

**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: Bitr. 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:

<u>TOTAL</u> points (p)	<u>Grade:</u>
$p < 50$	Fail;
$50 \leq p < 70$	Pass with grade 3;
$70 \leq p < 85$	Pass with grade 4;
$p \geq 85$	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

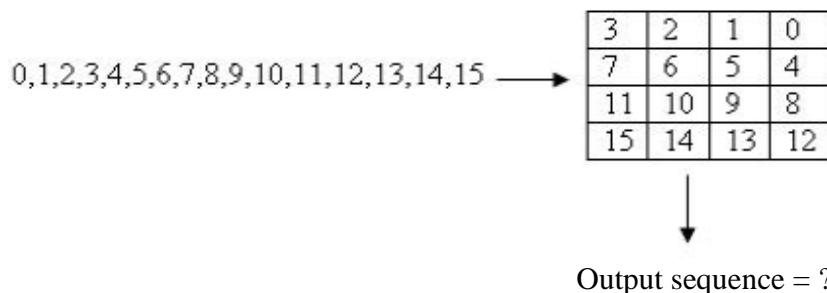
1.7. To achieve end-to-end (i.e., from the sender side to the receiver side) video performance optimization, there are several parameters that can be tuned in designing the end-to-end system. Write down the parameters that can be used in the following layers in the sender side:

- (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 $RS(n_i, k)$, $i = 1, 2$: 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!)