Assignment Report

1. Introduction of the STP implementation (python 3.6.4):

1.1.1 Sender side:

The implementation of the STP sender side involves 2 classes, 1 main threads and 4 sub threads.

1) The “Packet class”, defines packet header and payload.

2) The “Pld class”, includes the PLD module functions.

3) The “main” thread is the program’s main thread.

4) The “receiving_thread” which can receive packets from receiver side and handle flow control base on the ACK sequence number.

5) The “sending_thread” sends packets once the sending window slice to the next sequence number.

6) The “sender_timer_thread” is the only timer for the STP which handles timeout for a packet.

7) The “PLD_timer_thread” will check timeouts for packets which encounters PLD delay.

The high level flow control of the program is included in Appendix 1 (a)(b).

1.1.2 Receiver side:

The implementation of STP receiver side involves one main function “receiving_file ()” which can response for the three-way handshake connection, establishing stable segment transmission and performing connection closure procedure.

The high level flow control of the receiver side is included in Appendix 1 (c).

1.2 List of features I have successfully implemented (all the functionality as assignment spec):

1) A three-way handshake procedure for the connection establishment.

2) A four-segment connection termination.

3) Sender mains a single-timer for timeout operation, round-trip-time estimation and RTO estimation.

4) All features mentioned in Section 3.5.4 of the textbook for sender, with the exception of doubling the timeout.

5) All features mentioned in Section 3.5.4 of the textbook for receiver, with exception that all packets will be immediately acknowledged.

6) Includes sequence number and acknowledgement number in the STP header for each segment.

7) Sender is able to deal with different values of MSS and MWS.

8) All the features of PLD module.

2. STP header fields:

seqNum		
ackNum		
checksum		MSS
SYN	ACK	FIN

1) “seqNum” is an integer number which stands for the sequence number for each packet.

2) “ackNum” is an integer number which stands for the acknowledgement number for each packet received.

3) “checksum” is a md5 hash string of the payload.

4) “MSS” is an integer number which stands for the maximum size of the payload.

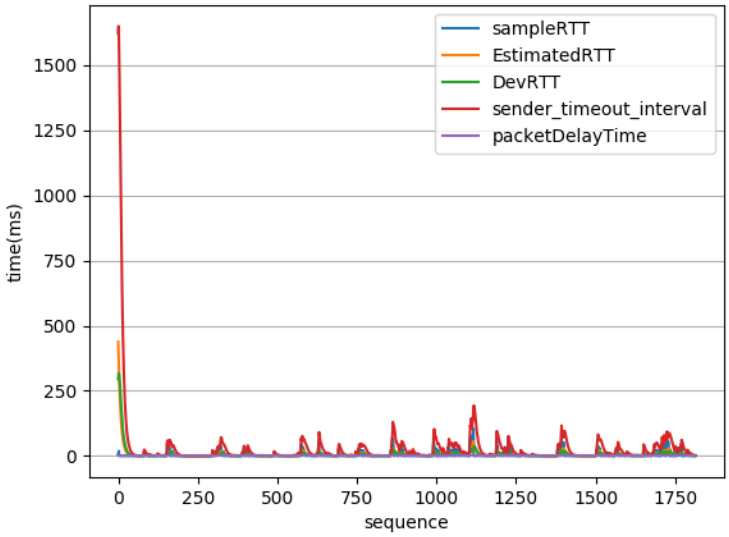
5) “SYN” is of type “None” in python or integer 1 which indicates connection setup command.

6) “ACK” is of type “None” in python or integer 1 which indicates the packet’s acknowledgement number is valid or not.

7) “FIN” is of type “None” in python or integer 1 which indicates connection teardown command.

3. Notice and assumptions:

1) When I was running a test for “Marking Policy section 1” with all error probabilities set to zero and MWS = 1, MSS =1 for test0.pdf, the sample RTT dropped very quickly and the RTO became very narrow. So that it is possible that when a packet is sent, then after a few milliseconds, if the sender has not received the ACK of that packet from receiver, then the sender retransmit that packet due to timeout (because the timeout interval is really small). Hence although the pDrop is set to zero, the statistics contains some timeout retransmission and fast-retransmission.



2) I haven’t implemented the command line input error checking for the program, so I assume that we will input the correct argument for sender.py and receiver.py, for example, the MSS should not be a negative number.

5. Experiments

Answer for experiment (a):

When dropping occurred, and if the receiver continue receives packets which sequence number is not equal to the last acknowledge number, the receiver will send packet back with last acknowledgement number. In experiment pDrop=0.1 (figure 4.1), we can see that after the receiver sending back ack=801, then it receives seq=901, so it sends back the last acknowledgement number 801, and the pattern repeats. Once the receiver receives the packet with sequence number equals to the last acknowledgement number, it will update the last acknowledgement number.

rcv	0.07	D	701	100	1
snd	0.07	A	1	0	801
rcv	0.07	D	901	100	1
snd/DA	0.07	A	1	0	801
rcv	0.07	D	1101	100	1
snd/DA	0.07	A	1	0	801
rcv	0.08	D	1201	100	1
snd/DA	0.08	A	1	0	801
rcv	0.13	D	801	100	1
snd	0.13	A	1	0	1001
rcv	0.25	D	1301	100	1
snd/DA	0.25	A	1	0	1001

Figure 4.1 (pDrop=0.1, receiver log file)

There are many such cases in the receiver log file, and the experiment log file for pDrop=0.1 and pDrop=0.3 is included in the appendix 2 (a).

Answer for experiment (b):

Gamma	Total STP packets	Total transfer time (min)
2	12359	100
4	12294	161
6	12285	186

We can see from the table that as the gamma increases, the total transfer time increases, but the total number of STP packets remains relatively stable. The reason behind this is that when the value of gamma increases, according to the calculation of timeout interval equation “TimeoutInterval = EstimatedRTT + gamma * DevRTT”, the timeout interval will also increase. Once a packet gets dropped, it will take a longer time to wait for timeout and retransmit the packet. Another reason is that since the pDrop is really high, it is difficult to successfully take a sampleRTT and recalculate the timeout interval (we do not calculate sampleRTT for retransmit packet), so that the timeout interval will remain long for a long time.

The initial 20 entries, last 20 entries and statistics summary for gamma 2, 4, 6 is included in Appendix 2 (b).

Answer for experiment (c):

The file has been successfully transferred, overall it takes about 17 minutes to transfer the file. The initial 20 entries, last 20 entries and statistics summary for experiment c is included in Appendix 2 (c).

