



Last name:

First name:

Student number:

---

## Question 1)

Points: .....

Maximum points: 7

An image has a size of 2000x1000 pixels. 2 Bytes per pixel are used for the color information. Assume the image is uncompressed. How long does it take to transmit the image via a...

$$2000 * 1000 \text{ pixels} = 2,000,000 \text{ pixels}$$

$$2,000,000 \text{ pixels} * 2 \text{ Bytes/pixel} = 4,000,000 \text{ Bytes}$$

$$4,000,000 \text{ Bytes} * 8 = 32,000,000 \text{ Bits}$$

a) 64 kbps ISDN connection?

$$\frac{32,000,000 \text{ Bits}}{64,000 \text{ Bits/s}} = 500 \text{ s}$$

b) 16 Mbps DSL connection?

$$\frac{32,000,000 \text{ Bits}}{16,000,000 \text{ Bits/s}} = 2 \text{ s}$$

c) 100 Mbps Ethernet connection?

$$\frac{32,000,000 \text{ Bits}}{100,000,000 \text{ Bits/s}} = 0.32 \text{ s}$$

Last name:

First name:

Student number:

---

## Question 2)

Points: .....

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

a) Computer networks usually implement...

- serial data transmission       parallel data transmission

b) Computer networks with coaxial cables operate in...

- simplex mode       full-duplex mode       half-duplex mode

c) The global positioning system (GPS) operates in...

- simplex mode       full-duplex mode       half-duplex mode

d) Computer networks with twisted pair cables operate in...

- simplex mode       full-duplex mode       half-duplex mode

e) Wireless networks with just a single channel operate in...

- simplex mode       full-duplex mode       half-duplex mode

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

*It describes the wiring.*

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

*It describes the flow of data.*

Last name:

First name:

Student number:

---

## Question 3)

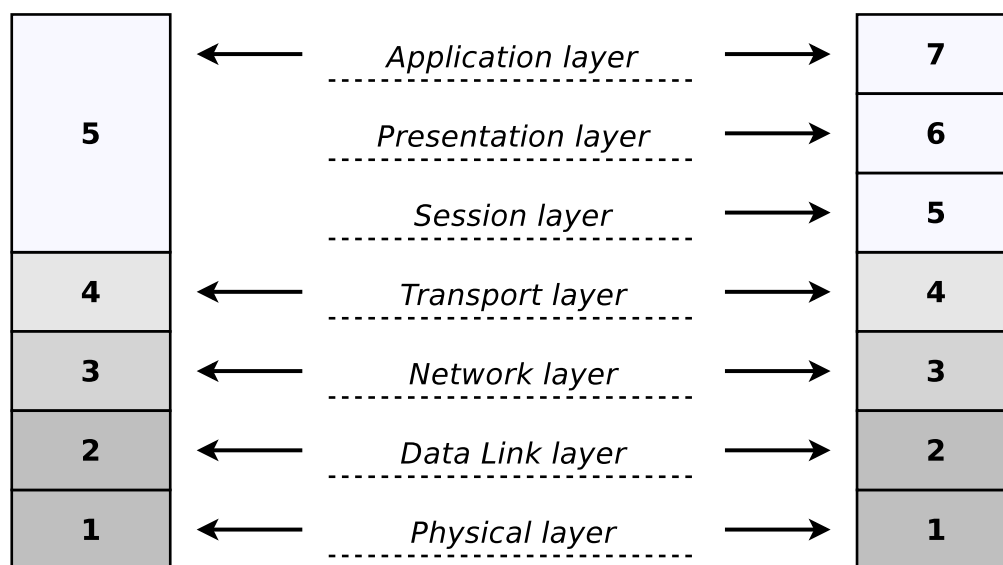
Points: .....

Maximum points:  $3.5+0.5+0.5+0.5+0.5+0.5=6$

- a) Write on the dotted lines the names of the layers.

