

## Report by Joshua Goodman z5117211

Written in python (python3 used)

### 1) How I implemented the STP protocol

| <u>Sender</u>  | <u>Receiver</u>                                     |
|--|---|
| Three way Handshake (syn synAck ack)   | Three way handshake (syn synAck ack)                |
| Four seg termination (fin ack fin ack)(sender initiated)                                       | Four seg termination (fin ack fin ack)              |
| Single timer for timeout operations (and respective RTO calculations)                          | Cummulative acknowledgments                         |
| PLD module   | Buffer out of order packets                         |
| Timeout retransmissions  | Handle corrupted packets (with checksum)            |
| Fast retransmit  | Handle duplicate packets                            |
| MWS sliding window (multiple segments being sent and received at once (thread implementation)) | Immediate acknowledgment (not delayed as per specs) |
| STP header with needed fields (explained bellow)   |   |

As far as I am aware all the needed features have been successfully implemented.

My STP works by having 2 clients (i.e the sender file and receiver file).

Within the sender file is three classes, PLD, Packet and Sender as well as a 'main' function. These classes hold all the useful and relevant implementation for their specific areas. Initially all the variables needed are initialised as well as a main sender and pld class. The main establishes a connection with the receiver by initiating and completing the 'three way handshake'. At the end of this process it starts three different threads, a sending thread, a receiving thread, and a thread that handles any delayed or re-ordered packets. The main while loop essentially acts as the fourth 'thread' that handles most of the processing. I thought this would be the fastest and easiest way to make sure no packets were lost.

The sender thread/loop is constantly trying to send the next possible packet. A packet is possible to be sent if the number unacknowledged is smaller than the window size. If it is, then the necessary payload is grabbed (through the sender function that grabs the necessary bites (max MSS) from the sendfile that had previously been staged), the packet is staged for sending and then pushed through the pld module. If it passes through the pld module without anything happening it is successfully sent and it goes back to the beginning of the loop. Otherwise the specific pld error is caused. **Note, whilst the pld module is integrated into main and sender, it uses no information from the sender, i.e it is completely independent of the sender as specified in the specs and could essentially be separated into its own file if needed.**

The receiving thread/loop is constantly trying to receive data using the timeout (RTO) estimation, by setting the socket.settimeout to the RTO value. If at any point a timeout occurs, an exception is

chucked and handled by retransmitting the oldest unacknowledged packet. This packet is re-sent through the pld module within the receiving loop. If a packet is timed-out and re-sent it is flagged as being unable to be used to calculate RTO. If a packet is successfully received it is appended to a queue, which is handled by the main function.

The last thread is used to handle any delayed or re-ordered packets. Any packet that is delayed or re-ordered is flagged by the system. For Delayed packets, it is sent to a deque, and the thread constantly pops the packets in the deque, and calculates if it is time to send them. If it is, it is sent immediately, and if not it is added to the back of the deque. The re-ordered packet is constantly checked to determine if the maxOrder count has been reached (this count is a global count incremented everytime a packet is sent), and when it is reached the re-ordered packet is sent, and a flag is signalled to tell the system that a new packet is now allowed to be re-ordered (count is set back to zero).

The 'main' function is used to do the calculations for the sequence number and acknowledgment received and compare it to the acknowledgment expected. Every loop it pops a packet of the received queue (if it isn't empty), and does the needed calculations for timeout (if applicable)(min timeout value set to 145ms as per the RFC6298 recommendation), cumulative ack calculation if the ack is greater than sendbase(to decrement number unacknowledged for the sender thread to have max packets (equal to window size)), and also checks if all the data has been successfully sent and acked, so it can start the finishing sequence. If the ack is equal to the sendbase, then the fast retransmission counter is incremented, and if it equals three then the send base packet is retransmitted (pending pld)(fast retransmission count is set back to zero if a timeout occurs). Once all the data has been received the finishing sequence is initiated (fin, ack, fin, ack).

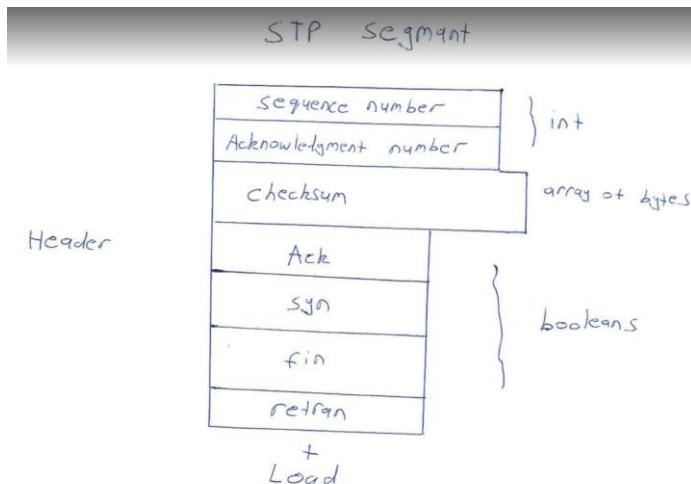
The receiver on the other hand runs with one thread and a main function. The thread is extremely simple, only waiting for a packet to arrive and then adding it to a Deque for the main function to deal with. The main function initialises all the needed variables and then completes the 3 way handshake with the sender. A packet is popped of the Deque if it is not empty and handled in the following way (the next steps are all run as elif statements i.e only 1 will occur). First, if the data is corrupted (checked in comparison with the checksum) it is discarded without sending any ack. Next, if the expected Sequence number is received, the data is immediately appended to the copy file, and the necessary stats, counters and expected numbers are incremented. During this step, if the buffer is not empty (buffer holding packets that were received out of order) the receiver attempts to clear the buffer by checking if the next expected packet is in the buffer, and if it is, its payload is appended and the necessary stats are updated. This loop continues until the buffer is cleared, or the next expected packet is not in the buffer. The cumulative ack (or regular ack if nothing was found in the buffer) is now sent for the next expected packet (this is an immediate ack).

Next, the packet is checked to see if it contains a fin flag, and if so the finishing sequence is initiated. Next, the packet is checked to see if it is a duplicate packet. This is needed because otherwise duplicate packets would be added to the buffer, and also so the log file will be accurate. Lastly, if nothing has run then the else statement is activated, i.e this should only happen when a packet has arrived out of order ( a packet arrives with seqNum > expectedSeqNum). A dupe ack is sent (with expectedSeqNum as ackNum) and the out of order packet is added to the buffer (this buffer is handled when an expected seqNum is received).

Through all the steps there are multiple flags that tell both the receiver and Sender what stage of the process they are in. For the Sender these include, noConnection, synSent, connected, finSent, connectionFinished. For the Receiver noConnection, synSent, connected, fin, connectionFinished.

These steps from both the sender and receiver make sure that the packet is reliably received in the shortest possible steps.

## 2) STP Header



- Sequence Number (int) – the byte stream number (from the send sendfile) of the first byte in the packets load
- Acknowledgement number (int) – the next expected byte (sequence number)
- Checksum (array of bytes) – Used to check the data hasn't been corrupted
- Ack (boolean) – Shows if the packet is an Acknowledgment
- Syn (boolean) – shows if the packet is a synchronise packet (for the initial three way handshake)
- Fin (boolean) – shows if the packet is for connection termination (a finishing segment (part of four way finish))
- Retran (boolean) – shows if the packet is a retransmission (i.e has previously timed out or been fast retransmitted)

## 3) Trade offs considered and Made, extensions

In my Sender file I decided to make several different threads, instead of just having one thread. Due to concurrency issues this occasionally increments different counters at the same time, or in a slightly different order. However I feel like the speed and ability to have the sending function and receiving function operating concurrently outweighs other issues that can sometimes be caused (any issues are still correctly handled).

For my PLD module, as discussed above it is not held in a separate file, but rather is run just before any packet (bar packets already delayed and re-ordered) are about to be sent. This is ok when run by the sending thread, however it means that the receiving thread (and main thread for fast retransmit)

becomes a fair bit slower when an exception occurs (or three dup ack's) and it then has to run the pld module before retransmitting. Whilst it is running this pld module it cannot receive other packets causing the system to slow down. To improve this I would completely separate the pld module from the sender, sending any packet to be sent to the receiver to the pld, who would then have the responsibility of on-sending it to the receiver address if no errors occurred (or creating the error if needed). However this would only improve the speed of the sender, and not in any way affect the implementation (i.e it is simple refactoring).

For the timeout calculation I believe that the single timer per window method for RTT calculations and thus RTO calculation are not very accurate or responsive, and a better method would be to track each packet sent and calculate RTT and RTO every time a packet is successfully received without retransmission or errors. To improve this I would have a deque keeping track of all the send times per packet, and calculate the RTO on each successful return.

On the Receiver side, I have to look through the buffer and constantly pop packets of the deque to figure out if it is the needed packet, and if not then I append it back on to the deque and check the next packet until I am back at the beginning. I feel an extension would be if I created an ordered buffer, which when adding packets would automatically make sure that the buffer was ordered by sequence numbers, so that popping the correct packet off would be easier.

#### **4) Snippets borrowed**

<https://pymotw.com/2/socket/udp.html> used for implementing my socket code (sending, receiving)

Code snippets for receiving ack from the class textbook (page 248 chapter 3)

Python3 docs examples

<https://stackoverflow.com/> (small snippets on specific queries)

Less than 1% of my code would have been taken from open resources (probably less)

### **Part 5**

a)

Startup, 1, 101, 301, 401, 501, 601, 201, 701, 801, 901, 1001, 1101, 1201, 1301, 1401, 1501, 1601, 1701, 1801, 1901, 2101, 2201, 2302, 2401, 2001, 2501, 2601, 2901, 3001, 2701, 29801, fin received

For a pDrop of 0.1, dropping occurred at packet 201, 2001, 2701 and 2801. As seen in the appendix, for the first dropped packet at the receiver, packet 301, 401, 501 and 601 are all received before 201 is received. This makes sense as three dup ack's are sent (401, 501, 601 all send ack 201) causing 201 to be retransmitted and the normal sequence to resume. At the end packet 2701 and 2801 are dropped back to back, and because there is not enough data being sent to cause a fast retransmit, a timeout occurs and both packets are re-sent.

For a pDrop of 0.3 way more packets are dropped (24) causing a much more disordered package arrival at the receiver (see appendix). It is critical to note that in the second experiment much more timeouts occurred compared to fast retransmits, and this is because too many packets were being lost (dropped) that the receiver often did not have a chance to even send three ack's before the timeout occurred.

b)

| Gamma | Total Packets Transmitted | Time taken to Transmit (mn) |
|-------|---------------------------|-----------------------------|
| 2     | 12508                     | 106                         |
| 4     | 12446                     | 168                         |
| 6     | 12450                     | 239                         |

As seen in the table above, it takes longer to run the simulation as gamma increases. This is due to the timeout interval being larger as gamma increases ( $RTO = estRTT + \gamma * devRTT$ ), causing dropped packets (the main cause of error from pld in this situation) to be picked up much slower. However, less packets are needed to be sent as gamma increases, because delayed packets are acknowledged in time to avoid a timeout (bigger gamma = longer timeout (RTO)). This explains the difference between gamma 2 and 4. However gamma 4 and 6 are roughly equal in terms of packets sent, as clearly a gamma of 4 is sufficient to pick up the majority of packets that have been delayed and not dropped.

c)

The file has been successfully transferred. The transfer took 26 minutes.

Duplicated segments do not cause much stress time wise on the receiver. Similarly, in the majority of cases, re-ordering with a maxOrder of 4 will cause a fast retransmit and also not cause much stress timewise on either the sender or the receiver. Since there was 700 more dropped packets than corrupted packets, and the fact that both are handled similarly by the receiver (i.e the receiver doesn't send an Ack for either case, for dropped packets it doesn't know anything came, and for corrupted packets it discards it), I believe that dropped packets was the single biggest contributing factor for transfer time.

