Assignment 1 Report

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1. A brief discussion of how you have implemented the STP protocol. Provide a list of features that you have successfully implemented. In case you have not been able to get certain features of STP working, you should also mention that in your report.

- A three-way handshake (SYN, SYN+ACK, ACK) for the connection establishment.
- The four-segment connection termination (FIN, ACK, FIN, ACK).
- A single-timer for timeout operation
- Sequence numbers, cumulative acknowledgements, timers, buffers for implementing protocol.
- MSS&MWS
- PLD Module

2. A detailed diagram of your STP header and a quick explanation of all fields (similar to the diagrams that we have used in the lectures to understand TCP/UDP headers).

```
value = {'SYN':False,'ACK':False,'FIN':True,'seq_num':message['seq_num'],'ack_num':message['ack_num'], 'data':'|'}
The header includes:
```

- The type of the message, SYN, ACK, or FIN
- The sequence number and the cumulated acknowledgement number.
- The data itself.

3. For the standard version of the assignment, answer the following questions:
(a) Use the following parameter setting: pdrop = 0.1, MWS = 500 bytes, MSS = 50 bytes, seed = 300. Explain how you determine a suitable value for timeout. Note that you may need to experiment with different timeout values to answer this question. Justify your answer.

The timeout used in this section is 1.5ms. Too small timeout value will increase the transmission time greatly because of packet retransmission. Too large timeout value will be useless.

The result shows as follow:

Pdrop = 0.1:

```
Amount of data transferred: 2676 bytes
Number of data segments sent: 54
Number of packets dropped: 8
Number of retransmitted segments: 24
Number of duplicate acknowledgements: 24
```

Pdrop = 0.3:

```
Amount of data transferred: 4122 bytes
Number of data segments sent: 83
Number of packets dropped: 28
Number of retransmitted segments: 63
Number of duplicate acknowledgements: 63
```

As we can see in these pictures, the transmission time becomes much longer due to the retransition of the dropped packet and wait for its acknowledgement.

The full packet sequences of all the experiments shows in the appendix section.

(b) Let Tcurrent represent the timeout value that you have chosen in part (a). Set pdrop = 0.1, MWS = 500 bytes, MSS = 50 bytes, seed = 300 and run three experiments with the following different timeout values:

i. Tcurrent

ii. 4 × Tcurrent

iii. Tcurrent/4

and transfer the file test2.txt (available on the assignment webpage) using STP. Show a table that indicates how many STP packets were transmitted (this should include retransmissions) in total and how long the overall transfer took. Discuss the results.

The result shows as follow:

i: 1.5ms

```
Amount of data transferred: 2704 bytes
Number of data segments sent: 55
Number of packets dropped: 9
Number of retransmitted segments: 25
Number of duplicate acknowledgements: 25
```

ii:6.0ms

```
Amount of data transferred: 2704 bytes
Number of data segments sent: 55
Number of packets dropped: 9
Number of retransmitted segments: 25
Number of duplicate acknowledgements: 25
```

iii:0.4ms

```
Amount of data transferred: 2704 bytes
Number of data segments sent: 55
Number of packets dropped: 9
Number of retransmitted segments: 25
Number of duplicate acknowledgements: 25
```

There is a timeout value as a "sign", when the timeout value used is above the sign, the time used increased linearly and slightly. In the current test, this case occurs.

If we decrease the timeout value until it below the "sign", the time used will increase sharply.

Appendix

1. 3a pdrop=0.1

```
snd 5.013916015625
                         9792
                                      0
                     S
                                 0
                                      9793
    5.013916015625
                     SA
                         8362
                                 0
rcv
snd 8.526611328125
                         9793
                                 0
                                      8363
snd 10.544921875
                         9793
                                     8363
                     D
                                 50
snd 11.0361328125
                     D
                         9843
                                 50
                                      8363
snd 11.0361328125
                     D
                         9893
                                     8363
                                 50
snd 11.534912109375 D
                                     8363
                         9943
                                 50
snd 11.534912109375 D
                         9993
                                 50
                                     8363
snd 12.0361328125
                     D
                         10043
                                 50
                                     8363
snd 12.0361328125
                         10093
                                     8363
                     D
                                 50
snd 12.0361328125
                     D
                         10143
                                 50
                                     8363
snd 12.5380859375
                     D
                         10193
                                 50
                                     8363
snd 12.5380859375
                                     8363
                         10243
                                 50
                     D
snd 12.5380859375
                     D
                         10293
                                 50
                                     8363
snd 12.5380859375
                         10343
                                     8363
                     D
                                 50
snd 13.03857421875
                         10393
                                     8363
                     D
                                 50
snd 13.03857421875
                     D
                         10443
                                 50
                                     8363
snd 13.03857421875
                         10493
                                 50
                                     8363
snd 13.540283203125 D
                         10543
                                 50
                                     8363
drop 13.540283203125 D
                                     8363
                         10593
                                 50
drop 13.540283203125 D
                         10643
                                 50
                                     8363
snd 13.540283203125 D
                         10693
                                 50
                                     8363
snd 13.540283203125 D
                         10743
                                 50
                                     8363
drop 14.041259765625 D
                         10793
                                 50
                                     8363
snd 14.041259765625 D
                         10843
                                 50
                                     8363
snd 14.041259765625 D
                         10893
                                     8363
                                 50
drop 14.041259765625 D
                         10943
                                 50
                                     8363
snd 14.041259765625 D
                         10993
                                 50
                                     8363
drop 14.041259765625 D
                         11043
                                 50
                                     8363
snd 14.542724609375 D
                         11093
                                 50
                                     8363
snd 14.542724609375 D
                                 50
                                     8363
                         11143
snd 14.542724609375 D
                         11193
                                     8363
                                 50
snd 15.044189453125 D
                         11243
                                     8363
                                 50
snd 15.044189453125 D
                         11293
                                 50
                                     8363
snd 15.044189453125 D
                         11343
                                 43
                                     8363
    16.04638671875 A
                         8363
                                 0
                                      9843
rcv
    16.04638671875
                         8363
                                 0
                                      9893
rcv
    16.04638671875
                                 0
                                      9943
                         8363
rcv
    16.04638671875
                         8363
                                 0
                                      9993
rcv
    16.04638671875 A
                         8363
                                 0
                                      10043
```

