Communication Systems and Protocols
Summer Term 2015

Institut für Technik der Informationsverarbeitung – ITIV
Prof. Dr.-Ing. Dr. h. c. Jürgen Becker

Communication Systems and Protocols

Date: 20.07.2015
Name:
Matriculation-ID.:
ID:
Lecture Hall:

Seat No..:

Prerequisites for the examination

Aids

- Allowed aids for the examination are writing utensils, a ruler, a non-programmable calculator and a single sheet of A4 paper with self- and hand-written notes. Writing may be on both sides. The use of own concept paper is not allowed.
- Use only indelible ink - use of pencils and red ink is prohibited.
- Other material than that mentioned above, is strictly forbidden. This includes any type of communication to other people.

Duration of the examination

120 minutes.

Examination documents

The examination comprises 28 pages (including title page). Answers may be given in English or German. A mix of language within a single (sub)-task is not allowed. In your solution mark clearly which part of the task you are solving. Do not write on the backside of the solution sheets. If additional paper is needed ask the examination supervisor.

You will not be allowed to hand in your examination and leave the lecture hall in the last 30 minutes of the examination.

At the end of the examination: Stay at your seat and put all sheets into the envelope. Only sheets in the envelope will be corrected. We will collect the examination.

Task 1	Physical Basics	2	~19%	Commented [PF(1]: 21P
Task 2	Wiring	7	~11%	Commented [PF(2]: 12P
Task 3	Data Transmission	10	~13%	Commented [PF(3]: 15P
Task 4	Error Protection	13	~14%	Commented [PF(4]: 16P
Task 5	Media Access	17	~13%	Commented [PF(5]: 15P
Task 6	Practical Aspects of Communication Systems	21	~13%	Commented [PF(6]: 15P
Task 7	Networks	25	~17%	Commented [PF(7]: 19P
			Σ	Commented [PF(8]: Insgesamt 113P

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Task 1 Physical Basics

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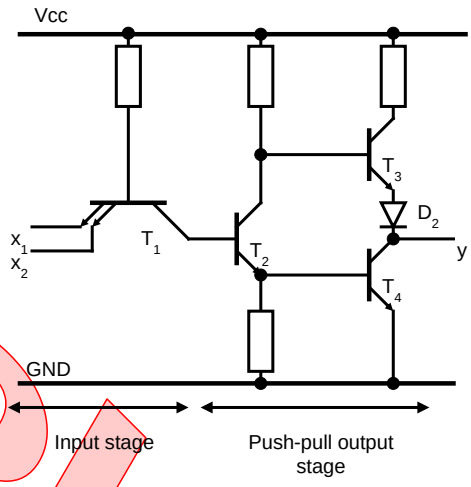
Task 1.1 TTL - Logic

A) Insert the logic level (HIGH, LOW) of the output and the state of the transistors (open, closed) into the table according to the input configuration x1 and x2 at the standard TTL output driver

2



X_1	X_2	T_1	T_2	T_3	T_4	y
0	0	OPEN	CLOSED	OPEN	CLOSED	H
0	1	OPEN	CLOSED	OPEN	CLOSED	H
1	0	OPEN	CLOSED	OPEN	CLOSED	H
1	1	CLOSED	OPEN	CLOSED	OPEN	L

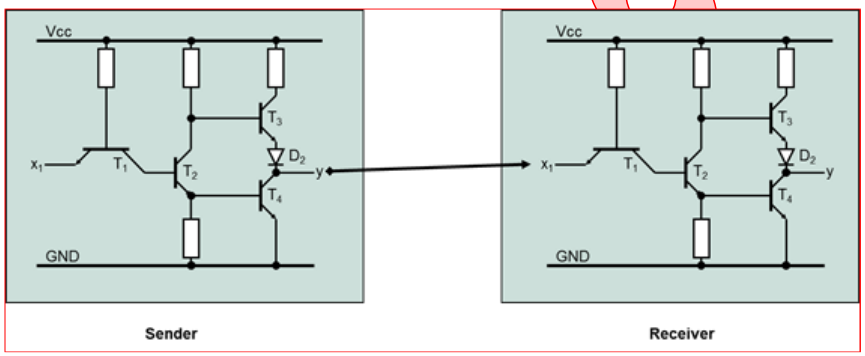
Commented [hm9]: -0.5p per wrong cell, consider consequential errors!

B) How would a transmission setup with TTL technology look like? (Drawing is not necessary, but when using a description, it has to be clear and distinct)

1

Usage of a second TTL output stage, connection of y1 to x2.

Commented [hm10]: 1p for description or drawing, simplyfied drawing would be sufficient



C) List two advantages for the use of TTL drivers.

1

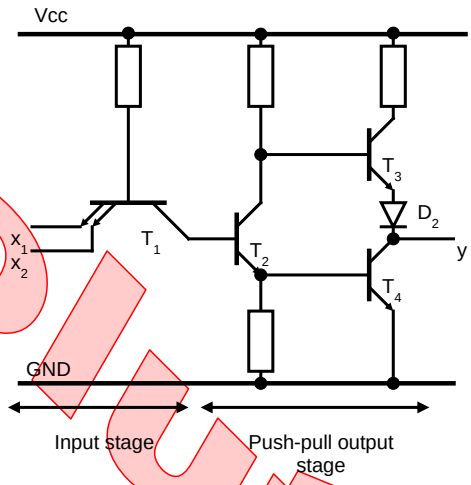
High currents are possible;

Valid HIGH and LOW areas are wider at the input due to possible voltage drops on the lines

Commented [hm11]: 0.5p per advantage

D) How would it be possible to overcome the disadvantage of possible short circuits of a TTL driver? Which part of the TTL driver needs to be modified? Modify the drawing to get the solution and describe the purpose of the adjustments made.

2



T1 needs an enable input. Additionally a diode in reverse direction is needed between enable and collector of T2.

Commented [hm12]: 1pt for correct drawing, 0,5pt for description of enable, 0,5pt for description of diode

Task 1.2 Differential Signals

A) How could differential signal generation be realized?

