=2898.550725 MB/S

Average time: 1.247200 S

Average speed: 2795.251937 S

Sender 127.0.0.1:49516 disconnected

Receiver finished

5% packet loss

```

noamco@noamco-VirtualBox:~/CN_EX3/communications_network_EX3$ sud *
o tc qdisc change dev lo root netem loss 5%
noamco@noamco-VirtualBox:~/CN_EX3/communications_network_EX3$ ./T
TCP Receiver -p 5060 -algo cubic
Starting Receiver...
Waiting for TCP connection...
Sender 127.0.0.1:49524 connected, beginning to receive file...
File transfer completed.
File transfer completed.
File transfer completed.
File transfer completed.
Sender 127.0.0.1:49524 disconnected
-----
* Statistics *
Run #1 Data: Time=1.511000 S ; Speed=1323.626737 MB/S
Run #2 Data: Time=0.983000 S ; Speed=2034.587996 MB/S
Run #3 Data: Time=0.535000 S ; Speed=3738.317757 MB/S
Run #4 Data: Time=0.752000 S ; Speed=2659.574468 MB/S
Run #5 Data: Time=0.577000 S ; Speed=3466.204506 MB/S
Average time: 0.871600 S
Average speed: 2644.462293 S
Sender 127.0.0.1:49524 disconnected
Receiver finished!
noamco@noamco-VirtualBox:~/CN_EX3/communications_network_EX3$

```

- * Statistics * -

Run #1 Data: Time=1.511000 S ; Speed=1323.626737 MB/S

Run #2 Data: Time=0.983000 S ; Speed=2034.587996 MB/S

Run #3 Data: Time=0.535000 S ; Speed=3738.317757 MB/S

Run #4 Data: Time=0.752000 S ; Speed=2659.574468 MB/S

Run #5 Data: Time=0.577000 S ; Speed=3466.204506 MB/S

Average time: 0.871600 S

Average speed: 2644.462293 S

Sender 127.0.0.1:49524 disconnected

!Receiver finished

10% packet loss

```

noamco@noamco-VirtualBox:~/CN_EX3/communications_network_EX3$ sudo ./TCP_Receiver -o 5060 -aloo reno
o tc qdisc change dev vif root netem loss 10%
noamco@noamco-VirtualBox:~/CN_EX3/communications_network_EX3$ ./TCP_Sender -p 5060 -algo cubic
TCP Sender -ip 127.0.0.1 -p 5060 -algo cubic
Connecting to 127.0.0.1:5060...
Successfully connected to the receiver!
Sending message to the receiver:
Sent 2097153 bytes to the receiver!
Do you want to send the file again?
No - press 0
Yes - press 1
1
Sent 2097153 bytes to the receiver!
Do you want to send the file again?
No - press 0
Yes - press 1
1
Sent 2097153 bytes to the receiver!
Do you want to send the file again?
No - press 0
Yes - press 1
1
Sent 2097153 bytes to the receiver!
Do you want to send the file again?
No - press 0
Yes - press 1
1
Sent 2097153 bytes to the receiver!
Do you want to send the file again?
No - press 0
Yes - press 1
0
Connection closed!
noamco@noamco-VirtualBox:~/CN_EX3/communications_network_EX3$

* Statistics *
Run #1 Data: Time=0.390000 S ; Speed=238.379023 MB/S
Run #2 Data: Time=0.903000 S ; Speed=2214.839424 MB/S
Run #3 Data: Time=2.753000 S ; Speed=726.480203 MB/S
Run #4 Data: Time=0.795000 S ; Speed=2515.723270 MB/S
Run #5 Data: Time=1.257000 S ; Speed=1591.089897 MB/S
Average time: 2.819600 S
Average speed: 1457.302363 S
Sender 127.0.0.1:60496 disconnected
Receiver finished!

```

- * Statistics * -

Run #1 Data: Time=8.390000 S ; Speed=238.379023 MB/S

Run #2 Data: Time=0.903000 S ; Speed=2214.839424 MB/S

Run #3 Data: Time=2.753000 S ; Speed=726.480203 MB/S

Run #4 Data: Time=0.795000 S ; Speed=2515.723270 MB/S

Run #5 Data: Time=1.257000 S ; Speed=1591.089897 MB/S

Average time: 2.819600 S

Average speed: 1457.302363 S

Sender 127.0.0.1:60496 disconnected

!Receiver finished

Bonus:**Algorithm: receiver- cubic, - sender- reno**

0% packet loss

```

barye@barye-VirtualBox:~/from git/CN_EX3/communications_network_
• EX3$ sudo tc qdisc change dev lo root netem loss 0%
barye@barye-VirtualBox:~/from git/CN_EX3/communications_network_
• EX3$ ./TCP Receiver -p 5060 -algo cubic
Starting Receiver...
Waiting for TCP connection...
Sender 127.0.0.1:49866 connected, beginning to receive file...
File transfer completed.
File transfer completed.
File transfer completed.
File transfer completed.
File transfer completed.
Sender 127.0.0.1:49866 disconnected
-----
- * Statistics * -
Run #1 Data: Time=0.576000 S ; Speed=3472.222222 MB/S
Run #2 Data: Time=0.711000 S ; Speed=2812.939522 MB/S
Run #3 Data: Time=0.571000 S ; Speed=3502.626970 MB/S
Run #4 Data: Time=0.833000 S ; Speed=2400.960384 MB/S
Run #5 Data: Time=1.009000 S ; Speed=1982.160555 MB/S
Average time: 0.740000 S
Average speed: 2834.181931 S
Sender 127.0.0.1:49866 disconnected
Receiver finished!
barye@barye-VirtualBox:~/from git/CN_EX3/communications_network_
• EX3$

```

```

barye@barye-VirtualBox:~/from git/CN_EX3/communications_network_
• EX3$ ./TCP Sender -ip 127.0.0.1 -p 5060 -algo reno
Connecting to 127.0.0.1:5060...
Successfully connected to the receiver!
Sending message to the receiver!
Sent 2097153 bytes to the receiver!
Do you want to send the file again?
No - press 0
Yes- press 1
1
Sent 2097153 bytes to the receiver!
Do you want to send the file again?
No - press 0
Yes- press 1
1
Sent 2097153 bytes to the receiver!
Do you want to send the file again?
No - press 0
Yes- press 1
1
Sent 2097153 bytes to the receiver!
Do you want to send the file again?
No - press 0
Yes- press 1
0
Connection closed!

