

# 深圳大学实验报告

课程名称： 计算机网络（Computer Networks）

实验名称： Transport Layer Assignment

学院： 电子与信息工程学院

专业： 电子信息工程

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教务部制

## **1. Purpose of experiment**

**(1)The experiment aims to deepen the understanding of network protocols and socket programming by developing a Stop-and-Wait protocol based on UDP.**

**(2)Through this experiment, the goal is to implement a simple mechanism for sending and receiving data packets, handling timeout situations, simulating packet loss, and calculating network round-trip time (RTT) and actual packet loss rate.**

## **2. Experimental principle**

**The Stop-and-Wait protocol requires the sender to wait for an acknowledgment (ACK) signal from the receiver after sending a data packet before sending the next one. If the sender does not receive acknowledgment within a timeout period, it assumes the packet is lost and triggers a retransmission mechanism. This experiment is based on UDP socket programming, using a loop to send data packets, calculating RTT, and simulating packet loss on the server side.**

### 3. Content

#### (1) communication in “localhost”

##### ① Sending 10 packets, packet loss rate is set to 0.5

```
Run  StopAndWait_server x StopAndWait_client x
D:\Software\anaconda\python.exe E:\Python_Project\Network\Experiment2
Timeout for Packet 0, resending...
Received ack for Packet 0: Ack for Packet 0 with RTT: 0.0s
Received ack for Packet 1: Ack for Packet 1 with RTT: 0.000991s
Timeout for Packet 2, resending...
Received ack for Packet 2: Ack for Packet 2 with RTT: 0.0s
Timeout for Packet 3, resending...
Received ack for Packet 3: Ack for Packet 3 with RTT: 0.000656s
Timeout for Packet 4, resending...
Received ack for Packet 4: Ack for Packet 4 with RTT: 0.0s
Received ack for Packet 5: Ack for Packet 5 with RTT: 0.0s
Timeout for Packet 6, resending...
Received ack for Packet 6: Ack for Packet 6 with RTT: 0.0s
Received ack for Packet 7: Ack for Packet 7 with RTT: 0.001s
Timeout for Packet 8, resending...
Timeout for Packet 8, resending...
Received ack for Packet 8: Ack for Packet 8 with RTT: 0.000519s
Timeout for Packet 9, resending...
Timeout for Packet 9, resending...
Received ack for Packet 9: Ack for Packet 9 with RTT: 0.001002s
Average RTT for 10 packets: 0.0004168s
Total time for sending packets: 9.106407s
Actual packet loss rate: 47.368421052631575%
```

```
Run  StopAndWait_server x StopAndWait_client x
D:\Software\anaconda\python.exe E:\Python_Project\Ne
Received Packet 0 from ('127.0.0.1', 59651)
Received Packet 1 from ('127.0.0.1', 59651)
Packet lost: Packet 2
Received Packet 2 from ('127.0.0.1', 59651)
Packet lost: Packet 3
Received Packet 3 from ('127.0.0.1', 59651)
Packet lost: Packet 4
Received Packet 4 from ('127.0.0.1', 59651)
Received Packet 5 from ('127.0.0.1', 59651)
Packet lost: Packet 6
Received Packet 6 from ('127.0.0.1', 59651)
Received Packet 7 from ('127.0.0.1', 59651)
Packet lost: Packet 8
Packet lost: Packet 8
Received Packet 8 from ('127.0.0.1', 59651)
Packet lost: Packet 9
Packet lost: Packet 9
Received Packet 9 from ('127.0.0.1', 59651)
|
```

