Chair of Distributed Systems and Security
School of Computation, Information, and Technology
Technical University of Munich

Esolution
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Note:

- During the attendance check a sticker containing a unique code will be put on this exam.
- This code contains a unique number that associates this exam with your registration number.
- This number is printed both next to the code and to the signature field in the attendance check list.

Computer Networking and IT-Security

Exam:	INHN0012 / Midterm	**Date:**	Thursday 14th December, 2023
Examiner:	Prof. Dr.-Ing. Stephan Günther	**Time:**	12:15 – 13:00

Working instructions

- This exam consists of **8 pages** with a total of **3 problems**.
  Please make sure now that you received a complete copy of the exam.
- The total amount of achievable credits in this exam is 45 credits.
- Detaching pages from the exam is prohibited.
- Allowed resources:
  - one **non-programmable pocket calculator**
  - one **analog dictionary** English ↔ native language
- Subproblems marked by * can be solved without results of previous subproblems.
- **Answers are only accepted if the solution approach is documented.** Give a reason for each answer unless explicitly stated otherwise in the respective subproblem.
- Do not write with red or green colors nor use pencils.
- Physically turn off all electronic devices, put them into your bag and close the bag.

Left room from _____ to _____ / Early submission at _____

Problem 1 Multiple Choice (15 credits)

The following subproblems are multiple choice / multiple answer, i. e. at least one answer per subproblem is correct. Subproblems with a single correct answer are graded with 1 credit if correct. Those with more than one correct answers are graded with 1 credit per correct answer and -1 credit per wrong answer. Missing crosses have no influence. The minimal amount of credits per subproblem is 0 credits.

Mark correct answers with a cross ☒
To undo a cross, completely fill out the answer option ■
To re-mark an option, use a human-readable marking ✕■

a)* Which statements regarding MLT-3 are correct?

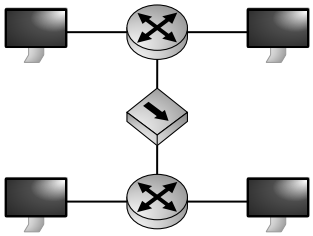
- ☒ It is a line code
- ☐ It is a source code
- ☐ It is guranteed to be DC-free
- ☐ It is a channel code
- ☐ One symbol encodes 3 bit
- ☒ The spectrum is narrower than Manchester

b)* What is the correct shortened form of `2001:000a:0000:0000:0001:0002:1122:0101/64`?

- ☒ `2001:a::1:2:1122:101/64`
- ☐ `2001:000a:0000:0000:0001:0002:1122:0101/64`
- ☐ `2001:a:0000:1:2:1122:101/64`
- ☐ `2001:a:0:0:1:2:1122:0101/64`

c)* How many broadcast domains does the network to the right contain?

- ☐ 4 ☐ 2 ☐ 3 ☐ 1 ☐ 6 ☒ 5



d)* How many collision domains does the network to the right contain?

- ☐ 2 ☒ 5 ☐ 3 ☐ 4 ☐ 6 ☐ 1

e)* What subnet can `192.168.8.0/23` and `192.168.12.0/23` directly be aggregated to?

- ☐ `192.168.8.0/24`
- ☒ `192.168.8.0/22`
- ☐ `192.168.0.0/16`
- ☐ Cannot be aggregated

f)* How long is an IPv6 address in octets?

- ☐ 12 ☐ 20 ☒ 16 ☐ 10 ☐ 8 ☐ 6 ☐ 4

g)* ~~What subnet can `192.168.8.0/23` and `192.168.12.0/23` directly be aggregated to?~~ (Duplicate)

- ☐ `192.168.0.0/16`
- ☒ `192.168.8.0/22`
- ☐ Cannot be aggregated
- ☐ `192.168.8.0/24`

h)* Which address type is used to send ARP requests?

- ☐ Unicast
- ☐ Multicast
- ☒ Broadcast
- ☐ Turbocast

i)* Which are IPv4 private address ranges?

- ☐ 127.0.0.0/8
- ☐ 169.254.0.0/16
- ☒ 192.168.0.0/16
- ☐ 192.168.0.0/8
- ☒ 172.16.0.0/12
- ☐ 0.0.0.0/8
- ☒ 10.0.0.0/8
- ☐ fe80::/10

j)* Which feature of the IPv4 header does a traceroute directly rely on?

- ☐ Flags
- ☐ Identification
- ☒ TTL
- ☐ Fragment Offset
- ☐ IHL

k)* CRC in Ethernet is used for . . .

- ☒ error detection.
- ☐ error propagation.
- ☐ error correction.
- ☐ error translation.

l)* What is true regarding 16-QAM?