```

- * Statistics * -

Run #1 Data: Time=0.576000 S ; Speed=3472.222222 MB/S

Run #2 Data: Time=0.711000 S ; Speed=2812.939522 MB/S

Run #3 Data: Time=0.571000 S ; Speed=3502.626970 MB/S

Run #4 Data: Time=0.833000 S ; Speed=2400.960384 MB/S

Run #5 Data: Time=1.009000 S ; Speed=1982.160555 MB/S

Average time: 0.740000 S

Average speed: 2834.181931 S

Sender 127.0.0.1:49866 disconnected

!Receiver finished

2% packet loss

```

barye@barye-VirtualBox:~/from git/CN_EX3/communications_network_
EX3$ sudo tc qdisc change dev lo root netem loss 2%
barye@barye-VirtualBox:~/from git/CN_EX3/communications_network_
EX3$ ./TCP_Receiver -p 5060 -algo cubic
Starting Receiver...
Waiting for TCP connection...
Sender 127.0.0.1:56106 connected, beginning to receive file...
File transfer completed.
File transfer completed.
File transfer completed.
File transfer completed.
File transfer completed.
Sender 127.0.0.1:56106 disconnected
-----
- * Statistics * -
Run #1 Data: Time=2.128000 S ; Speed=939.849624 MB/S
Run #2 Data: Time=0.384000 S ; Speed=5208.333333 MB/S
Run #3 Data: Time=0.546000 S ; Speed=3663.003663 MB/S
Run #4 Data: Time=0.488000 S ; Speed=4098.360656 MB/S
Run #5 Data: Time=0.436000 S ; Speed=4587.155963 MB/S
Average time: 0.796400 S
Average speed: 3699.340648 S
Sender 127.0.0.1:56106 disconnected
Receiver finished!
barye@barye-VirtualBox:~/from git/CN_EX3/communications_network_
EX3$

```

```

barye@barye-VirtualBox:~/from git/CN_EX3/communications_network
EX3$ ./TCP_Sender -ip 127.0.0.1 -p 5060 -algo reno
Connecting to 127.0.0.1:5060...
Successfully connected to the receiver!
Sending message to the receiver:
Sent 2097153 bytes to the receiver!
Do you want to send the file again?
No - press 0
Yes- press 1
1
Sent 2097153 bytes to the receiver!
Do you want to send the file again?
No - press 0
Yes- press 1
1
Sent 2097153 bytes to the receiver!
Do you want to send the file again?
No - press 0
Yes- press 1
1
Sent 2097153 bytes to the receiver!
Do you want to send the file again?
No - press 0
Yes- press 1
1
Sent 2097153 bytes to the receiver!
Do you want to send the file again?
No - press 0
Yes- press 1
0
Connection closed!
barye@barye-VirtualBox:~/from git/CN_EX3/communications_network

```

- * Statistics * -

Run #1 Data: Time=2.128000 S ; Speed=939.849624 MB/S

Run #2 Data: Time=0.384000 S ; Speed=5208.333333 MB/S

Run #3 Data: Time=0.546000 S ; Speed=3663.003663 MB/S

Run #4 Data: Time=0.488000 S ; Speed=4098.360656 MB/S

Run #5 Data: Time=0.436000 S ; Speed=4587.155963 MB/S

Average time: 0.796400 S

Average speed: 3699.340648 S

Sender 127.0.0.1:56106 disconnected

!Receiver finished

5% packet loss

```

barye@barye-VirtualBox:~/from git/CN_EX3/communications_network_
• EX3$ sudo tc qdisc change dev lo root netem loss 5%
barye@barye-VirtualBox:~/from git/CN_EX3/communications_network_
• EX3$ ./TCP_Receiver -p 5060 -algo cubic
Starting Receiver...
Waiting for TCP connection...
Sender 127.0.0.1:57512 connected, beginning to receive file...
File transfer completed.
File transfer completed.
File transfer completed.
File transfer completed.
File transfer completed.
Sender 127.0.0.1:57512 disconnected
-----
- * Statistics * -
Run #1 Data: Time=0.573000 S ; Speed=3490.401396 MB/S
Run #2 Data: Time=0.911000 S ; Speed=2195.389682 MB/S
Run #3 Data: Time=0.407000 S ; Speed=4914.004914 MB/S
Run #4 Data: Time=0.408000 S ; Speed=4901.960784 MB/S
Run #5 Data: Time=0.504000 S ; Speed=3968.253968 MB/S
Average time: 0.560600 S
Average speed: 3894.002149 S
Sender 127.0.0.1:57512 disconnected
Receiver finished!
barye@barye-VirtualBox:~/from git/CN_EX3/communications_network_
• EX3$

barye@barye-VirtualBox:~/from git/CN_EX3/communications_network
• EX3$ ./TCP_Sender -ip 127.0.0.1 -p 5060 -algo reno
Connecting to 127.0.0.1:5060...
Successfully connected to the receiver!
Sending message to the receiver:
Sent 2097153 bytes to the receiver!
Do you want to send the file again?
No - press 0
Yes- press 1
1
Sent 2097153 bytes to the receiver!
Do you want to send the file again?
No - press 0
Yes- press 1
1
Sent 2097153 bytes to the receiver!
Do you want to send the file again?
No - press 0
Yes- press 1
1
Sent 2097153 bytes to the receiver!
Do you want to send the file again?
No - press 0
Yes- press 1
1
Sent 2097153 bytes to the receiver!
Do you want to send the file again?
No - press 0
Yes- press 1
0
Connection closed!
barye@barye-VirtualBox:~/from git/CN_EX3/communications_network
• EX3$