### Hybrid Reference Model

### OSI Reference Model



- b) Ethernet frames are created in the *Data Link* layer.
- c) UDP segments are created in the *Transport* layer.
- d) IP packets are created in the *Network* layer.
- e) Signals are created in the *Physical* layer.
- f) TCP segments are created in the *Transport* layer.

Last name:

First name:

Student number:

---

## Question 4)

Points: .....

Maximum points:  $4+2+1+1+1=9$

- a) Assign the devices in the table to the layers of the hybrid reference model.

Column 1 stands for the bottom layer and column 5 for the top layer of the hybrid reference model. If more than just a single layer is a correct answer, it is sufficient to select at least one correct layer.

	Hybrid reference model layer				
	1	2	3	4	5
Bridge		X			
Gateway	X	X	X	X	X
Hub	X				
Modem	X	X			
Multiport Bridge		X			
Repeater	X				
Router			X		
Switch		X	X		

- b) Name two examples of Bridge implementations.

*WLAN Bridges and Laser Bridges.*

- c) What information is stored in forwarding tables of Bridges?

*Learning Bridges store this information, which network devices are accessible via which port in local forwarding tables.*

- d) Why do Bridges try to avoid loops?

*Loops can cause malfunctions and reduce the performance of the network or even lead to a network failure.*

- e) Which device connects wireless network devices in infrastructure mode?

*Access Point*

Last name:

First name:

Student number:

---

## Question 5)

Points: .....

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

- a) Which two problems can occur, when the line code NRZ is used to encode data?

*Baseline wander and clock recovery.*

- b) How can the problems from subtask a) be avoided?

*To prevent baseline wander, the usage of the signal levels must be equally distributed.*

*One way to ensure clock recovery is by using a separate line, which transmits just the clock. In computer networks, a separate signal line just for the clock is not practical because of the cabling effort. Instead, it is recommended to increase the number of guaranteed signal level changes to enable the clock recovery from the data stream.*

- c) Why do not all line codes ensure a signal level change for each transmitted bit?

*Lack of efficiency.*

- d) How is the efficiency of a line code calculated?

*Efficiency = Ratio of bit rate (payload in bits per time) and baud rate (signal changes per second).*



Last name:

First name:

Student number:

---

## Question 7)

Points: .....

Maximum points: 7

Which protocol...

- a) provides congestion control and flow control?  
*TCP*
- b) resolves logical addresses into physical addresses?  
*ARP*
- c) avoids collisions inside physical networks?  
*CSMA/CA*
- d) provides routing within autonomous systems via the Bellman-Ford algorithm?  
*RIP*
- e) allows remote control of computers in an encrypted way?  
*SSH*
- f) provides routing within autonomous systems via the Dijkstra algorithm?  
*OSPF*
- g) assigns the network configuration to network devices?  
*DHCP*
- h) allows remote control of computers in a unencrypted way?  
*Telnet*
- i) realizes connectionless inter-process communication?  
*UDP*
- j) resolves domain names into logical addresses?  
*DNS*
- k) detects collisions inside physical networks?  
*CSMA/CD*
- l) allows downloading and uploading files in an unencrypted way?  
*FTP*
- m) exchanges diagnostic and control messages?  
*ICMP*
- n) reduces a computer network to a loop-free tree?  
*STP*



Last name:

First name:

