

Practical Computer Networks and Application

Introduction and Fundamentals

Summer Term 2020

Prof. Dr. Christian Baun
Henry-Norbert Cocos
Maurizio Petrozziello

`{christianbaun,cocos,petrozziello}@fb2.fra-uas.de`

Computer Science
Faculty of Computer Science and Engineering
Frankfurt University of Applied Sciences

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Rules of the Game

The Lecture **Practical Computer Networks and Application** is organized as follows:

- You need to enroll into the Moodle Course and register for a group!
- You need to solve the 4 lab exercises!
(50% for passing the respective exercise)
- You need to submit your solution to Moodle!
- Throughout the semester you will have lectures accompanying the exercises!

Exercise Groups

The following exercise groups are available:

- Prof.Dr. Christian Baun
 - **Group B1**
 - **Group B2**
- Henry Cocos
 - **Group C1**
 - **Group C2**
- Maurizio Petrozziello
 - **Group P1**
 - **Group P2**
 - **Group P3**

Lectures

Throughout the semester there are 4 lectures!

Screencasts

Because of the current situation, there are no presence lectures planned for this semester. The Moodle course will provide you with screencasts for every Exercise Sheet, where the relevant information regarding the exercise sheet is presented!

Moodle Course

Moodle Course:

- **Practical Computer Networks and Application - SS20**
- **Enrollment Key:** `Networking_means_Success`

In the Moodle Course you will find all necessary information regarding the course (lecture slides, exercise sheets, etc.)!

Enrollment for Exercise Groups

Please make sure to register for a group until **8th May 2020!!!**

Exercise and Virtualbox Image

You need to pass 4 Exercises to pass the Lab:

- **Deadline Exercise 1:** 17th May 2020
- **Deadline Exercise 2:** 7th June 2020
- **Deadline Exercise 3:** 21st June 2020
- **Deadline Exercise 4:** 12th July 2020

Virtualbox Image

In the Moodle Course you will find a download link for a preconfigured **Ubuntu 18.04 LTS** Image for Virtualbox. It can be used to solve the lab exercises on your own Computers and only needs to be imported into Virtualbox!

Introduction

This slide set covers the following topics:

- **Linux Command-line tools for networking**
- **Basics on networks**
- **Basics on Wireshark**

After this introductory slide set you should be able to solve the Lab Exercise Sheet 1!

Basic network technologies

This section will cover...

- some basic network technologies
- some basic network protocols

Only some basics!

However this section only covers some fundamental technologies necessary for understanding the Lab exercises.

More details!

A more detailed view on the technologies is presented in the lectures **Computer Networks** from last semester!

ICMP

The Internet Control Message Protocol (ICMP) is used to exchange diagnosis information inside a network

Here is a list of some important message types ¹:

- 0 Echo Reply
- 3 Destination Unreachable
- 8 Echo Request
- 11 Time Exceeded
- 30 Traceroute

ping command-line tool

The command-line tool `ping` uses ICMP-Requests to check the reachability of a machine. If the machine is reachable and supports the ICMP protocol it answers with an ICMP-Reply.

¹The message type is specified by the code inside the header field

ICMP

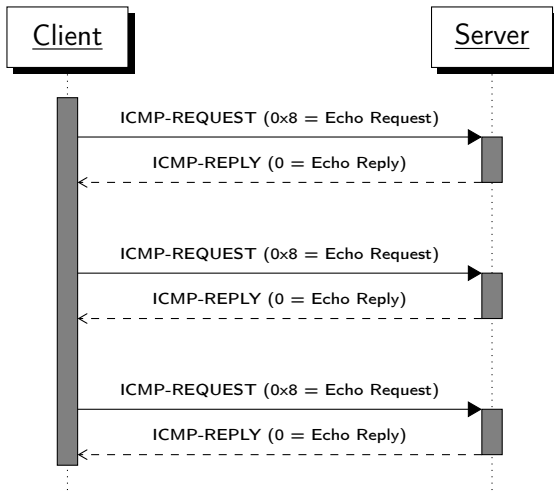


Figure: Message Sequence Diagram (MSC) ping

DHCP

The Dynamic Host Control Protocol (DHCP) is used to control the assignment of IP-Addresses

The assignment of IP-Addresses and network configurations is managed by a DHCP-Server

The DHCP-Server in a private network is usually the Router/Gateway

DHCP vs bootp

The Bootstrap Protocol (bootp) is the core protocol for dynamically assigning IP-Addresses, netmasks, and gateways. However in large private networks additional information is needed. Therefore DHCP was invented which is an extension of the Bootstrap Protocol. The flow of bootp is shown in the next slide.

