Solution to Exam in TSIN02 Internetworking

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Exam date: January 18, 2014, 14:00–18:00

1. See lecture 3, starting at slide 6.

2. $\log_2(131072) = 17$. 173.75.17.30=10101101.01001011.00010001.00011110. The closest subnet to this address which can contain 131072 addresses is thus 10101101.01001100.00000000.00000000-10101101.01001101.11111111.11111111, i.e., 173.76.0.0-173.77.255.255/15.

   This subnet is then subdivided into 10101101.01001100.00000000.00000000-10101101.01001100.11111111.11111111, and 10101101.01001101.00000000.00000000-10101101.01001101.11111111.11111111, i.e., 173.76.0.0-173.76.255.255/16, and 173.77.0.0-173.77.255.255/16.

3. Following the whiteboard notes of lecture 5, or Section 11.2.3 of 20Q, we have that

   a) 25 SEK

   b) -200 SEK

   c) Under flat rate, the customers are unhappy since the net utility is negative. On the other hand, with usage-based pricing, the users are happy since the net utility is positive. This follows from that the underlying utility function is based on a user poll where the users tell how much they are willing to pay for different amounts of data.

4. a) $m = 3$.

   b) $r = 500$.

   c) $m = 3 \geq 2n - 1 = 2 \cdot 2 - 1 = 3$, so the network is non-blocking.

   d) We want to maintain the non-blocking property in (c). At the same time, we want to reduce the number of switch connections of the 500×500-middle switches. One choice is a (n,m,r)=(2,3,250)-Clos network.

   See lecture 7 for more details!

5. a) The optimization problem is as follows:

$$\begin{aligned} \underset{\mathbf{x}}{\text{maximize}} \quad & F_{\beta,\lambda}(\mathbf{x}) = f_\beta \cdot (\sum_i x_i)^{1/\lambda} \\ \text{subject to} \quad & x_1 + x_4 \leq 1, \\ & x_2 + x_4 \leq 1, \\ & x_3 + x_5 \leq 1, \\ & x_i \geq 0, \; i = 1, \ldots, 5. \end{aligned} \tag{1}$$

b) When $1/\lambda = 0$, the objective function is the fairness function, and equal allocation obtains the optimal value. When $\frac{1}{\lambda}$ is increased, the weighting of the efficiency component increases and throughput is prioritized instead of fairness. The long session x_4 is penalized and short sessions x_1 and x_2 are given priority. Sessions x_3 and x_5 have the same length, so equal allocation is both fair and efficient and hence optimal for all values of $1/\lambda$. The sum throughput is 2.5 for $\frac{1}{\lambda} = 0$, and 3 for $\frac{1}{\lambda} = 10$, which supports our interpretation above.

6. We use the collection of formulas to get

$$\mathrm{MSE} = \frac{1 - \mathrm{a}^{2|\mathrm{k}|}}{1 - \mathrm{a}^2} \tag{2}$$

and with $k = 1$, we have MSE=1 with interleaving.

Without interleaving, we have very large k for most pixels. Hence, most pixels will have a distortion

$$\mathrm{MSE} \approx \frac{1}{1 - \mathrm{a}^2}, \tag{3}$$

and so the $MSE \approx 2$ without interleaving.