## Appendix

### a) Sender log file (pDrop 0.1)

|    |   |                       |      |      |     |      |
|----|---|-----------------------|------|------|-----|------|
| 1  | snd   | 0                     | S    | 0    | 0   | 0    |
| 2  | rcv   | 0.0017731189727783203 | SA   | 0    | 0   | 1    |
| 3  | snd   | 0.0029916763390564062 | A    | 1    | 0   | 1    |
| 4  | snd   | 0.02014946937561035   | D    | 1    | 100 | 1    |
| 5  | snd   | 0.02581620216369629   | D    | 101  | 100 | 1    |
| 6  | rcv   | 0.0317535400390625    | A    | 1    | 0   | 101  |
| 7  | drop  | 0.03772735595703125   | D    | 201  | 100 | 2    |
| 8  | rcv   | 0.0758674144744873    | A    | 2    | 0   | 201  |
| 9  | snd   | 0.08642911911018742   | D    | 301  | 100 | 3    |
| 10 | rcv/DA                                      | 0.09734725952148438   | A    | 2    | 0   | 201  |
| 11 | snd   | 0.1131134033203125    | D    | 401  | 100 | 3    |
| 12 | rcv/DA                                      | 0.12389993667602539   | A    | 2    | 0   | 201  |
| 13 | snd   | 0.129206527633667     | D    | 501  | 100 | 3    |
| 14 | snd   | 0.14035415649414062   | D    | 601  | 100 | 3    |
| 15 | rcv/DA                                      | 0.14053916931152344   | A    | 2    | 0   | 201  |
| 16 | snd/RXTF                                    | 0.16689252853393555   | D    | 201  | 100 | 0    |
| 17 | rcv/DA                                      | 0.2373490333557129    | A    | 2    | 0   | 201  |
| 18 | rcv   | 0.2898995876312256    | A    | 7    | 0   | 701  |
| 19 | snd   | 0.36176514625549316   | D    | 701  | 100 | 8    |
| 20 | rcv   | 0.3942553997039795    | A    | 8    | 0   | 801  |
| 21 | snd   | 0.39974164962768555   | D    | 801  | 100 | 9    |
| 22 | snd   | 0.42092370986938477   | D    | 901  | 100 | 9    |
| 23 | rcv   | 0.42144107818603516   | A    | 9    | 0   | 901  |
| 24 | snd   | 0.4319992179870605    | D    | 1001 | 100 | 10   |
| 25 | rcv   | 0.43810081401933594   | A    | 10   | 0   | 1001 |
| 26 | snd   | 0.4436147212982178    | D    | 1101 | 100 | 11   |
| 27 | rcv   | 0.4490787982940674    | A    | 11   | 0   | 1101 |
| 28 | snd   | 0.48008275032043457   | D    | 1201 | 100 | 12   |
| 29 | rcv   | 0.4801661968231201    | A    | 12   | 0   | 1201 |
| 30 | snd   | 0.49117588969887207   | D    | 1301 | 100 | 13   |
| 31 | rcv   | 0.49661898612976074   | A    | 13   | 0   | 1301 |
| 32 | snd   | 0.5281345844268799    | D    | 1401 | 100 | 15   |
| 33 | rcv   | 0.5280613899230957    | A    | 14   | 0   | 1401 |
| 34 | snd   | 0.5442378520965576    | D    | 1501 | 100 | 15   |
| 35 | rcv   | 0.5496985912322998    | A    | 15   | 0   | 1501 |
| 36 | snd   | 0.5602138042449951    | D    | 1601 | 100 | 16   |
| 37 | rcv   | 0.5658931732177734    | A    | 16   | 0   | 1601 |
| 38 | snd   | 0.5714633464813232    | D    | 1701 | 100 | 17   |
| 39 | rcv   | 0.5772922639031902    | A    | 17   | 0   | 1701 |
| 40 | snd   | 0.5981624126434326    | D    | 1801 | 100 | 18   |
| 41 | rcv   | 0.5983145236968994    | A    | 18   | 0   | 1801 |
| 42 | snd   | 0.614210844039917     | D    | 1901 | 100 | 19   |
| 43 | rcv   | 0.6196174621582031    | A    | 19   | 0   | 1901 |
| 44 | drop  | 0.6303627490997314    | D    | 2001 | 100 | 20   |
| 45 | rcv   | 0.6357152462005615    | A    | 20   | 0   | 2001 |
| 46 | snd   | 0.6414048671722412    | D    | 2101 | 100 | 21   |
| 47 | snd   | 0.6524896621704102    | D    | 2201 | 100 | 21   |
| 48 | rcv/DA                                      | 0.6579568386077881    | A    | 20   | 0   | 2001 |
| 49 | rcv/DA                                      | 0.6738440990447998    | A    | 20   | 0   | 2001 |
| 50 | snd   | 0.679288387298584     | D    | 2301 | 100 | 21   |
| 51 | rcv/DA                                      | 0.7006049156188965    | A    | 20   | 0   | 2001 |
| 52 | snd   | 0.7007827758789062    | D    | 2401 | 100 | 21   |
| 53 | snd/RXTF                                    | 0.7168211936950604    | D    | 2001 | 100 | 0    |
| 54 | rcv/DA                                      | 0.7358167171478271    | A    | 20   | 0   | 2001 |
| 55 | rcv   | 0.7801461219787598    | A    | 25   | 0   | 2501 |
| 56 | snd   | 0.8258426189422607    | D    | 2501 | 100 | 26   |
| 57 | rcv   | 0.8383224810467529    | A    | 26   | 0   | 2601 |
| 58 | snd   | 0.8438758850097656    | D    | 2601 | 100 | 27   |
| 59 | rcv   | 0.8800511360168457    | A    | 27   | 0   | 2701 |
| 60 | drop  | 0.8801229000091553    | D    | 2701 | 100 | 28   |
| 61 | drop  | 0.9063458442687988    | D    | 2801 | 100 | 28   |
| 62 | snd   | 0.9785535335540771    | D    | 2901 | 100 | 28   |
| 63 | rcv/DA                                      | 0.9892916679302324    | A    | 27   | 0   | 2701 |
| 64 | snd   | 0.9895672798156738    | D    | 3001 | 28  | 28   |
| 65 | rcv/DA                                      | 1.0008718967437744    | A    | 27   | 0   | 2701 |
| 66 | snd/RXTT                                    | 1.9059126377105713    | D    | 2701 | 100 | 0    |
| 67 | rcv   | 1.917388916015625     | A    | 28   | 0   | 2801 |
| 68 | snd/RXTT                                    | 2.8219088445739746    | D    | 2801 | 100 | 0    |
| 69 | rcv   | 2.8537375926971436    | A    | 31   | 0   | 3029 |
| 70 | snd   | 2.8648550510406494    | F    | 3029 | 0   | 32   |
| 71 | rcv   | 2.9659812450408936    | A    | 31   | 0   | 3029 |
| 72 | rcv   | 2.9720206260681152    | F    | 32   | 0   | 3030 |
| 73 | snd   | 2.9732019901275635    | A    | 3029 | 0   | 33   |
| 74 |   |                       |      |      |     |      |
| 75 | Size of the file (in Bytes)                 |                       | 3028 |      |     |      |
| 76 | Segments transmitted (including drop & RXT) |                       | 39   |      |     |      |
| 77 | Number of Segments handled by PLD           |                       | 35   |      |     |      |
| 78 | Number of Segments dropped                  |                       | 4    |      |     |      |
| 79 | Number of Segments Corrupted                |                       | 0    |      |     |      |
| 80 | Number of Segments Re-ordered               |                       | 0    |      |     |      |
| 81 | Number of Segments Duplicated               |                       | 0    |      |     |      |
| 82 | Number of Segments Delayed                  |                       | 0    |      |     |      |
| 83 | Number of Retransmissions due to TIMEOUT    |                       | 2    |      |     |      |
| 84 | Number of FAST RETRANSMISSION               |                       | 2    |      |     |      |
| 85 | Number of DUP ACKS received                 |                       | 10   |      |     |      |

## Receiver log File (pDrop 0.1)

|    |                                    |                       |                     |      |     |    |      |
|----|------------------------------------|-----------------------|---------------------|------|-----|----|------|
| 1  | rcv                                | 0                     | 0015282638920410156 | S    | 0   | 0  | 0    |
| 2  | snd                                | 0.0015282638920410156 | SA                  | 0    | 0   | 1  | 1    |
| 3  | rcv                                | 0.0027265548706054688 | A                   | 0    | 0   | 1  | 1    |
| 4  | rcv                                | 0.02522897720336914   | D                   | 1    | 100 | 1  | 1    |
| 5  | snd                                | 0.02941441535949707   | A                   | 1    | 0   | 1  | 101  |
| 6  | rcv                                | 0.030447721481323242  | D                   | 101  | 100 | 1  | 1    |
| 7  | snd                                | 0.03276705741882324   | A                   | 2    | 0   | 0  | 201  |
| 8  | rcv                                | 0.08675765991210938   | D                   | 301  | 100 | 3  | 100  |
| 9  | snd/DA                             | 0.08767414093017578   | A                   | 2    | 0   | 2  | 201  |
| 10 | rcv                                | 0.11315608024597168   | D                   | 401  | 100 | 3  | 3    |
| 11 | snd/DA                             | 0.11392641067504883   | A                   | 2    | 0   | 0  | 201  |
| 12 | rcv                                | 0.13424062728881836   | D                   | 501  | 100 | 3  | 3    |
| 13 | snd/DA                             | 0.13508499725341797   | A                   | 2    | 0   | 2  | 201  |
| 14 | rcv                                | 0.1454768180847168    | D                   | 601  | 100 | 3  | 3    |
| 15 | snd/DA                             | 0.1462407112121582    | A                   | 2    | 0   | 0  | 201  |
| 16 | rcv                                | 0.17185211181640625   | D                   | 201  | 100 | 0  | 0    |
| 17 | snd                                | 0.17547321319580078   | A                   | 7    | 0   | 7  | 701  |
| 18 | rcv                                | 0.36679720878601074   | D                   | 701  | 100 | 8  | 801  |
| 19 | snd                                | 0.36834216117858887   | A                   | 8    | 0   | 8  | 801  |
| 20 | rcv                                | 0.4046897888183594    | D                   | 801  | 100 | 9  | 901  |
| 21 | snd                                | 0.40612316131591797   | A                   | 9    | 0   | 9  | 901  |
| 22 | rcv                                | 0.426027059550537     | D                   | 901  | 100 | 9  | 9    |
| 23 | snd                                | 0.427487850189209     | A                   | 10   | 0   | 0  | 1001 |
| 24 | rcv                                | 0.4281914234161377    | D                   | 1001 | 100 | 10 | 10   |
| 25 | snd                                | 0.42963432265686035   | A                   | 11   | 0   | 11 | 1101 |
| 26 | rcv                                | 0.44859886169433594   | D                   | 1101 | 100 | 11 | 11   |
| 27 | snd                                | 0.4499826431274414    | A                   | 12   | 0   | 0  | 1201 |
| 28 | rcv                                | 0.48017001152038574   | D                   | 1201 | 100 | 12 | 12   |
| 29 | snd                                | 0.48186254501342773   | A                   | 13   | 0   | 13 | 1301 |
| 30 | rcv                                | 0.4961371421813965    | D                   | 1301 | 100 | 13 | 13   |
| 31 | snd                                | 0.49753260612487793   | A                   | 14   | 0   | 0  | 1401 |
| 32 | rcv                                | 0.5333468914031982    | D                   | 1401 | 100 | 14 | 14   |
| 33 | snd                                | 0.534764289855957     | A                   | 15   | 0   | 15 | 1501 |
| 34 | rcv                                | 0.5492541790080545    | D                   | 1501 | 100 | 15 | 15   |
| 35 | snd                                | 0.5506632328033447    | A                   | 16   | 0   | 0  | 1601 |
| 36 | rcv                                | 0.5653369426727295    | D                   | 1601 | 100 | 16 | 16   |
| 37 | snd                                | 0.5667593479156494    | A                   | 17   | 0   | 17 | 1701 |
| 38 | rcv                                | 0.5764153003692627    | D                   | 1701 | 100 | 17 | 17   |
| 39 | snd                                | 0.5779342651367188    | A                   | 18   | 0   | 0  | 1801 |
| 40 | rcv                                | 0.5980606079101562    | D                   | 1801 | 100 | 18 | 18   |
| 41 | snd                                | 0.5996189117431641    | A                   | 19   | 0   | 19 | 1901 |
| 42 | rcv                                | 0.6193215847015301    | D                   | 1901 | 100 | 19 | 19   |
| 43 | snd                                | 0.6206576824188232    | A                   | 20   | 0   | 0  | 2001 |
| 44 | rcv                                | 0.6464526653289795    | D                   | 2101 | 100 | 21 | 21   |
| 45 | snd/DA                             | 0.6471583843231201    | A                   | 20   | 0   | 0  | 2001 |
|    |                                    |                       |                     |      |     |    |      |
| 46 | rcv                                | 0.6574914455413818    | D                   | 2201 | 100 | 21 | 21   |
| 47 | snd/DA                             | 0.6582129001617432    | A                   | 20   | 0   | 0  | 2001 |
| 48 | rcv                                | 0.6842374801635742    | D                   | 2301 | 100 | 21 | 21   |
| 49 | snd/DA                             | 0.6852447986602783    | A                   | 20   | 0   | 0  | 2001 |
| 50 | rcv                                | 0.7059037685394287    | D                   | 2401 | 100 | 21 | 21   |
| 51 | snd/DA                             | 0.7067763805389404    | A                   | 20   | 0   | 0  | 2001 |
| 52 | rcv                                | 0.7217879295349121    | D                   | 2001 | 100 | 0  | 0    |
| 53 | snd                                | 0.7254538536071777    | A                   | 25   | 0   | 0  | 2501 |
| 54 | rcv                                | 0.8309977054595947    | D                   | 2501 | 100 | 26 | 26   |
| 55 | snd                                | 0.832679033279419     | A                   | 26   | 0   | 26 | 2601 |
| 56 | rcv                                | 0.8488137722015301    | D                   | 2601 | 100 | 27 | 27   |
| 57 | snd                                | 0.8501412868499756    | A                   | 27   | 0   | 0  | 2701 |
| 58 | rcv                                | 0.9837250789533691    | D                   | 2901 | 100 | 28 | 28   |
| 59 | snd/DA                             | 0.984576940536499     | A                   | 27   | 0   | 27 | 2701 |
| 60 | rcv                                | 0.9945318698883057    | D                   | 3001 | 28  | 28 | 28   |
| 61 | snd/DA                             | 0.9952571392059326    | A                   | 27   | 0   | 0  | 2701 |
| 62 | rcv                                | 1.9109258651733398    | D                   | 2701 | 100 | 0  | 0    |
| 63 | snd                                | 1.9127628803253174    | A                   | 28   | 0   | 28 | 2801 |
| 64 | rcv                                | 2.8269145488739014    | D                   | 2801 | 100 | 0  | 0    |
| 65 | snd                                | 2.8298354148864746    | A                   | 31   | 0   | 0  | 3029 |
| 66 | rcv                                | 2.87080803623962402   | F                   | 3029 | 0   | 0  | 32   |
| 67 | snd                                | 2.870830774307251     | A                   | 32   | 0   | 0  | 3030 |
| 68 | snd                                | 2.9720866600145264    | F                   | 32   | 0   | 0  | 3030 |
| 69 | rcv                                | 2.974546432495117     | A                   | 33   | 0   | 0  | 3029 |
| 70 |                                    |                       |                     |      |     |    |      |
| 71 | Amount of data received (in Bytes) |                       |                     | 3028 |     |    |      |
| 72 | Total segments received            |                       |                     | 35   |     |    |      |
| 73 | Data segments received             |                       |                     | 31   |     |    |      |
| 74 | Data segments with Bit Errors      |                       |                     | 0    |     |    |      |
| 75 | Duplicate data segments received   |                       |                     | 0    |     |    |      |
| 76 | Duplicate ACKs sent                |                       |                     | 10   |     |    |      |