1

Emitter Coupled Logic (ECL) with twisted lines.

B) What are the advantages for differential signal transmission? Name two.

1

Higher speed since transistors don't go into saturation (ECL)

Inherent compensation of disturbances, noise pulse on both lines and therefore not visible in the differential signal.

Commented [hm13]: 0.5p per correct advantage

Task 1.3 Modulation

A) The signal in Figure 1.1 is received after a transmission. Which modulation scheme is used when assuming all possible modulations are transmitted in that signal?

1

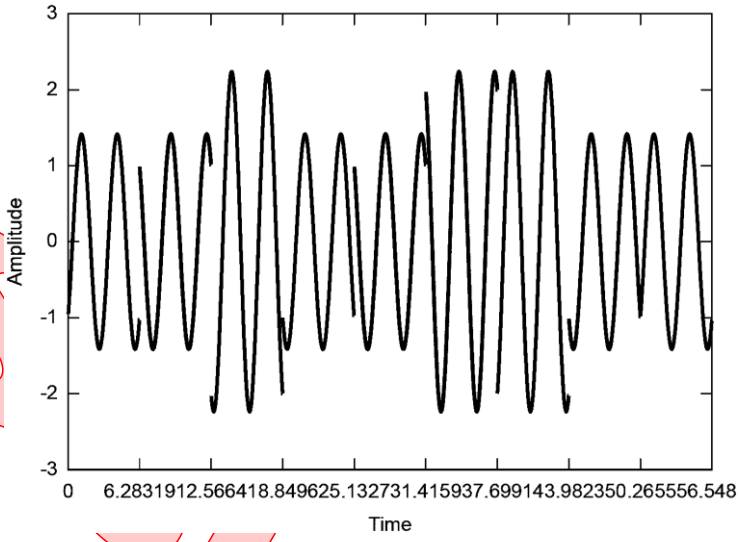


Figure 1.1: Modulated signal

8 QAM

Commented [hm14]: 1p for correct determination of modulation scheme

B) Now consider that 8QAM is used. Give a possible coding for the modulation scheme.

3

3 Bits are modulated in 8QAM.

Commented [hm15]: -0.5p per wrong insertion (double insertion or missing ones
-0.5p for wrong phases (when one is wrong and all others are ok, nor reduction of points -> one mistake is allowed
-0.5p for wrong amplitudes (no mistake allowed)
No points if other than three bit is used

Requirements:
- 8 different values
- Only one value per phase

Amplitude \ Phase	0	45	90	135	180	225	270	315
1		100		101		110		111
2	000		001		010		011	

C) Briefly describe ASK modulation and give one disadvantage.

1

Amplitude shift keying: Linear change in amplitude in radio broadcasting, susceptibility caused by varying reception quality.

Commented [hm16]: 0.5p for correct description of modulation scheme (varying amplitude)
0.5p for disadvantage

Task 1.4 Channel capacity, Bandwidth

A digital transmission system with a bandwidth of B=1,5*106 Hz has a channel capacity of C = 5 Mbit/s (according to Shannon).

A) What is the minimum for the signal-to-noise ratio (SNR) in dB? **2**

C=B*⟦log⟧_2 (1+SNR)

SNR=⟦10⟧^(10*log(2)/3)-1=0,26=9,58dB

Commented [hm17]: 0.5p formula
1.5p correct result
-0.5p if result is not in dB

B) Give the definition for the Cut-Off-Frequency. **1**

Frequency at which the signal amplitude has dropped by 3dB compared to the output value.

Task 1.5 Signal Conversion

A) When converting analog signals into digital signals, what has to be considered in order to be able to achieve an unambiguously reconstruction of the signal (name and formula)? **1**

Nyquist-Shannon-Sampling theorem, fsample ≥ 2 * fmax

B) Which classes of signals are used as analog and digital signals? Name 4 signal classes. **2**

Value- Continuous, Time- Continuous

Value- Continuous, Time- Discrete

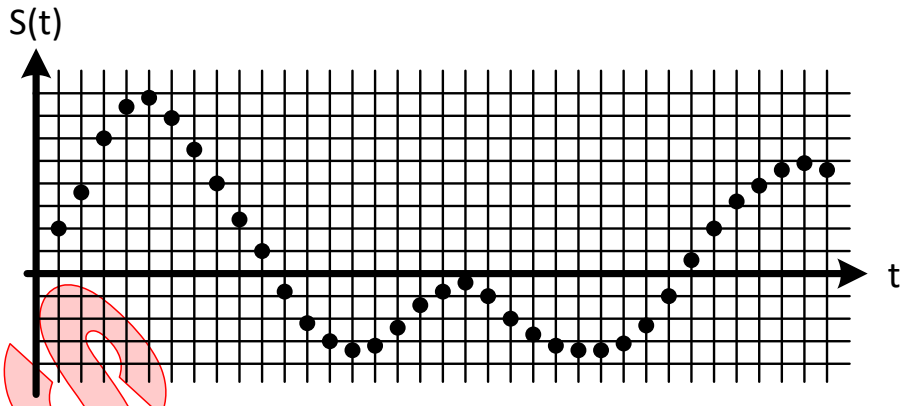
Value- Discrete, Time- Continuous

Value- Discrete, Time- Discrete

Commented [hm18]: 0.5p per correct class of signals

C) Which signal class does the following signal belong to? Briefly describe the generation of this signal class.

2



Signalclass name: Time discrete and value continuous

Signal generation: Using a dedicated clock signal equidistant sample timepoints are generated. At each of these timepoints the exact signal value is measured and stored.

Commented [hm19]: 1p for correct determination of class
1p for correct description

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Task 2 Wiring

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Task 2.1 General Questions

A) What is an asymmetric line? Name one example for its application.

1

The conductors share one common ground line.

Coaxial lines for television.

Commented [Br20]: 0.5pt for description, 0.5pt for example

B) How does the wire length affect the wave impedance ZW?