```

- * Statistics * -

Run #1 Data: Time=0.573000 S ; Speed=3490.401396 MB/S

Run #2 Data: Time=0.911000 S ; Speed=2195.389682 MB/S

Run #3 Data: Time=0.407000 S ; Speed=4914.004914 MB/S

Run #4 Data: Time=0.408000 S ; Speed=4901.960784 MB/S

Run #5 Data: Time=0.504000 S ; Speed=3968.253968 MB/S

Average time: 0.560600 S

Average speed: 3894.002149 S

Sender 127.0.0.1:57512 disconnected

!Receiver finished

10% packet loss

```

barye@barye-VirtualBox:~/from git/CN_EX3/communications_network_
• EX3$ sudo tc qdisc change dev lo root netem loss 10%
barye@barye-VirtualBox:~/from git/CN_EX3/communications_network_
• EX3$ ./TCP Receiver -p 5060 -algo cubic
Stating Receiver...
Waiting for TCP connection...
Sender 127.0.0.1:56976 connected, beginning to receive file...
File transfer completed.
File transfer completed.
File transfer completed.
File transfer completed.
File transfer completed.
Sender 127.0.0.1:56976 disconnected
-----
- * Statistics * -
Run #1 Data: Time=1.988000 S ; Speed=1006.036217 MB/S
Run #2 Data: Time=0.279000 S ; Speed=7168.458781 MB/S
Run #3 Data: Time=0.807000 S ; Speed=2478.314746 MB/S
Run #4 Data: Time=0.632000 S ; Speed=3164.556962 MB/S
Run #5 Data: Time=0.410000 S ; Speed=4878.048780 MB/S
Average time: 0.823200 S
Average speed: 3739.083097 S
Sender 127.0.0.1:56976 disconnected
Receiver finished!
barye@barye-VirtualBox:~/from git/CN_EX3/communications_network_
• EX3$

barye@barye-VirtualBox:~/from git/CN_EX3/communications_network
• EX3$ ./TCP Sender -ip 127.0.0.1 -p 5060 -algo reno
Connecting to 127.0.0.1:5060...
Successfully connected to the receiver!
Sending message to the receiver:
Sent 2097153 bytes to the receiver!
Do you want to send the file again?
No - press 0
Yes- press 1
1
Sent 2097153 bytes to the receiver!
Do you want to send the file again?
No - press 0
Yes- press 1
1
Sent 2097153 bytes to the receiver!
Do you want to send the file again?
No - press 0
Yes- press 1
1
Sent 2097153 bytes to the receiver!
Do you want to send the file again?
No - press 0
Yes- press 1
1
Sent 2097153 bytes to the receiver!
Do you want to send the file again?
No - press 0
Yes- press 1
0
Connection closed!
barye@barye-VirtualBox:~/from git/CN_EX3/communications_network

```

- * Statistics * -

Run #1 Data: Time=1.988000 S ; Speed=1006.036217 MB/S

Run #2 Data: Time=0.279000 S ; Speed=7168.458781 MB/S

Run #3 Data: Time=0.807000 S ; Speed=2478.314746 MB/S

Run #4 Data: Time=0.632000 S ; Speed=3164.556962 MB/S

Run #5 Data: Time=0.410000 S ; Speed=4878.048780 MB/S

Average time: 0.823200 S

Average speed: 3739.083097 S

Sender 127.0.0.1:56976 disconnected

!Receiver finished

Algorithm: receiver- reno, - sender- cubic

0% packet loss

```

noamco@noamco-VirtualBox:~/CN_EX3/communications_network_EX3$ ./TCP_Receiver -p 5060 -algo reno
1
2
noamco@noamco-VirtualBox:~/CN_EX3/communications_network_EX3$ ./TCP_Sender -ip 127.0.0.1 -p 5060 -algo cubic
Connecting to 127.0.0.1:5060...
Successfully connected to the receiver!
Sending message to the receiver:
Sent 2097153 bytes to the receiver!
Do you want to send the file again?
No - press 0
Yes - press 1
1
Sent 2097153 bytes to the receiver!
Do you want to send the file again?
No - press 0
Yes - press 1
1
Sent 2097153 bytes to the receiver!
Do you want to send the file again?
No - press 0
Yes - press 1
1
Sent 2097153 bytes to the receiver!
Do you want to send the file again?
No - press 0
Yes - press 1
0
Connection closed!
noamco@noamco-VirtualBox:~/CN_EX3/communications_network_EX3$

- * Statistics * -
Run #1 Data: Time=0.981000 S ; Speed=2038.735984 MB/S
Run #2 Data: Time=0.559000 S ; Speed=3577.817531 MB/S
Run #3 Data: Time=0.699000 S ; Speed=2861.230329 MB/S
Run #4 Data: Time=0.462000 S ; Speed=4329.004329 MB/S
Run #5 Data: Time=0.654000 S ; Speed=3058.103976 MB/S
Average time: 0.671000 S
Average speed: 3172.978430 S
Sender 127.0.0.1:42144 disconnected
Receiver finished

```

- * Statistics * -

Run #1 Data: Time=0.981000 S ; Speed=2038.735984 MB/S

Run #2 Data: Time=0.559000 S ; Speed=3577.817531 MB/S

Run #3 Data: Time=0.699000 S ; Speed=2861.230329 MB/S

Run #4 Data: Time=0.462000 S ; Speed=4329.004329 MB/S

Run #5 Data: Time=0.654000 S ; Speed=3058.103976 MB/S

Average time: 0.671000 S

Average speed: 3172.978430 S

Sender 127.0.0.1:42144 disconnected

Receiver finished

2% packet loss

```

noamco@noamco-VirtualBox:~/CN_EX3/communications_network_EX3$ sudo ./TCP_Receiver -p 5060 -algo reno
TCP_Receiver -p 5060 -algo reno
Waiting for TCP connection...
Sender 127.0.0.1:41522 connected, beginning to receive file...
File transfer completed.
File transfer completed.
File transfer completed.
File transfer completed.
Sender 127.0.0.1:41522 disconnected
* Statistics *
Run #1 Data: Time=2.908000 S ; Speed=687.757909 MB/S
Run #2 Data: Time=0.551000 S ; Speed=3629.764065 MB/S
Run #3 Data: Time=0.513000 S ; Speed=3898.635478 MB/S
Run #4 Data: Time=1.282000 S ; Speed=1560.062402 MB/S
Run #5 Data: Time=1.375000 S ; Speed=1454.545455 MB/S
Average time: 1.325800 S
Average speed: 2246.153062 S
Sender 127.0.0.1:41522 disconnected
Receiver finished!
noamco@noamco-VirtualBox:~/CN_EX3/communications_network_EX3$