# Sender Log File (pDrop 0.3)

|     |   |    |                       |      |      |     |      |
|-----|---|----|-----------------------|------|------|-----|------|
| 1   | snd   | 0  | 0.0018813610076904297 | S    | 0    | 0   | 0    |
| 2   | rcv   | 0  | 0.003321380615234375  | SA   | 0    | 0   | 1    |
| 3   | snd   | 0  | 0.003321380615234375  | A    | 1    | 0   | 1    |
| 4   | drop  | 0  | 0.010326862335205078  | D    | 1    | 100 | 1    |
| 5   | snd   | 0  | 0.011689424514770588  | D    | 101  | 100 | 1    |
| 6   | snd   | 0  | 0.01729106903076172   | D    | 201  | 100 | 1    |
| 7   | snd   | 0  | 0.035938262939453125  | D    | 301  | 100 | 1    |
| 8   | drop  | 0  | 0.04201245307522363   | D    | 401  | 100 | 1    |
| 9   | rcv/DA                                      | 0  | 0.036624908447265625  | A    | 0    | 0   | 1    |
| 10  | rcv/DA                                      | 0  | 0.06206526293029705   | A    | 0    | 0   | 1    |
| 11  | rcv/DA                                      | 0  | 0.07298755645751953   | A    | 0    | 0   | 1    |
| 12  | FRdrop                                      | 0  | 0.0839226245880127    | D    | 1    | 100 | 1    |
| 13  | drop  | 1  | 1.5768487453460093    | D    | 1    | 100 | 1    |
| 14  | snd/RXTT                                    | 3  | 1.1985364060164062    | D    | 1    | 100 | 0    |
| 15  | rcv   | 3  | 1.58320903778076      | A    | 4    | 0   | 401  |
| 16  | snd   | 3  | 1.2076613903045654    | D    | 501  | 100 | 5    |
| 17  | rcv/DA                                      | 3  | 1.2242026233673096    | A    | 4    | 0   | 401  |
| 18  | drop  | 3  | 1.2499916553497314    | D    | 601  | 100 | 5    |
| 19  | drop  | 3  | 1.2967889308929443    | D    | 701  | 100 | 5    |
| 20  | snd   | 3  | 1.36364483833313      | D    | 801  | 100 | 5    |
| 21  | rcv/DA                                      | 3  | 1.3996846675872803    | A    | 4    | 0   | 401  |
| 22  | snd/RXTT                                    | 4  | 1.4893354177474976    | D    | 401  | 100 | 0    |
| 23  | rcv   | 4  | 1.4901411714553833    | A    | 6    | 0   | 601  |
| 24  | drop  | 4  | 1.4986024618148804    | D    | 901  | 100 | 7    |
| 25  | snd   | 5  | 1.5009599060050559    | D    | 1001 | 100 | 0    |
| 26  | rcv/DA                                      | 5  | 1.5087104429160701    | A    | 6    | 0   | 701  |
| 27  | snd/RXTT                                    | 6  | 1.590274333953857     | D    | 601  | 100 | 0    |
| 28  | rcv   | 6  | 1.622171878014697     | A    | 7    | 0   | 701  |
| 29  | snd   | 6  | 1.668028010559082     | D    | 1101 | 100 | 0    |
| 30  | rcv/DA                                      | 6  | 1.694713354110718     | A    | 7    | 0   | 701  |
| 31  | snd/RXTT                                    | 8  | 1.206872463226318     | D    | 701  | 100 | 0    |
| 32  | rcv   | 8  | 1.294037018908691     | A    | 9    | 0   | 901  |
| 33  | snd   | 8  | 1.3301107188345337    | D    | 1201 | 100 | 10   |
| 34  | drop  | 8  | 1.346233367919922     | D    | 1301 | 100 | 10   |
| 35  | rcv/DA                                      | 8  | 1.351648569107056     | A    | 9    | 0   | 901  |
| 36  | snd/RXTT                                    | 9  | 1.4853125095367432    | D    | 901  | 100 | 0    |
| 37  | rcv   | 9  | 1.91003784071045      | A    | 13   | 0   | 1301 |
| 38  | drop  | 9  | 1.946053981781006     | D    | 1401 | 100 | 14   |
| 39  | drop  | 9  | 1.96363615989605      | D    | 1501 | 100 | 14   |
| 40  | snd   | 9  | 1.97462018383606      | D    | 1601 | 100 | 14   |
| 41  | rcv/DA                                      | 9  | 1.986377954483032     | A    | 13   | 0   | 1301 |
| 42  | snd   | 9  | 1.99170957039148      | D    | 1701 | 100 | 14   |
| 43  | rcv/DA                                      | 10 | 1.008822925567627     | A    | 13   | 0   | 1301 |
| 44  | drop  | 11 | 1.514092206954956     | D    | 1301 | 100 | 14   |
| 45  | snd/RXTT                                    | 13 | 1.0320935249332061    | D    | 1301 | 100 | 0    |
| 46  | rcv   | 13 | 1.130041122436523     | A    | 14   | 0   | 1401 |
| 47  | snd   | 13 | 1.182121753692627     | D    | 1801 | 100 | 15   |
| 48  | rcv/DA                                      | 13 | 1.24361276626587      | A    | 14   | 0   | 1401 |
| 49  | snd/RXTT                                    | 14 | 1.755342245101929     | D    | 1401 | 100 | 0    |
| 50  | rcv   | 14 | 1.817791223526001     | A    | 15   | 0   | 1501 |
| 51  | drop  | 14 | 1.843486309051514     | D    | 1901 | 100 | 16   |
| 52  | drop  | 16 | 1.32425856590271      | D    | 1501 | 100 | 16   |
| 53  | drop  | 17 | 1.851880073547363     | D    | 1501 | 100 | 16   |
|     |   |    |                       |      |      |     |      |
| 54  | drop  | 19 | 1.11656141281128      | D    | 1501 | 100 | 16   |
| 55  | drop  | 20 | 1.937068356704712     | D    | 1501 | 100 | 16   |
| 56  | snd/RXTT                                    | 22 | 1.472802877426147     | D    | 1501 | 100 | 0    |
| 57  | rcv   | 22 | 1.611042022705078     | A    | 19   | 0   | 1901 |
| 58  | snd   | 22 | 1.660156768798828     | D    | 2001 | 100 | 20   |
| 59  | snd   | 22 | 1.67878246307373      | D    | 2101 | 100 | 20   |
| 60  | rcv/DA                                      | 22 | 1.678966522216797     | A    | 19   | 0   | 1901 |
| 61  | snd   | 22 | 1.68452024459839      | D    | 2201 | 100 | 20   |
| 62  | rcv/DA                                      | 22 | 1.700771808624268     | A    | 19   | 0   | 1901 |
| 63  | snd   | 22 | 1.700656814971924     | D    | 2301 | 100 | 20   |
| 64  | rcv/DA                                      | 22 | 1.716694116592407     | A    | 19   | 0   | 1901 |
| 65  | FRdrop                                      | 22 | 1.738309621810913     | D    | 1901 | 100 | 20   |
| 66  | rcv/DA                                      | 22 | 1.74949598312370      | A    | 19   | 0   | 1901 |
| 67  | snd/RXTT                                    | 24 | 1.234955072402954     | D    | 1901 | 100 | 0    |
| 68  | rcv   | 24 | 1.28603196144104      | A    | 24   | 0   | 2401 |
| 69  | drop  | 24 | 1.321959733963013     | D    | 2401 | 100 | 25   |
| 70  | drop  | 24 | 1.342957250224407     | D    | 2501 | 100 | 25   |
| 71  | drop  | 24 | 1.354134798049927     | D    | 2601 | 100 | 25   |
| 72  | snd   | 24 | 1.365149974822998     | D    | 2701 | 100 | 25   |
| 73  | rcv/DA                                      | 24 | 1.392184495925903     | A    | 24   | 0   | 2401 |
| 74  | snd   | 24 | 1.4077627658044       | D    | 2801 | 100 | 25   |
| 75  | rcv/DA                                      | 24 | 1.418615102767944     | A    | 24   | 0   | 2401 |
| 76  | drop  | 25 | 1.930251359939575     | D    | 2401 | 100 | 25   |
| 77  | snd/RXTT                                    | 27 | 1.465545415878296     | D    | 2401 | 100 | 0    |
| 78  | rcv   | 27 | 1.550094604492188     | A    | 25   | 0   | 2501 |
| 79  | drop  | 27 | 1.58609414100647      | D    | 2901 | 100 | 26   |
| 80  | snd/RXTT                                    | 29 | 1.03415083885193      | D    | 2501 | 100 | 0    |
| 81  | rcv   | 29 | 1.097023487091064     | A    | 26   | 0   | 2601 |
| 82  | snd   | 29 | 1.143824577331543     | D    | 3001 | 100 | 27   |
| 83  | rcv/DA                                      | 29 | 1.149702072143555     | A    | 26   | 0   | 2601 |
| 84  | drop  | 30 | 1.656439304351807     | D    | 2601 | 100 | 27   |
| 85  | snd/RXTT                                    | 32 | 1.17417083072906      | D    | 2601 | 100 | 0    |
| 86  | rcv   | 32 | 1.185629844646553     | A    | 29   | 0   | 2901 |
| 87  | drop  | 33 | 1.68618416786194      | D    | 2901 | 100 | 30   |
| 88  | snd/RXTT                                    | 35 | 1.22218918800354      | D    | 2901 | 100 | 0    |
| 89  | rcv   | 35 | 1.265167236328125     | A    | 31   | 0   | 3029 |
| 90  | snd   | 35 | 1.28778600692749      | F    | 3029 | 0   | 32   |
| 91  | rcv   | 35 | 1.38890790939331      | A    | 31   | 0   | 3029 |
| 92  | rcv   | 35 | 1.39490209953308      | F    | 32   | 0   | 3030 |
| 93  | snd   | 35 | 1.39601731300354      | A    | 3029 | 0   | 33   |
| 94  |   |    |                       |      |      |     |      |
| 95  | Size of the file (in Bytes)                 |    |                       | 3028 |      |     |      |
| 96  | Segments transmitted (including drop & RXT) |    |                       | 59   |      |     |      |
| 97  | Number of Segments handled by PLD           |    |                       | 55   |      |     |      |
| 98  | Number of Segments dropped                  |    |                       | 24   |      |     |      |
| 99  | Number of Segments Corrupted                |    |                       | 0    |      |     |      |
| 100 | Number of Segments Re-ordered               |    |                       | 0    |      |     |      |
| 101 | Number of Segments Duplicated               |    |                       | 0    |      |     |      |
| 102 | Number of Segments Delayed                  |    |                       | 0    |      |     |      |
| 103 | Number of Retransmissions due to TIMEOUT    |    |                       | 22   |      |     |      |
| 104 | Number of FAST RETRANSMISSION               |    |                       | 2    |      |     |      |
| 105 | Number of DUP ACKS received                 |    |                       | 18   |      |     |      |



