



Assignment 1

Computer Networks - an introduction



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1 Introduction

All virtual machines are running in Docker containers, Docker's internal network is 172.17.0.0. Base host is addressed with 172.17.0.1. The container used is the official Java, and the specific version is OpenJDK / OpenJRE 8.

2 Assignment 1.1

This assignment is based on setting up a virtual environment and sending icmp (ping) packets.

Two Docker containers are set up, 172.17.0.2 and 172.17.0.3. 172.17.0.2 sends 5 icmp requests to 172.17.0.3 and gets 5 icmp replies back from target.

```
root@3d8f06993b5b:/# ip a
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
        valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host
        valid_lft forever preferred_lft forever
15: eth0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc noqueue state UP group default
    link/ether 02:42:ac:11:00:03 brd ff:ff:ff:ff:ff:ff
    inet 172.17.0.3/16 scope global eth0
        valid_lft forever preferred_lft forever
    inet6 fe80::42:acff:fe11:3/64 scope link
        valid_lft forever preferred_lft forever
root@3d8f06993b5b:/#

root@3f62830d209e:/# ip a
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
        valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host
        valid_lft forever preferred_lft forever
13: eth0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc noqueue state UP group default
    link/ether 02:42:ac:11:00:02 brd ff:ff:ff:ff:ff:ff
    inet 172.17.0.2/16 scope global eth0
        valid_lft forever preferred_lft forever
    inet6 fe80::42:acff:fe11:2/64 scope link
        valid_lft forever preferred_lft forever
root@3f62830d209e:/# ping -c 5 172.17.0.3
PING 172.17.0.3 (172.17.0.3): 56 data bytes
64 bytes from 172.17.0.3: icmp_seq=0 ttl=64 time=0.167 ms
64 bytes from 172.17.0.3: icmp_seq=1 ttl=64 time=0.127 ms
64 bytes from 172.17.0.3: icmp_seq=2 ttl=64 time=0.125 ms
64 bytes from 172.17.0.3: icmp_seq=3 ttl=64 time=0.119 ms
64 bytes from 172.17.0.3: icmp_seq=4 ttl=64 time=0.129 ms
--- 172.17.0.3 ping statistics ---
5 packets transmitted, 5 packets received, 0% packet loss
round-trip min/avg/max/stddev = 0.119/0.133/0.167/0.000 ms
root@3f62830d209e:/#
```

Figure 1: ping -c 5

3 Assignment 1.2

To handle commandline arguments I used Apache Commons CLI lib. This provides some good features for handling cli inputs. I had to write some exception handling when types didn't match. All of this is done in the abstract class Host and is then applied to all of the hosts by inheritance, see 3.2.2.

```

nls@deb-ctrl:~/Git/Computer-Networks-1DV701/UDP-server-client/target$ java -jar networking-1.0-SNAPSHOT.one-jar.jar
usage: Network Application
  -b,--buffer-size <arg>      buffer size. default: 1024
  -h,--help                    show help.
  -i,--ip-address <arg>       ip address. default: 127.0.0.1
  -m,--mode <arg>             { udpserver | udpclient | tcpserver |
                               tcpclient }
  -p,--port <arg>             port number. default: 4950
  -s,--seconds <arg>          how long to run on client. default: 1
  -t,--message-transfer-rate <arg> message time rate ( mtr ). default: 1
  -x,--text <arg>             message text, default: herro
nls@deb-ctrl:~/Git/Computer-Networks-1DV701/UDP-server-client/target$ java -jar networking-1.0-SNAPSHOT.one-jar.jar -m udpclient -i 172.17.0.2 -t 5
UDPClient - DEBUG - initialized: se.jherrlin.udp.UDPClient: { mode: udpclient, port: 4950, bufsize: 1024, mtr: 5, seconds: 1, ip: 172.17.0.2 }
16 bytes sent and received
16 bytes sent and received
16 bytes sent and received
16 bytes sent and received
16 bytes sent and received
nls@deb-ctrl:~/Git/Computer-Networks-1DV701/UDP-server-client/target$

.....

root@36729005f0e4:/code# java -jar networking-1.0-SNAPSHOT.one-jar.jar -m udpserver
UDPServer - DEBUG - initialized: se.jherrlin.udp.UDPServer: { mode: udpserver, port: 4950, bufsize: 1024, mtr: 1, seconds: 1, ip: 0.0.0.0 }
UDP echo request from 172.17.0.1 using port 4950
UDP echo request from 172.17.0.1 using port 4950
UDP echo request from 172.17.0.1 using port 4950
UDP echo request from 172.17.0.1 using port 4950
UDP echo request from 172.17.0.1 using port 4950

```

Figure 2: Send 5 UDP package in 1 sec

3.1 Exceptions

This is the exceptions that are handled in the commandline input workflow.

