

Step1:

Server:

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tl32rodan@tl32rodan-Sabre-15KV8: ~/Desktop/Course/107_2/Computer Network/project_tcp_over_udp/step1
File Edit View Search Terminal Help
receive a packet (seq_num = 0430 , ack_num = 00300)
^C
(base) tl32rodan@tl32rodan-Sabre-15KV8:~/Desktop/Course/107_2/Computer Network/project_tcp_over_udp/s
tep8$ cd ../step1/
(base) tl32rodan@tl32rodan-Sabre-15KV8:~/Desktop/Course/107_2/Computer Network/project_tcp_over_udp/s
tep1$ make
g++ -Wall -o server server.o connect_thread.o -lpthread
g++ -Wall -o client client.o
(base) tl32rodan@tl32rodan-Sabre-15KV8:~/Desktop/Course/107_2/Computer Network/project_tcp_over_udp/s
tep1$ ./server 6543
=====Parameters=====
The RTT delay = 150 ms
The threshold = 65535 bytes
The MSS = 1024 bytes
The buffer size = 32768 bytes
Server's IP is 127.0.0.1
Server is listening on port 6543
=====
Listening for clients....
Accepting new connection...
=====Start three-way handshake=====
Receive a packet(SYN) from 127.0.0.1 : 38535
    Receive a packet (seq_num = 3107 , ack_num = 0)
Send a packet(SYN/ACK) to 127.0.0.1 : 38535
Receive a packet(SYN) from 127.0.0.1 : 38535
    Receive a packet (seq_num = 3108 , ack_num = 2306)
=====Complete the three-way handshake=====
Start to send file "1.mp4" to 127.0.0.1 : 38535 , the file size is 123431 bytes.
    Send a packet at : 0 bytes
    Receive a packet (seq_num = 3109 , ack_num = 1004)
    Send a packet at : 1004 bytes
    Receive a packet (seq_num = 3110 , ack_num = 2008)
    Send a packet at : 2008 bytes
    Receive a packet (seq_num = 3111 , ack_num = 3012)
    Send a packet at : 3012 bytes
    Receive a packet (seq_num = 3112 , ack_num = 4016)
    Send a packet at : 4016 bytes
    Receive a packet (seq_num = 3113 , ack_num = 5020)
    Send a packet at : 5020 bytes
    Receive a packet (seq_num = 3114 , ack_num = 6024)
    Send a packet at : 6024 bytes
    Receive a packet (seq_num = 3115 , ack_num = 7028)
    Send a packet at : 7028 bytes
    Receive a packet (seq_num = 3116 , ack_num = 8032)
    Send a packet at : 8032 bytes
    Receive a packet (seq_num = 3117 , ack_num = 9036)
    Send a packet at : 9036 bytes
    Receive a packet (seq_num = 3118 , ack_num = 10040)
    Send a packet at : 10040 bytes
    Receive a packet (seq_num = 3119 , ack_num = 11044)
    Send a packet at : 11044 bytes
    Receive a packet (seq_num = 3120 , ack_num = 12048)
    Send a packet at : 12048 bytes
    Receive a packet (seq_num = 3121 , ack_num = 13052)
    Send a packet at : 13052 bytes
    Receive a packet (seq_num = 3122 , ack_num = 14056)
```

Client:

```
tl32rodan@tl32rodan-Sabre-15KV8: ~/Desktop/Course/107_2/Computer Network/project_tcp_over_udp/step1
File Edit View Search Terminal Help
      Receive a packet (seq_num = 64512 , ack_num = 6449)
Receive a packet from 127.0.0.1 : 59358
      Receive a packet (seq_num = 65536 , ack_num = 6449)
Receive a packet from 127.0.0.1 : 59358
      Receive a packet (seq_num = 66560 , ack_num = 6449)
^C
(base) tl32rodan@tl32rodan-Sabre-15KV8:~/Desktop/Course/107_2/Computer Network/project_tcp_over_udp/s
tep8$ cd ../step1
(base) tl32rodan@tl32rodan-Sabre-15KV8:~/Desktop/Course/107_2/Computer Network/project_tcp_over_udp/s
tep1$ ./client 127.0.0.1 6543 -f 1
Info : IP = 127.0.0.1 , port = 6543
=====Start three-way handshake=====
Send a packet(SYN) to 127.0.0.1 : 6543
Receive a packet(SYN/ACK) from 127.0.0.1 : 56914
      Receive a packet (seq_num = 1302 , ack_num = 3108)
Send a packet(ACK) to 127.0.0.1 : 56914
=====Complete the three-way handshake=====
Receive file "1_result.mp4" from 127.0.0.1 : 56914
Receive a packet from 127.0.0.1 : 56914
      Receive a packet (seq_num = 0 , ack_num = 3109)
Receive a packet from 127.0.0.1 : 56914
      Receive a packet (seq_num = 1004 , ack_num = 3110)
Receive a packet from 127.0.0.1 : 56914
      Receive a packet (seq_num = 2008 , ack_num = 3111)
Receive a packet from 127.0.0.1 : 56914
      Receive a packet (seq_num = 3012 , ack_num = 3112)
Receive a packet from 127.0.0.1 : 56914
      Receive a packet (seq_num = 4016 , ack_num = 3113)
Receive a packet from 127.0.0.1 : 56914
      Receive a packet (seq_num = 5020 , ack_num = 3114)
Receive a packet from 127.0.0.1 : 56914
      Receive a packet (seq_num = 6024 , ack_num = 3115)
Receive a packet from 127.0.0.1 : 56914
      Receive a packet (seq_num = 7028 , ack_num = 3116)
Receive a packet from 127.0.0.1 : 56914
      Receive a packet (seq_num = 8032 , ack_num = 3117)
Receive a packet from 127.0.0.1 : 56914
      Receive a packet (seq_num = 9036 , ack_num = 3118)
Receive a packet from 127.0.0.1 : 56914
      Receive a packet (seq_num = 10040 , ack_num = 3119)
Receive a packet from 127.0.0.1 : 56914
      Receive a packet (seq_num = 11044 , ack_num = 3120)
Receive a packet from 127.0.0.1 : 56914
      Receive a packet (seq_num = 12048 , ack_num = 3121)
Receive a packet from 127.0.0.1 : 56914
      Receive a packet (seq_num = 13052 , ack_num = 3122)
Receive a packet from 127.0.0.1 : 56914
      Receive a packet (seq_num = 14056 , ack_num = 3123)
Receive a packet from 127.0.0.1 : 56914
      Receive a packet (seq_num = 15060 , ack_num = 3124)
Receive a packet from 127.0.0.1 : 56914
      Receive a packet (seq_num = 16064 , ack_num = 3125)
Receive a packet from 127.0.0.1 : 56914
      Receive a packet (seq_num = 17068 , ack_num = 3126)
Receive a packet from 127.0.0.1 : 56914
      Receive a packet (seq_num = 18072 , ack_num = 3127)
```

Step 2:

Server:

```
tl32rodan@tl32rodan-Sabre-15KV8: ~/Desktop/Course/107_2/Computer Network/project_tcp_over_udp/step2
File Edit View Search Terminal Help
cd ^C
(base) tl32rodan@tl32rodan-Sabre-15KV8:~/Desktop/Course/107_2/Computer Network/project_tcp_over_udp/s
tep1$ cd ../step2/
(base) tl32rodan@tl32rodan-Sabre-15KV8:~/Desktop/Course/107_2/Computer Network/project_tcp_over_udp/s
tep2$ make
g++ -c server.cpp
g++ -c connect_thread.cpp
g++ -c client.cpp
g++ -Wall -o server server.o connect_thread.o -lpthread
g++ -Wall -o client client.o
(base) tl32rodan@tl32rodan-Sabre-15KV8:~/Desktop/Course/107_2/Computer Network/project_tcp_over_udp/s
tep2$ ./server 6543
=====Parameters=====
The RTT delay = 15 ms
The threshold = 65535 bytes
The MSS = 1024 bytes
The buffer size = 32768 bytes
Server's IP is 127.0.0.1
Server is listening on port 6543
=====
Listening for clients.....
Accepting new connection...
=====Start three-way handshake=====
Receive a packet(SYN) from 127.0.0.1 : 54462
    Receive a packet (seq_num = 4440 , ack_num = 0)
Send a packet(SYN/ACK) to 127.0.0.1 : 54462
Receive a packet(SYN) from 127.0.0.1 : 54462
    Receive a packet (seq_num = 4441 , ack_num = 5279)
=====Complete the three-way handshake=====
Start to send file "1.mp4" to 127.0.0.1 : 54462 , the file size is 123431 bytes.
    Send a packet at : 1004 bytes    **lost
Resend Sucesses!
    Receive a packet (seq_num = 4442 , ack_num = 1004)
    Send a packet at : 2008 bytes
    Receive a packet (seq_num = 4443 , ack_num = 2008)
    Send a packet at : 3012 bytes    **lost
Resend Sucesses!
    Receive a packet (seq_num = 4444 , ack_num = 3012)
    Send a packet at : 4016 bytes
    Receive a packet (seq_num = 4445 , ack_num = 4016)
    Send a packet at : 5020 bytes
    Receive a packet (seq_num = 4446 , ack_num = 5020)
    Send a packet at : 6024 bytes
    Receive a packet (seq_num = 4447 , ack_num = 6024)
    Send a packet at : 7028 bytes
    Receive a packet (seq_num = 4448 , ack_num = 7028)
    Send a packet at : 8032 bytes    **lost
Resend Sucesses!
    Receive a packet (seq_num = 4449 , ack_num = 8032)
    Send a packet at : 9036 bytes
    Receive a packet (seq_num = 4450 , ack_num = 9036)
    Send a packet at : 10040 bytes
    Receive a packet (seq_num = 4451 , ack_num = 10040)
    Send a packet at : 11044 bytes
    Receive a packet (seq_num = 4452 , ack_num = 11044)
```

Client:

```
tl32rodan@tl32rodan-Sabre-15KV8: ~/Desktop/Course/107_2/Computer Network/project_tcp_over_udp/step2
File Edit View Search Terminal Help
Receive a packet from 127.0.0.1 : 56914
    Receive a packet (seq_num = 122488 , ack_num = 3231)
Receive a packet from 127.0.0.1 : 56914
    Receive a packet (seq_num = 123492 , ack_num = 3232)
=====
=====Receive file "1_result.mp4" complete.=====
=====
All Receiving Requests Complete!
    Send FIN.
    Receive a packet (seq_num = 124496 , ack_num = 3234)
    Receive a packet (seq_num = 125500 , ack_num = 3234)
Closing connection with 127.0.0.1 : 56914
(base) tl32rodan@tl32rodan-Sabre-15KV8:~/Desktop/Course/107_2/Computer Network/project_tcp_over_udp/s
tep1$ cd ../step2/
(base) tl32rodan@tl32rodan-Sabre-15KV8:~/Desktop/Course/107_2/Computer Network/project_tcp_over_udp/s
tep2$ ./client 127.0.0.1 6543 -f 1
Info : IP = 127.0.0.1 , port = 6543
=====Start three-way handshake=====
Send a packet(SYN) to 127.0.0.1 : 6543
Receive a packet(SYN/ACK) from 127.0.0.1 : 42451
    Receive a packet (seq_num = 4275 , ack_num = 4441)
Send a packet(ACK) to 127.0.0.1 : 42451
=====Complete the three-way handshake=====
Receive file "1_result.mp4" from 127.0.0.1 : 42451
Receive a packet from 127.0.0.1 : 42451
    Receive a packet (seq_num = 0 , ack_num = 4442)
Receive a packet from 127.0.0.1 : 42451
    Receive a packet (seq_num = 1004 , ack_num = 4443)
Receive a packet from 127.0.0.1 : 42451
    Receive a packet (seq_num = 2008 , ack_num = 4444)
Receive a packet from 127.0.0.1 : 42451
    Receive a packet (seq_num = 3012 , ack_num = 4445)
Receive a packet from 127.0.0.1 : 42451
    Receive a packet (seq_num = 4016 , ack_num = 4446)
Receive a packet from 127.0.0.1 : 42451
    Receive a packet (seq_num = 5020 , ack_num = 4447)
Receive a packet from 127.0.0.1 : 42451
    Receive a packet (seq_num = 6024 , ack_num = 4448)
Receive a packet from 127.0.0.1 : 42451
    Receive a packet (seq_num = 7028 , ack_num = 4449)
Receive a packet from 127.0.0.1 : 42451
    Receive a packet (seq_num = 8032 , ack_num = 4450)
Receive a packet from 127.0.0.1 : 42451
    Receive a packet (seq_num = 9036 , ack_num = 4451)
Receive a packet from 127.0.0.1 : 42451
    Receive a packet (seq_num = 10040 , ack_num = 4452)
Receive a packet from 127.0.0.1 : 42451
    Receive a packet (seq_num = 11044 , ack_num = 4453)
Receive a packet from 127.0.0.1 : 42451
    Receive a packet (seq_num = 12048 , ack_num = 4454)
Receive a packet from 127.0.0.1 : 42451
    Receive a packet (seq_num = 13052 , ack_num = 4455)
Receive a packet from 127.0.0.1 : 42451
    Receive a packet (seq_num = 14056 , ack_num = 4456)
Receive a packet from 127.0.0.1 : 42451
```

Step 3 :

Server:


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tl32rodan@tl32rodan-Sabre-15KV8: ~/Desktop/Course/107_2/Computer Network/project_tcp_over_udp/step3
File Edit View Search Terminal Help
(base) tl32rodan@tl32rodan-Sabre-15KV8:~/Desktop/Course/107_2/Computer Network/project_tcp_over_udp/s
tep3$ ./server 6543
=====Parameters=====
The RTT delay = 150 ms
The threshold = 65535 bytes
The MSS = 1024 bytes
The buffer size = 32768 bytes
Server's IP is 127.0.0.1
Server is listening on port 6543
=====
Listening for clients.....
Accepting new connection...
=====Start three-way handshake=====
Receive a packet(SYN) from 127.0.0.1 : 60351
    Receive a packet (seq_num = 7167 , ack_num = 0)
Send a packet(SYN/ACK) to 127.0.0.1 : 60351
Receive a packet(SYN) from 127.0.0.1 : 60351
    Receive a packet (seq_num = 7168 , ack_num = 3316)
=====Complete the three-way handshake=====
Start to send file "1.mp4" to 127.0.0.1 : 60351 , the file size is 123431 bytes.
cwnd = 1004 , rwnd = 307200 , threshold = 65535
    Send a packet at : 0 bytes
    Send a packet at : 1004 bytes
    Receive a packet (seq_num = 7169 , ack_num = 2008)
cwnd = 1004 , rwnd = 30760 , threshold = 65535
    Send a packet at : 2008 bytes
    Send a packet at : 3012 bytes
    Receive a packet (seq_num = 7170 , ack_num = 4016)
cwnd = 1004 , rwnd = 28752 , threshold = 65535
    Send a packet at : 4016 bytes
    Send a packet at : 5020 bytes
    Receive a packet (seq_num = 7171 , ack_num = 6024)
cwnd = 1004 , rwnd = 26744 , threshold = 65535
    Send a packet at : 6024 bytes
    Send a packet at : 7028 bytes
    Receive a packet (seq_num = 7172 , ack_num = 8032)
cwnd = 1004 , rwnd = 24736 , threshold = 65535
    Send a packet at : 8032 bytes
    Send a packet at : 9036 bytes
    Receive a packet (seq_num = 7173 , ack_num = 10040)
cwnd = 1004 , rwnd = 22728 , threshold = 65535
    Send a packet at : 10040 bytes
    Send a packet at : 11044 bytes
    Receive a packet (seq_num = 7174 , ack_num = 12048)
cwnd = 1004 , rwnd = 20720 , threshold = 65535
    Send a packet at : 12048 bytes
    Send a packet at : 13052 bytes
    Receive a packet (seq_num = 7175 , ack_num = 14056)
cwnd = 1004 , rwnd = 18712 , threshold = 65535
    Send a packet at : 14056 bytes
    Send a packet at : 15060 bytes
    Receive a packet (seq_num = 7176 , ack_num = 16064)
cwnd = 1004 , rwnd = 16704 , threshold = 65535
    Send a packet at : 16064 bytes
    Send a packet at : 17068 bytes
    Receive a packet (seq_num = 7177 , ack_num = 18072)

