Assignment Report

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This code is written by python 3.6 **10/10/2018**

Brief Introduction

The main structure in sender.py:

A three-way handshake → Separating file by MSS and storing in a **list** → Sender Thread & Receiver Thread → Four-segment connection termination

In Sender Thread, the main structure:

Loop (LastByteSent – LastByteAcked ≤ MWS) → PLD (judging how to handle the data: drop, duplicate, corrupt, re-order, delay, normal transmission and transmitting the data)(In addition, every PLD should start a timer if there is not timer working) → Judging whether get a receiving ack from receiver or timeout (If getting an ack and it is from normal transmission but not retransmission, and then calculating the TimeoutInterval which is used in estimating time out. If timeout, setting the receiving ack flag to 0 which means timeout) → If receiving ack flag is 0, preparing for retransmitting the segments → Determining the size of the file that has been sent by the value of the last ack obtained from the receiver and it can locate (in the beginning of the definition of **list**) where the file should continue to be sent → Retransmitting the segments by using PLD → If at the end of the file, finishing the thread → Break

In Receiver Thread, the main structure:

Loop (if the timer is working) → Judging whether get the expected ack from receiver (If getting an expected ack or a larger one (cumulative ack), changing the expected ack. If getting three times same ack from receiver, then fast retransmitting) → (Fast retransmitting (or skipping this step) by using PLD)→ If at the end of the file, finishing the thread → Break

In PLD, the main structure:

Judging whether to drop or not → dropping the packet and recording → (If not drop) Judging whether to duplicate or not → duplicating the packet and sending and recording → (If not drop, duplicate) Judging whether to corrupt or not → calculating the original checksum and then corrupting the packet with original checksum and then sending and recording → (If not drop, duplicate, corrupt) Judging whether to re-order or not → If a reorder packet exists, once sending a packet, counting it one, until the “maxorder” packets are sent or the next reorder packet comes in → (If not drop, duplicate, corrupt, re-order) Judging whether to delay or not → delay the sending → (If not drop, duplicate,

corrupt, re-order, delay) Normal transmission

The main structure in receiver.py:

A three-way handshake → Loop (If the FIN flag is not 1, receiving the data) → Judging whether getting the expected data or not → ((If the data is in the correct order) Judging whether getting correct data or corrupt data → (If the data is correct) changing the expected data, and checking the buffer whether there are other segments already been transferred (cumulative ack) → (If the data is corrupted) ignored and just recording) **or** ((If the data is not in the correct order) Judging whether getting correct data or corrupt data → (If the data is correct) recording and putting the received data in the buffer (cumulative ack) → (If the data is corrupted) ignored and just recording) → sending the ack to the sender → getting the FIN flag is 1, break → Four-segment connection termination

The list of features that I have successfully implemented is as follows:

1. A three-way handshake (SYN, SYN+ACK, ACK) for the connection establishment. The ACK sent by the sender to conclude the three-way handshake should not contain any payload (i.e. data).
2. A four-segment (FIN, ACK, FIN, ACK) connection termination. The Sender will initiate the connection close once the entire file has been successfully transmitted.
3. Sender maintains a single-timer for timeout operation. The timeout is not a constant value but is given by the formula (TimeoutInterval = EstimatedRTT + 4 * DevRTT).
And EstimatedRTT = (1 - α) * 500 + α * SampleRTT, DevRTT = (1-β) * DevRTT + β * abs(SampleRTT – EstimatedRTT)(α = 0.125 and β = 0.25 respectively). The initial value of EstimatedRTT = 500 milliseconds and DevRTT = 250 milliseconds.
4. The STP protocol includes the simplified TCP sender and fast retransmit. I use many concepts in class, such as sequence numbers, cumulative acknowledgements, timers, buffers, etc.
5. The receiver uses ack with immediate confirmation and cumulative acknowledgement.
6. STP is a byte-stream oriented protocol. And it includes sequence number and acknowledgement number fields in the STP header for each segment. The meaning of sequence number and acknowledgment number are the same as in TCP.
7. MSS (Maximum segment size) is the maximum number of bytes of data that STP segment can contain. Sender can deal with different values of MSS. The value of MSS will be supplied to Sender as an input argument.
8. Another input argument for Sender is Maximum Window Size (MWS). MWS is the maximum number of un-acknowledged bytes that the Sender can have at any time. Header length does not be counted as part of MWS.
Since we do not need to implement flow or congestion control, I am limiting the number of unacknowledged bytes by using the MWS parameter. In other words, During the lifetime of the connection, the following condition is satisfied:
LastByteSent – LastByteAcked ≤ MWS
9. The functions of the PLD module are implemented according to the following steps:
1. If the STP segment is for connection establishment or teardown, then pass the segment

to UDP without going through PLD.

2. If the STP segment is not for connection establishment or teardown, the PLD does one of the following:

(a) With probability pDrop, drop the segment. The code simply generates a random number between 0 and 1. If the chosen number is less than pDrop, drop the STP segment.

(b) If the segment is not dropped, with probability pDuplicate, forward the STP segment twice back-to-back to UDP.

(c) If the packet is not dropped or duplicated, with probability pCorrupt, introduce one bit error (I just simply flip a bit in the end of each data segement) and forward the STP segment to UDP.

(d) If the packet is not dropped, duplicated or corrupted, with probability pOrder save the current STP segment and wait for forwarding of maxOrder segments to UDP before forwarding the saved STP segment to UDP. If there is a segment already waiting for re-ordering, forward the new STP segment without any delay.

(e) If the STP segment is not dropped, duplicated, corrupted or re-ordered, with probability pDelay the segment is to be delayed by anywhere between 0 to MaxDelay milliseconds before forwarding to UDP.

(f) If the STP segment is not dropped, duplicated, corrupted, re-ordered or delayed, forward the STP segment to UDP.

The list of functions that are not very well implemented:

1. In the PLD module, since I cannot ensure the encoding method of the pdf file provided especially for test2.pdf, I just corrupt one bit in the data when the data from pdf file in the byte coding is smaller than 255 and larger than 0. In other words, when I want to corrupt the data from pdf file and then pack it into bytes, it has something wrong because struct.pack() cannot pack the data because the value of data from pdf file in bytes coding is larger than 255 and struct.pack() can only pack the value which is larger than 0 and smaller than 255.
2. Two threads are parallel in sender.py. The sender thread is used to send data and timeout retransmission, and the receiver thread is used to receive acks and fast retransmission, so some processing may not be reasonable. For example, receiver thread receives an ACK and sets the flag of the received message to be received, but in the sender thread, the timeout may have just been completed calculating and the flag of the received message is set to not be received, which may result in some unnecessary retransmission. In other words, experimental phenomena do not necessarily reproduce exactly the same, but only probably similar, so in the latter question (b), I run twice for each gamma value, so I get two form.

STP segment format:

4 Bytes

SYN
ACK
FIN
Sequence number
Acknowledgement number
Data length (MSS)
Checksum
Payload data (length depends on MSS)

Above diagram is the STP segment format, and for easier programming, I default the length of 4 bytes to all field, such as SYN, ACK, FIN and sequence numbers. But in fact, we do not need to give some fields such a long length. I default the length just for easier programming. These extra lengths can be used for other purpose if necessary. The default set for segment header is: SYN=0, ACK=0, FIN=0, seq=0, acknowledgment=0, length=MSS, checksum=0, data=b''. I use a class to hold the mentioned information, they will keep zero each time if there is no need for change. SYN, ACK and FIN is flag for recognition, they are the same idea with TCP. The sequence number and acknowledgement number are also the same as TCP. Data length and checksum is a little bit different from TCP. Data length is the payload data's length but not the header length. And the checksum is just for payload data. That means if we calculate checksum, we just use the field of payload data. In addition, the calculation method is similar with TCP, but I separate the payload data into 8 bits, and then calculate the sum of all 8 bits from payload data. Therefore, my checksum is also 8 bits and it does not need the 4 bytes length either. All these field except payload data (it was originally binary forms) will be switched into binary type and decode once received.