NumberFormatException

When we want a number but gets something else

NullPointerException

When flag is given but no argument

UnrecognizedOptionException

When option is not known

MissingArgumentException

When flag is given but no argument

IP address

Make sure the IP address is valid

Port number

Make sure the port number is in the range

Message Transfer Rate

Not negative

Seconds

Not below 0

3.2 VG-tasks

Clairification on vg-tasks.

3.2.1 Task 1

Not implemented

3.2.2 Task 2

In the implementation there is a abstract class called Host. All of the hosts (UDPServer, UDPClient, TCPServer, TCPClient) extends Host. Host gives functionality to validate that all input parameters are correct. It also provides a run method. All hosts override the run method to implement the specific logic for the specific host.

4 Assignment 1.3

In 4 there is a screenshot of 4 clients creating TCP connections to the server.

```
/172.17.0.6 says ccc with a length of: 3
/172.17.0.4 says aaaaaaa with a length of: 7
/172.17.0.5 says bbbbbb with a length of: 5
/172.17.0.7 says ddddddddddddddddddd with a length of: 21
/172.17.0.6 says ccc with a length of: 3
/172.17.0.4 says aaaaaaa with a length of: 7
/172.17.0.5 says bbbbbb with a length of: 5
/172.17.0.7 says ddddddddddddddddddd with a length of: 21
/172.17.0.6 says ccc with a length of: 3
/172.17.0.4 says aaaaaaa with a length of: 7
/172.17.0.5 says bbbbbb with a length of: 5
/172.17.0.7 says ddddddddddddddddddd with a length of: 21
/172.17.0.6 says ccc with a length of: 3
/172.17.0.5 says bbbbbb with a length of: 5
/172.17.0.7 says ddddddddddddddddddd with a length of: 21
/172.17.0.6 says ccc with a length of: 3
/172.17.0.7 says ddddddddddddddddddd with a length of: 21
/172.17.0.6 says ccc with a length of: 3
/172.17.0.7 says ddddddddddddddddddd with a length of: 21
[ ]

Server says: aaaaaaa with a lenght of: 7
Server says: aaaaaaa with a lenght of: 7
Server says: aaaaaaa with a lenght of: 7
Server says: aaaaaaa with a lenght of: 7
Server says: aaaaaaa with a lenght of: 7
Server says: aaaaaaa with a lenght of: 7
Server says: aaaaaaa with a lenght of: 7
root@485d379036dd:/# [ ]

Server says: bbbbbb with a lenght of: 5
Server says: bbbbbb with a lenght of: 5
Server says: bbbbbb with a lenght of: 5
Server says: bbbbbb with a lenght of: 5
Server says: bbbbbb with a lenght of: 5
root@8f05ed614f0c:/# [ ]

Server says: ccc with a lenght of: 3
Server says: ccc with a lenght of: 3
Server says: ccc with a lenght of: 3
Server says: ccc with a lenght of: 3
Server says: ccc with a lenght of: 3
root@e0a97fe2d778:/# [ ]

Server says: ddddddddddddddddddd with a lenght of: 21
Server says: ddddddddddddddddddd with a lenght of: 21
Server says: ddddddddddddddddddd with a lenght of: 21
root@0af0ce6e0c64:/# [ ]
```