DHCP

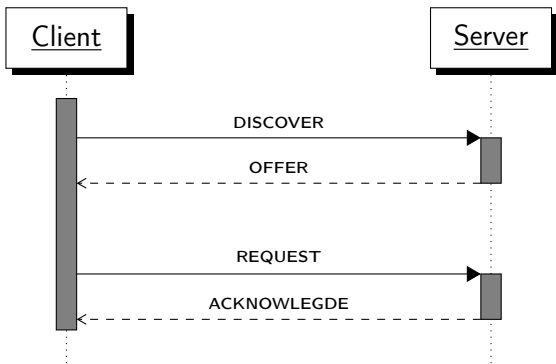


Figure: MSC for IP-Address assignment using DHCP

Linux Command-Line tools

Linux offers some useful Command-line tools for networking

The following list shows some of the most common tools

`ping` used to send ICMP-Requests to an IP-Address or a domain [1]

`traceroute` used to list the routers that forward an IP-Packet to the destination [2]

`dhclient` used to configure the DHCP on an interface [3]

`lynx` a textbased webbrowser [4]

`iptables` used to set up rules for a firewall [5]

ping

ping is a useful command-line tool for...

- checking the reachability of a server
- sending and receiving ICMP packets
- checking transmission information (time-to-live, response time, round-trip-time)

ping command-line tool

ping is the most essential tool for network administrators and is the first tool to use when analyzing a network!

ping

```
henry@henry-ThinkPad-X250:~$ ping google.com
PING google.com (172.217.22.110) 56(84) bytes of data:
64 bytes from fra15s18-in-f14.1e100.net (172.217.22.110): icmp_seq=1 ttl=55 time=17.3 ms
64 bytes from fra15s18-in-f14.1e100.net (172.217.22.110): icmp_seq=2 ttl=55 time=93.3 ms
64 bytes from fra15s18-in-f14.1e100.net (172.217.22.110): icmp_seq=3 ttl=55 time=16.2 ms
64 bytes from fra15s18-in-f14.1e100.net (172.217.22.110): icmp_seq=4 ttl=55 time=15.9 ms
64 bytes from fra15s18-in-f14.1e100.net (172.217.22.110): icmp_seq=5 ttl=55 time=17.1 ms
^C
--- google.com ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4005ms
rtt min/avg/max/mdev = 15.995/32.028/93.381/30.681 ms
```

Figure: Output of ping command for www.google.com

traceroute

traceroute is a useful command-line tool for...

- checking the number and IP-Addresses of Servers between sender and receiver
- checking the time consumption for every hop and for the transmission
- sending and receiving ICMP packets

traceroute command-line tool

traceroute is used to identify delays in the connection between sender and receiver. By using traceroute the response time of routers between sender and receiver can be analyzed.

traceroute

```
henry@henry-ThinkPad-X250:~$ traceroute google.com
traceroute to google.com (172.217.22.110), 30 hops max, 60 byte packets
 1 fritz.box (192.168.178.1) 6.634 ms 6.617 ms 6.605 ms
 2 compalhub.home (192.168.0.1) 13.626 ms 15.305 ms 15.302 ms
 3 * * *
 4 de-fra01b-rc1-ae28.fra.unity-media.net (81.210.141.33) 40.301 ms 41.300 ms 57.138 ms
 5 de-fra03b-ri1-ae10-0.aorta.net (84.116.132.178) 42.557 ms 56.417 ms 57.138 ms
 6 213.46.177.42 (213.46.177.42) 57.544 ms 16.440 ms 19.262 ms
 7 108.170.252.1 (108.170.252.1) 41.009 ms 108.170.251.129 (108.170.251.129) 27.553 ms 108.170.252.
 8 72.14.234.113 (72.14.234.113) 29.462 ms 27.979 ms 72.14.234.115 (72.14.234.115) 40.029 ms
 9 fra15s18-in-f110.1e100.net (172.217.22.110) 30.731 ms 28.434 ms 29.155 ms
```

Figure: Output of traceroute command for www.google.com

lynx webbrowser

lynx webbrowser is...