Reference code:

https://github.com/BiancaTong/Computer-Network-with-Python-and-C/blob/master/Assignments/Ass1/sender.py

Refer to some methods and structure of sender thread and receiver thread in sender.py.

Question A:

(Note: The initial SEQ value of all my experiments in sender.py is 8, and the initial SEQ value of all in receiver.py is 99. And the time is millisecond.) (Since using python 3, the command is "python3 …" e.g. python3 reciever.py 3300 file_r.pdf)

Run the protocol using pDrop = 0.1, MWS = 500 bytes, MSS = 100 bytes, seed = 100, gamma = 4, and pDuplicate, pCorrupt, pOrder, MaxOrder, pDelay, MaxDelay all set to 0. Transfer the file **test0.pdf**.

Show the sequence of STP packets that are observed at the Receiver. It is sufficient to just indicate the sequence numbers of the STP packets that have arrived.

Run an additional experiment with pdrop = 0.3, transferring the same file (**test0.pdf**). In your report, discuss the resulting packet sequences of both experiments indicating where dropping occurred.

(In the appendix section I show the packet sequences for both the above experiments.)

pDrop = 0.1:

	state	time	flag	seq	length	ack	
1	rcv	3229.082	S	8	100	0	
2	rcv	3229.536	S	9	100	100	
3	rcv	3231.168	D	9	100	100	
4	rcv	3231.639	D	109	100	100	drop 209
5	rcv	3232.292	D	309	100	100	
6	rcv	3232.646	D	409	100	100	
7	rcv	3232.914	D	209	100	100	
8	rcv	3233.152	D	509	100	100	
9	rcv	3233.379	D	609	100	100	
10	rcv	3244.559	D	709	100	100	
11	rcv	3244.961	D	809	100	100	
12	rcv	3245.332	D	909	100	100	
13	rcv	3245.621	D	1009	100	100	
14	rcv	3245.831	D	1109	100	100	
15	rcv	3245.991	D	1209	100	100	
16	rcv	3246.141	D	1309	100	100	
17	rcv	3246.288	D	1409	100	100	
18	rcv	3246.435	D	1509	100	100	
19	rcv	3246.684	D	1609	100	100	
20	rcv	3246.830	D	1709	100	100	
21	rcv	3246.976	D	1809	100	100	
22	rcv	3247.122	D	1909	100	100	drop 2009
23	rcv	3247.282	D	2109	100	100	
24	rcv	3247.436	D	2209	100	100	
25	rcv	3247.590	D	2009	100	100	
26	rcv	3247.741	D	2309	100	100	
27	rcv	3247.887	D	2409	100	100	
28	rcv	3248.033	D	2509	100	100	
29	rcv	3248.178	D	2609	100	100	drop 2709,2809
30	rcv	3248.350	D	2909	100	100	
31	rcv	3248.494	D	3009	100	100	
32	rcv	3248.645	D	2709	100	100	
33	rcv	4787.314	D	2809	100	100	
34	rcv&dup	4787.735	D	2809	100	100	
35	rcv	6321.160	F	3037	100	100	
36	rcv	6321.438	A	3038	100	101	

pDrop = 0.3:

	state	time	flag	seq	length	ack	
1	rcv	4876.726	S	8	100	0	
2	rcv	4877.158	S	9	100	100	
3	rcv	4879.469	D	109	100	100	drop 9
4	rcv	4879.744	D	209	100	100	
5	rcv	4879.970	D	309	100	100	
6	rcv	5879.660	D	9	100	100	
7	rcv&dup	5880.237	D	9	100	100	
8	rcv	5880.692	D	709	100	100	drop 409,509,609,809
9	rcv	5881.012	D	409	100	100	
10	rcv	5881.361	D	909	100	100	
11	rcv	7319.077	D	509	100	100	
12	rcv	7319.500	D	1009	100	100	
13	rcv	8780.522	D	609	100	100	
14	rcv	10314.572	D	809	100	100	
15	rcv	10314.922	D	1209	100	100	drop 1109,1309,1409
16	rcv	10315.112	D	1509	100	100	drop 1609
17	rcv	10315.269	D	1109	100	100	
18	rcv	10315.445	D	1709	100	100	
19	rcv	11830.947	D	1309	100	100	
20	rcv	11831.279	D	1809	100	100	
21	rcv	13346.873	D	1409	100	100	
22	rcv	13347.089	D	1909	100	100	
23	rcv	13347.251	D	2009	100	100	
24	rcv	13347.406	D	1609	100	100	
25	rcv	13347.563	D	2109	100	100	drop 2209
26	rcv	13347.731	D	2309	100	100	drop 2409,2509,2609
27	rcv	14863.233	D	2209	100	100	
28	rcv	14863.571	D	2709	100	100	drop 2809
29	rcv	16379.039	D	2409	100	100	drop 2909
30	rcv	17894.868	D	2509	100	100	
31	rcv	17895.172	D	3009	100	100	
32	rcv	19410.790	D	2609	100	100	
33	rcv	20926.564	D	2809	100	100	
34	rcv	22442.403	D	2909	100	100	
35	rcv	23958.522	F	3037	100	100	
36	rcv	23959.137	A	3038	100	101	

All purple marks are where drop occurs.

Question B:

The timeout for STP is given by: TimeoutInterval = EstimatedRTT + gamma * DevRTT

Set pdrop = 0.5, MWS = 500 bytes, MSS = 50 bytes, seed = 300, pdelay = 0.2, MaxDelay = 1000 and pDuplicate, pCorrupt, pOrder, MaxOrder all set to 0.

Run three experiments with the following different gamma values:

i. gamma = 2

ii. gamma = 4

iii. gamma = 6

and transfer the file **test1.pdf** using STP.

Show a table that indicates how many STP packets were transmitted in total and how

long the overall transfer took. Discuss the results.

	Number of STP packets	**Overall transfer time**
gamma = 2	14284	52 minutes
gamma = 4	14345	73 minutes
gamma = 6	13729	95 minutes

Answer: Overall transfer time is increasing when gamma value becomes larger. The reason is that when gamma is increasing, the Timeout Interval will also become larger when we estimate the timeout value. This will eventually lead to an increase in the time of message timeout and the timeout retransmission. In addition, the total number of STP packets will be affected due to the impact of timeout retransmission packets.

Question C:

Use the following values and run STP to transfer **test2.pdf**.
MWS=500bytes MSS=50 gamma=4 pDrop=0.1 pDuplicate=0.1 pCorrupt=0.1 pOrder=0.1 maxOrder=4 pDelay=0 maxDelay=0 seed=300
Has the file been successfully transferred?
Answer: Yes
Attached screen shot for the initial transfer (connection establishment + first 20 entries) and the last 20 entries plus the summary statistics table for the sender_log.txt and receiver_log.txt files in appendix(Question C)
How long the overall transfer took?
Answer: About 50 – 95 minutes. I did the transmission several times and get the scope.
For this experiment, which of the factor (out of pDrop, pDuplicate, pCorrupt and pOrder) is the most critical contributing most in the overall transfer time? How have you determined this?
Answer: I think the most critical contributing factor is dropping the packets since it will cause fast retransmission or timeout retransmission, which will cost more time in getting the correct packets order. In addition, corrupting the packets is also a critical factor because the receiver just drops the corrupted packets, which is like dropping a packet. On the contrary, I think duplicating is nearly no effect since it just make receiver send two ack to sender. To prove my hypothesis, I did the below experiment:
Initial time: 50-95 minutes.
(1) pDrop=0 and other thing is the same like initial experiment, time: 41 mins.
(2) pDuplicate=0 and other thing is the same like initial experiment, time: 90 mins.
(3) pCorrupt=0 and other thing is the same like initial experiment, time: 82 mins.
(4) pOrder=0 and other thing is the same like initial experiment, time: 73 mins
As we can see, the result is like my hypothesis. But re-order has also some similar effects like dropping. Therefore, corrupting and reordering have similar features.