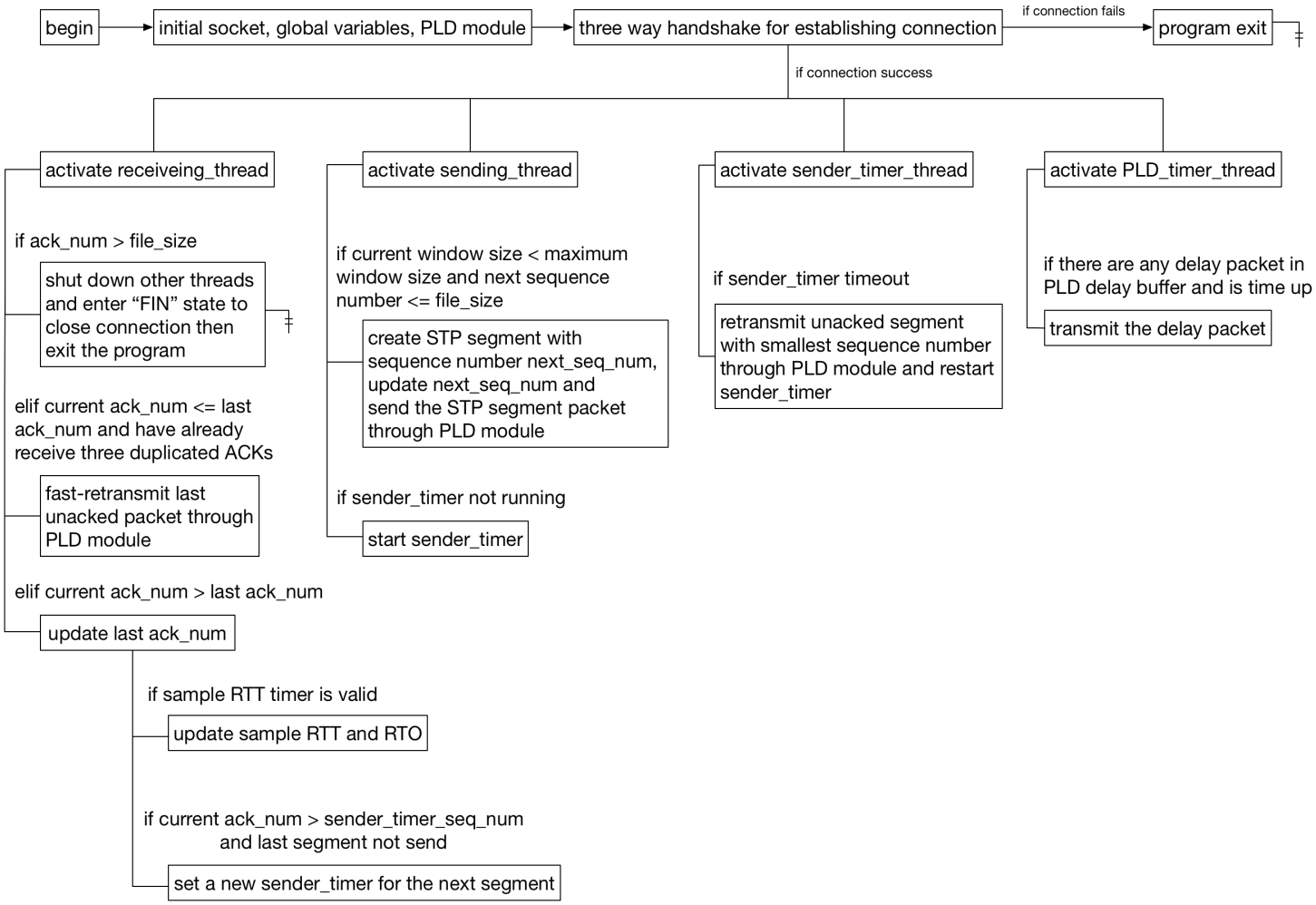
I ran several experiments by setting different factors to 0. The following table shows the overall transfer time for one of pDrop, pDup, pCorr, pOrder is set to 0 and others arguments remain the same as experiment c.

pDrop=0	pDup=0	pCorr=0	pOrder=0
9-13 min	17-18 min	9-14 min	12-14 min

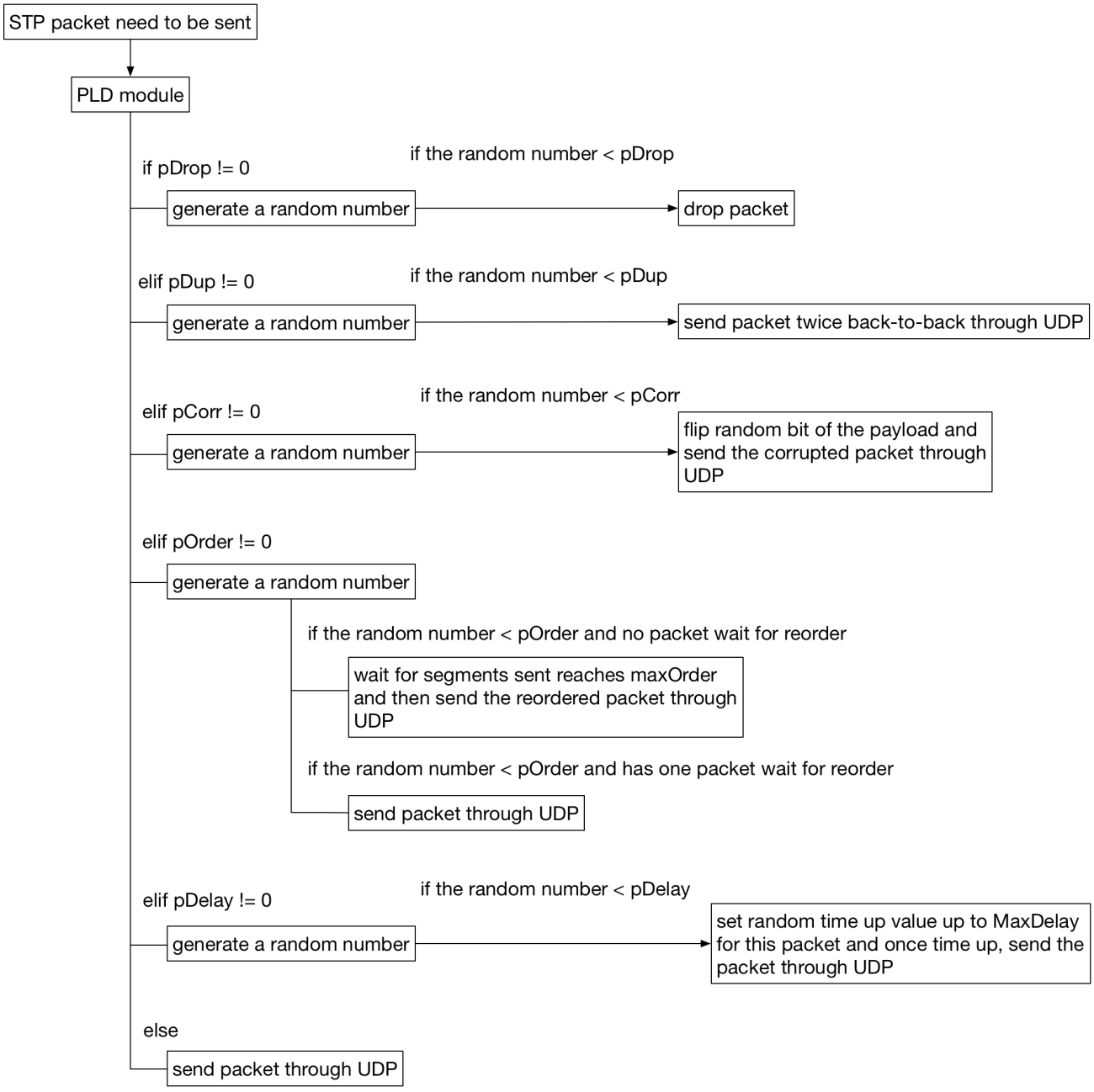
From the table we can see that pDrop and pCorr is the most critical contribution in the overall transfer time. When we set pDrop or pCorr rate equal to zero and other factors remain the same, the overall transfer time is the shortest. The reason behind this is when we reduce the number of dropping packets or corrupted packets, the total timeout packets will be reduced and we can finish the transfer faster.

