Communication Networks 2

SS 2021

Assignment 4

Group 06

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1 Task description

This task is based on the same network as the previous one and the goal is to determine its topology. Thereby, an unknown host should be found and routing tables created for each one of the three routers. Furthermore, the delay and packet loss of each link between the lab pc and every discovered host shall be measured, graphically represented and discussed.

2 Procedure

2.1 Host discovery with nmap

There are different techniques to discover active hosts on a network. One of them is the use of nmap, which is a free and open source tool for network discovery and security auditing. To find the missing host in `10.0.0.0/16` the following command was used:

```
$ nmap --privileged -sn -n -T5 --min-parallelism 100 --min-hostgroup 100
10.0.0.0/16
```

To speed up the discovery process, which can take very long time in large networks, multiple options were added to the bare nmap command `$ nmap 10.0.0.0/16`. This reduced the waiting time to 23 minutes, which is still quite long.

Table 1 shows the result of this nmap host discovery search in `10.1.0.0/8` and `10.0.0.0/8`.

Later research and additional information showed that the 6th found IP address `10.0.132.68` belongs to the missing host.

2.2 Ping measurements

To identify which IP address belongs to the landline and satellite host a simple ping command was sent out to the according DNS names. `landline.cn2lab.cn.tuwien.ac.at` was resolved to `10.1.6.110` and `satellite.cn2lab.cn.tuwien.ac.at` to `10.1.7.123`.

In order to obtain information about the network topology and the Round Trip Time (RTT) and loss rate of each host, the ping command was used as well. For each IP address from table 1 the following command was adapted and executed:

```
$ ping -c 50 -R 10.1.7.123 > 10_1_7_123.txt
```

This delivered 50 individual measurements of the RRT which were then saved to a text file and are discussed in section 3.

With the `-R` the record route option was activated. That means all internet modules that route this message add their IP address to the IP option field. This method is better than just using the command `traceroute` because here the reverse path is recorded as well.

Some recorded routes show that the reverse path can be different from the forward path. This is for example the recorded route of the satellite host:

```
RR:  pc18.cn2lab.cn.tuwien.ac.at (192.168.88.118)
     10.0.120.2 (10.0.120.2)
     10.0.248.2 (10.0.248.2)
     10.1.7.1 (10.1.7.1)
     satellite.cn2lab.cn.tuwien.ac.at (10.1.7.123)
     satellite.cn2lab.cn.tuwien.ac.at (10.1.7.123)
     10.0.4.2 (10.0.4.2)
     border.cn2lab.cn.tuwien.ac.at (192.168.88.2)
     pc18.cn2lab.cn.tuwien.ac.at (192.168.88.118)
```

2.3 Network topology

Using the data of the nmap and ping commands, the network topology could be identified and a network diagram created which can be seen in figure 1. Table 2 shows the routing tables of the three routers. Some entries could not be identified by just using the ping command on the lab pc.

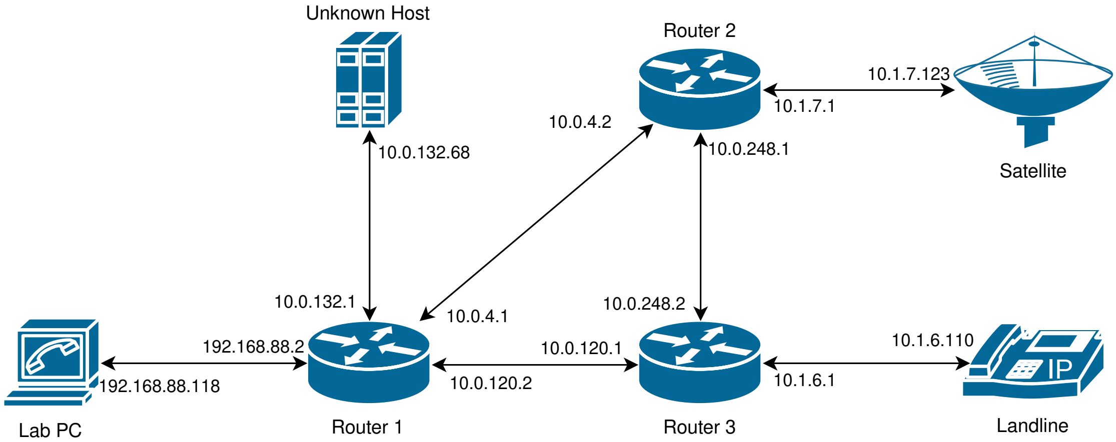

Figure 1: Network diagram

No.	Network	IP address	latency
1	10.0.0.0/8	10.0.4.1	0.0075s
2	10.0.0.0/8	10.0.4.2	0.23s
3	10.0.0.0/8	10.0.120.1	0.20s
4	10.0.0.0/8	10.0.120.2	0.0085s
5	10.0.0.0/8	10.0.132.1	0.024s
6	10.0.0.0/8	10.0.132.68	0.18s
7	10.0.0.0/8	10.0.248.1	0.78s
8	10.0.0.0/8	10.0.248.2	0.16s
9	10.1.0.0/8	10.1.6.1	0.18s
10	10.1.0.0/8	10.1.6.110	0.18s
11	10.1.0.0/8	10.1.7.1	1.5s
12	10.1.0.0/8	10.1.7.123	0.78s