- one of the oldest webbrowsers
- a textbased webbrowser for static websites
- is used for screenreaders and braille terminals

lynx webbrowser

```

Wikipedia
The Free Encyclopedia

[English 5 714 000+ articles
Español 1 472 000+ artículos
日本語 1 119 000+ 記事
Deutsch 2 218 000+ Artikel
Русский 1 495 000+ статей
Français 2 839 000+ articles
Italiano 1 459 000+ voci
中文 1 021 000+ 条目
Português 1 884 000+ artigos
Polski 1 259 000+ hasła

(English)
(OUTGO)
(OUTGO) Read Wikipedia in your language

1 000 000+ articles
  - Deutsch
  - English
  - Français
    
```

Figure: lynx webbrowser on the command-line for www.wikipedia.org



Figure: A braille terminal for blind persons

Image Source:

<https://de.wikipedia.org/wiki/Braillezeile>

Wireshark

Wireshark is an open-source tool for network analysis

Wireshark features the following functions:

- Graphical user interface
- Collection of transmitted data
- Detailed view of each packet and protocol
- Enables a detailed analysis of network traffic

Wireshark

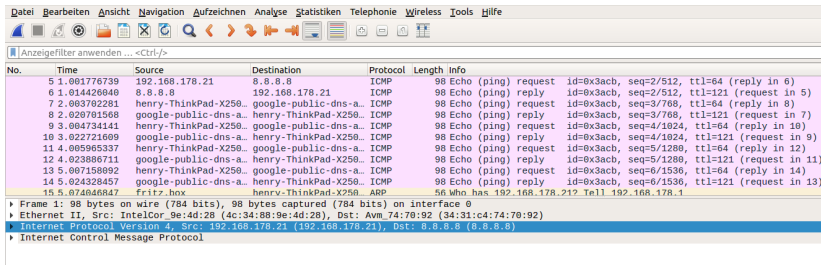


Figure: Wireshark Desktop

Wireshark Installation

Perform the following steps in order to install Wireshark [6]:

- 1 download and install the package:
 - `sudo apt-get install wireshark`
- 2 enable access to interfaces without root privileges and add Wireshark to user group:
 - `sudo dpkg-reconfigure wireshark-common`
 - `sudo adduser $USER wireshark`
- 3 log out user and afterwards log in to save changes
- 4 use Wireshark for network analysis

Adding Wireshark to User Group

The commands presented in step 2 are necessary in order to use Wireshark. Otherwise Wireshark has to be used with root privileges, which is considered a security hazard!

Lab Exercise 1

This slide set gives a you brief overview of the tools and technologies discussed in Lab exercise sheet 1.

Hopefully this slide set gives you the ability to solve the tasks of exercise sheet 1!

Lab Exercise 1

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

Submission Lab Exercise Sheet 1

Please do not forget to submit your results on Moodle until **17th May 2020 !!!**

- [1] ping man page. [accessed: April 1, 2020]. [Online]. Available: <https://linux.die.net/man/8/ping>
- [2] traceroute man page. [accessed: April 1, 2020]. [Online]. Available: <https://linux.die.net/man/8/traceroute>
- [3] dhclient man page. [accessed: April 1, 2020]. [Online]. Available: <https://linux.die.net/man/8/dhclient>
- [4] lynx man page. [accessed: April 1, 2020]. [Online]. Available: <https://linux.die.net/man/1/lynx>
- [5] “iptables man page,” [accessed: April 1, 2020]. [Online]. Available: <https://linux.die.net/man/8/iptables>
- [6] “Wireshark – ubuntuusers,” [accessed: April 1, 2020]. [Online]. Available: <https://wiki.ubuntuusers.de/Wireshark/>

- [7] “How to use wireshark: A complete tutorial,” [accessed: April 1, 2020]. [Online]. Available:
<https://www.lifewire.com/wireshark-tutorial-4143298>

- [8] Wireshark.org, *Wireshark User's Guide – Version 3.3.0*, [accessed: April 1, 2020]. [Online]. Available:
<https://www.wireshark.org/download/docs/user-guide.pdf>