

Written Exam in
Internetworking
TSIN02

15th March 2024 8:00 - 12:00

Location:	TER2
Examiner:	Harald Nautsch
Teacher:	Harald Nautsch, 1361
Department:	ISY
Module:	TEN1
Number of problems:	11
Number of pages:	7 + formula collection
Permitted equipment:	Calculator with empty memory, TSIN02 formula collection, general English dictionaries without notes
Grades:	3 : 23-29 points 4 : 30-38 points 5 : 39-46 points
Other:	Answers should preferably be given in English. The teacher will visit around 9:30.

1 **Link layer**

- a) Why is packet switching the more common choice for modern times?
(1 p)
- b) What is a MAC address?
(1 p)
- c) Why are wireless access networks divided into physical sub-spaces called cells?
(1 p)
- d) Communication protocols where the transmitter requires acknowledgement (ACK) packages from the receiver before sending new packages are limited in transmission rates when compared to protocols that do not use ACK packages. Explain why.
(1 p)

2 **Transport and application layers**

- a) What is used in addition to the IP address in the socket layer for addressing?
(1 p)
- b) Why is TCP more limited in bandwidth compared to UDP? State one more difference between TCP and UDP.
(2 p)
- c) Explain what DNS is and briefly describe how it works.
(2 p)

3 Optical networks

- a) Why is 1550 nm the preferred operational wavelength for optical communication systems?
(1 p)
- b) Name one effect that causes dispersion on an optical signal after propagation over an optical fiber?
(1 p)
- c) What is the main difference between dB and dBm?
(1 p)
- d) What is the main difference between an optical amplifier and a full regenerator?
(2 p)

4 Network Economics

- a) Why is flat rate considered unfair?
(1 p)
- b) What is the advantage of time dependent pricing for the telecom operator?
(1 p)

5 Data centers

- a) In the case of cloud networks, why is a simple inverted tree structure not scalable for growth? What should be used instead?
(2 p)
- b) How does a content delivery network (CDN) minimize latency to paying customers?
(1 p)

6 **Security**

a) Describe what SSL/TSL is and when it should be used. (2 p)

b) Why is DNSsec more secure than standard DNS? Why is it complex to implement in practice? (2 p)

7 **Optical networks**

You must design a basic optical network (source, optical fiber and receptor). The source that you will have available has the power $P = 1$ mW, the optical fiber has the attenuation coefficient $a=0.25$ dB/km and the receptor has the sensitivity $P_S = 10^{-2}$ mW.

a) Compute the maximum possible length of the optical fiber. (2 p)

b) In the future, we will need a 300 km link and we will use the same receiver and the same type of fiber. Define a suitable source (laser) for this link. (2 p)

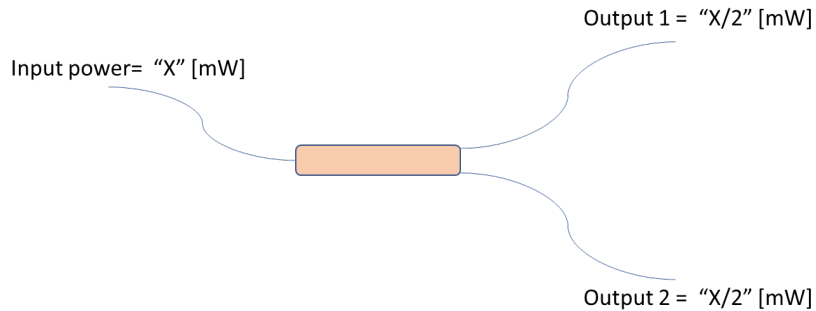
8 **Source/channel modelling**

Suppose a Binary Symmetric Channel (BSC) which has a big bit-error probability, equal to $p = 0.17$. Packets of 128 bytes are sent through this channel. Compute the theoretically obtainable efficiency if FEC is used over the link and compare it with the efficiency of using ARQ.

