LINKÖPING UNIVERSITY

Written Exam in
Internetworking
TSIN02

29th August 2024 14:00 - 18:00

Location:	TER1
Examiner:	Harald Nautsch
Teacher:	Harald Nautsch, 1361
Department:	ISY
Module:	TEN1
Number of problems:	12
Number of pages:	7 + formula collection
Permitted equipment:	Calculator with empty memory, TSIN02 formula collection, general English dictionaries without notes
Grades:	3 : 25-32 points 4 : 33-41 points 5 : 42-50 points
Other:	Answers should preferably be given in English. The teacher will visit around 15:30.

1 Link layer

a) Why is packet switching the more common choice for modern times?

(1 p)

b) As data transmission rates increase, it is often not efficient to keep simply increasing the speed of the components of the system. Why is that? What is often the preferred approach then?

(2 p)

c) Explain the main difference between forward error correction (FEC) and automatic repeat request (ARQ).

(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 IPv4 a major bottleneck for deployment of the Internet of Things?

(2 p)

c) How does congestion control work in TCP?

(2 p)

3 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)

4 **Optical networks**

a) Why is 1550 nm the preferred operational wavelength for optical communication systems?

(1 p)

b) Name the main advantage of using optical amplifiers instead of optical/electrical/optical converters.

(1 p)

c) What is a lightpath?

(1 p)

d) What is the main difference between an optical amplifier and a full regenerator?

(2 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) From the point of view of a company, name one advantage and one disadvantage of moving computing resources to the cloud.

(2 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 **Video streaming**

What is the main difference between a traditional client-server architeture and a P2P network?

(1 p)

8 **Optical Networks**

Suppose a basic optical network scheme (source, optical fiber and receptor). The source has an optical power output of $P = 1$ mW, the optical fiber has an attenuation coefficient $\alpha = 0.2$ dB/km and the receptor has a sensitivity $P_s = 10^{-4}$ mW.

a) Compute the maximum length of the optical fiber.

(2 p)

b) Suppose now that there is an additional loss in the network equal to 12 dB. Compute again the maximum length considering this loss.

(2 p)

9 **Source/channel modelling**

Consider coding for a network with packet losses with loss bursts following the Gilbert-Elliott process, i.e., the probability of a lost packet given that the previous packet was received $p_{l|r} = 0.05$, and the probability of a received packet given that the previous packet was lost $p_{r|l} = 0.45$. Assume that the probability density function (pdf) of the source is zero except in the interval [0,1]. Use uniform quantization with 7 reconstruction levels and assume that we operate in the high-rate regime. We do not use any means of protection against lost packets on the network. Assume that the MSE (Mean-Squared-Error) distortion is 1 if no packet arrives at the receiver.

a) Draw a diagram of the Gilbert-Elliot process that describes this problem.

(2 p)

b) What is the stationary channel loss probability?

(1 p)

c) What is the stationary channel receive probability?

(1 p)

d) What is the overall stationary mean MSE distortion considering the channel loss probability and the quantization distortion?

(1 p)

10 **Internetworking**

A large number of consecutive IP addresses are available starting at 198.16.0.0. Suppose that two organizations A and B request 4100 and 2070 addresses respectively, and in that order. For that reason, you must design 2 subblocks. For each of these, give the first IP address assigned in that block, the last address assigned in that block and how many IP addresses will be available in each organization, after the allocations.

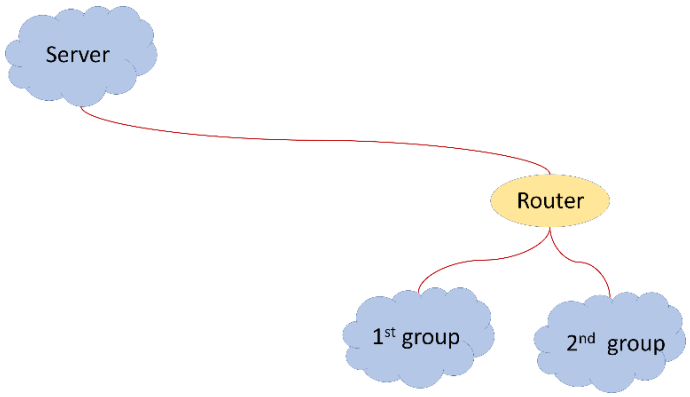
(4 p)

11 **Internetworking**

An ISP is granted a block of addresses starting with 192.60.0.0 / 16. The ISP wants to distribute them to 400 customers as follows:

- 1st group has 250 medium size businesses: each needs 128 addresses
- 2nd group has 150 small businesses: each needs 32 addresses

However, for the network to work properly, the optical parameters of the system must be tested. From the server, 13 dBm of optical power is injected into the network. The server and the router are connected by a standard optical fiber operating at 1550 nm with a length of 70 km. Insertion losses can be neglected. The router has a power sensitivity equal to -15 dBm. The attenuation constant of the optical fiber is $\alpha = 0.2$ dB/km. The following figure shows the network:



a) Considering the above data, is the optical power of the server enough for the router to work properly?

(2 p)

b) Now we will assume that the router works properly. Design the sub-blocks and provide the slash notation for each subblock. (Find the first and last IP address in each group)

(5 p)

c) Find out how many addresses after these allocations will be available.

(1 p)

12 **Network Economics**

An ISP has customers with two different price-demand curves. The ISP decides that the customers should pay p = 60 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. The pair of equations to model this problem are:

$$D_1(p) = -\frac{1}{50}p + 14$$
$$D_2(p) = -\frac{1}{140}p + 5$$

Where $D_1(p)$ and $D_2(p)$ are the demand functions of costumers 1 and 2 respectively (both measured in GB), and p represent the price in SEK/GB.

a) Make a graph where both demand curves are represented. For that, you must indicate which value the demand curve takes when the price $p = 0$. Furthermore, for which price p the demand is 0. Finally, you must determine which value the demand takes for $p = 60$ SEK/GB.

(2 p)

b) Determine which equation ($D_1(p)$ or $D_2(p)$) is modeling a heavy costumer.

(1 p)

c) What is the net utility measured in SEK for both groups of customers under usage-based pricing?

(1 p)