Assignment 1 1DV701 Spring 2020

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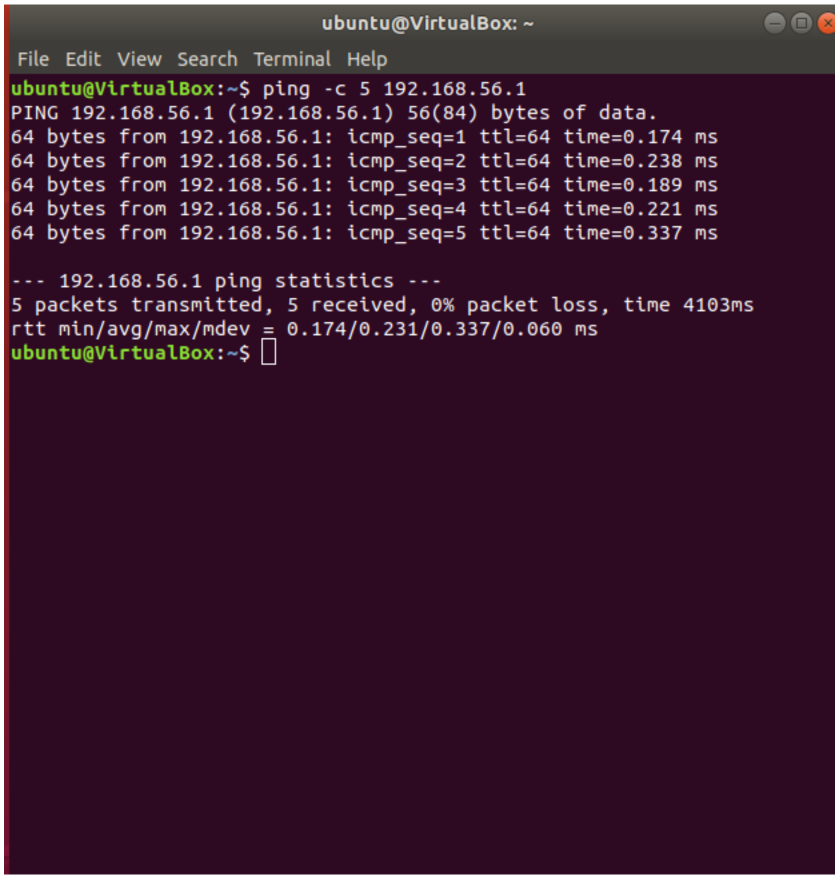
1 Problem 1



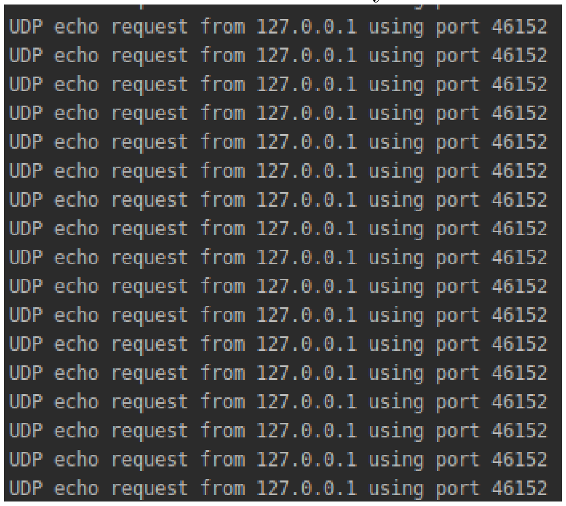
```
ubuntu@VirtualBox:~$ ping -c 5 192.168.56.1
PING 192.168.56.1 (192.168.56.1) 56(84) bytes of data.
64 bytes from 192.168.56.1: icmp_seq=1 ttl=64 time=0.174 ms
64 bytes from 192.168.56.1: icmp_seq=2 ttl=64 time=0.238 ms
64 bytes from 192.168.56.1: icmp_seq=3 ttl=64 time=0.189 ms
64 bytes from 192.168.56.1: icmp_seq=4 ttl=64 time=0.221 ms
64 bytes from 192.168.56.1: icmp_seq=5 ttl=64 time=0.337 ms

--- 192.168.56.1 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4103ms
rtt min/avg/max/mdev = 0.174/0.231/0.337/0.060 ms
ubuntu@VirtualBox:~$
```

I pinged my main machine from the virtual machine.