	400400074075		0000	_	40000
rcv	16.04638671875	A	8363	0	10093
rcv	16.04638671875	A	8363	0	10143
rcv	16.04638671875	A	8363	0	10193
rcv	16.04638671875	Α	8363	0	10243
rcv	16.04638671875	Α	8363	0	10293
rcv	16.04638671875	Α	8363	0	10343
rcv	16.04638671875	Α	8363	0	10393
rcv	16.04638671875	Α	8363	0	10443
rcv	16.04638671875	Α	8363	0	10493
rcv	16.04638671875	Α	8363	0	10543
rcv	16.04638671875	Α	8363	0	10593
rcv	16.04638671875	Α	8363	0	10593
rcv	16.04638671875	Α	8363	0	10593
rcv	16.04638671875	Α	8363	0	10593
rcv	16.04638671875	Α	8363	0	10593
rcv	16.04638671875	Α	8363	0	10593
rcv	16.04638671875	Α	8363	0	10593
rcv	16.54833984375	Α	8363	0	10593
rcv	16.54833984375	Α	8363	0	10593
rcv	16.54833984375	Α	8363	0	10593
rcv	16.54833984375	Α	8363	0	10593
rcv	16.54833984375	Α	8363	0	10593
snd	16.54833984375	D	10593	50	8363
snd	17.04931640625	D	10643	50	8363
drop	17.04931640625	D	10693	50	8363
snd	17.04931640625	D	10743	50	8363
drop	17.04931640625	D	10793	50	8363
snd	17.04931640625	D	10843	50	8363
snd	17.550537109375	D	10893	50	8363
snd	17.550537109375	D	10943	50	8363
snd	17.550537109375	D	10993	50	8363
snd	18.05224609375	D	11043	50	8363
snd	18.05224609375	D	11093	50	8363
snd	18.05224609375	D	11143	50	8363
snd	18.05224609375	D	11193	50	8363
snd	18.5537109375	D	11243	50	8363
snd	18.5537109375	D	11293	50	8363
snd	18.5537109375	D	11343	43	8363
rcv	19.054443359375	Α	8363	0	10643
rcv	19.054443359375	Α	8363	0	10693
rcv	19.054443359375		8363	0	10693
rcv	19.054443359375		8363	0	10693
rcv	19.054443359375		8363	0	10693
rcv	19.054443359375		8363	0	10693
	-		-		

```
19.054443359375 A
                         8363
                                     10693
                                 0
rcv
    19.054443359375 A
                         8363
                                 0
                                     10693
rcv
    19.054443359375 A
                                 0
                                     10693
rcv
                         8363
    19.054443359375 A
                                 0
                                     10693
rcv
                         8363
    19.054443359375 A
                         8363
                                 0
                                     10693
rcv
    19.054443359375 A
                         8363
                                 0
                                     10693
rcv
    19.054443359375 A
                         8363
                                     10693
                                 0
rcv
   19.054443359375 A
                                     10693
                         8363
                                 0
rcv
                                     8363
snd 19.556396484375 D
                         10693
                                 50
                                     8363
snd 19.556396484375 D
                         10743
                                 50
snd 19.556396484375 D
                         10793
                                 50
                                     8363
snd 20.0576171875
                         10843
                                     8363
                     D
                                 50
snd 20.0576171875
                     D
                         10893
                                 50 8363
snd 20.0576171875
                     D
                         10943
                                 50 8363
snd 20.55859375 D
                     10993
                             50
                                 8363
snd 20.55859375 D
                     11043
                             50
                                 8363
drop 20.55859375 D
                     11093
                             50
                                 8363
snd 20.55859375 D
                     11143
                             50
                                 8363
snd 21.060302734375 D
                         11193
                                 50 8363
snd 21.060302734375 D
                         11243
                                 50
                                     8363
snd 21.060302734375 D
                                     8363
                         11293
                                 50
snd 21.5615234375
                     D
                         11343
                                 43
                                     8363
rcv
   21.5615234375
                     Α
                         8363
                                 0
                                     10793
    21.5615234375
                         8363
                                     10793
                     Α
                                 0
rcv
    21.5615234375
                     Α
                         8363
                                 0
                                     10843
rcv
   21.5615234375
                     Α
                         8363
                                 0
                                     11386
rcv
snd 21.5615234375
                     F
                         11386
                                 0
                                     8363
    22.6884765625
                     FA 8364
                                 0
                                     11387
snd 24.692626953125 A
                         11387
                                 0
                                     8365
```

Amount of data transferred: 2679 bytes Number of data segments sent: 54 Number of packets dropped: 8

