

Computer Network Homework

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Three-way handshake

Server

```
[YuRongs-Macbook:network YuRong$ ./UDPSocket 12345
====Parameter=====
The RTT delay = 200 ms
The threshold = 4096 bytes
The MSS = 512 bytes
The buffer size = 10240 bytes
Server's IP is 127.0.0.1
Server is listening on port 12345
=====
Listening for Node...
(ClientFunction)Please Input Node [IP] [Port] you want to connect.
====Start the three-way handshake====
Received a packet (SYN) from 127.0.0.1 : 23456
    Received a packet(seq_num = 5115 ,ack_num = 0)
Send a packet (SYN/ACK) to 127.0.0.1 : 23456
Received a packet (ACK) from 127.0.0.1 : 23456
    Received a packet(seq_num = 5116 ,ack_num = 3923)
====Complete the three-way handshake====
```

Three-way handshake

Client

```
[YuRongs-Macbook:network YuRong$ ./UDPSocket 23456
====Parameter=====
The RTT delay = 200 ms
The threshold = 4096 bytes
The MSS = 512 bytes
The buffer size = 10240 bytes
Server's IP is 127.0.0.1
Server is listening on port 23456
=====
Listening for Node...
(ClientFunction)Please Input Node [IP] [Port] you want to connect.
127.0.0.1 12345
====Start the three-way handshake====
Send a packet(SYN) to 127.0.0.1 : 12345
Receive a packet (SYN/ACK) from 127.0.0.1 : 12345
    Received a packet(seq_num = 3922 ,ack_num = 5116)
Send a packet(ACK) to 127.0.0.1 : 12345
====Complete the three-way handshake====
```

Data Transmission Server

```
====Complete the three-way handshake====  
Start to send the file, the file size is 10240 bytes.  
*****Slow start*****  
  cwnd = 1, rwnd = 10240, threshold = 4096  
    Send a packet at 1 bytes  
cwnd = 2, rwnd = 10239, threshold = 4096  
    Send a packet at 2 bytes  
    Receive a packet (seq_num = 5118 ,ack_num = 4)  
cwnd = 4, rwnd = 10237, threshold = 4096  
    Send a packet at 4 bytes  
cwnd = 8, rwnd = 10233, threshold = 4096  
    Send a packet at 8 bytes  
    Receive a packet (seq_num = 5120 ,ack_num = 16)  
cwnd = 16, rwnd = 10225, threshold = 4096  
    Send a packet at 16 bytes  
cwnd = 32, rwnd = 10209, threshold = 4096  
    Send a packet at 32 bytes  
    Receive a packet (seq_num = 5122 ,ack_num = 64)  
cwnd = 64, rwnd = 10177, threshold = 4096  
    Send a packet at 64 bytes  
cwnd = 128, rwnd = 10113, threshold = 4096  
    Send a packet at 128 bytes  
    Receive a packet (seq_num = 5124 ,ack_num = 256)  
cwnd = 256, rwnd = 9985, threshold = 4096  
    Send a packet at 256 bytes  
cwnd = 512, rwnd = 9729, threshold = 4096  
    Send a packet at 512 bytes  
    Receive a packet (seq_num = 5126 ,ack_num = 1024)  
cwnd = 1024, rwnd = 9217, threshold = 4096  
    Send a packet at 1024 bytes  
    Send a packet at 1536 bytes  
    Receive a packet (seq_num = 5128 ,ack_num = 2048)  
cwnd = 2048, rwnd = 8193, threshold = 4096  
    Send a packet at 2048 bytes  
    Send a packet at 2560 bytes  
    Send a packet at 3072 bytes
```


Data Transmission Server(2)

```
Send a packet at 2048 bytes
Send a packet at 2560 bytes
Send a packet at 3072 bytes
Send a packet at 3584 bytes
Receive a packet (seq_num = 5130 ,ack_num = 3072)
Receive a packet (seq_num = 5132 ,ack_num = 4096)
*****Congestion Avoidance*****
cwnd = 4096, rwnd = 6145, threshold = 4096
Send a packet at 4096 bytes
Send a packet at 4608 bytes
Send a packet at 5120 bytes
Send a packet at 5632 bytes
Send a packet at 6144 bytes
Send a packet at 6656 bytes
Send a packet at 7168 bytes
Send a packet at 7680 bytes
Receive a packet (seq_num = 5134 ,ack_num = 5120)
Receive a packet (seq_num = 5136 ,ack_num = 6144)
Receive a packet (seq_num = 5138 ,ack_num = 7168)
Receive a packet (seq_num = 5140 ,ack_num = 8192)
cwnd = 4608, rwnd = 5633, threshold = 4096
Send a packet at 8192 bytes
Send a packet at 8704 bytes
Send a packet at 9216 bytes
Send a packet at 9728 bytes
Send a packet at 10240 bytes
Send a packet at 10752 bytes
Send a packet at 11264 bytes
Send a packet at 11776 bytes
Send a packet at 12288 bytes
Receive a packet (seq_num = 5142 ,ack_num = 9216)
Receive a packet (seq_num = 5144 ,ack_num = 10240)
Receive a packet (seq_num = 5146 ,ack_num = 11264)
Receive a packet (seq_num = 5148 ,ack_num = 12288)
*****The file transmission finished.*****
=====Start the four-way handshake=====
```