2 Problem 2

The UDP server and it's activity



```
UDP echo request from 127.0.0.1 using port 46152
UDP echo request from 127.0.0.1 using port 46152
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UDP echo request from 127.0.0.1 using port 46152
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UDP echo request from 127.0.0.1 using port 46152
```
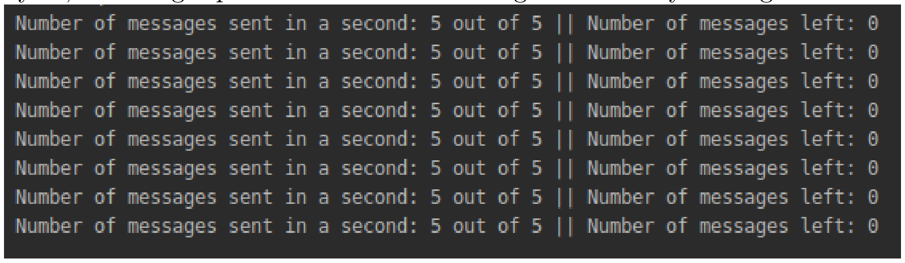

The UDP client and it's activity. The arguments here were a buffer of 1024 bytes, 5 messages per second and the messages were 10 bytes long



```
Number of messages sent in a second: 5 out of 5 || Number of messages left: 0
Number of messages sent in a second: 5 out of 5 || Number of messages left: 0
Number of messages sent in a second: 5 out of 5 || Number of messages left: 0
Number of messages sent in a second: 5 out of 5 || Number of messages left: 0
Number of messages sent in a second: 5 out of 5 || Number of messages left: 0
Number of messages sent in a second: 5 out of 5 || Number of messages left: 0
Number of messages sent in a second: 5 out of 5 || Number of messages left: 0
Number of messages sent in a second: 5 out of 5 || Number of messages left: 0
```

Exceptions covered:

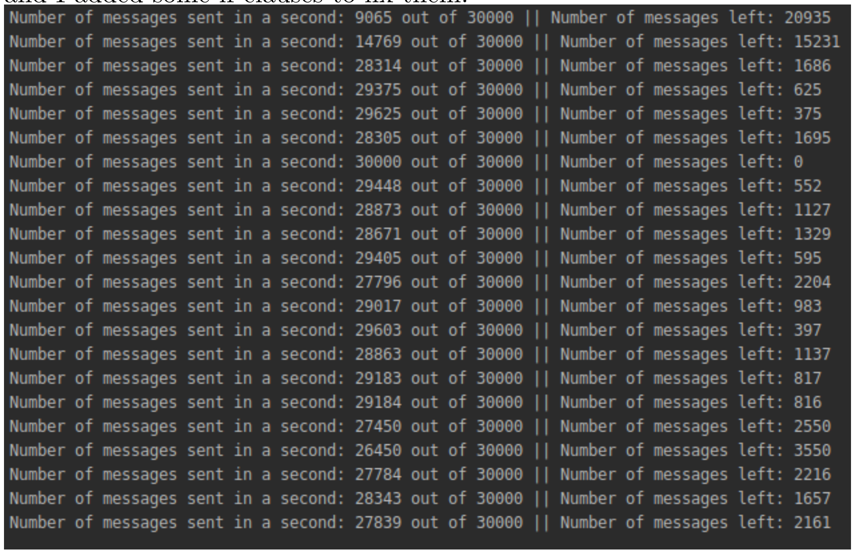
- Transmission rate must be positive.
- Port less than 65535 and greater than 0.
- The IP address that are allowed. Comments in the code.
- The buffer size allowed. Comments in the code.
- I allowed the messages to be sent if the are larger than the buffer but I print errors in the console
- I set the timeout to 2 seconds and print errors if the server is not served

I made this implementation this way because I also did VG task 1

2.1 VG task 1

The main logic is in UDPEchoClient.sendAndReceiveOneSec().

It turned out to be fairly complicated because I found some last minute bugs and I added some if clauses to fix them.



```
Number of messages sent in a second: 9065 out of 30000 || Number of messages left: 20935
Number of messages sent in a second: 14769 out of 30000 || Number of messages left: 15231
Number of messages sent in a second: 28314 out of 30000 || Number of messages left: 1686
Number of messages sent in a second: 29375 out of 30000 || Number of messages left: 625
Number of messages sent in a second: 29625 out of 30000 || Number of messages left: 375
Number of messages sent in a second: 28305 out of 30000 || Number of messages left: 1695
Number of messages sent in a second: 30000 out of 30000 || Number of messages left: 0
Number of messages sent in a second: 29448 out of 30000 || Number of messages left: 552
Number of messages sent in a second: 28873 out of 30000 || Number of messages left: 1127
Number of messages sent in a second: 28671 out of 30000 || Number of messages left: 1329
Number of messages sent in a second: 29405 out of 30000 || Number of messages left: 595
Number of messages sent in a second: 27796 out of 30000 || Number of messages left: 2204
Number of messages sent in a second: 29017 out of 30000 || Number of messages left: 983
Number of messages sent in a second: 29603 out of 30000 || Number of messages left: 397
Number of messages sent in a second: 28863 out of 30000 || Number of messages left: 1137
Number of messages sent in a second: 29183 out of 30000 || Number of messages left: 817
Number of messages sent in a second: 29184 out of 30000 || Number of messages left: 816
Number of messages sent in a second: 27450 out of 30000 || Number of messages left: 2550
Number of messages sent in a second: 26450 out of 30000 || Number of messages left: 3550
Number of messages sent in a second: 27784 out of 30000 || Number of messages left: 2216
Number of messages sent in a second: 28343 out of 30000 || Number of messages left: 1657
Number of messages sent in a second: 27839 out of 30000 || Number of messages left: 2161
```

The behaviour is the same like for every java program it speeds up due to the JVM optimizing the code. On my machine the limit is about 30000 messages depending on how many apps I have open. If I make room for the processing power it goes up. Resource dependant. This is a LAN network. It also stabilizes in the upper range.

