Universität Zürich[UZH]

0690 - Communication Systems Lab Course

Exercise 2

1) Introduction
2) Ethernet
3) DHCP

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1 Introduction

The goal of this lab course is to take a closer look at linux networking configuration. You will configure a Local Area Network (LAN) and analyze its network traffic. After analyzing the basic network properties, you will connect a router to the network. In this first phase, the router will solely be used as a DHCP server with the IP ranges provided below.

In the last step, you will connect your two lab machines to each other and connect two networks with different subnets to each other. This set up will be the basis of further exercises.

Go through the following exercise steps and execute them. At the same time, answer the questions as they appear. Questions are posed throughout the exercise and at the end of a section. Use the section and step / question number as a title to your answers (*e.g.,* 2.1.1).

Do not forget to send *(i)* your answers, *(ii)* the trace files and *(iii)* the dhcpd.conf to vonderassen@ifi.uzh.ch and killer@ifi.uzh.ch. Do not forget to attach your trace files as well.

Table 1: IP Addresses

Group	Client 1	Router	Subnet
Group 1	10.1.1.2	10.1.1.1	10.1.1.0/24
Group 2	10.1.2.2	10.1.2.1	10.1.2.0/24
Group 3	10.1.3.2	10.1.3.1	10.1.3.0/24
Group 4	10.1.4.2	10.1.4.1	10.1.4.0/24
Group 5	10.1.5.2	10.1.5.1	10.1.5.0/24
Group 6	10.1.6.2	10.1.6.1	10.1.6.0/24
Group 7	10.1.7.2	10.1.7.1	10.1.7.0/24
Group 8	10.1.8.2	10.1.8.1	10.1.8.0/24
Group 9	10.1.9.2	10.1.9.1	10.1.9.0/24

Figure 1: IP Address Ranges for each group

2 Ethernet

The topology of today's exercise is depicted in Figure 2. Every group has two PCs available. One of them will act as router and will therefore be referred to as Router from hereon. The task of the Router is to connect your group's network with the lab network. The second PC will act as a client and is therefore called Client 1.

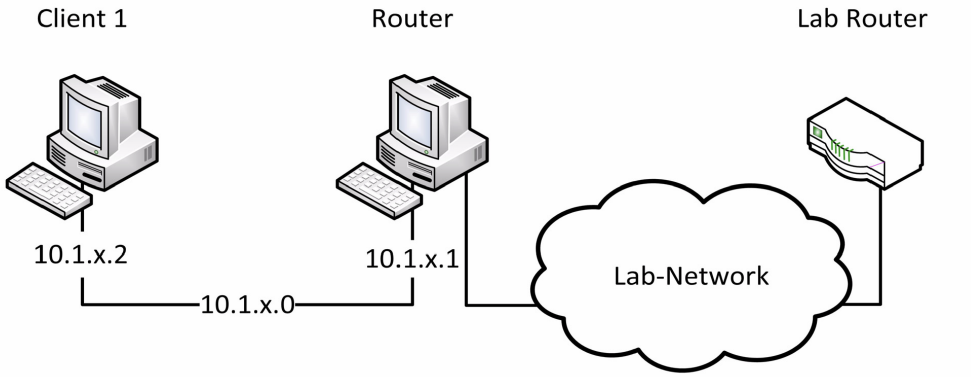

Figure 2: Network Topology

1. Connect your two lab machines as shown in Figure 2. One of the computers will act as the Router and the other one as Client 1. The interface `enp3s0` of Client 1 is directly connected to Router `enp3s0`. On the Router, `enp4s0` is connected to the lab network (Wall Socket `X.1`).

2. Second, check whether you have an active internet connection on the machine you defined as the Router. Otherwise, run, `dhclient enp4s0` This tells the machine to acquire an IP address by using DHCP (Dynamic Host Configuration Protocol). Once the command terminated check the IP address on `enp4s0`, if it takes a long time to complete there is most likely an issue with the physical connection. If there is already an IP address configured, run this first to release it: `dhclient enp4s0 -r`

3. Now, use the terminal to configure the default route on Client 1 with the `ip route` command. Use `man ip` and `man ip route` to get help output for the `man` command. Look at the routing table *before* and *after* you add the default route.

   → What is the command to add the route? Copy the command you used to the answer e-mail.

4. Configure the lab DNS server (192.168.3.1) as an upstream DNS server on Client 1 in `/etc/resolv.conf`. A good system administrator always has a backup. So, you should create a backup copy of the file first like this: `cp /etc/resolv.conf /etc/resolv.conf.backup`. Use `man resolv.conf` for help.