Figure 3: TCP server with threads, multi client connection

4.1 TCP server with small bufsize

In 4.1 there is a screenshot of an TCP server with a buffer size of 5. The client is sending a message with a size of 10. The server is handling this in a good way and assembles the stream. Returning a message that is the size of 10.

```
root@bfe19bf361e9:/# java -jar code/networking-1.0-SNAPSHOT-one.jar -m tcpserver -b 5
TCPserver - DEBUG - initialized: se.jherrlin.tcp.TCPserver: { mode: tcpserver, port: 4950, bufsize: 5, mtr: 1, seconds: 1, ip: 0.0.0.0 }
/172.17.0.4 says aaaaaaaaaa with a length of: 10
/172.17.0.4 says aaaaaaaaaa with a length of: 10
root@485d379036dd:/# java -jar code/networking-1.0-SNAPSHOT-one.jar -m tcpclient -i 172.17.0.3 -b 5 -x aaaaaaaaaa
TCPclient - DEBUG - initialized: se.jherrlin.tcp.TCPclient: { mode: tcpclient, port: 4950, bufsize: 5, mtr: 1, seconds: 1, ip: 172.17.0.3 }
Server says: aaaaaaaaaa with a lenght of: 10
root@485d379036dd:/#
```

Figure 4: TCP where bufsize is smaller than message length

4.2 UDP server with small bufsize

In 4.2 there is a screenshot of an UDP server with a buffer size of 5. The client is sendning a message with a size of 10. The UDP is not handeling this good, it cuts the message and sends back half the message to the client.

```
root@bfe19bf361e9:/# java -jar code/networking-1.0-SNAPSHOT-one.jar -m udpserver -b 5
UDPserver - DEBUG - initialized: se.jherrlin.udp.UDPserver: { mode: udpserver, port: 4950, bufsize: 5, mtr: 1, seconds: 1, ip: 0.0.0.0 }
UDP echo request from 172.17.0.4 using port 4950
root@485d379036dd:/# java -jar code/networking-1.0-SNAPSHOT-one.jar -m udpclient -i 172.17.0.3 -b 5 -x aaaaaaaaaa
UDPclient - DEBUG - initialized: se.jherrlin.udp.UDPclient: { mode: udpclient, port: 4950, bufsize: 5, mtr: 1, seconds: 1, ip: 172.17.0.3 }
Sent and received msg not equal!
root@485d379036dd:/#
```

Figure 5: UDP where bufsize is smaller than message length

4.3 Conclusion

The reason that TCP server is handling this in a good way it that is uses a stream. It can be refered to open a file and read or write a steam. In UDP we just get a package and nothing more, if we dont take care of the package UDP wont help us doing it.

5 Assignment 1.4, Wireshark

5.1 UDP

UDP client / server in Wireshark

5.1.1 To small buffersize

In 5.1.1 we see that the length is bigger on the way to the server than on the way back to the client

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000000	172.17.0.4	172.17.0.1	UDP	58	Source port: 4950 Destination port: 4950
2	0.000196000	172.17.0.1	172.17.0.4	UDP	47	Source port: 4950 Destination port: 4950

Figure 6: UDP server with small buffer size

5.1.2 Enough buffersize

In 5.1.2 we see that the length is the same on both ways

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000000	172.17.0.4	172.17.0.1	UDP	58	Source port: 4950 Destination port: 4950
2	0.000086000	172.17.0.1	172.17.0.4	UDP	58	Source port: 4950 Destination port: 4950

Figure 7: UDP server with enough buffer size

5.2 TCP

TCP client / server in Wireshark

5.2.1 To small buffersize

In 5.2.1 we see that there is alot of packages going back forth. TCP have the Three way handshake or Syn-Ack when esatblishing and finishing a connection stream. For every package that is send, the reciever returns an Ack to the sender that tells the sender that the reciever have got the package and the data inside is correct. If we compair the number of packages in 5.2.1 and 5.2.2 we see that 5.2.2 have less packages. The reason for this is that the buffer size is big enough to handle the data in fewer packets.

