

COMP 7005: Final Project

TCP simulator using UDP

Kevin Lo A00952922
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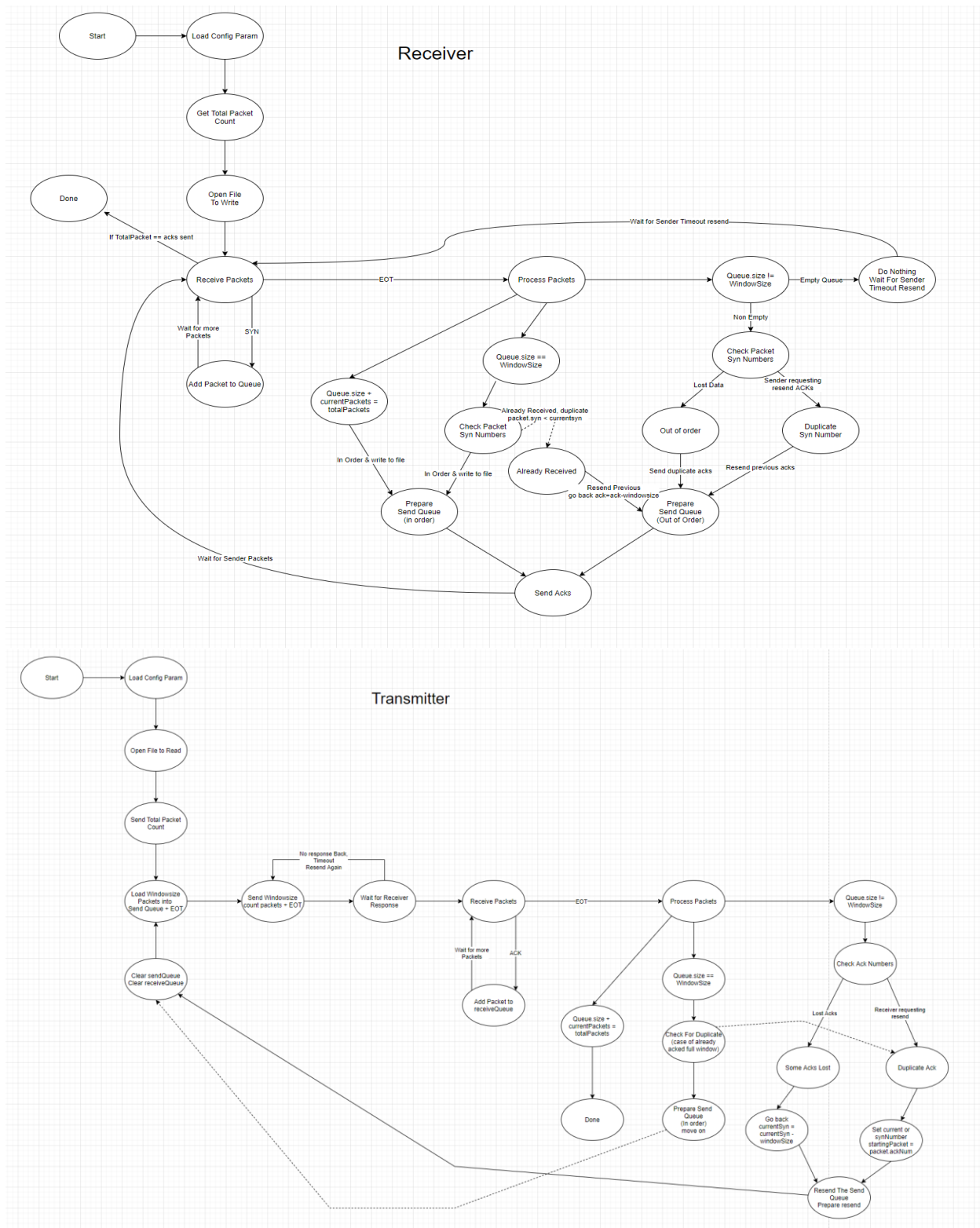
Introduction

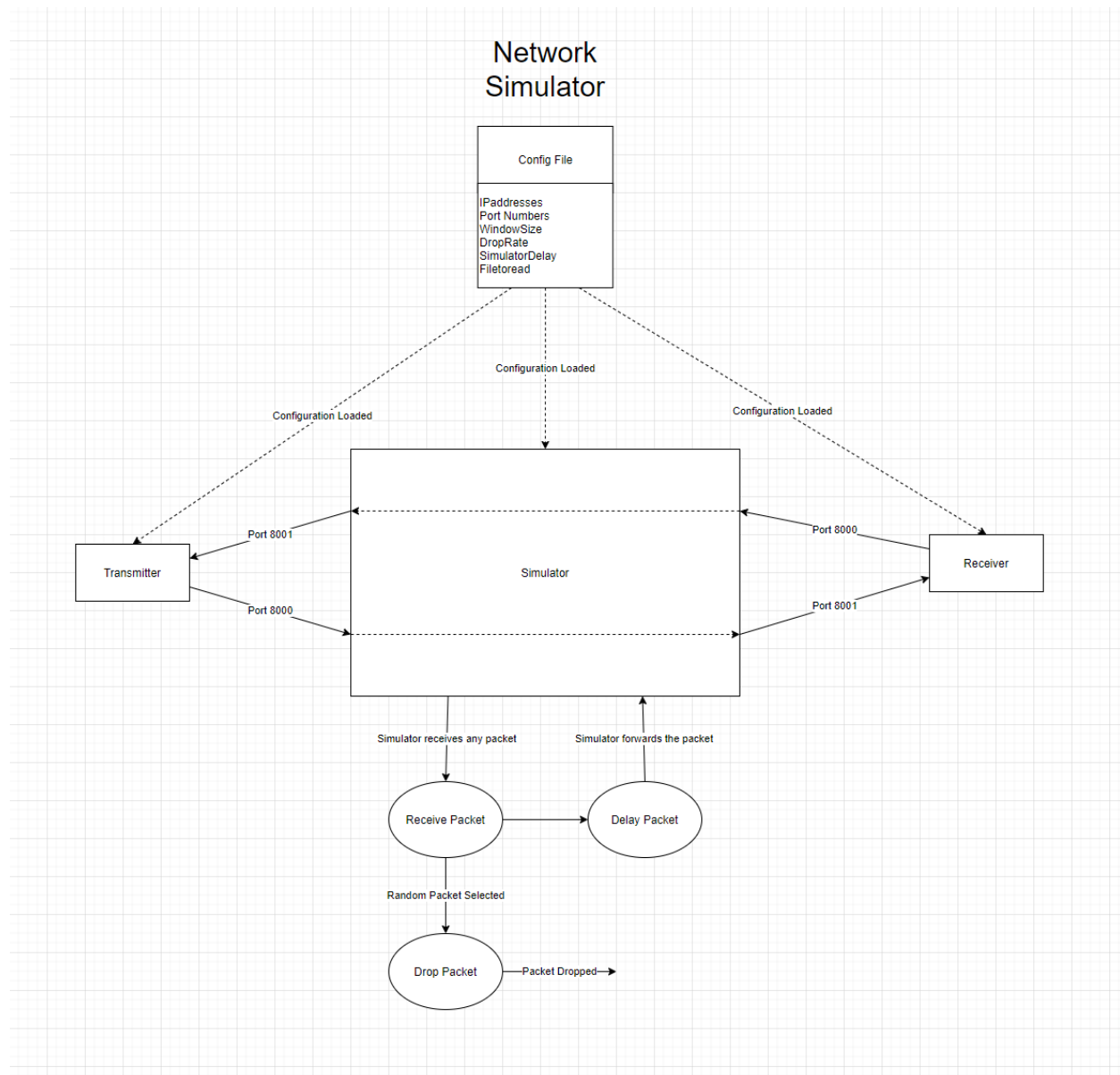
This project was to design a transmitter and a receiver using UDP to send multiple frames and handle network errors that may occur such as timeout or packet loss.

A network emulator is used in between the transmitter and receiver to simulate an unreliable channel such as introducing delays or dropping packets. The network emulator will take the packet from the transmitter and forward the packet to the receiver, and vice versa.

The finite state machine diagrams, pseudocode for the transmitter, receiver and network simulator will also be provided as .png and .txt files.