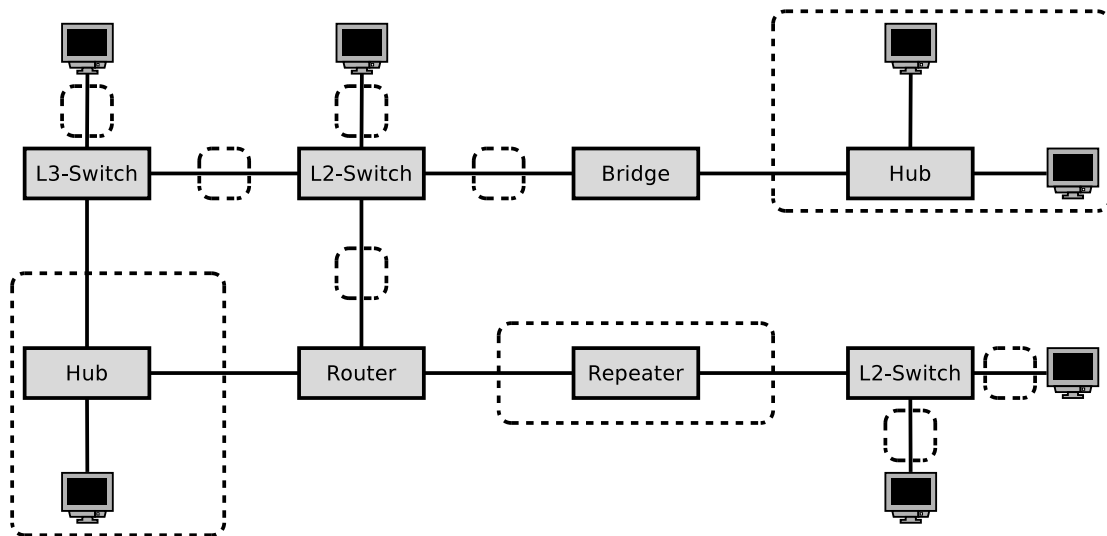
Student number:

# Question 8)

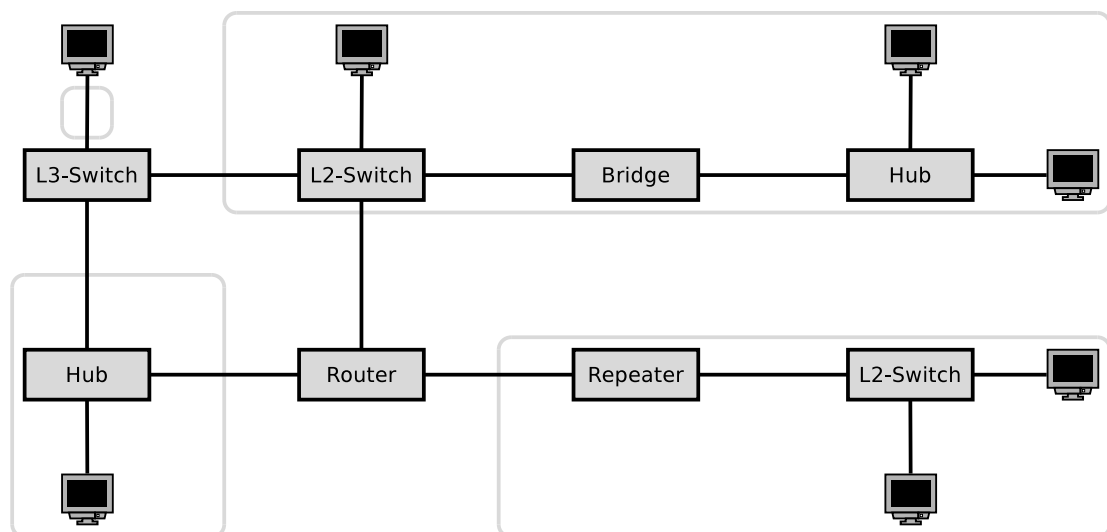
Points: .....

Maximum points: 4+2=6

a) Sketch in the diagram of the network topology all collision domains.



b) Sketch in the diagram of the network topology all broadcast domains.



Last name:

First name:

Student number:

# Question 9)

Points: .....

Maximum points: 4+4=8

- a) Error Detection via CRC: Check, if the received frame was transmitted correctly.

