Examination for:
Multimedia and Video Communications (SSY 150) - May 29, 2009

Dept. of Signals and Systems, Chalmers Univ. of Technology,
Morning, May 29, 2009 in "Maskin"-salar

Lecturer and Examiner: Prof. Irene Gu

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)

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.

Aids allowed:
The mathematical handbook 'Beta'.

Success and good luck!

Problem 1. (12p)

1.1. Compression of video signals:

(a) What is the main characteristic of video that is explored for achieving high compression rate in video? (*maximum one sentence*)

(b) Briefly describe the main advantages and disadvantages of: (*maximum 20 words):*

- using the *inter* coding mode for video;
- using the *intra* coding mode for video.

1.2. Compression of speech signals:

(a) Describe the minimum amount of required parameters for transmitting a 20ms stationary speech signal. Further, sketch a block diagram for re-synthesizing speech by using these parameters.

(b) Psycho-acoustics, or human auditory system models, are usually taken into account in speech coding, for obtaining a high compression rate with good sound quality. List several important psychoacoustic-related 'features' that are considered in the current speech compression standards (*maximum 20 words*)

1.3. For the IP protocol stack shown in Fig.1, choose the best combination of protocols for transmitting compressed video through the Internet.

(a) Write down the protocol combination you have chosen.

(b) *Briefly* state the reasons for your choice (*maximum 20 words*).

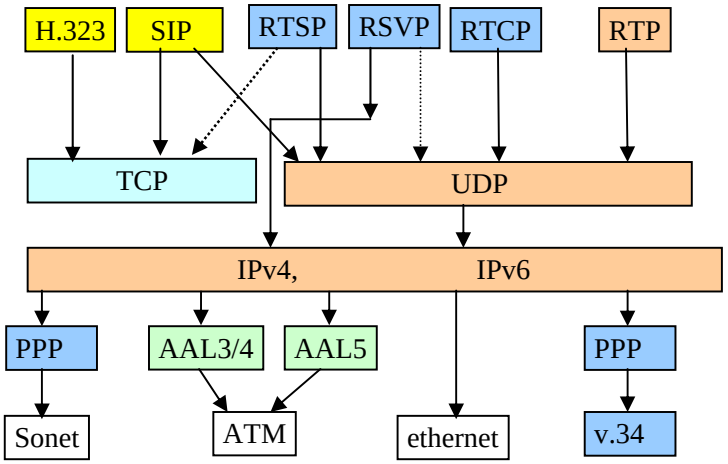

Fig.1. IP Protocol stack

1.4. *Briefly* describe several main Quality of Service (QoS) parameters related to the transportation of compressed multimedia data through a communication network *(maximum 30 words)*

1.5. The aim here is to achieve the best end-to-end performance, when transporting compressed videos through a communication network (see Fig.2 for a 5-layer model).

Briefly describe the parameters (or methods) in each layer that may be used for adjusting the end-to-end performance *(maximum 20 words for each layer).*

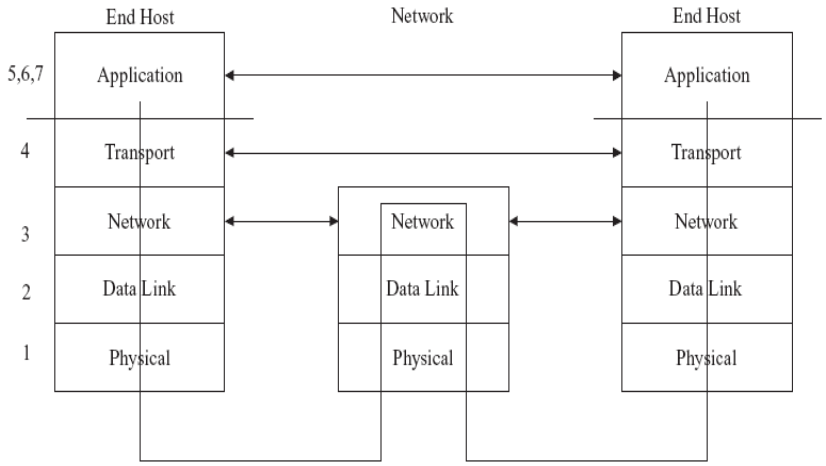

Fig.2. A 5-layer model

1.6. Choose the best suitable mathematical model for a video communication network where errors are primarily dominated by the bursty packet loss.
(a) Specify the name of the model you choose (maximum 15 words)
(b) *Briefly* describe the essential parameters of the model (maximum 20 words)
(c) Sketch a figure, or, an equation, *if that would help your description.*

1.7. Select a channel coding *method* (write down the name) that you consider as the best suitable one for correcting packet losses.
Also, *briefly* state the reasons of your choice *(maximum 30 word).*

1.8. (a) Briefly specify the main differences between TCP and UDP protocols.
(b) Which protocol (TCP or UDP) is more suitable for transmitting video packets?

Problem 2. (8p) For designing an end-to-end performance optimized video communication system, the following conditions are specified, and can be employed in your design process:

(a) Each frame of video consists of M packets, and each packet contains L bits. The probability of k-th packet loss is ρ_k , $k=1, \ldots M$.
(b) An error concealment scheme is employed: If a packet is lost, then it is replaced by its previous packet (i.e.: if the k-th packet is lost, then it is replaced by the $(k-1)$-th packet).
(c) No re-transmission of packets is allowed.
(d) Due to the physical limitation of the network, a maximum allowed transmission rate is R_0 .

Design a joint source-and-channel video coding system for achieving an end-to-end performance optimization, such that the expected distortion of the reconstructed video in the receiver side is minimized (note: the distortion D is defined under the Mean Square Errors (MSEs) sense).

Hints:

- define the expected distortion E(D) under the MSE sense for one packet;
- specify the adjustable parameter sets for the source coding and channel coding;
- write down the criterion function and the constraint condition according to the given condition;
- formulate the mathematic problem by using a total cost function by using the Lagrange multiples; and specify whether to minimize or maximize the function, and specify how the parameter sets can be estimated (Note: you do not need to get the final solution in numbers!)