Appendix 1

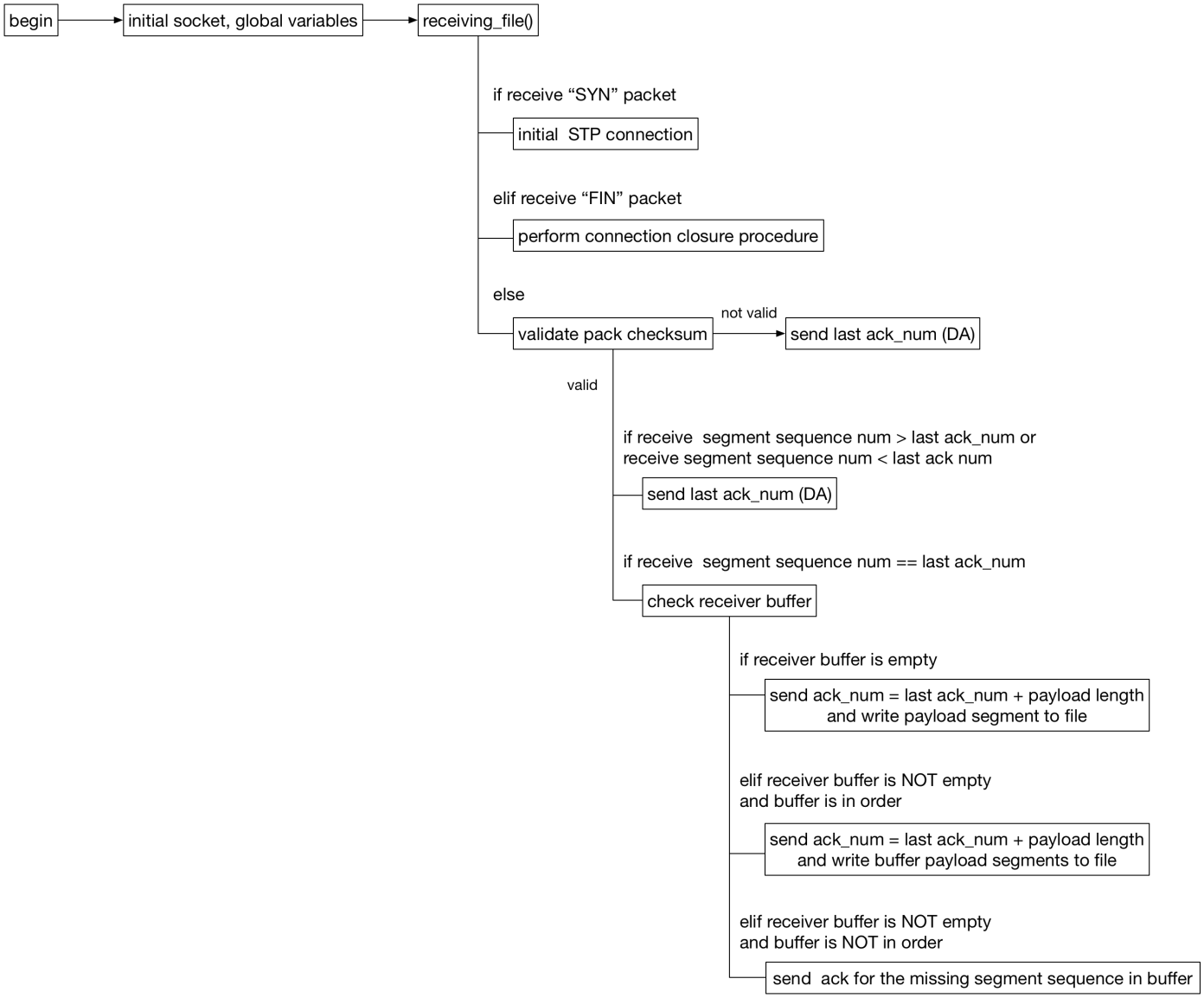
(a) Control flow of sender side:



(b) Control flow of PLD module:



(c) Control flow of receiver side:



Apendix 2 (a)