```

- * Statistics * -

Run #1 Data: Time=2.908000 S ; Speed=687.757909 MB/S

Run #2 Data: Time=0.551000 S ; Speed=3629.764065 MB/S

Run #3 Data: Time=0.513000 S ; Speed=3898.635478 MB/S

Run #4 Data: Time=1.282000 S ; Speed=1560.062402 MB/S

Run #5 Data: Time=1.375000 S ; Speed=1454.545455 MB/S

Average time: 1.325800 S

Average speed: 2246.153062 S

Sender 127.0.0.1:41522 disconnected

!Receiver finished

5% packet loss

```

noamco@noamco-VirtualBox:~/CN_EX3/communications_network_EX3$ sud
o tc qdisc change dev lo root netem loss 5%
noamco@noamco-VirtualBox:~/CN_EX3/communications_network_EX3$ ./T
CP Receiver -p 5060 -algo reno
Starting Receiver...
Waiting for TCP connection...
Sender 127.0.0.1:53348 connected, beginning to receive file...
File transfer completed.
File transfer completed.
File transfer completed.
File transfer completed.
Sender 127.0.0.1:53348 disconnected
-----
* Statistics *
Run #1 Data: Time=1.072000 S ; Speed=1865.671642 MB/S
Run #2 Data: Time=0.725000 S ; Speed=2758.620690 MB/S
Run #3 Data: Time=1.013000 S ; Speed=1974.333662 MB/S
Run #4 Data: Time=0.746000 S ; Speed=2680.965147 MB/S
Run #5 Data: Time=0.919000 S ; Speed=2176.278564 MB/S
Average time: 0.895000 S
Average speed: 2291.173941 S
Sender 127.0.0.1:53348 disconnected
Receiver finished!
noamco@noamco-VirtualBox:~/CN_EX3/communications_network_EX3$

```

- * Statistics * -

Run #1 Data: Time=1.072000 S ; Speed=1865.671642 MB/S

Run #2 Data: Time=0.725000 S ; Speed=2758.620690 MB/S

Run #3 Data: Time=1.013000 S ; Speed=1974.333662 MB/S

Run #4 Data: Time=0.746000 S ; Speed=2680.965147 MB/S

Run #5 Data: Time=0.919000 S ; Speed=2176.278564 MB/S

Average time: 0.895000 S

Average speed: 2291.173941 S

Sender 127.0.0.1:53348 disconnected

!Receiver finished

10% packet loss

```

noamco@noamco-VirtualBox:~/CN_EX3/communications_network_EX3$ sudo ./TCP_Receiver -p 5060 -algo reno
o tc qdisc change dev lo root netem loss 10%
noamco@noamco-VirtualBox:~/CN_EX3/communications_network_EX3$ ./TCP_Sender -ip 127.0.0.1 -p 5060 -algo cubic
Connecting to 127.0.0.1:5060...
Successfully connected to the receiver!
Sending message to the receiver!
Sent 2097153 bytes to the receiver!
Do you want to send the file again?
No - press 0
Yes- press 1
1
Sent 2097153 bytes to the receiver!
Do you want to send the file again?
No - press 0
Yes- press 1
1
Sent 2097153 bytes to the receiver!
Do you want to send the file again?
No - press 0
Yes- press 1
1
Sent 2097153 bytes to the receiver!
Do you want to send the file again?
No - press 0
Yes- press 1
1
Sent 2097153 bytes to the receiver!
Do you want to send the file again?
No - press 0
Yes- press 1
0
Connection closed!
noamco@noamco-VirtualBox:~/CN_EX3/communications_network_EX3$

* Statistics *
Run #1 Data: Time=1.638000 S ; Speed=1221.001221 MB/S
Run #2 Data: Time=0.928000 S ; Speed=2155.172414 MB/S
Run #3 Data: Time=1.094000 S ; Speed=1828.153565 MB/S
Run #4 Data: Time=1.566000 S ; Speed=1277.139208 MB/S
Run #5 Data: Time=0.639000 S ; Speed=3129.890454 MB/S
Average time: 1.173000 S
Average speed: 1922.271372 S
Sender 127.0.0.1:46216 disconnected
Receiver finished!
noamco@noamco-VirtualBox:~/CN_EX3/communications_network_EX3$

```

- * Statistics * -

Run #1 Data: Time=1.638000 S ; Speed=1221.001221 MB/S

Run #2 Data: Time=0.928000 S ; Speed=2155.172414 MB/S

Run #3 Data: Time=1.094000 S ; Speed=1828.153565 MB/S

Run #4 Data: Time=1.566000 S ; Speed=1277.139208 MB/S

Run #5 Data: Time=0.639000 S ; Speed=3129.890454 MB/S

Average time: 1.173000 S

Average speed: 1922.271372 S

Sender 127.0.0.1:46216 disconnected

!Receiver finished

Part B

Packet loss 0%:

```

PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS
received packet number 31
-send ack for 31
received packet number 32
-send ack for 32
received END packet
-send ack for packet END
got total rcv: 2097153
received FIN packet
send packet FIN ACK
-----
- * Statistics * -
Run #1 Data: Time= 126.441000 ms ; Speed= 15.817662 MB/S
Run #2 Data: Time= 28.506000 ms ; Speed= 140.321403 MB/S
Run #3 Data: Time= 26.547000 ms ; Speed= 226.014347 MB/S
Run #4 Data: Time= 8.531000 ms ; Speed= 937.756865 MB/S
Run #5 Data: Time= 3.850000 ms ; Speed= 2597.403836 MB/S
Average time: 38.775000 ms
Average speed: 783.462822 MB/s
Sender ip: 127.0.0.1 port: 5060 disconnected
Receiver finished!
barye@ubuntu22:~/Communication network/communications_network
k FX3/Part B$

-bash - Part B
-got ACK for packet number: 27
send packet 28
-got ACK for packet number: 28
send packet 29
-got ACK for packet number: 29
send packet 30
-got ACK for packet number: 30
send packet 31
-got ACK for packet number: 31
send packet 32
-got ACK for packet number: 32
send packet END
Sent 2097153 bytes to the receiver!
Do you want to send the file again?
No - press 0
Yes - press 1
0
send packet FIN
got FINACK close connection...
The connection ended successfully
barye@ubuntu22:~/Communication network/communications_network_E
X3/Part B$

```

- * Statistics *

Run #1 Data: Time= 126.441000 ms ; Speed= 15.817662 MB/S

Run #2 Data: Time= 28.506000 ms ; Speed= 140.321403 MB/S

Run #3 Data: Time= 26.547000 ms ; Speed= 226.014347 MB/S

Run #4 Data: Time= 8.531000 ms ; Speed= 937.756865 MB/S

Run #5 Data: Time= 3.850000 ms ; Speed= 2597.403836 MB/S

Average time: 38.775000 ms

Average speed: 783.462822 MB/S

Sender ip: 127.0.0.1 port: 5060 disconnected

Receiver finished!

