TSIN02 Internetworking

Exercise class 6 solutions

Exercise 1: The theoretical obtainable efficiency for FEC is given by the Shannon capacity $C = 1 - h(10^{-5})$ = 1 - 0.00018 = 99.98 %. The packet loss probability $P \approx 500 * 8 * 10^{-5} = 0.04$. Thus the efficiency of ARQ is 1- 0.04 = 96%.

Exercise 2:
a) Shannon channel capacity is 1 - h(0.05) = 71%
b) For each group of 10 bits, 1 more (FEC) bit is sent. Thus, the efficiency of this FEC scheme is 10/11 = 91%.

Exercise 3:

a) For uniform quantizer and Gaussian distributed samples, $SDR \approx 6R - 7.4$ [dB]. Here, $S = 1$, $D = 0.01$, and $SDR = 20$ dB, thus $R \approx 2.86$ bits per pixel, and thus 2.86 Mbit per image.

b) With $p(1) = 0.01$, $p(2) = 0.02$, $p(3) = 0.03$, $p(4) = 0.04$, and $p(5) = 0.9$, we have that $H = -\sum_{k=1}^{5} p(k) \cdot \log_2 p(k) \approx 0.7$ bits. $C = 1 - p_{err} = 0.9$ effective bits per transmitted bit. Since $H < C$, it is possible to transmit one pixel per transmitted bit without errors.

Exercise 4: We use the collection of formulas to get

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

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

$$\mathrm{MSE}_{\mathrm{pred}} = \frac{1}{1 - \mathrm{a}^2}$$

and so the MSE ≈ 2 without interleaving.

Exercise 5:

a) The stationary receive and loss probabilities are

$$\pi_r = \frac{P_{r\setminus l}}{P_{l\setminus r} + P_{r\setminus l}} \approx 0.97,$$

$$\pi_l = 1 - \pi_r \approx 0.03.$$

b) The number of reconstruction levels is $M = 10$, $A = 1$, so $\Delta = \frac{1}{M}$. According to lecture 8, the distortion if the packet arrives is $\frac{\Delta^2}{12} \approx 8.3 \text{ x } 10^{-4}$.

c) The stationary overall mean distortion is $D = \pi_r \frac{1}{12M^2} + \pi_l \approx 3.3 \text{ x } 10^{-2}$.