```

Client:

```
tl32rodan@tl32rodan-Sabre-15KV8: ~/Desktop/Course/107_2/Computer Network/project_tcp_over_udp/step3
File Edit View Search Terminal Help
(base) tl32rodan@tl32rodan-Sabre-15KV8:~/Desktop/Course/107_2/Computer Network/project_tcp_over_udp/s
tep3$ ./server 6543
=====Parameters=====
The RTT delay = 150 ms
The threshold = 65535 bytes
The MSS = 1024 bytes
The buffer size = 32768 bytes
Server's IP is 127.0.0.1
Server is listening on port 6543
=====
Listening for clients.....
Accepting new connection...
=====Start three-way handshake=====
Receive a packet(SYN) from 127.0.0.1 : 60351
    Receive a packet (seq_num = 7167 , ack_num = 0)
Send a packet(SYN/ACK) to 127.0.0.1 : 60351
Receive a packet(SYN) from 127.0.0.1 : 60351
    Receive a packet (seq_num = 7168 , ack_num = 3316)
=====Complete the three-way handshake=====
Start to send file "1.mp4" to 127.0.0.1 : 60351 , the file size is 123431 bytes.
cwnd = 1004 , rwnd = 307200 , threshold = 65535
    Send a packet at : 0 bytes
    Send a packet at : 1004 bytes
    Receive a packet (seq_num = 7169 , ack_num = 2008)
cwnd = 1004 , rwnd = 30760 , threshold = 65535
    Send a packet at : 2008 bytes
    Send a packet at : 3012 bytes
    Receive a packet (seq_num = 7170 , ack_num = 4016)
cwnd = 1004 , rwnd = 28752 , threshold = 65535
    Send a packet at : 4016 bytes
    Send a packet at : 5020 bytes
    Receive a packet (seq_num = 7171 , ack_num = 6024)
cwnd = 1004 , rwnd = 26744 , threshold = 65535
    Send a packet at : 6024 bytes
    Send a packet at : 7028 bytes
    Receive a packet (seq_num = 7172 , ack_num = 8032)
cwnd = 1004 , rwnd = 24736 , threshold = 65535
    Send a packet at : 8032 bytes
    Send a packet at : 9036 bytes
    Receive a packet (seq_num = 7173 , ack_num = 10040)
cwnd = 1004 , rwnd = 22728 , threshold = 65535
    Send a packet at : 10040 bytes
    Send a packet at : 11044 bytes
    Receive a packet (seq_num = 7174 , ack_num = 12048)
cwnd = 1004 , rwnd = 20720 , threshold = 65535
    Send a packet at : 12048 bytes
    Send a packet at : 13052 bytes
    Receive a packet (seq_num = 7175 , ack_num = 14056)
cwnd = 1004 , rwnd = 18712 , threshold = 65535
    Send a packet at : 14056 bytes
    Send a packet at : 15060 bytes
    Receive a packet (seq_num = 7176 , ack_num = 16064)
cwnd = 1004 , rwnd = 16704 , threshold = 65535
    Send a packet at : 16064 bytes
    Send a packet at : 17068 bytes
    Receive a packet (seq_num = 7177 , ack_num = 18072)
```

Step 4:

Server:


```

tl32rodan@tl32rodan-Sabre-15KV8: ~/Desktop/Course/107_2/Computer Network/project_tcp_over_udp/step4
File Edit View Search Terminal Help
(base) tl32rodan@tl32rodan-Sabre-15KV8:~/Desktop/Course/107_2/Computer Network/project_tcp_over_udp/s
tep4$ ./server 6543
=====Parameters=====
The RTT delay = 150 ms
The threshold = 65535 bytes
The MSS = 1044 bytes
The buffer size = 32768 bytes
Server's IP is 127.0.0.1
Server is listening on port 6543
=====
Listening for clients.....
Accepting new connection...
=====Start three-way handshake=====
Receive a packet(SYN) from 127.0.0.1 : 47053
    Receive a packet (seq_num = 2548 , ack_num = 0)
Send a packet(SYN/ACK) to 127.0.0.1 : 47053
Receive a packet(SYN) from 127.0.0.1 : 47053
    Receive a packet (seq_num = 2549 , ack_num = 4322)
=====Complete the three-way handshake=====
Start to send file "1.mp4" to 127.0.0.1 : 47053 , the file size is 123431 bytes.
*****Slow Start*****
cwnd = 1024 , rwnd = 307200 , threshold = 65535
    Send a packet at : 0 bytes
    Receive a packet (seq_num = 2550 , ack_num = 1024)
cwnd = 2048 , rwnd = 31744 , threshold = 65535
    Send a packet at : 1024 bytes
cwnd = 2048 , rwnd = 31744 , threshold = 65535
    Send a packet at : 2048 bytes
    Receive a packet (seq_num = 2551 , ack_num = 3072)
cwnd = 3072 , rwnd = 29696 , threshold = 65535
    Send a packet at : 3072 bytes
cwnd = 3072 , rwnd = 29696 , threshold = 65535
    Send a packet at : 4096 bytes
cwnd = 3072 , rwnd = 29696 , threshold = 65535
    Send a packet at : 5120 bytes
    Receive a packet (seq_num = 2552 , ack_num = 5120)
    Receive a packet (seq_num = 2553 , ack_num = 6144)
cwnd = 4096 , rwnd = 26624 , threshold = 65535
    Send a packet at : 6144 bytes
cwnd = 4096 , rwnd = 26624 , threshold = 65535
    Send a packet at : 7168 bytes
cwnd = 4096 , rwnd = 26624 , threshold = 65535
    Send a packet at : 8192 bytes
cwnd = 4096 , rwnd = 26624 , threshold = 65535
    Send a packet at : 9216 bytes
    Receive a packet (seq_num = 2554 , ack_num = 8192)
    Receive a packet (seq_num = 2555 , ack_num = 10240)
cwnd = 5120 , rwnd = 22528 , threshold = 65535
    Send a packet at : 10240 bytes
cwnd = 5120 , rwnd = 22528 , threshold = 65535
    Send a packet at : 11264 bytes
cwnd = 5120 , rwnd = 22528 , threshold = 65535
    Send a packet at : 12288 bytes
cwnd = 5120 , rwnd = 22528 , threshold = 65535
    Send a packet at : 13312 bytes
cwnd = 5120 , rwnd = 22528 , threshold = 65535