## Receiver Log File (pDrop 0.3)

|    |                                    |    |                     |      |      |     |      |
|----|------------------------------------|----|---------------------|------|------|-----|------|
| 1  | rcv                                | 0  | 0013802051544189453 | S    | 0    | 0   | 0    |
| 2  | snd                                | 0  | 0029065608970271484 | SA   | 0    | 0   | 1    |
| 3  | rcv                                | 0  | 0025099754333496094 | A    | 1    | 0   | 1    |
| 4  | rcv                                | 0  | 025099754333496094  | D    | 101  | 100 | 1    |
| 5  | snd/DA                             | 0  | 026175975799560547  | A    | 0    | 0   | 1    |
| 6  | rcv                                | 0  | 026990175247192383  | D    | 201  | 100 | 1    |
| 7  | snd/DA                             | 0  | 02780461311340332   | A    | 9    | 0   | 1    |
| 8  | rcv                                | 0  | 04087376594543457   | D    | 301  | 100 | 1    |
| 9  | snd/DA                             | 0  | 042043209075927734  | A    | 0    | 0   | 1    |
| 10 | rcv                                | 3  | 115478754043579     | D    | 1    | 100 | 0    |
| 11 | snd                                | 3  | 118901252746582     | A    | 4    | 0   | 401  |
| 12 | rcv                                | 3  | 2125930706132812    | D    | 501  | 100 | 5    |
| 13 | snd/DA                             | 3  | 213693857192993     | A    | 4    | 0   | 401  |
| 14 | rcv                                | 3  | 338324785232544     | D    | 801  | 100 | 5    |
| 15 | snd/DA                             | 3  | 3392646312713623    | A    | 4    | 0   | 401  |
| 16 | rcv                                | 4  | 8983213901519775    | D    | 401  | 100 | 0    |
| 17 | snd                                | 4  | 903478384017944     | A    | 6    | 0   | 601  |
| 18 | rcv                                | 5  | 014092206954956     | D    | 1901 | 100 | 7    |
| 19 | snd/DA                             | 5  | 015094995498657     | A    | 6    | 0   | 601  |
| 20 | rcv                                | 6  | 595268249511719     | D    | 601  | 100 | 0    |
| 21 | snd                                | 6  | 596875429153442     | A    | 7    | 0   | 701  |
| 22 | rcv                                | 6  | 668657541275824     | D    | 1101 | 100 | 8    |
| 23 | snd/DA                             | 6  | 669461965560913     | A    | 901  | 100 | 701  |
| 24 | rcv                                | 8  | 212249279022217     | D    | 701  | 100 | 0    |
| 25 | snd                                | 8  | 21843433380127      | A    | 9    | 0   | 901  |
| 26 | rcv                                | 8  | 33506965637207      | D    | 1201 | 100 | 10   |
| 27 | snd/DA                             | 8  | 33590579032898      | A    | 9    | 0   | 901  |
| 28 | rcv                                | 9  | 858095645904541     | D    | 901  | 100 | 0    |
| 29 | snd                                | 9  | 861684322357178     | A    | 13   | 0   | 1301 |
| 30 | rcv                                | 9  | 979738712310791     | D    | 1601 | 100 | 14   |
| 31 | snd/DA                             | 9  | 980822801589966     | A    | 13   | 0   | 1301 |
| 32 | rcv                                | 9  | 996954202651978     | D    | 1701 | 100 | 14   |
| 33 | snd/DA                             | 9  | 99771785736084      | A    | 13   | 0   | 1301 |
| 34 | rcv                                | 13 | 03702163696289      | D    | 1301 | 100 | 0    |
| 35 | snd                                | 13 | 046465396881104     | A    | 14   | 0   | 1401 |
| 36 | rcv                                | 13 | 187058687210083     | D    | 1801 | 100 | 15   |
| 37 | snd/DA                             | 13 | 188015699386597     | A    | 14   | 0   | 1401 |
| 38 | rcv                                | 14 | 76063871383667      | D    | 1401 | 100 | 0    |
| 39 | snd                                | 14 | 762360334396362     | A    | 15   | 0   | 1501 |
| 40 | rcv                                | 22 | 472647428512573     | D    | 1501 | 100 | 0    |
| 41 | snd                                | 22 | 47653341293335      | A    | 19   | 0   | 1901 |
| 42 | rcv                                | 22 | 67192029953003      | D    | 2001 | 100 | 20   |
| 43 | snd/DA                             | 22 | 672977924346924     | A    | 19   | 0   | 1901 |
| 44 | rcv                                | 22 | 683634042739808     | D    | 2101 | 100 | 20   |
| 45 | snd/DA                             | 22 | 68454647084209      | A    | 19   | 0   | 1901 |
| 46 | rcv                                | 22 | 690450429916382     | D    | 2201 | 100 | 20   |
| 47 | snd/DA                             | 22 | 691208839416504     | A    | 19   | 0   | 1901 |
| 48 | rcv                                | 22 | 70543670654297      | D    | 2301 | 100 | 20   |
| 49 | snd/DA                             | 22 | 706169366836548     | A    | 19   | 0   | 1901 |
| 50 | rcv                                | 24 | 245221376419067     | D    | 1901 | 100 | 0    |
| 51 | snd                                | 24 | 25421643257141      | A    | 24   | 0   | 2401 |
| 52 | rcv                                | 24 | 370115280151367     | D    | 2701 | 100 | 25   |
| 53 | snd/DA                             | 24 | 371113061904907     | A    | 24   | 0   | 2401 |
|    |                                    |    |                     |      |      |     |      |
| 54 | rcv                                | 24 | 40760040283203      | D    | 2801 | 100 | 25   |
| 55 | snd/DA                             | 24 | 408446311950684     | A    | 24   | 0   | 2401 |
| 56 | rcv                                | 27 | 47050976753235      | D    | 2401 | 100 | 0    |
| 57 | snd                                | 27 | 472315549080464     | A    | 25   | 0   | 2501 |
| 58 | rcv                                | 29 | 03952145576477      | D    | 2501 | 100 | 0    |
| 59 | snd                                | 29 | 046117305755615     | A    | 26   | 0   | 2601 |
| 60 | rcv                                | 29 | 143657445907593     | D    | 3001 | 28  | 27   |
| 61 | snd/DA                             | 29 | 144461393356323     | A    | 26   | 0   | 2601 |
| 62 | rcv                                | 32 | 17913317680359      | D    | 2601 | 100 | 0    |
| 63 | snd                                | 32 | 18211102405657      | A    | 29   | 0   | 2901 |
| 64 | rcv                                | 35 | 22727012634277      | D    | 2901 | 100 | 0    |
| 65 | snd                                | 35 | 229633808135906     | A    | 31   | 0   | 3029 |
| 66 | rcv                                | 35 | 29293179512024      | F    | 3029 | 0   | 32   |
| 67 | snd                                | 35 | 293729066848755     | A    | 32   | 0   | 3030 |
| 68 | snd                                | 35 | 39493536949158      | F    | 32   | 0   | 3030 |
| 69 | rcv                                | 35 | 411051750183105     | A    | 33   | 0   | 3029 |
| 70 |                                    |    |                     |      |      |     |      |
| 71 | Amount of data received (in Bytes) |    |                     | 3028 |      |     |      |
| 72 | Total segments received            |    |                     | 35   |      |     |      |
| 73 | Data segments received             |    |                     | 31   |      |     |      |
| 74 | Data segments with Bit Errors      |    |                     | 0    |      |     |      |
| 75 | Duplicate data segments received   |    |                     | 0    |      |     |      |
| 76 | Duplicate ACKs sent                |    |                     | 18   |      |     |      |

## (Sender Log File Snippets, gamma = 2)

|              |                       |    |     |    |     |
|--------------|-----------------------|----|-----|----|-----|
| 1 snd        | 0                     | S  | 0   | 0  | 0   |
| 2 rcv        | 0.0009608268737792969 | SA | 0   | 0  | 1   |
| 3 snd        | 0.0017039775848388672 | A  | 1   | 0  | 1   |
| 4 snd        | 0.002573728561401367  | D  | 1   | 50 | 1   |
| 5 drop       | 0.003306158436401367  | D  | 51  | 50 | 1   |
| 6 drop       | 0.00396761993400203   | D  | 151 | 50 | 1   |
| 7 snd        | 0.0045855045318603516 | D  | 201 | 50 | 1   |
| 8 drop       | 0.005177497863769531  | D  | 251 | 50 | 1   |
| 9 snd        | 0.0057735443115234375 | D  | 301 | 50 | 1   |
| 10 drop      | 0.0064029693603515625 | D  | 351 | 50 | 1   |
| 11 snd       | 0.006981372833251953  | D  | 401 | 50 | 1   |
| 12 snd       | 0.00757145801652832   | D  | 451 | 50 | 1   |
| 13 rcv       | 0.0017661190032959    | A  | 1   | 0  | 51  |
| 14 rcv/DA    | 0.10258007049560547   | A  | 1   | 0  | 51  |
| 15 rcv/DA    | 0.11331439018249512   | A  | 1   | 0  | 51  |
| 16 rcv/DA    | 0.12402105331420098   | A  | 1   | 0  | 51  |
| 17 snd/RXTF  | 0.13480877876281738   | D  | 51  | 50 | 0   |
| 18 rcv/DA    | 0.14559388160705566   | A  | 1   | 0  | 51  |
| 19 rcv       | 0.15647292137145996   | A  | 2   | 0  | 101 |
| 20 drop      | 0.1998147964477539    | D  | 551 | 50 | 3   |
| 21 snd/delay | 0.2518746852874756    | D  | 101 | 50 | 1   |
| 22 rcv       | 0.2797996997833252    | A  | 3   | 0  | 151 |
| 23 snd       | 0.331860654602051     | D  | 601 | 50 | 4   |
| 24 rcv/DA    | 0.36779141420086426   | A  | 3   | 0  | 151 |
| 25 snd/delay | 1.0239777565002441    | D  | 501 | 50 | 2   |
| 26 rcv/DA    | 1.0739338397979736    | A  | 3   | 0  | 151 |
| 27 drop      | 2.0491104125976562    | D  | 151 | 50 | 4   |
| 28 snd/RXTT  | 3.0058376026153564    | D  | 151 | 50 | 0   |
| 29 rcv       | 3.146815061569214     | A  | 5   | 0  | 251 |
| 30 drop      | 3.1740562915802       | D  | 651 | 50 | 6   |
| 31 drop      | 3.210488796234131     | D  | 701 | 50 | 6   |
| 32 drop      | 4.151744604110718     | D  | 251 | 50 | 6   |
| 33 snd/RXTT  | 5.183029890060425     | D  | 251 | 50 | 0   |
| 34 rcv       | 5.280935525894165     | A  | 7   | 0  | 351 |
| 35 drop      | 5.327897071838379     | D  | 751 | 50 | 8   |
| 36 drop      | 5.345368385314941     | D  | 801 | 50 | 8   |
| 37 snd/RXTT  | 6.2703001499176025    | D  | 351 | 50 | 0   |