Number of retransmitted segments: 24 Number of duplicate acknowledgements: 24

2. 3a pdrop=0.3

snd	4.9814453125	S	9792	0	0
rcv	4.9814453125	SA	2403	0	9793
snd	8.991943359375	Α	9793	0	2404
snd	10.49658203125	D	9793	50	2404
snd	10.998779296875	D	9843	50	2404
snd	10.998779296875	D	9893	50	2404
snd	10.998779296875	D	9943	50	2404

```
snd 10.998779296875 D
                         9993
                                     2404
                                 50
snd 10.998779296875 D
                         10043
                                 50
                                     2404
drop 10.998779296875 D
                                     2404
                         10093
                                 50
drop 10.998779296875 D
                                     2404
                         10143
                                 50
snd 10.998779296875 D
                         10193
                                 50
                                     2404
snd 12.127685546875 D
                         10243
                                 50
                                     2404
snd 12.127685546875 D
                         10293
                                 50
                                     2404
snd 12.127685546875 D
                                     2404
                         10343
                                 50
snd 12.127685546875 D
                         10393
                                 50
                                     2404
                                     2404
snd 12.127685546875 D
                         10443
                                 50
snd 12.127685546875 D
                         10493
                                 50
                                     2404
snd 13.126220703125 D
                                     2404
                         10543
                                 50
drop 13.126220703125 D
                         10593
                                 50
                                     2404
drop 13.126220703125 D
                         10643
                                 50
                                     2404
drop 13.126220703125 D
                         10693
                                 50
                                     2404
snd 13.126220703125 D
                         10743
                                 50
                                     2404
drop 13.126220703125 D
                         10793
                                 50
                                     2404
snd 13.126220703125 D
                         10843
                                 50
                                     2404
snd 13.126220703125 D
                         10893
                                 50
                                     2404
drop 13.126220703125 D
                         10943
                                     2404
                                 50
snd 13.126220703125 D
                         10993
                                 50
                                     2404
drop 13.126220703125 D
                         11043
                                 50
                                     2404
drop 13.126220703125 D
                         11093
                                 50
                                     2404
snd 13.126220703125 D
                                     2404
                         11143
                                 50
snd 14.10107421875 D
                         11193
                                 50
                                     2404
snd 14.10107421875
                         11243
                                 50
                                     2404
                     D
snd 14.10107421875
                         11293
                                 50
                                     2404
snd 14.10107421875
                         11343
                                 43
                                     2404
                     D
    14.10107421875
                     Α
                         2404
                                 0
                                      9843
rcv
    14.10107421875
                    Α
                         2404
                                 0
                                      9893
rcv
    14.10107421875 A
                         2404
                                 0
                                      9943
rcv
    14.10107421875 A
                                     9993
                         2404
                                 0
rcv
    14.10107421875 A
                         2404
                                 0
                                      10043
rcv
    14.10107421875
                         2404
                                 0
                                      10093
rcv
    14.10107421875
                    Α
                         2404
                                 0
                                     10093
rcv
    14.10107421875
                    Α
                         2404
                                 0
                                      10093
rcv
    14.10107421875 A
                         2404
                                     10093
                                 0
rcv
    14.10107421875
                         2404
                    Α
                                 0
                                      10093
rcv
    14.10107421875
                                 0
                                      10093
                         2404
rcv
    14.10107421875 A
                         2404
                                 0
                                     10093
rcv
rcv
    14.10107421875 A
                         2404
                                 0
                                      10093
    14.10107421875 A
                         2404
                                 0
                                      10093
rcv
    14.10107421875
                         2404
                                 0
                                      10093
rcv
    14.10107421875 A
                                 0
                                      10093
                         2404
rcv
```

```
14.10107421875 A
                         2404
                                      10093
                                 0
rcv
    14.10107421875 A
                         2404
                                 0
                                      10093
rcv
                                 0
                                      10093
rcv
    15.103759765625 A
                         2404
    15.103759765625 A
                         2404
                                     10093
rcv
                                 0
    15.103759765625 A
                         2404
                                 0
                                      10093
rcv
    15.103759765625 A
                         2404
                                 0
                                      10093
rcv
   15.103759765625 A
                         2404
                                 0
                                      10093
snd 15.103759765625 D
                                     2404
                         10093
                                 50
drop 15.103759765625 D
                         10143
                                 50
                                     2404
drop 15.103759765625 D
                         10193
                                 50
                                     2404
snd 15.103759765625 D
                         10243
                                 50
                                     2404
drop 15.103759765625 D
                         10293
                                     2404
                                 50
snd 15.103759765625 D
                         10343
                                 50
                                     2404
snd 16.107421875
                         10393
                                 50
                                     2404
                     D
snd 16.107421875
                     D
                         10443
                                 50
                                     2404
snd 16.107421875
                     D
                         10493
                                 50
                                     2404
snd 16.107421875
                     D
                         10543
                                 50
                                     2404
snd 16.107421875
                     D
                         10593
                                 50
                                     2404
snd 16.107421875
                         10643
                                 50
                                     2404
                     D
drop 16.107421875
                         10693
                                     2404
                     D
                                 50
drop 16.107421875
                         10743
                                 50
                                     2404
                     D
snd 17.14111328125
                     D
                         10793
                                 50
                                     2404
snd 17.14111328125
                     D
                         10843
                                 50
                                     2404
snd 17.14111328125
                         10893
                                     2404
                     D
                                 50
snd 17.14111328125
                         10943
                                 50
                                     2404
snd 17.14111328125
                     D
                         10993
                                 50
                                     2404
snd 17.14111328125
                         11043
                                 50
                                     2404
drop 17.14111328125 D
                         11093
                                     2404
                                 50
snd 18.145751953125 D
                         11143
                                 50
                                     2404
snd 18.145751953125 D
                         11193
                                 50
                                     2404
snd 18.145751953125 D
                         11243
                                 50
                                     2404
drop 18.145751953125 D
                         11293
                                 50
                                     2404
snd 18.145751953125 D
                         11343
                                 43
                                     2404
    18.145751953125 A
                         2404
                                     10143
rcv
                                 0
   18.145751953125 A
                         2404
                                 0
                                     10143
rcv
    18.145751953125 A
                                 0
                         2404
                                     10143
rcv
    18.145751953125 A
                         2404
                                 0
                                     10143
rcv
rcv
    18.145751953125 A
                         2404
                                 0
                                      10143
    18.145751953125 A
                         2404
                                 0
                                     10143
rcv
    18.145751953125 A
                         2404
                                 0
                                      10143
rcv
    18.145751953125 A
                                 0
                         2404
                                      10143
rcv
```

```
18.145751953125 A
                         2404
                                     10143
                                 0
rcv
    18.145751953125 A
                         2404
