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] with and without forward error correction (FEC) based on the loss models you studied in Lab 1.

You need to submit a Lab report and program source code through the ICE by the end of Sunday, 7 June 2020.

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.

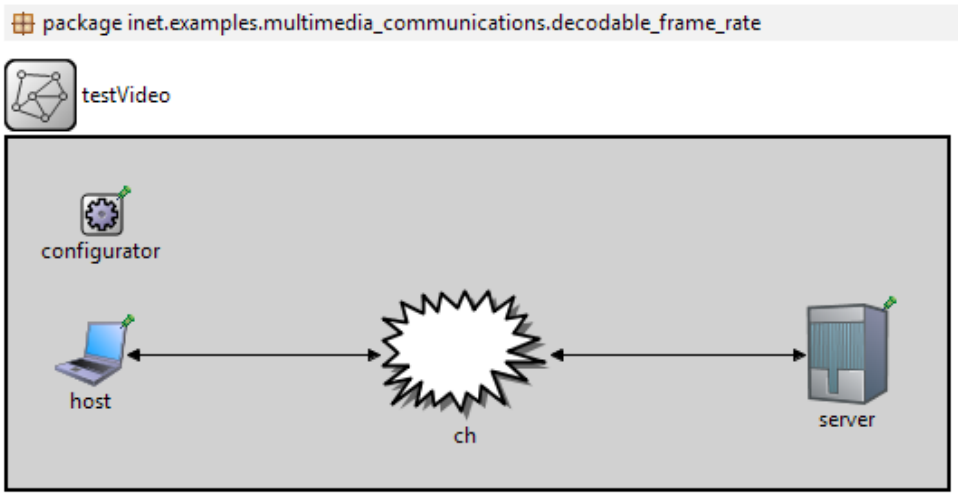

Fig. 1. A video streaming model.

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 following loss models:
   - Uniform loss model (i.e., Bernoulli process).
   - Simple Gilbert model (SGM) [2] (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.

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 *Terminator 2* video trace from H.264/AVC video trace library, which is shown below and can be downloaded from ICE.

```
# Frame Time [ms]       Type    Size [Bit] ...
0       0.00000         IDR     1290616
3       100.00000       P       914160
1       33.33333        B       420536
2       66.66667        B       439072
6       200.00000       P       918848
4       133.33333       B       439512
5       166.66667       B       458384
9       300.00000       P       952960
7       233.33333       B       459096
8       266.66667       B       455344
12      400.00000       I       1296440
10      333.33333       B       461472
...
```

Note that, for simplicity, we treat any *partially-filled* packets at the end of frames (e.g., the 859th packet from the first IDR frame of 1290616 bits ($\sim$858.12 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 *Terminator 2* video trace is IBBPBBPBBPBBI (i.e., M=3, N=12).

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

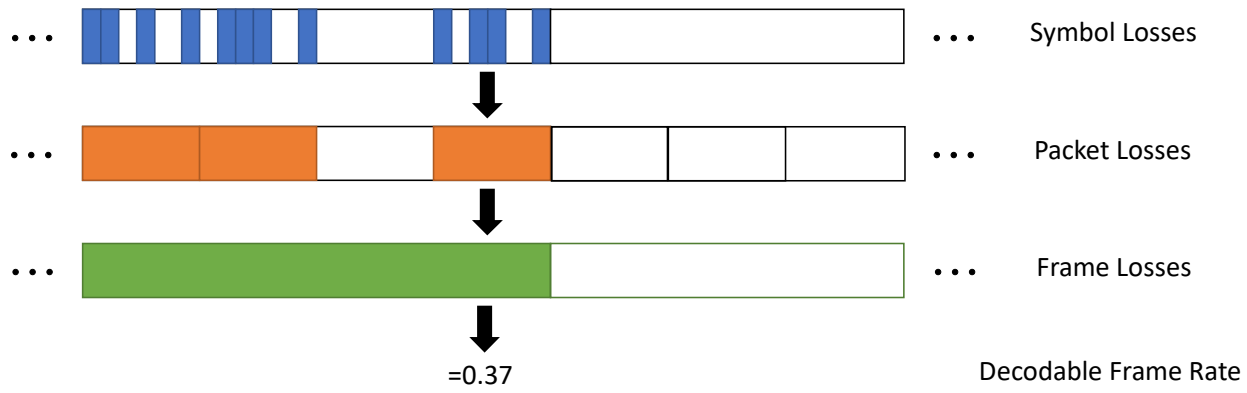

Fig. 2. Evaluating DFR from symbol losses.

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 [**20 points**] Read the types and sizes of 1,000 video frames from the Terminator 2 trace and generate symbol loss sequences for four symbol loss rates of 0.05, 0.1, 0.15 and 0.2 using the uniform loss model. Based on the procedure described in Sec. II, calculate DFR for each loss rate.

#2 [**20 points**] Repeat #1 with RS(204, 188, t=8).

#3 [**20 points**] Repeat #1 but this time using SGM for the same loss rates with p fixed to 0.05.

#4 [**20 points**] Repeat #3 with RS(204, 188, t=8).

#5 [**10 points**] Generate a plot comparing the resulting DFRs (similar to the one shown in the Lab slides for DFR).

#6 Discuss the following points based on the results from your analysis above:

- [**5 points**] Why are there such differences in resulting DFRs for the same loss rates between the uniform loss model and SGM?
- [**5 points**] What are the advantages and disadvantages of using FEC (i.e., RS code in our case)?

Note that The following files are provided on ICE for this task:

- *terminator2_verbose*: Video trace file for the simulation.
- *dfr_simulation.py*: Skeleton code 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] 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.