Written examination in Computer Networks

(including tasks from the lab)

February 26th 2016

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	13	14	15	**Σ**	Grade
Maximum points:	5	3	4	14	7	5	7	7	8	8	4	4	4	6	4	90	—
Achieved points:																	

Last name: First name: Student number:

Question 1)

Points: .....

Maximum points: 2+0,5+0,5+1+0,5+0,5=5

a) A scientific experiment produces 25 petabytes ($25 * 2^{50}$ Byte) of data per year, which need to be stored. What is the height of a stack of storage media, if for storing the data CDs (capacity: 600 MB = $600 * 10^6$ Byte, thickness: 1.2 mm) are used?

- Calculate the solution for 25 PB = $25 * 2^{50}$ Byte

- Calculate the solution for 25 PB = $25 * 10^{15}$ Byte

b) Name an advantage of serial data transmission compared with parallel data transmission.

c) Name an advantage of parallel data transmission compared with serial data transmission.

d) Do computer networks usually implement parallel or serial data transmission?

e) What describes the physical topology of a computer network?

f) What describes the logical topology of a computer network?

Last name: First name: Student number:

Question 2)

Points: .....

Maximum points: 3

A scientific experiment produces 25 petabytes ($25 * 2^{50}$ Byte) of data per year. How much time requires the transmission of the data via an Ethernet with a bandwidth of 1 gigabit per second?

Last name: First name: Student number:

Question 3)

Points: .....

Maximum points: 4

A webcam at the surface of planet Mars sends pictures to Earth. Each image has a size of 25 MB (1 MB = 2^{20} Byte). How quickly, after a picture is taken, can it reach Mission Control on Earth?

(Note: The network connection is a point-to-point link.)

Data rate = 196 kbps (kilobit per second))
Signal propagation speed = 299.792.458 m/s
Waiting time = 0 s
Distance = 55.000.000.000 m

(Note: The distance between Earth and Mars fluctuates between approx. 55,000,000 km and approx. 400,000,000 km. For the further calculations, we use the 55,000,000 km, which is the distance from Earth to Mars, when they are closest together.)

Last name: First name: Student number:

Question 4)

Points: .....

Maximum points: 12+2=14

a) Fill out all enpty fields.
(Please fill in each empty cell only one correct answer!)

ISO/OSI Reference Model

Layer	Protocol	Device	Sort of Data (data unit)	Addresses
7				
6				
5				
4				
3				
2				
1				

b) Why are two layers of the ISO/OSI Reference Model usually not used in practice?

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Question 5)

Points: .....

Maximum points: 1+2+2+2=7

a) Why is it impossible to connect different buildings with shielded cables?

b) Name a benefit and a drawback of mono-mode (single-mode) fibers compared with multi-mode fibers.

c) Name a benefit and a drawback of multi-mode fibers compared mono-mode (single-mode) fibers.

d) The following information come from existing twisted pair network cables. What information is provided about the shielding of these cables?

- `E138922 RU AWM 2835 24 AWG 60°C CSA LL81295 FT2 ETL VERIFIED EIA/TIA-568A CAT.5 UTP EVERNEW G3C511`
- `E188601 (UL) TYPE CM 75°C LL84201 CSA TYPE CMG FT4 CAT.5E PATCH CABLE TO TIA/EIA 568A STP 26AWG STRANDED`
- `SSTP ENHANCED CAT.5 350MHZ 26AWG X 4P PATCH TYPE CM (UL) C(UL) E200579 CMG CSA LL81924 3P VERIFIED`
- `EC-net 7.5 m 11184406 13/03 PremiumNet 4 PAIR 26AWG S-FTP HF IEC 332-1 ENHANCED CATEGORY 5 PATCH CORD EN0173+ISO/IEC`

Last name: First name: Student number:

Question 6)

Points: .....

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

a) What is the purpose of Repeaters in computer networks?

b) What is the major difference between Repeaters and Hubs?

c) Why do Repeaters and Hubs not require physical or logical addresses?

d) What network topologies do Hubs implement?

e) What is a collision domain?

Last name: First name: Student number:

Question 7)

Points: .....

Maximum points: 1+2+2+1+1=7

a) Describe the functioning of the line code Non-Return-To-Zero (NRZ)?

b) What two problems can occur, when NRZ is used to encode data?

c) How can the problems from subtask b) be avoided?

d) Why is it important for the receiver of signals, which are encoded according to the Differential Manchester Encoding, to know the initial signal level?

e) Why do some line codes, that map groups of payload bits onto groups of code bits, implement variants with neutral inequality, positive inequality and negative inequality?

