Assignment Two: Analysis

UDP Datagram Contents

All packets contain a few pieces of data. As a UDP datagram it contains the typical header containing a source port, a destination port, a length and a check sum. They also contain the IP address of where they started and where they are going. The first piece of a payload from the client is a sequence number, **1 byte in length**. Then, a reserved byte is placed at offset 1 for extensibility. At **offset 2**, the length of the file stream data is written. Finally, **offset 3** and beyond will contain at most 124 sequential bytes of file data. A termination datagram, or end of transmission datagram, is simply a datagram with a sequence number of negative one and is used to shut down the server. The server will shut down when receiving a sequence with -1 after sending an ACK to the client with a sequence of -1 as well. On the server side acknowledgement datagrams only contain the sequence number of what the datagram is acknowledging in their payloads.

Timing Analysis

Accelerator is a 300KB file and **homura** is a 1,500KB (1.5MB) file so they are both considered large files. On these two files, *Stop and Wait* (window size = 1) was consistently slower than *"Go Back N"*. On the accelerator image with and no loss, *Stop and Wait* was 10 times slower than *"Go Back N"* with a window size of 10. With no packet loss on the large files doubling the window size approximately halves the time taken, similarly multiplying the window by 4 divides time taken by approximately 4 and the pattern continues at size 10.

Increasing packet loss greatly increases the time required to send a large file but also diminishes the amount of time saved by increasing the window size. When not losing any packets, a window size of 80 sends the 300KB image in **2.2 seconds** and a window size of 40 sends it in **3.8 seconds**. Losing one in 5 packets causes the image to take 68-71 seconds to transmit for all three of the *"Go Back N*'s" with a timeout of 100ms. With *"Go Back N"* if we lose a packet every window increasing the window size has exponentially diminishing returns.

When different timeout values are used with different window sizes and a loss rate of zero for either file it has almost no effect on transmission time. Tripling the timeout value increases the time by about 0.03 times. With a loss rate of 1/5, based on the **accelerator** image, and stop and wait protocol, tripling the timeout multiplies transmission time by about 1.6 and multiplying timeout by 5 multiplies it by about 2.2. With a window size of 10, all else equal, tripling timeout increases transmission time by 2.8 times and multiplying timeout by 5 multiplies transmission time by 4.8 times. For a window size of 80 the multipliers are slightly larger. **Homura** has larger multipliers then **accelerator** which implies increasing the file size increases the multipliers.

For small files such as test border stop and wait is slower than any of the *"Go Back N"*'s with the same variables. The window size of "**test border**" has very little effect since it is a small file. With "**test short**" multiplying the window size by 10 divides time taken by about 5.5. This implies that with very short files increasing the window size has less of an effect than with large files. Loss rates have less of an effect with a timeout of 100. The time taken increases from 0.17s to 0.27s when 1 in 100 are lost 0.47s for a window size of 80 and a loss of 1/5.

In general long timeouts mixed with high loss rates greatly slows down the transfer regardless of file size. Timeouts are relatively unimportant when loss rates are low. With low loss rates window size greatly improves performance but does very little with high loss rates. A single packet in error can cause "*Go Back N*" to transmit many packets unnecessarily, the earlier in a window it occurs the more packets are wasted and while this has little to no effect on our system produces a significant amount of unnecessary congestion on the network. To keep congestion low, balancing the timeout and window size is important.

Data Tables

File Size Mapping Table

File Name	File Size (Bytes)
Homura.png	1,481,396
Accelerator.jpg	312,835
Test_short.txt	767
Test_medium	76,024
Test_long.txt	129,180
Test_border.txt	6

Test Run Timings

File Name	Reliability Number	Window Size	Timeout Value (in millseconds)	Time (in seconds)
accelerator.jpg	0	1	100	131.3442
accelerator.jpg	5	1	100	198.0722
accelerator.jpg	100	1	100	138.8452
accelerator.jpg	0	10	100	13.9876
accelerator.jpg	5	10	100	70.30409
accelerator.jpg	100	10	100	16.26743
accelerator.jpg	0	40	100	3.862785
accelerator.jpg	5	40	100	69.42953
accelerator.jpg	100	40	100	5.392754
accelerator.jpg	0	80	100	2.280841
accelerator.jpg	5	80	100	68.08334
accelerator.jpg	100	80	100	3.41488
accelerator.jpg	0	1	300	133.2539
accelerator.jpg	5	1	300	328.0112
accelerator.jpg	100	1	300	148.1826
accelerator.jpg	0	10	300	13.67713
accelerator.jpg	5	10	300	199.4791
accelerator.jpg	100	10	300	21.33811
accelerator.jpg	0	40	300	3.923289
accelerator.jpg	5	40	300	211.3862
accelerator.jpg	100	40	300	13.22427
accelerator.jpg	0	80	300	2.140684
accelerator.jpg	5	80	300	190.2243

