Cognitive Radio Experimentation World

Project Deliverable D8.8.7
Promotion & dissemination report of UTH-NICTA experiment

Contractual date of delivery:	31-03-2014
Actual date of delivery:	18-04-2014
Beneficiaries:	UTH
Lead beneficiary:	UTH
Authors:	Stratos Keranidis (UTH), Virgilios Passas (UTH), Thanasis Korakis (UTH), Thierry Rakotoarivelo (NICTA)
Reviewers:	Somsaï Thao (TCS), Hans Cappelle (imec)
Workpackage:	WP8 – Promotion and Sustainability
Estimated person months:	1
Nature:	R
Dissemination level:	PU
Version	2.0

Abstract: This deliverable compiles all the promotion and dissemination activity accomplished within the scope of WP8 by UTH-NICTA. These activities include 4 scientific publications, 4 general presentations and demonstrations , 1 tutorial session and further promotion activities as well.

Keywords: dissemination, publications, presentations, demonstrations, spectrum sensing, power consumption, sensing delay, testbeds, experimental evaluation

REVISION HISTORY

Version	Date	Author	Description
1.0	20/03/2014	UTH/NICTA	1st version of the document
1.1	21/03/2014	TCS	2nd version of the document
1.2	27/03/2014	imec	3rd version of the document
2.0	30/03/2014	UTH/NICTA	4th version of the document

Executive Summary

This document provides an overview of the UTH-NICTA dissemination activities during the duration of the experiment. The document collects all the publications and dissemination activities that were achieved by UTH-NICTA, which joined the CREW Consortium as an Open Call 2 partner. Dissemination activities that are related to scientific publications, participation and demonstrations in international conferences and finally tutorial sessions and promotion activities are included in this deliverable.

List of Acronyms and Abbreviations

CREW	Cognitive Radio Experimentation World
DoW	Description of Work
FFT	Fast Fourier Transform
FIA	Future Internet Assembly
FIRE	Future Internet Research & Experimentation
FuNeMS	Future Network & Mobile Summit
ICT	Information and Communication Technologies
IEEE	Institute of Electrical and Electronics Engineers
Iris	Implementing Radio in Software
OC2	(CREW) Open Call 2
OMF	cOntrol and Management Framework
USRP	Universal Software Radio Peripheral
WPx	(CREW) Work Package x

Table of contents

1 Introduction

UTH-NICTA experiment has focused on enabling the evaluation of spectrum sensing platforms of CREW testbeds in terms of power consumption and sensing delay. Our efforts resulted in the development of innovative hardware and software components that have been successfully integrated with the w-ilab.t testbed in Ghent, Belgium.

In the rest of this document, we detail the actions that were taken towards disseminating the developed framework and the first set of collected results. First, we present the scientific publications that were presented in international conferences and published in scientific journals. Moreover, we also refer to the public demonstrations and tutorial sessions that enabled interested experimenters to gather in-depth knowledge on the framework usage. Finally, we mention further promotion activities that were taken towards improving cooperation with core CREW partners and conclude about the outcome of our dissemination efforts.

2 Scientific publications

1 Virgilios Passas, Kostas Chounos, Stratos Keranidis, Wei Liu, Lieven Hollevoet, Thanasis Korakis, Iordanis Koutsopoulos, Ingrid Moerman and Leandros Tassiulas, "**Demo: Online Evaluation of Sensing Characteristics for Radio Platforms in the CREW Federated Testbed**", MobiCom '13 Proceedings of the 19th annual international conference on Mobile computing & networking Pages 167-170.

Publication

Abstract: Cognitive radio systems have gathered a lot of research interest during the last decade. Accuracy of spectrum sensing and efficiency of free spectrum utilization are considered as the primary objectives in this emerging technology, which promises a boost in wireless network performance, through exploitation of underutilized licensed frequency bands. As the focus of researchers is usually on these two major challenges, other aspects have been in part underestimated. In this work, we consider two factors that are rather important for evaluation of cognitive platforms, namely sensing delay and energy efficiency. The first is related to the latency induced by the spectrum sensing process and its impact on sensing efficiency, which is tightly connected to both the QoS performance of secondary users and the protection of primary users. On the other hand, energy consumption is considered as a crucial issue in all types of wireless communications, due to restricted battery autonomy of mobile devices, as well as for moving towards "greener" solutions in telecommunications. Therefore, it is important to extend existing testbed experimentation tools and develop new ones, in order to equip cognitive testbeds with such advanced monitoring capabilities. In this work, we present a monitoring procedure that has been directly integrated in the experimentation tools of the CREW testbed federation and demonstrate how it aids in the online evaluation of four different cognitive platforms in terms of the aforementioned metrics.