1

It doesn't affect the wave impedance.

C) Name four causes for distortions of real data signals.

1

Noise, bad signal edges, glitches, cross talk, reflections, bad GND, bandwidth issues

(cosmic) Radiation, magnetic/capacitive distortions

Commented [hm21]: 0.5p per two correct causes

Task 2.2 Twisted Pair

A) How does a twisted pair cable help against interferences from external sources?

1

Interferences affect both signal lines at the same time. When a **differential signal** is send,

the receiver can reconstruct the original signal by subtracting the signals from each other.

Any interferences are cancelled out.

Commented [hm22]: 0.5p both lines are affected
0.5p differential signaling

B) Is using a twisted pair cable more beneficial against interferences of small sources close to the wire or ones that are farther away? Explain your answer.

1

Better against sources farther away. The interferences close to the wire affects the closer

wire stronger than the one on the other side. The interference is therefore different. With

longer distances, the interferences should even out.

Commented [hm23]: 0.5p for nearer sources
0.5p for reasoning

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Task 2.3 Reflection on wires

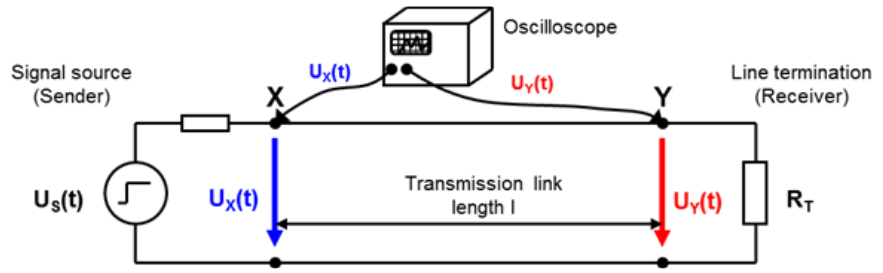

Figure 2.1: Test setup

You have found a transmission link in the basement and want to find out the wave impedance. With the setup given in Figure 2.1 you make the measurements that can be seen in Figure 2.2. The signal source is stuck at an unknown output voltage and has an internal resistance of 33 Ω. The termination resistance is RT = 200Ω. You can assume that the DC resistance is zero. When using numbers from Figure 2.2, only use one decimal place and only use values where the voltage is mostly constant.

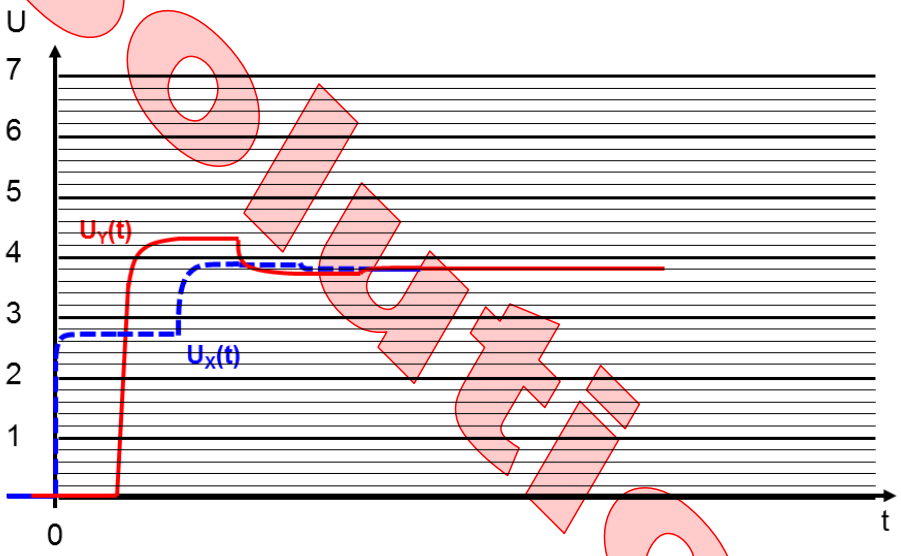

Figure 2.2: Measurement

A) How would you divide the timeline? Explain and mark at least four points on the timeline. **1**

t_d , the propagation time of a wave on the wire. Are quite distinct in the figure as the voltages on X and Y change abruptly.

Commented [hm24]: 0.5p t_d explained
0.5p two points are marked

B) Without calculation, make a quantitative statement about the reflection factors at the start and at the end.

1

Uy overshoots Uinf -> r at end positive,

value goes down -> r at start is negative

Commented [hm25]: 0.5p for estimation
0.5p for reasoning

C) Calculate the wave impedance (characteristic impedance) and the reflection factors at the start and at the end.

4

U_x (0)=U_S*Z_W/(R_i+Z_W)=2,7

U_x (inf)=U_S*R_T/(R_i+R_T)=3,8

US = 4,427 V

ZW = 51,59 V

ra = -0,22

re = 0,59

Alternative Solution:

At point Y: forward running wave = 2,7V

Reflected wave = 1,6 V

Re= 1,6V/2,7V=0,59

At point X: forward running wave = -1,6V

Reflected wave= 0,4V

Ra= -1,6V/0,4V=-0,25

Commented [hm26]: 1p correct values from figure
1p for z_w
1p for each reflection factor

Ra=ri-zw/(r-+zw)

Zw=(ri/ra-ri)/(1+1/ra)=51,75Ohm

D) Calculate the internal sender voltage us

1

ux(inf)=us*(rt/(rt+ri))

us= ux(inf)*(rt+ri)/rt=4,427V

Commented [hm27]: 0.5p formula
0.5p correct value

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Task 3 Data Transmission

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Task 3.1 Line Codes

A sensor node has to be connected to your existing system. To lower costs and complexity, only one line is available for data transmission. Nonetheless, timing recovery without additional measures should be possible.

A) Name two line codes that fulfill these requirements.

