



February - May 2017

Extra lab session: Cooperative challenge using the FRAMED-SOFT based on the Software Defined Radio environment LabVIEW and NI USRP-2920 hardware

(4 hours)

Objectives

The objectives of the lab can be summarized as follows:

- Reinforce the knowledge about UMTS and GSM system.
- Acquire skills handling the communications lab equipment such as transceivers with which being able to work by means of the Software Defined Radio (SDR), as well as to get familiar with the NI LabVIEW© environment.
- Utilize the knowledge acquired during the lab sessions to improve specific parts of the systems.
- Get closer to the real industry, where an engineer has to fulfill specifications on a limited period of time.

1 FRAMED-SOFT

The Flexible Radio Access Mobile Environment Defined by SOFTWARE (FRAMED-SOFT) is a platform designed in The University Carlos III of Madrid with the aim of getting closer to the students the mobile communication standards. The platform is divided into three parts, namely, the hardware, the base stations and the receivers. The hardware part is composed of the NI USRPs, usually two of them for each software part. Although the same USRP could work simultaneously as transmitter and receiver (one antenna for transmission and the other one for reception), this design uses two different USRP connected by the provided interconnection wire. This way, the design of each part is simpler, it allows the use of less powerful computers for controlling the USRP.

FRAMED-SOFT allows the modification or optimization of the transmission/reception parts independently, what is very useful for practical work. Thus, a base station needs two USRPs, one for transmission and the other one for reception. Since both are controlled by different LabVIEW designs (even running in different computers although this is not mandatory), they interchange information by using the interconnection wire provided with the USRP bundle.

The base station part allows one to select the GSM or the UMTS standard. Depending on which one is chosen, the adequate LabVIEW design is executed. Since both standards

are completely different from the physical layer point of view, two different designs have been implemented. However, from the logical point of view, both of them have several similarities.

It should be noted here that within the LabVIEW interface, there is the NI LabVIEW MathScript RT that allows the use of Matlab code directly into the LabVIEW designs. This can be used when a complex algorithm needs to be evaluated first in order to decide if it will be implemented or not.

In this lab work, the student will receive an incomplete version of FRAMED-SOFT and he/she, after studying the corresponding standard, must program the parts that are required. This way, the student becomes aware of the functioning of mobile communication technologies. Indeed, in this lab work, the student is asked for an open ended-design experience that consists in developing important parts of a communication system: the channel estimation, equalization, rake receiver, synchronization, etc.

2 Lab description

This lab is an open ended-design experience that consists principally in a competition. The class will be divided into groups of several students (depending on the number of students in class, the instructor will decide the size of the groups) and then, one of the standards will be assigned to each group (GSM or UMTS). The different groups will work on diverse parts of the system at the selection of its components in order to enhance them. They must cooperate with each other because at the end, the winner team will be the one that brings the whole system with the best performance, measured either in terms of error probability or throughput.

An incomplete version of the FRAMED-SOFT platform will be available for each group, as well as the hardware NI USRP-2920 necessary to carry out the challenge.

The grades of the lab session can be modified depending on the results of the extra lab session.

Next, a list of possible tasks that can be chosen by the different groups are presented. Note that each task can only be chosen twice (maximum two groups with the same task).

For the correct execution of the practise, it is highly recommended to have read the LabVIEW tutorials ([web link](#)).

3 Task list

Note: As soon as the group has chosen a task, communicate the decision to the instructor. Until the instructor does not confirm the assignment, the group should not start with the challenge lab because the task might be unavailable.

1. Channel Estimation based on the standard specifications, and on the knowledge acquired during the theory lessons.
2. Channel equalization. Again, based on the standard specifications, and on the knowledge acquired during the theory lessons.
3. Synchronization based on the standard specifications, and on the knowledge acquired during the theory lessons.
4. Improve the rake receiver.

5. Cell size estimation. (Help: Decode the parameter Maximum Timing Advanced included in one of the control channels defined in each standard).
6. Parameter detection of a BTS: Neighbour cell frequency detection (GSM), scrambling code detection (UMTS).
7. Study of the spectrum and signal characteristics. Figure out how many base stations are within your range and the technology used in each of them (GSM, EDGE, UMTS...).
8. Position estimation by means of a triangulation technique studied in theoretical classes.

4 Evaluation

The evaluation of this cooperative challenge has a difference with respect the previous lab sessions. As the rest of the laboratory, part of the evaluation will be placed in the lab itself, where each group will have to show the results. On top of that, it will be necessary to deliver a report where the group explain ALL the results, and the difficulties found to get those results, together with the procedures used to fix them. Likewise the code must be delivered properly commented. Besides, and in addition to rest, common to the previous lab session, Each group will have to perform a presentation of approximately 10 minutes explaining the decisions made during the challenge and the results obtained.