2 Stratos Keranidis, Giannis Kazdaridis, Virgilios Passas, Thanasis Korakis, Iordanis Koutsopoulos and Leandros Tassiulas, **"NITOS Energy Monitoring Framework: Real time Power Monitoring in Experimental Wireless Network Deployments"**, ACM SIGMOBILE Mobile Computing and Communications Review, Volume 18 Issue 1, January 2014 Pages 64-74.

Publication

Abstract: Development of energy-efficient protocols and algorithms requires in-depth understanding of the power consumption characteristics of real world devices. To this aim, energy efficiency analysis is performed by the research community, mainly focusing on the development of power consumption models. However, recent studies have highlighted the inability of existing models to accurately estimate energy consumption even in non-composite scenarios, where the operation of a single device is analyzed. The inability of such models is further highlighted under real life scenarios, where the impact induced by the simultaneous operation of several devices renders the application of traditional models completely inappropriate. As a result, energy efficiency evaluation under complex configurations and topologies, needs to be experimentally investigated through the application of online monitoring solutions. In this work, we propose the innovative NITOS Energy consumption Monitoring Framework (EMF) able to support online monitoring of energy expenditure, along with the experiment execution. The developed framework is built on a distributed network of low-cost, but highly accurate devices and is fully integrated with the large-scale wireless NITOS testbed. The framework evaluation is performed under both low-level experiments that demonstrate the platform's high-level accuracy, as well as through high-level experiments that showcase how online and distributed monitoring can facilitate energy performance assessment of realistic testbed experiments.

3 Stratos Keranidis, Giannis Kazdaridis, Nikos Makris, Thanasis Korakis, Iordanis Koutsopoulos and Leandros Tassiulas, "**Experimental Evaluation and Comparative Study on Energy Efficiency of the Evolving IEEE 802.11 Standards**", to be presented in 5th International Conference on Future Energy Systems (ACM e-Energy), June '14, Cambridge, UK.

Publication

Abstract: Over the last decade, the IEEE 802.11 has emerged as the most popular protocol in the wireless domain. Since the re- lease of the first standard version, several amendments have been introduced in an effort to improve its throughput performance, with the most recent one being the IEEE 802.11n extension. In this paper, we present experimentally obtained results that evaluate the energy efficiency of the base standard in comparison with the latest 802.11n version, under a wide range of settings. To the best of our knowledge, our work is the first to provide such a detailed comparative analysis on the performance of both standards. The followed power measurement methodology is based on custom-built hardware that enables online energy consumption evaluation at both the wireless transceiver and the total node levels. Based on in-depth interpretation of the collected results, we remark that the latest standard enables significant reduction of energy expenditure, when combined with innovative frame aggregation mechanisms. Our detailed findings can act as guidelines for researchers working on the design of energy efficient wireless protocols.

4 Stratos Keranidis, Giannis Kazdaridis, Virgilios Passas, Giannis Igoumenos, Thanasis Korakis, Iordanis Koutsopoulos and Leandros Tassiulas, "**NITOS Mobile Monitoring Solution: Realistic Energy Consumption Profiling of Mobile Devices**", to be presented in 5th International Conference on Future Energy Systems (ACM e-Energy), June '14, Cambridge, UK.

Publication

Abstract: The unprecedented penetration of "smart" mobile devices in everyday use case scenarios, along with their energy greedy profile have motivated researchers in the field of wireless networking, towards reducing energy consumption wherever possible. In order to support the design of energy efficient protocols, in-depth energy consumption profiling of mobile devices needs to be applied. These profiles need to be derived through long term monitoring under realistic conditions. To this aim, we have developed a tiny device able to fit in the battery pack of smartphones and monitor the resulting power consumption in an on-line way. In this work, we detail the components of the developed framework and demonstrate two indicative scenarios that showcase how the diversity of experimental conditions and configurations can significantly impact energy consumption.

3 Demonstrations & Posters

The "scientific publication" section of this document already indicated that several demonstrations were given, as a result of the acceptance of a peer-reviewed publications. In this section, additional CREW posters and demonstrations –those that are not attached to peer-reviewed publications– are listed:

5 "Online Monitoring of Spectrum Sensing Delay and Energy Consumption in the CREW Benchmarking Framework", *Future Internet Assembly (FIA)* in Dublin, Ireland, May 2013.