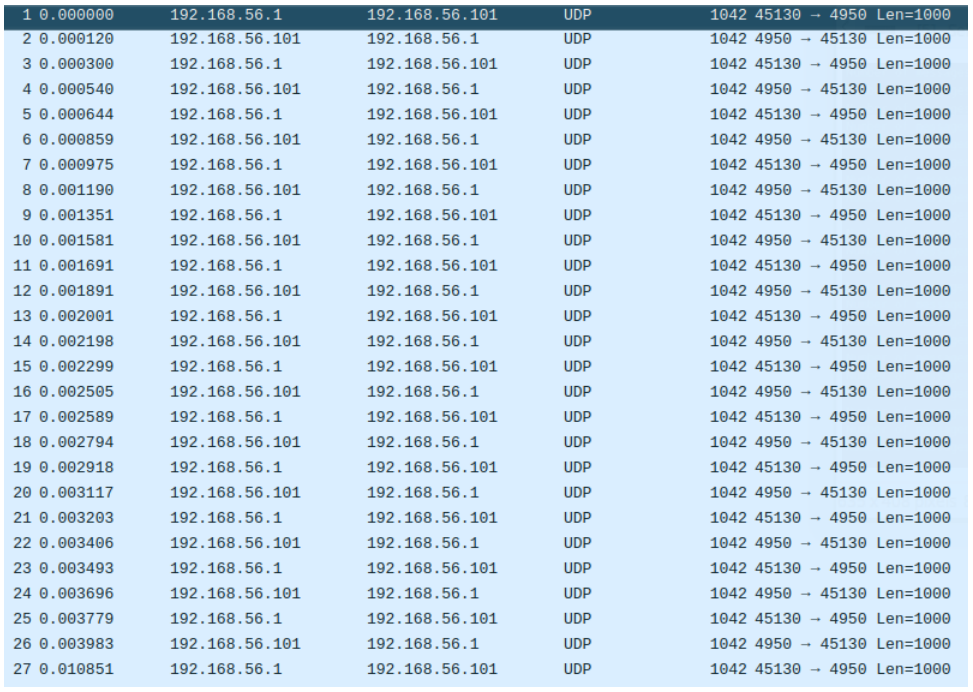
2.2 VG task 2

I created a NetworkLayer abstract class for this task. This class deals with argument validation and it holds the fields that classes have in common. I did so because it was the easiest for me. All the other classes extend the NetworkLayer. The Network layer has various constructors and private methods for validation. I specify in the comments which constructors are used by which classes. Also it looks better because in this way the servers and the clients can isolate their particular implementation. In the Network layer there is some code duplication that I kept for readability of the TA.

3 Task 3

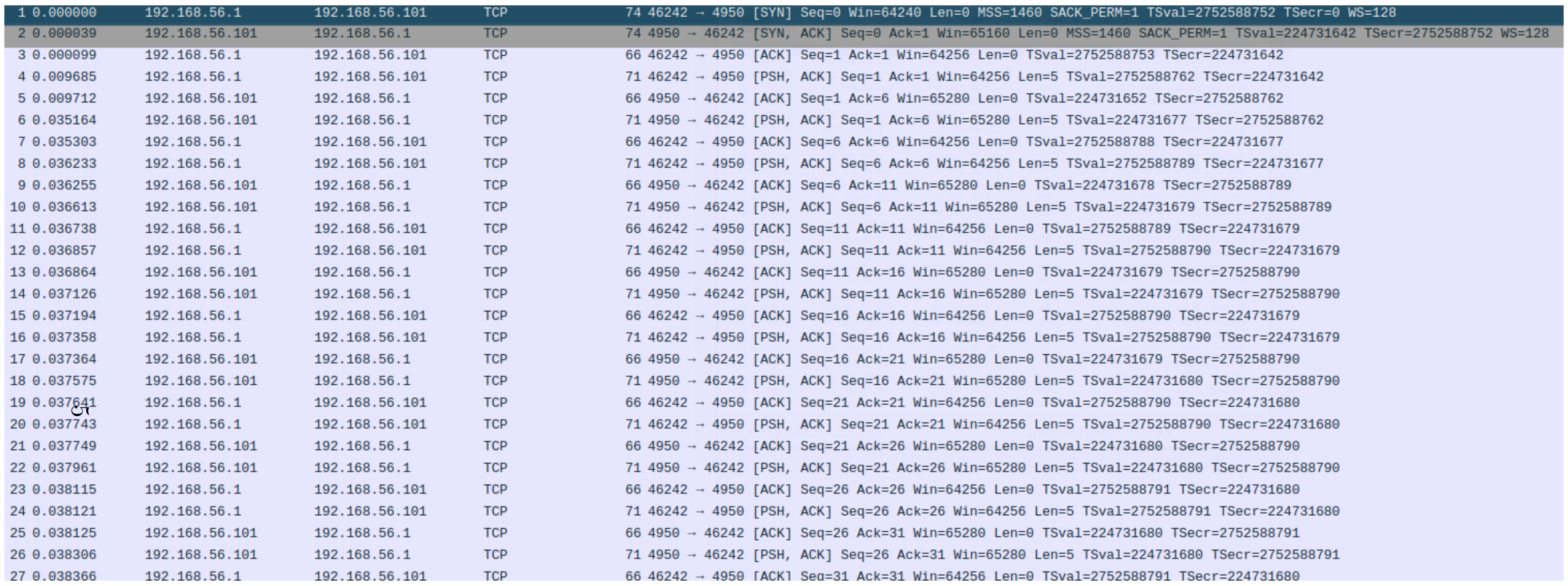
Here the TA told me I do not need to implement a transmission rate for Task 3 so I did not. I kept the implementation here for the TCP server and Client light. The argument validation is inherited from the Network layer.