## ② Sending 100 packets, packet loss rate is set to 0.2

```
Run  StopAndWait_server x StopAndWait_client x
Received ack for Packet 80: Ack for Packet 80 with RTT: 0.0s
Received ack for Packet 81: Ack for Packet 81 with RTT: 0.000992s
Received ack for Packet 82: Ack for Packet 82 with RTT: 0.0s
Received ack for Packet 83: Ack for Packet 83 with RTT: 0.0s
Timeout for Packet 84, resending...
Timeout for Packet 84, resending...
Received ack for Packet 84: Ack for Packet 84 with RTT: 0.000501s
Received ack for Packet 85: Ack for Packet 85 with RTT: 0.0s
Received ack for Packet 86: Ack for Packet 86 with RTT: 0.0s
Received ack for Packet 87: Ack for Packet 87 with RTT: 0.001003s
Received ack for Packet 88: Ack for Packet 88 with RTT: 0.0s
Received ack for Packet 89: Ack for Packet 89 with RTT: 0.0s
Received ack for Packet 90: Ack for Packet 90 with RTT: 0.001009s
Received ack for Packet 91: Ack for Packet 91 with RTT: 0.0s
Received ack for Packet 92: Ack for Packet 92 with RTT: 0.0s
Timeout for Packet 93, resending...
Received ack for Packet 93: Ack for Packet 93 with RTT: 0.0s
Received ack for Packet 94: Ack for Packet 94 with RTT: 0.001001s
Received ack for Packet 95: Ack for Packet 95 with RTT: 0.0s
Received ack for Packet 96: Ack for Packet 96 with RTT: 0.0s
Received ack for Packet 97: Ack for Packet 97 with RTT: 0.001001s
Received ack for Packet 98: Ack for Packet 98 with RTT: 0.0s
Received ack for Packet 99: Ack for Packet 99 with RTT: 0.0s
Average RTT for 100 packets: 0.00031508s
Total time for sending packets: 28.35054s
Actual packet loss rate: 21.875%
```

```
Run  StopAndWait_server x StopAndWait_client x
Packet lost: Packet 79
Received Packet 79 from ('127.0.0.1', 50149)
Packet lost: Packet 80
Received Packet 80 from ('127.0.0.1', 50149)
Received Packet 81 from ('127.0.0.1', 50149)
Received Packet 82 from ('127.0.0.1', 50149)
Received Packet 83 from ('127.0.0.1', 50149)
Packet lost: Packet 84
Packet lost: Packet 84
Received Packet 84 from ('127.0.0.1', 50149)
Received Packet 85 from ('127.0.0.1', 50149)
Received Packet 86 from ('127.0.0.1', 50149)
Received Packet 87 from ('127.0.0.1', 50149)
Received Packet 88 from ('127.0.0.1', 50149)
Received Packet 89 from ('127.0.0.1', 50149)
Received Packet 90 from ('127.0.0.1', 50149)
Received Packet 91 from ('127.0.0.1', 50149)
Received Packet 92 from ('127.0.0.1', 50149)
Packet lost: Packet 93
Received Packet 93 from ('127.0.0.1', 50149)
Received Packet 94 from ('127.0.0.1', 50149)
Received Packet 95 from ('127.0.0.1', 50149)
Received Packet 96 from ('127.0.0.1', 50149)
Received Packet 97 from ('127.0.0.1', 50149)
Received Packet 98 from ('127.0.0.1', 50149)
Received Packet 99 from ('127.0.0.1', 50149)
|
```

### ③ Sending 100 packets, packet loss rate is set to 0.5

```
Run  StopAndWait_server x StopAndWait_client x
Timeout for Packet 87, resending...
Timeout for Packet 89, resending...
Received ack for Packet 89: Ack for Packet 89 with RTT: 0.0s
Timeout for Packet 90, resending...
Received ack for Packet 90: Ack for Packet 90 with RTT: 0.0s
Received ack for Packet 91: Ack for Packet 91 with RTT: 0.001506s
Timeout for Packet 92, resending...
Timeout for Packet 92, resending...
Timeout for Packet 92, resending...
Received ack for Packet 92: Ack for Packet 92 with RTT: 0.006004s
Received ack for Packet 93: Ack for Packet 93 with RTT: 0.001001s
Timeout for Packet 94, resending...
Timeout for Packet 94, resending...
Received ack for Packet 94: Ack for Packet 94 with RTT: 0.001502s
Received ack for Packet 95: Ack for Packet 95 with RTT: 0.000502s
Received ack for Packet 96: Ack for Packet 96 with RTT: 0.0s
Timeout for Packet 97, resending...
Timeout for Packet 97, resending...
Received ack for Packet 97: Ack for Packet 97 with RTT: 0.0s
Timeout for Packet 98, resending...
Received ack for Packet 98: Ack for Packet 98 with RTT: 0.0s
Received ack for Packet 99: Ack for Packet 99 with RTT: 0.0s
Average RTT for 100 packets: 0.000419s
Total time for sending packets: 93.898091s
Actual packet loss rate: 48.18652849740933%
```

```
Run  StopAndWait_server x StopAndWait_client x
Received Packet 86 from ('127.0.0.1', 63099)
Received Packet 87 from ('127.0.0.1', 63099)
Received Packet 88 from ('127.0.0.1', 63099)
Packet lost: Packet 89
Packet lost: Packet 89
Received Packet 89 from ('127.0.0.1', 63099)
Packet lost: Packet 90
Received Packet 90 from ('127.0.0.1', 63099)
Received Packet 91 from ('127.0.0.1', 63099)
Packet lost: Packet 92
Packet lost: Packet 92
Packet lost: Packet 92
Received Packet 92 from ('127.0.0.1', 63099)
Received Packet 93 from ('127.0.0.1', 63099)
Packet lost: Packet 94
Packet lost: Packet 94
Received Packet 94 from ('127.0.0.1', 63099)
Received Packet 95 from ('127.0.0.1', 63099)
Received Packet 96 from ('127.0.0.1', 63099)
Packet lost: Packet 97
Packet lost: Packet 97
Received Packet 97 from ('127.0.0.1', 63099)
Packet lost: Packet 98
Received Packet 98 from ('127.0.0.1', 63099)
Received Packet 99 from ('127.0.0.1', 63099)
,
```