accelerator.jpg	100	80	300	7.20571
accelerator.jpg	0	1	500	131.4196
accelerator.jpg	5	1	500	445.6884
accelerator.jpg	100	1	500	145.3268
accelerator.jpg	0	10	500	14.44885
accelerator.jpg	5	10	500	337.726
accelerator.jpg	100	10	500	24.97293
accelerator.jpg	0	40	500	4.34945
accelerator.jpg	5	40	500	331.5759
accelerator.jpg	100	40	500	15.41676
accelerator.jpg	0	80	500	2.174893
accelerator.jpg	5	80	500	329.9176
accelerator.jpg	100	80	500	15.55935
homura.png	0	1	100	604.6048
homura.png	5	1	100	910.8798
homura.png	100	1	100	630.693
homura.png	0	10	100	63.88887
homura.png	5	10	100	320.1506
homura.png	100	10	100	74.4638
homura.png	0	40	100	16.08515
homura.png	5	40	100	313.5878
homura.png	100	40	100	28.09522
homura.png	0	80	100	8.77639
homura.png	5	80	100	304.7992
homura.png	100	80	100	20.30085
homura.png	0	1	300	610.3656
homura.png	5	1	300	1517.982
homura.png	100	1	300	659.5585
homura.png	0	10	300	64.12733
homura.png	5	10	300	922.7717
homura.png	100	10	300	102.0611
homura.png	0	40	300	16.95166
homura.png	5	40	300	875.9216
homura.png	100	40	300	51.68552
homura.png	0	80	300	9.010271
homura.png	5	80	300	900.0537
homura.png	100	80	300	38.7888
homura.png	0	1	500	607.6181
homura.png	5	1	500	2144.851
homura.png	100	1	500	687.2477

homura.png	0	10	500	64.06942
homura.png	5	10	500	1584.435
homura.png	100	10	500	125.5415
homura.png	0	40	500	16.87746
homura.png	5	40	500	1533.123
homura.png	100	40	500	72.26439
homura.png	0	80	500	8.767542
homura.png	5	80	500	1578.698
homura.png	100	80	500	75.24278
test_border.txt	0	1	100	0.4148
test_border.txt	5	1	100	0.623781
test_border.txt	100	1	100	0.520651
test_border.txt	0	10	100	0.172758
test_border.txt	5	10	100	0.680945
test_border.txt	100	10	100	0.1602
test_border.txt	0	40	100	0.163978
test_border.txt	5	40	100	0.474593
test_border.txt	100	40	100	0.163541
test_border.txt	0	80	100	0.182228
test_border.txt	5	80	100	0.472585
test_border.txt	100	80	100	0.173217
test_border.txt	0	1	300	0.716748
test_border.txt	5	1	300	1.638449
test_border.txt	100	1	300	0.425784
test_border.txt	0	10	300	0.171498
test_border.txt	5	10	300	0.46358
test_border.txt	100	10	300	0.17431
test_border.txt	0	40	300	0.171769
test_border.txt	5	40	300	0.764958
test_border.txt	100	40	300	0.170708
test_border.txt	0	80	300	0.1612
test_border.txt	5	80	300	1.067337
test_border.txt	100	80	300	0.164205
test_border.txt	0	1	500	0.428874
test_border.txt	5	1	500	0.91815
test_border.txt	100	1	500	0.419526
test_border.txt	0	10	500	0.169211
test_border.txt	5	10	500	0.173481
test_border.txt	100	10	500	0.168193
test_border.txt	0	40	500	0.17422