                                 0
                                     10143
rcv
    18.145751953125 A
rcv
                         2404
                                 0
                                     10143
    18.145751953125 A
rcv
                         2404
                                 0
                                     10143
    18.145751953125 A
                         2404
                                 0
                                     10143
rcv
    18.145751953125 A
                         2404
                                 0
                                     10143
rcv
    18.145751953125 A
                         2404
                                 0
                                     10143
rcv
   18.145751953125 A
                         2404
                                 0
                                     10143
rcv
snd 19.113525390625 D
                         10143
                                 50
                                     2404
snd 19.113525390625 D
                         10193
                                 50
                                     2404
drop 19.113525390625 D
                         10243
                                 50
                                     2404
snd 19.113525390625 D
                         10293
                                     2404
                                 50
snd 19.113525390625 D
                         10343
                                 50
                                     2404
drop 19.113525390625 D
                         10393
                                 50
                                     2404
snd 19.113525390625 D
                         10443
                                 50
                                     2404
drop 19.113525390625 D
                         10493
                                 50
                                     2404
snd 19.113525390625 D
                         10543
                                 50
                                     2404
snd 20.154296875
                     D
                         10593
                                 50
                                     2404
snd 20.154296875
                         10643
                                 50
                                     2404
                     D
drop 20.154296875
                         10693
                                     2404
                     D
                                 50
snd 20.154296875
                         10743
                                 50
                                     2404
                     D
snd 20.154296875
                     D
                         10793
                                 50
                                     2404
snd 20.154296875
                     D
                         10843
                                 50
                                     2404
snd 20.154296875
                         10893
                                     2404
                     D
                                 50
snd 21.154052734375 D
                         10943
                                 50
                                     2404
snd 21.154052734375 D
                         10993
                                 50
                                     2404
snd 21.154052734375 D
                         11043
                                 50
                                     2404
drop 21.154052734375 D
                         11093
                                     2404
                                 50
drop 21.154052734375 D
                         11143
                                 50
                                     2404
drop 21.154052734375 D
                         11193
                                 50
                                     2404
snd 21.154052734375 D
                         11243
                                 50
                                     2404
snd 21.154052734375 D
                         11293
                                 50
                                     2404
drop 21.154052734375 D
                         11343
                                 43
                                     2404
   22.13134765625 A
                         2404
                                     10193
rcv
                                 0
    22.13134765625 A
                         2404
                                 0
                                     10693
rcv
   22.13134765625 A
                         2404
                                 0
                                     10693
rcv
   22.13134765625 A
                         2404
                                 0
                                     10693
rcv
                         2404
   22.13134765625
                    Α
                                 0
                                     10693
rcv
   22.13134765625
                                 0
                         2404
                                     10693
rcv
   22.13134765625 A
                         2404
                                 0
                                     10693
rcv
rcv
   22.13134765625 A
                         2404
                                 0
                                     10693
   22.13134765625 A
                         2404
                                 0
                                     10693
rcv
    22.13134765625
                         2404
                                 0
                                     10693
rcv
    22.13134765625 A
                                 0
                         2404
                                     10693
```

```
22.13134765625
                         2404
                                      10693
                    Α
                                  0
rcv
    22.13134765625
                    Α
                         2404
                                  0
                                      10693
rcv
                                  0
                                      10693
rcv
    22.13134765625
                     Α
                         2404
    22.13134765625
                         2404
                                      10693
rcv
                                  0
    22.13134765625
                     Α
                         2404
                                  0
                                      10693
rcv
    22.13134765625
                     Α
                         2404
                                  0
                                      10693
rcv
drop 22.13134765625
                                      2404
                         10693
                                  50
snd 22.13134765625
                         10743
                                      2404
                     D
                                  50
                                  50
snd 22.13134765625
                         10793
                                      2404
                             2404
snd 23.125
             D
                 10843
                         50
snd 23.125
             D
                 10893
                         50
                             2404
snd 23.125
                 10943
                             2404
             D
                         50
snd 23.125
             D
                 10993
                         50
                             2404
                             2404
snd 23.125
             D
                 11043
                         50
                         50 2404
snd 23.125
             D
                 11093
snd 24.126953125
                     D
                         11143
                                  50
                                      2404
snd 24.126953125
                     D
                         11193
                                  50
                                      2404
snd 24.126953125
                     D
                         11243
                                  50
                                      2404
                         11293
snd 24.126953125
                     D
                                  50
                                      2404
snd 24.126953125
                     D
                         11343
                                  43
                                      2404
    25.148193359375 A
                         2404
                                  0
                                      10693
rcv
rcv
    25.148193359375 A
                         2404
                                  0
                                      10693
rcv
    25.148193359375 A
                         2404
                                  0
                                      10693
    25.148193359375 A
                         2404
                                      10693
                                  0
rcv
    25.148193359375 A
                         2404
                                  0
                                      10693
rcv
   25.148193359375 A
                         2404
                                  0
                                      10693
rcv
    25.148193359375 A
                                      10693
rcv
                         2404
                                  0
    25.148193359375 A
                         2404
                                  0
                                      10693
rcv
snd 26.152099609375 D
                         10693
                                  50
                                      2404
snd 26.152099609375 D
                         10743
                                  50
                                      2404
snd 26.152099609375 D
                         10793
                                  50
                                      2404
drop 26.152099609375 D
                         10843
                                      2404
                                  50
                         10893
                                      2404
drop 26.152099609375 D
                                  50
drop 26.152099609375 D
                         10943
                                      2404
                                  50
snd 26.152099609375 D
                         10993
                                  50 2404
snd 27.140625
                     11043
                              50
                                  2404
snd 27.140625
                 D
                     11093
                              50
                                  2404
snd 27.140625
                 D
                     11143
                              50
                                  2404
snd 27.140625
                     11193
                              50
                                  2404
                 D
```

```
snd 27.140625
                     11243
                             50
                                  2404
                 D
snd 27.140625
                 D
                     11293
                             50
                                  2404
                                      2404
snd 28.1396484375
                     D
                         11343
                                  43
    28.1396484375
                         2404
                                  0
                                      10743
rcv
                     Α
    28.1396484375
                     Α
                         2404
                                  0
                                      11386
rcv
snd 28.1396484375
                     F
                         11386
                                  0
                                      2404
    29.140380859375 FA
                         2405
                                  0
                                      11387
snd 30.14599609375 A
                         11387
                                  0
                                      2406
```