|   |                    |        |        |    |        |
|---|--------------------|--------|--------|----|--------|
| 18688 snd/delay                                   | 6375.0962034358215 | D      | 308051 | 50 | 6153   |
| 18689 rcv/DA                                      | 6375.107787132263  | A      | 6152   | 0  | 307601 |
| 18690 snd/RXTF                                    | 6375.13338136673   | D      | 307601 | 50 | 0      |
| 18691 rcv   | 6375.144418001175  | A      | 6156   | 0  | 307801 |
| 18692 drop  | 6375.187826633453  | D      | 308101 | 50 | 6157   |
| 18693 snd   | 6375.205462694168  | D      | 308201 | 3  | 6157   |
| 18694 rcv/DA                                      | 6375.216596126556  | A      | 6156   | 0  | 307801 |
| 18695 snd/delay                                   | 6375.783054722077  | D      | 308151 | 50 | 6157   |
| 18696 rcv/DA                                      | 6375.82670438591   | A      | 6156   | 0  | 307801 |
| 18697 drop  | 6376.479746580124  | D      | 307801 | 50 | 6157   |
| 18698 snd/RXTT                                    | 6377.159979104996  | D      | 307801 | 50 | 0      |
| 18699 rcv   | 6377.187341451645  | A      | 6157   | 0  | 307851 |
| 18700 snd/delay                                   | 6377.891353368759  | D      | 307851 | 50 | 0      |
| 18701 rcv   | 6377.90706038475   | A      | 6159   | 0  | 307951 |
| 18702 drop  | 6378.569798707962  | D      | 307951 | 50 | 6160   |
| 18703 snd/RXTT                                    | 6379.259932279507  | D      | 307951 | 50 | 0      |
| 18704 rcv   | 6379.282785892487  | A      | 6162   | 0  | 308101 |
| 18705 drop  | 6379.9455189704895 | D      | 308101 | 50 | 6163   |
| 18706 snd/RXTT                                    | 6380.629544258118  | D      | 308101 | 50 | 0      |
| 18707 rcv   | 6380.667129039764  | A      | 6165   | 0  | 308204 |
| 18708 snd   | 6380.6894273757935 | F      | 308204 | 0  | 6166   |
| 18709 rcv   | 6380.790380239487  | A      | 6165   | 0  | 308204 |
| 18710 rcv   | 6380.796459436417  | F      | 6166   | 0  | 308205 |
| 18711 snd   | 6380.797326007952  | A      | 308204 | 0  | 6167   |
| 18712   |                    |        |        |    |        |
| 18713 Size of the file (in Bytes)                 |                    | 308203 |        |    |        |
| 18714 Segments transmitted (including drop & RXT) |                    | 12508  |        |    |        |
| 18715 Number of Segments handled by PLD           |                    | 12504  |        |    |        |
| 18716 Number of Segments dropped                  |                    | 6304   |        |    |        |
| 18717 Number of Segments Corrupted                |                    | 0      |        |    |        |
| 18718 Number of Segments Re-ordered               |                    | 0      |        |    |        |
| 18719 Number of Segments Duplicated               |                    | 0      |        |    |        |
| 18720 Number of Segments Delayed                  |                    | 1243   |        |    |        |
| 18721 Number of Retransmissions due to TIMEOUT    |                    | 6108   |        |    |        |
| 18722 Number of FAST RETRANSMISSION               |                    | 231    |        |    |        |
| 18723 Number of DUP ACKS received                 |                    | 3086   |        |    |        |

Receiver Log File Snippets (Gamma = 2)

|  |                       |        |        |     |        |
|--|-----------------------|--------|--------|-----|--------|
| 1 rcv                                    | 0                     | S      | 0      | 0   | 0      |
| 2 snd                                    | 0.0006099370422363281 | SA     | 0      | 0   | 1      |
| 3 rcv                                    | 0.0015096664428710938 | A      | 1      | 0   | 1      |
| 4 rcv                                    | 0.027930259704589844  | D      | 1      | 50  | 1      |
| 5 snd                                    | 0.03011465072631836   | A      | 1      | 0   | 51     |
| 6 rcv                                    | 0.030922651290893555  | D      | 201    | 50  | 1      |
| 7 snd/DA                                 | 0.03654909133911133   | A      | 1      | 0   | 51     |
| 8 rcv                                    | 0.03730511665344238   | D      | 301    | 50  | 1      |
| 9 snd/DA                                 | 0.03808021545410156   | A      | 1      | 0   | 51     |
| 10 rcv                                   | 0.0387966320430176    | D      | 401    | 50  | 1      |
| 11 snd/DA                                | 0.039576053619384766  | A      | 1      | 0   | 51     |
| 12 rcv                                   | 0.040287017822265625  | D      | 451    | 50  | 1      |
| 13 snd/DA                                | 0.041049957275390625  | A      | 1      | 0   | 51     |
| 14 rcv                                   | 0.13988900104631348   | D      | 51     | 50  | 0      |
| 15 snd                                   | 0.1414201259613037    | A      | 2      | 0   | 101    |
| 16 rcv                                   | 0.25695204734802246   | D      | 101    | 50  | 1      |
| 17 snd                                   | 0.25845709909362793   | A      | 3      | 0   | 151    |
| 18 rcv                                   | 0.33696484565734863   | D      | 601    | 50  | 4      |
| 19 snd/DA                                | 0.33943748474121094   | A      | 3      | 0   | 151    |
| 20 rcv                                   | 1.029043436050415     | D      | 501    | 50  | 2      |
| 21 snd/DA                                | 1.0299992561340332    | A      | 3      | 0   | 151    |
| 22 rcv                                   | 3.091153621673584     | D      | 151    | 50  | 0      |
| 23 snd                                   | 3.093863010406494     | A      | 5      | 0   | 251    |
| 24 rcv                                   | 5.186104152679443     | D      | 251    | 50  | 0      |
| 25 snd                                   | 5.190259695053101     | A      | 7      | 0   | 351    |
| 26 rcv                                   | 6.275397539138794     | D      | 351    | 50  | 0      |
| 27 snd                                   | 6.278369665145874     | A      | 11     | 0   | 551    |
| 28 rcv                                   | 6.432904950724976     | D      | 1001   | 50  | 12     |
| 29 snd/DA                                | 6.433567762374878     | A      | 11     | 0   | 551    |
| 30 rcv                                   | 11.669804334640503    | D      | 551    | 50  | 0      |
| 31 snd                                   | 11.672221422195435    | A      | 13     | 0   | 651    |
| 32 rcv                                   | 12.044985294342041    | D      | 1101   | 50  | 14     |
| 33 snd/DA                                | 12.045841693078174    | A      | 13     | 0   | 651    |
| ...                                      | ...                   | A      | ...    | ... | ...    |
| 12380 rcv                                | 6371.571648359299     | D      | 307901 | 50  | 6151   |
| 12381 snd/DA                             | 6371.572489976883     | A      | 6150   | 0   | 307501 |
| 12382 rcv                                | 6374.337012529273     | D      | 307501 | 50  | 0      |
| 12383 snd                                | 6374.339153051376     | A      | 6152   | 0   | 307601 |
| 12384 rcv                                | 6374.480946302414     | D      | 308001 | 50  | 6153   |
| 12385 snd/DA                             | 6374.481785297394     | A      | 6152   | 0   | 307601 |
| 12386 rcv/dup                            | 6374.497263421549     | D      | 307501 | 50  | 0      |
| 12387 snd/DA                             | 6374.4981009960175    | A      | 6152   | 0   | 307601 |
| 12388 rcv                                | 6375.096236944199     | D      | 308051 | 50  | 6153   |
| 12389 snd/DA                             | 6375.09725022316      | A      | 6152   | 0   | 307601 |
| 12390 rcv                                | 6375.138303380519     | D      | 307601 | 50  | 0      |
| 12391 snd                                | 6375.14159488678      | A      | 6156   | 0   | 307801 |
| 12392 rcv                                | 6375.210459947586     | D      | 308201 | 3   | 6157   |
| 12393 snd/DA                             | 6375.21133605112      | A      | 6156   | 0   | 307801 |
| 12394 rcv                                | 6375.789093255997     | D      | 308151 | 50  | 6157   |
| 12395 snd/DA                             | 6375.78998208046      | A      | 6156   | 0   | 307801 |
| 12396 rcv                                | 6377.165234804153     | D      | 307801 | 50  | 0      |
| 12397 snd                                | 6377.17178606907      | A      | 6157   | 0   | 307851 |
| 12398 rcv                                | 6377.896444797516     | D      | 307851 | 50  | 0      |
| 12399 snd                                | 6377.89849114418      | A      | 6159   | 0   | 307951 |
| 12400 rcv                                | 6379.265071392059     | D      | 307951 | 50  | 0      |
| 12401 snd                                | 6379.267978660213     | A      | 6162   | 0   | 308101 |
| 12402 rcv                                | 6380.63472533226      | D      | 308101 | 50  | 0      |
| 12403 snd                                | 6380.637104511261     | A      | 6165   | 0   | 308204 |
| 12404 rcv                                | 6380.694708455963     | F      | 308204 | 0   | 6166   |
| 12405 snd                                | 6380.695406559143     | A      | 6166   | 0   | 308205 |
| 12406 snd                                | 6380.796428442001     | F      | 6166   | 0   | 308205 |
| 12407 rcv                                | 6380.797447919846     | A      | 6167   | 0   | 308204 |
| 12408                                    |                       |        |        |     |        |
| 12409 Amount of data received (in Bytes) |                       | 308203 |        |     |        |
| 12410 Total segments received            |                       | 6204   |        |     |        |
| 12411 Data segments received             |                       | 6200   |        |     |        |
| 12412 Data segments with Bit Errors      |                       | 0      |        |     |        |
| 12413 Duplicate data segments received   |                       | 35     |        |     |        |
| 12414 Duplicate ACKs sent                |                       | 3086   |        |     |        |