Finite State Machines





Pseudocode

Transmitter

```
Load configuration from netSim.config
Open file to read
Read file and convert into packets
Send total packet count to receiver

While currentSyn < totalPacketCount
    put windowSize packets into sendQueue
    send all packets in the sendQueue to receiver/netSimulator

    for (timeoutMax)
        listen for response
        if (timed out)
            resend packets and listen for response

        packet received
        if(packet is ACK)
            put packet into receiveQueue
        else if(packet is EOT)
            break

    Process the packets in receiveQueue
    if (expectedAck + receiveQueue.size == totalPackets)
        receiver got entire file, program ends
        break
    if (receiveQueue.size == windowSize)
        check if contains duplicate acks
        if (isDuplicate)
            currentSyn = packet.ackNum
        else
            expectedAck = expectedAck + windowSize
    if (receiveQueue.size != windowSize)
        if (isDuplicate) #is duplicate ack
            currentSyn = packet.ackNum
        else #its out of order
            currentSyn = currentSyn - windowSize

    sendQueue.clear()
    receiveQueue.clear()
```

Receiver

Load configuration from netSim.config

Open file to write

Receive total packet count from sender

```
while (currentAck < totalPacket)
```

```
    while 1 #wait for packets
```

```
        get packet from sender
```

```
        if (SYN packet)
```

```
            add packet to receiveQueue
```

```
        else if (EOT packet)
```

```
            break
```

```
if (receiveQueue.size + expectedSyn == totalpacket)
```

```
    read packet data and write to file
```

```
    load packets of corresponding acks into sendQueue
```

```
    # read all the data sent, can close application now
```

```
if (receiveQueue.size == windowSize)
```

```
    if (alreadyAked)
```

```
        load packets of duplicate ack into sendQueue
```

```
    else
```

```
        read packet data and write to file
```

```
        load packets of corresponding acks into sendQueue
```

```
if (receiveQueue.size != windowSize)
```

```
    if (isDuplicate)
```

```
        load acks corresponding to syn number into sendQueue
```

```
    else
```

```
        load duplicate acks it is currently on into sendQueue
```

```
Send packets that are loaded into sendQueue
```

```
receiveQueue.clear
```

```
sendQueue.clear
```

Network Simulator

Load configuration from netSim.config

Open file to read

```
while 1
    receive packets from transmitter/receiver

    delaytime = random(0-configDelay)
    droprate = random(0-100)

    random delay based on delayTime
    pick random packets to drop based on dropRate compared to dropConfig

    if(not dropped)
        forward packet to the right computer
    else
        do nothing, packet dropped
```


Protocol

The basic protocol used is Send and Wait where only one client will send packets at any time. The other client will receive an End of Transmission packet (EOT) to signal that the other client is done sending their packets to let they can start sending their own packets.

The protocol can send multiple packets at a time for example, with a window of 8, it will send 8 packets before sending an EOT packet and the EOT packet does not count towards the packet limit for simplicity

The sender sends window size number of packets to the receiver.

The receiver only accepts complete windows of packets or if it is the last of the packets left.

For example window size 8, it will only accept 1,2,3,4,5,6,7,8 but it won't accept 1,2,3,5,6,7,8 because an incomplete window. It will send back an equal amount of ACKs back 1,2,3,4,5,6,7,8 or 1,1,1,1,1,1,1,1 depending on it is current ack number and if it is a full or duplicate window.

The sender responds to the ACKs from the receiver.

If it is not a full window, check if it is duplicate acks.

If it is a duplicate ACK, set next packets to send starting from the stated ACK number.

If it is a full window and is in order, it is ok to send the next packets

The network simulator simply forwards packets to the corresponding IP addresses stated in the configuration file.

When it receives any packet, it will delay the application.

It picks random packets to "drop" by not sending it.

Testing

Test 1: Successful Transfer, No Packet Loss

In a test with no losses will end both the receiver and transmitter programs gracefully as they both successfully got their last packets. It affirms the basic pattern of how my algorithm works.

The sequence number is sent incrementally to the transmitter, then the receiver responds with incrementing acknowledgement numbers

Transmitter

```
E:\Homework\COMP7005\FinalProject\cmd.exe
24. Sending type=0 seq=12 ack=12 payload=b'enberg.org. If you are not loca'
25. Sending type=0 seq=13 ack=12 payload=b"ted in the United States, you'll"
26. Sending type=0 seq=14 ack=12 payload=b' have\r\nto check the laws of the '
27. Sending type=0 seq=15 ack=12 payload=b'country where you are located be'
Sending EOT
28. Incoming type=1 seq=12 ack=12
29. Incoming type=1 seq=13 ack=13
30. Incoming type=1 seq=14 ack=14
31. Incoming type=1 seq=15 ack=15
Got EOT
Receivecode= 2
32. Sending type=0 seq=16 ack=16 payload=b'fore using this ebook.\r\n\r\nTitle:'
33. Sending type=0 seq=17 ack=16 payload=b' Alice\xe2\x80\x99s Adventures in Wonderl'
34. Sending type=0 seq=18 ack=16 payload=b'and\r\n\r\nAuthor: Lewis Carroll\r\n\r\n'
35. Sending type=0 seq=19 ack=16 payload=b'Release Date: June 25, 2008 [EBo'
Sending EOT
36. Incoming type=1 seq=16 ack=16
37. Incoming type=1 seq=17 ack=17
38. Incoming type=1 seq=18 ack=18
39. Incoming type=1 seq=19 ack=19
Got EOT
Receivecode= 2
40. Sending type=0 seq=20 ack=20 payload=b'ok #11]\r\n[Most recently updated:'
41. Sending type=0 seq=21 ack=20 payload=b' October 12, 2020]'
Sending EOT
42. Incoming type=1 seq=20 ack=20
43. Incoming type=1 seq=21 ack=21
Got EOT
Receivecode= 0
E:\Homework\COMP7005\FinalProject>
```

Receiver

```
kevinlo@fedora:~/Desktop
21. Sending type =1 syn=9 ack=9
22. Sending type =1 syn=10 ack=10
23. Sending type =1 syn=11 ack=11
Sending EOT
24. Recieving type =0 syn=12 ack=12 payload=b'enberg.org. If you are not loca'
25. Recieving type =0 syn=13 ack=12 payload=b"ted in the United States, you'll"
26. Recieving type =0 syn=14 ack=12 payload=b' have\r\nto check the laws of the '
27. Recieving type =0 syn=15 ack=12 payload=b'country where you are located be'
Receivecode= 2
28. Sending type =1 syn=12 ack=12
29. Sending type =1 syn=13 ack=13
30. Sending type =1 syn=14 ack=14
31. Sending type =1 syn=15 ack=15
Sending EOT
32. Recieving type =0 syn=16 ack=16 payload=b'fore using this ebook.\r\n\r\nTitle:'
33. Recieving type =0 syn=17 ack=16 payload=b' Alice\xe2\x80\x99s Adventures in Wonderl'
34. Recieving type =0 syn=18 ack=16 payload=b'and\r\n\r\nAuthor: Lewis Carroll\r\n\r\n'
35. Recieving type =0 syn=19 ack=16 payload=b'Release Date: June 25, 2008 [EBo'
Receivecode= 2
36. Sending type =1 syn=16 ack=16
37. Sending type =1 syn=17 ack=17
38. Sending type =1 syn=18 ack=18
39. Sending type =1 syn=19 ack=19
Sending EOT
40. Recieving type =0 syn=20 ack=20 payload=b'ok #11]\r\n[Most recently updated:'
41. Recieving type =0 syn=21 ack=20 payload=b' October 12, 2020]
Receivecode= 0
42. Sending type =1 syn=20 ack=20
43. Sending type =1 syn=21 ack=21
Sending EOT
[kevinlo@localhost Desktop]$
```

Simulator

```
2020-12-04 20:02:50:133443 51. 192.168.1.253 -> 192.168.1.250 type=0 sleep=0.00011608806403150729
2020-12-04 20:02:50:335606 52. 192.168.1.253 -> 192.168.1.250 type=0 sleep=0.00017191294562990734
2020-12-04 20:02:50:335988 53. 192.168.1.253 -> 192.168.1.250 type=2 sleep=0.00017663708127711608
2020-12-04 20:02:50:751097 54. 192.168.1.253 <- 192.168.1.250 type=1 sleep=0.00032960740680991224
2020-12-04 20:02:50:952750 55. 192.168.1.253 <- 192.168.1.250 type=1 sleep=0.00047855814073011346
2020-12-04 20:02:50:953102 56. 192.168.1.253 <- 192.168.1.250 type=2 sleep=0.00019184481644501995
```

Test 2: Successful Transfer, Some Packet Loss, Loss on Last ACKs

The file will successfully be transferred to the receiver however it will take a little bit longer due to needing to retransmit the whole window again. The sender is also not guaranteed to receive the last ACKs either which would put it into a loop of trying to resend the last frames when the receiver has already stopped responding.