Sender_log with pDrop = 0.1

snd	0.00	S	0	0	0
rcv	0.00	SA	0	0	1
snd	0.00	A	1	0	1
snd	0.00	D	1	100	1
rcv	0.00	A	1	0	101
snd	0.00	D	101	100	1
snd	0.00	D	201	100	1
snd	0.00	D	301	100	1
snd	0.00	D	401	100	1
snd	0.00	D	501	100	1
rcv	0.01	A	1	0	201
snd	0.01	D	601	100	1
rcv	0.06	A	1	0	301
snd	0.07	D	701	100	1
rcv	0.07	A	1	0	401
rcv	0.08	A	1	0	501
rcv	0.08	A	1	0	601
drop	0.09	D	801	100	1
snd	0.09	D	901	100	1
drop	0.09	D	1001	100	1
rcv	0.09	A	1	0	701
snd	0.09	D	1101	100	1
rcv	0.10	A	1	0	801
snd	0.10	D	1201	100	1
rcv/DA	0.18	A	1	0	801
rcv/DA	0.19	A	1	0	801
rcv/DA	0.21	A	1	0	801
snd/RXT	0.22	D	801	100	1
rcv	0.23	A	1	0	1001
snd	0.24	D	1301	100	1
snd	0.24	D	1401	100	1
rcv/DA	0.26	A	1	0	1001
rcv/DA	0.28	A	1	0	1001
snd/RXT	1.66	D	1001	100	1
rcv	1.67	A	1	0	1501
snd	1.67	D	1501	100	1
snd	1.67	D	1601	100	1
snd	1.67	D	1701	100	1
snd	1.67	D	1801	100	1
snd	1.67	D	1901	100	1
rcv	1.69	A	1	0	1601
snd	1.69	D	2001	100	1
rcv	1.70	A	1	0	1701
snd	1.71	D	2101	100	1
rcv	1.73	A	1	0	1801
snd	1.73	D	2201	100	1
rcv	1.74	A	1	0	1901
rcv	1.74	A	1	0	2001
snd	1.74	D	2301	100	1
snd	1.74	D	2401	100	1
rcv	1.75	A	1	0	2101
rcv	1.75	A	1	0	2201
rcv	1.75	A	1	0	2301
rcv	1.75	A	1	0	2401
rcv	1.75	A	1	0	2501
snd	1.75	D	2501	100	1
snd	1.75	D	2601	100	1
snd	1.75	D	2701	100	1
drop	1.75	D	2801	100	1
snd	1.75	D	2901	100	1
rcv	1.78	A	1	0	2601
snd	1.79	D	3001	28	1
rcv	1.79	A	1	0	2701
rcv	1.79	A	1	0	2801
rcv/DA	1.79	A	1	0	2801
rcv/DA	1.79	A	1	0	2801
snd/RXT	3.07	D	2801	100	1

```
rcv             3.07        A                  1                  0                3029
snd             3.07        F               3029                  0                   1
rcv             3.07        A                  1                  0                3030
rcv             3.07        F                  1                  0                3030
snd             3.07        A               3030                  0                   2
============================================================
Size of the file (in Bytes)                          3028
Segments transmitted (including drop & RXT)            38
Number of Segments handled by PLD                      34
Number of Segments dropped                              3
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 RETRANSMISSION                           1
Number of DUP ACKS received                             7
============================================================
```

Receiver_log with pDrop = 0.1

rcv	0.00	S	0	0	0
snd	0.00	SA	0	0	1
rcv	0.00	A	1	0	1
rcv	0.00	D	1	100	1
snd	0.00	A	1	0	101
rcv	0.00	D	101	100	1
snd	0.00	A	1	0	201
rcv	0.00	D	201	100	1
snd	0.00	A	1	0	301
rcv	0.00	D	301	100	1
snd	0.00	A	1	0	401
rcv	0.00	D	401	100	1
snd	0.00	A	1	0	501
rcv	0.00	D	501	100	1
snd	0.00	A	1	0	601
rcv	0.01	D	601	100	1
snd	0.01	A	1	0	701
rcv	0.07	D	701	100	1
snd	0.07	A	1	0	801
rcv	0.08	D	901	100	1
snd/DA	0.09	A	1	0	801
rcv	0.09	D	1101	100	1
snd/DA	0.09	A	1	0	801
rcv	0.10	D	1201	100	1
snd/DA	0.10	A	1	0	801
rcv	0.22	D	801	100	1
snd	0.22	A	1	0	1001
rcv	0.24	D	1301	100	1
snd/DA	0.24	A	1	0	1001
rcv	0.24	D	1401	100	1
snd/DA	0.24	A	1	0	1001
rcv	1.65	D	1001	100	1
snd	1.65	A	1	0	1501
rcv	1.67	D	1501	100	1
snd	1.67	A	1	0	1601
rcv	1.67	D	1601	100	1
snd	1.67	A	1	0	1701
rcv	1.67	D	1701	100	1
snd	1.67	A	1	0	1801
rcv	1.67	D	1801	100	1
snd	1.67	A	1	0	1901
rcv	1.67	D	1901	100	1
snd	1.67	A	1	0	2001
rcv	1.69	D	2001	100	1
snd	1.69	A	1	0	2101
rcv	1.71	D	2101	100	1
snd	1.71	A	1	0	2201
rcv	1.73	D	2201	100	1
snd	1.73	A	1	0	2301
rcv	1.74	D	2301	100	1
snd	1.74	A	1	0	2401
rcv	1.74	D	2401	100	1
snd	1.74	A	1	0	2501
rcv	1.75	D	2501	100	1
snd	1.75	A	1	0	2601
rcv	1.75	D	2601	100	1
snd	1.75	A	1	0	2701
rcv	1.75	D	2701	100	1
snd	1.75	A	1	0	2801
rcv	1.75	D	2901	100	1
snd/DA	1.75	A	1	0	2801
rcv	1.79	D	3001	28	1
snd/DA	1.79	A	1	0	2801
rcv	3.07	D	2801	100	1
snd	3.07	A	1	0	3029
rcv	3.07	F	3029	0	1
snd	3.07	A	1	0	3030
snd	3.07	F	1	0	3030
rcv	3.07	A	3030	0	2