Amount of data transferred: 4122 bytes

Number of data segments sent: 83 Number of packets dropped: 28

Number of retransmitted segments: 63

Number of duplicate acknowledgements: 63

3. 3b timeout=1.5

```
snd 5.0302734375
                     S
                         9792
                                 0
                                     0
    6.028564453125
                     SA
                         6851
                                 0
                                     9793
rcv
snd 9.02490234375
                     Α
                         9793
                                 0
                                     6852
snd 11.0302734375
                     D
                         9793
                                     6852
                                 50
snd 11.0302734375
                         9843
                                 50
                                     6852
                     D
snd 11.0302734375
                     D
                         9893
                                 50
                                     6852
snd 12.033203125
                     D
                         9943
                                 50
                                     6852
snd 12.033203125
                         9993
                                     6852
                     D
                                 50
snd 12.033203125
                     D
                         10043
                                 50
                                     6852
snd 12.033203125
                     D
                         10093
                                 50
                                     6852
snd 13.0361328125
                     D
                         10143
                                 50
                                     6852
snd 13.0361328125
                         10193
                                     6852
                     D
                                 50
snd 13.0361328125
                     D
                         10243
                                 50
                                     6852
snd 13.0361328125
                     D
                         10293
                                 50
                                     6852
snd 14.038818359375 D
                         10343
                                 50
                                     6852
snd 14.038818359375 D
                         10393
                                     6852
                                 50
snd 14.038818359375 D
                         10443
                                     6852
                                 50
snd 14.038818359375 D
                         10493
                                     6852
                                 50
snd 15.0419921875
                     D
                         10543
                                 50
                                     6852
drop 15.0419921875
                     D
                         10593
                                     6852
                                 50
drop 15.0419921875
                         10643
                                     6852
                     D
                                 50
snd 15.0419921875
                         10693
                                     6852
                     D
                                 50
snd 16.0439453125
                         10743
                                     6852
                     D
                                 50
drop 16.0439453125
                     D
                         10793
                                 50
                                     6852
snd 16.0439453125
                     D
                         10843
                                 50
                                     6852
snd 16.0439453125
                     D
                         10893
                                 50
                                     6852
drop 16.0439453125
                     D
                         10943
                                 50
                                     6852
snd 16.0439453125
                         10993
                                     6852
                     D
                                 50
```

```
drop 16.0439453125
                          11043
                                       6852
                      D
                                  50
snd 16.0439453125
                      D
                          11093
                                  50
                                       6852
snd 17.046142578125 D
                          11143
                                  50
                                       6852
snd 17.046142578125 D
                                       6852
                          11193
                                  50
snd 17.046142578125 D
                          11243
                                  50
                                       6852
snd 17.046142578125 D
                          11293
                                  50
                                       6852
snd 17.046142578125 D
                          11343
                                  50
                                       6852
snd 17.046142578125 D
                          11393
                                  50
                                      6852
snd 17.046142578125 D
                          11443
                                  50
                                       6852
drop 18.04833984375 D
                          11493
                                  50
                                       6852
snd 18.04833984375
                     D
                          11543
                                  50
                                       6852
                                       6852
drop 18.04833984375
                      D
                          11593
                                  50
snd 18.04833984375
                     D
                          11643
                                  50
                                       6852
snd 18.04833984375
                          11693
                                  50
                                       6852
                      D
snd 18.04833984375
                     D
                          11743
                                  4
                                       6852
rcv
    18.04833984375
                          6852
                                  0
                                       9843
    18.04833984375 A
                          6852
                                  0
                                       9893
rcv
    18.04833984375
                          6852
                                  0
                                       9943
rcv
    18.04833984375
                          6852
                                  0
                                       9993
rcv
    18.04833984375
                     Α
                          6852
                                  0
                                       10043
rcv
    18.04833984375
                     Α
                          6852
                                  0
                                       10093
rcv
rcv
    18.04833984375
                     Α
                          6852
                                  0
                                       10143
    18.04833984375
                     Α
                          6852
                                  0
                                       10193
rcv
    18.04833984375
                                       10243
                     Α
                          6852
                                  0
rcv
    18.04833984375
                     Α
                          6852
                                  0
                                       10293
rcv
    18.04833984375
                     Α
                          6852
                                  0
                                       10343
rcv
    18.04833984375
                          6852
                                  0
                                       10393
rcv
    18.04833984375
                     Α
                                  0
rcv
                          6852
                                       10443
    18.04833984375
                     Α
                          6852
                                  0
                                       10493
rcv
    18.04833984375
                     Α
                          6852
                                  0
                                       10543
rcv
    18.04833984375
                     Α
                          6852
                                  0
                                       10593
rcv
    19.052734375
                      Α
                          6852
                                  0
                                       10593
rcv
                          6852
                                       10593
    19.052734375
                      Α
                                  0
rcv
    19.052734375
                      Α
                          6852
                                  0
                                       10593
rcv
    19.052734375
                                  0
                      Α
                          6852
                                       10593
rcv
    19.052734375
                      Α
                          6852
                                  0
                                       10593
rcv
rcv
    19.052734375
                      Α
                          6852
                                  0
                                       10593
    19.052734375
                      Α
                          6852
                                  0
                                       10593
rcv
    19.052734375
                      Α
                          6852
                                  0
                                       10593
rcv
    19.052734375
                                  0
                                       10593
                      Α
                          6852
rcv
```

rcv	19.052734375	Α	6852	0	10593
rcv rcv	19.052734375	Α	6852	0	10593
rcv	19.052734375	Α	6852	0	10593
rcv	19.052734375	Α	6852	0	10593
snd	19.052734375	D	10593	50	6852
snd	19.052734375	D	10643	50	6852
snd	19.052734375	D	10693	50	6852
snd	19.052734375	D	10743	50	6852
snd	20.054931640625	D	10793	50	6852
snd	20.054931640625	D	10843	50	6852
snd	20.054931640625	D	10893	50	6852
snd	20.054931640625	D	10943	50	6852
snd	20.054931640625	D	10993	50	6852
snd	20.054931640625	D	11043	50	6852
snd	21.05712890625	D	11093	50	6852
snd	21.05712890625	D	11143	50	6852
snd	21.05712890625	D	11193	50	6852
snd	21.05712890625	D	11243	50	6852
snd	21.05712890625	D	11293	50	6852
snd	21.05712890625	D	11343	50	6852
drop	21.05712890625	D	11393	50	6852
snd	22.059814453125	D	11443	50	6852
snd	22.059814453125	D	11493	50	6852
snd	22.059814453125	D	11543	50	6852
snd	22.059814453125	D	11593	50	6852
snd	22.059814453125	D	11643	50	6852
snd	23.06298828125	D	11693	50	6852
drop	23.06298828125	D	11743	4	6852
rcv	23.06298828125	Α	6852	0	10643
rcv	23.06298828125	Α	6852	0	10693
rcv	23.06298828125	Α	6852	0	10793
rcv	23.06298828125	Α	6852	0	10793
rcv	23.06298828125	Α	6852	0	10843
rcv	23.06298828125	Α	6852	0	10943
rcv	23.06298828125	Α	6852	0	10943
rcv	23.06298828125	Α	6852	0	10993
rcv	23.06298828125	Α	6852	0	11043
rcv	23.06298828125	Α	6852	0	11093
rcv	23.06298828125	Α	6852	0	11493
rcv	23.06298828125	Α	6852	0	11493
rcv	23.06298828125	Α	6852	0	11493
rcv	23.06298828125	Α	6852	0	11493
rcv	23.06298828125	Α	6852	0	11493
rcv	23.06298828125	Α	6852	0	11493

```
23.06298828125 A
                         6852
                                     11493
                                 0
rcv
    23.06298828125 A
                         6852
                                 0
                                     11543
rcv
    23.06298828125
                    Α
                         6852
                                 0
                                      11593
    23.06298828125 A
                         6852
rcv
                                 0
                                     11643
    23.06298828125 A
                         6852
                                 0
                                     11747
rcv
snd 23.06298828125 F
                         11747
                                 0
                                     6852
    24.065185546875 FA
                         6853
                                 0
                                      11748
snd 27.07373046875 A
                         11748
                                 0
                                      6854
```