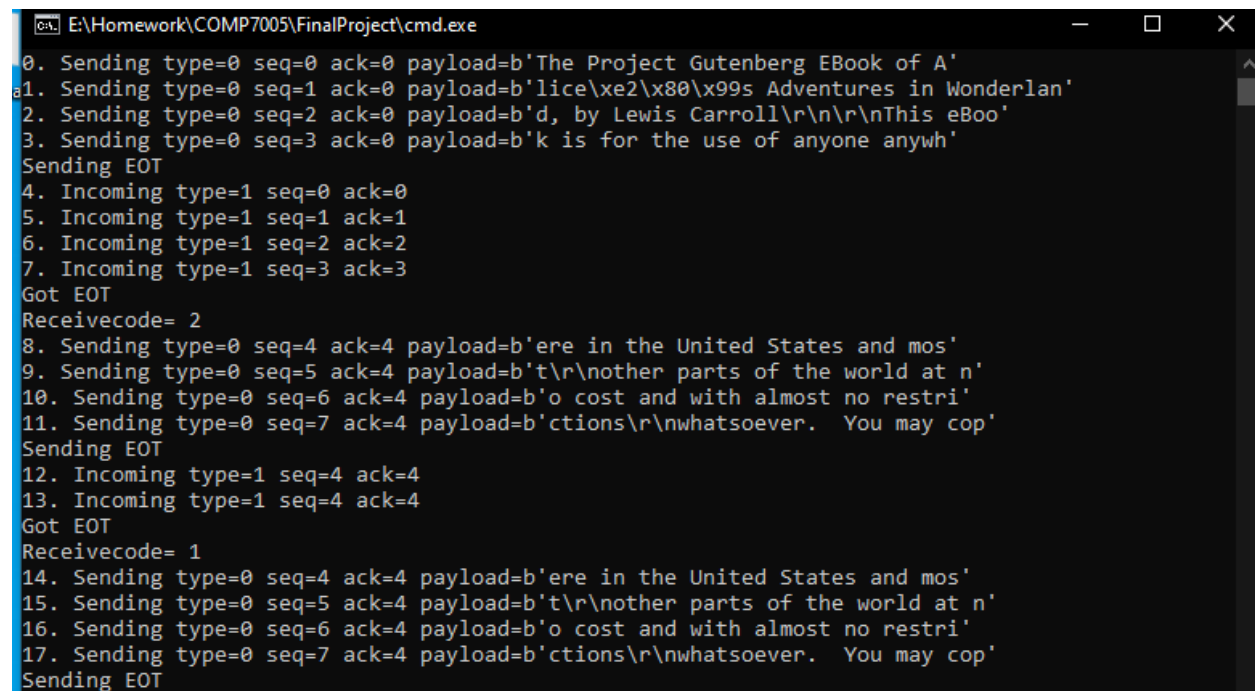
As shown by the network simulator's log, one of the frames in the last ACK was dropped so the sender tries to resend but the receiver has already finished receiving the full file.

The transmitter then will keep timing out until it reaches its max timeouts before closing the program

Loss of Sequence Frames

When the sender gets any duplicate ACK, it will set it's current sequence to that specific ACK since duplicate ACKs in my program signal the sender that the receiver needs the window starting at that specific ACK.

Transmitter



```
E:\Homework\COMP7005\FinalProject\cmd.exe
0. Sending type=0 seq=0 ack=0 payload=b'The Project Gutenberg EBook of A'
1. Sending type=0 seq=1 ack=0 payload=b'lice\xe2\x80\x99s Adventures in Wonderlan'
2. Sending type=0 seq=2 ack=0 payload=b'd, by Lewis Carroll\r\n\r\nThis eBoo'
3. Sending type=0 seq=3 ack=0 payload=b'k is for the use of anyone anywh'
Sending EOT
4. Incoming type=1 seq=0 ack=0
5. Incoming type=1 seq=1 ack=1
6. Incoming type=1 seq=2 ack=2
7. Incoming type=1 seq=3 ack=3
Got EOT
Receivecode= 2
8. Sending type=0 seq=4 ack=4 payload=b'ere in the United States and mos'
9. Sending type=0 seq=5 ack=4 payload=b't\r\nother parts of the world at n'
10. Sending type=0 seq=6 ack=4 payload=b'o cost and with almost no restri'
11. Sending type=0 seq=7 ack=4 payload=b'ctions\r\nwhatsoever. You may cop'
Sending EOT
12. Incoming type=1 seq=4 ack=4
13. Incoming type=1 seq=4 ack=4
Got EOT
Receivecode= 1
14. Sending type=0 seq=4 ack=4 payload=b'ere in the United States and mos'
15. Sending type=0 seq=5 ack=4 payload=b't\r\nother parts of the world at n'
16. Sending type=0 seq=6 ack=4 payload=b'o cost and with almost no restri'
17. Sending type=0 seq=7 ack=4 payload=b'ctions\r\nwhatsoever. You may cop'
Sending EOT
```

Receiver

```
kevinlo@fedora:~/Desktop
0. Recieving type =0 syn=0 ack=0 payload=b'The Project Gutenberg EBook of A'
1. Recieving type =0 syn=1 ack=0 payload=b'lice\xe2\x80\x99s Adventures in Wonderlan'
2. Recieving type =0 syn=2 ack=0 payload=b'd, by Lewis Carroll\r\n\r\nThis eBoo'
3. Recieving type =0 syn=3 ack=0 payload=b'k is for the use of anyone anywh'
Receivecode= 2
4. Sending type =1 syn=0 ack=0
5. Sending type =1 syn=1 ack=1
6. Sending type =1 syn=2 ack=2
7. Sending type =1 syn=3 ack=3
Sending EOT
8. Recieving type =0 syn=6 ack=4 payload=b'o cost and with almost no restri'
9. Recieving type =0 syn=7 ack=4 payload=b'ctions\r\nwhatsoever. You may cop'
Receivecode= 4
10. Sending type =1 syn=4 ack=4
11. Sending type =1 syn=4 ack=4
Sending EOT
12. Recieving type =0 syn=4 ack=4 payload=b'ere in the United States and mos'
13. Recieving type =0 syn=5 ack=4 payload=b't\r\nother parts of the world at n'
14. Recieving type =0 syn=6 ack=4 payload=b'o cost and with almost no restri'
15. Recieving type =0 syn=7 ack=4 payload=b'ctions\r\nwhatsoever. You may cop'
```

Simulator

```
yuiiko@fedora:~/Desktop
2020-12-04 20:19:32:211733 0. 192.168.1.253 -> 192.168.1.250 type=-1 sleep=6.718212205620062e-05
2020-12-04 20:19:32:621753 1. 192.168.1.253 -> 192.168.1.250 type=0 sleep=3.1553410943854664e-05
2020-12-04 20:19:32:826683 2. 192.168.1.253 -> 192.168.1.250 type=0 sleep=0.0002477175435459705
2020-12-04 20:19:33:032743 3. 192.168.1.253 -> 192.168.1.250 type=0 sleep=0.0002361226217880583
2020-12-04 20:19:33:238120 4. 192.168.1.253 -> 192.168.1.250 type=0 sleep=0.0003943616755677566
2020-12-04 20:19:33:238738 5. 192.168.1.253 -> 192.168.1.250 type=2 sleep=0.00024392832826207377
2020-12-04 20:19:33:670356 6. 192.168.1.253 <- 192.168.1.250 type=1 sleep=0.0002163835339525267
2020-12-04 20:19:33:871711 7. 192.168.1.253 <- 192.168.1.250 type=1 sleep=0.00038357881457398105
2020-12-04 20:19:34:070951 8. 192.168.1.253 <- 192.168.1.250 type=1 sleep=0.000226935970274007
2020-12-04 20:19:34:271670 9. 192.168.1.253 <- 192.168.1.250 type=1 sleep=0.0004009131834982418
2020-12-04 20:19:34:272510 10. 192.168.1.253 <- 192.168.1.250 type=2 sleep=0.00047263534777696115
2020-12-04 20:19:34:696282 11. 192.168.1.253 -> 192.168.1.250 type=0 sleep=1.5294991516776767e-05 DROPPED
2020-12-04 20:19:34:902945 12. 192.168.1.253 -> 192.168.1.250 type=0 sleep=0.0003247730677627492 DROPPED
2020-12-04 20:19:35:111147 13. 192.168.1.253 -> 192.168.1.250 type=0 sleep=0.0004695745813892553
2020-12-04 20:19:35:313219 14. 192.168.1.253 -> 192.168.1.250 type=0 sleep=0.0003432419270895399
2020-12-04 20:19:35:313973 15. 192.168.1.253 -> 192.168.1.250 type=2 sleep=0.0003629263007232576
2020-12-04 20:19:35:731619 16. 192.168.1.253 <- 192.168.1.250 type=1 sleep=0.00011084583313651753
2020-12-04 20:19:35:946012 17. 192.168.1.253 <- 192.168.1.250 type=1 sleep=0.0004695835094742933
2020-12-04 20:19:35:946512 18. 192.168.1.253 <- 192.168.1.250 type=2 sleep=0.00011654222512878631
2020-12-04 20:19:36:368650 19. 192.168.1.253 -> 192.168.1.250 type=0 sleep=0.0003384242699249872
2020-12-04 20:19:36:560722 20. 192.168.1.253 -> 192.168.1.250 type=0 sleep=0.0002298017328688668
2020-12-04 20:19:36:774102 21. 192.168.1.253 -> 192.168.1.250 type=0 sleep=0.00046325331189293303
2020-12-04 20:19:36:979557 22. 192.168.1.253 -> 192.168.1.250 type=0 sleep=0.00041878898783128646
2020-12-04 20:19:36:980359 23. 192.168.1.253 -> 192.168.1.250 type=2 sleep=0.00046109428123494375
```

Loss of Last ACK Frames

When there is a loss of ACKs during the last window of data, a problem occurs with the sender where it will keep trying to send the last window sequence because it did not get back the full ACKs back. It loops because it will timeout due to the receiver not responding anymore because the program has completed when it received the last of the sequence numbers and data.