- ☒ At the same baudrate it needs more bandwidth than 2-PSK
- ☐ It is more robust than 2-PSK
- ☐ It uses only the phase of the signal to encode data
- ☐ It is short for Quart-Archimedes Modulation

Problem 2 Waternet (15 credits)

Figure 2.1 shows a hypothetical network that uses pipes filled with water as a transmission medium instead of copper cables. The distribution unit *V* essentially consists only of a sphere filled with water without any further logic. To simplify matters, we assume that reflections do not play a role. The distance between *PC*1 or *PC*3 and *V* is 20 m and 10 m, respectively. The distance between *V* and *PC*2 is so small that it can be neglected.

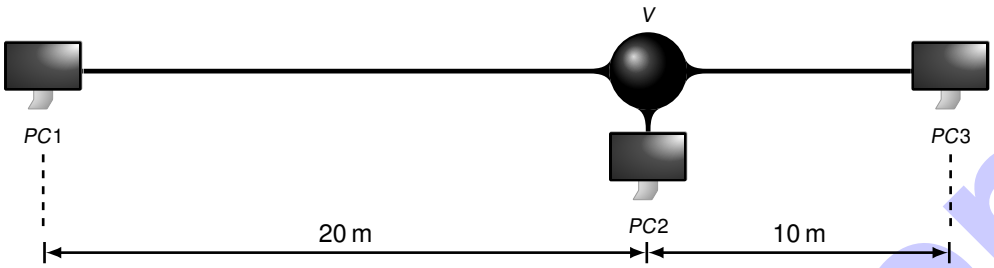


Figure 2.1: Waternet consisting of three computers and one distribution unit.

The propagation speed c_{sw} of sound in water at 20 °C is approx. 1500 m/s. This technology, known as Waternet, uses CSMA/CD as the media access method, just like conventional Ethernet. The transmit rate is 1 Mbit/s.

0 1 2

a)* Which device does the distribution unit *V* in an ordinary Ethernet correspond to? Give a reason for your answer.

(Passive) Hub since it does not contain any logic.

At time $t_0 = 0$ *PC*1 starts to transmit a frame of 1500 B.

0 1 2

b)* Determine the serialization time t_s.

$$t_s = \frac{l}{r} = \frac{1500 \cdot 8\text{bit}}{1 \cdot 10^6\ \text{bit/s}} = 12\ \text{ms}$$

0 1 2

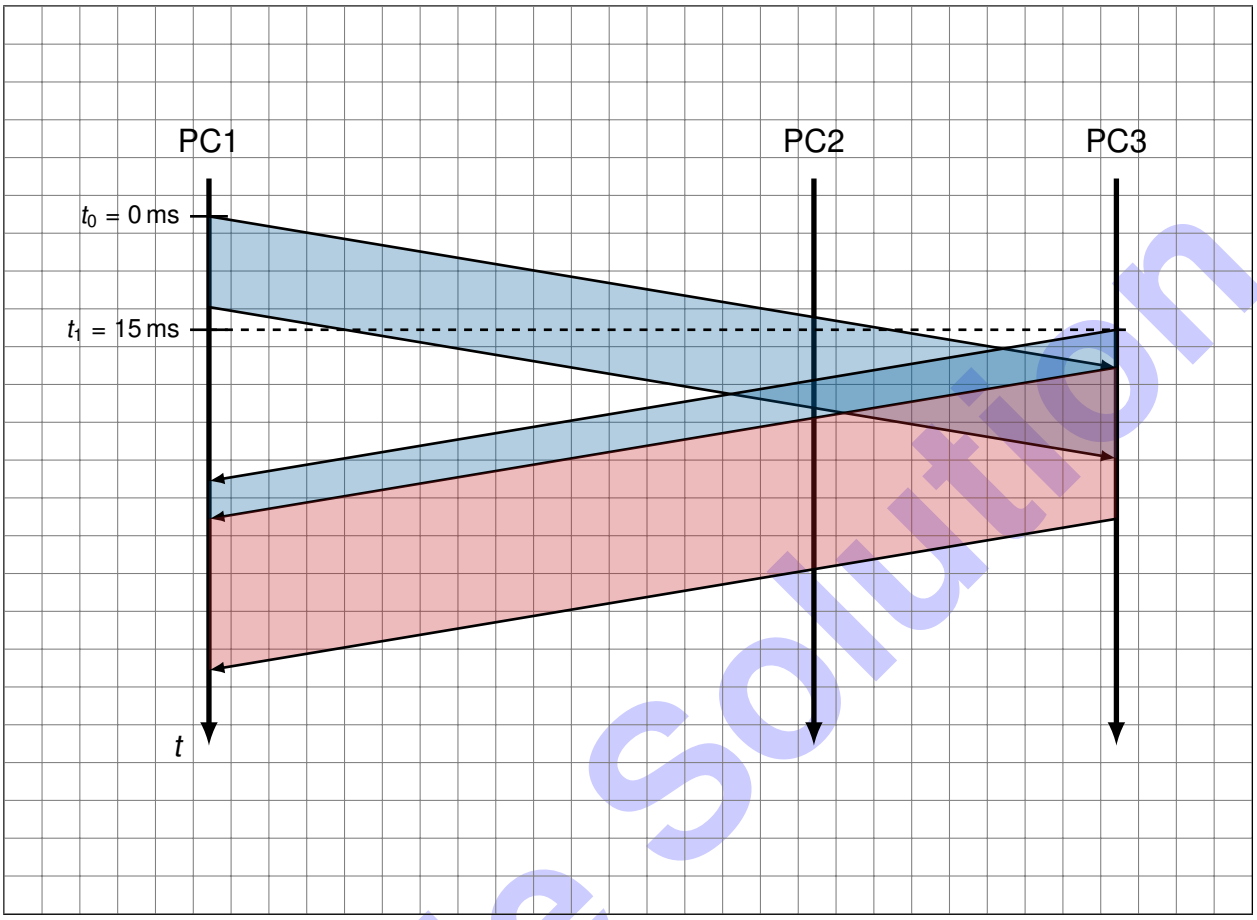
c)* Determine the propagation delay t_p between *PC*1 and *PC*2.