Table 1: Discovered IP addresses

router	**destination**	**via**
r1	10.0.4.0/24	10.0.4.1
r1	10.0.120.0/24	10.0.120.2
r1	10.0.132.0/24	10.0.132.1
r1	10.0.248.0/24	10.0.120.1
r1	10.1.6.0/24	10.0.120.1
r1	10.1.7.0/24	10.0.120.1
r1	192.168.88.0/24	192.168.88.2
r2	10.0.4.0/24	-
r2	10.0.120.0/24	10.0.120.1
r2	10.0.132.0/24	-
r2	10.0.248.0/24	10.0.248.2
r2	10.1.6.0/24	10.1.6.1
r2	10.1.7.0/24	10.0.248.1
r2	192.168.88.0/24	10.0.120.1
r3	10.0.4.0/24	10.0.4.2
r3	10.0.120.0/24	-
r3	10.0.132.0/24	-
r3	10.0.248.0/24	10.0.248.1
r3	10.1.6.0/24	-
r3	10.1.7.0/24	10.0.7.1
r3	192.168.88.0/24	10.0.4.2

Table 2: Routing table

3 Data analysis and comparison

One of the most important metrics of real-time communication is the end-to-end (T_{EE}) delay. In this context the ITU-T recommendation G.114 has classified the user acceptance for end-to-end delays in a VoIP call [**ITU-TRecommendationG.114**]:

End-to-End delay	**User experience**
$T_{EE} < 150$	acceptable for all users
$150 < T_{EE} < 300$	noticeable quality degradation, but still acceptable for most users
$T_{EE} \geq 300$	not acceptable

Table 3: Delay to user experience

One approach to determine the one-way delay is to timestamp the packet on the sender and check the time difference on the receiver. For our setup the round trip time could also be a approximately estimation for the end-to-end delay. The captured delay is visualized in figure 2.

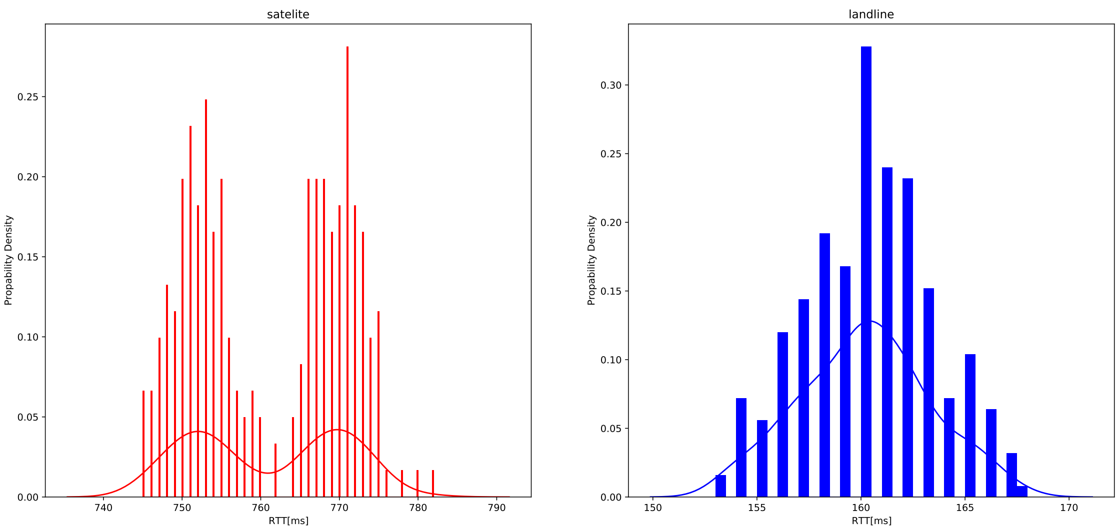

Figure 2: Propobility density of one way delay

The measurement contains two important aspects, one is the network probability distribution and the second is the overall delay. The landline connection seems to have a gaussian distribution and low latency, satellite on the other hand has an complete different shape and higher latency.

To further investigate the distribution it is important to understand the way how packets are treated in packet switched networks. As the topology section already explained the ping can propagate on different paths, this behavior could lead to different cost function on each link.

Another mechanism to utilize the network more efficiently is called load-balancing. A load-balancing router attempts to route Internet traffic optimally across two or more broadband connections to deliver a better experience to broadband users simultaneously accessing Internet applications.

An overview of the network statistics can be found in Table 2.2.

Device	**IP addresses**	**loss**	**RTT: min**	**avg**	**max**	**mdev**
r1	10.0.120.2	0 %	7.326 ms	8.116 ms	8.910 ms	0.420 ms
	10.0.4.1	0 %	7.370 ms	8.117 ms	8.911 ms	0.457 ms
	10.0.132.1	0 %	7.402 ms	8.164 ms	8.910 ms	0.431 ms
r2	10.0.120.1	0 %	153.474 ms	163.019 ms	313.394 ms	21.716 ms
	10.0.248.2	0 %	154.024 ms	160.040 ms	167.527 ms	3.571 ms
	10.1.6.1	0 %	153.802 ms	160.757 ms	166.669 ms	3.147 ms
r3	10.0.4.2	0 %	153.550 ms	163.382 ms	307.946 ms	20.883 ms
	10.0.248.1	6 %	747.294 ms	759.654 ms	777.453 ms	9.390 ms
	10.1.7.1	8 %	748.035 ms	759.357 ms	773.321 ms	8.581 ms
Satellite	10.1.7.123	6 %	745.616 ms	759.713 ms	776.987 ms	10.471 ms
Landline	10.1.6.110	0 %	154.818 ms	159.911 ms	165.216 ms	3.349 ms
Unknown host	10.0.132.68	0 %	7.323 ms	8.189 ms	8.966 ms	0.518 ms

Table 4: Ping data from lab pc to different network devices (250 packets)

4 Conclusion

As the second assignment showed the subjective quality and metrics like jitter are more acceptable on landline than on satellite call. This observation can also be seen on this paper. The measured packet loss and overall delay is much better on landline.