Written examination in Computer Networks

February 23th 2018

Last name: _____

First name: _____

Student number: _____

I confirm with my signature that I will process the written examination alone and that I feel healthy and capable to participate this examination.
I am aware, that from the moment, when I receive the written examination, I am a participant of this examination and I will be graded.

Signature: _____

- Provide on all sheets (including the cover sheet) your *last name*, *first name* and *student number*.

- Use the provided sheets. Own paper must *not* be used.

- Place your *ID card* and your *student ID card* on your table.

- You are allowed to use a *self prepared, single sided DIN-A4 sheet* in the exam. Only *handwritten originals* are allowed, but no copies.

- You are allowed to use a non-programmable calculator.

- Answers written with pencil or red pen are *not* accepted.

- Time limit: *90 minutes*

- Turn off your mobile phones!

Result:

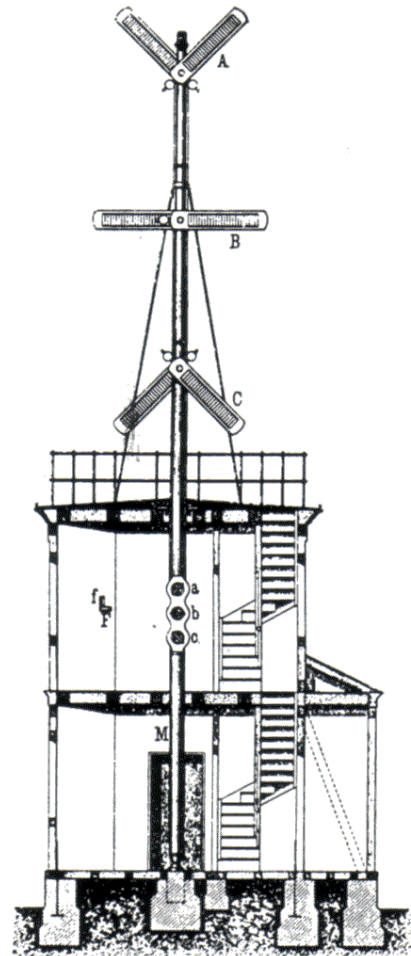| Question:	1	2	3	4	5	6	7	8	9	10	11	12	Σ	Grade
Maximum points:	4	7	6	8	8	8	6	5	6	8	8	16	90	—
Achieved points:														

Question 1)

Maximum points: 2+2=4

The Prussian semaphore system (dt. *Preußischer optischer Telegraf*) was a telegraphic communications system used from 1832 until 1849 between Berlin and Koblenz.

Messages were transmitted using optical signals over a distance of nearly 550 km via 62 telegraph stations.

Each station was equipped with 6 telegraph arms. Each arm had 4 positions for encoding.

a) Data rate: How many bits can be transmitted per second when a new adjustment of the telegraph arms can be performed every 6 seconds?

b) Latency: If each station requires 2 minutes for the forwarding, what is the end-to-end delay?

Question 2)

Maximum points: 7

A true color image has a size of 1366x768 pixels. True color means that 3 Bytes per pixel are used for the color information. How long does it take to transmit the image via a. . .

a) 64 kbps ISDN connection?

b) 16 Mbps DSL connection?

c) 1 Gbps Ethernet connection?

Question 3)

Maximum points: 3+1+1+1=6

a) What information contains an Ethernet frame?

☐ Sender MAC address
☐ Hostname of the receiver
☐ Sender IP address
☐ Information about the Transport Layer protocol used
☐ Preamble to synchronize the receiver
☐ Information about the Application Layer protocol used
☐ VLAN tag
☐ Port number of the receiver
☐ Receiver MAC address
☐ Receiver IP address
☐ Information about the Network Layer protocol used
☐ Port number of the sender
☐ Hostname of the sender
☐ Mojo-factor
☐ CRC checksum
☐ Signals, which are transmitted via the transmission medium

b) Describe the function of the Address Resolution Protocol (ARP).

c) Describe what the ARP cache is.

d) Name one benefit of the ARP cache.

Question 4)

Maximum points: 4+4=8

a) Error detection via CRC: Calculate the frame to be transferred.

   ```
   Generator polynomial: 100101
   Payload: 10101010
   ```

b) Error detection via CRC: Check, if the received frame was transmitted correctly.

   ```
   Transferred frame: 1011010110110
   Generator polynomial: 100101
   ```

Question 5)   Points: ....

Maximum points: 1+1+1+1+2+1+1=8

a) Describe Unicast in the network layer.

b) Describe Broadcast in the network layer.

c) Describe Anycast in the network layer.

d) Describe Multicast in the network layer.

e) Describe the purpose of Routers in computer networks.
   (*Also explain the difference to Layer-3-Switches.*)

f) Describe the purpose of Gateways in computer networks.

g) Describe why Gateways in the network layer are seldom required nowadays.

Question 6)

Points: ....

Maximum points: 5+1+1+1=8

a) Split the class A network `16.0.0.0` for implementing 2500 subnets. Calculate the subnet masks and answer the questions.

```
Network ID:     00010000.00000000.00000000.00000000     16.0.0.0

Number of bits for subnet IDs? _____

Subnet mask:     _____._____._____._____     ___.___.___.___

Number of bits for host IDs? _____

Number of host IDs per subnet? _____
```

binary representation	decimal representation	binary representation	decimal representation
10000000	128	11111000	248
11000000	192	11111100	252
11100000	224	11111110	254
11110000	240	11111111	255

b) Name one private IPv4 address space.

c) Describe the function of the Internet Control Message Protocol (ICMP).

d) Give two examples for command line tools, which use the ICMP.