4 Task 4



```
 1 0.000000    192.168.56.1     192.168.56.101    UDP    1042 45130 → 4950 Len=1000
 2 0.000120    192.168.56.101   192.168.56.1      UDP    1042 4950 → 45130 Len=1000
 3 0.000300    192.168.56.1     192.168.56.101    UDP    1042 45130 → 4950 Len=1000
 4 0.000540    192.168.56.101   192.168.56.1      UDP    1042 4950 → 45130 Len=1000
 5 0.000644    192.168.56.1     192.168.56.101    UDP    1042 45130 → 4950 Len=1000
 6 0.000859    192.168.56.101   192.168.56.1      UDP    1042 4950 → 45130 Len=1000
 7 0.000975    192.168.56.1     192.168.56.101    UDP    1042 45130 → 4950 Len=1000
 8 0.001190    192.168.56.101   192.168.56.1      UDP    1042 4950 → 45130 Len=1000
 9 0.001351    192.168.56.1     192.168.56.101    UDP    1042 45130 → 4950 Len=1000
10 0.001581    192.168.56.101   192.168.56.1      UDP    1042 4950 → 45130 Len=1000
11 0.001691    192.168.56.1     192.168.56.101    UDP    1042 45130 → 4950 Len=1000
12 0.001891    192.168.56.101   192.168.56.1      UDP    1042 4950 → 45130 Len=1000
13 0.002001    192.168.56.1     192.168.56.101    UDP    1042 45130 → 4950 Len=1000
14 0.002198    192.168.56.101   192.168.56.1      UDP    1042 4950 → 45130 Len=1000
15 0.002299    192.168.56.1     192.168.56.101    UDP    1042 45130 → 4950 Len=1000
16 0.002505    192.168.56.101   192.168.56.1      UDP    1042 4950 → 45130 Len=1000
17 0.002589    192.168.56.1     192.168.56.101    UDP    1042 45130 → 4950 Len=1000
18 0.002794    192.168.56.101   192.168.56.1      UDP    1042 4950 → 45130 Len=1000
19 0.002918    192.168.56.1     192.168.56.101    UDP    1042 45130 → 4950 Len=1000
20 0.003117    192.168.56.101   192.168.56.1      UDP    1042 4950 → 45130 Len=1000
21 0.003203    192.168.56.1     192.168.56.101    UDP    1042 45130 → 4950 Len=1000
22 0.003406    192.168.56.101   192.168.56.1      UDP    1042 4950 → 45130 Len=1000
23 0.003493    192.168.56.1     192.168.56.101    UDP    1042 45130 → 4950 Len=1000
24 0.003696    192.168.56.101   192.168.56.1      UDP    1042 4950 → 45130 Len=1000
25 0.003779    192.168.56.1     192.168.56.101    UDP    1042 45130 → 4950 Len=1000
26 0.003983    192.168.56.101   192.168.56.1      UDP    1042 4950 → 45130 Len=1000
27 0.010851    192.168.56.1     192.168.56.101    UDP    1042 45130 → 4950 Len=1000
```

Here you can see clearly that UDP is much simpler compared to TCP. No flags no startup packages. The datagrams here are 1042 because I mis-typed the buffer size in the arguments. The message length was 1000.

