Lab 2: Packet Losses and Their Impact on Streaming Video Quality

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I. Introduction

In this Lab, you are to investigate packet losses and their impact on streaming video quality through the evaluation of the decodable frame rate (DFR) [1], [2] with and without forward error correction (FEC) and convolutional interleaving/deinterleaving based on the loss models you studied in Lab 1.

You need to submit a Lab report and program source code through the Learning Mall Online by the end of Sunday, 12 May 2024.

II. Evaluation of Decodable Frame Rate (DFR) in Video Streaming

Fig. 1 shows a video streaming model for the analysis of packet loss impact on video quality, which consists of one server and one client connected through a lossy channel.

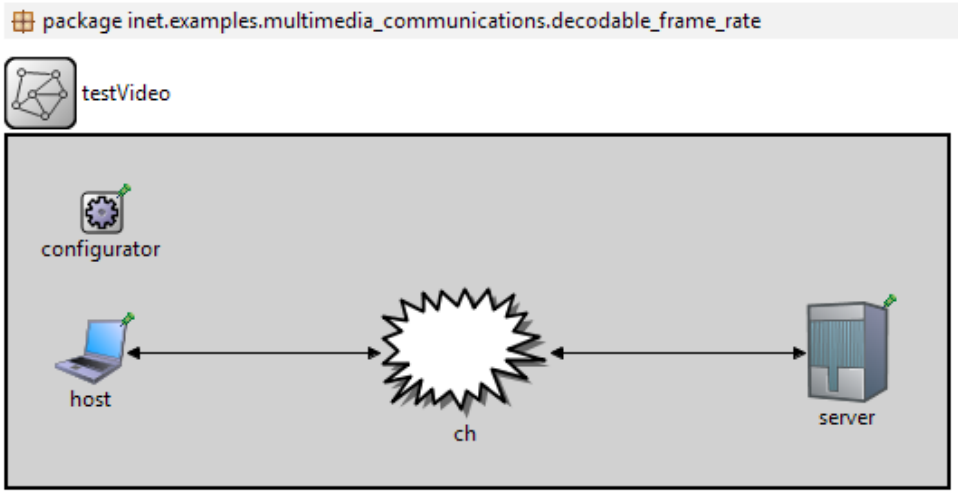

Fig. 1. A video streaming model.

You are to evaluate DFR [1] to quantify the impact of packet losses on streaming video quality step by step as follows:

1) Generate symbol loss sequences using the Simple Gilbert model (SGM) [3] (i.e., the model studied in Lab 1).

2) Map symbol losses to packet losses based on the number of symbols per packet under the following conditions:
   - Without FEC.
   - With FEC.

- With FEC and convolutional interleaving/deinterleaving.

We assume 8 bits per symbol and 188 symbols per packet. In case of FEC, a Reed-Solomon code of RS(204, 188, t=8) from the digital video broadcasting (DVB) standard is applied to each packet, resulting in 204-symbol packets. We assume that there are *no other overhead, randomization, and interpolation during the packetization*.

3) Map packet losses to frame losses based on the number of bits per frame for a given video trace. For this Lab assignment, we use *The Silence of the Lambs* video trace from the Arizona State University H.264/AVC video trace library, which is shown below and can be downloaded from Learning Mall Online.

```
# Frame Time [ms]   Type    Size [Bit]  ...
0       0.000000    I       536
4       133.333330  P       152
1       33.333330   B       136
2       66.666670   B       136
3       100.000000  B       136
8       266.666670  P       160
5       166.666670  B       136
6       200.000000  B       136
7       233.333330  B       136
12      400.000000  P       160
9       300.000000  B       136
10      333.333330  B       136
11      366.666670  B       136
16      533.333330  I       528
13      433.333330  B       136
14      466.666670  B       136
15      500.000000  B       136
...
```

For simplicity, we treat any *partially-filled* packets at the end of frames (e.g., the second packet from a frame of 1664 bits ($\sim$1.1064 packets) as normal 188-symbol packets (before FEC) during the loss mapping.

4) Calculate DFR based on the GOP structure and the coding dependencies of frames. The GOP structure of *The Silence of the Lambs* video trace is IBBBPBBBPBBBPBBBI (i.e., M=4, N=16).