## Sender Log File (gamma = 4)

|       |   |                       |        |        |    |        |
|-------|---|-----------------------|--------|--------|----|--------|
| 1     | snd   | 0                     | S      | 0      | 0  | 0      |
| 2     | rcv   | 0.0011026859283447266 | SA     | 0      | 0  | 1      |
| 3     | snd   | 0.0016183853149414062 | A      | 1      | 0  | 1      |
| 4     | snd   | 0.002511739730834961  | D      | 1      | 50 | 1      |
| 5     | drop  | 0.0032553672798527344 | D      | 51     | 50 | 1      |
| 6     | drop  | 0.0039434443298339844 | D      | 151    | 0  | 1      |
| 7     | snd   | 0.004635810852050781  | D      | 201    | 50 | 1      |
| 8     | drop  | 0.0053064823150634766 | D      | 251    | 50 | 1      |
| 9     | snd   | 0.006021738052368164  | D      | 301    | 50 | 1      |
| 10    | drop  | 0.0066957473754083201 | D      | 351    | 50 | 1      |
| 11    | snd   | 0.0074384212493896484 | D      | 401    | 50 | 1      |
| 12    | snd   | 0.008156061172485352  | D      | 451    | 50 | 1      |
| 13    | rcv   | 0.10066413879394531   | A      | 1      | 0  | 51     |
| 14    | rcv/DA                                      | 0.10651922225952140   | A      | 1      | 0  | 51     |
| 15    | rcv/DA                                      | 0.17820477485656738   | A      | 1      | 0  | 51     |
| 16    | rcv/DA                                      | 0.1991722583770752    | A      | 1      | 0  | 51     |
| 17    | snd/RXTF                                    | 0.22525668144226074   | D      | 51     | 50 | 0      |
| 18    | rcv/DA                                      | 0.24113045825195312   | A      | 1      | 0  | 51     |
| 19    | rcv   | 0.25229787826538086   | A      | 2      | 0  | 101    |
| 20    | snd/delay                                   | 0.25256824493408203   | D      | 101    | 50 | 1      |
| 21    | drop  | 0.2680978775024414    | D      | 551    | 50 | 3      |
| 22    | rcv   | 0.2682020664215088    | A      | 3      | 0  | 151    |
| 23    | snd   | 0.31586217800249023   | D      | 601    | 50 | 4      |
| 24    | rcv/DA                                      | 0.37791013717651367   | A      | 3      | 0  | 151    |
| 25    | snd/delay                                   | 1.0299797058105469    | D      | 501    | 50 | 2      |
| 26    | rcv/DA                                      | 1.0510187149047852    | A      | 3      | 0  | 151    |
| 27    | drop  | 2.6097323894500732    | D      | 151    | 50 | 4      |
| 28    | snd/RXTT                                    | 4.179250717163086     | D      | 151    | 50 | 0      |
| 29    | rcv   | 4.31939172744751      | A      | 5      | 0  | 251    |
| 30    | drop  | 4.371819019317627     | D      | 651    | 50 | 6      |
| 31    | drop  | 4.392319917670833     | D      | 701    | 50 | 6      |
| 32    | drop  | 5.862597703933716     | D      | 251    | 50 | 6      |
| 33    | snd/RXTT                                    | 7.467935085296631     | D      | 251    | 50 | 0      |
| 34    | rcv   | 7.548932790756226     | A      | 7      | 0  | 351    |
| 35    | drop  | 7.563812952041626     | D      | 751    | 50 | 8      |
| 36    | drop  | 7.59693717956543      | D      | 801    | 50 | 8      |
| 37    | snd/RXTT                                    | 9.107626914978027     | D      | 351    | 50 | 0      |
| 38    | rcv   | 9.147822141647339     | A      | 11     | 0  | 551    |
|       |   |                       |        |        |    |        |
| 18579 | drop  | 10118.558006286621    | D      | 307801 | 50 | 6148   |
| 18580 | rcv/DA                                      | 10118.558215379715    | A      | 6147   | 0  | 307351 |
| 18581 | snd/RXTT                                    | 10119.38762086368     | D      | 307351 | 50 | 0      |
| 18582 | rcv   | 10119.91937160492     | A      | 6148   | 0  | 307401 |
| 18583 | snd   | 10119.969974279404    | D      | 307851 | 50 | 6149   |
| 18584 | rcv/DA                                      | 10120.019822835922    | A      | 6148   | 0  | 307401 |
| 18585 | snd/RXTT                                    | 10121.331877231598    | D      | 307401 | 50 | 0      |
| 18586 | rcv   | 10121.36381149292     | A      | 6149   | 0  | 307451 |
| 18587 | snd   | 10121.419858455658    | D      | 307901 | 50 | 6150   |
| 18588 | rcv/DA                                      | 10121.440797567368    | A      | 6149   | 0  | 307451 |
| 18589 | drop  | 10122.77022266388     | D      | 307451 | 50 | 6150   |
| 18590 | snd/RXTT                                    | 10124.114929199219    | D      | 307451 | 50 | 0      |
| 18591 | rcv   | 10124.279284477234    | A      | 6151   | 0  | 307551 |
| 18592 | snd   | 10124.319097420834    | D      | 307951 | 50 | 6152   |
| 18593 | rcv/DA                                      | 10124.330240249634    | A      | 6151   | 0  | 307551 |
| 18594 | snd   | 10124.335624933243    | D      | 308001 | 50 | 6152   |
| 18595 | rcv/DA                                      | 10124.356833457947    | A      | 6151   | 0  | 307551 |
| 18596 | snd/RXTT                                    | 10125.691884756088    | D      | 307551 | 50 | 0      |
| 18597 | rcv   | 10125.74316740036     | A      | 6156   | 0  | 307801 |
| 18598 | drop  | 10125.784926891327    | D      | 308101 | 50 | 6157   |
| 18599 | snd   | 10125.805424920665    | D      | 308151 | 50 | 6157   |
| 18600 | snd   | 10125.816667318344    | D      | 308201 | 3  | 6157   |
| 18601 | rcv/DA                                      | 10125.816723823547    | A      | 6156   | 0  | 307801 |
| 18602 | rcv/DA                                      | 10125.838101387024    | A      | 6156   | 0  | 307801 |
| 18603 | snd/delay                                   | 10125.871052397919    | D      | 308051 | 50 | 6157   |
| 18604 | rcv/DA                                      | 10125.923724412918    | A      | 6156   | 0  | 307801 |
| 18605 | snd/RXTF                                    | 10125.964854001999    | D      | 307801 | 50 | 0      |
| 18606 | rcv   | 10125.995823060168    | D      | 6162   | 0  | 308101 |
| 18607 | drop  | 10127.29958319664     | D      | 308101 | 50 | 6163   |
| 18608 | drop  | 10128.643839120865    | D      | 308101 | 50 | 6163   |
| 18609 | snd/RXTT                                    | 10129.993810653687    | D      | 308101 | 50 | 0      |
| 18610 | rcv   | 10130.065427064096    | A      | 6165   | 0  | 308204 |
| 18611 | snd   | 10130.066230535507    | F      | 308204 | 0  | 6166   |
| 18612 | rcv   | 10130.167083501816    | A      | 6165   | 0  | 308204 |
| 18613 | rcv   | 10130.173089265023    | F      | 6166   | 0  | 308205 |
| 18614 | snd   | 10130.174001216088    | A      | 308204 | 0  | 6167   |
| 18615 |   |                       |        |        |    |        |
| 18616 | Size of the file (in Bytes)                 |                       | 308203 |        |    |        |
| 18617 | Segments transmitted (including drop & RXT) |                       | 12446  |        |    |        |
| 18618 | Number of Segments handled by PLD           |                       | 12442  |        |    |        |
| 18619 | Number of Segments dropped                  |                       | 6277   |        |    |        |
| 18620 | Number of Segments Corrupted                |                       | 0      |        |    |        |
| 18621 | Number of Segments Re-ordered               |                       | 0      |        |    |        |
| 18622 | Number of Segments Duplicated               |                       | 0      |        |    |        |
| 18623 | Number of Segments Delayed                  |                       | 1234   |        |    |        |
| 18624 | Number of Retransmissions due to TIMEOUT    |                       | 6046   |        |    |        |
| 18625 | Number of FAST RETRANSMISSION               |                       | 231    |        |    |        |
| 18626 | Number of DUP ACKS received                 |                       | 3088   |        |    |        |

|  |                    |   |        |    |        |
|--|--------------------|---|--------|----|--------|
| 12304 rcv                                | 10118.456842422485 | D | 307251 | 50 | 0      |
| 12305 snd                                | 10118.45874619484  | A | 6147   | 0  | 307351 |
| 12306 rcv                                | 10118.544777870178 | D | 30751  | 50 | 6148   |
| 12307 snd/DA                             | 10118.547852039337 | D | 6147   | 0  | 307351 |
| 12308 rcv                                | 10119.892532110214 | D | 307351 | 50 | 0      |
| 12309 snd                                | 10119.89375925064  | A | 6148   | 0  | 307401 |
| 12310 rcv                                | 10119.974809504132 | D | 30751  | 50 | 6149   |
| 12311 snd/DA                             | 10119.975611925125 | A | 6148   | 0  | 307401 |
| 12312 rcv                                | 10121.336786746979 | D | 307401 | 50 | 0      |
| 12313 snd                                | 10121.339768807495 | A | 6149   | 0  | 307451 |
| 12314 rcv                                | 10121.424785852432 | D | 307901 | 50 | 6150   |
| 12315 snd/DA                             | 10121.42554140091  | A | 6149   | 0  | 307451 |
| 12316 rcv                                | 10124.11994680296  | D | 307451 | 50 | 0      |
| 12317 snd                                | 10124.121775388718 | A | 6151   | 0  | 307551 |
| 12318 rcv                                | 10124.324807882309 | D | 307951 | 50 | 6152   |
| 12319 snd/DA                             | 10124.325537204742 | A | 6151   | 0  | 307551 |
| 12320 rcv                                | 10124.340604543686 | D | 308001 | 50 | 6151   |
| 12321 snd/DA                             | 10124.341239213943 | A | 6151   | 0  | 307551 |
| 12322 rcv                                | 10125.69679570198  | D | 307551 | 50 | 0      |
| 12323 snd                                | 10125.700346946716 | A | 6156   | 0  | 307801 |
| 12324 rcv                                | 10125.810792446136 | D | 308151 | 50 | 6157   |
| 12325 snd/DA                             | 10125.811338663101 | A | 6156   | 0  | 307801 |
| 12326 rcv                                | 10125.821534872055 | D | 308201 | 3  | 6157   |
| 12327 snd/DA                             | 10125.82222032547  | A | 6156   | 0  | 307801 |
| 12328 rcv                                | 10125.877173185349 | D | 308051 | 50 | 6157   |
| 12329 snd                                | 10125.87784075737  | A | 6156   | 0  | 307801 |
| 12330 rcv                                | 10125.964755296707 | D | 307801 | 50 | 0      |
| 12331 snd                                | 10125.967906951904 | A | 6162   | 0  | 308101 |
| 12332 rcv                                | 10129.998819589615 | D | 308101 | 50 | 0      |
| 12333 snd                                | 10130.081148462296 | A | 6165   | 0  | 308204 |
| 12334 rcv                                | 10130.071153640747 | D | 308204 | 50 | 6166   |
| 12335 snd                                | 10130.07188463211  | A | 6166   | 0  | 308205 |
| 12336 snd                                | 10130.172810316086 | F | 6166   | 0  | 308205 |
| 12337 rcv                                | 10130.173892259598 | A | 6167   | 0  | 308204 |
| 12338                                    |                    |   |        |    |        |
| 12339 Amount of data received (in Bytes) |                    |   | 308203 |    |        |
| 12340 Total segments received            |                    |   | 6169   |    |        |
| 12341 Data segments received             |                    |   | 6165   |    |        |
| 12342 Data segments with Bit Errors      |                    |   | 0      |    |        |
| 12343 Duplicate data segments received   |                    |   | 0      |    |        |
| 12344 Duplicate ACKs sent                |                    |   | 3088   |    |        |