Transmitter

```
70. Sending type=0 seq=16 ack=16 payload=b'fore using this ebook.\r\n\r\nTitle:'
71. Sending type=0 seq=17 ack=16 payload=b' Alice\xe2\x80\x99s Adventures in Wonderl'
72. Sending type=0 seq=18 ack=16 payload=b'and\r\n\r\nAuthor: Lewis Carroll\r\n\r\n'
73. Sending type=0 seq=19 ack=16 payload=b'Release Date: June 25, 2008 [EBo'
Sending EOT
74. Incoming type=1 seq=16 ack=16
75. Incoming type=1 seq=17 ack=17
76. Incoming type=1 seq=18 ack=18
77. Incoming type=1 seq=19 ack=19
Got EOT
Receivecode= 2
78. Sending type=0 seq=20 ack=20 payload=b'ok #11]\r\n[Most recently updated:'
79. Sending type=0 seq=21 ack=20 payload=b' October 12, 2020]'
Sending EOT
80. Incoming type=1 seq=21 ack=21
Got EOT
Receivecode= 4
81. Sending type=0 seq=18 ack=20 payload=b'ok #11]\r\n[Most recently updated:'
82. Sending type=0 seq=19 ack=20 payload=b' October 12, 2020]'
Sending EOT
Timed out
83. Sending type=0 seq=18 ack=20 payload=b'ok #11]\r\n[Most recently updated:'
84. Sending type=0 seq=19 ack=20 payload=b' October 12, 2020]'
Sending EOT
```

Receiver

```
Receivecode= 2
74. Sending type =1 syn=16 ack=16
75. Sending type =1 syn=17 ack=17
76. Sending type =1 syn=18 ack=18
77. Sending type =1 syn=19 ack=19
Sending EOT
78. Recieving type =0 syn=20 ack=20 payload=b'ok #11]\r\n[Most recently updated:'
79. Recieving type =0 syn=21 ack=20 payload=b' October 12, 2020]'
Receivecode= 0
80. Sending type =1 syn=20 ack=20
81. Sending type =1 syn=21 ack=21
Sending EOT
[kevinlo@localhost Desktop]$
```


Simulator

```
2020-12-04 20:19:56:407720 95. 192.168.1.253 -> 192.168.1.250 type=0 sleep=0.0004884880780264531
2020-12-04 20:19:56:610206 96. 192.168.1.253 -> 192.168.1.250 type=0 sleep=0.0003989054288530755
2020-12-04 20:19:56:814032 97. 192.168.1.253 -> 192.168.1.250 type=0 sleep=0.00022542251357136585
2020-12-04 20:19:57:019760 98. 192.168.1.253 -> 192.168.1.250 type=0 sleep=0.0003242532090496282
2020-12-04 20:19:57:020404 99. 192.168.1.253 -> 192.168.1.250 type=2 sleep=0.00033745128875913456
2020-12-04 20:19:57:636659 100. 192.168.1.253 <- 192.168.1.250 type=1 sleep=0.00032991194587553985
2020-12-04 20:19:57:836424 101. 192.168.1.253 <- 192.168.1.250 type=1 sleep=2.9392558103245648e-05
2020-12-04 20:19:58:038754 102. 192.168.1.253 <- 192.168.1.250 type=1 sleep=6.284166115486362e-05
2020-12-04 20:19:58:238390 103. 192.168.1.253 <- 192.168.1.250 type=1 sleep=0.00043776712211757965
2020-12-04 20:19:58:238572 104. 192.168.1.253 <- 192.168.1.250 type=2 sleep=3.5363438943454616e-05
2020-12-04 20:19:58:658576 105. 192.168.1.253 -> 192.168.1.250 type=0 sleep=0.00015518181367656702
2020-12-04 20:19:58:860985 106. 192.168.1.253 -> 192.168.1.250 type=0 sleep=0.00037192105933356057
2020-12-04 20:19:58:861868 107. 192.168.1.253 -> 192.168.1.250 type=2 sleep=0.0002824703613383997
2020-12-04 20:19:59:270095 108. 192.168.1.253 <- 192.168.1.250 type=1 sleep=4.240131231834421e-06 DROPPED
2020-12-04 20:19:59:471140 109. 192.168.1.253 <- 192.168.1.250 type=1 sleep=0.00029529198564370765
2020-12-04 20:19:59:471962 110. 192.168.1.253 <- 192.168.1.250 type=2 sleep=0.00048110056259040903
2020-12-04 20:19:59:886497 111. 192.168.1.253 -> 192.168.1.250 type=0 sleep=0.0002304262450766455
2020-12-04 20:20:00:091609 112. 192.168.1.253 -> 192.168.1.250 type=0 sleep=0.0003520115711650357
2020-12-04 20:20:00:091914 113. 192.168.1.253 -> 192.168.1.250 type=2 sleep=1.8711687542382007e-05
2020-12-04 20:20:04:310465 114. 192.168.1.253 -> 192.168.1.250 type=0 sleep=0.00017346544228131084
2020-12-04 20:20:04:517425 115. 192.168.1.253 -> 192.168.1.250 type=0 sleep=0.00028669135151115433
2020-12-04 20:20:04:518138 116. 192.168.1.253 -> 192.168.1.250 type=2 sleep=0.0002957046560724029
```

Test 3: Successful Transfer, High Window, No Loss

Using a window size of 32 and setting the packet drop rate to not drop, the transfer completed much faster than in test 1 because it did not need to send EOT frames as often.

In this scenario the program sent the entire file's contents in one window, 22 frames in a 32 frame window.

Transmitter

```
E:\Homework\COMP7005\FinalProject\cmd.exe
22 Packets total of data
0. Sending type=0 seq=0 ack=0 payload=b'The Project Gutenberg EBook of A'
1. Sending type=0 seq=1 ack=0 payload=b'lice\xe2\x80\x99s Adventures in Wonderlan'
2. Sending type=0 seq=2 ack=0 payload=b'd, by Lewis Carroll\r\n\r\nThis eBoo'
3. Sending type=0 seq=3 ack=0 payload=b'k is for the use of anyone anywh'
4. Sending type=0 seq=4 ack=0 payload=b'ere in the United States and mos'
5. Sending type=0 seq=5 ack=0 payload=b't\r\nother parts of the world at n'
6. Sending type=0 seq=6 ack=0 payload=b'o cost and with almost no restri'
7. Sending type=0 seq=7 ack=0 payload=b'ctions\r\nwhatsoever. You may cop'
8. Sending type=0 seq=8 ack=0 payload=b'y it, give it away or re-use it '
9. Sending type=0 seq=9 ack=0 payload=b'under the terms of\r\nthe Project '
10. Sending type=0 seq=10 ack=0 payload=b'Gutenberg License included with '
11. Sending type=0 seq=11 ack=0 payload=b'this eBook or online at\r\nwww.gut'
12. Sending type=0 seq=12 ack=0 payload=b'enberg.org. If you are not loca'
13. Sending type=0 seq=13 ack=0 payload=b"ted in the United States, you'll"
14. Sending type=0 seq=14 ack=0 payload=b' have\r\nto check the laws of the '
15. Sending type=0 seq=15 ack=0 payload=b'country where you are located be'
16. Sending type=0 seq=16 ack=0 payload=b'fore using this ebook.\r\n\r\nTitle:'
17. Sending type=0 seq=17 ack=0 payload=b' Alice\xe2\x80\x99s Adventures in Wonderl'
18. Sending type=0 seq=18 ack=0 payload=b'and\r\n\r\nAuthor: Lewis Carroll\r\n\r\n'
19. Sending type=0 seq=19 ack=0 payload=b'Release Date: June 25, 2008 [EBo'
20. Sending type=0 seq=20 ack=0 payload=b'ok #11]\r\n[Most recently updated:'
21. Sending type=0 seq=21 ack=0 payload=b' October 12, 2020]'
Sending EOT
22. Incoming type=1 seq=0 ack=0
23. Incoming type=1 seq=1 ack=1
24. Incoming type=1 seq=2 ack=2
25. Incoming type=1 seq=3 ack=3
26. Incoming type=1 seq=4 ack=4
27. Incoming type=1 seq=5 ack=5
28. Incoming type=1 seq=6 ack=6
29. Incoming type=1 seq=7 ack=7
30. Incoming type=1 seq=8 ack=8
31. Incoming type=1 seq=9 ack=9
32. Incoming type=1 seq=10 ack=10
33. Incoming type=1 seq=11 ack=11
34. Incoming type=1 seq=12 ack=12
35. Incoming type=1 seq=13 ack=13
36. Incoming type=1 seq=14 ack=14
37. Incoming type=1 seq=15 ack=15
38. Incoming type=1 seq=16 ack=16
39. Incoming type=1 seq=17 ack=17
40. Incoming type=1 seq=18 ack=18
41. Incoming type=1 seq=19 ack=19
42. Incoming type=1 seq=20 ack=20
43. Incoming type=1 seq=21 ack=21
Got EOT
Receivecode= 0
E:\Homework\COMP7005\FinalProject>
```