```

Client:

```
tl32rodan@tl32rodan-Sabre-15KV8: ~/Desktop/Course/107_2/Computer Network/project_tcp_over_udp/step4
File Edit View Search Terminal Help
Receive a packet (seq_num = 66560 , ack_num = 4097)
^C
(base) tl32rodan@tl32rodan-Sabre-15KV8:~/Desktop/Course/107_2/Computer Network/project_tcp_over_udp/s
tep4$ ./client 127.0.0.1 6543 -f 1
Info : IP = 127.0.0.1 , port = 6543
=====Start three-way handshake=====
Send a packet(SYN) to 127.0.0.1 : 6543
Receive a packet(SYN/ACK) from 127.0.0.1 : 53876
Receive a packet (seq_num = 3298 , ack_num = 2549)
Send a packet(ACK) to 127.0.0.1 : 53876
=====Complete the three-way handshake=====
Receive file "1_result.mp4" from 127.0.0.1 :53876
Receive a packet from 127.0.0.1 : 53876
Receive a packet (seq_num = 0 , ack_num = 2550)
Receive a packet from 127.0.0.1 : 53876
Receive a packet (seq_num = 1024 , ack_num = 2551)
Receive a packet from 127.0.0.1 : 53876
Receive a packet (seq_num = 2048 , ack_num = 2551)
Receive a packet from 127.0.0.1 : 53876
Receive a packet (seq_num = 3072 , ack_num = 2552)
Receive a packet from 127.0.0.1 : 53876
Receive a packet (seq_num = 4096 , ack_num = 2552)
Receive a packet from 127.0.0.1 : 53876
Receive a packet (seq_num = 5120 , ack_num = 2552)
Receive a packet from 127.0.0.1 : 53876
Receive a packet (seq_num = 6144 , ack_num = 2554)
Receive a packet from 127.0.0.1 : 53876
Receive a packet (seq_num = 7168 , ack_num = 2554)
Receive a packet from 127.0.0.1 : 53876
Receive a packet (seq_num = 8192 , ack_num = 2554)
Receive a packet from 127.0.0.1 : 53876
Receive a packet (seq_num = 9216 , ack_num = 2554)
Receive a packet from 127.0.0.1 : 53876
Receive a packet (seq_num = 10240 , ack_num = 2556)
Receive a packet from 127.0.0.1 : 53876
Receive a packet (seq_num = 11264 , ack_num = 2556)
Receive a packet from 127.0.0.1 : 53876
Receive a packet (seq_num = 12288 , ack_num = 2556)
Receive a packet from 127.0.0.1 : 53876
Receive a packet (seq_num = 13312 , ack_num = 2556)
Receive a packet from 127.0.0.1 : 53876
Receive a packet (seq_num = 14336 , ack_num = 2556)
Receive a packet from 127.0.0.1 : 53876
Receive a packet (seq_num = 15360 , ack_num = 2559)
Receive a packet from 127.0.0.1 : 53876
Receive a packet (seq_num = 16384 , ack_num = 2559)
Receive a packet from 127.0.0.1 : 53876
Receive a packet (seq_num = 17408 , ack_num = 2559)
Receive a packet from 127.0.0.1 : 53876
Receive a packet (seq_num = 18432 , ack_num = 2559)
Receive a packet from 127.0.0.1 : 53876
Receive a packet (seq_num = 19456 , ack_num = 2559)
Receive a packet from 127.0.0.1 : 53876
Receive a packet (seq_num = 20480 , ack_num = 2559)
Receive a packet from 127.0.0.1 : 53876
```

Step 5:

Server:


```

tl32rodan@tl32rodan-Sabre-15KV8: ~/Desktop/Course/107_2/Computer Network/project_tcp_over_udp/step5
File Edit View Search Terminal Help
(base) tl32rodan@tl32rodan-Sabre-15KV8:~/Desktop/Course/107_2/Computer Network/project_tcp_over_udp/step5$ ./server 6543
=====Parameters=====
The RTT delay = 150 ms
The threshold = 65535 bytes
The MSS = 1044 bytes
The buffer size = 32768 bytes
Server's IP is 127.0.0.1
Server is listening on port 6543
=====
Listening for clients.....
Accepting new connection...
=====Start three-way handshake=====
Receive a packet(SYN) from 127.0.0.1 : 47736
    Receive a packet (seq_num = 9926 , ack_num = 0)
Send a packet(SYN/ACK) to 127.0.0.1 : 47736
Receive a packet(SYN) from 127.0.0.1 : 47736
    Receive a packet (seq_num = 9927 , ack_num = 3649)
=====Complete the three-way handshake=====
Start to send file "1.mp4" to 127.0.0.1 : 47736 , the file size is 123431 bytes.
****Slow Start****
cwnd = 1024 , rwnd = 307200 , threshold = 65535
    Send a packet at : 0 bytes
    Receive a packet (seq_num = 9928 , ack_num = 1024)
cwnd = 2048 , rwnd = 31744 , threshold = 65535
    Send a packet at : 1024 bytes
cwnd = 2048 , rwnd = 31744 , threshold = 65535
    Send a packet at : 2048 bytes
    Receive a packet (seq_num = 9929 , ack_num = 2048)
    Receive a packet (seq_num = 9930 , ack_num = 3072)
cwnd = 3072 , rwnd = 29696 , threshold = 65535
    Send a packet at : 3072 bytes
cwnd = 3072 , rwnd = 29696 , threshold = 65535
    Send a packet at : 4096 bytes
cwnd = 3072 , rwnd = 29696 , threshold = 65535
    Send a packet at : 5120 bytes
    Receive a packet (seq_num = 9931 , ack_num = 4096)
    Receive a packet (seq_num = 9932 , ack_num = 5120)
    Receive a packet (seq_num = 9933 , ack_num = 6144)
cwnd = 4096 , rwnd = 26624 , threshold = 65535
    Send a packet at : 6144 bytes    **lost
cwnd = 4096 , rwnd = 26624 , threshold = 65535
    Send a packet at : 7168 bytes
cwnd = 4096 , rwnd = 26624 , threshold = 65535
    Send a packet at : 8192 bytes
cwnd = 4096 , rwnd = 26624 , threshold = 65535
    Send a packet at : 9216 bytes
    Receive a packet (seq_num = 9934 , ack_num = 6144)
    Receive a packet (seq_num = 9935 , ack_num = 6144)
    Receive a packet (seq_num = 9936 , ack_num = 6144)
Received three duplicate ACKs.
****Fast Retransmit****
cwnd = 5120 , rwnd = 26624 , threshold = 2048
    Send a packet at : 6144 bytes
cwnd = 5120 , rwnd = 26624 , threshold = 2048
    Send a packet at : 7168 bytes

```

Client:

```
tl32rodan@tl32rodan-Sabre-15KV8: ~/Desktop/Course/107_2/Computer Network/project_tcp_over_udp/step5
File Edit View Search Terminal Help
(base) tl32rodan@tl32rodan-Sabre-15KV8:~/Desktop/Course/107_2/Computer Network/project_tcp_over_udp/s
tep5$ ./client 127.0.0.1 6543 -f 1
Info : IP = 127.0.0.1 , port = 6543
=====Start three-way handshake=====
Send a packet(SYN) to 127.0.0.1 : 6543
Receive a packet(SYN/ACK) from 127.0.0.1 : 54068
    Receive a packet (seq_num = 2625 , ack_num = 9927)
Send a packet(ACK) to 127.0.0.1 : 54068
=====Complete the three-way handshake=====
Receive file "1_result.mp4" from 127.0.0.1 : 54068
Receive a packet from 127.0.0.1 : 54068
    Receive a packet (seq_num = 0 , ack_num = 9928)
Receive a packet from 127.0.0.1 : 54068
    Receive a packet (seq_num = 1024 , ack_num = 9929)
Receive a packet from 127.0.0.1 : 54068
    Receive a packet (seq_num = 2048 , ack_num = 9929)
Receive a packet from 127.0.0.1 : 54068
    Receive a packet (seq_num = 3072 , ack_num = 9931)
Receive a packet from 127.0.0.1 : 54068
    Receive a packet (seq_num = 4096 , ack_num = 9931)
Receive a packet from 127.0.0.1 : 54068
    Receive a packet (seq_num = 5120 , ack_num = 9931)
Receive a packet from 127.0.0.1 : 54068
    Receive a packet (seq_num = 6144 , ack_num = 9937)
Receive a packet from 127.0.0.1 : 54068
    Receive a packet (seq_num = 7168 , ack_num = 9937)
Receive a packet from 127.0.0.1 : 54068
    Receive a packet (seq_num = 8192 , ack_num = 9937)
Receive a packet from 127.0.0.1 : 54068
    Receive a packet (seq_num = 9216 , ack_num = 9937)
Receive a packet from 127.0.0.1 : 54068
    Receive a packet (seq_num = 10240 , ack_num = 9937)
Receive a packet from 127.0.0.1 : 54068
    Receive a packet (seq_num = 11264 , ack_num = 9942)
Receive a packet from 127.0.0.1 : 54068
    Receive a packet (seq_num = 12288 , ack_num = 9943)
Receive a packet from 127.0.0.1 : 54068
    Receive a packet (seq_num = 13312 , ack_num = 9943)
Receive a packet from 127.0.0.1 : 54068
    Receive a packet (seq_num = 14336 , ack_num = 9945)
Receive a packet from 127.0.0.1 : 54068
    Receive a packet (seq_num = 15360 , ack_num = 9945)
Receive a packet from 127.0.0.1 : 54068
    Receive a packet (seq_num = 16384 , ack_num = 9947)
Receive a packet from 127.0.0.1 : 54068
    Receive a packet (seq_num = 17408 , ack_num = 9947)
Receive a packet from 127.0.0.1 : 54068
    Receive a packet (seq_num = 18432 , ack_num = 9949)
Receive a packet from 127.0.0.1 : 54068
    Receive a packet (seq_num = 19456 , ack_num = 9949)
Receive a packet from 127.0.0.1 : 54068
    Receive a packet (seq_num = 20480 , ack_num = 9951)
Receive a packet from 127.0.0.1 : 54068
    Receive a packet (seq_num = 21504 , ack_num = 9951)
Receive a packet from 127.0.0.1 : 54068
```