Packet loss 2%:

```

Part B > C RUDP_API.c > rudp_recv(int, int, int*)
253 int rudp_recv(int sock, int data_size, int* arr)
289 else
PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS COMMENTS
- send ack for 30
received packet number 30
- send ack for 30
received packet number 31
- send ack for 31
received packet number 32
- send ack for 32
received END packet
- send ack for packet END
got total recv: 2097153
received FIN packet
send packet FIN ACK
-----
* Statistics *
Run #1 Data: Time= 5.958000 ms ; Speed= 335.683275 MB/S
Run #2 Data: Time= 18.283000 ms ; Speed= 218.782580 MB/S
Run #3 Data: Time= 16.667000 ms ; Speed= 359.992972 MB/S
Run #4 Data: Time= 12.113000 ms ; Speed= 660.447768 MB/S
Run #5 Data: Time= 14.049000 ms ; Speed= 711.794773 MB/S
Average time: 13.414000 ms
Average speed: 457.340274 MB/s
Sender ip: 127.0.0.1 port: 5060 disconnected
Receiver finished!
noamco@noamco-VirtualBox:~/CN_EX3/communications_network_EX3/Part B$

- got ACK for packet number: 26
send packet 27
- got ACK for packet number: 27
send packet 28
- got ACK for packet number: 28
send packet 29
- got ACK for packet number: 29
send packet 30
recvfrom() FAILED! send packet 30
- got ACK for packet number: 30
send packet 31
- got ACK for packet number: 31
send packet 32
- got ACK for packet number: 32
send packet END
Sent 2097153 bytes to the receiver!
Do you want to send the file again?
No - press 0
Yes - press 1
0
send packet FIN
got FINACK close connection...
The connection ended successfully
noamco@noamco-VirtualBox:~/CN_EX3/communications_network_EX3/Part B$

```

* -Statistics- *

Run #1 Data: Time= 5.958000 ms ; Speed= 335.683275 MB/S

Run #2 Data: Time= 18.283000 ms ; Speed= 218.782580 MB/S

Run #3 Data: Time= 16.667000 ms ; Speed= 359.992972 MB/S

Run #4 Data: Time= 12.113000 ms ; Speed= 660.447768 MB/S

Run #5 Data: Time= 14.049000 ms ; Speed= 711.794773 MB/S

Average time: 13.414000 ms

Average speed: 457.340274 MB/s

Packet loss 5%:

```

barye@ubuntu22:~/Communication network/communications_network
k_EX3/Part B$ sudo tc qdisc change d
ev lo root netem loss 5%
barye@ubuntu22:~/Communication network/communications_network_EX3/Part B$

```

```

- send ack for packet END
got total rcv: 2097153
received FIN packet
send packet FIN ACK
-----
- * Statistics * -
Run #1 Data: Time= 40.875000 ms ; Speed= 48.9296
87 MB/S
Run #2 Data: Time= 58.324000 ms ; Speed= 68.5824
34 MB/S
Run #3 Data: Time= 18.888000 ms ; Speed= 317.662
159 MB/S
Run #4 Data: Time= 11.445000 ms ; Speed= 698.995
528 MB/S
Average time: 32.755800 ms
Average speed: 285.233265 MB/s
Sender ip: 127.0.0.1 port: 5060 disconnected
Receiver finished!
barye@ubuntu22:~/Communication network/communications_network_EX3/Part B$

```

* -Statistics- *

Run #1 Data: Time= 40.875000 ms ; Speed= 48.929687 MB/S

Run #2 Data: Time= 58.324000 ms ; Speed= 68.582434 MB/S

Run #3 Data: Time= 18.888000 ms ; Speed= 317.662159 MB/S

Run #4 Data: Time= 11.445000 ms ; Speed= 698.995528 MB/S

Run #5 Data: Time= 34.247000 ms ; Speed= 291.996518 MB/S MB/S

Average time: 32.755800 ms

Average speed: 285.233265 MB/S

Sender ip: 127.0.0.1 port: 5060 disconnected

Receiver finished!

Packet loss 10%:

```

PROBLEMS  OUTPUT  DEBUG CONSOLE  TERMINAL  PORTS  COMMENTS
- send ack for 23
received packet number 24
- send ack for 24
received packet number 25
- send ack for 25
received packet number 26
- send ack for 26
received packet number 26
- send ack for 26
received packet number 27
- send ack for 27
received packet number 27
- send ack for 27
received packet number 28
- send ack for 28
received packet number 29
- send ack for 29
received packet number 30
- send ack for 30
received packet number 31
- send ack for 31
received packet number 32
- send ack for 32
received END packet
- send ack for packet END
got total recv: 2097153
received FIN packet
send packet FIN ACK
-----
* Statistics *
Run #1 Data: Time= 21.517000 ms ; Speed= 92.949805 MB/S
Run #2 Data: Time= 17.946000 ms ; Speed= 222.891001 MB/S
Run #3 Data: Time= 7.469000 ms ; Speed= 803.320774 MB/S
Run #4 Data: Time= 18.211000 ms ; Speed= 439.295141 MB/S
Run #5 Data: Time= 17.411000 ms ; Speed= 574.349823 MB/S
Average time: 16.510800 ms
Average speed: 426.561309 MB/s
Sender ip: 127.0.0.1 port: 5060 disconnected
Receiver finished!

recvfrom() FAILED! send packet 19
- got ACK for packet number: 19
send packet 20
- got ACK for packet number: 20
send packet 21
- got ACK for packet number: 21
send packet 22
- got ACK for packet number: 22
send packet 23
- got ACK for packet number: 23
send packet 24
- got ACK for packet number: 24
send packet 25
- got ACK for packet number: 25
send packet 26
recvfrom() FAILED! send packet 26
- got ACK for packet number: 26
send packet 27
recvfrom() FAILED! send packet 27
- got ACK for packet number: 27
send packet 28
- got ACK for packet number: 28
send packet 29
- got ACK for packet number: 29
send packet 30
- got ACK for packet number: 30
send packet 31
- got ACK for packet number: 31
send packet 32
- got ACK for packet number: 32
send packet END
Sent 2097153 bytes to the receiver!
Do you want to send the file again?
No - press 0
Yes - press 1
0
send packet FIN
got FINACK close connection...
The connection ended successfully
noamco@noamco-VirtualBox:~/CN_EX3/communications_network_EX3/Part B$
noamco@noamco-VirtualBox:~/CN_EX3/communications_network_EX3/Part B$

