

Written examination in Computer Networks

June 24th 2021

Last name: _____

First name: _____

Student number: _____

Mit dem Bearbeiten dieser schriftlichen Prüfung (Klausur) bestätigen Sie, dass Sie diese alleine bearbeiten und dass Sie sich gesund und prüfungsfähig fühlen. Mit dem Erhalt der Aufgabenstellung gilt die Klausur als angetreten und wird bewertet.

By attending this written exam, you confirm that you are working on it alone and feel healthy and capable to participate. Once you have received the examination paper, you are considered to have participated in the exam, and it will be graded.

- Use the provided sheets. Do *not* use own paper.
- You are allowed to use a *self prepared, single sided DIN-A4 sheet* in the exam. Only *hand-written 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!

Grade: _____

Questions:	1	2	3	4	5	6	7	8	9	10	Σ
Maximum points:	8	10	13	6	7	8	9	9	15	5	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)

Points:

1 Point

- (1) Explain the difference between serial data transmission and parallel data transmission.

1 Point

- (2) Name an advantage of serial data transmission compared with parallel data transmission.

1 Point

- (3) Name an advantage of parallel data transmission compared with serial data transmission.

$\frac{1}{2}$ Point

- (4) Computer networks usually implement...

☐ parallel data transmission ☐ serial data transmission

$\frac{1}{2}$ Point

- (5) Explain your answer of question (4).

2 Points

- (6) 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 $35 \text{ PB} = 35 * 2^{50} \text{ Byte}$

2 Points

- (7) Calculate the solution of question (6) for $35 \text{ PB} = 35 * 10^{15} \text{ Byte}$

Question 2)

Points:

1 Point

(1) Name two systems, that operate according to the simplex principle.

1 Point

(2) Name two systems, that operate according to the full-duplex principle.

1 Point

(3) Name two systems, that operate according to the half-duplex principle.

5 Points

(4) A file with a size of $15 * 10^7$ bits must be transferred from terminal device A to terminal device B. The signal propagation speed is 200,000 km/s. A and B are directly connected by a link with a length of 20,000 km. The file is transferred as a single message, that has a size of $15 * 10^7$ bits. No network protocol headers or trailers exist.

Calculate the transfer time (latency) of the file, when the data rate of the computer network between both terminal devices is 50 Mbps.

2 Points

(5) Calculate the volume of the network connection. In other words: What is the maximum number of bits that can reside inside the line between the sender and receiver?

Hint: Transmission delay = 0s, Waiting time = 0s.

Question 3)

Points:

11 Points

(1) 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	SMTP		Message	
6				
5				
4				
3				
2				
1				

1 Point

(2) Explain why computer networks require line codes.

1 Point

(3) Many different line codes exist. Explain why it is impossible to use one single line code for every network technology.

Question 4)

Points:

1 Point

(1) Explain the way Non-Return-To-Zero (NRZ) works.

1 Point

(2) Name the two problems that can occur when NRZ is used to encode data.

2 Points

(3) Explain both problems from question (2) in detail.

2 Points

(4) Explain how the problems from question (2) can be avoided.

Question 5)

Points:

1 Point

(1) Name two examples of Bridge implementations.

1 Point

(2) Explain what a spanning tree is.

1 Point

(3) Explain what a BPDU message is and for what purpose it is used.

1 Point

(4) Explain what a switched network is.

1 Point

(5) Explain the benefit of a switched network compared to a non-switched network.

1 Point

(6) Explain why it is important that the transmission of a frame is not completed when a collision occurs in an Ethernet network.