Appendix

Question A:

(1) pDrop = 0.1:

Sender_log.txt:

snd 0.045 S 8 0 0

rcv 0.394 SA 99 100 9

snd 0.464 A 9 0 100

snd 1.908 D 9 100 100

rcv 2.482 A 100 100 109

rcv 3.014 A 100 100 209

snd 3.144 D 109 100 100

drop 3.183 D 209 100 100

rcv/DA 3.501 A 100 100 209

snd 3.590 D 309 100 100

rcv/DA 3.851 A 100 100 209

snd 4.096 D 409 100 100

snd 4.321 D 509 100 100

snd/RXT 4.552 D 209 100 100

snd 4.628 D 609 100 100

rcv 15.168 A 100 100 509

rcv 15.233 A 100 100 609

rcv 15.422 A 100 100 709

rcv 15.824 A 100 100 809

snd 15.899 D 709 100 100

rcv 16.177 A 100 100 909

snd 16.260 D 809 100 100

rcv 16.541 A 100 100 1009

snd 16.611 D 909 100 100

rcv 16.803 A 100 100 1109

snd 16.829 D 1009 100 100

rcv 16.963 A 100 100 1209

snd 16.986 D 1109 100 100

rcv 17.122 A 100 100 1309

snd 17.145 D 1209 100 100

rcv 17.270 A 100 100 1409

snd 17.292 D 1309 100 100

rcv 17.416 A 100 100 1509

snd 17.439 D 1409 100 100

rcv 17.666 A 100 100 1609

snd 17.689 D 1509 100 100

rcv 17.812 A 100 100 1709

snd 17.835 D 1609 100 100

rcv 17.959 A 100 100 1809

snd 17.981 D 1709 100 100

rcv 18.105 A 100 100 1909

snd 18.127 D 1809 100 100

rcv 18.250 A 100 100 2009

snd 18.272 D 1909 100 100

drop 18.288 D 2009 100 100

rcv/DA 18.411 A 100 100 2009

snd 18.435 D 2109 100 100

rcv/DA 18.570 A 100 100 2009

snd/RXT 18.601 D 2009 100 100

rcv 18.723 A 100 100 2309

snd 18.745 D 2209 100 100

rcv 18.869 A 100 100 2409

snd 18.892 D 2309 100 100

rcv 19.016 A 100 100 2509

snd 19.037 D 2409 100 100

rcv 19.161 A 100 100 2609

snd 19.183 D 2509 100 100

rcv 19.306 A 100 100 2709

snd 19.328 D 2609 100 100

drop 19.344 D 2709 100 100

drop 19.358 D 2809 100 100

rcv/DA 19.480 A 100 100 2709

snd 19.501 D 2909 100 100

rcv/DA 19.627 A 100 100 2709

snd/RXT 19.657 D 2709 100 100

rcv 19.775 A 100 100 2809

snd 19.797 D 3009 28 100

snd/RXT 1558.618 D 2809 100 100

snd/RXT 1559.027 D 2809 100 100

rcv 1571.836 A 100 100 3109

snd 3092.017 F 3037 0 100

snd 3092.433 A 3038 0 101

Size of the file (in Bytes): 3028

Segments transmitted (including drop & RXT): 40

Number of Segments handled by PLD: 36

Number of Segments Dropped: 4

Number of Segments Corrupted: 0

Number of Segments Re-ordered: 0

Number of Segments Duplicated: 0

Number of Segments Delayed: 0

Number of Retransmissions due to timeout: 2

Number of Fast Retransmissions: 3

Number of Duplicate Acknowledgements received: 6

Receiver_log.txt:

rcv 3229.082 S 8 100 0

snd 3229.204 SA 99 0 9

rcv 3229.536 S 9 100 100

rcv 3231.168 D 9 100 100

snd 3231.228 A 100 0 109

rcv 3231.639 D 109 100 100

snd 3231.712 A 100 0 209

rcv 3232.292 D 309 100 100

snd&DA 3232.316 A 100 0 209

rcv 3232.646 D 409 100 100

snd&DA 3232.672 A 100 0 209

rcv 3232.914 D 209 100 100

snd 3232.953 A 100 0 509

rcv 3233.152 D 509 100 100

snd 3233.186 A 100 0 609

rcv 3233.379 D 609 100 100

snd 3233.412 A 100 0 709

rcv 3244.559 D 709 100 100

snd 3244.598 A 100 0 809

rcv 3244.961 D 809 100 100

snd 3244.998 A 100 0 909

rcv 3245.332 D 909 100 100

snd 3245.369 A 100 0 1009

rcv 3245.621 D 1009 100 100

snd 3245.657 A 100 0 1109

rcv 3245.831 D 1109 100 100

snd 3245.864 A 100 0 1209

rcv 3245.991 D 1209 100 100

snd 3246.025 A 100 0 1309

rcv 3246.141 D 1309 100 100

snd 3246.173 A 100 0 1409

rcv 3246.288 D 1409 100 100

snd 3246.320 A 100 0 1509

rcv 3246.435 D 1509 100 100

snd 3246.467 A 100 0 1609

rcv 3246.684 D 1609 100 100

snd 3246.715 A 100 0 1709

rcv 3246.830 D 1709 100 100

snd 3246.862 A 100 0 1809

rcv 3246.976 D 1809 100 100

snd 3247.008 A 100 0 1909

rcv 3247.122 D 1909 100 100

snd 3247.154 A 100 0 2009

rcv 3247.282 D 2109 100 100

snd&DA 3247.301 A 100 0 2009

rcv 3247.436 D 2209 100 100

snd&DA 3247.458 A 100 0 2009

rcv 3247.590 D 2009 100 100

snd 3247.626 A 100 0 2309

rcv 3247.741 D 2309 100 100

snd 3247.773 A 100 0 2409

rcv 3247.887 D 2409 100 100

snd 3247.919 A 100 0 2509

rcv 3248.033 D 2509 100 100

snd 3248.064 A 100 0 2609

rcv 3248.178 D 2609 100 100

snd 3248.209 A 100 0 2709

rcv 3248.350 D 2909 100 100

snd&DA 3248.369 A 100 0 2709

rcv 3248.494 D 3009 100 100

snd&DA 3248.516 A 100 0 2709

rcv 3248.645 D 2709 100 100

snd 3248.678 A 100 0 2809

rcv 4787.314 D 2809 100 100

snd 4787.410 A 100 0 3109

rcv&dup 4787.735 D 2809 100 100

snd&DA 4787.769 A 100 0 3109

rcv 6321.160 F 3037 100 100

snd 6321.242 A 100 0 3038

snd 6321.282 FA 100 0 3038

rcv 6321.438 A 3038 100 101

Amount of Data Received (bytes): 3300

Total segments received: 37

Data segments received: 32

Data Segments with bit errors: 0

Duplicate data segments received: 2

Duplicate Acks sent: 7

(2) pDrop = 0.3:

Sender_log.txt:

snd 0.047 S 8 0 0

rcv 0.590 SA 99 100 9

snd 0.989 A 9 0 100

drop 2.789 D 9 100 100

snd 3.178 D 109 100 100

snd 3.423 D 209 100 100

snd 3.640 D 309 100 100

drop 3.679 D 409 100 100

rcv/DA 26.735 A 100 100 9

rcv/DA 26.825 A 100 100 9

rcv/DA 26.963 A 100 100 9

drop/RXT 26.996 D 9 100 100

drop/RXT 1002.833 D 9 100 100

snd/RXT 1003.090 D 9 100 100

rcv 1003.643 A 100 100 409

rcv/DA 1003.975 A 100 100 409

snd/RXT 1004.030 D 9 100 100

drop 1004.103 D 509 100 100

drop 1004.138 D 609 100 100

rcv/DA 1004.414 A 100 100 409

snd/RXT 1004.477 D 409 100 100

rcv 1004.725 A 100 100 509

snd 1004.771 D 709 100 100

drop 1004.807 D 809 100 100

rcv/DA 1005.101 A 100 100 509

snd 1005.149 D 909 100 100

rcv 2442.827 A 100 100 609

snd/RXT 2442.881 D 509 100 100

rcv/DA 2443.185 A 100 100 609

snd 2443.210 D 1009 100 100

snd/RXT 3904.271 D 609 100 100

rcv 3922.513 A 100 100 809

rcv 5438.299 A 100 100 1109

snd/RXT 5438.339 D 809 100 100

drop 5438.392 D 1109 100 100

rcv/DA 5438.567 A 100 100 1109

snd 5438.591 D 1209 100 100

drop 5438.607 D 1309 100 100

drop 5438.623 D 1409 100 100

rcv/DA 5438.756 A 100 100 1109

snd/RXT 5438.787 D 1109 100 100

rcv 5438.909 A 100 100 1309

snd 5438.931 D 1509 100 100

drop 5438.956 D 1609 100 100

rcv/DA 5439.085 A 100 100 1309

snd 5439.191 D 1709 100 100

rcv 6954.711 A 100 100 1409

snd/RXT 6954.750 D 1309 100 100

rcv/DA 6954.957 A 100 100 1409

snd 6954.981 D 1809 100 100

drop/RXT 8470.206 D 1409 100 100

drop/RXT 8470.260 D 1409 100 100

drop/RXT 8470.280 D 1409 100 100

drop/RXT 8470.300 D 1409 100 100

drop/RXT 8470.321 D 1409 100 100

rcv 8470.562 A 100 100 1609

snd/RXT 8470.593 D 1409 100 100

rcv/DA 8470.737 A 100 100 1609

snd 8470.760 D 1909 100 100

rcv/DA 8470.893 A 100 100 1609

snd/RXT 8470.924 D 1609 100 100

rcv 8471.049 A 100 100 2109

snd 8471.073 D 2009 100 100

rcv 8471.198 A 100 100 2209

snd 8471.221 D 2109 100 100

drop 8471.237 D 2209 100 100

rcv/DA 8471.374 A 100 100 2209

snd 8471.397 D 2309 100 100

drop 8471.415 D 2409 100 100

drop 8471.437 D 2509 100 100

drop 8471.451 D 2609 100 100

rcv 9987.002 A 100 100 2409

snd/RXT 9987.041 D 2209 100 100

rcv/DA 9987.240 A 100 100 2409

snd 9987.263 D 2709 100 100

drop 9987.281 D 2809 100 100

rcv 11502.813 A 100 100 2509

snd/RXT 11502.851 D 2409 100 100

drop 11502.903 D 2909 100 100

rcv 13018.612 A 100 100 2609

snd/RXT 13018.651 D 2509 100 100

rcv/DA 13018.839 A 100 100 2609

snd 13018.862 D 3009 28 100

drop/RXT 14534.124 D 2609 100 100

rcv 14534.484 A 100 100 2809

snd/RXT 14534.515 D 2609 100 100

drop/RXT 16049.985 D 2809 100 100

rcv 16050.346 A 100 100 2909

snd/RXT 16050.376 D 2809 100 100

rcv 17566.133 A 100 100 3109

snd/RXT 17566.369 D 2909 100 100

snd 19081.884 F 3037 0 100

snd 19082.606 A 3038 0 101

Size of the file (in Bytes): 3028

Segments transmitted (including drop & RXT): 60

Number of Segments handled by PLD: 56

Number of Segments Dropped: 24

Number of Segments Corrupted: 0

Number of Segments Re-ordered: 0

Number of Segments Duplicated: 0

Number of Segments Delayed: 0

Number of Retransmissions due to timeout: 21

Number of Fast Retransmissions: 4

Number of Duplicate Acknowledgements received: 16

Receiver_log.txt:

rcv 4876.726 S 8 100 0

snd 4876.881 SA 99 0 9

rcv 4877.158 S 9 100 100

rcv 4879.469 D 109 100 100

snd 4879.567 A 100 0 9

rcv 4879.744 D 209 100 100

snd&DA 4879.790 A 100 0 9

rcv 4879.970 D 309 100 100

snd&DA 4880.011 A 100 0 9

rcv 5879.660 D 9 100 100

snd 5879.816 A 100 0 409

rcv&dup 5880.237 D 9 100 100

snd&DA 5880.280 A 100 0 409

rcv 5880.692 D 709 100 100

snd&DA 5880.732 A 100 0 409

rcv 5881.012 D 409 100 100

snd 5881.079 A 100 0 509

rcv 5881.361 D 909 100 100

snd&DA 5881.411 A 100 0 509

rcv 7319.077 D 509 100 100

snd 7319.148 A 100 0 609

rcv 7319.500 D 1009 100 100

snd&DA 7319.525 A 100 0 609

rcv 8780.522 D 609 100 100

snd 8780.612 A 100 0 809

rcv 10314.572 D 809 100 100

snd 10314.667 A 100 0 1109

rcv 10314.922 D 1209 100 100

snd&DA 10314.944 A 100 0 1109

rcv 10315.112 D 1509 100 100

snd&DA 10315.136 A 100 0 1109

rcv 10315.269 D 1109 100 100

snd 10315.304 A 100 0 1309

rcv 10315.445 D 1709 100 100

snd&DA 10315.467 A 100 0 1309

rcv 11830.947 D 1309 100 100

snd 11831.019 A 100 0 1409

rcv 11831.279 D 1809 100 100

snd&DA 11831.305 A 100 0 1409

rcv 13346.873 D 1409 100 100

snd 13346.934 A 100 0 1609

rcv 13347.089 D 1909 100 100

snd&DA 13347.114 A 100 0 1609

rcv 13347.251 D 2009 100 100

snd&DA 13347.273 A 100 0 1609

rcv 13347.406 D 1609 100 100

snd 13347.445 A 100 0 2109

rcv 13347.563 D 2109 100 100

snd 13347.594 A 100 0 2209

rcv 13347.731 D 2309 100 100

snd&DA 13347.751 A 100 0 2209

rcv 14863.233 D 2209 100 100

snd 14863.318 A 100 0 2409

rcv 14863.571 D 2709 100 100

snd&DA 14863.592 A 100 0 2409

rcv 16379.039 D 2409 100 100

snd 16379.123 A 100 0 2509

rcv 17894.868 D 2509 100 100

snd 17894.937 A 100 0 2609

rcv 17895.172 D 3009 100 100

snd&DA 17895.201 A 100 0 2609

rcv 19410.790 D 2609 100 100

snd 19410.851 A 100 0 2809

rcv 20926.564 D 2809 100 100

snd 20926.636 A 100 0 2909

rcv 22442.403 D 2909 100 100

snd 22442.471 A 100 0 3109

rcv 23958.522 F 3037 100 100

snd 23958.617 A 100 0 3038

snd 23958.664 FA 100 0 3038

rcv 23959.137 A 3038 100 101

Amount of Data Received (bytes): 3300

Total segments received: 37

Data segments received: 32

Data Segments with bit errors: 0

Duplicate data segments received: 2

Duplicate Acks sent: 15

Question B:

(1) gamma = 2:

Sender_log.txt:

snd 0.308 S 8 0 0

rcv 0.386 SA 99 50 9

snd 0.804 A 9 0 100

snd 86.892 D 9 50 100

drop 87.024 D 59 50 100

rcv 87.335 A 100 50 59

dely 333.827 D 109 50 100

drop 334.109 D 159 50 100

snd 334.276 D 209 50 100

drop 334.321 D 259 50 100

snd 334.396 D 309 50 100

drop 334.446 D 359 50 100

snd 334.518 D 409 50 100

snd 334.579 D 459 50 100

rcv/DA 336.112 A 100 50 59

rcv/DA 336.414 A 100 50 59

snd/RXT 336.999 D 59 50 100

rcv/DA 337.162 A 100 50 59

rcv/DA 337.240 A 100 50 59

rcv/DA 337.524 A 100 50 59

drop/RXT 337.572 D 59 50 100

rcv 337.827 A 100 50 159

dely 1228.157 D 509 50 100

snd 1228.253 D 559 50 100

drop 1228.361 D 609 50 100

rcv/DA 1237.925 A 100 50 159

snd/RXT 1387.068 D 159 50 100

rcv/DA 1403.551 A 100 50 159

drop/RXT 1408.677 D 159 50 100

rcv 1418.929 A 100 50 259

drop/RXT 2472.928 D 259 50 100

drop 2473.026 D 659 50 100

snd 2473.074 D 709 50 100

drop/RXT 2473.262 D 259 50 100

drop/RXT 2473.390 D 259 50 100

snd/RXT 2473.433 D 259 50 100

drop/RXT 2473.453 D 259 50 100

drop/RXT 2473.711 D 259 50 100

drop/RXT 2473.964 D 259 50 100

rcv/DA 2474.180 A 100 50 259

rcv 2474.351 A 100 50 359

rcv/DA 2479.477 A 100 50 359

dely/RXT 2479.536 D 259 50 100

drop 2479.585 D 759 50 100

drop 2479.639 D 809 50 100

drop/RXT 3523.286 D 359 50 100

drop/RXT 3523.476 D 359 50 100

snd/RXT 3523.883 D 359 50 100

drop/RXT 3523.958 D 359 50 100

rcv 3524.441 A 100 50 609

dely/RXT 3731.081 D 359 50 100

drop 3731.148 D 859 50 100

drop 3731.184 D 909 50 100

drop 3731.200 D 959 50 100

rcv/DA 3731.405 A 100 50 609

dely 3920.593 D 1009 50 100

drop 3920.651 D 1059 50 100

rcv/DA 3930.957 A 100 50 609

snd/RXT 3941.636 D 609 50 100

rcv 3951.943 A 100 50 659

snd/RXT 5005.954 D 659 50 100

drop 5006.148 D 1109 50 100

rcv 5006.611 A 100 50 759

dely/RXT 5615.965 D 659 50 100

drop 5616.049 D 1159 50 100

drop 5616.105 D 1209 50 100

rcv/DA 5621.421 A 100 50 759

… (Since it is too large, I omitted the rest of the txt)

drop/RXT 3149653.041 D 307709 50 100

rcv 3149653.435 A 100 50 307859

snd/RXT 3149653.469 D 307709 50 100

rcv/DA 3149654.017 A 100 50 307859

snd 3149654.049 D 308209 3 100

drop/RXT 3150702.313 D 307859 50 100

drop/RXT 3150702.477 D 307859 50 100

drop/RXT 3150702.516 D 307859 50 100

rcv 3150702.913 A 100 50 307909

snd/RXT 3150702.945 D 307859 50 100

rcv 3151752.210 A 100 50 307959

snd/RXT 3151752.253 D 307909 50 100

rcv 3152801.531 A 100 50 308009

snd/RXT 3152801.580 D 307959 50 100

rcv 3153850.847 A 100 50 308159

snd/RXT 3153850.890 D 308009 50 100

rcv 3154900.099 A 100 50 308259

snd/RXT 3154900.366 D 308159 50 100

snd 3155949.179 F 308212 0 100

snd 3155949.867 A 308213 0 101

Size of the file (in Bytes): 308203

Segments transmitted (including drop & RXT): 14284

Number of Segments handled by PLD: 14280

Number of Segments Dropped: 7224

Number of Segments Corrupted: 0

Number of Segments Re-ordered: 0

Number of Segments Duplicated: 0

Number of Segments Delayed: 1398

Number of Retransmissions due to timeout: 7028

Number of Fast Retransmissions: 1087

Number of Duplicate Acknowledgements received: 3870

Receiver_log.txt:

snd 0.308 S 8 0 0

rcv 0.386 SA 99 50 9

snd 0.804 A 9 0 100

snd 86.892 D 9 50 100

drop 87.024 D 59 50 100

rcv 87.335 A 100 50 59

dely 333.827 D 109 50 100

drop 334.109 D 159 50 100

snd 334.276 D 209 50 100

drop 334.321 D 259 50 100

snd 334.396 D 309 50 100

drop 334.446 D 359 50 100

snd 334.518 D 409 50 100

snd 334.579 D 459 50 100

rcv/DA 336.112 A 100 50 59

rcv/DA 336.414 A 100 50 59

snd/RXT 336.999 D 59 50 100

rcv/DA 337.162 A 100 50 59

rcv/DA 337.240 A 100 50 59

rcv/DA 337.524 A 100 50 59

drop/RXT 337.572 D 59 50 100

rcv 337.827 A 100 50 159

dely 1228.157 D 509 50 100

snd 1228.253 D 559 50 100

drop 1228.361 D 609 50 100

rcv/DA 1237.925 A 100 50 159

snd/RXT 1387.068 D 159 50 100

rcv/DA 1403.551 A 100 50 159

drop/RXT 1408.677 D 159 50 100

rcv 1418.929 A 100 50 259

drop/RXT 2472.928 D 259 50 100

drop 2473.026 D 659 50 100

snd 2473.074 D 709 50 100

drop/RXT 2473.262 D 259 50 100

drop/RXT 2473.390 D 259 50 100

snd/RXT 2473.433 D 259 50 100

drop/RXT 2473.453 D 259 50 100

drop/RXT 2473.711 D 259 50 100

drop/RXT 2473.964 D 259 50 100

rcv/DA 2474.180 A 100 50 259

rcv 2474.351 A 100 50 359

rcv/DA 2479.477 A 100 50 359

dely/RXT 2479.536 D 259 50 100

drop 2479.585 D 759 50 100

drop 2479.639 D 809 50 100

drop/RXT 3523.286 D 359 50 100

drop/RXT 3523.476 D 359 50 100

snd/RXT 3523.883 D 359 50 100

drop/RXT 3523.958 D 359 50 100

rcv 3524.441 A 100 50 609

dely/RXT 3731.081 D 359 50 100

drop 3731.148 D 859 50 100

drop 3731.184 D 909 50 100

drop 3731.200 D 959 50 100

rcv/DA 3731.405 A 100 50 609

dely 3920.593 D 1009 50 100

drop 3920.651 D 1059 50 100

rcv/DA 3930.957 A 100 50 609

snd/RXT 3941.636 D 609 50 100

rcv 3951.943 A 100 50 659

snd/RXT 5005.954 D 659 50 100

drop 5006.148 D 1109 50 100

rcv 5006.611 A 100 50 759

dely/RXT 5615.965 D 659 50 100

drop 5616.049 D 1159 50 100

drop 5616.105 D 1209 50 100

rcv/DA 5621.421 A 100 50 759

…

rcv 3152123.427 D 308109 50 100

snd&DA 3152123.582 A 100 0 307709

rcv 3152745.520 D 307709 50 100

snd 3152745.686 A 100 0 307859

rcv 3152746.183 D 308209 50 100

snd&DA 3152746.267 A 100 0 307859

rcv 3153794.967 D 307859 50 100

snd 3153795.181 A 100 0 307909

rcv 3154844.252 D 307909 50 100

snd 3154844.395 A 100 0 307959

rcv 3155893.562 D 307959 50 100

snd 3155893.796 A 100 0 308009

rcv 3156942.865 D 308009 50 100

snd 3156943.018 A 100 0 308159

rcv 3157992.193 D 308159 50 100

snd 3157992.365 A 100 0 308259

rcv 3159041.657 F 308212 50 100

snd 3159041.736 A 100 0 308213

snd 3159041.774 FA 100 0 308213

rcv 3159042.508 A 308213 50 101

Amount of Data Received (bytes): 352850

Total segments received: 7061

Data segments received: 7056

Data Segments with bit errors: 0

Duplicate data segments received: 1782

Duplicate Acks sent: 3870

(2) gamma = 4:

Sender_log.txt:

snd 0.046 S 8 0 0

rcv 0.405 SA 99 50 9

snd 0.505 A 9 0 100

snd 46.868 D 9 50 100

drop 46.937 D 59 50 100

rcv 47.174 A 100 50 59

dely 293.701 D 109 50 100

drop 293.795 D 159 50 100

snd 294.033 D 209 50 100

drop 294.073 D 259 50 100

snd 294.259 D 309 50 100

drop 294.305 D 359 50 100

snd 294.376 D 409 50 100

snd 294.539 D 459 50 100

rcv/DA 296.512 A 100 50 59

rcv/DA 296.743 A 100 50 59

snd/RXT 297.268 D 59 50 100

rcv/DA 297.491 A 100 50 59

rcv/DA 297.682 A 100 50 59

rcv/DA 297.869 A 100 50 59

drop/RXT 298.018 D 59 50 100

rcv 298.331 A 100 50 159

dely 1188.190 D 509 50 100

snd 1188.306 D 559 50 100

drop 1188.433 D 609 50 100

rcv/DA 1199.122 A 100 50 159

snd/RXT 1865.928 D 159 50 100

rcv/DA 1866.211 A 100 50 159

drop/RXT 1876.647 D 159 50 100

rcv 1887.850 A 100 50 259

drop/RXT 3441.815 D 259 50 100

drop 3441.869 D 659 50 100

snd 3442.322 D 709 50 100

rcv/DA 3442.563 A 100 50 259

drop/RXT 3442.923 D 259 50 100

drop/RXT 3443.204 D 259 50 100

snd/RXT 3443.546 D 259 50 100

rcv 3443.780 A 100 50 359

drop/RXT 3444.121 D 359 50 100

drop 3444.301 D 759 50 100

drop 3444.324 D 809 50 100

rcv 4998.537 A 100 50 609

dely/RXT 4998.575 D 359 50 100

drop 4998.638 D 859 50 100

drop 4998.655 D 909 50 100

drop 4998.669 D 959 50 100

drop 4998.683 D 1009 50 100

rcv/DA 4998.825 A 100 50 609

snd 4998.850 D 1059 50 100

drop/RXT 6547.400 D 609 50 100

rcv 6754.365 A 100 50 659

dely/RXT 6754.428 D 609 50 100

drop 6754.477 D 1109 50 100

drop/RXT 8303.219 D 659 50 100

drop/RXT 8303.364 D 659 50 100

rcv 8492.839 A 100 50 759

dely/RXT 8493.043 D 659 50 100

drop 8493.185 D 1159 50 100

rcv/DA 8493.518 A 100 50 759

snd 8493.711 D 1209 50 100

rcv 10042.016 A 100 50 809

snd/RXT 10042.098 D 759 50 100

drop 10042.157 D 1259 50 100

rcv 12200.447 A 100 50 859

dely/RXT 12200.675 D 809 50 100

drop 12200.826 D 1309 50 100

…

drop/RXT 4386709.882 D 308009 50 100

dely 4386710.213 D 308209 3 100

rcv 4388042.333 A 100 50 308059

snd/RXT 4388042.372 D 308009 50 100

dely/RXT 4390046.695 D 308059 50 100

snd/RXT 4390046.856 D 308059 50 100

drop/RXT 4390047.028 D 308059 50 100

drop/RXT 4390047.082 D 308059 50 100

drop/RXT 4390047.124 D 308059 50 100

drop/RXT 4390047.305 D 308059 50 100

drop/RXT 4390047.408 D 308059 50 100

snd/RXT 4390047.473 D 308059 50 100

drop/RXT 4390047.614 D 308059 50 100

drop/RXT 4390047.657 D 308059 50 100

rcv 4390049.206 A 100 50 308109

rcv/DA 4390049.292 A 100 50 308109

rcv/DA 4390049.363 A 100 50 308109

snd/RXT 4390049.429 D 308109 50 100

rcv 4390049.810 A 100 50 308259

dely/RXT 4390387.056 D 308059 50 100

snd 4391598.794 F 308212 0 100

snd 4391599.621 A 308213 0 101

Size of the file (in Bytes): 308203

Segments transmitted (including drop & RXT): 14345

Number of Segments handled by PLD: 14341

Number of Segments Dropped: 7252

Number of Segments Corrupted: 0

Number of Segments Re-ordered: 0

Number of Segments Duplicated: 0

Number of Segments Delayed: 1408

Number of Retransmissions due to timeout: 7044

Number of Fast Retransmissions: 1132

Number of Duplicate Acknowledgements received: 3947

Receiver_log.txt:

rcv 6614.854 S 8 50 0

snd 6615.009 SA 99 0 9

rcv 6615.225 S 9 50 100

rcv 6661.150 D 9 50 100

snd 6661.242 A 100 0 59

rcv 6909.324 D 109 50 100

snd&DA 6909.374 A 100 0 59

rcv 6909.500 D 209 50 100

snd&DA 6909.542 A 100 0 59

rcv 6909.644 D 309 50 100

snd&DA 6909.682 A 100 0 59

rcv 6909.777 D 409 50 100

snd&DA 6909.814 A 100 0 59

rcv 6909.907 D 459 50 100

snd&DA 6909.945 A 100 0 59

rcv 6911.626 D 59 50 100

snd 6911.714 A 100 0 159

rcv 7808.354 D 509 50 100

snd&DA 7808.431 A 100 0 159

rcv 7808.647 D 559 50 100

snd&DA 7808.693 A 100 0 159

rcv 8475.039 D 159 50 100

snd 8475.169 A 100 0 259

rcv 10056.620 D 709 50 100

snd&DA 10056.661 A 100 0 259

rcv 10058.209 D 259 50 100

snd 10058.268 A 100 0 359

rcv 11612.957 D 359 50 100

snd 11613.048 A 100 0 609

rcv 11613.376 D 1059 50 100

snd&DA 11613.401 A 100 0 609

rcv 13368.649 D 609 50 100

snd 13368.880 A 100 0 659

rcv 15107.215 D 659 50 100

snd 15107.336 A 100 0 759

rcv 15107.966 D 1209 50 100

snd&DA 15108.020 A 100 0 759

rcv 16656.518 D 759 50 100

snd 16656.588 A 100 0 809

rcv 18814.787 D 809 50 100

snd 18814.922 A 100 0 859

rcv 20364.368 D 859 50 100

snd 20364.428 A 100 0 909

rcv 21913.939 D 909 50 100

snd 21913.997 A 100 0 959

rcv 23894.821 D 959 50 100

snd 23894.940 A 100 0 1009

rcv 26030.003 D 1009 50 100

snd 26030.154 A 100 0 1109

rcv 26030.922 D 1559 50 100

snd&DA 26031.024 A 100 0 1109

rcv 28279.555 D 1109 50 100

snd 28279.696 A 100 0 1159

rcv 28280.452 D 1609 50 100

snd&DA 28280.509 A 100 0 1159

rcv 29829.447 D 1159 50 100

snd 29829.607 A 100 0 1259

rcv&dup 29829.704 D 1159 50 100

snd&DA 29829.743 A 100 0 1259

rcv&dup 29829.846 D 1159 50 100

snd&DA 29829.880 A 100 0 1259

rcv&dup 29829.975 D 1159 50 100

snd&DA 29830.008 A 100 0 1259

rcv&dup 29830.109 D 1159 50 100

snd&DA 29830.142 A 100 0 1259

rcv&dup 29830.234 D 1159 50 100

…

rcv 4393238.585 D 308159 50 100

snd&DA 4393238.776 A 100 0 308009

rcv 4393323.796 D 308209 50 100

snd&DA 4393324.162 A 100 0 308009

rcv 4394656.597 D 308009 50 100

snd 4394656.898 A 100 0 308059

rcv 4396662.545 D 308059 50 100

snd 4396662.782 A 100 0 308109

rcv&dup 4396663.093 D 308059 50 100

snd&DA 4396663.244 A 100 0 308109

rcv&dup 4396663.563 D 308059 50 100

snd&DA 4396663.710 A 100 0 308109

rcv 4396664.163 D 308109 50 100

snd 4396664.358 A 100 0 308259

rcv&dup 4397005.329 D 308059 50 100

snd&DA 4397005.552 A 100 0 308259

rcv 4398213.612 F 308212 50 100

snd 4398213.714 A 100 0 308213

snd 4398213.768 FA 100 0 308213

rcv 4398214.500 A 308213 50 101

Amount of Data Received (bytes): 354500

Total segments received: 7094

Data segments received: 7089

Data Segments with bit errors: 0

Duplicate data segments received: 1848

Duplicate Acks sent: 3948

(3) gamma = 6:

Sender_log.txt:

snd 0.444 S 8 0 0

rcv 0.504 SA 99 50 9

snd 0.799 A 9 0 100

snd 44.754 D 9 50 100

drop 44.781 D 59 50 100

rcv 44.901 A 100 50 59

dely 291.932 D 109 50 100

drop 291.998 D 159 50 100

snd 292.062 D 209 50 100

drop 292.102 D 259 50 100

snd 292.149 D 309 50 100

drop 292.845 D 359 50 100

snd 292.907 D 409 50 100

snd 292.957 D 459 50 100

rcv/DA 299.367 A 100 50 59

rcv/DA 299.499 A 100 50 59

snd/RXT 300.067 D 59 50 100

rcv/DA 300.169 A 100 50 59

rcv/DA 300.236 A 100 50 59

rcv/DA 300.297 A 100 50 59

drop/RXT 300.392 D 59 50 100

rcv 300.467 A 100 50 159

dely 1186.599 D 509 50 100

snd 1186.729 D 559 50 100

drop 1186.774 D 609 50 100

rcv/DA 1206.640 A 100 50 159

snd/RXT 2364.563 D 159 50 100

rcv/DA 2369.786 A 100 50 159

drop/RXT 2374.950 D 159 50 100

rcv 2385.217 A 100 50 259

drop/RXT 4438.925 D 259 50 100

drop 4439.031 D 659 50 100

snd 4439.078 D 709 50 100

drop/RXT 4439.171 D 259 50 100

drop/RXT 4439.243 D 259 50 100

snd/RXT 4439.439 D 259 50 100

drop/RXT 4439.737 D 259 50 100

drop/RXT 4439.889 D 259 50 100

drop/RXT 4439.918 D 259 50 100

rcv/DA 4440.274 A 100 50 259

rcv 4440.418 A 100 50 359

rcv/DA 4445.507 A 100 50 359

dely/RXT 4445.599 D 259 50 100

drop 4445.648 D 759 50 100

drop 4445.666 D 809 50 100

drop/RXT 6488.865 D 359 50 100

drop/RXT 6488.915 D 359 50 100

rcv 6489.661 A 100 50 609

snd/RXT 6489.790 D 359 50 100

drop 6489.976 D 859 50 100

dely 6696.514 D 909 50 100

drop 6696.631 D 959 50 100

drop 6696.936 D 1009 50 100

drop 6696.988 D 1059 50 100

rcv/DA 6707.405 A 100 50 609

dely/RXT 8727.643 D 609 50 100

drop/RXT 8728.121 D 609 50 100

rcv 8728.288 A 100 50 659

snd/RXT 8728.582 D 659 50 100

snd 8728.690 D 1109 50 100

rcv 8739.547 A 100 50 759

rcv/DA 8749.940 A 100 50 759

drop/RXT 10793.067 D 759 50 100

dely 11402.328 D 1159 50 100

drop 11402.432 D 1209 50 100

drop/RXT 11402.602 D 759 50 100

…

rcv 5704579.083 A 100 50 307659

drop/RXT 5706627.496 D 307659 50 100

dely 5707626.639 D 308109 50 100

snd/RXT 5707626.961 D 307659 50 100

rcv/DA 5707628.323 A 100 50 307659

rcv 5707628.434 A 100 50 307759

rcv/DA 5707628.969 A 100 50 307759

snd/RXT 5707629.371 D 307659 50 100

rcv/DA 5707633.373 A 100 50 307759

snd/RXT 5707633.688 D 307759 50 100

rcv 5707634.105 A 100 50 307809

snd 5707634.454 D 308159 50 100

drop 5707634.524 D 308209 3 100

rcv 5709683.021 A 100 50 307909

snd/RXT 5709683.151 D 307809 50 100

rcv 5711731.834 A 100 50 308209

snd/RXT 5711731.880 D 307909 50 100

rcv 5713780.549 A 100 50 308259

snd/RXT 5713780.805 D 308209 3 100

snd 5715829.181 F 308212 0 100

snd 5715829.941 A 308213 0 101

Size of the file (in Bytes): 308203

Segments transmitted (including drop & RXT): 13729

Number of Segments handled by PLD: 13725

Number of Segments Dropped: 6944

Number of Segments Corrupted: 0

Number of Segments Re-ordered: 0

Number of Segments Duplicated: 0

Number of Segments Delayed: 1346

Number of Retransmissions due to timeout: 6561

Number of Fast Retransmissions: 999

Number of Duplicate Acknowledgements received: 3668

Receiver_log.txt:

rcv 1749.793 S 8 50 0

snd 1749.877 SA 99 0 9

rcv 1750.276 S 9 50 100

rcv 1794.266 D 9 50 100

snd 1794.313 A 100 0 59

rcv 2041.287 D 109 50 100

snd&DA 2041.355 A 100 0 59

rcv 2041.975 D 209 50 100

snd&DA 2042.027 A 100 0 59

rcv 2042.143 D 309 50 100

snd&DA 2042.182 A 100 0 59

rcv 2042.771 D 409 50 100

snd&DA 2042.889 A 100 0 59

rcv 2042.996 D 459 50 100

snd&DA 2043.036 A 100 0 59

rcv 2049.492 D 59 50 100

snd 2049.586 A 100 0 159

rcv 2950.566 D 509 50 100

snd&DA 2950.636 A 100 0 159

rcv 2950.764 D 559 50 100

snd&DA 2950.802 A 100 0 159

rcv 4108.865 D 159 50 100

snd 4108.950 A 100 0 259

rcv 6189.083 D 709 50 100

snd&DA 6189.202 A 100 0 259

rcv 6189.440 D 259 50 100

snd 6189.519 A 100 0 359

rcv&dup 6195.008 D 259 50 100

snd&DA 6195.051 A 100 0 359

rcv 8238.748 D 359 50 100

snd 8238.809 A 100 0 609

rcv 8446.362 D 909 50 100

snd&DA 8446.456 A 100 0 609

rcv 10477.059 D 609 50 100

snd 10477.204 A 100 0 659

rcv 10478.494 D 659 50 100

snd 10478.587 A 100 0 759

rcv 10478.739 D 1109 50 100

snd&DA 10478.803 A 100 0 759

rcv 13152.210 D 1159 50 100

snd&DA 13152.322 A 100 0 759

rcv 13153.181 D 759 50 100

snd 13153.300 A 100 0 809

rcv 15202.096 D 809 50 100

snd 15202.152 A 100 0 859

rcv 17682.637 D 859 50 100

snd 17682.786 A 100 0 959

rcv 18274.094 D 1409 50 100

snd&DA 18274.182 A 100 0 959

rcv 19736.725 D 959 50 100

snd 19736.899 A 100 0 1009

rcv&dup 20436.787 D 959 50 100

snd&DA 20436.876 A 100 0 1009

rcv 20437.160 D 1459 50 100

snd&DA 20437.210 A 100 0 1009

rcv 21786.056 D 1009 50 100

snd 21786.228 A 100 0 1059

rcv&dup 21786.423 D 1009 50 100

snd&DA 21786.462 A 100 0 1059

rcv&dup 21786.571 D 1009 50 100

snd&DA 21786.607 A 100 0 1059

rcv&dup 21786.756 D 1009 50 100

snd&DA 21786.793 A 100 0 1059

rcv 21787.447 D 1059 50 100

snd 21787.510 A 100 0 1209

rcv 21787.820 D 1509 50 100

…

snd 5706328.513 A 100 0 307659

rcv 5709376.771 D 308109 50 100

snd&DA 5709377.020 A 100 0 307659

rcv 5709377.189 D 307659 50 100

snd 5709377.381 A 100 0 307759

rcv&dup 5709378.318 D 307659 50 100

snd&DA 5709378.520 A 100 0 307759

rcv 5709382.747 D 308159 50 100

snd&DA 5709382.925 A 100 0 307759

rcv 5709383.543 D 307759 50 100

snd 5709383.751 A 100 0 307809

rcv 5711432.395 D 307809 50 100

snd 5711432.561 A 100 0 307909

rcv 5713481.278 D 307909 50 100

snd 5713481.462 A 100 0 308209

rcv 5715530.016 D 308209 50 100

snd 5715530.182 A 100 0 308259

rcv 5717579.305 F 308212 50 100

snd 5717579.405 A 100 0 308213

snd 5717579.458 FA 100 0 308213

rcv 5717579.725 A 308213 50 101

Amount of Data Received (bytes): 339100

Total segments received: 6786

Data segments received: 6781

Data Segments with bit errors: 0

Duplicate data segments received: 1232

Duplicate Acks sent: 3668

Question C:

Sender_log.txt:

snd 0.058 S 8 0 0

rcv 0.728 SA 99 50 9

snd 1.276 A 9 0 100

corr 323.019 D 9 50 100

snd 323.694 D 59 50 100

snd 324.333 D 109 50 100

snd 324.944 D 159 50 100

snd 325.546 D 209 50 100

dup 326.607 D 259 50 100

snd 327.178 D 309 50 100

corr 327.774 D 359 50 100

snd 328.341 D 409 50 100

snd 328.907 D 459 50 100

rcv/DA 347.094 A 100 50 9

rcv/DA 347.528 A 100 50 9

rcv/DA 347.836 A 100 50 9

snd/RXT 348.459 D 9 50 100

rcv/DA 348.659 A 100 50 9

rcv/DA 348.730 A 100 50 9

rcv/DA 348.975 A 100 50 9

snd/RXT 349.394 D 9 50 100

rcv/DA 349.524 A 100 50 9

rcv/DA 349.589 A 100 50 9

rcv/DA 349.640 A 100 50 9

corr/RXT 350.485 D 9 50 100

rcv/DA 350.686 A 100 50 9

rcv/DA 350.755 A 100 50 9

rcv 350.933 A 100 50 359

rcv/DA 350.996 A 100 50 359

rcv/DA 351.166 A 100 50 359

snd/RXT 351.589 D 359 50 100

rcv 351.718 A 100 50 509

rcv 352.227 A 100 50 559

snd 352.332 D 509 50 100

rcv 352.788 A 100 50 609

END:

corr/RXT 3011324.151 D 1605359 50 100

rcv/DA 3011334.423 A 100 50 1605359

rcv/DA 3011344.655 A 100 50 1605359

rcv/DA 3011354.919 A 100 50 1605359

snd/RXT 3011365.162 D 1605359 50 100

rcv/DA 3011375.507 A 100 50 1605359

rcv/DA 3011385.761 A 100 50 1605359

rcv 3011396.014 A 100 50 1605409

snd/RXT 3012818.674 D 1605409 50 100

rcv 3012818.899 A 100 50 1605459

rcv/DA 3012819.671 A 100 50 1605459

snd 3012819.735 D 1605409 50 100

snd 3012820.210 D 1605459 50 100

rcv 3012820.491 A 100 50 1605509

snd 3012820.763 D 1605509 50 100

rcv 3012820.953 A 100 50 1605559

rcv 3012821.327 A 100 50 1605609

snd 3012821.375 D 1605559 35 100

snd 3014336.637 F 1605594 0 100

snd 3014337.088 A 1605595 0 101

Size of the file (in Bytes): 1605585

Segments transmitted (including drop & RXT): 317711

Number of Segments handled by PLD: 317707

Number of Segments Dropped: 29447

Number of Segments Corrupted: 23757

Number of Segments Re-ordered: 21429

Number of Segments Duplicated: 26452

Number of Segments Delayed: 0

Number of Retransmissions due to timeout: 206191

Number of Fast Retransmissions: 54783

Number of Duplicate Acknowledgements received: 162686

Receiver_log.txt:

rcv 2259.816 S 8 50 0

snd 2260.072 SA 99 0 9

rcv 2260.527 S 9 50 100

rcv&corr 2582.200 D 9 50 100

snd 2582.335 A 100 0 9

rcv 2582.901 D 59 50 100

snd&DA 2582.950 A 100 0 9

rcv 2583.580 D 109 50 100

snd&DA 2583.633 A 100 0 9

rcv 2584.197 D 159 50 100

snd&DA 2584.249 A 100 0 9

rcv 2584.803 D 209 50 100

snd&DA 2584.853 A 100 0 9

rcv 2585.417 D 259 50 100

snd&DA 2585.606 A 100 0 9

rcv&dup 2585.932 D 259 50 100

snd&DA 2585.981 A 100 0 9

rcv 2586.473 D 309 50 100

snd&DA 2586.526 A 100 0 9

rcv&corr 2587.105 D 359 50 100

snd&DA 2587.152 A 100 0 9

rcv 2587.632 D 409 50 100

snd&DA 2587.686 A 100 0 9

rcv 2588.202 D 459 50 100

snd&DA 2588.255 A 100 0 9

rcv 2607.626 D 9 50 100

snd 2607.729 A 100 0 359

rcv&dup 2608.671 D 9 50 100

snd&DA 2608.708 A 100 0 359

rcv&corr 2609.802 D 9 50 100

snd&DA 2609.844 A 100 0 359

rcv 2610.851 D 359 50 100

snd 2610.919 A 100 0 509

rcv 2611.444 D 509 50 100

END:

rcv&dup 3013566.802 D 1605009 50 100

snd&DA 3013567.156 A 100 0 1605359

rcv&corr 3013578.666 D 1605359 50 100

snd&DA 3013579.106 A 100 0 1605359

rcv 3013619.694 D 1605359 50 100

snd 3013620.160 A 100 0 1605409

rcv 3015077.832 D 1605409 50 100

snd 3015078.196 A 100 0 1605459

rcv&dup 3015078.873 D 1605409 50 100

snd&DA 3015079.162 A 100 0 1605459

rcv 3015079.426 D 1605459 50 100

snd 3015079.715 A 100 0 1605509

rcv 3015079.953 D 1605509 50 100

snd 3015080.248 A 100 0 1605559

rcv 3015080.519 D 1605559 50 100

snd 3015080.826 A 100 0 1605609

rcv 3016596.325 F 1605594 50 100

snd 3016596.477 A 100 0 1605595

snd 3016596.502 FA 100 0 1605595

rcv 3016596.720 A 1605595 50 101

Amount of Data Received (bytes): 9015250

Total segments received: 180309

Data segments received: 180304

Data Segments with bit errors: 14852

Duplicate data segments received: 266680

Duplicate Acks sent: 162915