```

*Statistics- *

Run #1 Data: Time= 21.517000 ms ; Speed= 92.949805 MB/S

Run #2 Data: Time= 17.946000 ms ; Speed= 222.891001 MB/S

Run #3 Data: Time= 7.469000 ms ; Speed= 803.320774 MB/S

Run #4 Data: Time= 18.211000 ms ; Speed= 439.295141 MB/S

Run #5 Data: Time= 17.411000 ms ; Speed= 574.349823 MB/S

Average time: 16.510800 ms

Average speed: 426.561309 MB/s

After you've gathered the data set for both TCP and Reliable UDP, answer the following questions:

- 1) In TCP, which congestion control algorithm gave better results overall? TCP Reno or TCP Cubic? Which one gave better results on high packet loss? Explain how you came to this conclusion based on the data set you've gathered. (5 points)
- 2) How did your implementation of Reliable UDP perform overall compared to regular TCP? Which one is better for high packet loss? (5 points)
- 3) According to the data you've gathered, in which scenarios and applications would we prefer to use TCP and in which situations would we prefer to use reliable UDP? Explain your answer. (5 points)

1. לפי ההרצות שביצענו ניתן לראות שבאחוז איבוד פקטות הכי גבוה (10%) יש הבדל משמעותי במהירות בין congestion control מסוג tcp reno לסוג tcp cubic, מהיר יותר. וככל שהאחוזי איבוד יורדים ההבדלים יותר קטנים. באחוז איבוד של 5% ראינו מגמה הפוכה אך אנו חושבים שבגלל שההרצות בוצעו ממחשבים שונים ראינו הבדלים בזמנים.

2. מימשנו rudp על ידי פרוטוקול stop&wait (תמיד מחכים לack על בקשה). לפי ההרצות שביצענו ניתן לראות שמהירות הtcp גבוה יותר ממהירות הrudp הן ע"י שימוש באלגוריתם reno והן ע"י שימוש באלגוריתם cubic. נראה שrudp שמימשנו איטי יותר מtcp כיוון שכתבנו rudp בצורה פשוטה ויחסית מנוונת ביחס לאלגוריתמי reno וcubic הממומשים בtcp ומבצעים בקרות זרימה. (לדוגמה הגדלת חלון השליחה והקטנתו בהתאם למצב התעבורה ברשת)

3. כשמסתכלים על תוצאות ההרצות שביצענו רואים שtcp מהיר יותר מהrudp. בנוסף הrudp שמימשנו ממומש בצורה פשוטה וללא בדיקות המבטיחות אמינות (לדוגמה חישוב checksum בצורה מתוחכמת יותר ובקרה על המידע המועבר). נוסף על כך, מימוש rudp מסובך יותר. לכן במקרה זה נעדיף להתשמש בTCP.

בהתאם לנלמד בקורס נעדיף את הrudp כיוון שהוא מורכב מrudp שבד"כ מהיר יותר מtcp וכאשר מוסיפים לו את האמינות (reliable) הוא גם נהיה אמין כמו tcp ולכן בסה"כ אמין כמו tcp ומהיר ממנו ולכן נעדיף rudp.

בחרנו בתוכנית שלנו לתמוך בIPv4

נפרט על הקוד:

פירוט על RUDP_API כפי שמופיע בקובץ.

הלקוח והשרת משתמשים בפקודות אלה כמו "בקופסה שחורה"

```
/*
 * creating RUDP socket
 * @return the socket number if the socket was created successfully,
 * -1 if it failed.
 */
int rudp_sockets();

/*
 * opening connection between two peers.
 * @return 1 if the connection was successful, -1 otherwise.
 */
int RUDP_connect_reciever(int sock, int port);

/*
 * connect sender to reciver and established handshake by SYN ,SYN_ACK
 */
int RUDP_connect_sender(int sock, char* ip ,int port);

/*
 * Sending data to the peer. The function should wait for an
 * acknowledgment packet, and if it didn't receive any, retransmits the data.
 */
int rudp_send(int sock, const void *user_data, size_t size_D,int*arr);

/*
 * Receive data from a peer.
 */
int rudp_rcv(int sock, int data_size,int*arr);

/*
 * Closes a connection between peers.
 */
int rudp_close(int sock);
```

header structure:

```
typedef struct RUDP_header{
    int length_data;
    int sequence_number;
    int checksum;
    int flags;
    char data[Buffer];
}header , *pheader;
```

בחרנו לממש header עם 5 שדות :

1. Length_data - גודל המידע בכל packet בחרנו שיהיה גודל קבוע של 65000 כגודל BUFFER והpacket האחרונה שנישלח תהיה בגודל שנשאר לאחר הפחתת הפקטות שנשלחו מגודל file.

2. sequence number - כעין מספר סידורי על כל packet שמאפשר בקרה על הpackets שהגיעו לצד השני וגם על סדר שליחת וקבלת ack בנוסף יש הpackets מיוחדת שנתנו להם Seqn מיוחד כמו packet fin - כשהקליינט רוצה לסיים הקשר. packet finack - אישור של הרסיבר שקיבל את ההודעה לסיום הקשר. packet end - פאקטה המציינת שסיימנו לקבל את הקובץ.

3. checksum - בדיקה על הdata שלנו(לקחנו את פונקציית הבדיקה שניתנה לנו במטלה)בודקת האם המידע עבר נכון ובשלמותו.

4. flags - כמה סוגי דגלים שהגדרנו שיעזרו לנו בלוגיקת החיבור בין שני צדדים ברשת.

5. data - המידע עצמו שמועבר בכל פאקטה כגודל buffer.

הסבר על flags:

```
#define SYN 1
#define ACK 2
#define DATA 3
#define FIN 4
#define FIN_ACK 5
#define END 6
```

SYN - דגל המורה על packet של פתיחת קשר.

ACK - דגל המורה על packet של אישור על קבלת מידע .

DATA - דגל המורה על packet עם data.

FIN - דגל המורה על packet של סיום קשר של צד אחד.

FIN_ACK - דגל המורה על packet שמסכמת את סיום הקשר של הצד השני .

END - דגל המורה על packet שמסיימת את שליחת data בסיבוב זה .

