

Written examination in Computer Networks

February 18th 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: _____

- 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:

[illegible]

Last name:

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Student number:

Question 1)

Points:

Maximum points: $6+1+1+1+1+1=11$

- 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: $650 \text{ MB} = 650 * 10^6 \text{ Byte}$, thickness: 1.2 mm) are used?
- Calculate the solution for $35 \text{ PB} = 35 * 2^{50} \text{ Byte}$

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

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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?

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Question 3)

Points:

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.)

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Question 4)

Points:

Maximum points: 12+1+1=14

a) Fill out all empty 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) 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
```

c) 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
```

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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

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Question 7)

Points:

Maximum points: 3+4=7

- 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

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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*).

8 Bit	8 Bit	8 Bit		8 Bit		8 Bit	16 Bit
SYN	SYN	SOH	<i>Header</i>	STX	<i>Body</i>	ETX	<i>CRC</i>
Synchronization Characters		Start of Header		Start of Text		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** character. A single **ETX** in the payload area is represented by the sequence **DLE ETX**. The **DLE** character itself 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 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

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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: 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]?

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Question 12)

Points:

Maximum points: $1+1+2+1=5$

- 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?