Written Examination for:
Multimedia and Video Communications (SSY 150) - May 30, 2008

Dept. of Signals and Systems, Chalmers Univ. of Technology,
8:30-12:30 am, 30 May, 2008

Lecturer and Examiner: Prof. Irene Gu (tel: 1796).

This written exam may yield a maximum of 20 points.

The total exam yields 100 points (where the 4 laboratory work yields a maximum 80 points, and a maximum of 5 bonus points)

To pass the examination, a minimum of 50 points is required.

Grades are defined as follows:

TOTAL points (p)	Grade:
$p < 50$	Fail;
$50 \le p < 70$	Pass with grade 3;
$70 \le p < 85$	Pass with grade 4;
$p \ge 85$	Pass with grade 5.

Correction and appraisal time: 13:00-15:00 June 24, 2008 in E-building, 6th floor, blue room (room 6439).

Aids allowed:
The mathematical handbook 'Beta'.

Success and good luck!

Problem 1. Multiple choices (10p)

1.1. Choose a protocol combination below that is suitable to transmit compressed video packets over the Internet:

(a) TCP / IP
(b) UDP / IP
(c) RTP / UDP / IP

1.2. Choose some of the items below (can be more than one) that the UDP protocol offers:

(a) acknowledge of packet loss
(b) packet ordering (i.e. received packets are always in the correct order)
(c) unlimited delay
(d) re-send lost packets
(e) possible of receiving duplicated packets
(f) with packet loss

1.3. Choose some of the items below (can be more than one) related to the main parameters for the Quality of Service (QoS) in the networks:

(a) Source data compression rate
(b) Packet end-to-end delay
(c) Channel coding rate
(d) Delay jitter
(e) Network bandwidth
(f) Network throughput
(g) Packet round-trip delay time
(h) Packet size

1.4. For transporting compressed video over the Internet, the most essential errors are generated from:

(a) bit errors
(b) packet losses

1.5. In the current standards, which of the following situations that a video packet is considered as lost? (you may choose more than one items)

(a) some bit errors appear in a packet, however cannot be corrected by a FEC scheme
(b) a packet is delayed
(c) a packet is delayed than the maximum allowed time
(d) a packet is lost
(e) a packet is lost but successfully re-transmitted

1.6. Choose the correct statement from the following list:

(a) packet loss appears in the physical layer
(b) packet loss appears the network layer
(c) bit errors appear in the physical layer
(d) bit errors appear in the network layer

1.7. To achieve end-to-end (i.e., from the sender side to the receiver side) video performance optimization, there are several parameters that can be tuned in designing the end-to-end system. Write down the parameters that can be used in the following layers in the sender side:

(a) parameters in the application layer (including video source and channel encoders):

(b) parameters in the transport layer:

(c) parameters in the network layer:

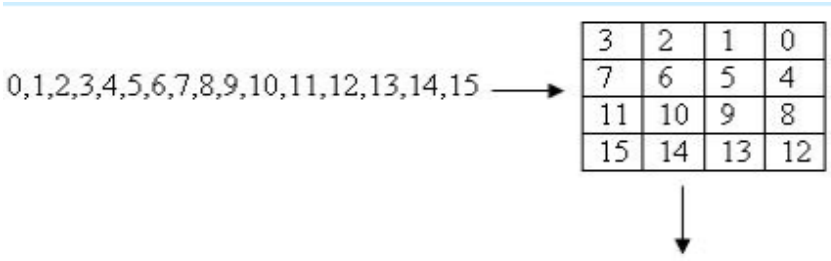
(d) parameters in the link layer:

(e) parameters in the physical layer:

1.8. Which of the following mathematical model(s) best suits for the network with packet losses?

(a) Raleigh fading channel
(b) AWGN channel
(c) Rician fading channel
(d) Erasure channel

1.9. In the following figure, the symbol sequence in the left side of the matrix contains 4 codewords (each contains 4 symbols). Specify the output sequence from the following matrix interleaver:



Problem 2. (10p)
In order to design an end-to-end performance optimized video communication system, the following conditions in the system are specified and can be employed for your design process:

(a) The selected network is able to acknowledge the packet loss and re-transmit the lost packets. Further, the sender's buffer can store up to 2 frames of video, each frame of video contains M packets. The re-transmission parameter for the k-th packet in the n-th frame is $\sigma_k^{(n)} \in \{0,1\}$, where 0 denotes no packet re-transmission, and 1 with packet re-transmission.

(b) RS codes is used for channel coding. To allow different error protection for the codewords obtained from the inter-mode and the intra-mode in video source codec, the RS codes allows 2 rate-modes $\text{RS}(n_i, k),\ i = 1, 2$: that lead to two different channel rates $c_i = k / n_i$, where k is the number of source symbols, and n_i is the length of RS codewords.

(c) For video source coding: both one directional and bidirectional predictions are employed (i.e. P frames and B frames are used) for inter-coding; for intra coding, the quantization step size can be adjusted that may impact the coding errors and the coding rate.

Further, the following delay constraint is specified: The maximum allowed delay time for receiving each video packet is: $T_0 = R_0 / R_T$ (where R_0 is the rate constraint, and R_T is the throughput).

Your aim is to design an end-to-end performance optimized video system, such that the expected distortion of the reconstructed video in the receiver side is minimized (assume the distortion function is D). *You are asked to formulate a criterion function **L** to design this video system*, where ***L*** is a function of the parameters in source coding, channel coding and packet re-transmission, and is subject to the delay constraint. You should then specify on how these parameters can be adjusted, in order to yield an optimized system.

(hint: specify the parameter sets for the source coding, channel coding and re-transmission; formulate the criterion function and the constraint condition; formulate a criterion function L using the Lagrange multiples, and specify whether to minimize or maximize the function L, and specify how the parameter sets can be estimated.
Note, you do not need to get the final solution in numbers!)