# Written examination in Computer Networks

February 23th 2018

Last name:
First name:
rirst 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*.
- $\bullet$  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.
- $\bullet$  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)

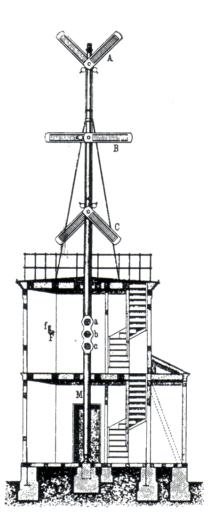
Maximum points: 2+2=4

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  $550\,\mathrm{km}$  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?



Points: .....

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

## Question 2)

Points: .....

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?

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Question	3)	Points:	
Maximum points: 3+1+	,		
a) What information  Sender MAC as Hostname of th Sender IP addr Information ab Preamble to sy Information ab VLAN tag Port number of Receiver MAC Receiver IP add Information ab Port number of Hostname of th Mojo-factor CRC checksum Signals, which	contains an Ethernet freddress he receiver hess hes an Ethernet fress he receiver hess hout the Transport Layer heronize the receiver he Application Layer heronize the receiver heronize the receiver heronize the receiver heronize the receiver heronize the Transport Layer heronize the Transport Layer heronize the Sender heronize the Sender heronize the Sender	er protocol used  protocol used  protocol used  transmission medium	
c) Describe what the	e ARP cache is.		

d) Name one benefit of the ARP cache.

#### Question 4)

Points: .....

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.

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Student number:

Question	6)	)
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Points:											
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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.

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					
1000000	128	11111000	248					
11000000	192	11111100	252					
11100000	224	11111110	254					
11110000	240	11111111	255					

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#### Question 8)

Points: .....

Student number:

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  $\dots$ 
  - $\square$  Intra-AS routing  $\square$  Inter-AS routing
- d) Which routing protocol class from subtask a) implements the RIP?
- e) The Border Gateway Protocol (BGP) is a protocol for...
  - $\square$  Intra-AS routing  $\square$  Inter-AS routing
- f) Which routing protocol class from subtask a) implements the BGP?
- g) Open Shortest Path First (OSPF) is a protocol for...
  - $\square$  Intra-AS routing  $\square$  Inter-AS routing
- h) Which routing protocol class from subtask a) implements OSPF?

#### Question 9)

Points: .....

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

a) The concept of TCP congestion control is called AIMD (= Additive Increase / Multiplicative 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

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#### Question 11)

Maximum points: 8

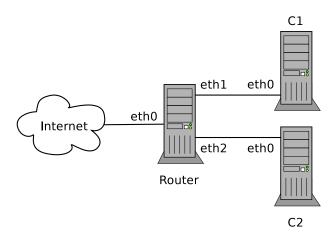
```
# WAN Interface
auto eth0
iface eth0 inet dhcp

# 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
```

Points: .....

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	auto eth0
address	address
netmask	netmask
gateway	gaceway

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

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Points:																					
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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.

#### 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.