

**S72-630 Capacity Enhancement Methods for Radio Interface  
Exam 06.05.2004**

Answer the following five problems

Problem 1; two of Problems 2,3 and 4; two of Problems 5,6 and 7.

1. Compare the component decoder algorithms of a turbo decoder: MAP, logMAP, maxlogMAP, soft Viterbi. Describe shortly each of them. What are the differences between them? How they are related to each other? How the performance of a turbo decoder is impacted by selection of these algorithms?
2. We have three bits  $B = [b_1 \ b_2 \ b_3]$ . At the same time all bits have the same values: they all are ones or they all are zeros. We observe the value of these bits in a noise environment. We have observed that the first two bits are 1 with probabilities  $p(b_1 = 1) = \frac{1}{3}$  and  $p(b_2 = 1) = \frac{1}{4}$ . What is the probability that the last bit is equal to 0:  $p(b_3 = 0)$ .
3. The input to the AWGN channel has binary values  $\pm 1$ . The channel contains noise with variance  $\sigma^2$ . We observe in the channel output value  $x$ . What is the log likelihood ratio  $L(x)$  of the observed bit? Express the probability of the bit being +1  $p(x = 1)$  as a function of  $L(x)$ .
4. Consider the detection of a signal  $s_i$  embedded in AWGN with variance  $\sigma^2$  based on the observed samples  $r_i$  for  $i = 0, 1, \dots, 2N - 1$ . The signal is given by

$$H_0 = \begin{cases} A & n = 0, 1, \dots, N - 1 \\ 0 & n = N, N + 1, \dots, 2N - 1 \end{cases}$$
$$H_1 = \begin{cases} A & n = 0, 1, \dots, N - 1 \\ 2A & n = N, N + 1, \dots, 2N - 1 \end{cases}$$

Assume that  $A > 0$  and find the likelihood ratio test (LRT) for deciding which hypothesis has occurred. Explain the operation of the detector.

5. Describe what kind of hypothesis testing problem is called composite hypothesis testing?
6. Describe the working principle, (main properties) of HARQ-II schemes. What are the differences compared to HARQ-I schemes?
7. Describe transmit diversity methods utilized in WCDMA systems. What type methods are standardized? Comment on the performance of different methods?