test_border.txt	5	40	500	2.667954
test_border.txt	100	40	500	0.166208
test_border.txt	0	80	500	0.17722
test_border.txt	5	80	500	0.166207
test_border.txt	100	80	500	0.165207
test_long.txt	0	1	100	57.56053
test_long.txt	5	1	100	87.09577
test_long.txt	100	1	100	59.52004
test_long.txt	0	10	100	6.186211
test_long.txt	5	10	100	29.09815
test_long.txt	100	10	100	6.85561
test_long.txt	0	40	100	1.630564
test_long.txt	5	40	100	30.12347
test_long.txt	100	40	100	2.812276
test_long.txt	0	80	100	1.151097
test_long.txt	5	80	100	31.40481
test_long.txt	100	80	100	1.85032
test_long.txt	0	1	300	57.61417
test_long.txt	5	1	300	150.1978
test_long.txt	100	1	300	64.13299
test_long.txt	0	10	300	6.025547
test_long.txt	5	10	300	90.55995
test_long.txt	100	10	300	10.76575
test_long.txt	0	40	300	1.710143
test_long.txt	5	40	300	76.9148
test_long.txt	100	40	300	5.055358
test_long.txt	0	80	300	1.058327
test_long.txt	5	80	300	79.55254
test_long.txt	100	80	300	5.882368
test_long.txt	0	1	500	58.38539
test_long.txt	5	1	500	206.5459
test_long.txt	100	1	500	66.21308
test_long.txt	0	10	500	6.175734
test_long.txt	5	10	500	158.4217
test_long.txt	100	10	500	7.672611
test_long.txt	0	40	500	1.797088
test_long.txt	5	40	500	137.3231
test_long.txt	100	40	500	9.461852
test_long.txt	0	80	500	1.466836
test_long.txt	5	80	500	143.4689

test_long.txt	100	80	500	9.313397
test_medium.txt	0	1	100	31.16704
test_medium.txt	5	1	100	49.29846
test_medium.txt	100	1	100	33.35478
test_medium.txt	0	10	100	3.431301
test_medium.txt	5	10	100	16.10233
test_medium.txt	100	10	100	3.712639
test_medium.txt	0	40	100	1.037745
test_medium.txt	5	40	100	15.42429
test_medium.txt	100	40	100	1.327703
test_medium.txt	0	80	100	0.725909
test_medium.txt	5	80	100	16.47064
test_medium.txt	100	80	100	1.170541
test_medium.txt	0	1	300	31.73075
test_medium.txt	5	1	300	77.08442
test_medium.txt	100	1	300	34.87978
test_medium.txt	0	10	300	3.45633
test_medium.txt	5	10	300	51.50713
test_medium.txt	100	10	300	4.308419
test_medium.txt	0	40	300	1.022261
test_medium.txt	5	40	300	42.82764
test_medium.txt	100	40	300	3.294126
test_medium.txt	0	80	300	0.681887
test_medium.txt	5	80	300	53.75897
test_medium.txt	100	80	300	1.499763
test_medium.txt	0	1	500	31.91492
test_medium.txt	5	1	500	103.8462
test_medium.txt	100	1	500	35.64307
test_medium.txt	0	10	500	3.500386
test_medium.txt	5	10	500	82.07072
test_medium.txt	100	10	500	6.484463
test_medium.txt	0	40	500	1.485861
test_medium.txt	5	40	500	76.55199
test_medium.txt	100	40	500	3.424541
test_medium.txt	0	80	500	0.660828
test_medium.txt	5	80	500	81.22677
test_medium.txt	100	80	500	3.9718
test_short.txt	0	1	100	1.568966
test_short.txt	5	1	100	2.191747
test_short.txt	100	1	100	1.627038

test_short.txt	0	10	100	0.270181
test_short.txt	5	10	100	1.181936
test_short.txt	100	10	100	0.276345
test_short.txt	0	40	100	0.172216
test_short.txt	5	40	100	0.695698
test_short.txt	100	40	100	0.200515
test_short.txt	0	80	100	0.178223
test_short.txt	5	80	100	0.47583
test_short.txt	100	80	100	0.280351
test_short.txt	0	1	300	1.541931
test_short.txt	5	1	300	3.95266
test_short.txt	100	1	300	1.606005
test_short.txt	0	10	300	0.290325
test_short.txt	5	10	300	3.179983
test_short.txt	100	10	300	0.277858
test_short.txt	0	40	300	0.189234
test_short.txt	5	40	300	2.902636
test_short.txt	100	40	300	0.181227
test_short.txt	0	80	300	0.18323
test_short.txt	5	80	300	1.375723
test_short.txt	100	80	300	0.474893
test_short.txt	0	1	500	1.565961
test_short.txt	5	1	500	6.10489
test_short.txt	100	1	500	2.091524
test_short.txt	0	10	500	0.292366
test_short.txt	5	10	500	4.728151
test_short.txt	100	10	500	0.28722
test_short.txt	0	40	500	0.177836
test_short.txt	5	40	500	4.187245
test_short.txt	100	40	500	0.671243
test_short.txt	0	80	500	0.17663
test_short.txt	5	80	500	5.185603
test_short.txt	100	80	500	0.180126