## (2) Communication with partner

### ① Sending 10 packets, packet loss rate is set to 0.5

```
Run  StopAndWait_client (1) x
:
Timeout for Packet 4, resending...
Received ack for Packet 4: Ack for Packet 4 with RTT: 0.003s
Timeout for Packet 5, resending...
Timeout for Packet 5, resending...
Received ack for Packet 5: Ack for Packet 5 with RTT: 0.002885s
Timeout for Packet 6, resending...
Timeout for Packet 6, resending...
Timeout for Packet 6, resending...
Received ack for Packet 6: Ack for Packet 6 with RTT: 0.00332s
Received ack for Packet 7: Ack for Packet 7 with RTT: 0.003011s
Timeout for Packet 8, resending...
Received ack for Packet 8: Ack for Packet 8 with RTT: 0.004989s
Timeout for Packet 9, resending...
Received ack for Packet 9: Ack for Packet 9 with RTT: 0.005575s
Average RTT for 10 packets: 0.0043311s
Total time for sending packets: 12.065544s
Actual packet loss rate: 54.54545454545454%

Process finished with exit code 0

PythonProject > StopAndWait_client.py

Run  StopAndWait_server x
Received Packet 4 from ('172.26.87.52', 55936)
Packet lost: Packet 5
Packet lost: Packet 5
Received Packet 5 from ('172.26.87.52', 55936)
Packet lost: Packet 6
Packet lost: Packet 6
Packet lost: Packet 6
Received Packet 6 from ('172.26.87.52', 55936)
Received Packet 7 from ('172.26.87.52', 55936)
Packet lost: Packet 8
Received Packet 8 from ('172.26.87.52', 55936)
Packet lost: Packet 9
Received Packet 9 from ('172.26.87.52', 55936)

PythonProject > Network > Experiment2 > StopAndWait_server.py
```

## ② Sending 100 packets, packet loss rate is set to 0.2

```
Run StopAndWait_client (1) x

Received ack for Packet 90: Ack for Packet 90 with RTT: 0.000902s
Received ack for Packet 91: Ack for Packet 91 with RTT: 0.004028s
Received ack for Packet 92: Ack for Packet 92 with RTT: 0.003413s
Timeout for Packet 93, resending...
Timeout for Packet 93, resending...
Timeout for Packet 93, resending...
Timeout for Packet 93, resending...
Received ack for Packet 93: Ack for Packet 93 with RTT: 0.003958s
Received ack for Packet 94: Ack for Packet 94 with RTT: 0.003548s
Received ack for Packet 95: Ack for Packet 95 with RTT: 0.003133s
Received ack for Packet 96: Ack for Packet 96 with RTT: 0.003975s
Received ack for Packet 97: Ack for Packet 97 with RTT: 0.003018s
Received ack for Packet 98: Ack for Packet 98 with RTT: 0.002894s
Received ack for Packet 99: Ack for Packet 99 with RTT: 0.003556s
Average RTT for 100 packets: 0.00430221s
Total time for sending packets: 23.44397s
Actual packet loss rate: 18.69918699186992%

Process finished with exit code 0
```

```
Run StopAndWait_server x

Received Packet 92 from ('172.26.87.52', 64873)
Packet lost: Packet 93
Packet lost: Packet 93
Packet lost: Packet 93
Packet lost: Packet 93
Received Packet 93 from ('172.26.87.52', 64873)
Received Packet 94 from ('172.26.87.52', 64873)
Received Packet 95 from ('172.26.87.52', 64873)
Received Packet 96 from ('172.26.87.52', 64873)
Received Packet 97 from ('172.26.87.52', 64873)
Received Packet 98 from ('172.26.87.52', 64873)
Received Packet 99 from ('172.26.87.52', 64873)
```