Receiver

```
kevinlo@fedora: ~/Desktop
0. Recieving type =0 syn=0 ack=0 payload=b'The Project Gutenberg EBook of A'
1. Recieving type =0 syn=1 ack=0 payload=b'lice\xe2\x80\x99s Adventures in Wonderlan'
2. Recieving type =0 syn=2 ack=0 payload=b'd, by Lewis Carroll\r\n\r\nThis eBoo'
3. Recieving type =0 syn=3 ack=0 payload=b'k is for the use of anyone anywh'
4. Recieving type =0 syn=4 ack=0 payload=b'ere in the United States and mos'
5. Recieving type =0 syn=5 ack=0 payload=b't\r\nother parts of the world at n'
6. Recieving type =0 syn=6 ack=0 payload=b'o cost and with almost no restri'
7. Recieving type =0 syn=7 ack=0 payload=b'ctions\r\nwhatsoever. You may cop'
8. Recieving type =0 syn=8 ack=0 payload=b'y it, give it away or re-use it '
9. Recieving type =0 syn=9 ack=0 payload=b'under the terms of\r\nthe Project '
10. Recieving type =0 syn=10 ack=0 payload=b'Gutenberg License included with '
11. Recieving type =0 syn=11 ack=0 payload=b'this eBook or online at\r\nwww.gut'
12. Recieving type =0 syn=12 ack=0 payload=b'enberg.org. If you are not loca'
13. Recieving type =0 syn=13 ack=0 payload=b"ted in the United States, you'll"
14. Recieving type =0 syn=14 ack=0 payload=b' have\r\nto check the laws of the '
15. Recieving type =0 syn=15 ack=0 payload=b'country where you are located be'
16. Recieving type =0 syn=16 ack=0 payload=b'fore using this ebook.\r\n\r\nTitle:'
17. Recieving type =0 syn=17 ack=0 payload=b' Alice\xe2\x80\x99s Adventures in Wonderl'
18. Recieving type =0 syn=18 ack=0 payload=b'and\r\n\r\nAuthor: Lewis Carroll\r\n\r\n'
19. Recieving type =0 syn=19 ack=0 payload=b'Release Date: June 25, 2008 [EBo'
20. Recieving type =0 syn=20 ack=0 payload=b'ok #11]\r\n[Most recently updated:'
21. Recieving type =0 syn=21 ack=0 payload=b' October 12, 2020]'
Receivecode= 0
22. Sending type =1 syn=0 ack=0
23. Sending type =1 syn=1 ack=1
24. Sending type =1 syn=2 ack=2
25. Sending type =1 syn=3 ack=3
26. Sending type =1 syn=4 ack=4
27. Sending type =1 syn=5 ack=5
28. Sending type =1 syn=6 ack=6
29. Sending type =1 syn=7 ack=7
30. Sending type =1 syn=8 ack=8
31. Sending type =1 syn=9 ack=9
32. Sending type =1 syn=10 ack=10
33. Sending type =1 syn=11 ack=11
34. Sending type =1 syn=12 ack=12
35. Sending type =1 syn=13 ack=13
36. Sending type =1 syn=14 ack=14
37. Sending type =1 syn=15 ack=15
38. Sending type =1 syn=16 ack=16
39. Sending type =1 syn=17 ack=17
40. Sending type =1 syn=18 ack=18
41. Sending type =1 syn=19 ack=19
42. Sending type =1 syn=20 ack=20
43. Sending type =1 syn=21 ack=21
Sending EOT
```

As it did not need to send as much EOTs, the transfer completed much faster considering this is a perfect case scenario where there are no packet losses

Test 4: Successful Transfer, High Window, Low Loss

Using a window size of 32 and setting the packet drop rate to 1%, the moment any packet is dropped or lost the large window size instantly becomes inefficient due to how my protocol works due to not accepting incomplete windows with missing sequences or acknowledgements.

For example, having a window size of 32 and 1% drop rate. A total of 66 packets need to be sent, 32 SEQs, 32 ACKs, 2 EOTs. When any of these packets are lost, the sender will need to resend the whole frame again. Taking this into account, 0.99^{66} will be the probability of sending and getting the acknowledgements back successfully which is 0.51514. A rate of roughly 51.5% of doing the transfer of one window successfully is not good and can only get worse as the loss rate increases or window size increases.

Transmitter

```

E:\Homework\COMP7009\FinalProject\cmd.exe
22 Packets total of data
0. Sending type=0 seq=0 ack=0 payload=b'The Project Gutenberg EBook of A'
1. Sending type=0 seq=1 ack=0 payload=b'lice\x02\x00\x99s Adventures in Wonderlan'
2. Sending type=0 seq=2 ack=0 payload=b'd, by Lewis Carroll\r\n\r\nThis eBoo'
3. Sending type=0 seq=3 ack=0 payload=b'k is for the use of anyone anywh'
4. Sending type=0 seq=4 ack=0 payload=b'ere in the United States and mos'
5. Sending type=0 seq=5 ack=0 payload=b't\r\nother parts of the world at n'
6. Sending type=0 seq=6 ack=0 payload=b'o cost and with almost no restrit'
7. Sending type=0 seq=7 ack=0 payload=b'ctions\r\nwhatsoever. You may cop'
8. Sending type=0 seq=8 ack=0 payload=b'y it, give it away or re-use it '
9. Sending type=0 seq=9 ack=0 payload=b'under the terms of\r\nthe Project '
10. Sending type=0 seq=10 ack=0 payload=b'Gutenberg License included with '
11. Sending type=0 seq=11 ack=0 payload=b'this eBook or online at\r\nwww.gut'
12. Sending type=0 seq=12 ack=0 payload=b'enberg.org. If you are not loca'
13. Sending type=0 seq=13 ack=0 payload=b"ted in the United States, you'lll"
14. Sending type=0 seq=14 ack=0 payload=b' have\r\nnto check the laws of the '
15. Sending type=0 seq=15 ack=0 payload=b'country where you are located be'
16. Sending type=0 seq=16 ack=0 payload=b'fore using this ebook.\r\n\r\nTitle:'
17. Sending type=0 seq=17 ack=0 payload=b' Alice\x02\x00\x99s Adventures in Wonderl'
18. Sending type=0 seq=18 ack=0 payload=b'and\r\n\r\nAuthor: Lewis Carroll\r\n\r\n'
19. Sending type=0 seq=19 ack=0 payload=b'Release Date: June 25, 2008 [EBo'
20. Sending type=0 seq=20 ack=0 payload=b'ok #11]\r\n[Most recently updated:'
21. Sending type=0 seq=21 ack=0 payload=b' October 12, 2020]'
Sending EOT
22. Incoming type=1 seq=0 ack=0
23. Incoming type=1 seq=0 ack=0
24. Incoming type=1 seq=0 ack=0
25. Incoming type=1 seq=0 ack=0
26. Incoming type=1 seq=0 ack=0
27. Incoming type=1 seq=0 ack=0
28. Incoming type=1 seq=0 ack=0
29. Incoming type=1 seq=0 ack=0
30. Incoming type=1 seq=0 ack=0
31. Incoming type=1 seq=0 ack=0
32. Incoming type=1 seq=0 ack=0
33. Incoming type=1 seq=0 ack=0
34. Incoming type=1 seq=0 ack=0
35. Incoming type=1 seq=0 ack=0
36. Incoming type=1 seq=0 ack=0
37. Incoming type=1 seq=0 ack=0
38. Incoming type=1 seq=0 ack=0
39. Incoming type=1 seq=0 ack=0
40. Incoming type=1 seq=0 ack=0
41. Incoming type=1 seq=0 ack=0
42. Incoming type=1 seq=0 ack=0
Got EOT
ReceiveCode= 1
43. Sending type=0 seq=0 ack=0 payload=b'The Project Gutenberg EBook of A'
44. Sending type=0 seq=1 ack=0 payload=b'lice\x02\x00\x99s Adventures in Wonderlan'
45. Sending type=0 seq=2 ack=0 payload=b'd, by Lewis Carroll\r\n\r\nThis eBoo'
46. Sending type=0 seq=3 ack=0 payload=b'k is for the use of anyone anywh'
47. Sending type=0 seq=4 ack=0 payload=b'ere in the United States and mos'
48. Sending type=0 seq=5 ack=0 payload=b't\r\nother parts of the world at n'
49. Sending type=0 seq=6 ack=0 payload=b'o cost and with almost no restrit'
50. Sending type=0 seq=7 ack=0 payload=b'ctions\r\nwhatsoever. You may cop'
51. Sending type=0 seq=8 ack=0 payload=b'y it, give it away or re-use it '
52. Sending type=0 seq=9 ack=0 payload=b'under the terms of\r\nthe Project '
53. Sending type=0 seq=10 ack=0 payload=b'Gutenberg License included with '
54. Sending type=0 seq=11 ack=0 payload=b'this eBook or online at\r\nwww.gut'
55. Sending type=0 seq=12 ack=0 payload=b'enberg.org. If you are not loca'
56. Sending type=0 seq=13 ack=0 payload=b"ted in the United States, you'lll"
57. Sending type=0 seq=14 ack=0 payload=b' have\r\nnto check the laws of the '
58. Sending type=0 seq=15 ack=0 payload=b'country where you are located be'
59. Sending type=0 seq=16 ack=0 payload=b'fore using this ebook.\r\n\r\nTitle:'
60. Sending type=0 seq=17 ack=0 payload=b' Alice\x02\x00\x99s Adventures in Wonderl'
61. Sending type=0 seq=18 ack=0 payload=b'and\r\n\r\nAuthor: Lewis Carroll\r\n\r\n'
62. Sending type=0 seq=19 ack=0 payload=b'Release Date: June 25, 2008 [EBo'
63. Sending type=0 seq=20 ack=0 payload=b'ok #11]\r\n[Most recently updated:'
64. Sending type=0 seq=21 ack=0 payload=b' October 12, 2020]'
Sending EOT
65. Incoming type=1 seq=0 ack=0
66. Incoming type=1 seq=0 ack=0
67. Incoming type=1 seq=0 ack=0
68. Incoming type=1 seq=0 ack=0
69. Incoming type=1 seq=0 ack=0
70. Incoming type=1 seq=0 ack=0
71. Incoming type=1 seq=0 ack=0
72. Incoming type=1 seq=0 ack=0
73. Incoming type=1 seq=0 ack=0
74. Incoming type=1 seq=0 ack=0
75. Incoming type=1 seq=0 ack=0
76. Incoming type=1 seq=0 ack=0
77. Incoming type=1 seq=0 ack=0
78. Incoming type=1 seq=0 ack=0
79. Incoming type=1 seq=0 ack=0
```