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```
Amount of data received (bytes)               3028
Total Segments Received                         35
Data segments received                          31
Data segments with Bit Errors                    0
Duplicate data segments received                 0
Duplicate ACKs sent                              7
================================================
```

Sender_log for pDrop = 0.3

snd	0.00	S	0	0	0
rcv	0.00	SA	0	0	1
snd	0.00	A	1	0	1
drop	0.00	D	1	100	1
snd	0.00	D	101	100	1
snd	0.00	D	201	100	1
snd	0.00	D	301	100	1
snd	0.00	D	401	100	1
rcv/DA	0.02	A	1	0	1
rcv/DA	0.02	A	1	0	1
rcv/DA	0.02	A	1	0	1
snd/RXT	0.02	D	1	100	1
rcv/DA	0.05	A	1	0	1
rcv	0.05	A	1	0	501
snd	0.05	D	501	100	1
snd	0.05	D	601	100	1
drop	0.05	D	701	100	1
snd	0.05	D	801	100	1
drop	0.05	D	901	100	1
rcv	0.10	A	1	0	601
snd	0.10	D	1001	100	1
rcv	0.13	A	1	0	701
rcv/DA	0.13	A	1	0	701
rcv/DA	0.13	A	1	0	701
snd	0.13	D	1101	100	1
rcv/DA	0.14	A	1	0	701
snd/RXT	0.14	D	701	100	1
rcv	0.15	A	1	0	901
snd	0.15	D	1201	100	1
snd	0.15	D	1301	100	1
rcv/DA	0.15	A	1	0	901
rcv/DA	0.15	A	1	0	901
drop	1.69	D	901	100	1
drop	3.30	D	901	100	1
drop	4.90	D	901	100	1
snd/RXT	6.50	D	901	100	1
rcv	6.51	A	1	0	1401
snd	6.51	D	1401	100	1
snd	6.51	D	1501	100	1
drop	6.51	D	1601	100	1
snd	6.51	D	1701	100	1
snd	6.51	D	1801	100	1
rcv	6.52	A	1	0	1501
snd	6.52	D	1901	100	1
rcv	6.53	A	1	0	1601
rcv/DA	6.53	A	1	0	1601
rcv/DA	6.53	A	1	0	1601
snd	6.53	D	2001	100	1
rcv/DA	6.54	A	1	0	1601
drop	6.54	D	1601	100	1
rcv/DA	6.54	A	1	0	1601
snd/RXT	8.16	D	1601	100	1
rcv	8.18	A	1	0	2101
drop	8.19	D	2101	100	1
drop	8.19	D	2201	100	1
snd	8.19	D	2301	100	1
snd	8.19	D	2401	100	1
snd	8.19	D	2501	100	1
rcv/DA	8.22	A	1	0	2101
rcv/DA	8.23	A	1	0	2101
rcv/DA	8.31	A	1	0	2101
drop	8.32	D	2101	100	1
snd/RXT	9.83	D	2101	100	1
rcv	9.84	A	1	0	2201
snd	9.84	D	2601	100	1
rcv/DA	9.85	A	1	0	2201
drop	11.47	D	2201	100	1
snd/RXT	13.12	D	2201	100	1
rcv	13.14	A	1	0	2701
snd	13.15	D	2701	100	1

snd	13.15	D	2801	100	1
drop	13.15	D	2901	100	1
snd	13.15	D	3001	28	1
rcv	13.15	A	1	0	2801
rcv	13.15	A	1	0	2901
rcv/DA	13.15	A	1	0	2901
snd/RXT	14.76	D	2901	100	1
rcv	14.76	A	1	0	3029
snd	14.76	F	3029	0	1
rcv	14.76	A	1	0	3030
rcv	14.76	F	1	0	3030
snd	14.76	A	3030	0	2

Size of the file (in Bytes)	3028
Segments transmitted (including drop & RXT)	48
Number of Segments handled by PLD	44
Number of Segments dropped	13
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	9
Number of FAST RETRANSMISSION	4
Number of DUP ACKS received	18

Receiver_log for pDrop = 0.3

rcv	0.00	S	0	0	0
snd	0.00	SA	0	0	1
rcv	0.00	A	1	0	1
rcv	0.00	D	101	100	1
snd/DA	0.00	A	1	0	1
rcv	0.00	D	201	100	1
snd/DA	0.00	A	1	0	1
rcv	0.00	D	301	100	1
snd/DA	0.00	A	1	0	1
rcv	0.00	D	401	100	1
snd/DA	0.00	A	1	0	1
rcv	0.02	D	1	100	1
snd	0.02	A	1	0	501
rcv	0.05	D	501	100	1
snd	0.05	A	1	0	601
rcv	0.05	D	601	100	1
snd	0.05	A	1	0	701
rcv	0.05	D	801	100	1
snd/DA	0.05	A	1	0	701
rcv	0.10	D	1001	100	1
snd/DA	0.10	A	1	0	701
rcv	0.13	D	1101	100	1
snd/DA	0.13	A	1	0	701
rcv	0.14	D	701	100	1
snd	0.14	A	1	0	901
rcv	0.15	D	1201	100	1
snd/DA	0.15	A	1	0	901
rcv	0.15	D	1301	100	1
snd/DA	0.15	A	1	0	901
rcv	6.50	D	901	100	1
snd	6.50	A	1	0	1401
rcv	6.51	D	1401	100	1
snd	6.51	A	1	0	1501
rcv	6.51	D	1501	100	1
snd	6.51	A	1	0	1601
rcv	6.51	D	1701	100	1
snd/DA	6.51	A	1	0	1601
rcv	6.51	D	1801	100	1
snd/DA	6.51	A	1	0	1601
rcv	6.52	D	1901	100	1
snd/DA	6.52	A	1	0	1601
rcv	6.53	D	2001	100	1
snd/DA	6.53	A	1	0	1601
rcv	8.15	D	1601	100	1
snd	8.15	A	1	0	2101
rcv	8.19	D	2301	100	1
snd/DA	8.19	A	1	0	2101
rcv	8.19	D	2401	100	1
snd/DA	8.19	A	1	0	2101
rcv	8.19	D	2501	100	1
snd/DA	8.19	A	1	0	2101
rcv	9.83	D	2101	100	1
snd	9.83	A	1	0	2201
rcv	9.84	D	2601	100	1
snd/DA	9.84	A	1	0	2201
rcv	13.11	D	2201	100	1
snd	13.11	A	1	0	2701
rcv	13.15	D	2701	100	1
snd	13.15	A	1	0	2801
rcv	13.15	D	2801	100	1
snd	13.15	A	1	0	2901
rcv	13.15	D	3001	28	1
snd/DA	13.15	A	1	0	2901
rcv	14.76	D	2901	100	1
snd	14.76	A	1	0	3029
rcv	14.76	F	3029	0	1
snd	14.76	A	1	0	3030
snd	14.76	F	1	0	3030
rcv	14.76	A	3030	0	2

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Amount of data received (bytes)               3028
Total Segments Received                         35
Data segments received                          31
Data segments with Bit Errors                    0
Duplicate data segments received                 0
