ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE
School of Computer and Communication Sciences

Handout 21 Principles of Digital Communications
Project Apr. 25, 2018

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 proof of concept to show that we can exchange files "over the air"between two laptops, by using the speaker of one laptop as the transmitting device and the microphone of the other laptop as the receiving device in presence of an *interfering* third party.

More precisely, on one laptop you should implement a transmitter that reads a text file and transmits it by means of playing sound waves from the computer's speaker. On the other laptop, you implement a receiver that records the transmitted sounds from the other laptop from the microphone and reproduces the text file.

However, there will be another source (speaker) placed very close to the receiver emitting a signal which will make transmission outside certain frequency intervals infeasible. The signal emitted by the interferer will be filtered white Gaussian noise with the filter frequency response either $H_I(f)$ or $H_{II}(f)$ shown below (see Fig. 1):

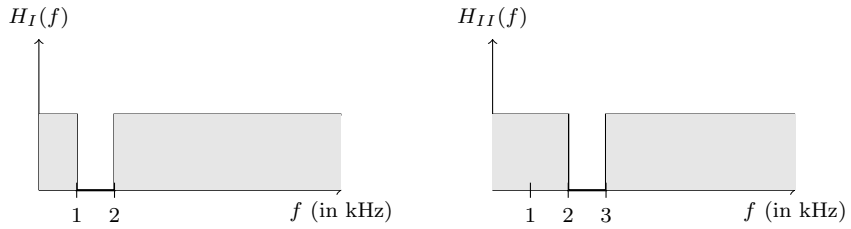

Figure 1: Spectrum of type I (left) and type II (right) noises

Fig. 1 shows that with frequency response $H_I(f)$, the noise level will be very high outside the interval $[1\text{kHz}, 2\text{kHz}]$ and almost zero over this same interval. Similar observation can be made for frequency response $H_{II}(f)$ but with the interval of interest being $[2\text{kHz}, 3\text{kHz}]$. By placing the interferer close to the receiver we make sure that transmission over the shaded frequency regions is very hard. Before the transmission starts one of the two filters will be chosen by a coin flip. Your system should be designed to work in either event without the transmitter and receiver knowing in advance which filter will be chosen.

Rules and Recommendations:

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

  Please choose your teammates at latest by **Wednesday, May 2** and send an email to `elie.najm@epfl.ch` in order to register your team.

- We recommend that you use MATLAB as the programming language, but any other satisfactory solution is also accepted, as long as all the code pertaining to the transmitter and receiver is produced by your team.

- During the last class session (June 1), each group presents their project in a few minutes and gives a demonstration by transmitting a file that we provide.

(i) You will run the transmitter and the receiver on your own laptops (*in airplane mode*) but the interfering source will be set by us.

(ii) You, however, need to send us your code before **Friday, June 1, 10am**.

(iii) The two laptops will be at a distance of roughly 3m from each other and the interfering source will be close to the receiver.

(iv) You *cannot* use external speakers at the transmitter but you may use an external microphone at the receiver if you wish.

(v) The text file which you will be asked to transmit will contain *roughly 160 characters*.

(vi) You will have 5 minutes in total for presentation during which you have to explain your signaling scheme briefly in 2 minutes and then will have 3 minutes for the transmission of the text file (that will be given to you on the spot).

(vii) Decoding need not be real-time, i.e., you can sample and store the received signal and process afterwards.

(viii) 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. However, the total duration (of both transmissions) must not exceed *three* minutes.

- 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.

  (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.

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). Remember that the final exam accounts for 40% of the points.