Last name: First name: Student number:

Question 8)

Points: .....

Maximum points: 1+1+1+1+1+1+1=7

a) What is the purpose of Bridges in computer networks?

b) Why do Bridges try to avoid loops?

c) What protocol use Bridges to handle loops?

d) What is the selection criteria for determining, whether a Bridge becomes the Root Bridge?

e) What is a Designated Bridge and what is its task?

f) How many Designated Bridges does a computer network contain?

g) What is the impact of Bridges and Layer-2-Switches on the collision domain?

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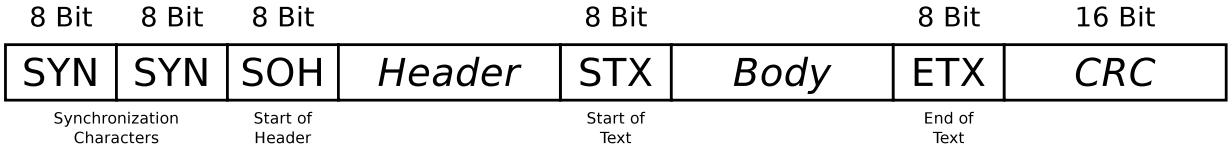
Question 9)

Points: .....

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

The character-oriented protocol BISYNC uses control characters to mark the structure of the frames. The start of a frame highlights the character `SYN`. The start of the header highlights the character `SOH` (*Start of header*). The payload is located between `STX` (*Start of text*) and `ETX` (*End of text*).



If the payload (body) contains the control characters `ETX` and `DLE` (*Data Link Escape*), they are protected (*escaped*) by the Data Link Layer protocol with a stuffed `DLE` caracter. A single `ETX` in the payload area is represented by the sequence `DLE ETX`. The `DLE` character itsef is represented by the sequence `DLE DLE`.

Control character	SOH	STX	ETX	DLE	SYN
Hexadecimal notation	01	02	03	10	16

Mark the payload inside the following BISYNC frames?

a) `16 16 01 99 98 97 96 95 02 C1 12 34 56 78 90 C2 03 A0 B7`

b) `16 16 01 99 98 97 96 95 02 B1 10 10 10 10 10 10 10 10 10 10 B3 03 76 35`

c) `16 16 01 99 98 97 96 95 02 10 03 10 10 10 03 10 10 10 03 10 10 03 92 55`

d) `16 16 01 99 98 97 96 95 02 10 10 A1 10 10 B1 10 03 C1 01 C2 A1 03 99 B2`

Last name: First name: Student number:

Question 10)

Points: .....

Maximum points: 4+4=8

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

```
Generator polynomial: 100101
Payload: 10110101
```

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

```
Transferred frame: 1010010110100
Generator polynomial: 100101
```

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Question 11)

Points: .....

Maximum points: 2.5+1.5=4

a) Split the class A network `16.0.0.0` for implementing 513 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?
```

b) The sender transmits an IP packet to a receiver. Calculate the subnet ID of sender and receiver and specify whether the IP packet leaves the subnet during transmission or not.

```
Sender:        10000100.10011000.01010011.11111110    132.152.83.254
Subnet mask:   11111111.11111111.11111100.00000000    255.255.252.0


Receiver:      10000100.10011000.01010001.00000010    132.152.81.2
Subnet mask:   11111111.11111111.11111100.00000000    255.255.252.0


       Subnet ID of sender?


       Subnet ID of receiver?