1

RZ (bipolar), diff. Manchester, Manchester

Commented [Br28]: 0.5pt per correct code
-0.5pt for incorrect code

B) Your channel's signal power is 500 times higher than its noise, its maximum frequency amounts to 4500 Hz. Your sensor node delivers its data with 5 Kbit/s. Which line code that fulfills the requirements above would you use? Justify your answer by comparing it with its alternatives you mentioned in the preceding task.

2

Shannon Limit = W * log2(1+S/N)[bit/s] ~ 5000byte/s →high enough,

symbol rate <= 2xfmax → only 1bit/symbol possible→ none of the codes mentioned above is suitable

Commented [Br29]: 1pt for usage of symbol rate as criteria
1pt for conclusion

Task 3.2 CDMA

GPS and mobile phones use CDMA to distinguish their participants.

A) CDMA is using a special class of codes, one example are Walsh-Codes. How is this class of codes named and why are they called like that?

1

Spreading codes, because they spread the spectrum

Commented [Br30]: 0.5pt for spreading codes, 0.5pt for reason

B) Which influence does this have on the bandwidth of the transmitted signal?

1

The bandwidth increases.

The so-called Gold code is an alternative to the method of generating these codes presented in the lecture. It uses two different linear feedback shift registers (LFSR) whose outputs are XOR-ed. The start value of the LFSRs is called “seed”. The different codes are obtained by using different seeds for LFSR1 while LFSR2’s seed is left unchanged.

The gold code generator in Figure 3.1 shall be used in the following. The seed of LFSR2 is fixed to “001”

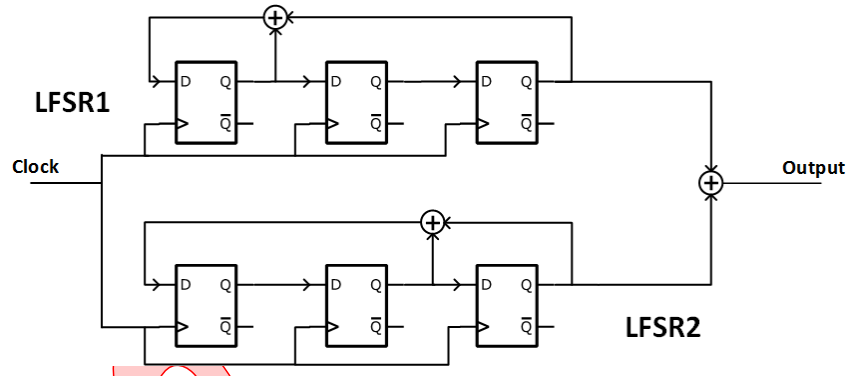

Figure 3.1: Gold code generator

C) How many Gold codes can be generated in this way? **1**

2^n-1 = 7 (000 as seed does not count)

D) List the first two gold codes generated by this generator (start seeds 001 and 010), how many different participants does the generator allow on your channel? **5**

001: 0010100

010: 1100110

→ 7 participants

Commented [Br31]: 1pt for number of participants
2pt per correct gold code

E) What would happen if you used the seed “000” in one of the LFSRs?

This LFSR would not contribute to the code generation and render itself therefor useless.

1

Task 3.3 Symbol Stuffing

You want to transmit formatted text but due to limitations of your transmission system you can only use the uppercase letters A-Z and whitespace. However, it should be possible to transmit italic, bold and strike-through text.

To achieve this, the command character „C“ is used which denotes the beginning and the end of a command sequence. The commands are then applied to all following characters until the command sequence is repeated. If the character “C” is to be send as part of the text, it therefore has to be escaped by doubling it at sender site.

Available commands are “B” for bold text, “I” for italic text, “L” for lowercase letters and “S” for strike-through text.

A) Format the following text according to these rules:

2

This task is ~~**stupid**~~ *COOL*

TCLCHIS TASK IS CBSCSTUPIDCBSC CLICCCOOLCIC

Commented [Br32]: 1pt for correct starting and ending of commands
0.5pt for correct escaping of “C”
0.5pt for correct sentence

B) What could happen if you did not use a separate command word?

Repetitions would be problematic

1

Task 4 Error Protection

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Task 4.1 Error Detection

A) What is the general difference between Safety and Security?

1

Security: Malicious errors caused by attackers

Safety: Accidental errors

Commented [hm33]: 1p correct difference

B) Name two properties of a good hash function (for communication purposes)?

1

Different inputs should lead to different hash values (reduce number of collisions)

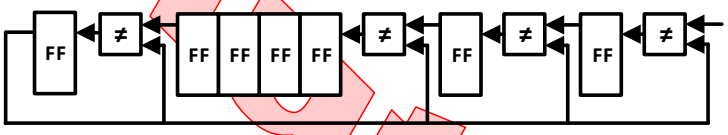
Efficient calculation of hash

Small change in input values -> large change in hash value

Commented [hm34]: 0.5p for each correct property

Task 4.2 CRC-Calculation

To protect data transmissions, the given CRC scheme is implemented using linear feedback registers with XOR operations.



A) Determine the given generator polynomial

1

CRC-8 (x7+x6+x2+x1+1)

Commented [hm35]: 1p correct polynomial
-0.5p without x^7

B) Calculate the data stream that will be transmitted if the following bit string is to be protected:

10101110

3

```
1010 1110 0000 000 : 1100 0111
1100 0111
0110 1001 0000 000
 110 0011 1
 000 1010 1000 000
      1100 0111
      0110 1111 000
       110 0011 1
       000 1100 100
```

Bit stream as it is transmitted: 1010 1110 1100 100

Commented [hm36]: 2p: calculation correct
0p if systematic error
1p if single calculation error
0p if more than 1 calc error

1p correct transmitted bit stream

C) With a transmission system that uses CRC for error protection, a sender transmits the following bitstream: **10011000 00100011 011**
Carry out the CRC error detection scheme of the receiver, assuming that the generator polynomial CRC-4 (x3+1) has been used. What does the receiver conclude from the result?