Data Transmission Client

```
=====Complete the three-way handshake=====
Receive a file from 127.0.0.1 : 12345
Receive a packet (seq_num = 1 , ack_num = 5117)
Receive a packet (seq_num = 2 , ack_num = 5118)
Receive a packet (seq_num = 4 , ack_num = 5119)
Receive a packet (seq_num = 8 , ack_num = 5120)
Receive a packet (seq_num = 16 , ack_num = 5121)
Receive a packet (seq_num = 32 , ack_num = 5122)
Receive a packet (seq_num = 64 , ack_num = 5123)
Receive a packet (seq_num = 128 , ack_num = 5124)
Receive a packet (seq_num = 256 , ack_num = 5125)
Receive a packet (seq_num = 512 , ack_num = 5126)
Receive a packet (seq_num = 1024 , ack_num = 5127)
Receive a packet (seq_num = 1536 , ack_num = 5128)
Receive a packet (seq_num = 2048 , ack_num = 5129)
Receive a packet (seq_num = 2560 , ack_num = 5130)
Receive a packet (seq_num = 3072 , ack_num = 5131)
Receive a packet (seq_num = 3584 , ack_num = 5132)
Receive a packet (seq_num = 4096 , ack_num = 5133)
Receive a packet (seq_num = 4608 , ack_num = 5134)
Receive a packet (seq_num = 5120 , ack_num = 5135)
Receive a packet (seq_num = 5632 , ack_num = 5136)
Receive a packet (seq_num = 6144 , ack_num = 5137)
Receive a packet (seq_num = 6656 , ack_num = 5138)
Receive a packet (seq_num = 7168 , ack_num = 5139)
Receive a packet (seq_num = 7680 , ack_num = 5140)
Receive a packet (seq_num = 8192 , ack_num = 5141)
Receive a packet (seq_num = 8704 , ack_num = 5142)
Receive a packet (seq_num = 9216 , ack_num = 5143)
Receive a packet (seq_num = 9728 , ack_num = 5144)
Receive a packet (seq_num = 10240 , ack_num = 5145)
Receive a packet (seq_num = 10752 , ack_num = 5146)
Receive a packet (seq_num = 11264 , ack_num = 5147)
Receive a packet (seq_num = 11776 , ack_num = 5148)
Receive a packet (seq_num = 12288 , ack_num = 5149)
=====Start four-way handshake=====
```

Four-way handshake

Server

```
*****The file transmission finished.*****  
=====Start the four-way handshake=====  
Send a packet (FIN) to 127.0.0.1 : 23456  
Received a packet (ACK) from 127.0.0.1 : 23456  
    Received a packet(seq_num = 5150 ,ack_num = 8778)  
Received a packet (FIN) from 127.0.0.1 : 23456  
    Received a packet(seq_num = 5151 ,ack_num = 8778)  
Send a packet (ACK) to 127.0.0.1 : 23456  
=====Complete the four-way handshake=====  
Listening for Node
```

Four-way handshake

Client

```
=====Start four-way handshake=====
Receive a packet (FIN) from 127.0.0.1 : 12345
    Received a packet(seq_num = 8777 ,ack_num = 5150)
Send a packet(ACK) to 127.0.0.1 : 12345
Send a packet(FIN) to 127.0.0.1 : 12345
Receive a packet (ACK) from 127.0.0.1 : 12345
    Received a packet(seq_num = 8778 ,ack_num = 5152)
===== Complete the four-way handshake
```


Tahoe Server

```
Receive a packet (seq_num = 3608 ,ack_num = 512)
cwnd = 512, rwnd = 9729, threshold = 4096
Send a packet at 512 bytes
Receive a packet (seq_num = 3609 ,ack_num = 1024)
cwnd = 1024, rwnd = 9217, threshold = 4096
Send a packet at 1024 bytes
Send a packet at 1536 bytes
Receive a packet (seq_num = 3610 ,ack_num = 1536)
Receive a packet (seq_num = 3611 ,ack_num = 2048)
cwnd = 2048, rwnd = 8193, threshold = 4096
****Data loss at byte : 2048
Send a packet at 2048 bytes
Send a packet at 2560 bytes
Send a packet at 3072 bytes
Send a packet at 3584 bytes
Receive a packet (seq_num = 3612 ,ack_num = 2048)
Receive a packet (seq_num = 3613 ,ack_num = 2048)
Receive a packet (seq_num = 3614 ,ack_num = 2048)
Receive three duplicate ACKs.
****Fast transmission****
****Slow start****
cwnd = 1, rwnd = 10240, threshold = 1024
Send a packet at 2048 bytes
Receive a packet (seq_num = 3615 ,ack_num = 2049)
cwnd = 2, rwnd = 10239, threshold = 1024
Send a packet at 2049 bytes
Receive a packet (seq_num = 3616 ,ack_num = 2051)
cwnd = 4, rwnd = 10237, threshold = 1024
Send a packet at 2051 bytes
Receive a packet (seq_num = 3617 ,ack_num = 2055)
cwnd = 8, rwnd = 10233, threshold = 1024
Send a packet at 2055 bytes
Receive a packet (seq_num = 3618 ,ack_num = 2063)
cwnd = 16, rwnd = 10225, threshold = 1024
Send a packet at 2063 bytes
Receive a packet (seq_num = 3619 ,ack_num = 2079)
```