       Does the IP packet leave the subnet [yes/no]?
```

Last name: First name: Student number:

Question 12)

Points: .....

Maximum points: 1+1+1+1=4

a) Describe one example, where using the Transport Layer protocol TCP makes sense.

b) Describe one example, where using the Transport Layer protocol UDP makes sense.

c) Which two possible reasons for the occurrence of congestion in computer networks exist?

d) Why does the sender maintain two windows when using TCP and not just a single one?

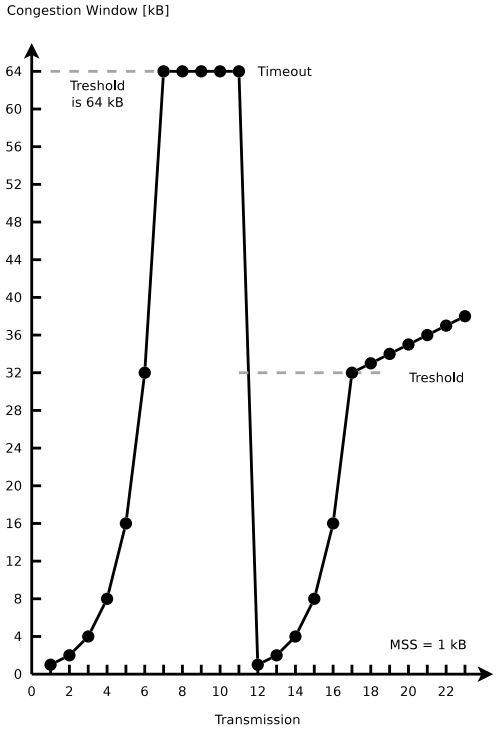
Last name: First name: Student number:

Question 13)

Points: .....

Maximum points: 2+1+1=4

a) Mark in the figure the slow-start phase and the congestion avoidance phase both.



b) Describe what fast retransmit is?

c) Describe what fast recovery is?

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Question 14)

Points: .....

Maximum points: 2+2+2=6

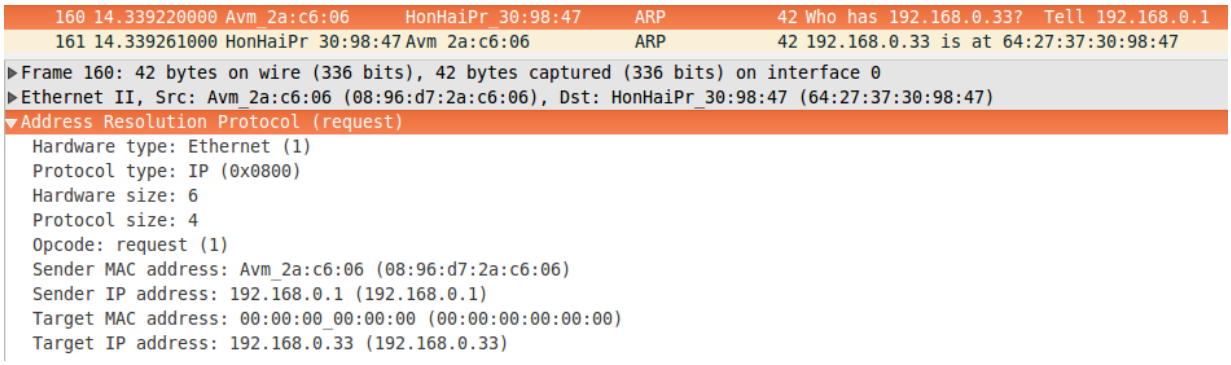
a) Mark the IP Address of the Default Gateway in the output of `route -n`.

```
# route -n
Kernel IP routing table
Destination     Gateway         Genmask         Flags Metric Ref    Use Iface
0.0.0.0         192.168.0.1     0.0.0.0         UG    1024   0        0 eth0
192.168.0.0     0.0.0.0         255.255.255.0   U     0      0        0 eth0
```

b) Mark the MAC Address of the Default Gateway in the output of `arp -n`.

```
# arp -n
192.168.0.191            ether   00:11:32:1c:03:f3   C                     eth0
192.168.0.21             ether   1c:b0:94:c4:a2:74   C                     eth0
192.168.0.1              ether   08:96:d7:2a:c6:06   C                     eth0
```

c) The following picture is a screenshot of the wireshark tool.



- What is the objective of these two ARP packets?

- What does the target MAC address 00:00:00:00:00:00 mean?

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Question 15)

Points: .....

Maximum points: 1+1+1+1=4

a) The `ifconfig` tool says the local IP address is 192.168.150.71, but the website `checkip.dyndns.org` says the current IP address is 194.94.82.237. What technology is probably used?

b) What is the effect, when you insert the following line to your local `/etc/hosts` file?

```
127.0.0.1                www.google.com
```

c) Given the following configuration, what will happen if you send UDP segments with length 2500 Bytes via `eth0` from this machine?

```
# ifconfig eth0
eth0   Link encap:Ethernet  HWaddr B8:27:EB:CE:50:E2
       inet addr:10.0.0.9  Bcast:10.0.0.255  Mask:255.255.255.0
       UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
       RX packets:6853190 errors:0 dropped:370 overruns:0 frame:0
       TX packets:3453175 errors:0 dropped:0 overruns:0 carrier:0
       collisions:0 txqueuelen:1000
       RX bytes:1516614221 (1.4 GiB)  TX bytes:306452639 (292.2 MiB)
```

d) Give one possible compressed notation for this IPv6 Address:
`fe80:0000:0000:0000:0000:a1ff:0000:5fc3`