

Master Course Computer Networks

Exercise 2

(submission until November 19th, 10:30 CET via SVN)

(submission of corrected version until November 22th, 10:30 CET via SVN)

Note: Each subproblem gives you 0, 1 or 2 points. See the slides from October 29th for more information on the 0.3 bonus.

Note 2: Subproblems marked by * can be solved without preceding results.

Network Topology (Tracing the routes)

Figure 1 shows the output of a `traceroute` to `www.caida.org`. Try out different things with the tool yourself!

The `traceroute` output can also be found in the SVN repository in the `/pub` folder.

```
traceroute to www.caida.org (192.172.226.123), 30 hops max, 60 byte packets
 1  * * *
 2  188.95.232.65  14.478 ms  14.598 ms  14.600 ms
 3  94.186.156.137  14.600 ms  14.600 ms  14.598 ms
 4  94.186.128.66  15.589 ms  15.710 ms  15.714 ms
 5  134.222.106.30  15.715 ms  15.717 ms  15.718 ms
 6  134.222.227.89  107.263 ms  106.242 ms  106.347 ms
 7  134.222.230.242  104.429 ms  104.541 ms  104.541 ms
 8  134.222.227.122  29.901 ms  29.903 ms  29.767 ms
 9  134.222.226.165  107.061 ms  107.177 ms  107.176 ms
10  198.32.118.161  121.520 ms  104.380 ms  103.843 ms
11  64.57.20.196  110.845 ms  110.078 ms  111.520 ms
12  64.57.20.247  197.913 ms  198.024 ms  196.273 ms
13  64.57.20.227  179.597 ms  179.370 ms  179.475 ms
14  137.164.46.117  181.008 ms  182.409 ms  182.052 ms
15  137.164.46.65  182.977 ms  179.929 ms  183.470 ms
16  137.164.47.111  186.017 ms  185.649 ms  185.595 ms
17  137.164.23.130  187.997 ms  187.243 ms  187.943 ms
18  192.12.207.62  219.261 ms  219.375 ms  216.682 ms
19  192.172.226.123  186.684 ms  186.693 ms  186.026 ms
```

Figure 1: Output from `traceroute` to `www.caida.org`.

a)* What is `traceroute`? How does it operate? What is it used for?

b)* Plot the average RTT deltas between all consecutive hops from Figure 1, i.e. the delta between hop 1 and 2, hop 2 and 3, hop 3 and 4, etc. For example, the difference between hop 5 and 6 is approximately 90.9 ms. What unexpected results do you see? Give possible explanations for your findings!

```

traceroute to www.caida.org (192.172.226.123), 30 hops max, 60 byte packets
 1 188.95.234.2 0.146 ms * *
 2 188.95.232.65 14.506 ms 14.621 ms 14.618 ms
 3 94.186.156.137 14.623 ms 14.618 ms 14.600 ms
 4 94.186.128.66 17.612 ms 17.783 ms 17.855 ms
 5 134.222.106.30 14.565 ms 14.977 ms 14.892 ms
 6 134.222.227.77 107.054 ms 134.222.227.89 106.817 ms 134.222.227.77 106.929 ms
 7 134.222.229.10 105.136 ms 134.222.230.242 104.217 ms 134.222.229.10 105.105 ms
 8 134.222.227.122 30.762 ms 134.222.232.142 105.003 ms 106.881 ms
 9 134.222.232.77 30.550 ms 134.222.226.165 107.765 ms 134.222.232.77 30.115 ms
10 134.222.226.165 106.485 ms 198.32.118.161 103.791 ms 134.222.226.165 107.798 ms
11 198.32.118.161 104.474 ms 64.57.20.196 111.450 ms 198.32.118.161 104.852 ms
12 * 64.57.20.196 110.601 ms 64.57.20.247 176.146 ms
13 64.57.20.247 176.186 ms 176.938 ms 64.57.21.115 178.703 ms
14 137.164.46.58 178.328 ms 64.57.21.115 178.708 ms 137.164.46.58 180.935 ms
15 137.164.46.58 179.513 ms 137.164.46.65 180.878 ms 181.482 ms
16 137.164.47.111 185.809 ms 185.788 ms 137.164.46.65 181.496 ms
17 137.164.23.130 187.784 ms 187.823 ms 137.164.47.111 186.337 ms
18 192.12.207.62 190.683 ms 190.433 ms 186.734 ms
19 192.12.207.62 186.783 ms 192.172.226.123 186.140 ms 193.180 ms

```

Figure 2: Output from another traceroute to `www.caida.org`.

c)* Figure 2 shows another output with a different type of traceroute. What basic different traceroute types are there? What are their advantages and disadvantages?

d)* What do the stars * mean in the output figures? Why are there stars for some hops and not for others?

e)* How can you determine the approximate geographical location of the hops? Figure out the approximate location for as many hops as possible!

f)* Draw a network topology graph based on all three measurements for all hops from Figure 2! Is the resulting topology a realistic description of the network layout? Explain why or why not!

ICMP (BC of death)

In this exercise we will look at the ICMP and IP protocols in more detail. Figure 3 shows the hex dump of an ICMP packet you will be analyzing in the subtasks.

```

0000 00 25 90 ab cd ef 3c 97 0e ca ff ee 08 00 45 00
0010 00 3c ec 61 00 00 0b 01 87 a0 83 9f 13 37 c0 ac
0020 e2 ff 08 00 2c c3 55 97 00 20 48 49 4a 4b 4c 4d
0030 4e 4f 50 51 52 53 54 55 56 57 58 59 5a 5b 5c 5d
0040 5e 5f 60 61 62 63 64 65 66 67

```

Figure 3: Hex dump, leftmost column indicates the hex offset from the beginning of the frame.

a)* Is the frame in Figure 3 valid? If it is not, change as little bytes as necessary to make it valid!

- b)* List all addresses of the frame dumped in Figure 3!
- c)* What is special about the destination IP address?
- d) What can happen when the (changed) packet reaches the destination network? What can be done to avoid bad consequences?

Routing (The Dear Administrator and the Lost Tables)

In this exercise we will look at how routing tables are constructed. Figure 4 shows a router with four interfaces.

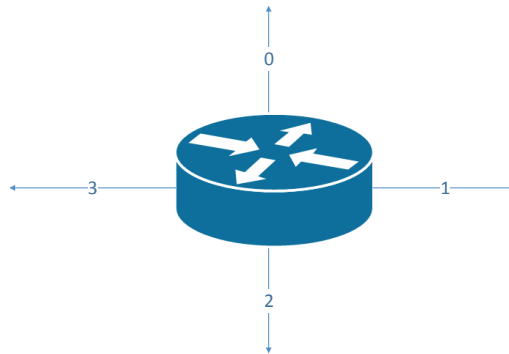


Figure 4: Router with four interfaces.

a)* Our dear network administrator forgot to save the current configuration of the router shown in Figure 4. One day, Murphy switched the router off. Upon starting it up again, the routing tables were empty. Our dear administrator found some log files that show the destination IP and the chosen output interface, shown in Table 1. Try to reconstruct the routing tables such that the packets are routed accordingly. Use as few routing table entries as possible and use a default route as well! Additionally, make the entries as restrictive as possible, i.e. smaller subnet mask is better.

Dest IP	Iface
123.0.42.38	0
123.0.42.47	1
123.0.42.240	2
8.8.4.4	1
123.0.42.32	0
123.0.42.128	1
123.0.42.30	0
123.0.42.42	1
123.0.42.249	1

Table 1: Destination IP address with the chosen output interface.

The slides from October 29th explain the SVN submission process.