1 Point

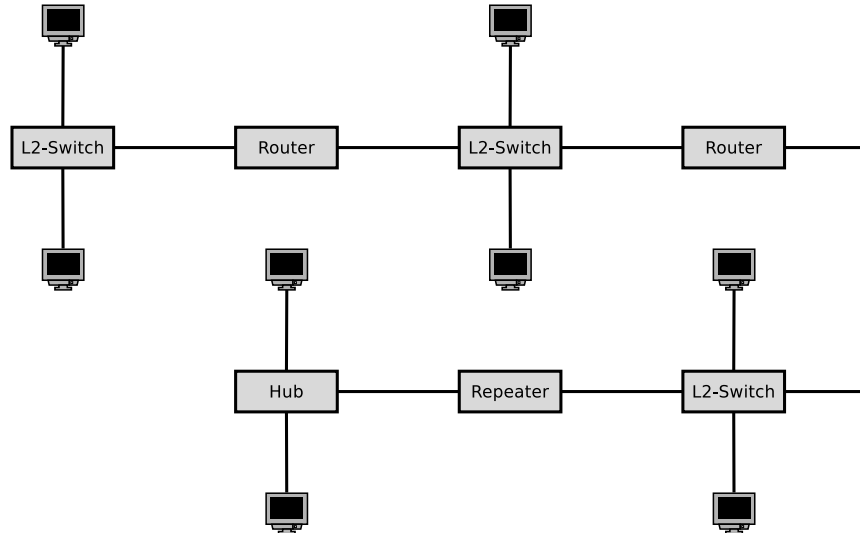
(7) Explain what is done to ensure that the transmission of a frame is not completed when a collision occurs in an Ethernet network.

Question 6)

Points:

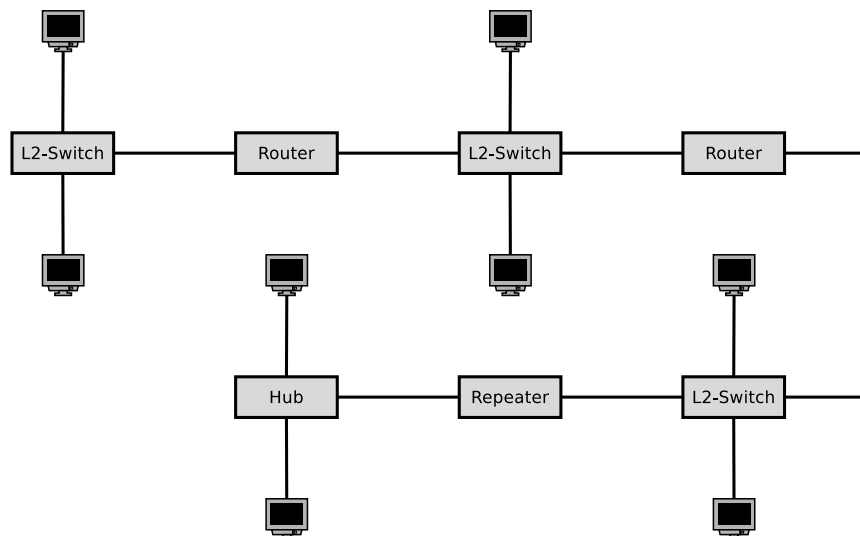
5½ Points

(1) Sketch in the diagram all collision domains.



1½ Points

(2) Sketch in the diagram all broadcast domains.



1 Point

(3) Give the number of logical subnets required for the given network topology.

Question 7)

Points:

1 Point

- (1) Name the two special characteristics of the transmission medium in wireless networks that cause undetected collisions at the receiver.

2 Points

- (2) Describe both special characteristics of question (1).

2 Points

- (3) Explain what the Network Allocation Vector (NAV) is and for what purpose it is used.

2 Points

- (4) Explain what the Contention Window (CW) is and for what purpose it is used.

2 Points

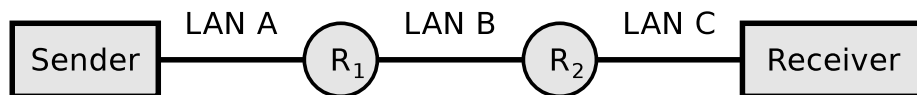
- (5) Name a benefit and a drawback of using the control frames Request To Send (RTS) and Clear To Send (CTS)?

Question 8)

Points:

9 Points

- (1) 6500 bytes payload need to be transmitted via the IP protocol. The payload must be fragmented, because it is transmitted over multiple physical networks, whose MTU is < 6500 bytes. Display graphically the way, the payload is fragmented, and how many bytes of payload each fragment contains.