3

```
1001 1000 0010 0011 011 : 1001
1001
0000 1000 0010 0011 011
     1001
     0001 0010 0011 011
        1 001
        0 0000 0011 011
                10 01
                01 001
                 1 001
                 0 000
```

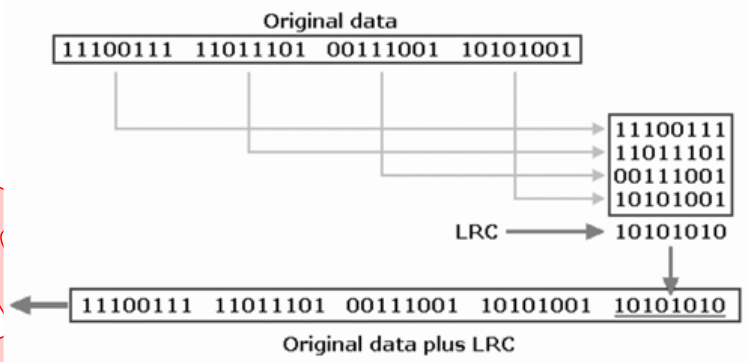
The receiver will assume that the transmission is error free.

Commented [hm37]: 2p calculation correct (remainder =0)
0p if systematic error
1p if single calculation error
0p if more than 1 calc error

1p receiver ASSUMES an error free transmission

Task 4.3 Comparison of LRC and CRC

In Longitudinal Redundancy Check (LRC), a block of bits is organized in a table with rows and columns. Then the parity bit for each column is calculated and used to create a new row of an additional parity data word. After that the new calculated parity bits are attached to the original data and sent to the receiver.



A) With a transmission system that uses LRC for error protection, the following bitstream was received: **00011000 10100011 10111011**
Carry out the LRC error detection scheme of the receiver, assuming that even parity has been used. What does the receiver conclude from the result?

1

00011000

10100011

10111011

the receiver will assume that the transmission is error free.

Commented [hm38]: 0.5p calculation correct
0.5p receiver ASSUMES an error free transmission

B) Assuming that the sender has sent the following bitstream instead of the bitstream in Task 4.3A):
10011000 00100011 10111011
Would these errors be detected by using LRC? Determine the Hamming Distance (HD) of the LRC method.
Note: Hamming Distance (HD) is lowest weight of any undetectable error. For example, HD=4 means **all** 1, 2, 3 bit errors detected.

No, the receiver will still assume that the transmission is error free

Commented [hm39]: 0.5p receiver still ASSUMES an error free transmission
0.5p correct HD of LRC

So, the HD of LRC = 2

C) Could these errors from Task 4.3A)-B) be detected by using the CRC method with a "good" selected CRC polynomial? Name an example from the given table where the CRC would guarantee detection of these errors. Explain your answer.
Note: Hamming Distance (HD) is lowest weight of any undetectable error. For example, HD=4 means **all** 1, 2, 3 bit errors detected.

2

CRC Polynomial	Guaranteed HD	Up to max. data lenght (in bits)
CRC-3 (x^2+1)	HD=2	2048
CRC-4 (x^3+1)	HD=3	11
CRC-5 (x^4+x^1)	HD=3	26
CRC-5 (x^4+x^2+1)	HD=4	10
CRC-8 ($x^7+x^4+x^3+x^1+1$)	HD=4	119
CRC-8 ($x^7+x^4+x^3+x^2$)	HD=5	9

Table 4.1: "Good" polynomials for HD at given CRC size and data length

Yes, with a "good" CRC polynomial these errors would be detected.

There are two CRC polynomial with HD > 2 and max. data words length > 16:

CRC-5 (x4+x1) or CRC-8 (x7+x4+x3+x1+1)

Commented [hm40]: 1p this error is detectable with CRC
1p for one correct polynomial

D) Compare LRC against CRC on the following criteria:

- Error detection
- Implementation

3

Which detection scheme would you prefer regarding these criteria? Explain your answer!

Error detection:

There are some CRC Polynomials with HD > 2 (and Size < 8 bits) -> CRC detects more errors than LRC.

Implementation:

CRC has a clever hardware implementation (shift register) –> fast and cheap

By LRC the complete data plus LRC have to stored and compared -> slower and more expensive

For this criteria CRC seems more efficient

Commented [hm41]: 1p reasonable explanation for error detection
1p reasonable axplanation for implementation
1p reasonable statement

Task 5 Media Access

15

Task 5.1 CSMA/CD

In this task we have a look at a bus system with arbitration that is derived from CSMA/CD. The following rules apply:

- All nodes want to send as many messages as possible. The length of each message is given in Table 5.1.
- A node is not allowed to send twice in a row. After each successful transmission it has to wait until another node has finished its transmission. The values of the assigned waiting times for each node are given in Table 5.1.
- If a node willing to send detects that the bus is occupied it withdraws and waits for the time specified in Table 5.1 (waiting time) until it will retry to transmit. Any ongoing transmission is not influenced.
- If two or more nodes want to start a transmission on the free bus at the same time there is a collision. All involved nodes withdraw from the bus and wait for the time given in Table 5.1.

Node	Packet length	Waiting time
A	1	2
B	2	2
C	3	2

Table 5.1: Specifications of nodes

A) Fill in the signal sequence of the bus nodes, resulting from the specification as given above (use Figure 5.1). Mark waiting times and collisions that occur.

1

Commented [hm42]: +1 P correct solution

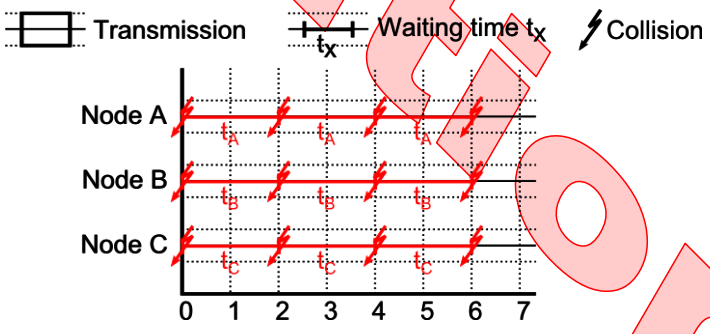


Figure 5.1: Signal sequence

B) Which problem occurs and how could it be solved?