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000000	172.17.0.4	172.17.0.1	TCP	74	38336-4950 [SYN, Seq=0 Win=29200 Len=0 MSS=1460 SACK_PERM=1 TSval=13933987 TSecr=0 WS
2	0.000047000	172.17.0.1	172.17.0.4	TCP	74	4950-38336 [SYN, ACK] Seq=0 Ack=1 Win=28960 Len=0 MSS=1460 SACK_PERM=1 TSval=13933987
3	0.000064000	172.17.0.4	172.17.0.1	TCP	66	38336-4950 [ACK] Seq=1 Ack=1 Win=29312 Len=0 TSval=13933987 TSecr=13933987
4	0.001060000	172.17.0.4	172.17.0.1	TCP	67	38336-4950 [PSH, ACK] Seq=1 Ack=1 Win=29312 Len=1 TSval=13933988 TSecr=13933987
5	0.001090000	172.17.0.1	172.17.0.4	TCP	66	4950-38336 [ACK] Seq=1 Ack=2 Win=29056 Len=0 TSval=13933988 TSecr=13933988
6	0.001136000	172.17.0.4	172.17.0.1	TCP	67	38336-4950 [PSH, ACK] Seq=2 Ack=1 Win=29312 Len=1 TSval=13933988 TSecr=13933988
7	0.001144000	172.17.0.1	172.17.0.4	TCP	66	4950-38336 [ACK] Seq=1 Ack=3 Win=29056 Len=0 TSval=13933988 TSecr=13933988
8	0.001164000	172.17.0.4	172.17.0.1	TCP	67	38336-4950 [PSH, ACK] Seq=3 Ack=1 Win=29312 Len=1 TSval=13933988 TSecr=13933988
9	0.001170000	172.17.0.1	172.17.0.4	TCP	66	4950-38336 [ACK] Seq=1 Ack=4 Win=29056 Len=0 TSval=13933988 TSecr=13933988
10	0.001178000	172.17.0.4	172.17.0.1	TCP	67	38336-4950 [PSH, ACK] Seq=4 Ack=1 Win=29312 Len=1 TSval=13933988 TSecr=13933988
11	0.001182000	172.17.0.1	172.17.0.4	TCP	66	4950-38336 [ACK] Seq=1 Ack=5 Win=29056 Len=0 TSval=13933988 TSecr=13933988
12	0.001190000	172.17.0.4	172.17.0.1	TCP	67	38336-4950 [PSH, ACK] Seq=5 Ack=1 Win=29312 Len=1 TSval=13933988 TSecr=13933988
13	0.001194000	172.17.0.1	172.17.0.4	TCP	66	4950-38336 [ACK] Seq=1 Ack=6 Win=29056 Len=0 TSval=13933988 TSecr=13933988
14	0.001201000	172.17.0.4	172.17.0.1	TCP	67	38336-4950 [PSH, ACK] Seq=6 Ack=1 Win=29312 Len=1 TSval=13933988 TSecr=13933988
15	0.001205000	172.17.0.1	172.17.0.4	TCP	66	4950-38336 [ACK] Seq=1 Ack=7 Win=29056 Len=0 TSval=13933988 TSecr=13933988
16	0.001213000	172.17.0.4	172.17.0.1	TCP	67	38336-4950 [PSH, ACK] Seq=7 Ack=1 Win=29312 Len=1 TSval=13933988 TSecr=13933988
17	0.001217000	172.17.0.1	172.17.0.4	TCP	66	4950-38336 [ACK] Seq=1 Ack=8 Win=29056 Len=0 TSval=13933988 TSecr=13933988
18	0.001225000	172.17.0.4	172.17.0.1	TCP	67	38336-4950 [PSH, ACK] Seq=8 Ack=1 Win=29312 Len=1 TSval=13933988 TSecr=13933988
19	0.001229000	172.17.0.1	172.17.0.4	TCP	66	4950-38336 [ACK] Seq=1 Ack=9 Win=29056 Len=0 TSval=13933988 TSecr=13933988
20	0.001236000	172.17.0.4	172.17.0.1	TCP	67	38336-4950 [PSH, ACK] Seq=9 Ack=1 Win=29312 Len=1 TSval=13933988 TSecr=13933988
21	0.001240000	172.17.0.1	172.17.0.4	TCP	66	4950-38336 [ACK] Seq=1 Ack=10 Win=29056 Len=0 TSval=13933988 TSecr=13933988
22	0.001248000	172.17.0.4	172.17.0.1	TCP	67	38336-4950 [PSH, ACK] Seq=10 Ack=1 Win=29312 Len=1 TSval=13933988 TSecr=13933988
23	0.001252000	172.17.0.1	172.17.0.4	TCP	66	4950-38336 [ACK] Seq=1 Ack=11 Win=29056 Len=0 TSval=13933988 TSecr=13933988
24	0.400960000	172.17.0.1	172.17.0.4	TCP	76	4950-38336 [PSH, ACK] Seq=1 Ack=11 Win=29056 Len=10 TSval=13934087 TSecr=13933988
25	0.401071000	172.17.0.4	172.17.0.1	TCP	66	38336-4950 [ACK] Seq=11 Ack=11 Win=29312 Len=0 TSval=13934088 TSecr=13934087
26	0.401520000	172.17.0.4	172.17.0.1	TCP	66	38336-4950 [FIN, ACK] Seq=11 Ack=11 Win=29312 Len=0 TSval=13934088 TSecr=13934087
27	0.441057000	172.17.0.1	172.17.0.4	TCP	66	4950-38336 [ACK] Seq=11 Ack=12 Win=29056 Len=0 TSval=13934098 TSecr=13934088