Receiver

```
kevinlo@fedora:~/Desktop
0. Recieving type =0 syn=0 ack=0 payload=b'The Project Gutenberg EBook of A'
1. Recieving type =0 syn=1 ack=0 payload=b'lice\xe2\x80\x99s Adventures in Wonderlan'
2. Recieving type =0 syn=2 ack=0 payload=b'd, by Lewis Carroll\r\n\r\nThis eBoo'
3. Recieving type =0 syn=3 ack=0 payload=b'k is for the use of anyone anywh'
4. Recieving type =0 syn=4 ack=0 payload=b'ere in the United States and mos'
5. Recieving type =0 syn=5 ack=0 payload=b't\r\nother parts of the world at n'
6. Recieving type =0 syn=6 ack=0 payload=b'o cost and with almost no restri'
7. Recieving type =0 syn=7 ack=0 payload=b'ctions\r\nwhatsoever. You may cop'
8. Recieving type =0 syn=8 ack=0 payload=b'y it, give it away or re-use it '
9. Recieving type =0 syn=9 ack=0 payload=b'under the terms of\r\nthe Project '
10. Recieving type =0 syn=10 ack=0 payload=b'Gutenberg License included with '
11. Recieving type =0 syn=12 ack=0 payload=b'enberg.org. If you are not loca'
12. Recieving type =0 syn=13 ack=0 payload=b"ted in the United States, you'll"
13. Recieving type =0 syn=14 ack=0 payload=b' have\r\nnto check the laws of the '
14. Recieving type =0 syn=15 ack=0 payload=b'country where you are located be'
15. Recieving type =0 syn=16 ack=0 payload=b'fore using this ebook.\r\n\r\nTitle:'
16. Recieving type =0 syn=17 ack=0 payload=b' Alice\xe2\x80\x99s Adventures in Wonderl'
17. Recieving type =0 syn=18 ack=0 payload=b'and\r\n\r\nAuthor: Lewis Carroll\r\n\r\n'
18. Recieving type =0 syn=19 ack=0 payload=b'Release Date: June 25, 2008 [EBo'
19. Recieving type =0 syn=20 ack=0 payload=b'ok #11]\r\n[Most recently updated:'
20. Recieving type =0 syn=21 ack=0 payload=b' October 12, 2020]'
Receivecode= 4
21. Sending type =1 syn=0 ack=0
22. Sending type =1 syn=0 ack=0
23. Sending type =1 syn=0 ack=0
24. Sending type =1 syn=0 ack=0
25. Sending type =1 syn=0 ack=0
26. Sending type =1 syn=0 ack=0
27. Sending type =1 syn=0 ack=0
28. Sending type =1 syn=0 ack=0
29. Sending type =1 syn=0 ack=0
30. Sending type =1 syn=0 ack=0
31. Sending type =1 syn=0 ack=0
32. Sending type =1 syn=0 ack=0
33. Sending type =1 syn=0 ack=0
34. Sending type =1 syn=0 ack=0
35. Sending type =1 syn=0 ack=0
36. Sending type =1 syn=0 ack=0
37. Sending type =1 syn=0 ack=0
38. Sending type =1 syn=0 ack=0
39. Sending type =1 syn=0 ack=0
40. Sending type =1 syn=0 ack=0
41. Sending type =1 syn=0 ack=0
Sending EOT
42. Recieving type =0 syn=0 ack=0 payload=b'The Project Gutenberg EBook of A'
43. Recieving type =0 syn=1 ack=0 payload=b'lice\xe2\x80\x99s Adventures in Wonderlan'
44. Recieving type =0 syn=3 ack=0 payload=b'k is for the use of anyone anywh'
45. Recieving type =0 syn=4 ack=0 payload=b'ere in the United States and mos'
46. Recieving type =0 syn=5 ack=0 payload=b't\r\nother parts of the world at n'
47. Recieving type =0 syn=6 ack=0 payload=b'o cost and with almost no restri'
48. Recieving type =0 syn=7 ack=0 payload=b'ctions\r\nwhatsoever. You may cop'
49. Recieving type =0 syn=8 ack=0 payload=b'y it, give it away or re-use it '
50. Recieving type =0 syn=10 ack=0 payload=b'Gutenberg License included with '
51. Recieving type =0 syn=11 ack=0 payload=b'this eBook or online at\r\nwww.gut'
52. Recieving type =0 syn=12 ack=0 payload=b'enberg.org. If you are not loca'
53. Recieving type =0 syn=13 ack=0 payload=b"ted in the United States, you'll"
54. Recieving type =0 syn=14 ack=0 payload=b' have\r\nnto check the laws of the '
55. Recieving type =0 syn=15 ack=0 payload=b'country where you are located be'
56. Recieving type =0 syn=16 ack=0 payload=b'fore using this ebook.\r\n\r\nTitle:'
57. Recieving type =0 syn=17 ack=0 payload=b' Alice\xe2\x80\x99s Adventures in Wonderl'
58. Recieving type =0 syn=19 ack=0 payload=b'Release Date: June 25, 2008 [EBo'
59. Recieving type =0 syn=20 ack=0 payload=b'ok #11]\r\n[Most recently updated:'
60. Recieving type =0 syn=21 ack=0 payload=b' October 12, 2020]'
Receivecode= 4
61. Sending type =1 syn=0 ack=0
62. Sending type =1 syn=0 ack=0
63. Sending type =1 syn=0 ack=0
64. Sending type =1 syn=0 ack=0
65. Sending type =1 syn=0 ack=0
66. Sending type =1 syn=0 ack=0
67. Sending type =1 syn=0 ack=0
68. Sending type =1 syn=0 ack=0
69. Sending type =1 syn=0 ack=0
70. Sending type =1 syn=0 ack=0
71. Sending type =1 syn=0 ack=0
72. Sending type =1 syn=0 ack=0
73. Sending type =1 syn=0 ack=0
74. Sending type =1 syn=0 ack=0
75. Sending type =1 syn=0 ack=0
76. Sending type =1 syn=0 ack=0
77. Sending type =1 syn=0 ack=0
78. Sending type =1 syn=0 ack=0
79. Sending type =1 syn=0 ack=0
Sending EOT
```

Test 5: Successful Transfer, Small Window, High Loss

Using a window size of 4 and 10% drop rate, it can successfully transfer the file to the receiver albeit at an abysmal slow speed due to the massive number of retransfers needed.

The success rate of having all my 4 SEQs, 4 ACKs and 2 EOTs successfully reaching their destination with no loss is 0.9^{10} which is 0.34868 and equates to approximately 34.9%.

If I was using a larger window with high loss, the transfer would be near impossible in relation to the previous test of 32 window size, 32 SEQs, 32 ACKs, 2 EOTs then calculating the rate 0.9^{66} is 0.000955 and equates to 0.0955% of successful transfer.

Having high losses shows my timeouts and detecting errors in the return ACKs in action such as when the transmitter's EOTs get lost, the sender will not respond and wait for the sender to resend.