1

Identical waiting time causes many collisions, transmitting is impossible. The waiting time has to be changed so that every node has a different waiting time.

Commented [hm43]: +0.5p for collisions
+0.5p for solution

C) The packet length is unchanged and node C has the highest priority. Modify the waiting times so that all nodes have send data after nine clock cycles (use Table 5.2). The waiting times should be as short as possible. Fill in the signal sequence of the bus nodes, resulting from the modified waiting times (use Figure 5.2). Mark waiting times and collisions that occur, label which graph should be evaluated with a cross.

5

Commented [hm44]: +1 P for tc=2
+1 P for tb=3
+1 P for tc=4
+1 P all send data until t=9
+1P correct solution

Node	Packet length	Waiting time
A	1	4
B	2	3
C	3	2

Table 5.2: Modified waiting time

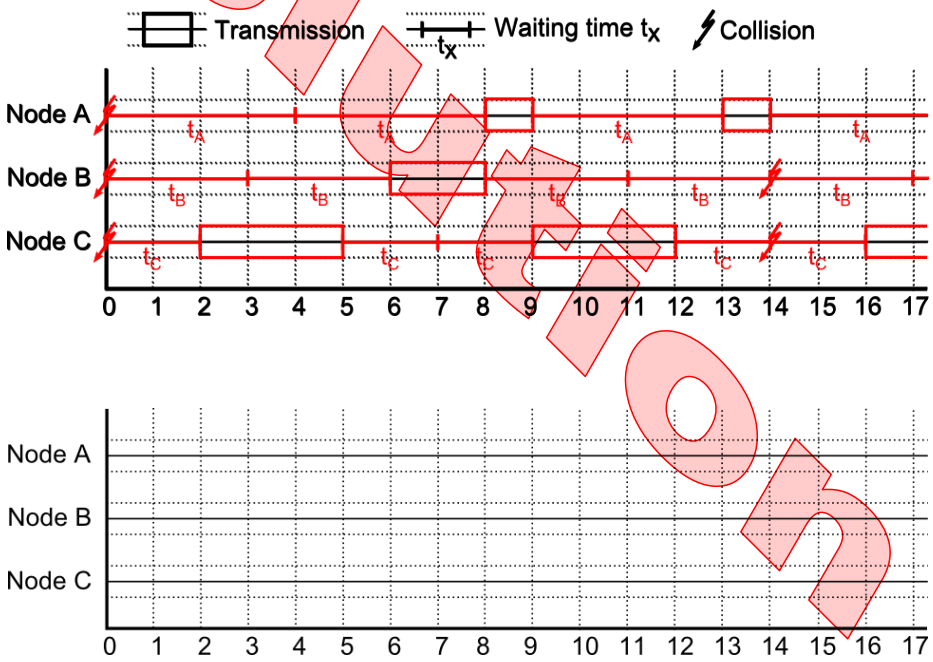


Figure 5.2: Signal sequence

Task 5.2 CSMA/CA

A communication system comprises five communication nodes that use CSMA/CA as arbitration scheme. In order to transmit data a node transmits a dominant start bit (‚0') for synchronization purpose. After that a 5 bit message identifier followed and 10 bits of payload data is sent. The message identifiers are unique for each node and all data is sent MSB first. The bus has to cover a maximum distance of 500m.

A) Name two advantages and two disadvantages of CSMA/CA **2**

Advantages

- no collisions on the bus
- easy to prioritize because of individual identifiers
- partly real-time capable with additional rules
- efficient use of bandwidth

Disadvantages

- length of the bus and data transmission rate are limited because of simultaneity requirement

Commented [hm45]: 0.5p for each advantage or disadvantage

B) Which requirements have to be fulfilled in order to guaranty a faultless function of the system? What are the implications for the transmission rate? **1**

The requirement of simultaneity has to be fulfilled. The signal propagation time t_s is much smaller compared to the digit length (bit time) t_b.

$$\left[t_s = \frac{l}{v}\right] \ll \left[t_b = \frac{1}{TR}\right]$$

Commented [hm46]: +0.5P for Simultaneity
+0.5P for Transmission rate formula

C) Calculate the maximum payload data rate of this bus. Assume a propagation time of 0.66·c (c=3·10^8 m/s). **2**

Transmission rate

[t_s= l/v]≪[t_b= 1/TR]

With l=500m, v=0.66·3·〖10〗^8 m/s

TR≪v/l=(0.66·3·〖10〗^8 m/s)/500m=396000 1/s

Start Bit +5 Bit message identifier and 10 bits data

payload data rate= 10/16·transmission rate=247500 1/s

Commented [hm47]: 1P for transmission rate
+1P for payload data rate

D) Figure 5.3 shows an impulse diagram for the bus system described above and the signal level of the shared bus line. Indicate the identifiers of the given nodes as far as possible (use Table 5.3, mark uncertain identifier bits as X).

2

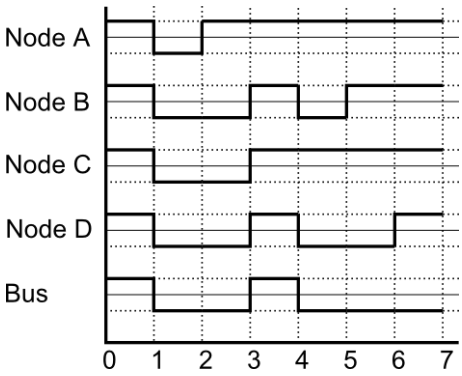


Figure 5.3: Bus Access

Node	Bit 0	Bit 1	Bit 2	Bit 3	Bit 4
A	1	X	X	X	X
B	0	1	0	1	X
C	0	1	1	X	X
D	0	1	0	0	1

Table 5.3: Identifiers of the nodes

Commented [hm48]: 0.5p for each correct line

E) Which node is granted exclusive access to the bus?