Duplicate ACKs sent                             18
================================================
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Appendix (b)

Sender_log file, gamma = 2

First 20 entries:

snd	0.00	S	0	0	0
rcv	0.00	SA	0	0	1
snd	0.00	A	1	0	1
snd	0.00	D	1	50	1
drop	0.00	D	51	50	1
drop	0.00	D	101	50	1
snd	0.00	D	151	50	1
drop	0.00	D	251	50	1
snd	0.00	D	301	50	1
snd	0.00	D	351	50	1
snd	0.00	D	401	50	1
rcv	0.01	A	1	0	51
drop	0.01	D	501	50	1
rcv/DA	0.03	A	1	0	51
rcv/DA	0.03	A	1	0	51
rcv/DA	0.07	A	1	0	51
snd/RXT	0.08	D	51	50	1
rcv/DA	0.08	A	1	0	51
snd/dely	0.09	D	451	50	1
rcv	0.11	A	1	0	101
rcv/DA	0.11	A	1	0	101
snd	0.11	D	551	50	1
rcv/DA	0.14	A	1	0	101

…
…
…
…
…

Last 20 entries and statistics summary:

rcv/DA	6010.72	A	1	0	307701
snd/RXT	6011.12	D	307701	50	1
rcv	6011.15	A	1	0	307751
snd/dely	6011.68	D	308201	3	1
rcv/DA	6011.68	A	1	0	307751
snd/RXT	6011.97	D	307751	50	1
rcv	6011.97	A	1	0	307851
drop	6012.82	D	307851	50	1
drop	6013.69	D	307851	50	1
drop	6014.54	D	307851	50	1
drop	6015.39	D	307851	50	1
snd/RXT	6016.24	D	307851	50	1
rcv	6016.25	A	1	0	307901
drop	6017.10	D	307901	50	1
snd/RXT	6017.95	D	307901	50	1
rcv	6017.95	A	1	0	308001
snd/RXT	6018.80	D	308001	50	1
rcv	6018.80	A	1	0	308101
drop	6019.65	D	308101	50	1
snd/RXT	6020.50	D	308101	50	1
rcv	6020.50	A	1	0	308204
snd	6020.50	F	308204	0	1
rcv	6020.51	A	1	0	308205
rcv	6020.51	F	1	0	308205
snd	6020.51	A	308205	0	2

Size of the file (in Bytes)	308203
Segments transmitted (including drop & RXT)	12359
Number of Segments handled by PLD	12355
Number of Segments dropped	6155
Number of Segments Corrupted	0
Number of Segments Re-ordered	0
Number of Segments Duplicated	0
Number of Segments Delayed	1229
Number of Retransmissions due to TIMEOUT	5938
Number of FAST RETRANSMISSION	252
Number of DUP ACKS received	3107

Appendix (b)

Receiver_log file, gamma = 2

First 20 entries:

rcv	0.00	S	0	0	0
snd	0.00	SA	0	0	1
rcv	0.00	A	1	0	1
rcv	0.00	D	1	50	1
snd	0.00	A	1	0	51
rcv	0.00	D	151	50	1
snd/DA	0.00	A	1	0	51
rcv	0.00	D	301	50	1
snd/DA	0.00	A	1	0	51
rcv	0.00	D	351	50	1
snd/DA	0.00	A	1	0	51
rcv	0.00	D	401	50	1
snd/DA	0.00	A	1	0	51
rcv	0.07	D	51	50	1
snd	0.07	A	1	0	101
rcv	0.09	D	451	50	1
snd/DA	0.09	A	1	0	101
rcv	0.11	D	551	50	1
snd/DA	0.11	A	1	0	101
rcv	0.45	D	201	50	1
snd/DA	0.45	A	1	0	101
rcv	2.07	D	101	50	1
snd	2.07	A	1	0	251

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Last 20 entries and statistics summary:

rcv	6009.60	D	308051	50	1
snd/DA	6009.60	A	1	0	307601
rcv	6010.26	D	307601	50	1
snd	6010.26	A	1	0	307701
rcv	6010.31	D	308151	50	1
snd/DA	6010.31	A	1	0	307701
rcv	6011.12	D	307701	50	1
snd	6011.12	A	1	0	307751
rcv	6011.68	D	308201	3	1
snd/DA	6011.68	A	1	0	307751
rcv	6011.97	D	307751	50	1
snd	6011.97	A	1	0	307851
rcv	6016.24	D	307851	50	1
snd	6016.24	A	1	0	307901
rcv	6017.95	D	307901	50	1
snd	6017.95	A	1	0	308001
rcv	6018.80	D	308001	50	1
snd	6018.80	A	1	0	308101
rcv	6020.50	D	308101	50	1
snd	6020.50	A	1	0	308204
rcv	6020.50	F	308204	0	1
snd	6020.50	A	1	0	308205
snd	6020.51	F	1	0	308205
rcv	6020.51	A	308205	0	2

Amount of data received (bytes)	309953
Total Segments Received	6204
Data segments received	6200
Data segments with Bit Errors	0
Duplicate data segments received	35
Duplicate ACKs sent	3107

Appendix (b)

Sender_log file, gamma = 4

First 20 entries:

snd	0.00	S	0	0	0
rcv	0.00	SA	0	0	1
snd	0.00	A	1	0	1
snd	0.00	D	1	50	1
drop	0.00	D	51	50	1
drop	0.00	D	101	50	1
snd	0.00	D	151	50	1
drop	0.00	D	251	50	1
snd	0.00	D	301	50	1
snd	0.00	D	351	50	1
snd	0.00	D	401	50	1
rcv	0.01	A	1	0	51
rcv/DA	0.01	A	1	0	51
rcv/DA	0.01	A	1	0	51
rcv/DA	0.01	A	1	0	51
drop	0.01	D	51	50	1
rcv/DA	0.01	A	1	0	51
snd	0.02	D	501	50	1
rcv/DA	0.05	A	1	0	51
snd/dely	0.08	D	451	50	1
rcv/DA	0.13	A	1	0	51
snd/RXT	0.14	D	51	50	1
rcv	0.15	A	1	0	101

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Last 20 entries and statistics summary:

drop	9663.75	D	307851	50	1
drop	9665.30	D	307851	50	1
snd/RXT	9666.86	D	307851	50	1
rcv	9666.86	A	1	0	307901
drop	9668.41	D	307901	50	1
snd/dely	9670.55	D	307901	50	1
rcv	9670.55	A	1	0	307951
drop	9671.51	D	307951	50	1
drop	9673.07	D	307951	50	1
snd/RXT	9674.62	D	307951	50	1
rcv	9674.62	A	1	0	308051
drop	9676.17	D	308051	50	1
snd/RXT	9677.72	D	308051	50	1
rcv	9677.72	A	1	0	308151
drop	9679.28	D	308151	50	1
drop	9680.83	D	308151	50	1
snd/RXT	9682.38	D	308151	50	1
rcv	9682.38	A	1	0	308201
