Practical Computer Networks and Application
Network Configuration in Linux
Summer Term 2020

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Introduction

In the last Lab Exercise you did the following things:

- **Set up a Linux Operating System**
- **Install Wireshark and work with the Command-Line**
- **Inspect some basic Networking Protocols and Technologies**

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Introduction

In this Lab Exercise you will learn the following things:

- **How to set up a network (with Linux)**
- **How to enable switching and/or forwarding with Linux**
- **Some more advanced Command-Line Fun ;-)**

After this Lab Exercise

After you solved this Lab Exercise you are able to make basic network configuration on Linux Systems. This is a pivotal task for any Computer Scientist. So if you understood the task in this Lab Exercise you have mastered some fundamental and important skills in Computer Networks!
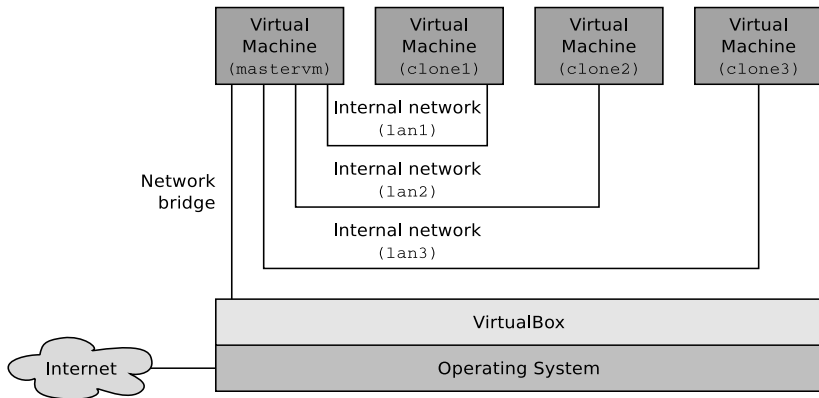
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Lab Exercise 2 Network

Figure: Network Topology in Lab Exercise 2

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Lab Exercise 2 Network

The Network in Lab Exercise 2 consists of:

- 1 Virtual Machine for the Gateway (mastervm)
- 3 Virtual Machines for the Clients (clone[1-3])
- 1 Bridged Interface between the Host OS and the Gateway
- Internal Network connections from the Gateway to each client

The Goal: Configure the Gateway and the Clients in such a way that a connection can be established between the Gateway, the Clients and the Internet!

Before we dive in

Before we discuss the solutions we need to learn more about the files and tools necessary for the network configuration

The `interfaces` File

The File /etc/network/interfaces includes the following parameters:

- Information about the interfaces
- The configuration of the Interface
- Infomation about the IP-Address, Subnetmask, Gateway

Important Interfaces [1]:

`lo`	– Loopback Address for development purposes
`eth0`	– Wired (Ethernet) Interface
`wlan0`	– Wireless (WiFi) Interface
`enp0s3`	– Wired Interface in Virtualbox

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Interfaces File

```
1  # Example Interfaces File
2
3  auto lo
4  iface lo inet loopback
5
6  # WAN Interface
7  auto enp0s3
8  iface enp0s3 inet dhcp
9
10 # LAN 1
11 auto enp0s8
12 iface enp0s8 inet static
13   address 192.168.1.1
14   netmask 255.255.255.0
15   broadcast 192.168.1.255
```

Listing 1: Interfaces File

Tools for configuration

An important tool for the configuration of networks in Linux is
ifconfig [2]

ifconfig is used to configure the interfaces of the machine

Examples for the use of ifconfig:

- Setting the IP-Address for interface eth0
    - sudo ifconfig eth0 172.16.0.1 netmask 255.240.0.0
- Setting the IP-Address for interface wlan0
    - sudo ifconfig wlan0 192.168.0.1
      netmask 255.255.255.0
- Starting up interface eth1:
    - sudo ifconfig eth1 up

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Tools for configuration

In order to save changes made to the `interfaces` file you need to restart the network interfaces!