Amount of data transferred: 2704 bytes Number of data segments sent: 55

Number of packets dropped: 9

Number of retransmitted segments: 25 Number of duplicate acknowledgements: 25

4. 3b timeout=0.4

```
snd 5.025146484375 S
                        9792
                                0
                                    0
    6.017333984375
                    SA
                        7174
                                0
                                    9793
snd 7.02197265625
                    Α
                        9793
                                0
                                    7175
snd 10.026611328125 D
                        9793
                                    7175
                                50
snd 10.026611328125 D
                        9843
                                50
                                    7175
snd 11.0302734375
                    D
                        9893
                                50
                                   7175
snd 11.0302734375
                    D
                        9943
                                50
                                   7175
snd 11.0302734375
                        9993
                                   7175
                    D
                                50
                                   7175
snd 11.0302734375
                    D
                        10043
                                50
snd 11.0302734375
                    D
                        10093
                                50
                                   7175
snd 12.031982421875 D
                        10143
                                50
                                   7175
snd 12.031982421875 D
                        10193
                                   7175
                                50
snd 12.031982421875 D
                        10243
                                50
                                   7175
snd 12.031982421875 D
                        10293
                                50 7175
snd 12.031982421875 D
                        10343
                                50 7175
snd 13.03466796875
                        10393
                                   7175
                                50
snd 13.03466796875
                        10443
                                50 7175
                    D
snd 13.03466796875
                        10493
                                50
                                   7175
snd 13.03466796875
                    D
                        10543
                                50 7175
drop 13.03466796875
                        10593
                                   7175
                    D
                                50
drop 13.03466796875
                                   7175
                    D
                        10643
                                50
                        10693
                                   7175
snd 13.03466796875 D
                                50
snd 14.052978515625 D
                        10743
                                   7175
                                50
drop 14.052978515625 D
                        10793
                                50 7175
snd 14.052978515625 D
                        10843
                                50
                                   7175
snd 14.052978515625 D
                        10893
                                50 7175
drop 14.052978515625 D
                        10943
                                50
                                    7175
snd 14.052978515625 D
                        10993
                                50 7175
```

```
drop 15.061767578125 D
                         11043
                                  50 7175
snd 15.061767578125 D
                         11093
                                  50
                                     7175
snd 15.061767578125 D
                         11143
                                  50
                                     7175
snd 15.061767578125 D
                                  50
                                     7175
                         11193
snd 15.061767578125 D
                         11243
                                  50
                                     7175
snd 15.061767578125 D
                         11293
                                  50 7175
snd 16.042724609375 D
                                  50 7175
                         11343
snd 16.042724609375 D
                                  50 7175
                         11393
                                     7175
snd 16.042724609375 D
                         11443
                                  50
drop 16.042724609375 D
                         11493
                                  50
                                     7175
snd 16.042724609375 D
                         11543
                                  50
                                     7175
drop 16.042724609375 D
                                     7175
                         11593
                                  50
snd 17.056396484375 D
                         11643
                                  50
                                     7175
                                     7175
snd 17.566162109375 D
                         11693
                                  50
snd 17.566162109375 D
                         11743
                                  4
                                      7175
    17.566162109375 A
rcv
                         7175
                                  0
                                      9843
    17.566162109375 A
                         7175
                                  0
                                      9893
rcv
    17.566162109375 A
                         7175
                                  0
                                      9943
rcv
    17.566162109375 A
                         7175
                                  0
                                      9993
rcv
    17.566162109375 A
                         7175
                                  0
                                      10043
rcv
    17.566162109375 A
                         7175
                                  0
                                      10093
rcv
rcv
    17.566162109375 A
                         7175
                                  0
                                      10143
    17.566162109375 A
                         7175
                                  0
                                      10193
rcv
    17.566162109375 A
                         7175
                                      10243
                                  0
rcv
    17.566162109375 A
                         7175
                                  0
                                      10293
rcv
    18.06298828125 A
                         7175
                                  0
                                      10343
rcv
    18.06298828125 A
                         7175
                                  0
                                      10393
rcv
                    Α
                         7175
                                  0
rcv
    18.06298828125
                                      10443
    18.06298828125
                     Α
                         7175
                                  0
                                      10493
rcv
    18.06298828125
                    Α
                         7175
                                  0
                                      10543
rcv
    18.06298828125
                    Α
                         7175
                                  0
                                      10593
rcv
    18.06298828125
                         7175
                                  0
                                      10593
rcv
    18.06298828125 A
                         7175
                                  0
                                      10593
rcv
    18.06298828125
                         7175
                                  0
                                      10593
rcv
    18.06298828125
                    Α
                         7175
                                  0
                                      10593
rcv
    18.06298828125
                    Α
                         7175
                                  0
                                      10593
rcv
    18.06298828125
                         7175
                                      10593
                                  0
rcv
                         7175
    18.06298828125
                    Α
                                  0
                                      10593
rcv
    18.06298828125
                         7175
                                  0
                                      10593
rcv
    18.06298828125 A
                         7175
                                  0
                                      10593
rcv
rcv
    18.06298828125
                         7175
                                  0
                                      10593
    18.06298828125
                         7175
                                  0
                                      10593
rcv
    18.06298828125
                         7175
                                  0
                                      10593
rcv
    18.06298828125 A
                         7175
                                  0
                                      10593
```

```
18.06298828125
                         7175
                                      10593
                    Α
                                 0
rcv
    18.06298828125
                    Α
                         7175
                                 0
                                      10593
rcv
    18.06298828125
                     Α
                         7175
                                 0
                                      10593
rcv
    18.06298828125
                         7175
                                      10593
rcv
                                 0
snd 18.57177734375
                     D
                         10593
                                 50
                                     7175
snd 18.57177734375 D
                         10643
                                 50
                                     7175
snd 19.103759765625 D
                                     7175
                         10693
                                 50
snd 19.103759765625 D
                                     7175
                         10743
                                 50
   19.103759765625 D
snd
                         10793
                                 50
                                     7175
snd 19.605712890625 D
                         10843
                                 50
                                     7175
snd 19.605712890625 D
                         10893
                                 50
                                     7175
snd 20.104248046875 D
                                     7175
                         10943
                                 50
snd 20.104248046875 D
                         10993
                                 50
                                     7175
snd 20.104248046875 D
                                 50
                                     7175
                         11043
snd 20.607666015625 D
                         11093
                                 50 7175
snd
    20.607666015625 D
                         11143
                                 50
                                     7175
snd 20.607666015625 D
                         11193
                                 50 7175
snd 21.10986328125
                         11243
                                 50
                                     7175
snd 21.10986328125
                         11293
                                 50
                                     7175
                     D
snd 21.10986328125
                         11343
                                     7175
                     D
                                 50
drop 21.10986328125
                         11393
                                 50
                                     7175
snd 21.611572265625 D
                         11443
                                 50
                                     7175
snd 21.611572265625 D
                         11493
                                 50
                                     7175
snd 21.611572265625 D
                         11543
                                     7175
                                 50
snd 22.109130859375 D
                         11593
                                 50
                                     7175
snd 22.109130859375 D
                                 50
                                     7175
                         11643
snd 22.109130859375 D
                         11693
                                 50
                                     7175
drop 22.109130859375 D
                                      7175
                         11743
                                 4
    22.6123046875
                     Α
                         7175
                                 0
                                      10643
rcv
    22.6123046875
                     Α
                         7175
                                 0
                                      10693
rcv
    22.6123046875
                     Α
                         7175
                                 0
                                      10793
rcv
                         7175
                                      10793
    22.6123046875
                     Α
                                 0
rcv
    22.6123046875
                         7175
                                 0
                                      10843
                     Α
rcv
    22.6123046875
                         7175
                                 0
                                      10943
rcv
                     Α
    22.6123046875
                     Α
                         7175
                                 0
                                      10943
rcv
    22.6123046875
                     Α
                         7175
                                 0
                                      10993
rcv
                         7175
    22.6123046875
                     Α
                                 0
                                      11043
rcv
                         7175
    22.6123046875
                     Α
                                 0
                                      11093
rcv
    22.6123046875
                         7175
                                 0
                     Α
                                      11493
rcv
    22.6123046875
                     Α
                         7175
                                 0
                                      11493
rcv
rcv
    22.6123046875
                     Α
                         7175
                                 0
                                      11493
    22.6123046875
                     Α
                         7175
                                 0
                                      11493
rcv
    22.6123046875
                     Α
                         7175
                                 0
                                      11493
rcv
    22.6123046875
                         7175
                                 0
                     Α
                                      11493
```

```
22.6123046875
                          7175
                                       11493
                      Α
                                  0
rcv
    22.6123046875
                      Α
                          7175
                                  0
                                       11543
rcv
    22.6123046875
                      Α
                          7175
                                  0
                                       11593
    22.6123046875
                          7175
rcv
                      Α
                                  0
                                       11643
    22.6123046875
                      Α
                          7175
                                  0
                                       11747
rcv
snd 23.07470703125
                     F
                          11747
                                  0
                                       7175
    23.07470703125
                         7176
                                  0
                                       11748
                     FΑ
snd 24.583984375
                      Α
                          11748
                                  0
                                       7177
```