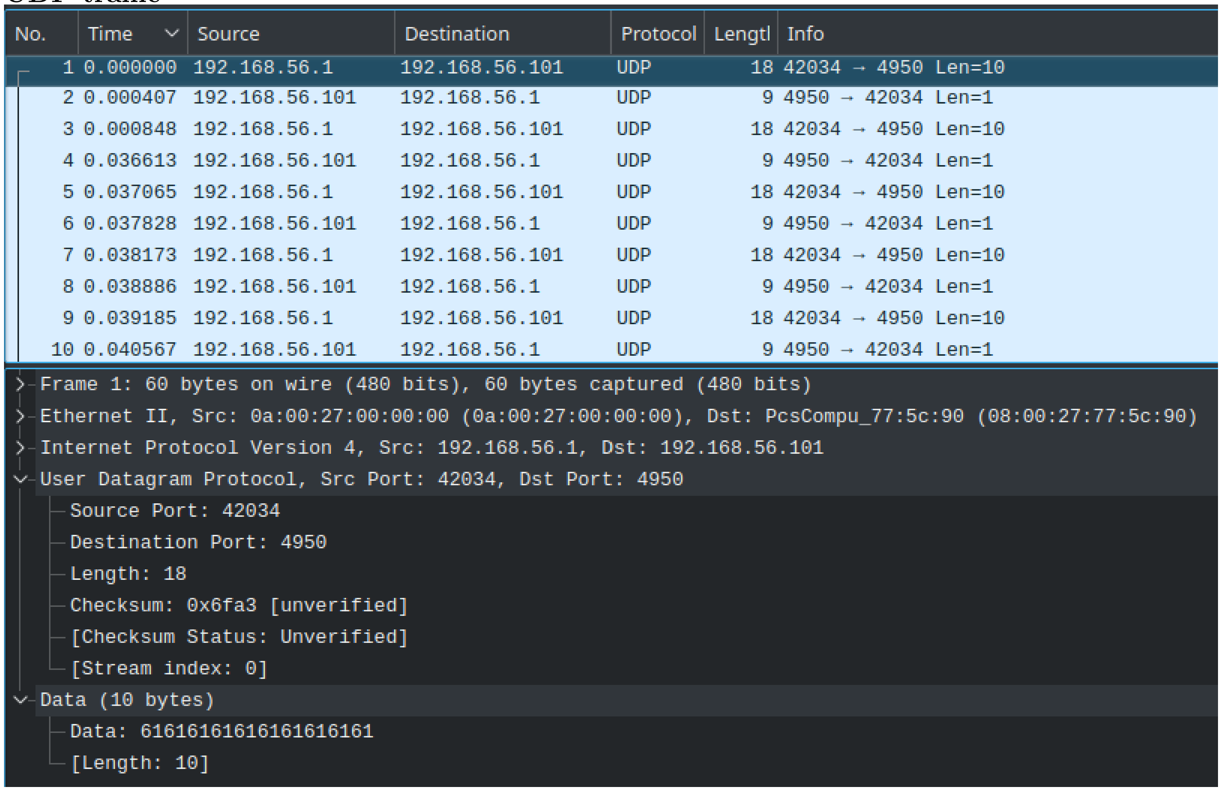


```
 1 0.000000   192.168.56.1     192.168.56.101   TCP        74 46242 → 4950 [SYN] Seq=0 Win=64240 Len=0 MSS=1460 SACK_PERM=1 TSval=2752588752 TSecr=0 WS=128
 2 0.000039   192.168.56.101   192.168.56.1     TCP        74 4950 → 46242 [SYN, ACK] Seq=0 Ack=1 Win=65160 Len=0 MSS=1460 SACK_PERM=1 TSval=224731642 TSecr=2752588752 WS=128
 3 0.000099   192.168.56.1     192.168.56.101   TCP        66 46242 → 4950 [ACK] Seq=1 Ack=1 Win=64256 Len=0 TSval=2752588753 TSecr=224731642
 4 0.009685   192.168.56.1     192.168.56.101   TCP        71 46242 → 4950 [PSH, ACK] Seq=1 Ack=1 Win=64256 Len=5 TSval=2752588762 TSecr=224731642
 5 0.009712   192.168.56.101   192.168.56.1     TCP        66 4950 → 46242 [ACK] Seq=1 Ack=6 Win=65280 Len=0 TSval=224731652 TSecr=2752588762
 6 0.035164   192.168.56.101   192.168.56.1     TCP        71 4950 → 46242 [PSH, ACK] Seq=1 Ack=6 Win=65280 Len=5 TSval=224731677 TSecr=2752588762
 7 0.035303   192.168.56.1     192.168.56.101   TCP        66 46242 → 4950 [ACK] Seq=6 Ack=6 Win=64256 Len=0 TSval=2752588788 TSecr=224731677
 8 0.036233   192.168.56.1     192.168.56.101   TCP        71 46242 → 4950 [PSH, ACK] Seq=6 Ack=6 Win=64256 Len=5 TSval=2752588789 TSecr=224731677
 9 0.036255   192.168.56.101   192.168.56.1     TCP        66 4950 → 46242 [ACK] Seq=6 Ack=11 Win=65280 Len=0 TSval=224731678 TSecr=2752588789
10 0.036613   192.168.56.101   192.168.56.1     TCP        71 4950 → 46242 [PSH, ACK] Seq=6 Ack=11 Win=65280 Len=5 TSval=224731679 TSecr=2752588789
11 0.036738   192.168.56.1     192.168.56.101   TCP        66 46242 → 4950 [ACK] Seq=11 Ack=11 Win=64256 Len=0 TSval=2752588789 TSecr=224731679
12 0.036857   192.168.56.1     192.168.56.101   TCP        71 46242 → 4950 [PSH, ACK] Seq=11 Ack=11 Win=64256 Len=5 TSval=2752588790 TSecr=224731679
13 0.036864   192.168.56.101   192.168.56.1     TCP        66 4950 → 46242 [ACK] Seq=11 Ack=16 Win=65280 Len=0 TSval=224731679 TSecr=2752588790