snd/dely	9683.99	D	308201	3	1
rcv	9683.99	A	1	0	308204
snd	9683.99	F	308204	0	1
rcv	9683.99	A	1	0	308205
rcv	9683.99	F	1	0	308205
snd	9683.99	A	308205	0	2

Size of the file (in Bytes)	308203
Segments transmitted (including drop & RXT)	12294
Number of Segments handled by PLD	12290
Number of Segments dropped	6119
Number of Segments Corrupted	0
Number of Segments Re-ordered	0
Number of Segments Duplicated	0
Number of Segments Delayed	1224
Number of Retransmissions due to TIMEOUT	5873
Number of FAST RETRANSMISSION	252
Number of DUP ACKS received	3056

Appendix (b)

Receiver_log file, gamma = 4

First 20 entries:

rcv	0.00	S	0	0	0
snd	0.00	SA	0	0	1
rcv	0.00	A	1	0	1
rcv	0.00	D	1	50	1
snd	0.00	A	1	0	51
rcv	0.00	D	151	50	1
snd/DA	0.00	A	1	0	51
rcv	0.00	D	301	50	1
snd/DA	0.00	A	1	0	51
rcv	0.00	D	351	50	1
snd/DA	0.00	A	1	0	51
rcv	0.00	D	401	50	1
snd/DA	0.00	A	1	0	51
rcv	0.03	D	501	50	1
snd/DA	0.03	A	1	0	51
rcv	0.08	D	451	50	1
snd/DA	0.08	A	1	0	51
rcv	0.14	D	51	50	1
snd	0.14	A	1	0	101
rcv	0.45	D	201	50	1
snd/DA	0.45	A	1	0	101
rcv	3.27	D	101	50	1
snd	3.27	A	1	0	251

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Last 20 entries and statistics summary:

rcv	9652.84	D	307551	50	1
snd	9652.84	A	1	0	307601
rcv	9656.29	D	307601	50	1
snd	9656.29	A	1	0	307701
rcv	9656.31	D	308101	50	1
snd/DA	9656.31	A	1	0	307701
rcv	9657.54	D	307701	50	1
snd	9657.54	A	1	0	307851
rcv	9666.86	D	307851	50	1
snd	9666.86	A	1	0	307901
rcv	9670.55	D	307901	50	1
snd	9670.55	A	1	0	307951
rcv	9674.62	D	307951	50	1
snd	9674.62	A	1	0	308051
rcv	9677.72	D	308051	50	1
snd	9677.72	A	1	0	308151
rcv	9682.38	D	308151	50	1
snd	9682.38	A	1	0	308201
rcv	9683.99	D	308201	3	1
snd	9683.99	A	1	0	308204
rcv	9683.99	F	308204	0	1
snd	9683.99	A	1	0	308205
snd	9683.99	F	1	0	308205
rcv	9683.99	A	308205	0	2

Amount of data received (bytes)	308503
Total Segments Received	6175
Data segments received	6171
Data segments with Bit Errors	0
Duplicate data segments received	6
Duplicate ACKs sent	3056

Appendix (b)

Sender_log file, gamma = 6

First 20 entries:

snd	0.00	S	0	0	0
rcv	0.00	SA	0	0	1
snd	0.00	A	1	0	1
snd	0.01	D	1	50	1
rcv	0.01	A	1	0	51
drop	0.01	D	51	50	1
drop	0.01	D	101	50	1
snd	0.01	D	151	50	1
rcv/DA	0.01	A	1	0	51
drop	0.01	D	251	50	1
snd	0.01	D	301	50	1
rcv/DA	0.01	A	1	0	51
snd	0.01	D	351	50	1
rcv/DA	0.01	A	1	0	51
snd/RXT	0.01	D	51	50	1
rcv	0.01	A	1	0	101
drop	0.01	D	451	50	1
snd	0.01	D	501	50	1
rcv/DA	0.01	A	1	0	101
snd	0.01	D	551	50	1
rcv/DA	0.02	A	1	0	101
snd/dely	0.09	D	401	50	1
rcv/DA	0.10	A	1	0	101

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Last 20 entries and statistics summary:

drop	11140.19	D	307801	50	1
drop	11141.48	D	307801	50	1
snd/dely	11143.07	D	307801	50	1
rcv	11143.07	A	1	0	307901
snd/RXT	11144.06	D	307901	50	1
rcv	11144.06	A	1	0	308051
drop	11145.35	D	308051	50	1
snd/RXT	11146.64	D	308051	50	1
rcv	11146.64	A	1	0	308101
drop	11147.92	D	308101	50	1
drop	11149.21	D	308101	50	1
drop	11150.50	D	308101	50	1
drop	11151.79	D	308101	50	1
drop	11153.08	D	308101	50	1
drop	11154.37	D	308101	50	1
snd/RXT	11155.65	D	308101	50	1
rcv	11155.65	A	1	0	308151
drop	11156.94	D	308151	50	1
snd/dely	11158.82	D	308151	50	1
rcv	11158.82	A	1	0	308204
snd	11158.82	F	308204	0	1
rcv	11158.82	A	1	0	308205
rcv	11158.82	F	1	0	308205
snd	11158.82	A	308205	0	2

Size of the file (in Bytes)	308203
Segments transmitted (including drop & RXT)	12285
Number of Segments handled by PLD	12281
Number of Segments dropped	6114
Number of Segments Corrupted	0
Number of Segments Re-ordered	0
Number of Segments Duplicated	0
Number of Segments Delayed	1223
Number of Retransmissions due to TIMEOUT	5847
Number of FAST RETRANSMISSION	269
Number of DUP ACKS received	3078

Appendix (b)

Receiver_log file, gamma = 6

First 20 entries:

rcv	0.00	S	0	0	0
snd	0.00	SA	0	0	1
rcv	0.00	A	1	0	1
rcv	0.01	D	1	50	1
snd	0.01	A	1	0	51
rcv	0.01	D	151	50	1
snd/DA	0.01	A	1	0	51
rcv	0.01	D	301	50	1
snd/DA	0.01	A	1	0	51
rcv	0.01	D	351	50	1
snd/DA	0.01	A	1	0	51
rcv	0.01	D	51	50	1
snd	0.01	A	1	0	101
rcv	0.01	D	501	50	1
snd/DA	0.01	A	1	0	101
rcv	0.01	D	551	50	1
snd/DA	0.01	A	1	0	101
rcv	0.09	D	401	50	1
snd/DA	0.09	A	1	0	101
rcv	0.45	D	201	50	1
snd/DA	0.45	A	1	0	101
rcv	4.45	D	101	50	1
snd	4.45	A	1	0	251

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Last 20 entries and statistics summary:

snd/DA	11132.63	A	1	0	307401
rcv	11133.72	D	307401	50	1