Received frame: 1011010110110

Generator polynomial: 100101

```

1011010110110
100101|||||
-----vv|||||
  100001|||||
  100101|||||
  -----vvv||
    100101||
    100101||
    -----vv
      10 => Error

```

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

Received message: 101110100010

```

Received data: 1  2  3  4  5  6  7  8  9 10 11 12
                1  0  1  1  1  0  1  0  0  0  1  0

```

```

      0011 Position 3
      0101 Position 5
      0111 Position 7
XOR 1011 Position 11
-----
      1010 Parity bits calculated
XOR 1010 Parity bits received
-----
      0000 => Correct transmission

```

Last name:

First name:

Student number:

---

## Question 10)

Points: .....

Maximum points: 5+5=10

Calculate for each subtask the subnet mask and answer the questions.

- a) Split the class B network 175.8.0.0 for implementing 50 subnets.

Network ID: 10101111.00001000.00000000.00000000 175.8.0.0

Number of bits for subnet IDs? 6 Bits

Subnet mask: 11111111.11111111.11111100.00000000 255.255.252.0

Number of bits for host IDs? 10

Number of host IDs per subnet?  $2^{10} - 2 = 1022$

- b) Split the class C network 200.111.222.0 into subnets, which contain 7 hosts each.

Network ID: 11001000.01101111.11011110.00000000 200.111.222.0

Number of bits for host IDs? 4 Bits

Subnet mask: 11111111.11111111.11111111.11110000 255.255.255.240

Number of bits for subnet IDs? 4 Bits

Number of possible subnets? 16

binary representation	decimal representation
10000000	128
11000000	192
11100000	224
11110000	240
11111000	248
11111100	252
11111110	254
11111111	255



Last name:

First name:

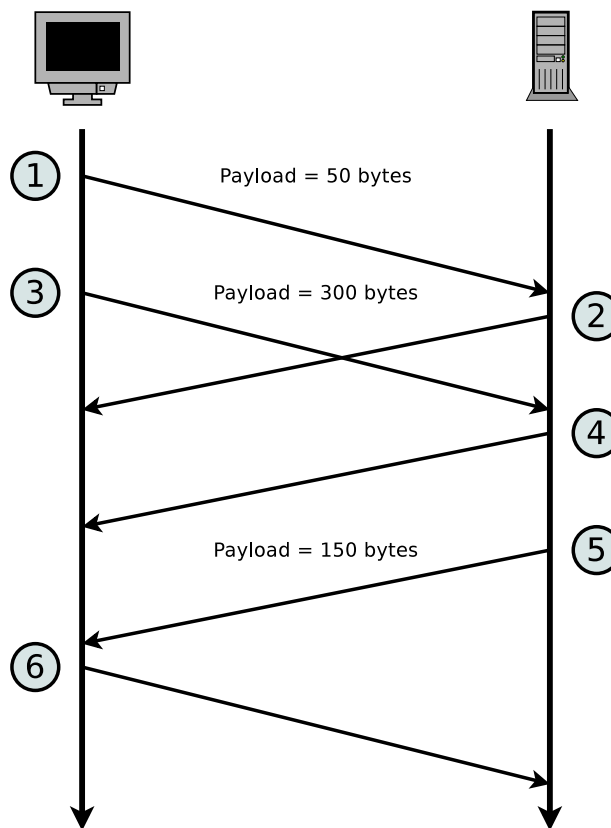
Student number:

## Question 12)

Points: .....

Maximum points: 8

The diagram shows an excerpt of the transmission phase of a TCP connection. Complete the table.



Message	ACK	SYN	FIN	Payload length	Seq number	Ack number
1	0	0	0	50	220	931
2	1	0	0	0	931	270
3	0	0	0	300	270	931
4	1	0	0	0	931	570
5	0	0	0	150	931	570
6	1	0	0	0	570	1081

Last name:

First name:

Student number:

# Question 13)

Points: .....

Maximum points: 1+1+1=3

a) Which two possible reasons for the occurrence of congestion exist?

*Receiver capacity: The receiver can not process the received data fast enough and therefore its receive buffer becomes full.*

*Network capacity: Congestion of the network occurs.*

b) Mark in the figure the slow-start phase.

c) Mark in the figure the congestion avoidance phase.