Step 6:

Server:


```

tl32rodan@tl32rodan-Sabre-15KV8: ~/Desktop/Course/107_2/Computer Network/project_tcp_over_udp/step6
File Edit View Search Terminal Help
(base) tl32rodan@tl32rodan-Sabre-15KV8:~/Desktop/Course/107_2/Computer Network/project_tcp_over_udp/s
tep6$ ./server 6543
=====Parameters=====
The RTT delay = 150 ms
The threshold = 65535 bytes
The MSS = 1044 bytes
The buffer size = 32768 bytes
Server's IP is 127.0.0.1
Server is listening on port 6543
=====
Listening for clients.....
Accepting new connection...
=====Start three-way handshake=====
Receive a packet(SYN) from 127.0.0.1 : 43019
    Receive a packet (seq_num = 8221 , ack_num = 0)
Send a packet(SYN/ACK) to 127.0.0.1 : 43019
Receive a packet(SYN) from 127.0.0.1 : 43019
    Receive a packet (seq_num = 8222 , ack_num = 9434)
=====Complete the three-way handshake=====
Start to send file "1.mp4" to 127.0.0.1 : 43019 , the file size is 123431 bytes.
*****Slow Start*****
cwnd = 1024 , rwnd = 307200 , threshold = 65535
    Send a packet at : 0 bytes
    Receive a packet (seq_num = 8223 , ack_num = 1024)
cwnd = 2048 , rwnd = 31744 , threshold = 65535
    Send a packet at : 1024 bytes
cwnd = 2048 , rwnd = 31744 , threshold = 65535
    Send a packet at : 2048 bytes
    Receive a packet (seq_num = 8224 , ack_num = 2048)
    Receive a packet (seq_num = 8225 , ack_num = 3072)
cwnd = 3072 , rwnd = 29696 , threshold = 65535
    Send a packet at : 3072 bytes
cwnd = 3072 , rwnd = 29696 , threshold = 65535
    Send a packet at : 4096 bytes
cwnd = 3072 , rwnd = 29696 , threshold = 65535
    Send a packet at : 5120 bytes
    Receive a packet (seq_num = 8226 , ack_num = 4096)
    Receive a packet (seq_num = 8227 , ack_num = 5120)
    Receive a packet (seq_num = 8228 , ack_num = 6144)
cwnd = 4096 , rwnd = 26624 , threshold = 65535
    Send a packet at : 6144 bytes    **lost
cwnd = 4096 , rwnd = 26624 , threshold = 65535
    Send a packet at : 7168 bytes
cwnd = 4096 , rwnd = 26624 , threshold = 65535
    Send a packet at : 8192 bytes
cwnd = 4096 , rwnd = 26624 , threshold = 65535
    Send a packet at : 9216 bytes
    Receive a packet (seq_num = 8229 , ack_num = 6144)
    Receive a packet (seq_num = 8230 , ack_num = 6144)
    Receive a packet (seq_num = 8231 , ack_num = 6144)
Received three duplicate ACKs.
*****Fast Recovery*****
cwnd = 5120 , rwnd = 26624 , threshold = 2048
    Send a packet at : 6144 bytes
cwnd = 5120 , rwnd = 26624 , threshold = 2048
    Send a packet at : 7168 bytes