## Sender Log File (gamma = 6)

|       |   |                       |        |        |    |        |
|-------|---|-----------------------|--------|--------|----|--------|
| 1     | snd   | 0                     | S      | 0      | 0  | 0      |
| 2     | rcv   | 0.0011489391326904297 | SA     | 0      | 0  | 1      |
| 3     | snd   | 0.002003908157348633  | A      | 1      | 0  | 1      |
| 4     | snd   | 0.0032037390899658203 | D      | 1      | 50 | 1      |
| 5     | drop  | 0.015075922012329102  | D      | 51     | 50 | 1      |
| 6     | drop  | 0.0453035831451416    | D      | 151    | 50 | 2      |
| 7     | rcv   | 0.05596470832824707   | A      | 1      | 0  | 51     |
| 8     | snd   | 0.071929931640625     | D      | 201    | 50 | 2      |
| 9     | drop  | 0.11288595199584961   | D      | 251    | 0  | 2      |
| 10    | rcv/DA                                      | 0.11305642127990723   | A      | 1      | 0  | 51     |
| 11    | snd   | 0.12394356727608098   | D      | 301    | 50 | 2      |
| 12    | rcv/DA                                      | 0.150521993637080496  | A      | 1      | 0  | 51     |
| 13    | drop  | 0.15587615966796875   | D      | 351    | 50 | 2      |
| 14    | snd   | 0.21753597259521484   | D      | 401    | 50 | 2      |
| 15    | rcv/DA                                      | 0.2697913646697998    | A      | 1      | 0  | 51     |
| 16    | snd   | 0.2764148712158203    | D      | 451    | 50 | 2      |
| 17    | snd   | 0.2865326404571533    | D      | 501    | 50 | 2      |
| 18    | snd/delay                                   | 0.2767832279205322    | D      | 101    | 50 | 1      |
| 19    | rcv/DA                                      | 0.29677677154541016   | A      | 1      | 0  | 51     |
| 20    | rcv/DA                                      | 0.3182046413421631    | A      | 1      | 0  | 51     |
| 21    | rcv/DA                                      | 0.34937000274658203   | A      | 1      | 0  | 51     |
| 22    | FRdrop                                      | 0.42099738121032715   | D      | 51     | 50 | 2      |
| 23    | snd/delay                                   | 1.1989062227783203    | D      | 51     | 0  | 0      |
| 24    | rcv   | 1.2468578815460205    | D      | 3      | 0  | 151    |
| 25    | snd   | 1.2988922595977783    | D      | 551    | 4  | 4      |
| 26    | rcv/DA                                      | 1.3252384662628174    | A      | 3      | 0  | 151    |
| 27    | drop  | 1.3306972980499268    | D      | 601    | 50 | 4      |
| 28    | snd/RXT                                     | 3.5180351734161377    | D      | 151    | 50 | 0      |
| 29    | rcv   | 3.579702854156494     | A      | 5      | 0  | 251    |
| 30    | drop  | 3.6188316345214844    | D      | 651    | 50 | 6      |
| 31    | drop  | 3.6364541053771973    | D      | 701    | 50 | 6      |
| 32    | drop  | 5.731700897216797     | D      | 251    | 50 | 6      |
| 33    | snd/RXT                                     | 7.914928674697076     | D      | 251    | 0  | 0      |
| 34    | rcv   | 8.040005207061768     | A      | 7      | 0  | 351    |
| 35    | drop  | 8.180078105926514     | D      | 751    | 50 | 8      |
| 36    | drop  | 8.120750427246094     | D      | 801    | 50 | 0      |
| 37    | snd/RXT                                     | 10.206929922103882    | D      | 351    | 50 | 0      |
| 38    | rcv   | 10.314737796783447    | A      | 12     | 0  | 601    |
| 39    | drop  | 10.361004829406738    | D      | 851    | 50 | 13     |
| 40    | drop  | 10.381664037704468    | D      | 901    | 50 | 13     |
| 41    | drop  | 10.392861127853394    | D      | 951    | 50 | 13     |
| 42    | drop  | 10.413865089416504    | D      | 1051   | 50 | 13     |
| 43    | snd/delay                                   | 10.442062272262573    | D      | 1001   | 50 | 13     |
| 44    | rcv/DA                                      | 10.484569549560547    | A      | 12     | 0  | 601    |
|       |   |                       |        |        |    |        |
| 18588 | rcv/DA                                      | 14375.0927298069      | A      | 6147   | 0  | 307351 |
| 18589 | drop  | 14377.318533182144    | D      | 307351 | 50 | 6148   |
| 18590 | snd/RXT                                     | 14379.577899456024    | D      | 307351 | 50 | 0      |
| 18591 | rcv   | 14379.640893127045    | A      | 6149   | 0  | 307451 |
| 18592 | snd   | 14379.726907014847    | D      | 307851 | 50 | 6150   |
| 18593 | rcv/DA                                      | 14379.743705511093    | A      | 6149   | 0  | 307451 |
| 18594 | snd   | 14379.749139785767    | D      | 307901 | 50 | 6150   |
| 18595 | rcv/DA                                      | 14379.769941091537    | A      | 6149   | 0  | 307451 |
| 18596 | snd/RXT                                     | 14382.063654899597    | D      | 307451 | 50 | 0      |
| 18597 | rcv   | 14382.1420590803009   | A      | 6154   | 0  | 307701 |
| 18598 | drop  | 14382.170929431915    | D      | 308001 | 50 | 6155   |
| 18599 | snd   | 14382.196595430374    | D      | 308051 | 50 | 6155   |
| 18600 | snd   | 14382.213427066803    | D      | 308101 | 50 | 6155   |
| 18601 | rcv/DA                                      | 14382.213307300676    | A      | 6154   | 0  | 307701 |
| 18602 | snd   | 14382.230578184128    | D      | 308151 | 50 | 6155   |
| 18603 | rcv/DA                                      | 14382.235945224762    | A      | 6154   | 0  | 307701 |
| 18604 | rcv/DA                                      | 14382.255471944809    | A      | 6154   | 0  | 307701 |
| 18605 | snd/delay                                   | 14382.255722522736    | D      | 307951 | 50 | 6155   |
| 18606 | FRdrop                                      | 14382.266725063324    | D      | 307701 | 50 | 6155   |
| 18607 | rcv/DA                                      | 14382.282743213561    | A      | 6154   | 0  | 307701 |
| 18608 | drop  | 14384.486874818802    | D      | 307701 | 50 | 6155   |
| 18609 | snd/RXT                                     | 14386.738505601883    | D      | 307701 | 50 | 0      |
| 18610 | rcv   | 14386.803402522501    | A      | 6160   | 0  | 308001 |
| 18611 | drop  | 14386.830868244171    | D      | 308201 | 3  | 6161   |
| 18612 | drop  | 14389.014179706573    | D      | 308001 | 50 | 6161   |
| 18613 | snd/RXT                                     | 14391.254966974258    | D      | 308001 | 50 | 0      |
| 18614 | rcv   | 14391.266708135605    | A      | 6164   | 0  | 308201 |
| 18615 | snd/RXT                                     | 14393.40693060875     | D      | 308201 | 3  | 0      |
| 18616 | rcv   | 14393.529914617538    | A      | 6165   | 0  | 308204 |
| 18617 | snd   | 14393.532475929206    | F      | 308204 | 0  | 6166   |
| 18618 | rcv   | 14393.753701925278    | A      | 6166   | 0  | 308205 |
| 18619 | rcv   | 14393.759650945663    | F      | 6166   | 0  | 308205 |
| 18620 | snd   | 14393.760637044907    | D      | 308204 | 0  | 6167   |
| 18621 |   |                       |        |        |    |        |
| 18622 | Size of the file (in Bytes)                 |                       | 308203 |        |    |        |
| 18623 | Segments transmitted (including drop & RXT) |                       | 12450  |        |    |        |
| 18624 | Number of Segments handled by PLD           |                       | 12446  |        |    |        |
| 18625 | Number of Segments dropped                  |                       | 6279   |        |    |        |
| 18626 | Number of Segments Corrupted                |                       | 0      |        |    |        |
| 18627 | Number of Segments Re-ordered               |                       | 0      |        |    |        |
| 18628 | Number of Segments Duplicated               |                       | 0      |        |    |        |
| 18629 | Number of Segments Delayed                  |                       | 1234   |        |    |        |
| 18630 | Number of Retransmissions due to TIMEOUT    |                       | 6034   |        |    |        |
| 18631 | Number of FAST RETRANSMISSION               |                       | 247    |        |    |        |
| 18632 | Number of DUP ACKS received                 |                       | 3114   |        |    |        |

## Receiver Log File (gamma = 6)

|  |                       |        |        |    |        |
|--|-----------------------|--------|--------|----|--------|
| 1 rcv                                    | 0                     | S      | 0      | 0  | 0      |
| 2 snd                                    | 0.0007085800170898438 | SA     | 0      | 0  | 1      |
| 3 rcv                                    | 0.0018854141235351562 | A      | 1      | 0  | 1      |
| 4 rcv                                    | 0.008296012878417969  | D      | 1      | 50 | 1      |
| 5 snd                                    | 0.00965473548583064   | A      | 1      | 0  | 51     |
| 6 rcv                                    | 0.07727885246276855   | D      | 201    | 50 | 2      |
| 7 snd/DA                                 | 0.07813501358032227   | A      | 1      | 0  | 51     |
| 8 rcv                                    | 0.1289818286895752    | D      | 301    | 50 | 2      |
| 9 snd/DA                                 | 0.12982821464538574   | A      | 1      | 0  | 51     |
| 10 rcv                                   | 0.2176528824432373    | D      | 401    | 50 | 2      |
| 11 snd/DA                                | 0.2183840274810791    | A      | 1      | 0  | 51     |
| 12 rcv                                   | 0.2805309295654297    | D      | 451    | 50 | 2      |
| 13 snd/DA                                | 0.2812495231628418    | A      | 1      | 0  | 51     |
| 14 rcv                                   | 0.28183984756469727   | D      | 101    | 50 | 1      |
| 15 snd/DA                                | 0.2824440002441406    | A      | 1      | 0  | 51     |
| 16 rcv                                   | 0.291640043258667     | D      | 501    | 50 | 2      |
| 17 snd/DA                                | 0.2923400402069092    | A      | 1      | 0  | 51     |
| 18 rcv                                   | 1.2039439678192139    | D      | 51     | 50 | 0      |
| 19 snd                                   | 1.2061147689819336    | A      | 3      | 0  | 151    |
| 20 rcv                                   | 1.3039116859436035    | D      | 551    | 50 | 4      |
| 21 snd/DA                                | 1.3048267364501953    | A      | 3      | 0  | 151    |
| 22 rcv                                   | 3.518275022506714     | D      | 151    | 50 | 0      |
| 23 snd                                   | 3.5204522609710693    | A      | 5      | 0  | 251    |
| 24 rcv                                   | 7.920252323150635     | D      | 251    | 50 | 0      |
| 25 snd                                   | 7.922428131103516     | A      | 7      | 0  | 351    |
| 26 rcv                                   | 10.212184429168701    | D      | 351    | 50 | 0      |
| 27 snd                                   | 10.21573543548584     | A      | 12     | 0  | 601    |
| 28 rcv                                   | 10.448004007339478    | D      | 1001   | 50 | 13     |
| 29 snd/DA                                | 10.448764562606812    | A      | 12     | 0  | 601    |
| 30 rcv                                   | 19.26816964149475     | D      | 601    | 50 | 0      |
| 31 snd                                   | 19.269845724105835    | A      | 13     | 0  | 651    |
| 32 rcv                                   | 21.70818305015564     | D      | 651    | 50 | 0      |
| 33 snd                                   | 21.709571838378906    | A      | 14     | 0  | 701    |
| 34 rcv                                   | 28.45201301574707     | D      | 701    | 50 | 0      |
| 35 snd                                   | 28.453531742095947    | A      | 15     | 0  | 751    |
| 36 rcv                                   | 30.679172321124878    | D      | 751    | 50 | 0      |
| 37 snd                                   | 30.685870885849       | A      | 16     | 0  | 801    |
| 38 rcv                                   | 30.798480987548828    | D      | 1251   | 50 | 17     |
| 39 snd/DA                                | 30.806476831436157    | A      | 16     | 0  | 801    |
| 40 rcv                                   | 35.81192064285278     | D      | 801    | 50 | 0      |
| 41 snd                                   | 35.816216230392456    | A      | 17     | 0  | 851    |
| 42 rcv                                   | 40.196176528930664    | D      | 851    | 50 | 0      |
|  |                       |        |        |    |        |
| 12310 rcv                                | 14372.670319080353    | D      | 307751 | 50 | 6147   |
| 12311 snd/DA                             | 14372.676333904266    | A      | 6146   | 0  | 307301 |
| 12312 rcv                                | 14374.982256412506    | D      | 307301 | 50 | 0      |
| 12313 snd                                | 14374.98417854309     | A      | 6147   | 0  | 307351 |
| 12314 rcv                                | 14375.07184100151     | D      | 307801 | 50 | 6148   |
| 12315 snd/DA                             | 14375.072586536407    | A      | 6147   | 0  | 307351 |
| 12316 rcv                                | 14379.5829099584045   | D      | 307351 | 50 | 0      |
| 12317 snd                                | 14379.585204601288    | A      | 6149   | 0  | 307451 |
| 12318 rcv                                | 14379.73213815689     | D      | 307851 | 50 | 6150   |
| 12319 snd/DA                             | 14379.732978343964    | A      | 6149   | 0  | 307451 |
| 12320 rcv                                | 14379.75412607193     | D      | 307901 | 50 | 6150   |
| 12321 snd/DA                             | 14379.754889965057    | A      | 6149   | 0  | 307451 |
| 12322 rcv                                | 14382.068946838379    | D      | 307451 | 50 | 0      |
| 12323 snd                                | 14382.074254089624    | A      | 6154   | 0  | 307701 |
| 12324 rcv                                | 14382.20183968544     | D      | 308051 | 50 | 6155   |
| 12325 snd/DA                             | 14382.202823162079    | A      | 6154   | 0  | 307701 |
| 12326 rcv                                | 14382.219447851181    | D      | 308101 | 50 | 6155   |
| 12327 snd/DA                             | 14382.220334768295    | A      | 6154   | 0  | 307701 |
| 12328 rcv                                | 14382.235813379288    | D      | 308151 | 50 | 6155   |
| 12329 snd/DA                             | 14382.236658334732    | A      | 6154   | 0  | 307701 |
| 12330 rcv                                | 14382.260724544525    | D      | 307951 | 50 | 6155   |
| 12331 snd/DA                             | 14382.26142168045     | A      | 6154   | 0  | 307701 |
| 12332 rcv                                | 14386.743531227112    | D      | 307701 | 50 | 0      |
| 12333 snd                                | 14386.748057365417    | A      | 6160   | 0  | 308001 |
| 12334 rcv                                | 14391.260801897012    | D      | 308001 | 50 | 0      |
| 12335 snd                                | 14391.263415336609    | A      | 6164   | 0  | 308201 |
| 12336 rcv                                | 14393.491945028305    | D      | 308201 | 3  | 0      |
| 12337 snd                                | 14393.493413686752    | A      | 6165   | 0  | 308204 |
| 12338 rcv                                | 14393.557720422745    | F      | 308204 | 0  | 6166   |
| 12339 snd                                | 14393.558454990387    | A      | 6166   | 0  | 308205 |
| 12340 snd                                | 14393.759445667267    | F      | 6166   | 0  | 308205 |
| 12341 rcv                                | 14393.767382383347    | A      | 6167   | 0  | 308204 |
| 12342                                    |                       |        |        |    |        |
| 12343 Amount of data received (in Bytes) |                       | 308203 |        |    |        |
| 12344 Total segments received            |                       | 6171   |        |    |        |
| 12345 Data segments received             |                       | 6167   |        |    |        |
| 12346 Data segments with Bit Errors      |                       | 0      |        |    |        |
| 12347 Duplicate data segments received   |                       | 2      |        |    |        |
| 12348 Duplicate ACKs sent                |                       | 3114   |        |    |        |