Timeout

```
int set_timeout(int socket, int time) { // set timeout for the socket
    struct timeval timeout;
    timeout.tv_sec = time;
    timeout.tv_usec = 0;

    if (setsockopt(socket, SOL_SOCKET, SO_RCVTIMEO, &timeout, sizeof(timeout)) < 0) {
        perror("setsockopt() FAILED");
        return FAIL;
    }
    return SUCCESS;
}
```

השתמשנו בפונקציית set timeout (קראנו באינטרנט עליה) מכניסה ל socket timeout למשל בפונקציית receive from שהיא "פונקציה תוקעת" אפשר להגדיר שאחרי זמן מסוים היא תצא מהתקיעה

```
}
if (packetRCV.flags == END)
{
    set_timeout(sock, 1000000000);
}
```

למשל כאן בפונקציית rudp_recv כאשר התקבל כל datan אנחנו נותנים למשתמש זמן ארוך לבחור האם הוא רוצה לסיים את הקשר (בלחיצת 0 מתחיל תהליך הסגירה) או לקבל את הדאטה שוב ע"י לחיצת 1.

```
int rudp_send(int sock, const void* user_data, size_t size_D, int* arr)
{
    set_timeout(sock, TIME_OUT * 3);
    int sq = 0;
    int total_bytes_sent = 0;
    int packet_count = (size_D / Buffer);
}
```

כאן הגדרנו time_out בפונקציית rudp_send זה עזר לנו למשל כאשר packet של ack נשלחה ולא הגיע יש timeout לשליחה חוזרת של המידע ואז נקבל ack בצורה מסודרת

```
if (packetRecv.flags == SYN)
{
    header send_ack;
    memset(&send_ack, 0, sizeof(send_ack));
    send_ack.flags = ACK;
    int sendResult = sendto(sock, &send_ack, sizeof(header), 0, NULL, 0);
    if (sendResult == -1)
    {
        printf("sendto() FAILED");
        return FAIL;
    }
    set_timeout(sock, TIME_OUT * 10);
}

return 1;
```

RUDP_connect_reciever

```

int RUDP_connect_sender(int sock, char* ip, int port)
{
    // setup a timeout for the socket
    set_timeout(sock, TIME_OUT * 7);

    struct sockaddr_in reciver_address;
    memset(&reciver_address, 0, sizeof(reciver_address));
}

```

RUDP_connect_sender

השתמשנו גם בפונקציות אלו כדי לא לתקוע את התהליך בתחילת דרכו דהיינו בחיבור בין
 sender ל receiver

פונקציה wait_for_ack מחכה לאck ואם הגענו לtimeout תחזיר 1- נשתמש בזה כדי לבצע שליחה מחדש של פקטה אם היא אובדת בדרך.

```
int wait_for_ACK(int socket, int seq_num, clock_t start_time, int timeout)
{
    header packetRCV;
    while ((double)(clock() - start_time) / CLOCKS_PER_SEC < timeout)//if time finish got timeout
    {
        int bytes_recive = recvfrom(socket, &packetRCV, sizeof(packetRCV), 0, NULL, 0);
        if (bytes_recive == -1)
        {
            printf("recvfrom() FAILED1");
            return FAIL;
        }
        if (packetRCV.sequence_number == seq_num && packetRCV.flags == ACK)
        {
            printf("-got ACK for packet number: %d\n", seq_num);
            return SUCCESS;
        }
    }
    printf("got timeout\n");

    return -1; // timeout!
}
```

```
// just to send data!
int rudp_send(int sock, const void* user_data, size_t size_D, int* arr)
{
    set_timeout(sock, TIME_OUT * 3);
    int sq = 0;
    int total_bytes_sent = 0;
    int packet_count = (size_D / Buffer);

    // calculate the size of the last packet
    int rest_data = size_D - packet_count * Buffer;

    for (int i = 0; i < packet_count; i++)
    {
        header packet;
        packet.length_data = Buffer;
        packet.flags = DATA;
        packet.sequence_number = sq++;
        memcpy(packet.data, user_data + i * Buffer, Buffer);
        packet.checksum = calculate_checksum(packet.data, packet.length_data);

        do
        {
            // Try to send the message to the server using the created socket and the server structure.
            int bytes_sent = sendto(sock, &packet, sizeof(header), 0, NULL, 0);
            printf("send packet %d\n", packet.sequence_number);

            if (bytes_sent == -1)
            {
                printf("sendto() FAILED");
                return FAIL;
            }
            if (arr[packet.sequence_number] == 0)
            {
                total_bytes_sent += packet.length_data;
                arr[packet.sequence_number] = 1;
            }
        } while (wait_for_ACK(sock, packet.sequence_number, clock(), TIME_OUT) < 0);
    }
}
```

Handshake

מתבצע ע"י 2 פונקציות עיקריות

1. `RUDP_connect_reciever` משמשת לחיבור בצד receiver

2. `RUDP_connect_sender` משמשת לחיבור בצד client

פישטנו את התהליך שיהיה נוח למימוש

עוד לפני handshake נסביר תהליכים קצרים:

```
int RUDP_connect_reciever(int sock, int port)
{
    // Setup the server address structure.
    struct sockaddr_in serverAddress;
    memset(&serverAddress, 0, sizeof(serverAddress));
    serverAddress.sin_family = AF_INET;
    serverAddress.sin_port = htons(port);
    serverAddress.sin_addr.s_addr = htonl(INADDR_ANY);
    int bind_Sock = bind(sock, (struct sockaddr*)&serverAddress, sizeof(serverAddress));
}
```

נתחיל בפתיחת socket בצד receiver עי פונקציית bind של קישור ip וport לsocket

הקו שהשתמשנו בו הוא לתהליכים פנימיים 127.0.0.1 וport 5060

```
if (connect(sock, (struct sockaddr*)&reciver_address, sizeof(reciver_address)) == -1)
{
    printf("connect() FAILED");
    return FAIL;
}
```

```

}

if (connect(sock, (struct sockaddr*)&sender_address, sizeof(sender_address)) == -1)
{
    perror("connect() FAILED");
    return FAIL;
}
```

השתמשנו בפונקציית connect בצד sender וreceiver
אומנם זו לא פונקציה של udp (עליו בעצם בנינו את הרדק) אבל יש אפשרות כזאת שהיא מקשרת בין הצדדים ולא צריך לומר במפורש לאן אנו שולחים אחרי החיבור הזה

```

header packetSYN;
memset(&packetSYN, 0, sizeof(packetSYN));
packetSYN.flags = SYN;

header packetAck;
memset(&packetAck, 0, sizeof(packetAck));

if (connect(sock, (struct sockaddr*)&receiver_address, sizeof(receiver_address)) == -1)
{
    printf("connect() FAILED");
    return FAIL;
}

int bytes_SYN_sent = sendto(sock, &packetSYN, sizeof(packetSYN), 0, NULL, 0);

```

שלחנו פאקטת SYN לפתיחת קשר מצד הsender

```

if (packetRecv.flags == SYN)
{
    header send_ack;
    memset(&send_ack, 0, sizeof(send_ack));
    send_ack.flags = ACK;
    int sendResult = sendto(sock, &send_ack, sizeof(header), 0, NULL, 0);
    if (sendResult == -1)
    {

```

קיבלנו את פאקטת SYN בצד הreceiver ושלחנו פאקטת ack לאישור

```

    }
    if (packetAck.flags == ACK)
    {
        printf("connected complited\n");
        return SUCCESS;
    }
    return SUCCESS;
}

```

אם הsender קיבל את פאקטת הack החיבור הוקם בהצלחה!