Amount of data transferred: 2704 bytes

Number of data segments sent: 55 Number of packets dropped: 9

Number of retransmitted segments: 25 Number of duplicate acknowledgements: 25

5. 3b timeout = 6.0

```
snd 5.984130859375 S
                        9792
                                 0
                                     0
    5.984130859375 SA
                        2629
                                 0
                                     9793
snd 16.177001953125 A
                        9793
                                 0
                                     2630
snd 18.163818359375 D
                        9793
                                     2630
                                 50
snd 18.163818359375 D
                        9843
                                     2630
                                 50
snd 18.163818359375 D
                        9893
                                 50
                                    2630
snd 19.1669921875
                    D
                        9943
                                 50
                                    2630
snd 19.1669921875
                        9993
                                    2630
                    D
                                 50
snd 19.1669921875
                    D
                        10043
                                 50
                                     2630
snd 19.1669921875
                    D
                        10093
                                 50
                                    2630
snd 19.1669921875
                    D
                        10143
                                 50
                                    2630
snd 19.1669921875
                        10193
                                    2630
                    D
                                 50
snd 20.16943359375
                    D
                        10243
                                 50
                                    2630
snd 20.16943359375
                        10293
                                 50
                                    2630
                    D
snd 20.16943359375
                    D
                        10343
                                 50
                                    2630
snd 20.16943359375
                        10393
                    D
                                 50
                                    2630
snd 20.16943359375
                        10443
                                    2630
                    D
                                 50
snd 20.16943359375
                         10493
                                     2630
                                 50
snd 21.172119140625 D
                        10543
                                 50
                                    2630
drop 21.172119140625 D
                        10593
                                    2630
                                 50
drop 21.172119140625 D
                                    2630
                        10643
                                 50
snd 21.172119140625 D
                        10693
                                 50
                                    2630
snd 21.172119140625 D
                                     2630
                        10743
                                 50
drop 21.172119140625 D
                        10793
                                 50
                                    2630
snd 21.172119140625 D
                        10843
                                 50
                                    2630
snd 21.172119140625 D
                        10893
                                 50
                                    2630
drop 21.172119140625 D
                         10943
                                 50
                                     2630
snd 21.172119140625 D
                        10993
                                    2630
                                 50
```

```
drop 21.172119140625 D
                                      2630
                          11043
                                  50
snd 22.175537109375 D
                          11093
                                  50
                                      2630
snd 22.175537109375 D
                          11143
                                  50
                                      2630
snd 22.175537109375 D
                                      2630
                          11193
                                  50
snd 22.175537109375 D
                          11243
                                  50
                                      2630
snd 22.175537109375 D
                          11293
                                  50
                                      2630
snd 22.175537109375 D
                          11343
                                  50
                                      2630
snd 23.177734375
                     D
                          11393
                                  50
                                      2630
snd 23.177734375
                     D
                          11443
                                  50
                                      2630
drop 23.177734375
                     D
                          11493
                                  50
                                      2630
snd 23.177734375
                     D
                          11543
                                  50
                                      2630
drop 23.177734375
                     D
                          11593
                                  50
                                      2630
snd 23.177734375
                     D
                          11643
                                  50
                                      2630
snd 23.177734375
                          11693
                                  50
                                      2630
                     D
snd 23.177734375
                     D
                          11743
                                  4
                                      2630
rcv
    24.181396484375 A
                          2630
                                  0
                                      9843
    24.181396484375 A
                          2630
                                  0
                                      9893
rcv
    24.181396484375 A
                          2630
                                  0
                                      9943
rcv
    24.181396484375 A
                          2630
                                  0
                                      9993
rcv
    24.181396484375 A
                                  0
                                      10043
                          2630
rcv
    24.181396484375 A
                          2630
                                  0
                                      10093
rcv
rcv
    24.181396484375 A
                          2630
                                  0
                                      10143
    24.181396484375 A
                          2630
                                  0
                                      10193
rcv
    24.181396484375 A
                                      10243
                          2630
                                  0
rcv
    24.181396484375 A
                          2630
                                  0
                                      10293
rcv
    24.181396484375 A
                          2630
                                  0
                                      10343
rcv
    24.181396484375 A
                          2630
                                  0
                                      10393
rcv
    24.181396484375 A
                                  0
rcv
                          2630
                                      10443
    24.181396484375 A
                          2630
                                  0
                                      10493
rcv
    24.181396484375 A
                          2630
                                  0
                                      10543
rcv
    24.181396484375 A
                          2630
                                  0
                                      10593
rcv
    24.181396484375 A
                          2630
                                  0
                                      10593
rcv
    24.181396484375 A
                                  0
                                      10593
                          2630
rcv
    24.181396484375 A
                          2630
                                  0