1

Node E (five nodes are mentioned in the task) is able to send data.

OR: No one of the four nodes A-D is allowed to send data.

Commented [hm49]: 1p for correct solution

Matr.-ID.: Name: ID:

Task 6 Practical Aspects of Communication Systems

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Task 6.1 General Questions

A student wants to transmit data over a very long distance. Because of budget reasons, a connection with one single wire has to be used for this transmission. The transmission should use Aloha with unipolar NRZI.

A) How can clock recovery be done for the above network? 1

Since a long line of '0's or '1's can be transmitted a bit stuffing is necessary to change the value frequently.

A preamble can be used to synchronize the two clocks.

Commented [hm50]: 1p for correct answer either bit stuffing or preamble

B) The transmitted data will have variable length. Name two ways of determining the data field length within a transmission: 1

Length specification in length field of frame

Use of delimiter for data field

Commented [hm51]: 0.5p for each correct answer

C) What needs to be changed in order to make the network real time capable? 1

An appropriate protocol and media access have to be chosen.

Examples: token passing at protocol level, FDMA, TDMA

All access is controlled by one master

Commented [hm52]: 1p for changing protocol or media access

Task 6.2 Physical Layer of Customized Bus

A customized bus should code the raw data with Manchester. The voltage level on the bus is generated by an inductivity. This inductivity is driven by an open-collector that is connected to the output stage of the microcontroller. The transmission is initialized by a logical Zero (start-bit) and ended by a logical One (stop-bit).

A) What is the advantage of the induced voltage levels? **1**

Sine-shaped pulses require lower bandwidth for transmission.

Data can be transmitted on power line

Commented [Br53]: Also galvanical isolation might be possible.

B) Can the clock be recovered within this system? Justify your answer. If clock recovery is not working give a possible solution. **1**

Yes. Manchester is used → change of level for every bit.

C) Draw the Manchester coded and raw data (information) transmitted over the wire in the following graphic. Please write down the transmitted data. The figure shows the transmission of a complete frame. **3**

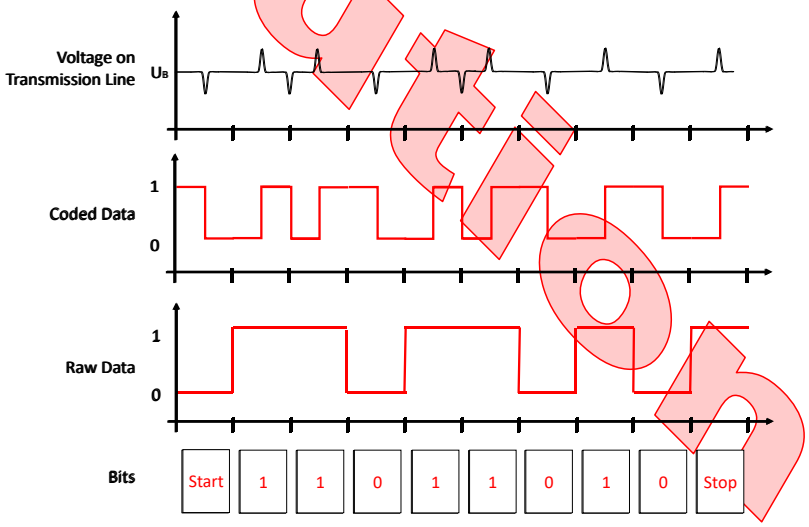


Figure 6.1: Transmission on customized bus

Commented [hm54]: 1p for correct coded data
1p for correct raw data
1p for start and stop bit (it is OK, if first and last bit is empty)

D) How can data integrity be checked purely on physical layer? (Name two)

Check for start-bit and stop-bit

Successive pulses must have different polarity

Between two clocks/pulses of a frame only one pulse is allowed to be missing

Commented [hm55]: 1p for each correct answer

E) Because of license reasons Manchester coding cannot be used. Why can't differential Manchester be used for the system? Please name the Problem and a possible solution.

2

Differential Manchester is alternating, therefor last level depends on number of '0's and '1's. This means the stop bit ends not always at recessive level.

For odd parity a second stop-bit or parity-bit has to be added.

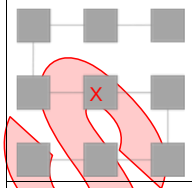
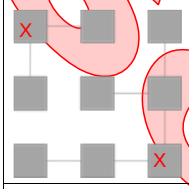
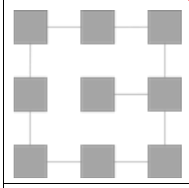
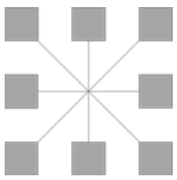
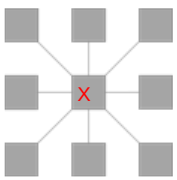
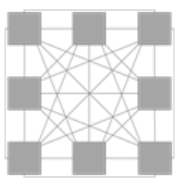
Commented [hm56]: 1p for problem
1p for possible solution

Matr.-ID.: Name: ID:

Task 6.3 FireWire

A) Different FireWire structures were built during a student laboratory. During test phase you notice that not all FireWire systems are working correctly. Please state if the below FireWire systems are working correct. Mark the roots, if the systems are correct and all nodes starting at the same time. Give a reason, if the FireWire is not working correctly.

3

	Correct	Wrong	Reason
	X		
	X		
		X	Rings are not allowed in FireWire
		X	One output cannot have multiple connections
	X		
		X	Connections between all nodes are not allowed within FireWire. Because we get rings and multiple connections to the different nodes.