Shown by the screen captures below are the many packet losses caused by the simulator dropping them

Transmitter

```
E:\Homework\COMP7005\FinalProject\cmd.exe
67. Sending type=0 seq=9 ack=8 payload=b'under the terms of\r\nthe Project '
68. Sending type=0 seq=10 ack=8 payload=b'Gutenberg License included with '
69. Sending type=0 seq=11 ack=8 payload=b'this eBook or online at\r\nwww.gut'
Sending EOT
70. Incoming type=1 seq=12 ack=12
71. Incoming type=1 seq=12 ack=12
72. Incoming type=1 seq=12 ack=12
73. Incoming type=1 seq=12 ack=12
74. Incoming type=1 seq=12 ack=12
75. Incoming type=1 seq=12 ack=12
76. Incoming type=1 seq=12 ack=12
77. Incoming type=1 seq=12 ack=12
Got EOT
Receivecode= 1
78. Sending type=0 seq=12 ack=12 payload=b'enberg.org. If you are not loca'
79. Sending type=0 seq=13 ack=12 payload=b"ted in the United States, you'll"
80. Sending type=0 seq=14 ack=12 payload=b' have\r\n to check the laws of the '
81. Sending type=0 seq=15 ack=12 payload=b'country where you are located be'
Sending EOT
Timed out
82. Sending type=0 seq=12 ack=12 payload=b'enberg.org. If you are not loca'
83. Sending type=0 seq=13 ack=12 payload=b"ted in the United States, you'll"
84. Sending type=0 seq=14 ack=12 payload=b' have\r\n to check the laws of the '
85. Sending type=0 seq=15 ack=12 payload=b'country where you are located be'
Sending EOT
86. Incoming type=1 seq=12 ack=12
87. Incoming type=1 seq=12 ack=12
88. Incoming type=1 seq=12 ack=12
89. Incoming type=1 seq=12 ack=12
90. Incoming type=1 seq=12 ack=12
91. Incoming type=1 seq=12 ack=12
92. Incoming type=1 seq=12 ack=12
Timed out
93. Sending type=0 seq=12 ack=12 payload=b'enberg.org. If you are not loca'
94. Sending type=0 seq=13 ack=12 payload=b"ted in the United States, you'll"
95. Sending type=0 seq=14 ack=12 payload=b' have\r\n to check the laws of the '
96. Sending type=0 seq=15 ack=12 payload=b'country where you are located be'
Sending EOT
97. Incoming type=1 seq=12 ack=12
98. Incoming type=1 seq=13 ack=13
99. Incoming type=1 seq=14 ack=14
100. Incoming type=1 seq=15 ack=15
Timed out
101. Sending type=0 seq=12 ack=12 payload=b'enberg.org. If you are not loca'
102. Sending type=0 seq=13 ack=12 payload=b"ted in the United States, you'll"
103. Sending type=0 seq=14 ack=12 payload=b' have\r\n to check the laws of the '
104. Sending type=0 seq=15 ack=12 payload=b'country where you are located be'
Sending EOT
105. Incoming type=1 seq=16 ack=12
106. Incoming type=1 seq=16 ack=13
107. Incoming type=1 seq=16 ack=14
```

Receiver

kevinlo@fedora:~/Desktop

```
Sending EOT
62. Recieving type =0 syn=8 ack=8 payload=b'y it, give it away or re-use it '
63. Recieving type =0 syn=9 ack=8 payload=b'under the terms of\r\nthe Project '
64. Recieving type =0 syn=10 ack=8 payload=b'Gutenberg License included with '
65. Recieving type =0 syn=11 ack=8 payload=b'this eBook or online at\r\nwww.gut'
66. Recieving type =0 syn=8 ack=8 payload=b'y it, give it away or re-use it '
67. Recieving type =0 syn=9 ack=8 payload=b'under the terms of\r\nthe Project '
68. Recieving type =0 syn=10 ack=8 payload=b'Gutenberg License included with '
69. Recieving type =0 syn=11 ack=8 payload=b'this eBook or online at\r\nwww.gut'
Receivecode= 4
70. Sending type =1 syn=12 ack=12
71. Sending type =1 syn=12 ack=12
72. Sending type =1 syn=12 ack=12
73. Sending type =1 syn=12 ack=12
74. Sending type =1 syn=12 ack=12
75. Sending type =1 syn=12 ack=12
76. Sending type =1 syn=12 ack=12
77. Sending type =1 syn=12 ack=12
Sending EOT
78. Recieving type =0 syn=13 ack=12 payload=b"ted in the United States, you'll"
79. Recieving type =0 syn=14 ack=12 payload=b' have\r\nto check the laws of the '
80. Recieving type =0 syn=15 ack=12 payload=b'country where you are located be'
81. Recieving type =0 syn=12 ack=12 payload=b'enberg.org. If you are not loca'
82. Recieving type =0 syn=13 ack=12 payload=b"ted in the United States, you'll"
83. Recieving type =0 syn=14 ack=12 payload=b' have\r\nto check the laws of the '
84. Recieving type =0 syn=15 ack=12 payload=b'country where you are located be'
Receivecode= 4
85. Sending type =1 syn=12 ack=12
86. Sending type =1 syn=12 ack=12
87. Sending type =1 syn=12 ack=12
88. Sending type =1 syn=12 ack=12
89. Sending type =1 syn=12 ack=12
90. Sending type =1 syn=12 ack=12
91. Sending type =1 syn=12 ack=12
Sending EOT
92. Recieving type =0 syn=12 ack=12 payload=b'enberg.org. If you are not loca'
93. Recieving type =0 syn=13 ack=12 payload=b"ted in the United States, you'll"
94. Recieving type =0 syn=14 ack=12 payload=b' have\r\nto check the laws of the '
95. Recieving type =0 syn=15 ack=12 payload=b'country where you are located be'
Receivecode= 2
96. Sending type =1 syn=12 ack=12
97. Sending type =1 syn=13 ack=13
98. Sending type =1 syn=14 ack=14
99. Sending type =1 syn=15 ack=15
Sending EOT
100. Recieving type =0 syn=12 ack=12 payload=b'enberg.org. If you are not loca'
101. Recieving type =0 syn=13 ack=12 payload=b"ted in the United States, you'll"
102. Recieving type =0 syn=14 ack=12 payload=b' have\r\nto check the laws of the '
103. Recieving type =0 syn=15 ack=12 payload=b'country where you are located be'
Receivecode= 1
104. Sending type =1 syn=16 ack=12
105. Sending type =1 syn=16 ack=13
```