14 0.037126   192.168.56.101   192.168.56.1     TCP        71 4950 → 46242 [PSH, ACK] Seq=11 Ack=16 Win=65280 Len=5 TSval=224731679 TSecr=2752588790
15 0.037194   192.168.56.1     192.168.56.101   TCP        66 46242 → 4950 [ACK] Seq=16 Ack=16 Win=64256 Len=0 TSval=2752588790 TSecr=224731679
16 0.037358   192.168.56.1     192.168.56.101   TCP        71 46242 → 4950 [PSH, ACK] Seq=16 Ack=16 Win=64256 Len=5 TSval=2752588790 TSecr=224731679
17 0.037364   192.168.56.101   192.168.56.1     TCP        66 4950 → 46242 [ACK] Seq=16 Ack=21 Win=65280 Len=0 TSval=224731679 TSecr=2752588790
18 0.037575   192.168.56.101   192.168.56.1     TCP        71 4950 → 46242 [PSH, ACK] Seq=16 Ack=21 Win=65280 Len=5 TSval=224731680 TSecr=2752588790
19 0.037641   192.168.56.1     192.168.56.101   TCP        66 46242 → 4950 [ACK] Seq=21 Ack=21 Win=64256 Len=0 TSval=2752588790 TSecr=224731680
20 0.037743   192.168.56.1     192.168.56.101   TCP        71 46242 → 4950 [PSH, ACK] Seq=21 Ack=21 Win=64256 Len=5 TSval=2752588790 TSecr=224731680
21 0.037749   192.168.56.101   192.168.56.1     TCP        66 4950 → 46242 [ACK] Seq=21 Ack=26 Win=65280 Len=0 TSval=224731680 TSecr=2752588790
22 0.037961   192.168.56.101   192.168.56.1     TCP        71 4950 → 46242 [PSH, ACK] Seq=21 Ack=26 Win=65280 Len=5 TSval=224731680 TSecr=2752588790
23 0.038115   192.168.56.1     192.168.56.101   TCP        66 46242 → 4950 [ACK] Seq=26 Ack=26 Win=64256 Len=0 TSval=2752588791 TSecr=224731680
24 0.038121   192.168.56.1     192.168.56.101   TCP        71 46242 → 4950 [PSH, ACK] Seq=26 Ack=26 Win=64256 Len=5 TSval=2752588791 TSecr=224731680
25 0.038125   192.168.56.101   192.168.56.1     TCP        66 4950 → 46242 [ACK] Seq=26 Ack=31 Win=65280 Len=0 TSval=224731680 TSecr=2752588791
26 0.038306   192.168.56.101   192.168.56.1     TCP        71 4950 → 46242 [PSH, ACK] Seq=26 Ack=31 Win=65280 Len=5 TSval=224731680 TSecr=2752588791
27 0.038366   192.168.56.1     192.168.56.101   TCP        66 46242 → 4950 [ACK] Seq=31 Ack=31 Win=64256 Len=0 TSval=2752588791 TSecr=224731680
```