Commented [hm57]: 0.5p for correct and right master

Commented [hm58]: 0.5p for correct and both masters 0.5p for wrong if masters are marked AND reason says two different nets

Commented [hm59]: 0.5p for wrong and correct reason

Commented [hm60]: 0.5p for wrong and correct reason

Commented [hm61]: 0.5p for correct and right master

Commented [hm62]: 0.5p for wrong and correct reason

Matr.-ID.: Name: ID:

Task 7 Networks

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Task 7.1 General Questions

A) Your task is to decide on which type of connection to be used in a network consisting of components in need of predictable latencies. Justify your decision. 1

Circuit Switching, easier to guarantee latency

B) Your task is to decide on which type of connection to be used in a network consisting of components that mainly communicate by streaming data, thus in need of high and guaranteed throughput. Justify your decision. 1

Circuit Switching, easier to guarantee throughput

C) Name the three components of a network on chip node in the basic setup and their respective task 2

Computing Unit : Runs an application or part of an application

Network Interface : Mediating between Computing Unit and Network

Routing Unit : Embedded intelligence that decides on the direction of the data

D) How do networks and busses differ from each other? 1

Bus : dedicated and fixed physical communication channel

Network : different and multiple communication channels are possible

Commented [Br63]: There are other correct answers possible. 1pt is given for correct distinction.

Task 7.2 Routing

Figure 1 2 shows a 4x4 meshed network with bidirectional links for wormhole packet-switching communication.

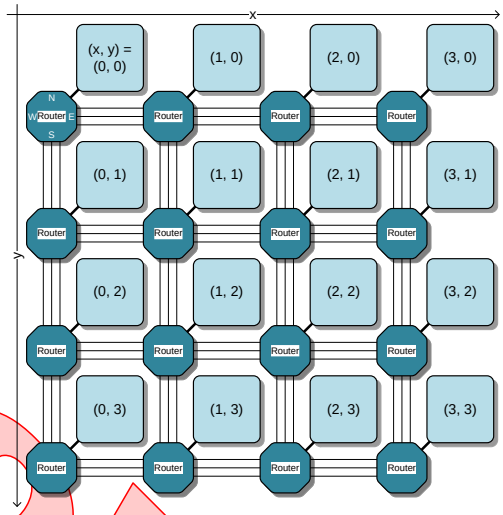

Figure 7.1: 4x4 meshed network

A) Which routers are passed by a packet sent from (x, y) = (1, 0) to (3, 3) using XY-Routing. Please provide the coordinates of the passed router in the order given by the transmission process. **1**

(1, 0), (2, 0), (3, 0), (3, 1), (3, 2), (3, 3)

B) The routers (1, 0) and (2, 1) are experiencing heavy traffic towards their east port, such that packets have to wait before being forwarded. As an alternative "hot potato XY-Routing" is used. If a port is occupied the opposite dimension is used, so in case of X towards Y and in case of Y towards X. If no heavy traffic is present common XY Routing is used. Which routers are passed by a packet sent from (x, y) = (1, 0) to (3, 3) for that routing **1**

(1, 0), (1, 1), (2, 1), (2, 2), (3, 2), (3, 3)

C) Which classes of routing algorithms is hot potato XY-Routing associated with? **1**

Adaptive Routing: Since Ports are used depending on Traffic in Routers

Non-Minimal Routing: New routes can lead to non-minimal detours

D) Describe two scenarios: one in which common XY Routing is preferable and one in which "hot potato XY Routing". **2**

Balanced network traffic XY Routing will find the shortest Path

If heavy traffic is present at certain ports, hot potato XY can reduce the latency

E) Instead of XY-Routing, Flooding is considered for the given network. **2**
How many times is a packet forwarded when flooding is used, with router (1, 0) being the origin and router (2, 2) the destination

4*1 + 7*2 + 3*3 + 3 = 30

F) How many times is a packet forwarded by routers, using Flooding with a time to live of 2, when router (1, 0) is the origin and router (2, 2) the destination? **1**

9

G) What is the minimal time to live for a packet sent by router (1,0) to reach router (2,2) ? **1**

3

Task 7.3 Communication Models

This task focuses on Communication Models like the OSI reference model.

A) The (notional) company “Simple Communications” has taken the position that layered communication models are unnecessary. Name one reason why they would fare better with a layered model and justify your answer. **1**

Maintainability

Commented [Br64]: Also other answers are possible if they show the advantages of layered models.

B) What is the purpose of the presentation layer in the OSI reference model? **1**

Correct data representation between Applications

The following Latencies for data processing within each layer of the OSI reference model can be assumed for all devices in the following:

[1] Physical Layer: 1 us

[2] Data Link Layer: 10 us

[3] Network Layer: 100 us

[4] Transport Layer: 500 us

[5] Session Layer: 1 ms

[6] Presentation Layer: 1.5 ms

[7] Application Layer: 2.5 ms

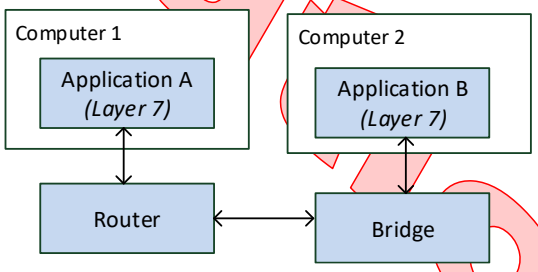

Figure 7.2: Data Transmission Scenario

C) Please calculate the communication latency for the router, bridge and for Computer 1. The payload size can be assumed as small. Thus, data transmission latency is assumed to be independent from the payload size. **3**

Router L3 = 2* Layer[3]+ 2* Layer[2]+ 2* Layer[1]=222 us

Bridge L2 = 2* Layer[2]+ 2* Layer[1]=22 us

Computer 1 = 2* Layer[7]+ 2* Layer[6]+ 2* Layer[5]+2* Layer[4]

+ 2* Layer[3]+ 2* Layer[2]+ 2* Layer[1]

= 5ms+ 3 ms + 2ms + 1000 us + 222 us = 11222 us

Commented [Br65]: 1pt per correct component.
-0.5P falls die oberste Schicht nur einmal berechnet wird (Abzug pro Rechnung)