ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE
School of Computer and Communication Sciences

Handout 22 Principles of Digital Communications
Project Apr. 8, 2020

Goal: The purpose of this PDC project is to complement the theory with a hands-on experience. What you do in this project is not very different from what a communication engineer might do to test the feasibility of a concept.

Assignment: Develop a system capable of reliably transmitting text files over an Additive Gaussian Noise channels. Specifically:

- Design a transmitter that reads a text file and returns real-valued samples of an information-bearing signal $\mathbf{X}$.
- You send $\mathbf{X}$ to a server that applies channel effects, returning $\mathbf{Y}$.
- Having received $\mathbf{Y}$, your designed receiver must reconstruct the contents of the text file.

Channel Effect The channel output signal $\mathbf{Y} \in \mathcal{R}^n$ is linked to the input $\mathbf{X} \in [-1, 1]^n$ through the relation

$$\mathbf{Y} = \mathbf{X} + \mathbf{Z}.$$

The noise $\mathbf{Z}$ is i.i.d. Gaussian random variables distributed as $\mathcal{N}(b, \sigma^2)$. The value of b and σ will not change across transmission, i.e. the value is fixed for this whole semester. You are free to choose the value of n as long as $n \leq 51200$.

Rules and Recommendations:

- You work in teams of *two or three*.

  Please choose your teammates at latest by **Friday, May 1** and send an email to `reka.inovan@epfl.ch` in order to register your team.

- You can use any programming language, as long as all the code pertaining to the transmitter and receiver is produced by your team.
- During the last session (May 29), each group presents their project in 5–10 minutes and gives a demonstration by transmitting a file that we provide.

  (i) You will run the transmitter and the receiver on your own laptop.

  (ii) You must send us your code before **Friday, May 29, 10am**.

  (iii) The text file which you will be asked to transmit will contain *roughly 80 characters/bytes*.

  (iv) Your presentation should contain a brief explanation of your signaling scheme, followed by the transmission and decoding of the chosen text (that will be given to you on the spot).

  (v) You will be given *two* chances for transmission. I.e., if the received text is different than the sent one at the first attempt, you can repeat the transmission once more.

- Reliability plays the most important role in the evaluation. Hopefully the communication will be error-free. The data rate and the implementation details play a secondary role. Nevertheless there is an upper-bound on accepted transmission size to keep server load reasonable.

  (a) If you manage to transmit the file without errors during the first transmission you will get the full mark (15/15 pts).

  (b) In case of error-free transmission in the second attempt you will get 12 pts out of 15.

  (c) Otherwise your mark will be $(1 - \varepsilon) \times 12$ (out of 15 pts) where ε is the fraction of incorrect *words* in the reproduced text at the receiver.

  (d) On top of that, the group with the fastest transmission scheme (among the error-free ones) will get 5 additional (bonus) points.

Channel Access: To simplify communication with the channel server, we provide you a Python script `client.py` that you can download on the course webpage. Please read the associated docstrings for more information. You can only connect with the server if you are inside EPFL's VPN. Some extra information:

- Real-world transmitter/receiver front-ends can reliably quantize signals on a finite interval only. We replicate this behavior in the channel by clipping your inputs to $[-1, 1]$.
- `--srv_hostname=iscsrv72.epfl.ch`
- `--srv_port=80`

Note: This project is meant to be instructive and enjoyable. It accounts only for 15% of the points that you can accumulate towards your final grade. Do not let it become a major time investment unless you can afford to do so. In particular, we strongly recommend that you do not let the project keep you from fulfilling the other assignments (for PDC and other classes).