An Experimental Framework for Channel Sensing through USRP/GNU Radios*

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Abstract. In the last decade testbeds have been set-up to evaluate network protocols and algorithms under realistic settings. In order to draw solid conclusions about the corresponding experimental results, it is important for the experimenter to have a detailed view of the existing channel conditions. Moreover, especially in the context of non-RF-isolated wireless testbeds, where external interference severely impacts the resulting performance, the requirement of experimenters for accurate channel monitoring becomes a prerequisite. Toward, this direction, various channel sensing platforms have been introduced, where each one offers different operational characteristics. In this demo, we propose the NITOS Channel Sensing framework, which is based on software-defined radio (SDR) devices that feature highly flexible wireless transceivers and are able to provide highly accurate channel sensing measurements. Through this framework, online measurement gathering is automated and further simplified using specifically developed scripts, so that it becomes a transparent process for the experimenter. The proposed framework is also accompanied by a web user interface that allows the user to get a graphical representation of the gathered measurements.

Keywords: GNU radios, channel sensing, experimental evaluation.

1 Introduction

The constantly growing demand for experimentation of protocols designed for wireless networks under realistic settings has resulted in the development of experimental network facilities (testbeds). In order to provide for accurate channel sensing during protocol validation in such experimental testbeds, the use of sophisticated and configurable spectrum sensing platforms is required. To this end, NITOS has developed a specific framework that provides experimenters with the ability of accurate channel sensing, based on SDRs and more specifically the USRP device [1] accompanied by the GNU radio platform [2].

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2 NITOS Channel Sensing Framework

In this demo, we will present a framework for channel sensing through SDR systems. The tool was developed for NITOS testbed [3], which is a large scale wireless testbed that currently consists of 50 operational WiFi nodes. NITOS is deployed at the Computer & Communication Dept. University of Thessaly building. As NITOS is an outdoor deployed, non-RF-isolated testbed that offers rich interference conditions, it is important to provide NITOS users with a spectrum sensing platform that is able to provide accurate information regarding the dynamically varying channel conditions.

We implement this framework based on USRPs, which is a hardware platform for software radio, and is commonly used by research labs and universities, and the GNU Radio, which is a free, open-source software development toolkit that provides signal processing blocks to implement software radios. A total number of 9 wireless nodes are equipped with USRP1 and USRP N210 devices and are spread among the multiple floors of the testbed deployment. The main scope of the spectrum scanning procedure is to estimate the occupancy ratio per sampled frequency, regarding only Received Signal Strength (RSS) measurements that exceed a predefined RSS threshold. More details about the definition of the Channel Occupancy Ratio (COT) can be found in our previous work [4].

As for the first step, the reservation of the appropriate nodes that are equipped with USRPs is required. As for the second step, the experimenter simply executes specifically developed scripts that enable the definition of multiple sampling parameters, such as:

– the list of frequencies that will be sampled,
– the duration of sampling per individual frequency,
– the number of iterations of the repeated sensing procedure,
– the overall sampling period,
– and the RSS threshold that will be used for measurement filtering.

In the next step, the actual spectrum sensing is performed on each frequency among the list of frequencies that have been specified by the user and the gathered samples are saved locally at each node in an .out file format. Each frequency is sampled for duration equal to the provided duration and this sampling procedure is repeated for the specified number of iterations with interspace equal to the specified sampling period.

In the following step, all the locally saved files are filtered out, so that only values that are equal or above the specified threshold are taken into account. In order to accomplish this step, we set all values that are lower than the threshold equal to zero and save the filtered file into a new one. Afterwards, we calculate the average channel occupancy ratio per sampled frequency among the multiple measurements that have been gathered and store the corresponding results at the NITOS database, with a unique identification tag. A flowchart representation of the sensing procedure follows in Fig. 1.