There are two ways to do that

Restart a specific Interface:

- `ifdown <INTERFACE>`
- `ifup <INTERFACE>`

or

Restart all networking interfaces

- `/etc/init.d/networking restart`

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Configuring Networks

Solution 1: Install `bridge-utils` [3] and configure a Switch on the Gateway!

Solution 2: Install `iptables` and configure IP-Forwarding [4] and NAT-Masquerading [5] on the Gateway!

Recommended Solution

The recommended solution is **Solution 2**! Since `iptables` will be discussed in exercise sheet 3, setting up **Solution 2** reduces administration and configuration efforts throughout the semester!

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Solution 1 – `bridge-utils` (1/3)

The following steps need to be carried out:

- Install `bridge-utils` on `mastervm`:
  - `sudo apt-get install -y bridge-utils`
- List the Interfaces and add a Bridge on `mastervm`:
  - `sudo brctl show`
  - `sudo brctl addbr bridgelan1`
- Add Network Interfaces to the Logical Bridge:
  - `sudo brctl addif bridgelan1 <INTERFACE>`
- Add Network Interfaces for `clone[1-3]` the Logical Bridge (e.g. `enp0s8` for `clone1`):
  - `sudo brctl addif bridgelan1 enp0s8`

Interface Naming

Inside Virtualbox the naming scheme for the interfaces can be quite confusing. The naming convention of the interfaces is the following: **Adapter 1**:enp0s3, **Adapter 2**:enp0s8, **Adapter 3**:enp0s9, **Adapter 4**:enp0s10

Solution 1 – `bridge-utils` (2/3)

The following steps need to be carried out:

- Set network configurations for the Interfaces on `mastervm`:
  - `sudo ifconfig bridgelan1 192.168.1.10 netmask 255.255.255.0 up`
  - `sudo ifconfig enp0s8 192.168.1.11 netmask 255.255.255.0` [1]
- Make the necessary configurations on the Clones aswell:
  - `sudo ifconfig enp0s3 192.168.1.12 netmask 255.255.255.0`
- Finally include this in `/etc/network/interfaces` on the `clone1`[2]:

  ```
  auto enp0s3
  iface enp0s3 inet static
  address 192.168.1.12
  netmask 255.255.255.0
  gateway 192.168.1.11
  dns-nameservers 8.8.4.4 8.8.8.8
  ```

---

[1] This is done for `enp0s9` and `enp0s10` aswell!

[2] Make sure that the configuration for `clone[1-3]` is set corresponding to the defined network on interfaces `enp0s9` and `enp0s10`

Solution 1 – `bridge-utils` (3/3)

The steps listed configure a bridged network between `mastervm` and `clone1`!

Please Note: The previously shown steps are an example and maybe you need to adjust your files!

Please Note: The previously shown configuration is temporary and will be erased after a reboot! To make them permanent you need to include them in the `/etc/network/interfaces` file [6]!

Accessing Files on the Command-Line

In order to access files on the Command-Line you need to use an Editor. The oldest Editor avaiable on every Linux System is `vi`. A more userfriendly Editor is `nano`. Make sure that you have root access to the file in order to save the changes!

Solution 2 – IP-Forwarding and NAT-Masquerading (1/5)

The following steps need to be carried out:

- Install `iptables` on `mastervm`:
    - `sudo apt-get install -y iptables`
- Configure `iptables` on `mastervm`
- Configure the interfaces on `mastervm`
- Configure the interfaces on `clone[1-3]`

Solution 2 – IP-Forwarding and NAT-Masquerading (2/5)

Configure `iptables` on `mastervm`:

- This rule forwards packets to the WAN-interface:
    - `iptables -A FORWARD -o enp0s3`
      `-s 0.0.0.0/0 -m conntrack --ctstate NEW -j ACCEPT`
- This rule forwards established packets to the WAN-interface:
    - `iptables -A FORWARD -m conntrack`
      `--ctstate ESTABLISHED,RELATED -j ACCEPT`
- This rule sets the `POSTROUTING` [3] rules for the WAN-interface:
    - `iptables -t nat -A POSTROUTING -o enp0s3`
      `-j MASQUERADE`
- Enable `iptables`:
    - `sysctl -w net.ipv4.ip_forward=1`

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[3]More on `iptables` and Rule Chains in the next Lab Exercise!