Fig. 2 illustrates the whole procedure for evaluating DFR from symbol losses.

III. Task: Analysis of Packet Loss Impact on Streaming Video Quality

For this task, you need to submit a Lab report and program source code summarizing the following activities:

#1 [**30 points**] Read the types and sizes of 10,000 video frames from the *The Silence of the Lambs* trace and generate symbol loss sequences for two symbol loss rates (p_L) of 1×10^{-4} and 1×10^{-3}

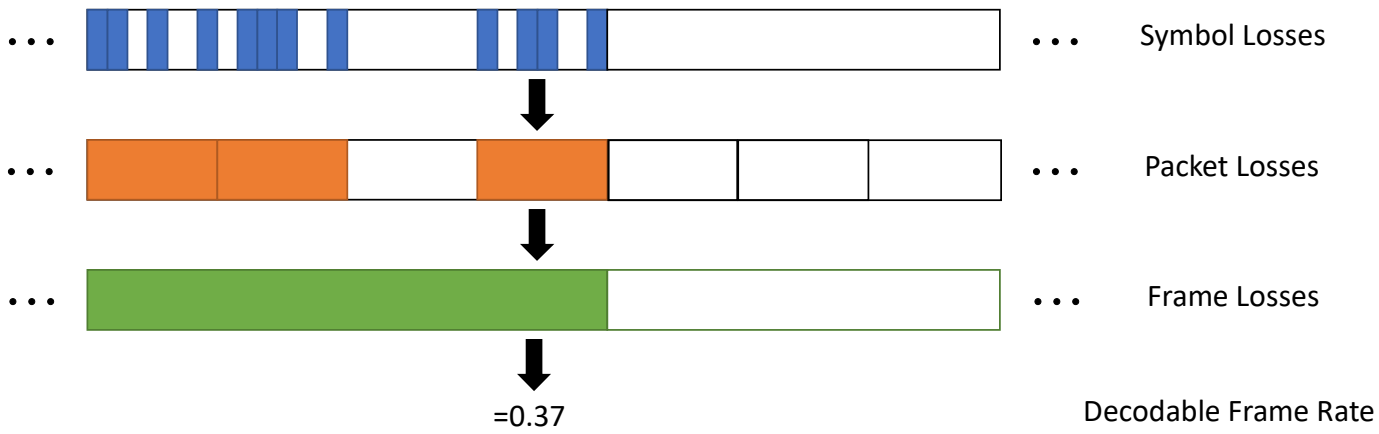

Fig. 2. Evaluating DFR from symbol losses.

using the SGM with p=1×10^{-4}. Based on the procedure described in Sec. II, calculate DFR for each loss rate.

#2 [**25 points**] Repeat #1 with RS(204, 188, t=8).

#3 [**25 points**] Repeat #2 with convolutional interleaving/deinterleaving.

#4 [**20 points**] Generate a plot comparing the resulting DFRs (similar to the one shown in the Lab slides for DFR) and discuss the advantages and disadvantages of using RS code and/or convolutional interleaving/deinterleaving.

Note that The following files are provided on Learning Mall Online for this task:

- *conv_interleave.py*: Code for convolutional interleaving/deinterleaving.
- *dfr_simulation_template.py*: Skeleton code for the simulation.
- *sgm_generate.py*: Code for generating loss patterns based on SGM.
- *silenceOfTheLambs_verbose*: Video trace file for the simulation.

REFERENCES

[1] A. Ziviani, B. E. Wolfinger, J. F. Rezende, O. C. Duarte, and S. Fdida, "Joint adoption of QoS schemes for MPEG streams," Multimedia Tools Appl., vol. 26, no. 1, pp. 59–80, 2005.

[2] K. S. Kim, "The effect of ISP traffic shaping on user-perceived performance in broadband shared access networks," Computer Networks, vol. 70, pp. 192–209, Sep. 2014.

[3] M. Yajnik, S. Moon, J. Kurose, and D. Towsley, "Measurement and modelling of the temporal dependence in packet loss," in Proc. 1999 IEEE INFOCOM, vol. 1, Mar. 1999, pp. 345–352.