$$t_p = \frac{d(PC1, PC3)}{c_{sw}} = \frac{20\ \text{m}}{1500\ \text{m/s}} = 13.33\ \text{ms}$$

At time $t_1 = 15\,\text{ms}$ *PC*2 and *PC*3 also have data to be transmitted, 1500 B each.

d) Draw a network communication diagram that shows all events starting at $t_0 = 0\,\text{ms}$. In case there is a jam signal, it is sufficient to mark its starting time. Completely mark the diagram (devices, serialization time, and propagation delay). **Scale:** horizontally 1 cm ≙ 2.5 m, vertically 1 cm ≙ 10 ms.

0 1 2 3 4 5



e) Reason whether or not CSMA/CD correctly works under these conditions.

0 1 2

*PC*1 is unable to detect the collision since it already finished its transmission when the first bit from *PC*3 arrives.

f) Suggest a modification so that CSMA/CD works correctly. We expect a calculation here.

0 1 2

$$l_{\min} = 2t_{p,\max}r = 2 \cdot 20\,\text{ms} \cdot 10^6\,\text{bit/s} = 5000\,\text{B} \quad \textbf{or}$$

$$d_{\max} = \frac{1}{2}c_{sw}t_{s,\min} = \frac{1}{2} \cdot 1500\,\text{m/s} \cdot 12\,\text{ms} = 9\,\text{m}$$

Problem 3 CRC (15 credits)

In this problem we consider the binary message `00100110` which should be protected by a CRC as we introduced it for Ethernet-based networks in the lecture. We assume the reduction polynomial $r(x) = x^2 + 1$.

0 1

a)* Briefly explain what CRC is used for in the context of Ethernet.

Detection of bit errors at the receiving node.

0 1

b)* What is the reduction polynomial being used for?

Mapping of a message of arbitrary length to a fixed length checksum.

0 1

c)* What does it mean if the reduction polynomial is *irreducible*.

It cannot be represented as the product of two other polynomials of degree strictly less than deg$r(x)$.

0 1 2

d)* Reason whether or not CRC requires an irreducible reduction polynomial.

It does not: using an irreducible reduction polynomial leads to finite field. However, the purpose of CRC is primarily error detection.Reducible polynomials may have desireable properties such as being able to detect all bit errors of odd length if the factor $(x + 1)$ is contained in the reduction polynomial.

0 1

e)* Show whether or not $r(x)$ is irreducible.

$r(x) = x^2 + 1 = (x + 1)^2 \quad \Rightarrow \quad$ it is reducible

0 1

f)* Assuming **Ethernet**, what is the reaction of the receiving node when a bit error is detected.

The frame is dropped without further action.

0 1

g)* Assuming **IEEE 802.11**, what is the reaction of the receiving node when a bit error is detected.

The same – no reaction.

h)* Determine the CRC checksum for the given message (see beginning of the problem).

```
00100110 00 : 101 = 101101
  101|||  ||
  ---|||  ||
  00111|  ||
    101|  ||
    ---|  ||
    0100  ||
     101  ||
     ---  ||
     001  00
       1  01
       -  --
          1
```

Checksum is 01.

0 1 2 3 4

i) Explicitly state the transmitted message.

00100110 01

0 1

Let us assume a different message (including its checksum): 111011010010111001. Assume that this message is transmitted and arrives as 11101101001011**100** at the receiver.

j)* Argue whether or not the error is being detected.

It is not detected sind the error is 101, which is a multiple of the reduction polynomial.

0 1 2

Additional space for solutions–clearly mark the (sub)problem your answers are related to and strike out invalid solutions.