Question 7)

Maximum points: 6

Calculate for each network configuration whether an IP packet, which is send from the given IP address to the destination address, leaves the subnet during transmission or not.

IP address	Subnet mask	Destination address	Leaves the subnet
15.200.99.23	255.192.0.0	15.239.1.1	☐ **yes** ☐ **no** <=== ! ! !

```
00001111.11001000.01100011.00010111     15.200.99.23
```

```
00001111.11101111.00000001.00000001     15.239.1.1
```

IP address	Subnet mask	Destination address	Leaves the subnet
201.20.222.13	255.255.255.240	201.20.222.17	☐ **yes** ☐ **no** <=== ! ! !

```
11001001.00010100.11011110.00001101     201.20.222.13
```

```
11001001.00010100.11011110.00010001     201.20.222.17
```

binary representation	decimal representation	binary representation	decimal representation
10000000	128	11111000	248
11000000	192	11111100	252
11100000	224	11111110	254
11110000	240	11111111	255

Question 8)   Points: . . . .

Maximum points: 1+1+0.5+0.5+0.5+0.5+0.5+0.5=5

a) Name the two major classes of routing protocols.

b) Describe what an autonomous system is.

c) The Routing Information Protocol (RIP) is a protocol for. . .
   ☐ Intra-AS routing   ☐ Inter-AS routing

d) Which routing protocol class from subtask a) implements the RIP?

e) The Border Gateway Protocol (BGP) is a protocol for. . .
   ☐ Intra-AS routing   ☐ Inter-AS routing

f) Which routing protocol class from subtask a) implements the BGP?

g) Open Shortest Path First (OSPF) is a protocol for. . .
   ☐ Intra-AS routing   ☐ Inter-AS routing

h) Which routing protocol class from subtask a) implements OSPF?

Question 9)

Maximum points: 2+2+1+1=6

a) The concept of TCP congestion control is called AIMD (= Additive Increase / Multi-plicative Decrease). Describe the reason for the aggressive reduction and conservative increase of the congestion window.

b) Describe the steps of a Denial-of-Service attack via SYN flood.

c) Describe what the congestion avoidance phase of TCP is.

d) Describe what the slow-start phase of TCP is.

Question 10)

Points: ....

Maximum points: 2+2+2+2=8

a) Simplify this IPv6 address:
   `1080:0000:0000:0000:0007:0700:0003:316b`

b) Simplify this IPv6 address:
   `2001:0db8:0000:0000:f065:00ff:0000:03ec`

c) Provide all positions of this simplified IPv6 address:
   `2001:db8:0:c::1c`

d) Provide all positions of this simplified IPv6 address:
   `1080::9956:0:0:234`

Question 11)

Maximum points: 8

```
# WAN Interface
auto eth0
iface eth0 inet dhcp

# LAN 1
auto eth1
iface eth1 inet static
  address 192.168.100.1
  netmask 255.255.255.0
  broadcast 192.168.100.255

# LAN 2
auto eth2
iface eth2 inet static
  address 10.20.0.1
  netmask 255.255.0.0
  broadcast 10.20.255.255
```

Diagram 1 presents the setup of a network. Listing 1 contains the content of the file /etc/network/interfaces of the **Router** machine.
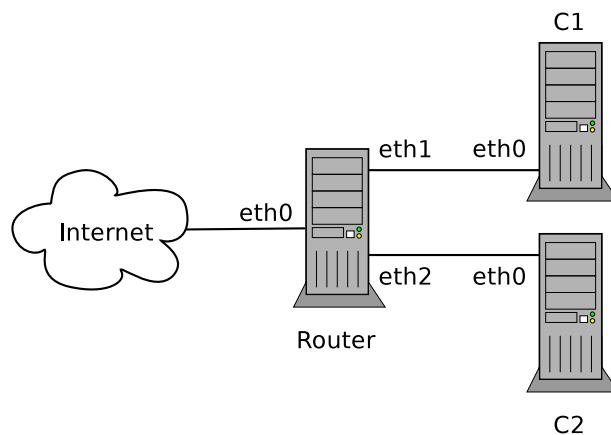
Listing 1: /etc/network/interfaces of **Router**   Diagram 1: Example network

a) Assign valid network configurations for the Computers **C1** and **C2**. Make your configurations in a way, that a connection between the **Router** and the computers **C1** and **C2** is established. The IP addresses **have to be** assigned statically!

```
auto eth0

_____
address _____
netmask _____
gateway _____
```

```
auto eth0

_____
address _____
netmask _____
gateway _____
```

Listing 2: /etc/network/interfaces of **C1**   Listing 3: /etc/network/interfaces of **C2**

Question 12)

Points: ....

Maximum points: 10+1+1+1+2+1=16

a) Use the configuration details from question 11 to fill in the missing parts of the three commands below, that need to be executed on the **Router** machine to implement NAT forwarding.

```
# NAT forwarding

# Configure the forwarding for the interface
iptables -A _____ -o _____ -s _____ \
        -m conntrack --ctstate _____ -j _____

# Configure the NAT masquerading for the interface
iptables -t _____ -A _____ -o _____ -j _____

# Activate IP forwarding

_____
```

Listing 4: `iptables` of **Router**

b) Name a command that can be used in Linux to stop the network interfaces.

c) Name a command that can be used in Linux to start the network interfaces.

d) Name a command that can be used in Linux to check the network configuration of the local machine.

e) Describe the functionality of the command `dnsmasq`.

f) Explain the content of the file `/etc/hosts`.