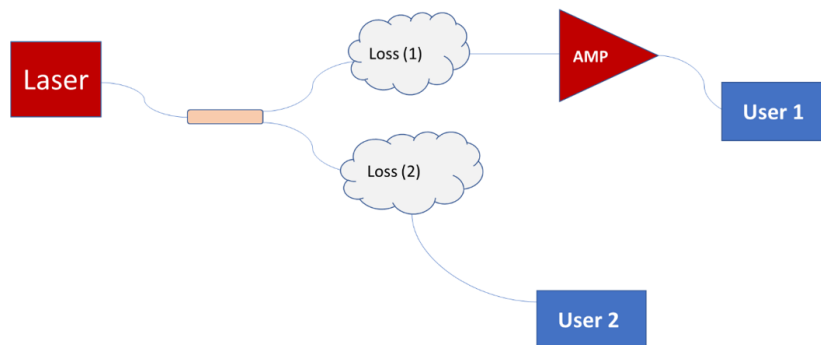
(3 p)

9 Optical Networks

A beam splitter is an optical component able of splitting an incoming light beam into two different light beams. For our case, we will assume that both output beams have the same optical power and we will ignore any other additional losses. The following scheme explain this:



In the figure, “X” represents any power measured in milliwatts. We can place this component in an optical network to use a single laser for two different users as is shown in the following figure:



In the figure, the laser is used to send optical information (a light beam) to the network. A beam splitter is placed to divide light and send information to two different users. Clouds represent all losses in each path: Loss (2) has a value of 7dB and Loss (1) is unknown. AMP is an amplifier used to compensate losses on upper path and have a gain of 8dB. “User 1” measure the power received and obtain a value of -15dBm after the light travelled the network. We know that “User 2” receives half the power of “User 1”. We will ignore any other losses or non-linear effect. Now answer the following:

- What is the power received at “User 2” in dBm and mW?
(2 p)
- Compute “Loss (1)”.
(3 p)
- What is the power of the laser in dBm?
(2 p)

10 **Internetworking**

An ISP is granted a block of addresses starting with 120.80.0.0 / 17. The ISP wants to distribute them to 150 customers as follows:

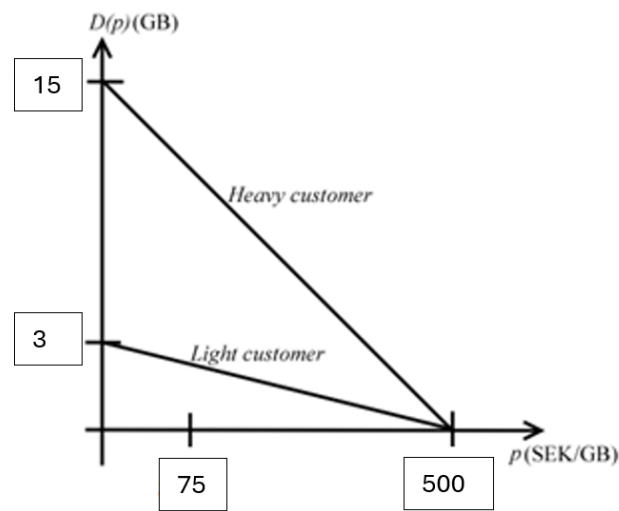
- 1st group has 120 large size businesses; each needs 256 addresses
- 2nd group has 30 medium size businesses; each needs 32 addresses

Design the sub-blocks and give the slash notation for each subblock. (Find the first and the last IP addresses in each group). Finally, find out how many addresses after these allocations will be available.

(4 p)

11 Network Economics

An ISP has customers with two different price-demand curves as shown in the figure below. The ISP decides that the customers should pay $p = 50$ SEK/GB. The underlying utility function (for both groups of customers) is based on a user poll where the users have told how much they are willing to pay for different amounts of data; that the utility function is concave; that the derivative of the utility function is invertible; and that the utility function evaluated for 0 GB is 0.



- What is the net utility measured in SEK for both groups of customers under usage-based pricing? (2 p)
- What is the net utility measured in SEK for both groups of customers under flat rate? (2 p)
- Which of these pricings are the best choice for the customers? (1 p)