TCP is much more complicated. The diffrence is connection oriented vs connectionless. Stream based vs datagram based. PSH is a Push flag, ACK is aknowledge the transmission of a packet. SYN is a TCP packet sent to another computer requesting that a connection be established between them. If the SYN is received by the second machine, an SYN/ACK is sent back to the address requested by the SYN.

5 Task 5

UDP traffic



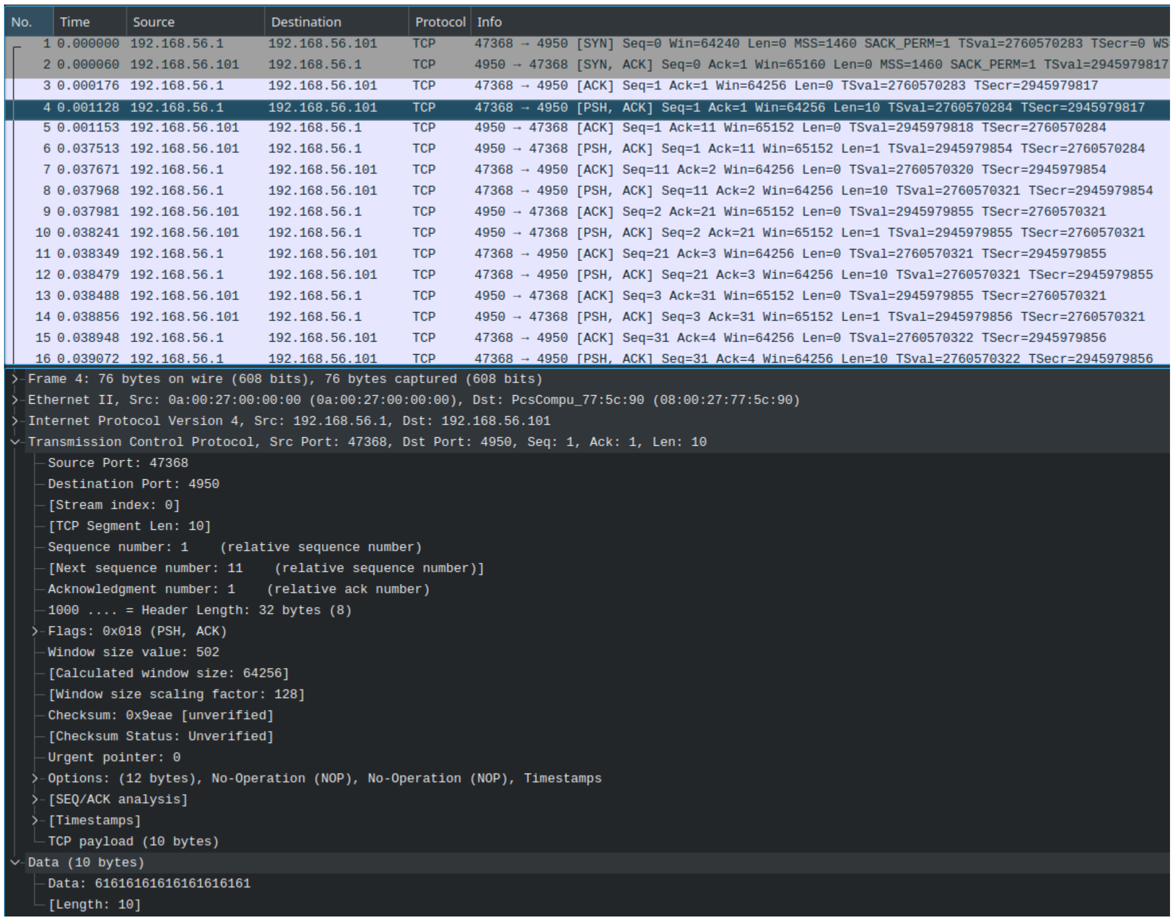
```
No.  Time      Source          Destination     Protocol Lengtl Info
   1 0.000000  192.168.56.1    192.168.56.101  UDP         18 42034 → 4950 Len=10
   2 0.000407  192.168.56.101  192.168.56.1    UDP          9 4950 → 42034 Len=1
   3 0.000848  192.168.56.1    192.168.56.101  UDP         18 42034 → 4950 Len=10
   4 0.036613  192.168.56.101  192.168.56.1    UDP          9 4950 → 42034 Len=1
   5 0.037065  192.168.56.1    192.168.56.101  UDP         18 42034 → 4950 Len=10
   6 0.037828  192.168.56.101  192.168.56.1    UDP          9 4950 → 42034 Len=1
   7 0.038173  192.168.56.1    192.168.56.101  UDP         18 42034 → 4950 Len=10
   8 0.038886  192.168.56.101  192.168.56.1    UDP          9 4950 → 42034 Len=1
   9 0.039185  192.168.56.1    192.168.56.101  UDP         18 42034 → 4950 Len=10
  10 0.040567  192.168.56.101  192.168.56.1    UDP          9 4950 → 42034 Len=1

> Frame 1: 60 bytes on wire (480 bits), 60 bytes captured (480 bits)
> Ethernet II, Src: 0a:00:27:00:00:00 (0a:00:27:00:00:00), Dst: PcsCompu_77:5c:90 (08:00:27:77:5c:90)
> Internet Protocol Version 4, Src: 192.168.56.1, Dst: 192.168.56.101
v User Datagram Protocol, Src Port: 42034, Dst Port: 4950
    Source Port: 42034
    Destination Port: 4950
    Length: 18
    Checksum: 0x6fa3 [unverified]
    [Checksum Status: Unverified]
    [Stream index: 0]
v Data (10 bytes)
    Data: 61616161616161616161
    [Length: 10]
```

1. Client - 192.168.56.1
2. Server - 192.168.56.101

Packet number 1 is the packet that is sent by the client to the server. It's total length is 18 bytes. 8 bytes for the UDP header and 10 bytes for the payload. The payload is represented in HEX, in ASCII it is a string of 10 'a' chars. You can see that the port of the server is 4950 and the port of the client is 42034, an automatically generated one. For this task I used a buffer for the server of 1 byte. The server receives the message, discards the rest of the bytes, and sends the first byte back. This can be seen in packet number 2.