שאלות תיאורטיות

1.

ענו על השאלות הבאות (5 נקודות):

- ב"רשת אמינה" הכוונה היא לרשת שבה מעט מאוד חבילות הולכות לאיבוד. ב"קשר ארוך" הכוונה היא לקשר TCP שיש בו הרבה מאוד מידע לשלוח. מוצע להגדיל ב-TCP את SStreshold בתחילת הקשר. באיזה מהמקרים הבאים השינוי הזה עשוי להועיל במידה המירבית? נמק.

 1. בקשר ארוך על גבי רשת אמינה עם RTT גדול.
 2. בקשר קצר על גבי רשת לא אמינה עם RTT גדול.
 3. בקשר ארוך על גבי רשת לא אמינה עם RTT גדול.
 4. בקשר קצר על גבי רשת אמינה עם RTT קטן.
 5. בקשר ארוך על גבי רשת אמינה עם RTT קטן.
 6. בקשר קצר על גבי רשת לא אמינה עם RTT קטן.
 7. בקשר ארוך על גבי רשת לא אמינה עם RTT קטן.
 8. בקשר קצר על גבי רשת אמינה עם RTT גדול.

במקרה 5 השינוי הזה יועיל במידה המירבית כלומר בקשר ארוך – קשר TCP שיש לו הרבה מידע לשלוח, על גבי רשת אמינה – רשת שבה מעט מאוד חבילות הולכות לאיבוד, עם RTT גדול. נסביר-אנו יודעים שיש מידע רב לשלוח ושהרשת אמינה אם SStreshold ישאר כמו שהוא אז בגלל שRTT גדול יהיה זמן שבו השולח מחכה לקבל ack על הפקטות שהוא שולח ובזמן הזה הוא לא שולח פקטות נוספות. אפשר לשלוח פקטות נוספות בזמן ההמתנה הזה ובגלל שהרשת אמינה לא נגיע לtimeout ולכן נרוויח בהגדלת SStreshold.

2.

- A שולח ל-B חבילות מידע באמצעות קשר TCP. נתון כי הקשר מתחיל עם חלון בגודל MSS1. הקשר מסתיים בפעם הראשונה שהוא מגיע ל-Sstresh. במהלך הקשר לא אובדות חבילות. נסמן בקיצור: $Sstresh = S * MSS$

נתון כי לאורך כל הקשר $rwnd < S * MSS$.

מהי התפוקה של הקשר מ-A ל-B (ב-Bytes / sec) בזמן הנ"ל? נמקי.

1. בערך $[S * MSS / (\lg(S) * RTT * 2)]$
2. בערך $[S * MSS / (S^{0.5} * RTT * 2)]$
3. בערך $S * MSS / RTT$
4. בערך $(S^2 * MSS) / RTT$

בתחילה נתון כי הקשר מתחיל עם חלון בגודל 1mss, בכל שליחה נכפיל את גודל החלון פי 2, כיוון שאין איבוד חבילות, גודל השליחה לא יצטמצם אלא רק יגדל. ומכאן כמות הRTT שלוקח לקשר היא $\log s$. בנוסף $\sum_{i=0}^{\log s} 2^i = 2(s-1)$ לכן גודל החבילה הוא בערך $2s$.

ומכאן התשובה הנכונה היא 1 בערך $\frac{2s}{\log s} \frac{MSS}{RTT}$

3.

- שתי תחנות מתקשרות באופן אלחוטי בשיטת Go Back N.

נסמן ב-X את ספרת הביקורת של הת.ז. שלך. אם שני שותפים מגישים את התרגיל יחד, X הוא ספרת הביקורת בעלת הערך הנמוך יותר מבין השתיים.

קצב התקשורת הוא 8Gbps, וגודל כל חבילה הוא X*KByte. גדלי ה-headers וה-Acks זניחים.

קצב ההתפשטות הוא $2 \cdot 10^8 \text{ m/sec}$, והמרחק בין התחנות הוא 1Km. זמן עיבוד הנתונים בתחנות זניח. אף חבילה ואף Ack לא הולכים לאיבוד.

- מהו X שלך?
- מה צריך להיות גודל חלון המשלוח כדי להבטיח תפוקה מקסימלית?

ספרת הביקורת הנמוכה מבין תעודות הזהות שלנו היא 8. X=8.

נחשב את זמן העיכוב (מרחק לחלק לקצב התפשטות)

$$1000(\text{m}) / (2 \cdot 10^8 \text{ (m/sec)}) = 0.5 \cdot 10^{-5}(\text{sec})$$

$$\frac{1000}{2 \cdot 10^8} = \frac{1}{2 \cdot 10^5} \text{ שניות}$$

זמן שידור:

$$\frac{8 \cdot 10^3 \cdot 8}{8 \cdot 10^9} = \frac{8}{10^6} \text{ שניות}$$

$$2 \cdot \left(\frac{1}{2 \cdot 10^5} + \frac{8}{10^6} \right) = 0.000026 \text{ שנקבל: RTT סה"כ}$$

גודל כל חבילה הוא 8kbps

קצב התקשורת 8gbps

אין אובדן פקטות ולכן יתקבל ack על כל פקטה ולא יהיו שידורים חוזרים. ולכן ניתן להגדיל את החלון כמה שיותר

$$\text{window size} = \frac{RTT \cdot \text{קצב תקשורת}}{\text{גודל חבילה}} = \frac{8 \cdot 10^9 \cdot 0.000026}{2 \cdot 8 \cdot 10^3} = 13$$