Written examination in Computer Networks

May 24th 2019

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: _____

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

- 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.

- Do *not* use a red pen.

- Time limit: *90 minutes*

- Turn off your mobile phones!

Result:

Question:	1	2	3	4	5	6	7	8	9	10	Σ	Grade
Maximum points:	9	4	6	12	20	8	8	7	8	8	90	—
Achieved points:												

1.0: 90.0-85.5, **1.3**: 85.0-81.0, **1.7**: 80.5-76.5, **2.0**: 76.0-72.0, **2.3**: 71.5-67.5,
2.7: 67.0-63.0, **3.0**: 62.5-58.5, **3.3**: 58.0-54.0, **3.7**: 53.5-49.5, **4.0**: 49.0-45.0, **5.0**: <45

Question 1)

Maximum points: 6+1+1+1=9

a) A scientific experiment produces 35 petabytes ($35 * 2^{50}$ 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: 650 MB $= 650 * 10^6$ Byte, thickness: 1.2 mm) are used?

- Calculate the solution for 35 PB $= 35 * 2^{50}$ Byte

- Calculate the solution for 35 PB $= 35 * 10^{15}$ Byte

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

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

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

Question 2)   Points: ....

Maximum points: 4

A scientific experiment produces 30 petabytes $(30 * 2^{50}$ 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?

Question 3)

Maximum points: 6

A webcam at the surface of planet Mars sends pictures to Earth. Each image has a size of 30 MB ($1\,\text{MB} = 2^{20}\,\text{Byte}$). 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 = 256 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.)

Question 4)

Maximum points: 12

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				

Question 5 – Part 1/2)   Points: ....

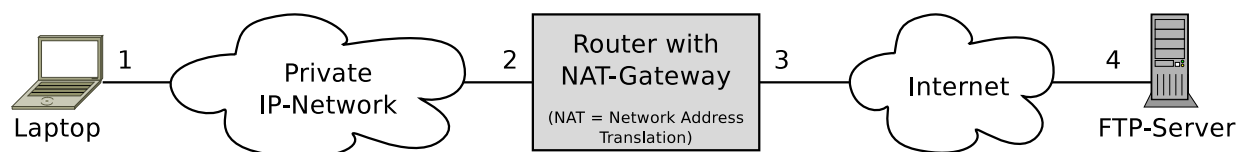Maximum points: 4.5+10+2+3.5=20

Figure 1: Network topology

Figure 2: Wireshark output of a received transmission on interface 1

```
⊞ Ethernet II, Src: JuniperN_7a:d6:81 (50:c5:8d:7a:d6:81), Dst: ActionSt_0b:2a:ed (00:24:9b:0b:2a:ed)
⊟ Internet Protocol Version 4, Src: 217.160.233.106, Dst: 192.168.50.17
     0100 .... = Version: 4
     .... 0101 = Header Length: 20 bytes (5)
   ⊞ Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)
     Total Length: 75
     Identification: 0x1eb4 (7860)
   ⊞ Flags: 0x00
     Fragment offset: 0
     Time to live: 56
     Protocol: TCP (6)
   ⊞ Header checksum: 0xae34 [validation disabled]
     Source: 217.160.233.106
     Destination: 192.168.50.17
⊞ Transmission Control Protocol, Src Port: 21 (21), Dst Port: 4934 (4934), Seq: 24, Ack: 11, Len: 35
⊞ File Transfer Protocol (FTP)
```

Figure 3: Wireshark output of a received transmission on interface 3

```
⊞ Ethernet II, Src: 22:ac:11:45:e3:44 (22:ac:11:45:e3:44), Dst: JuniperN_bb:2e:fa (50:c5:8d:bb:2e:fa)
⊟ Internet Protocol Version 4, Src: 217.160.233.106, Dst: 194.94.80.16
     0100 .... = Version: 4
     .... 0101 = Header Length: 20 bytes (5)
   ⊞ Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)
     Total Length: 75
     Identification: 0x1eb4 (7860)
   ⊞ Flags: 0x00
     Fragment offset: 0
     Time to live: 56
     Protocol: TCP (6)
   ⊞ Header checksum: 0xae34 [validation disabled]
     Source: 217.160.233.106
     Destination: 194.94.80.16
⊞ Transmission Control Protocol, Src Port: 21 (21), Dst Port: 22345 (22345), Seq: 3306717526, Ack: 1149803236, Len: 35
⊞ File Transfer Protocol (FTP)
```

The transmissions in figure 2 and figure 3 correspond with each other because they are used to transport the same FTP data. They transport the reply from the FTP server, which is initiated by a request of the laptop.

Question 5 – Part 2/2)   Points: ....

Maximum points: 4.5+10+2+3.5=20

a) Fill out all empty fields of the table.

Interface	1	2	3	4
MAC address				████
IP address		████		
Port number		████		

b) Show the protocol stack (starting with OSI layer 2) of the transmission in Figure 3. Fill in the correct number of Bytes of the headers, trailer and payloads. Also name the protocols used. Consider the FTP data as pure payload.

c) What is the amount of overhead in Bytes for the transmission of the FTP data (header and payload)?

d) Calculate the overhead ratio in % (possible OSI layer 1 overhead is ignored).

Question 6)

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

a) Simplify this IPv6 address:
   `2001:0db8:0000:0001:0000:0000:0010:01ff`

b) Simplify this IPv6 address:
   `2001:0db8:0000:000b:0000:0000:0000:001a`

c) Provide all positions of this simplified IPv6 address:
   `2001:db8:0:200::7`

d) Provide all positions of this simplified IPv6 address:
   `2001:14e0:50::10:0:1`

Question 7)

Maximum points: 3+5=8

a) Error Correction via simplified Hamming Distance (Hamming ECC method). Calculate the message, that will be transmitted (payload inclusive parity bits).

   `Payload: 10011010`

b) Error Correction via simplified Hamming Distance (Hamming ECC method). Verify, if the received message was transmitted correctly.

   `Received message: 0001101100101101`

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?

Question 9)

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
```

Question 10)

Maximum points: 5+3=8

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]?
```