Finally, the user is able to get a graphical representation of each measurement set that has been stored in NITOS database, through a web interface that is

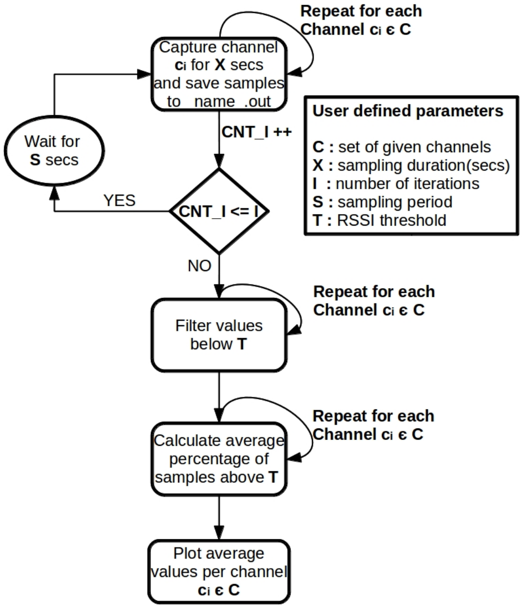
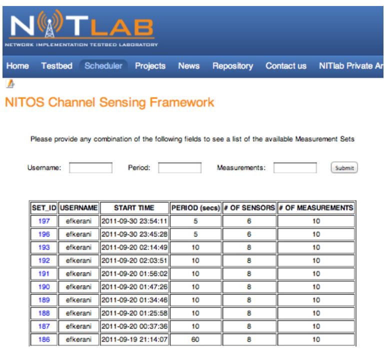
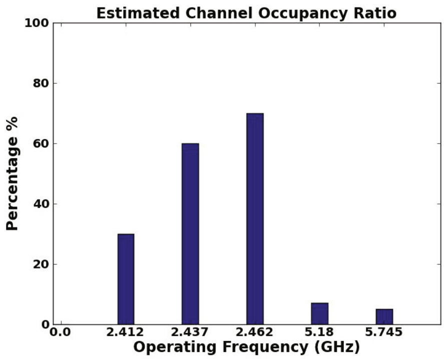


Fig. 1. Flowchart representation of the channel sensing procedure



SET_ID	USERNAME	START TIME	PERIOD (secs)	# OF SENSORS	# OF MEASUREMENTS
197	efkerani	2011-09-30 23:54:11	5	6	10
196	efkerani	2011-09-30 23:45:28	5	6	10
193	efkerani	2011-09-20 02:14:49	10	8	10
192	efkerani	2011-09-20 02:03:51	10	8	10
191	efkerani	2011-09-20 01:56:02	10	8	10
190	efkerani	2011-09-20 01:47:26	10	8	10
189	efkerani	2011-09-20 01:34:46	10	8	10
188	efkerani	2011-09-20 01:25:58	10	8	10
187	efkerani	2011-09-20 00:37:36	10	8	10
186	efkerani	2011-09-19 21:14:07	60	8	10

(a) Web interface.



(b) Average Channel Occupancy Ratio plot

Fig. 2. NITOS Channel Sensing Framework Graphical tools

illustrated in Fig. 2(a). Various statistical measures can be extracted from the corresponding records, such as average and deviation values per each frequency or per each individual iteration. Another important feature that the framework provides is the correlation matrix representation that provides an indication of how much the measurements of each USRP-enabled node are correlated with each other. Figure 2(b) shows a representation of average channel occupancy ratio values for the multiple frequencies that are being monitored.

3 Conclusions and Future Work

In this demo paper we presented a framework that enables channel sensing based on software-defined radio (SDR) devices. Through specifically developed scripts based on the GNU framework, the experimenter is able to gather RSS samples over a specified list of frequencies. Moreover, the proposed framework features a web user interface that enables the user to get a graphical representation of the gathered results. Thus, experimenters are able to accurately monitor channel conditions during the execution of their experiments, which results in improvement of the experimental evaluation process. Currently, we are in the process of extending the framework features by providing mechanisms able to estimate Signal to Noise Ratio (SNR) for each individual frequency that is being monitored.

References

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