	LAN A	LAN B	LAN C
Network technology	WLAN	Ethernet	PPPoE
MTU [bytes]	2312	1500	1492
IP header [bytes]	20	20	20
max. payload [bytes]	2292	1480	1472

Hint: In practice, the fragment offset is counted in 8-byte increments; therefore, the payload in a fragment must be a multiple of 8. However, for the sake of simplicity, you can also create fragments that are not multiples of 8 in this task.

Question 9)

Points:

2 Points

- (1) Simplify this IPv6 address:
21da:00d3:0000:0000:02aa:00ff:fe28:9c5a

2 Points

- (2) Simplify this IPv6 address:
2001:0db8:0000:0000:5a6b:0000:0001:678a

2 Points

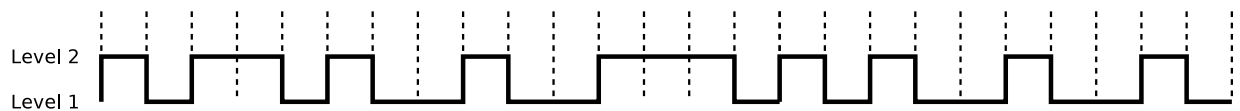
- (3) Provide all positions of this simplified IPv6 address:
2001:db8:84a2::8a2e:70:4

2 Points

- (4) Provide all positions of this simplified IPv6 address:
2001:cdba::18:2

5 Points

- (5) This signal curve is encoded with NRZI and 4B5B. Decode the data.



Label	4B	5B	Function
0	0000	11110	0 hexadecimal
1	0001	01001	1 hexadecimal
2	0010	10100	2 hexadecimal
3	0011	10101	3 hexadecimal
4	0100	01010	4 hexadecimal
5	0101	01011	5 hexadecimal
6	0110	01110	6 hexadecimal
7	0111	01111	7 hexadecimal

Label	4B	5B	Function
8	1000	10010	8 hexadecimal
9	1001	10011	9 hexadecimal
A	1010	10110	A hexadecimal
B	1011	10111	B hexadecimal
C	1100	11010	C hexadecimal
D	1101	11011	D hexadecimal
E	1110	11100	E hexadecimal
F	1111	11101	F hexadecimal

1 Point

- (6) Explain the purpose of the Internet Control Message Protocol (ICMP).

1 Point

- (7) Give two examples for command line tools, which use ICMP.

Question 10)

Points:

1 Point

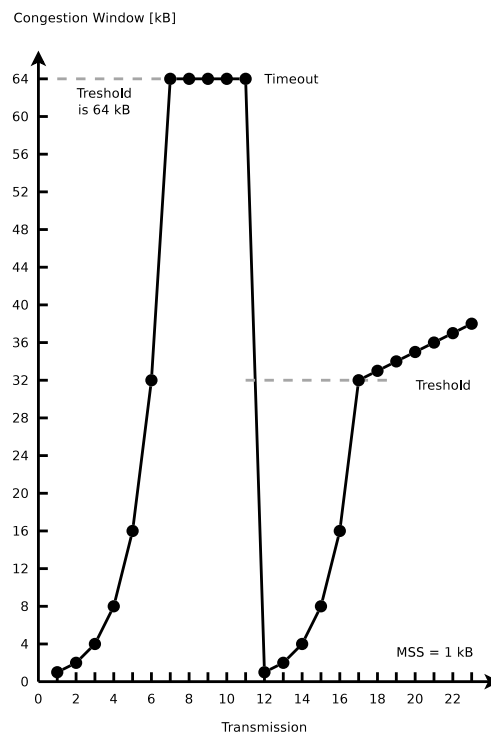
(1) Describe what the Seq number in an TCP segment specifies.

1 Point

(2) Describe what the Ack number in an TCP segment specifies.

1 Point

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



1 Point

(4) Describe what fast retransmit is.

1 Point

(5) Describe what fast recovery is.