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Solution 2 – IP-Forwarding and NAT-Masquerading (3/5)

Configure the file /etc/network/interfaces on mastervm e.g.:

```
# WAN Interface
auto enp0s3
iface enp0s3 inet dhcp

# LAN 1
auto enp0s8
iface enp0s8 inet static
address 192.168.1.1
netmask 255.255.255.0
broadcast 192.168.1.255
```

Solution 2 – IP-Forwarding and NAT-Masquerading (4/5)

Configure the file /etc/network/interfaces on clone1 e.g.:

```
auto enp0s3
iface enp0s3 inet static
address 192.168.1.10
netmask 255.255.255.0
broadcast 192.168.1.255
gateway 192.168.1.1
dns-nameservers 8.8.4.4 8.8.8.8
```

Solution 2 – IP-Forwarding and NAT-Masquerading (5/5)

The steps listed configure IP-Forwarding and NAT-Masquerading between `mastervm` and `clone1`!

Please Note: The previously shown steps are an example and maybe you need to adjust your files!

Please Note: The previously shown configuration is temporary and will be erased after a reboot! To make them permanent you need to include them in the `/etc/network/interfaces` file preceded by the command `up /sbin/iptables`!

General Remarks on Exercise Sheet 2

Disable IPv6:

- `sudo sysctl -w net.ipv6.conf.all.disable_ipv6=1`
- `sudo sysctl -w net.ipv6.conf.default.disable_ipv6=1`

This is how it is configured on Bootup in /etc/default/grub:

- `GRUB_CMDLINE_LINUX_DEFAULT="ipv6.disable=1"`
- `GRUB_CMDLINE_LINUX="ipv6.disable=1"`

Afterwards reboot the system!

DNS Issue

If you encounter the problem of a failure in name resolution by DNS, these steps can fix the issue. The issue is caused by a configuration error. The resolver works fine and the command `nslookup` shows the Name Servers, but there is a problem with the name resolution on IPv4! Start with the first commands (**Step Disable IPv6**) and test it before making the changes permanent.

Lab Exercise 2

This slide set gives a you brief overview of the tools and technologies discussed in Lab exercise sheet 2.

Hopefully this slide set gives you the abillity to solve the tasks of exercise sheet 2!

Lab Exercise 2

Have fun solving the Exercise Sheet and if you have questions, don't be afraid to ask ;-)

Submission Lab Exercise Sheet 2

Please do not forget to submit your results on Moodle until 7th June 2020 !!!

References I

[1] Debian network configuration. [accessed: May 14, 2020]. [Online]. Available: https://wiki.debian.org/NetworkConfiguration

[2] `ifconfig` man page. [accessed: May 14, 2020]. [Online]. Available: https://linux.die.net/man/8/ifconfig

[3] Debian bridge network connections. [accessed: May 14, 2020]. [Online]. Available: https://wiki.debian.org/BridgeNetworkConnections

[4] Redhat – `forward` and nat rules. [accessed: May 14, 2020]. [Online]. Available: https://access.redhat.com/documentation/en-US/Red_Hat_Enterprise_Linux/4/html/Security_Guide/s1-firewall-ipt-fwd.html

[5] Nat - network address translation. [accessed: May 14, 2020]. [Online]. Available: https://www.karlrupp.net/en/computer/nat_tutorial

[6] Configuring bridging in /etc/network/interfaces. [accessed: May 14, 2020]. [Online]. Available: https://wiki.debian.org/BridgeNetworkConnections