Simulator

```

yuiko@fedora:~/Desktop
2020-12-04 21:16:23:844628 77. 192.168.1.253 -> 192.168.1.250 type=0 sleep=9.230509156146222e-05
2020-12-04 21:16:24:045976 78. 192.168.1.253 -> 192.168.1.250 type=0 sleep=3.475768926542367e-05
2020-12-04 21:16:24:046464 79. 192.168.1.253 -> 192.168.1.250 type=2 sleep=0.00012760805907614675
2020-12-04 21:16:24:458725 80. 192.168.1.253 -> 192.168.1.250 type=1 sleep=0.00032832825285536953
2020-12-04 21:16:24:659253 81. 192.168.1.253 -> 192.168.1.250 type=1 sleep=0.00035579496359263644
2020-12-04 21:16:24:860110 82. 192.168.1.253 -> 192.168.1.250 type=1 sleep=0.00035131277636439264
2020-12-04 21:16:25:060989 83. 192.168.1.253 -> 192.168.1.250 type=1 sleep=0.00023688550708513944 DROPPED
2020-12-04 21:16:25:061552 84. 192.168.1.253 -> 192.168.1.250 type=2 sleep=0.00015600246335028523
2020-12-04 21:16:25:490738 85. 192.168.1.253 -> 192.168.1.250 type=0 sleep=0.00021045933960453796
2020-12-04 21:16:25:695118 86. 192.168.1.253 -> 192.168.1.250 type=0 sleep=0.00012921041663274796
2020-12-04 21:16:25:900080 87. 192.168.1.253 -> 192.168.1.250 type=0 sleep=0.0004499092501780101
2020-12-04 21:16:26:106180 88. 192.168.1.253 -> 192.168.1.250 type=0 sleep=0.0004883691378276459
2020-12-04 21:16:26:106786 89. 192.168.1.253 -> 192.168.1.250 type=2 sleep=0.00021582777357488742 DROPPED
2020-12-04 21:16:30:321768 90. 192.168.1.253 -> 192.168.1.250 type=0 sleep=0.00011268700665930104
2020-12-04 21:16:30:532746 91. 192.168.1.253 -> 192.168.1.250 type=0 sleep=7.323087019967301e-05
2020-12-04 21:16:30:733490 92. 192.168.1.253 -> 192.168.1.250 type=0 sleep=0.00047994665861214543
2020-12-04 21:16:30:937810 93. 192.168.1.253 -> 192.168.1.250 type=0 sleep=0.0003523028139260013
2020-12-04 21:16:30:938332 94. 192.168.1.253 -> 192.168.1.250 type=2 sleep=0.0002133325135137966
2020-12-04 21:16:31:421827 95. 192.168.1.253 -> 192.168.1.250 type=1 sleep=0.0004884880780264531
2020-12-04 21:16:31:622610 96. 192.168.1.253 -> 192.168.1.250 type=1 sleep=0.0003989054288530755
2020-12-04 21:16:31:825673 97. 192.168.1.253 -> 192.168.1.250 type=1 sleep=0.00022542251357136585
2020-12-04 21:16:32:023452 98. 192.168.1.253 -> 192.168.1.250 type=1 sleep=0.0003242532090496282
2020-12-04 21:16:32:226361 99. 192.168.1.253 -> 192.168.1.250 type=1 sleep=0.00033745128875913456
2020-12-04 21:16:32:425339 100. 192.168.1.253 -> 192.168.1.250 type=1 sleep=0.00032991194587553985
2020-12-04 21:16:32:624995 101. 192.168.1.253 -> 192.168.1.250 type=1 sleep=2.9392558103245648e-05
2020-12-04 21:16:32:825362 102. 192.168.1.253 -> 192.168.1.250 type=1 sleep=6.284166115486362e-05
2020-12-04 21:16:32:826135 103. 192.168.1.253 -> 192.168.1.250 type=2 sleep=0.00043776712211757965
2020-12-04 21:16:33:236862 104. 192.168.1.253 -> 192.168.1.250 type=0 sleep=3.536343894345461e-05 DROPPED
2020-12-04 21:16:33:442957 105. 192.168.1.253 -> 192.168.1.250 type=0 sleep=0.00015518181367656702
2020-12-04 21:16:33:647139 106. 192.168.1.253 -> 192.168.1.250 type=0 sleep=0.00037192105933356057
2020-12-04 21:16:33:852010 107. 192.168.1.253 -> 192.168.1.250 type=0 sleep=0.0002824703613383997
2020-12-04 21:16:33:852364 108. 192.168.1.253 -> 192.168.1.250 type=2 sleep=4.240131231834421e-06 DROPPED
2020-12-04 21:16:38:069394 109. 192.168.1.253 -> 192.168.1.250 type=0 sleep=0.00029529198564370765
2020-12-04 21:16:38:275236 110. 192.168.1.253 -> 192.168.1.250 type=0 sleep=0.00048110056259040903
2020-12-04 21:16:38:481514 111. 192.168.1.253 -> 192.168.1.250 type=0 sleep=0.0002304262450766455
2020-12-04 21:16:38:682011 112. 192.168.1.253 -> 192.168.1.250 type=0 sleep=0.0003520115711650357
2020-12-04 21:16:38:682204 113. 192.168.1.253 -> 192.168.1.250 type=2 sleep=1.8711687542382007e-05
2020-12-04 21:16:39:100965 114. 192.168.1.253 -> 192.168.1.250 type=1 sleep=0.00017346544228131084
2020-12-04 21:16:39:302198 115. 192.168.1.253 -> 192.168.1.250 type=1 sleep=0.00028669135151115433
2020-12-04 21:16:39:503676 116. 192.168.1.253 -> 192.168.1.250 type=1 sleep=0.0002957046560724029
2020-12-04 21:16:39:704168 117. 192.168.1.253 -> 192.168.1.250 type=1 sleep=5.221211142075766e-05
2020-12-04 21:16:39:906128 118. 192.168.1.253 -> 192.168.1.250 type=1 sleep=0.00019503026938465484
2020-12-04 21:16:40:127144 119. 192.168.1.253 -> 192.168.1.250 type=1 sleep=0.000249899961184008
2020-12-04 21:16:40:306187 120. 192.168.1.253 -> 192.168.1.250 type=1 sleep=0.00030606418055154945
2020-12-04 21:16:40:307050 121. 192.168.1.253 -> 192.168.1.250 type=2 sleep=0.0004498391348173906 DROPPED
2020-12-04 21:16:44:516385 122. 192.168.1.253 -> 192.168.1.250 type=0 sleep=7.848264724333958e-05
2020-12-04 21:16:44:719202 123. 192.168.1.253 -> 192.168.1.250 type=0 sleep=0.00040556953097525876
2020-12-04 21:16:44:919996 124. 192.168.1.253 -> 192.168.1.250 type=0 sleep=0.0003913501878646878
2020-12-04 21:16:45:122691 125. 192.168.1.253 -> 192.168.1.250 type=0 sleep=0.000214620207298658
2020-12-04 21:16:45:123666 126. 192.168.1.253 -> 192.168.1.250 type=2 sleep=0.0003372275348618816
2020-12-04 21:16:45:555764 127. 192.168.1.253 -> 192.168.1.250 type=1 sleep=0.00046609373594681363
2020-12-04 21:16:45:756442 128. 192.168.1.253 -> 192.168.1.250 type=1 sleep=0.00045722231970128863
2020-12-04 21:16:45:957122 129. 192.168.1.253 -> 192.168.1.250 type=1 sleep=0.0002671650219131213
2020-12-04 21:16:46:157584 130. 192.168.1.253 -> 192.168.1.250 type=1 sleep=0.0004927541149128989
2020-12-04 21:16:46:157954 131. 192.168.1.253 -> 192.168.1.250 type=2 sleep=3.2661384811495167e-05 DROPPED
2020-12-04 21:16:50:378871 132. 192.168.1.253 -> 192.168.1.250 type=0 sleep=4.23401152082421e-05
2020-12-04 21:16:50:582328 133. 192.168.1.253 -> 192.168.1.250 type=0 sleep=8.32762752137623e-05
2020-12-04 21:16:50:787104 134. 192.168.1.253 -> 192.168.1.250 type=0 sleep=0.00010648409749571208
2020-12-04 21:16:50:990295 135. 192.168.1.253 -> 192.168.1.250 type=0 sleep=0.00016611673906523296
2020-12-04 21:16:50:991136 136. 192.168.1.253 -> 192.168.1.250 type=2 sleep=0.00042056609785292757
2020-12-04 21:16:51:496475 137. 192.168.1.253 -> 192.168.1.250 type=1 sleep=0.00016942579053448597
2020-12-04 21:16:51:693117 138. 192.168.1.253 -> 192.168.1.250 type=1 sleep=0.00014560764370556733
2020-12-04 21:16:51:893934 139. 192.168.1.253 -> 192.168.1.250 type=1 sleep=0.0003897699227717051
2020-12-04 21:16:52:094462 140. 192.168.1.253 -> 192.168.1.250 type=1 sleep=0.0004436325523584814
2020-12-04 21:16:52:095094 141. 192.168.1.253 -> 192.168.1.250 type=2 sleep=0.00028997852858592
2020-12-04 21:16:52:503789 142. 192.168.1.253 -> 192.168.1.250 type=0 sleep=5.21374990073068e-05 DROPPED
2020-12-04 21:16:52:707124 143. 192.168.1.253 -> 192.168.1.250 type=0 sleep=0.0002032994630679243
2020-12-04 21:16:52:914711 144. 192.168.1.253 -> 192.168.1.250 type=0 sleep=0.000433084178683286
2020-12-04 21:16:53:123703 145. 192.168.1.253 -> 192.168.1.250 type=0 sleep=7.3664191471435e-05
2020-12-04 21:16:53:124179 146. 192.168.1.253 -> 192.168.1.250 type=2 sleep=0.0001704487320582917
2020-12-04 21:16:53:744977 147. 192.168.1.253 -> 192.168.1.250 type=1 sleep=0.0002937039613049611
2020-12-04 21:16:53:945130 148. 192.168.1.253 -> 192.168.1.250 type=1 sleep=3.83258185192254e-05
2020-12-04 21:16:54:145757 149. 192.168.1.253 -> 192.168.1.250 type=1 sleep=0.00011185703637438461 DROPPED
2020-12-04 21:16:54:146541 150. 192.168.1.253 -> 192.168.1.250 type=2 sleep=0.0004761231141787903
2020-12-04 21:16:54:567938 151. 192.168.1.253 -> 192.168.1.250 type=0 sleep=0.00044538406392765267
2020-12-04 21:16:54:772321 152. 192.168.1.253 -> 192.168.1.250 type=0 sleep=0.00026714709373216035
2020-12-04 21:16:54:973661 153. 192.168.1.253 -> 192.168.1.250 type=0 sleep=0.00022888462952062267
2020-12-04 21:16:55:174530 154. 192.168.1.253 -> 192.168.1.250 type=0 sleep=5.386534253885844e-05 DROPPED
2020-12-04 21:16:55:175188 155. 192.168.1.253 -> 192.168.1.250 type=2 sleep=0.00041388407832286485 DROPPED
2020-12-04 21:16:59:393179 156. 192.168.1.253 -> 192.168.1.250 type=0 sleep=0.0003068384627640681 DROPPED
2020-12-04 21:16:59:595218 157. 192.168.1.253 -> 192.168.1.250 type=0 sleep=4.5841561308258996e-05
2020-12-04 21:16:59:799123 158. 192.168.1.253 -> 192.168.1.250 type=0 sleep=0.0004130599415017686 DROPPED

```

Conclusion

My protocol is great when there is no losses in the system however, it becomes massively inefficient due to only accepting full windows of the correct frames or it will get rejected and ask for a resend of the same window.

To deal with the losses I would have to reduce my window size to ensure the overall success rate of getting all my SEQs, ACKs, EOTs through successfully is higher when compared to using a high window size. Both ways would cause wastes of bandwidth due to needing to send more EOTs or retransmits of full windows.

Due to my protocol requiring the receiver to know the total packet count for the transfer, it will fail to run if the receiver does not know how many packets it will receive.

If I could do this project again, I would try to make the sender able to accept partial windows such as, sending 1,2,3,4,5,6,7,8 but receiving 1,2,3,4,6,7,8 it would accept 1,2,3,4 and send duplicate ACKs requesting starting at SEQ 5, this way entire frames are not wasted and progress can slowly be made.