snd	11133.72	A	1	0	307451
rcv	11135.02	D	307451	50	1
snd	11135.02	A	1	0	307651
rcv	11135.04	D	307951	50	1
snd/DA	11135.04	A	1	0	307651
rcv	11135.04	D	308001	50	1
snd/DA	11135.04	A	1	0	307651
rcv	11137.62	D	307651	50	1
snd	11137.62	A	1	0	307751
rcv	11137.65	D	308201	3	1
snd/DA	11137.65	A	1	0	307751
rcv	11138.91	D	307751	50	1
snd	11138.91	A	1	0	307801
rcv	11143.06	D	307801	50	1
snd	11143.06	A	1	0	307901
rcv	11144.06	D	307901	50	1
snd	11144.06	A	1	0	308051
rcv	11146.64	D	308051	50	1
snd	11146.64	A	1	0	308101
rcv	11155.65	D	308101	50	1
snd	11155.65	A	1	0	308151
rcv	11158.82	D	308151	50	1
snd	11158.82	A	1	0	308204
rcv	11158.82	F	308204	0	1
snd	11158.82	A	1	0	308205
snd	11158.82	F	1	0	308205
rcv	11158.82	A	308205	0	2

Amount of data received (bytes)	308303
Total Segments Received	6171
Data segments received	6167
Data segments with Bit Errors	0
Duplicate data segments received	2
Duplicate ACKs sent	3078

Appendix (c)

Sender_log file

First 20 entries:

snd	0.00	S	0	0	0
rcv	0.00	SA	0	0	1
snd	0.00	A	1	0	1
snd/corr	0.01	D	1	50	1
snd	0.01	D	51	50	1
snd	0.01	D	101	50	1
snd	0.01	D	151	50	1
snd	0.01	D	201	50	1
snd/dup	0.01	D	201	50	1
drop	0.01	D	251	50	1
snd/corr	0.01	D	301	50	1
snd/corr	0.01	D	351	50	1
snd	0.01	D	401	50	1
snd/corr	0.01	D	451	50	1
rcv/DA	0.02	A	1	0	1
rcv/DA	0.02	A	1	0	1
snd/RXT	0.02	D	1	50	1
rcv/DA	0.02	A	1	0	1
rcv/DA	0.02	A	1	0	1
rcv/DA	0.02	A	1	0	1
snd/RXT	0.02	D	1	50	1
rcv/DA	0.02	A	1	0	1
rcv	0.05	A	1	0	251

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Last 20 entries and statistics summary:

snd/RXT	1031.76	D	1605001	50	1
rcv	1031.82	A	1	0	1605351
drop	1031.82	D	1605501	50	1
snd	1031.82	D	1605551	35	1
rcv/DA	1031.82	A	1	0	1605351
rcv/DA	1031.82	A	1	0	1605351
rcv/DA	1031.82	A	1	0	1605351
snd	1031.82	D	1605351	50	1
snd/dup	1031.82	D	1605351	50	1
rcv/DA	1031.82	A	1	0	1605351
rcv/DA	1031.82	A	1	0	1605351
rcv/DA	1031.82	A	1	0	1605351
snd/RXT	1031.82	D	1605351	50	1
rcv/DA	1031.82	A	1	0	1605351
rcv/DA	1031.82	A	1	0	1605351
rcv	1031.82	A	1	0	1605501
rcv/DA	1031.82	A	1	0	1605501
rcv/DA	1031.82	A	1	0	1605501
snd/RXT	1031.89	D	1605501	50	1
rcv	1031.89	A	1	0	1605586
snd	1031.89	F	1605586	0	1
rcv	1031.89	A	1	0	1605587
rcv	1031.89	F	1	0	1605587
snd	1031.89	A	1605587	0	2

Size of the file (in Bytes)	1605585
Segments transmitted (including drop & RXT)	52111
Number of Segments handled by PLD	52107
Number of Segments dropped	4705
Number of Segments Corrupted	3849
Number of Segments Re-ordered	2699
Number of Segments Duplicated	4311
Number of Segments Delayed	0
Number of Retransmissions due to TIMEOUT	6978
Number of FAST RETRANSMISSION	8706
Number of DUP ACKS received	33575

Appendix (c)

Receiver_log file

First 20 entries:

rcv	0.00	S	0	0	0
snd	0.00	SA	0	0	1
rcv	0.00	A	1	0	1
rcv/corr	0.01	D	1	50	1
rcv	0.01	D	51	50	1
snd/DA	0.01	A	1	0	1
rcv	0.01	D	101	50	1
snd/DA	0.01	A	1	0	1
rcv	0.01	D	151	50	1
snd/DA	0.01	A	1	0	1
rcv	0.01	D	201	50	1
snd/DA	0.01	A	1	0	1
rcv	0.01	D	201	50	1
snd/DA	0.01	A	1	0	1
rcv/corr	0.01	D	301	50	1
rcv/corr	0.01	D	351	50	1
rcv	0.01	D	401	50	1
snd/DA	0.01	A	1	0	1
rcv/corr	0.01	D	451	50	1
rcv	0.02	D	1	50	1
snd	0.02	A	1	0	251
rcv	0.02	D	1	50	1
snd/DA	0.02	A	1	0	251

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Last 20 entries and statistics summary:

rcv	1031.41	D	1605001	50	1
snd/DA	1031.41	A	1	0	1605351
rcv	1031.44	D	1605001	50	1
snd/DA	1031.44	A	1	0	1605351
rcv	1031.50	D	1605001	50	1
snd/DA	1031.50	A	1	0	1605351
rcv	1031.54	D	1605001	50	1
snd/DA	1031.54	A	1	0	1605351
rcv/corr	1031.64	D	1605001	50	1
rcv	1031.65	D	1605001	50	1
snd/DA	1031.65	A	1	0	1605351
rcv	1031.67	D	1605001	50	1
snd/DA	1031.67	A	1	0	1605351
rcv	1031.75	D	1605001	50	1
snd/DA	1031.75	A	1	0	1605351
rcv	1031.82	D	1605551	35	1
snd/DA	1031.82	A	1	0	1605351
rcv	1031.82	D	1605351	50	1
snd	1031.82	A	1	0	1605501
rcv	1031.82	D	1605351	50	1
snd/DA	1031.82	A	1	0	1605501
rcv	1031.82	D	1605351	50	1
snd/DA	1031.82	A	1	0	1605501
rcv	1031.89	D	1605501	50	1
snd	1031.89	A	1	0	1605586
rcv	1031.89	F	1605586	0	1
snd	1031.89	A	1	0	1605587
snd	1031.89	F	1	0	1605587
rcv	1031.89	A	1605587	0	2

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Amount of data received (bytes)	2370085
Total Segments Received	47406
Data segments received	47402
Data segments with Bit Errors	3849
Duplicate data segments received	11441
Duplicate ACKs sent	33575

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