TCP traffic

1. Client - 192.168.56.1
2. Server - 192.168.56.101



```
No. Time     Source          Destination     Protocol Info
  1 0.000000 192.168.56.1    192.168.56.101  TCP     47368 → 4950 [SYN] Seq=0 Win=64240 Len=0 MSS=1460 SACK_PERM=1 TSval=2760570283 TSecr=0 WS
  2 0.000060 192.168.56.101  192.168.56.1    TCP     4950 → 47368 [SYN, ACK] Seq=0 Ack=1 Win=65160 Len=0 MSS=1460 SACK_PERM=1 TSval=2945979817
  3 0.000176 192.168.56.1    192.168.56.101  TCP     47368 → 4950 [ACK] Seq=1 Ack=1 Win=64256 Len=0 TSval=2760570283 TSecr=2945979817
  4 0.001128 192.168.56.1    192.168.56.101  TCP     47368 → 4950 [PSH, ACK] Seq=1 Ack=1 Win=64256 Len=10 TSval=2760570284 TSecr=2945979817
  5 0.001153 192.168.56.101  192.168.56.1    TCP     4950 → 47368 [ACK] Seq=1 Ack=11 Win=65152 Len=0 TSval=2945979818 TSecr=2760570284
  6 0.037513 192.168.56.101  192.168.56.1    TCP     4950 → 47368 [PSH, ACK] Seq=1 Ack=11 Win=65152 Len=1 TSval=2945979854 TSecr=2760570284
  7 0.037671 192.168.56.1    192.168.56.101  TCP     47368 → 4950 [ACK] Seq=11 Ack=2 Win=64256 Len=0 TSval=2760570320 TSecr=2945979854
  8 0.037968 192.168.56.1    192.168.56.101  TCP     47368 → 4950 [PSH, ACK] Seq=11 Ack=2 Win=64256 Len=10 TSval=2760570321 TSecr=2945979854
  9 0.037981 192.168.56.101  192.168.56.1    TCP     4950 → 47368 [ACK] Seq=2 Ack=21 Win=65152 Len=0 TSval=2945979855 TSecr=2760570321
 10 0.038241 192.168.56.101  192.168.56.1    TCP     4950 → 47368 [PSH, ACK] Seq=2 Ack=21 Win=65152 Len=1 TSval=2945979855 TSecr=2760570321
 11 0.038349 192.168.56.1    192.168.56.101  TCP     47368 → 4950 [ACK] Seq=21 Ack=3 Win=64256 Len=0 TSval=2760570321 TSecr=2945979855
 12 0.038479 192.168.56.1    192.168.56.101  TCP     47368 → 4950 [PSH, ACK] Seq=21 Ack=3 Win=64256 Len=10 TSval=2760570321 TSecr=2945979855
 13 0.038488 192.168.56.101  192.168.56.1    TCP     4950 → 47368 [ACK] Seq=3 Ack=31 Win=65152 Len=0 TSval=2945979855 TSecr=2760570321
 14 0.038856 192.168.56.101  192.168.56.1    TCP     4950 → 47368 [PSH, ACK] Seq=3 Ack=31 Win=65152 Len=1 TSval=2945979856 TSecr=2760570321
 15 0.038948 192.168.56.1    192.168.56.101  TCP     47368 → 4950 [ACK] Seq=31 Ack=4 Win=64256 Len=0 TSval=2760570322 TSecr=2945979856
 16 0.039072 192.168.56.1    192.168.56.101  TCP     47368 → 4950 [PSH, ACK] Seq=31 Ack=4 Win=64256 Len=10 TSval=2760570322 TSecr=2945979856
```

```
> Frame 4: 76 bytes on wire (608 bits), 76 bytes captured (608 bits)
> Ethernet II, Src: 0a:00:27:00:00:00 (0a:00:27:00:00:00), Dst: PcsCompu_77:5c:90 (08:00:27:77:5c:90)
> Internet Protocol Version 4, Src: 192.168.56.1, Dst: 192.168.56.101
v Transmission Control Protocol, Src Port: 47368, Dst Port: 4950, Seq: 1, Ack: 1, Len: 10
    Source Port: 47368
    Destination Port: 4950
    [Stream index: 0]
    [TCP Segment Len: 10]
    Sequence number: 1    (relative sequence number)
    [Next sequence number: 11    (relative sequence number)]
    Acknowledgment number: 1    (relative ack number)
    1000 .... = Header Length: 32 bytes (8)
  > Flags: 0x018 (PSH, ACK)
    Window size value: 502
    [Calculated window size: 64256]
    [Window size scaling factor: 128]
    Checksum: 0x9eae [unverified]
    [Checksum Status: Unverified]
    Urgent pointer: 0
  > Options: (12 bytes), No-Operation (NOP), No-Operation (NOP), Timestamps
  > [SEQ/ACK analysis]
  > [Timestamps]
    TCP payload (10 bytes)
v Data (10 bytes)
    Data: 61616161616161616161
    [Length: 10]
```

This is much more complicated. The first 3 packets represent the 3 way handshake. In the packet number 4, the client sends a message with a length of 10 bytes. Here you can see that the PSH flag is enabled. In the packet number 5, the server replies with a message with an ACK. In the packet number 6 the server sends the client a message with a length of 1 bytes. This is for the same reason as before, the buffer is 1, the server discards every byte that does not fit in the browser. In the picture there is no FIN flag but the FIN flag indicates the end of data transmission to finish a TCP connection.

5.1 Difference between UDP and TCP

The difference between TCP and UDP is, connection oriented vs connectionless. TCP is slower, UDP is faster. TCP guarantees the order of the packets, UDP does not. TCP is reliable, UDP is not. TCP has a bigger header size, UDP smaller. TCP checks for errors, UDP does not.