## Part c Sender Log File

|            |   |                     |    |     |    |     |
|------------|---|---------------------|----|-----|----|-----|
| 1 snd      | 0 | 001386880874633789  | S  | 0   | 0  | 0   |
| 2 rcv      | 0 | 001386880874633789  | SA | 0   | 0  | 1   |
| 3 snd      | 0 | 0019966403442382812 | A  | 1   | 0  | 1   |
| 4 snd/Cor  | 0 | 0080549213409423828 | D  | 1   | 50 | 1   |
| 5 snd      | 0 | 03777837532958984   | D  | 51  | 50 | 1   |
| 6 rcv/DA   | 0 | 06083689765930176   | A  | 0   | 0  | 1   |
| 7 snd      | 0 | 07561755180358887   | D  | 101 | 50 | 1   |
| 8 rcv/DA   | 0 | 09161257743835449   | A  | 0   | 0  | 1   |
| 9 snd      | 0 | 10261106401088867   | D  | 151 | 50 | 1   |
| 10 rcv/DA  | 0 | 11836743354797363   | A  | 0   | 0  | 1   |
| 11 snd     | 0 | 12375235557556152   | D  | 201 | 50 | 1   |
| 12 snd/RXT | 0 | 12933945655022754   | D  | 0   | 50 | 0   |
| 13 snd     | 0 | 1447293758392334    | D  | 251 | 50 | 1   |
| 14 snd/Cor | 0 | 17171168327331543   | D  | 301 | 50 | 1   |
| 15 snd/DUP | 0 | 1715545654296875    | D  | 1   | 50 | 0   |
| 16 snd     | 0 | 18253421783447266   | D  | 351 | 50 | 1   |
| 17 rcv/DA  | 0 | 18811821937561035   | A  | 0   | 0  | 1   |
| 18 snd     | 0 | 203568696975708     | D  | 401 | 50 | 1   |
| 19 rcv     | 0 | 214400053024292     | A  | 5   | 0  | 251 |
| 20 snd     | 0 | 219818115234375     | D  | 451 | 50 | 6   |
| 21 rcv     | 0 | 22510695457458496   | A  | 6   | 0  | 301 |
| 22 snd     | 0 | 230910862789917     | D  | 501 | 50 | 7   |
| 23 rcv/DA  | 0 | 2310166358947754    | A  | 6   | 0  | 301 |
| 24 snd/Cor | 0 | 23645353317260742   | D  | 551 | 50 | 7   |
| 25 rcv/DA  | 0 | 24184560775756836   | A  | 6   | 0  | 301 |
| 26 snd     | 0 | 24716687202453613   | D  | 601 | 50 | 7   |
| 27 rcv/DA  | 0 | 2528359889984131    | A  | 6   | 0  | 301 |
| 28 snd     | 0 | 2583029270172119    | D  | 651 | 50 | 7   |
| 29 snd/RXT | 0 | 2636866569519043    | D  | 701 | 50 | 7   |
| 30 snd     | 0 | 2693347930908203    | D  | 751 | 50 | 7   |
| 31 rcv/DA  | 0 | 26944422721862793   | A  | 6   | 0  | 301 |
| 32 rcv/DA  | 0 | 2958977222442627    | A  | 6   | 0  | 301 |
| 33 rcv/DA  | 0 | 3168489933013916    | A  | 6   | 0  | 301 |
| 34 snd/RXT | 0 | 3377835750579834    | D  | 301 | 50 | 0   |
| 35 snd/DUP | 0 | 37487220764160156   | D  | 301 | 50 | 0   |

|   |                    |         |         |    |         |
|---|--------------------|---------|---------|----|---------|
| 82107 snd   | 1565.6760001182556 | D       | 1605401 | 50 | 32101   |
| 82108 rcv   | 1565.6764554977417 | A       | 32101   | 0  | 1605051 |
| 82109 rcv/DA                                      | 1565.6771850585938 | A       | 32101   | 0  | 1605051 |
| 82110 snd/rozd                                    | 1565.6762351389746 | D       | 1605201 | 50 | 32099   |
| 82111 snd   | 1565.6774451732635 | D       | 1605451 | 50 | 32102   |
| 82112 rcv/DA                                      | 1565.6778593063354 | A       | 32101   | 0  | 1605051 |
| 82113 rcv/DA                                      | 1565.6785093440247 | A       | 32101   | 0  | 1605051 |
| 82114 snd/RXT                                     | 1565.6893348693848 | D       | 1605051 | 50 | 0       |
| 82115 snd   | 1565.678704738617  | D       | 1605501 | 50 | 32102   |
| 82116 rcv/DA                                      | 1565.6955609321594 | A       | 32101   | 0  | 1605051 |
| 82117 snd/DUP                                     | 1565.701141834259  | D       | 1605501 | 50 | 32102   |
| 82118 rcv/DA                                      | 1565.7065389156342 | A       | 32101   | 0  | 1605051 |
| 82119 rcv/DA                                      | 1565.7196831703186 | A       | 32101   | 0  | 1605051 |
| 82120 snd/RXT                                     | 1565.7304606437683 | D       | 1605051 | 50 | 0       |
| 82121 rcv/DA                                      | 1565.7412884235382 | A       | 32101   | 0  | 1605051 |
| 82122 rcv/DA                                      | 1565.752204656601  | A       | 32101   | 0  | 1605051 |
| 82123 rcv/DA                                      | 1565.7630457878113 | A       | 32101   | 0  | 1605051 |
| 82124 rcv/DA                                      | 1565.7739112377167 | A       | 32101   | 0  | 1605051 |
| 82125 rcv   | 1565.7846913337708 | A       | 32111   | 0  | 1605551 |
| 82126 rcv/DA                                      | 1565.7954668998718 | A       | 32111   | 0  | 1605551 |
| 82127 snd   | 1565.7957730292274 | D       | 1605551 | 35 | 32112   |
| 82128 rcv/DA                                      | 1565.80104470253   | A       | 32111   | 0  | 1605551 |
| 82129 rcv   | 1565.8122763633728 | A       | 32112   | 0  | 1605586 |
| 82130 snd   | 1565.8230636119043 | F       | 1605586 | 0  | 32113   |
| 82131 rcv   | 1566.024086713791  | A       | 32113   | 0  | 1605587 |
| 82132 rcv   | 1566.0301070213318 | F       | 32113   | 0  | 1605587 |
| 82133 snd   | 1566.031002521515  | A       | 1605586 | 0  | 32114   |
| 82134   |                    |         |         |    |         |
| 82135 Size of the file (in Bytes)                 |                    | 1605585 |         |    |         |
| 82136 Segments transmitted (including drop & RXT) |                    | 44838   |         |    |         |
| 82137 Number of Segments handled by PLD           |                    | 44834   |         |    |         |
| 82138 Number of Segments dropped                  |                    | 4187    |         |    |         |
| 82139 Number of Segments Corrupted                |                    | 3353    |         |    |         |
| 82140 Number of Segments Re-ordered               |                    | 2138    |         |    |         |
| 82141 Number of Segments Duplicated               |                    | 3678    |         |    |         |
| 82142 Number of Segments Delayed                  |                    | 0       |         |    |         |
| 82143 Number of Retransmissions due to TIMEOUT    |                    | 2771    |         |    |         |
| 82144 Number of FAST RETRANSMISSION               |                    | 6273    |         |    |         |
| 82145 Number of DUP ACKS received                 |                    | 26471   |         |    |         |



|               |                       |   |           |     |    |         |
|---------------|-----------------------|---|-----------|-----|----|---------|
| 1 rcv         |                       | 0 | S         | 0   |    | 0       |
| 2 snd         | 0.0011267662048339844 | A | 0         |     | 0  | 1       |
| 3 rcv         | 0.0020966529846191406 | D | 1         |     | 1  | 1       |
| 4 rcv/Cor     | 0.026473482650756836  | D | 1         | 50  | 1  | 1       |
| 5 rcv         | 0.042308906933664551  | D | 1         | 0   | 0  | 1       |
| 6 snd/DA      | 0.04381704384444336   | A | 0         |     | 0  | 1       |
| 7 rcv         | 0.0895358886711875    | A | 101       | 50  | 1  | 1       |
| 8 snd/DA      | 0.001235400782295988  | A | 9         |     | 1  | 1       |
| 9 rcv         | 0.10754132720812988   | D | 151       | 50  | 1  | 1       |
| 10 snd/DA     | 0.1081843376159668    | A | 0         |     | 0  | 1       |
| 11 rcv        | 0.12865805625915527   | D | 201       | 50  | 1  | 1       |
| 12 snd/DA     | 0.129508390991211     | A | 9         |     | 0  | 1       |
| 13 rcv        | 0.13086114959716797   | D | 1         | 50  | 0  | 1       |
| 14 snd        | 0.1331472396855886    | A | 5         |     | 0  | 251     |
| 15 rcv        | 0.14452195167541504   | D | 251       | 50  | 1  | 1       |
| 16 snd        | 0.14595317840576172   | A | 6         |     | 0  | 301     |
| 17 rcv/dup    | 0.1765493510345459    | D | 1         | 50  | 0  | 0       |
| 18 snd/DA     | 0.1776123046875       | A | 6         | 50  | 0  | 301     |
| 19 rcv/Cor    | 0.1781987081604004    | D | 301       |     | 0  | 1       |
| 20 rcv        | 0.1873893737929688    | D | 351       | 50  | 1  | 1       |
| 21 snd/DA     | 0.1880810260772705    | A | 6         |     | 0  | 301     |
| 22 rcv        | 0.20878124237060547   | D | 401       | 50  | 1  | 1       |
| 23 snd/DA     | 0.20956993103027344   | A | 6         |     | 0  | 301     |
| 24 rcv        | 0.22473597256550293   | D | 451       | 50  | 6  | 301     |
| 25 snd/DA     | 0.22559426215402685   | A | 1         |     | 0  | 301     |
| 26 rcv        | 0.23587250709533691   | D | 6         | 501 | 50 | 7       |
| 27 snd/DA     | 0.23647546768188477   | A | 6         |     | 0  | 301     |
| 28 rcv/Cor    | 0.23707222938537598   | D | 651       | 50  | 51 | 7       |
| 29 rcv        | 0.2521629333496094    | D | 601       | 50  | 0  | 301     |
| 30 snd/DA     | 0.25290898975793457   | A | 6         |     | 0  | 7       |
| 31 rcv        | 0.2632758617401123    | D | 551       | 50  | 1  | 7       |
| 32 snd/DA     | 0.26397252082824707   | A | 6         |     | 0  | 301     |
| 33 rcv        | 0.26454925537109375   | D | 301       | 50  | 0  | 0       |
| <br>          |                       |   |           |     |    |         |
| <br>          |                       |   |           |     |    |         |
| <br>          |                       |   |           |     |    |         |
| 77928 snd/DA  | 1565.6633727550507    | A | 32101     | 0   |    | 1605851 |
| 77921 rcv/dup | 1565.6639289855957    | D | 1605251   | 50  |    | 32099   |
| 77922 snd/DA  | 1565.6646523475647    | A | 32101     |     |    | 1605851 |
| 77923 rcv     | 1565.6652069091797    | D | 1605301   | 50  |    | 32099   |
| 77924 snd/DA  | 1565.6656987667084    | A | 32101     |     |    | 1605851 |
| 77925 rcv     | 1565.6661999225616    | D | 1605351   | 50  |    | 32099   |
| 77926 snd/DA  | 1565.6666889326477    | A | 32101     |     |    | 1605851 |
| 77927 rcv     | 1565.668932044983     | D | 1605401   | 50  |    | 32101   |
| 77928 snd/DA  | 1565.6681967559814    | A | 32101     |     |    | 1605851 |
| 77929 rcv     | 1565.6821377777374    | D | 1605401   | 50  |    | 32099   |
| 77930 snd/DA  | 1565.682762862518     | A | 32101     |     |    | 1605851 |
| 77931 rcv     | 1565.68337392807      | D | 1605451   | 50  |    | 32102   |
| 77932 snd/DA  | 1565.6840181350708    | A | 32101     |     |    | 1605851 |
| 77933 rcv     | 1565.6845955848694    | D | 1605501   | 50  |    | 32102   |
| 77934 snd/DA  | 1565.685210943222     | A | 32101     |     |    | 1605851 |
| 77935 rcv     | 1565.694321155548     | D | 1605051   | 50  |    | 0       |
| 77936 snd     | 1565.7133116722107    | A | 32111     |     |    | 1605551 |
| 77937 rcv/dup | 1565.714268128479     | D | 1605501   | 50  |    | 32102   |
| 77938 snd/DA  | 1565.7149102687836    | A | 32111     |     |    | 1605551 |
| 77939 rcv/dup | 1565.7373847961426    | D | 1605051   | 50  |    | 0       |
| 77940 snd/DA  | 1565.7474942207336    | A | 32111     |     |    | 1605551 |
| 77941 rcv     | 1565.8007125654492    | D | 1605551</ |     |    |         |