5. Check whether the connection works correctly by using Client 1 to `ping` the Router. Also try to ping a server from the internet (e.g. ping www.google.com).

→ Which hosts are reachable?

6. Allow packet forwarding on the router by writing the value `1` into `/proc/sys/net/ipv4/ip_forward` (e.g., `sysctl -w net.ipv4.ip_forward=1`) execute the following command (Note: Adapt `X` to your group's subnet and enpXs0 to the router's uplink interface): `iptables -t nat -A POSTROUTING -s 10.1.X.0/24 -o enpXs0 -j MASQUERADE`, also change the default forwarding policy to accept `iptables -P FORWARD ACCEPT`

   → Reading the manpages and consulting online resource, what does this iptables command do?

7. Check again the connectivity from Client 1 to the router and a publicly available server.

   → Which ones are reachable?

8. Test the `traceroute -n 8.8.8.8` command.

   → What does the output show?

9. On layer two of the TCP/IP stack, hosts are addressed with the so-called Media Access Control (MAC) address. Look at the MAC address table of your PC (Client 1), use the command `ip neigh show`. After that, delete the entries of the table with `ip neigh flush all`, monitor the link with Wireshark, and then send a `ping` to the Router or any other host in your subnet. Monitor the packets with Wireshark.

   → Which protocol is used to resolve the MAC address of a host in the same subnet?

3 DHCP

Now, we automate the network configuration of the client, therefore you will configure a DHCP server. A DHCP Server provides automatic network interface configuration for clients

3.1 DHCP-Server

Configure a DHCP on the Router machine. As a help, you can use the default config file, which contains many examples: `/etc/dhcp/dhcpd.conf`.

1. Install the DHCP server software on Router: `apt install isc-dhcp-server` In case of issues where updates are running in the background and therefore locking `dpkg` or `apt`, you can simply run the following:

```
killall apt apt-get

rm /var/lib/apt/lists/lock \
/var/cache/apt/archives/lock \
/var/lib/dpkg/lock*
```

2. Configure the dynamic address range in the server. Use addresses x.y.z.100 - 150 as dynamic range. You need to provide configuration values for subnet mask, default gateway, and DNS (as you did manually in the previous section). The DHCP server machine (Router) will be used as gateway, therefore the server IP can be used. You need to change the default configuration by editing `/etc/dhcp/dhcpd.conf` to suit your needs and particular configuration.

3. You also need to edit `/etc/default/isc-dhcp-server` to specify the interfaces dhcpd should listen to. Write a line in the following syntax into the file:

   ```
   INTERFACES="<interfacename1> <interfacename2>"
   ```

4. Restart the DHCP server process `systemctl restart isc-dhcp-server`. Check the status of the dhcp deamon with `systemctl status isc-dhcp-server`. If it failed, the syslog `/var/log/syslog` might give you further clues.

5. In Client 1 restore the backup of `/etc/resolv.conf`, but first back up the actual one again:

   ```
   cp /etc/resolv.conf /etc/resolv.conf.ex2
   rm /etc/resolv.conf
   mv /etc/resolv.conf.backup /etc/resolv.conf
   ```

6. Restart the network interface of Client 1 which is connected to the router. Check if your client received an IP and if it can reach the router and an internet host. If not, release the current IP and request a new one from the DHCP server:

   ```
   dhclient enpXs0 -r
   dhclient enpXs0
   ```

7. Check if everything works as intended. Then, repeat the step after starting Wireshark on Client 1, capturing DHCP packets (Filter). Now, use `dhclient enpXs0 -r` and `dhclient enpXs0` to release and request an IP address over DHCP. If you see the packets, save the trace as 3.1.7.pcap and attach it to your solution e-mail.

8. Configure the DHCP server such that it gives a static IP Address to one of your clients.

   → How does the server identify the host to give it a specific address?

3.2 Questions

(a) What are the benefits of DHCP?

(b) What messages are exchanged between the DHCP server and client?

(c) To which destination address is the DHCP request sent?

(d) The client sends a DHCP request to obtain an IP address to use. How can it do so without having an IP address in the first place? *i.e.,* what is the source address that is used for the request?

(e) Which port does the DHCP server use?

(f) Given a network of hosts, how is decided which host is the DHCP server? How can clients find the authoritative DHCP server?

(g) Based on the previous question - are there any security concerns involved in the operation of DHCP?

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