Tahoe Client

```
Receive a packet (seq_num = 32 , ack_num = 3605)
Receive a packet (seq_num = 64 , ack_num = 3606)
Receive a packet (seq_num = 128 , ack_num = 3607)
Receive a packet (seq_num = 256 , ack_num = 3608)
Receive a packet (seq_num = 512 , ack_num = 3609)
Receive a packet (seq_num = 1024 , ack_num = 3610)
Receive a packet (seq_num = 1536 , ack_num = 3611)
Receive a packet (seq_num = 2560 , ack_num = 3613)
Receive a packet (seq_num = 3072 , ack_num = 3614)
Receive a packet (seq_num = 3584 , ack_num = 3615)
Receive a packet (seq_num = 2048 , ack_num = 3615)
Receive a packet (seq_num = 2049 , ack_num = 3616)
Receive a packet (seq_num = 2051 , ack_num = 3617)
Receive a packet (seq_num = 2055 , ack_num = 3618)
Receive a packet (seq_num = 2063 , ack_num = 3619)
Receive a packet (seq_num = 2079 , ack_num = 3620)
Receive a packet (seq_num = 2111 , ack_num = 3621)
Receive a packet (seq_num = 2175 , ack_num = 3622)
Receive a packet (seq_num = 2303 , ack_num = 3623)
Receive a packet (seq_num = 2559 , ack_num = 3624)
```

Reno Server

```
Send a packet at 512 bytes
Receive a packet (seq_num = 9765 ,ack_num = 1024)
cwnd = 1024, rwnd = 9217, threshold = 4096
Send a packet at 1024 bytes
Send a packet at 1536 bytes
Receive a packet (seq_num = 9766 ,ack_num = 1536)
Receive a packet (seq_num = 9767 ,ack_num = 2048)
cwnd = 2048, rwnd = 8193, threshold = 4096
Send a packet at 2048 bytes
*****Data loss at byte : 2048
Send a packet at 2560 bytes
Send a packet at 3072 bytes
Send a packet at 3584 bytes
Receive a packet (seq_num = 9768 ,ack_num = 2048)
Receive a packet (seq_num = 9769 ,ack_num = 2048)
Receive a packet (seq_num = 9770 ,ack_num = 2048)
Receive three duplicate ACKs.
*****Fast transmission*****
*****Congestion Avoidance*****
cwnd = 1024, rwnd = 9217, threshold = 1024
Send a packet at 2048 bytes
Send a packet at 2560 bytes
Receive a packet (seq_num = 9771 ,ack_num = 2560)
Receive a packet (seq_num = 9772 ,ack_num = 3072)
cwnd = 1536, rwnd = 8705, threshold = 1024
Send a packet at 3072 bytes
Send a packet at 3584 bytes
Send a packet at 4096 bytes
Receive a packet (seq_num = 9773 ,ack_num = 3584)
Receive a packet (seq_num = 9774 ,ack_num = 4096)
Receive a packet (seq_num = 9775 ,ack_num = 4608)
cwnd = 2048, rwnd = 8193, threshold = 1024
Send a packet at 4608 bytes
Send a packet at 5120 bytes
```


Reno Client

```
Receive a packet (seq_num = 128 , ack_num = 9763)
Receive a packet (seq_num = 256 , ack_num = 9764)
Receive a packet (seq_num = 512 , ack_num = 9765)
Receive a packet (seq_num = 1024 , ack_num = 9766)
Receive a packet (seq_num = 1536 , ack_num = 9767)
Receive a packet (seq_num = 2560 , ack_num = 9769)
Receive a packet (seq_num = 3072 , ack_num = 9770)
Receive a packet (seq_num = 3584 , ack_num = 9771)
Receive a packet (seq_num = 2048 , ack_num = 9771)
Receive a packet (seq_num = 2560 , ack_num = 9772)
Receive a packet (seq_num = 3072 , ack_num = 9773)
Receive a packet (seq_num = 3584 , ack_num = 9774)
Receive a packet (seq_num = 4096 , ack_num = 9775)
Receive a packet (seq_num = 4608 , ack_num = 9776)
Receive a packet (seq_num = 5120 , ack_num = 9777)
Receive a packet (seq_num = 5632 , ack_num = 9778)
Receive a packet (seq_num = 6144 , ack_num = 9779)
Receive a packet (seq_num = 6656 , ack_num = 9780)
```