Poster
Abstract: In this poster, we presented the developed NITOS ACM card and indicative results that were obtained during our initial tests in comparison with high-end commercial power meters.

6 "Online Monitoring of Spectrum Sensing Delay and Energy Consumption in the CREW Benchmarking Framework", *Future Network & Mobile Summit 2013*, Lisbon, Portugal, July 2013.

Demonstration & Poster
Abstract: In this demonstration, we demonstrated a live power measurement experiment that characterizes the power consumption of commercial Wi-Fi chipsets through the NITOS ACM card. Moreover, detailed results that characterize the energy consumption profile of both 802.11a/g and 802.11n chipsets were also presented. Finally, we also showed experimental results that analyze how the configuration of operating channel in 802.11 links affects energy consumption, under high congestion and/or interference conditions.

Video: https://www.youtube.com/watch?v=SiZEk3ze4NE

7 "Online Monitoring of Spectrum Sensing Delay and Energy Consumption in the CREW Benchmarking Framework", *ICT 2013*, Vilnius, Lithuania, Nov. 2013.

Demonstration & poster
Abstract: In this demonstration, we presented a live experiment, through which we evaluated the energy consumption and sensing delay of a Wi-Fi chipset (Atheros AR9380), while monitoring the spectrum through FFT processing in hardware. Our experiment clearly demonstrated the online monitoring capabilities of the developed framework, while the obtained results showed that the operation of the power optimized commercial transceiver resulted in both low energy consumption and sensing delay.

8 "Online Monitoring of Spectrum Sensing Delay and Energy Consumption in the CREW Benchmarking Framework", *Future Internet Assembly (FIA) 2014*, Athens, Greece, Mar. 2014.

Demonstration & poster
Abstract: In this demonstration, we presented the execution of a remote experiment in w-ilab.t testbed on top of the developed power consumption and sensing delay monitoring framework. The experimental setup consisted of one w-ilab.t testbed nodes that are equipped with the Atheros AR9280 Wi-Fi chipset and one USRP N210 device that are both configured to characterize the Power Spectral Density on a given frequency of the 2.4 GHz band. In order

to generate controllable transmissions, 2 more w-ilab.t testbed nodes were configured to transmit on the given channel.

4 Tutorials

9 Virgilios Passas, Stratos Keranidis, Wei Liu, "Usage of UTH – NICTA ACM cards in w-iLab.t", *CREW Training Days 14-15 Jan 2014*.

Tutorial and Demonstration Examples.
Abstract: This tutorial took place during the CREW training days, during which experimenters interested in using the CREW facilities were trained. Our tutorial introduced the audience to the concept of Energy Consumption evaluation in testbed deployments and also provided a hands-on experience in the usage of UTH – NICTA ACM cards in w-iLab.t testbed.

5 Further Promotion and Dissemination Activities

As a further promotion action towards improving cooperation with the core CREW partners and disseminating the use of the OMF framework, the UTH-NICTA team took the initiative to work towards further integrating the OMF framework with the CREW experimentation tools. The main aim was to develop a fully OMF compatible interface for the IRIS framework to enable distributed control of USRP devices and measurements collection. Although this action was not required to be completed in the context of the UTH-NICTA Open Call (OC) 2 experiment, our team exploited the long OMF expertise towards further extending the CREW experimentation tools. Nikos Makris, Stratos Keranidis and Christos Zarafetas from UTH worked jointly with Paul Sutton from TCD to enable the integration of IRIS with OMF. Below, we briefly describe the most important actions that were taken. The first part includes the development of an OMF Resource Controller (RC) entity that is able to properly control the operation of USRP devices through the configuration of the IRIS framework. Secondly, we proceeded by extending the OMF Experiment Control (EC) entity, so that four new device control commands could be supported. Our implementation is completely transparent to IRIS users, while also enabling run-time re-configurability.

UTH-NICTA members are already preparing new publications, presentations and demonstrations. Experimental tests and result analysis will be completed by the end of March. Moreover, we will have new demonstration during the EUCNC conference in Bologna, Italy (June 2014).

6 Conclusion

Considering the list of publications, demonstrations and events above, it can be seen that UTH-NICTA proceeded to numerous dissemination activities during the duration of the experiment. Our dissemination activities mainly targeted to promote the use of the developed framework by interested CREW experimenters.