```

Client:

```
tl32rodan@tl32rodan-Sabre-15KV8: ~/Desktop/Course/107_2/Computer Network/project_tcp_over_udp/step6
File Edit View Search Terminal Help
^C
(base) tl32rodan@tl32rodan-Sabre-15KV8:~/Desktop/Course/107_2/Computer Network/project_tcp_over_udp/step5$ cd ../step6
(base) tl32rodan@tl32rodan-Sabre-15KV8:~/Desktop/Course/107_2/Computer Network/project_tcp_over_udp/step6$ ./client 127.0.0.1 6543 -f 1
Info : IP = 127.0.0.1 , port = 6543
=====Start three-way handshake=====
Send a packet(SYN) to 127.0.0.1 : 6543
Receive a packet(SYN/ACK) from 127.0.0.1 : 38183
      Receive a packet (seq_num = 8410 , ack_num = 8222)
Send a packet(ACK) to 127.0.0.1 : 38183
=====Complete the three-way handshake=====
Receive file "1_result.mp4" from 127.0.0.1 : 38183
Receive a packet from 127.0.0.1 : 38183
      Receive a packet (seq_num = 0 , ack_num = 8223)
Receive a packet from 127.0.0.1 : 38183
      Receive a packet (seq_num = 1024 , ack_num = 8224)
Receive a packet from 127.0.0.1 : 38183
      Receive a packet (seq_num = 2048 , ack_num = 8224)
Receive a packet from 127.0.0.1 : 38183
      Receive a packet (seq_num = 3072 , ack_num = 8226)
Receive a packet from 127.0.0.1 : 38183
      Receive a packet (seq_num = 4096 , ack_num = 8226)
Receive a packet from 127.0.0.1 : 38183
      Receive a packet (seq_num = 5120 , ack_num = 8226)
Receive a packet from 127.0.0.1 : 38183
      Receive a packet (seq_num = 6144 , ack_num = 8232)
Receive a packet from 127.0.0.1 : 38183
      Receive a packet (seq_num = 7168 , ack_num = 8232)
Receive a packet from 127.0.0.1 : 38183
      Receive a packet (seq_num = 8192 , ack_num = 8232)
Receive a packet from 127.0.0.1 : 38183
      Receive a packet (seq_num = 9216 , ack_num = 8232)
Receive a packet from 127.0.0.1 : 38183
      Receive a packet (seq_num = 10240 , ack_num = 8232)
Receive a packet from 127.0.0.1 : 38183
      Receive a packet (seq_num = 11264 , ack_num = 8237)
Receive a packet from 127.0.0.1 : 38183
      Receive a packet (seq_num = 12288 , ack_num = 8237)
Receive a packet from 127.0.0.1 : 38183
      Receive a packet (seq_num = 13312 , ack_num = 8239)
Receive a packet from 127.0.0.1 : 38183
      Receive a packet (seq_num = 14336 , ack_num = 8239)
Receive a packet from 127.0.0.1 : 38183
      Receive a packet (seq_num = 15360 , ack_num = 8241)
Receive a packet from 127.0.0.1 : 38183
      Receive a packet (seq_num = 16384 , ack_num = 8241)
Receive a packet from 127.0.0.1 : 38183
      Receive a packet (seq_num = 17408 , ack_num = 8243)
Receive a packet from 127.0.0.1 : 38183
      Receive a packet (seq_num = 18432 , ack_num = 8243)
Receive a packet from 127.0.0.1 : 38183
      Receive a packet (seq_num = 19456 , ack_num = 8243)
Receive a packet from 127.0.0.1 : 38183
      Receive a packet (seq_num = 20480 , ack_num = 8246)
Receive a packet from 127.0.0.1 : 38183
```

Step 8:

Server:


```
tl32rodan@tl32rodan-Sabre-15KV8: ~/Desktop/Course/107_2/Computer Network/project_tcp_over_udp/step8
File Edit View Search Terminal Help
(base) tl32rodan@tl32rodan-Sabre-15KV8:~/Desktop/Course/107_2/Computer Network/project_tcp_over_udp/s
tep8$ ./server 6543
=====Parameters=====
The RTT delay = 150 ms
The threshold = 65535 bytes
The MSS = 1044 bytes
The buffer size = 32768 bytes
Server's IP is 127.0.0.1
Server is listening on port 6543
=====
Listening for clients.....
Accepting new connection...
=====Start three-way handshake=====
Receive a packet(SYN) from 127.0.0.1 : 34921
    Receive a packet (seq_num = 5925 , ack_num = 0)
Send a packet(SYN/ACK) to 127.0.0.1 : 34921
Receive a packet(SYN) from 127.0.0.1 : 34921
    Receive a packet (seq_num = 5926 , ack_num = 6414)
=====Complete the three-way handshake=====
Start to send file "1.mp4" to 127.0.0.1 : 34921 , the file size is 123431 bytes.
*****Slow Start*****
cwnd = 1024 , rwnd = 307200 , threshold = 65535
    Send a packet at : 0 bytes
    Receive a packet (seq_num = 5927 , ack_num = 1024)
cwnd = 2048 , rwnd = 31744 , threshold = 65535
    Send a packet at : 1024 bytes
cwnd = 2048 , rwnd = 31744 , threshold = 65535
    Send a packet at : 2048 bytes
    Receive a packet (seq_num = 5928 , ack_num = 3072)
cwnd = 3072 , rwnd = 29696 , threshold = 65535
    Send a packet at : 3072 bytes
cwnd = 3072 , rwnd = 29696 , threshold = 65535
    Send a packet at : 4096 bytes
cwnd = 3072 , rwnd = 29696 , threshold = 65535
    Send a packet at : 5120 bytes
    Receive a packet (seq_num = 5929 , ack_num = 5120)
    Receive a packet (seq_num = 5930 , ack_num = 6144)
cwnd = 4096 , rwnd = 26624 , threshold = 65535
    Send a packet at : 6144 bytes    **lost
cwnd = 4096 , rwnd = 26624 , threshold = 65535
    Send a packet at : 7168 bytes
cwnd = 4096 , rwnd = 26624 , threshold = 65535
    Send a packet at : 8192 bytes
cwnd = 4096 , rwnd = 26624 , threshold = 65535
    Send a packet at : 9216 bytes
    Receive a packet (seq_num = 5931 , ack_num = 6144)
    Receive a packet (seq_num = 5932 , ack_num = 6144)
    Receive a packet (seq_num = 5933 , ack_num = 6144)
Received three duplicate ACKs.
*****Fast Recovery*****
cwnd = 5120 , rwnd = 26624 , threshold = 2048
    Send a packet at : 6144 bytes
cwnd = 5120 , rwnd = 26624 , threshold = 2048
    Send a packet at : 7168 bytes
cwnd = 5120 , rwnd = 26624 , threshold = 2048
    Send a packet at : 8192 bytes
```

Client:

[illegible]