                                      10593
rcv
    24.181396484375 A
                          2630
                                  0
                                      10593
rcv
    24.181396484375 A
                                  0
                                      10593
                          2630
rcv
    24.181396484375 A
                                      10593
                          2630
                                  0
rcv
    24.181396484375 A
                          2630
                                  0
                                      10593
rcv
    24.181396484375 A
                                  0
                          2630
                                      10593
rcv
    24.181396484375 A
                          2630
                                  0
                                      10593
rcv
rcv
    24.181396484375 A
                          2630
                                  0
                                      10593
    24.181396484375 A
                          2630
                                  0
                                      10593
rcv
    24.181396484375 A
                          2630
                                  0
                                      10593
rcv
    24.181396484375 A
                                  0
                          2630
                                      10593
```

```
24.181396484375 A
                                      10593
                         2630
                                  0
rcv
    24.181396484375 A
                         2630
                                  0
                                      10593
rcv
    24.181396484375 A
                         2630
                                  0
                                      10593
    24.181396484375 A
                                      10593
rcv
                         2630
                                  0
snd 24.181396484375 D
                         10593
                                  50
                                      2630
snd 24.181396484375 D
                         10643
                                  50
                                      2630
snd 25.18115234375 D
                         10693
                                  50
                                      2630
snd 25.18115234375
                     D
                         10743
                                  50
                                      2630
snd 25.18115234375
                         10793
                                  50
                                      2630
snd 25.18115234375
                     D
                         10843
                                  50
                                      2630
snd 25.18115234375
                     D
                         10893
                                  50
                                      2630
snd 25.18115234375
                         10943
                     D
                                  50 2630
snd 26.18359375 D
                     10993
                              50
                                  2630
snd 26.18359375 D
                     11043
                              50
                                  2630
snd 26.18359375 D
                     11093
                              50
                                  2630
snd 26.18359375 D
                     11143
                              50
                                  2630
snd 27.18798828125
                     D
                         11193
                                  50
                                      2630
snd 27.18798828125
                     D
                         11243
                                  50
                                      2630
snd 27.18798828125
                         11293
                                  50
                                      2630
                     D
snd 27.18798828125
                         11343
                                      2630
                     D
                                  50
drop 27.18798828125
                         11393
                                      2630
                     D
                                  50
snd 28.1904296875
                     D
                         11443
                                  50
                                      2630
snd 28.1904296875
                     D
                         11493
                                  50
                                      2630
snd 28.1904296875
                         11543
                                      2630
                     D
                                  50
snd 28.1904296875
                     D
                         11593
                                  50
                                      2630
snd 28.1904296875
                                  50
                                      2630
                     D
                         11643
snd 28.1904296875
                     D
                         11693
                                  50
                                      2630
                                      2630
drop 28.1904296875
                     D
                         11743
                                  4
    28.1904296875
                     Α
                         2630
                                  0
                                      10643
rcv
    28.1904296875
                     Α
                         2630
                                  0
                                      10693
rcv
    29.191650390625 A
                         2630
                                  0
                                      10793
rcv
    29.191650390625 A
                         2630
                                  0
                                      10793
rcv
    29.191650390625 A
                                  0
                                      10843
                         2630
rcv
    29.191650390625 A
                         2630
                                  0
                                      10943
rcv
    29.191650390625 A
                         2630
                                  0
                                      10943
rcv
    29.191650390625 A
                                  0
                                      10993
                         2630
rcv
    29.191650390625 A
                         2630
                                  0
                                      11043
rcv
    29.191650390625 A
                         2630
                                  0
                                      11093
rcv
    29.191650390625 A
                         2630
                                  0
                                      11493
rcv
    29.191650390625 A
                                  0
                                      11493
rcv
                         2630
rcv
    29.191650390625 A
                         2630
                                  0
                                      11493
    29.191650390625 A
                         2630
                                  0
                                      11493
rcv
    29.191650390625 A
                         2630
                                  0
                                      11493
rcv
    29.191650390625 A
                                  0
                         2630
                                      11493
```

```
29.191650390625 A
                        2630
                                    11493
                                0
rcv
    29.191650390625 A
                        2630
                                0
                                    11543
rcv
    29.191650390625 A
                        2630
                                0
                                    11593
rcv
   29.191650390625 A
                        2630
                                0
                                    11643
rcv
    29.191650390625 A
                        2630
                                    11747
                                0
rcv
snd 29.191650390625 F
                        11747
                                0
                                    2630
    29.191650390625 FA 2631
                                0
                                    11748
snd 31.19677734375 A
                        11748
                                0
                                    2632
```

Amount of data transferred: 2704 bytes Number of data segments sent: 55 Number of packets dropped: 9

Number of retransmitted segments: 25 Number of duplicate acknowledgements: 25