### ③ Sending 100 packets, packet loss rate is set to 0.5

```
Run StopAndWait_client (1) x
Received ack for Packet 95: Ack for Packet 95 with RTT: 0.0129995s
Timeout for Packet 96, resending...
Received ack for Packet 96: Ack for Packet 96 with RTT: 0.005282s
Timeout for Packet 97, resending...
Timeout for Packet 97, resending...
Timeout for Packet 97, resending...
Timeout for Packet 97, resending...
Received ack for Packet 97: Ack for Packet 97 with RTT: 0.004882s
Timeout for Packet 98, resending...
Timeout for Packet 98, resending...
Timeout for Packet 98, resending...
Timeout for Packet 98, resending...
Received ack for Packet 98: Ack for Packet 98 with RTT: 0.003579s
Received ack for Packet 99: Ack for Packet 99 with RTT: 0.004461s
Average RTT for 100 packets: 0.00816002s
Total time for sending packets: 123.871356s
Actual packet loss rate: 55.15695067264574%

Process finished with exit code 0
```

```
> Python_Project E:\Python_Project
Run StopAndWait_server x
Received Packet 88 from ('172.26.87.52', 57753)
Packet lost: Packet 89
Packet lost: Packet 89
Received Packet 89 from ('172.26.87.52', 57753)
Received Packet 90 from ('172.26.87.52', 57753)
Packet lost: Packet 91
Packet lost: Packet 91
Packet lost: Packet 91
Received Packet 91 from ('172.26.87.52', 57753)
Received Packet 92 from ('172.26.87.52', 57753)
Received Packet 93 from ('172.26.87.52', 57753)
Received Packet 94 from ('172.26.87.52', 57753)
Packet lost: Packet 95
Packet lost: Packet 95
Received Packet 95 from ('172.26.87.52', 57753)
Packet lost: Packet 96
Received Packet 96 from ('172.26.87.52', 57753)
Packet lost: Packet 97
Packet lost: Packet 97
Packet lost: Packet 97
Packet lost: Packet 97
Received Packet 97 from ('172.26.87.52', 57753)
Packet lost: Packet 98
Packet lost: Packet 98
Packet lost: Packet 98
Packet lost: Packet 98
Received Packet 98 from ('172.26.87.52', 57753)
Received Packet 99 from ('172.26.87.52', 57753)
```



**(1)The client sends a series of data packets to the server using a UDP socket.**

**(2)The server receives data packets, simulates packet loss, and sends acknowledgments (ACK) to the client.**

**(3)The client records the sending time and the time ACK is received for each data packet, calculating RTT.**

**(4)In the case of packet loss, the client triggers a timeout mechanism and retransmits the packet.**

**(5)The client calculates the average RTT and actual packet loss rate, and outputs the results.**

#### **4. Conclusion and discussion**

**The client successfully sends data packets and prints received ACK and corresponding RTT on the console, as shown below.**

**In the case of packet loss, the client triggers a timeout retransmission mechanism and prints relevant information on the console.**

**The client calculates and outputs the average RTT and actual packet loss rate.**

**The server simulates packet loss, and the console outputs relevant information.**

**The experiment successfully implemented features such as sending, receiving, timeout retransmission, and simulated packet loss. In**

**practical applications, additional considerations such as security, error handling, and reliability may be necessary.**

指导教师批阅意见：

成绩评定：

指导教师签字：  
年 月 日

备注：