Figure 8: TCP server with small buffer size

5.2.2 Enought buffersize

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000000	172.17.0.4	172.17.0.1	TCP	74	38339-4950 [SYN, Seq=0 Win=29200 Len=0 MSS=1460 SACK_PERM=1 TSval=13948717 TSecr=0 WS
2	0.000040000	172.17.0.1	172.17.0.4	TCP	74	4950-38339 [SYN, ACK] Seq=0 Ack=1 Win=28960 Len=0 MSS=1460 SACK_PERM=1 TSval=13948717
3	0.000057000	172.17.0.4	172.17.0.1	TCP	66	38339-4950 [ACK] Seq=1 Ack=1 Win=29312 Len=0 TSval=13948717 TSecr=13948717
4	0.001081000	172.17.0.4	172.17.0.1	TCP	67	38339-4950 [PSH, ACK] Seq=1 Ack=1 Win=29312 Len=1 TSval=13948718 TSecr=13948717
5	0.001099000	172.17.0.1	172.17.0.4	TCP	66	4950-38339 [ACK] Seq=1 Ack=2 Win=29056 Len=0 TSval=13948718 TSecr=13948718
6	0.001129000	172.17.0.4	172.17.0.1	TCP	67	38339-4950 [PSH, ACK] Seq=2 Ack=1 Win=29312 Len=1 TSval=13948718 TSecr=13948718
7	0.001146000	172.17.0.1	172.17.0.4	TCP	66	4950-38339 [ACK] Seq=1 Ack=3 Win=29056 Len=0 TSval=13948718 TSecr=13948718
8	0.001154000	172.17.0.4	172.17.0.1	TCP	67	38339-4950 [PSH, ACK] Seq=3 Ack=1 Win=29312 Len=1 TSval=13948718 TSecr=13948718
9	0.001168000	172.17.0.1	172.17.0.4	TCP	66	4950-38339 [ACK] Seq=1 Ack=4 Win=29056 Len=0 TSval=13948718 TSecr=13948718
10	0.400758000	172.17.0.1	172.17.0.4	TCP	69	4950-38339 [PSH, ACK] Seq=1 Ack=4 Win=29056 Len=3 TSval=13948818 TSecr=13948718
11	0.400808000	172.17.0.4	172.17.0.1	TCP	66	38339-4950 [ACK] Seq=4 Ack=4 Win=29312 Len=0 TSval=13948818 TSecr=13948818
12	0.401276000	172.17.0.4	172.17.0.1	TCP	66	38339-4950 [FIN, ACK] Seq=4 Ack=4 Win=29312 Len=0 TSval=13948818 TSecr=13948818
13	0.440157000	172.17.0.1	172.17.0.4	TCP	66	4950-38339 [ACK] Seq=4 Ack=5 Win=29056 Len=0 TSval=13948828 TSecr=13948818

Figure 9: TCP server with enought buffer size

6 Instructions

Install, compile and run instructions.

6.1 Install dependencies

This is a Maven project. Install Maven3 and OpenJDK on a Debian based system.

```
apt-get install openjdk-7-jdk  
apt-get install maven
```

6.2 Compile and run

6.2.1 Compile

Navigate to project root, where the file pom.xml is located. Package the project with:

```
mvn package -e -DskipTests
```

6.2.2 Execute

Execute the code:

```
java -jar target/networking-1.0-SNAPSHOT.one-jar.jar
```

6.2.3 Docker, Optional

The code needs to be compiled with Maven before running in Docker, see 6.2.1.

```
apt-get install docker  
docker run -i -t --rm -v $PWD:/code java:8 /bin/bash  
java -jar code/networking-1.0-SNAPSHOT.one-jar.jar
```