Cognitive Radio Experimentation World

Project Deliverable D8.4
Third Promotion and Dissemination Status Report

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Abstract: This deliverable compiles all the promotion and dissemination activity accomplished within the scope of WP8 during the third year of the project. These activities include scientific presentations, general presentations and demonstrations. The document also provides details on the strategy for the announcement of the third CREW open call for experimenters.

Keywords: dissemination, presentations, publications, demonstrations, network testbeds, federation, wireless networks, cognitive radio, cognitive network, benchmarking

REVISION HISTORY

Version	Date	Author	Description
1.0	14/08/2013	Daan Pareit (iMinds)	Initial draft with first inputs
2.0	22/08/2013	Daan Pareit (iMinds)	Processed known input so far
3.0	5/09/2013	Christoph Heller (EADS)	Additional input
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4.3	19/09/2013	Mikolaj Chwalisz (TUB)	Additional input
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5.0	27/09/2013	Daan Pareit (iMinds) Ingrid Moerman (iMinds)	Final editing

Executive Summary

This deliverable presents an overview of the CREW dissemination activities in year 3 of the project. Dissemination activities that are related to standardization or regulation are also included in this deliverable. In addition, the deliverable summarizes the promotion strategy that was followed for the third CREW open call.

List of Acronyms and Abbreviations

BSN	Body Sensor Networks
CN	Cognitive Networking
CR	Cognitive Radio
CREW	Cognitive Radio Experimentation World
DoW	Description of Work
DSA	Dynamic Spectrum Access
FER	Frame Error Rate
FIA	Future Internet Assembly
FIRE	Future Internet Research & Experimentation
FNMS	Future Network & Mobile Summit
FuNeMS	Future Network & Mobile Summit
ICT	Information and Communication Technologies
IEEE	Institute of Electrical and Electronics Engineers
Iris	Implementing Radio in Software
ISM	Industrial Scientific Medical
OC2	(CREW) Open Call 2
OC3	(CREW) Open Call 3
OFDM	Orthogonal Frequency Division Multiplexing
OMF	cOntrol and Management Framework
OOB	Out-Of-Band
RF	Radio Frequency
RFIC	Radio Frequency Integrated Circuit
SDR	Software Defined Radio
TWIST	TKN Wireless Indoor Sensor Network Testbed
USRP	Universal Software Radio Peripheral
VESNA	VErsatile platform for Sensor Network Applications
WPx	(CREW) Work Package x

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1 Introduction

1.1 Scope

This document provides an overview of all WP8 promotion and dissemination activities during the third year of the CREW project. It succeeds deliverables D8.1 and D8.2, which gave an overview of the first and second year, respectively. This document compiles all the publications and dissemination activities that were undertaken by core members of the CREW consortium. The CREW dissemination activities that are led by partners that joined CREW as a result of the second open call are not included in this deliverable in order to avoid duplication: the dissemination activities of these partners will be included in separate deliverables authored by the open call 2 partners (D8.8.4, D8.8.5, D8.8.6 and D8.8.7). The CREW dissemination activities that were led by the first open call partners can be found in D8.8.1, D8.8.2 and D8.8.3.

The content is offered in the same way as was done for the second year in D8.2: scientific publications are mostly linked to a presentation, a poster, or a demonstration. These linked activities are mentioned only once under the "publication" category. Where applicable, it is indicated whether a presentation or demonstration was linked to this publication.

Dissemination activities that are related to standardization or regulation are also included in this deliverable (opposite to year 2, when there were two separate deliverables for promotion and dissemination and standardization and regulation activities in D8.2 and D8.3, respectively).

In addition to this dissemination work belonging to activities 8.1.1 "Demonstrations" and 8.1.3 "Dissemination" of task 8.1, the document also provides an overview of the dissemination efforts for the third CREW open call (OC3) to date.

1.2 Document purpose and intended audience

D8.4 is a public deliverable, primarily targeting the European Commission staff as a report of external activities towards dissemination and external reaching of the project. It can help in measuring the impact of the project on the scientific community.

Moreover, it can provide good insights on the major outstanding contents to anyone interested in the CREW project.

2 Scientific publications

1 Liu, W., Pareit, D., De Poorter, E., Moerman, I. "Advanced spectrum sensing with parallel processing based on Software-Defined Radio", *EURASIP Journal on Wireless Communications and Networking 2013*, 13 September 2013.

Publication

Abstract: Due to interference between co-located wireless networks, obtaining accurate channel assessment becomes increasingly important for wireless network configuration. This information is used, among others, for cognitive radio solutions and for intelligent channel selection in wireless networks. Solutions such as spectrum analyzers are capable of scanning a wide spectrum range, but are not dedicated for channel occupation assessment because they are extremely costly and not able to perform continuous recording for a time period longer than a few seconds. On the other hand, low-cost solutions lack the flexibility and required performance in terms of configuration and sensing efficiency. To remedy the situation, this paper presents an alternative for channel assessment on top of a commercial software-defined radio platform. Although there exist software solutions for performing spectrum sensing on such platforms, to the best of our knowledge, continuous spectrum sensing and long-term recording remain challenging. We propose a pioneering solution that is capable of seamless spectrum sensing over a wide spectrum band and guarantees sufficient flexibility in terms of configurations. The proposed solution is validated experimentally. We demonstrate two advantages of seamless spectrum sensing: the capability of accurate channel occupancy measurement and detecting transient signals such as Bluetooth.

2 DaSilva, L. A., Kibilda, J., di Francesco, P., Forde, T. K., Doyle, L., "Customized Services over Virtual Wireless Networks: The Path towards Networks without Borders", *Future Network and Mobile Summit (FNMS)*, Lisbon, Portugal, 4 July 2013.

Publication & presentation

Abstract: We propose a new architecture to enable wireless networks to meet the challenges of ever-increasing demand for high data rate services and ubiquitous connectivity, heterogeneity of access technologies, and spectrum scarcity. This architecture, which we call Networks without Borders, envisions a pool of resources (spectrum, infrastructure, network management, authentication, subscriber tracking services, etc.) from which a virtual wireless network can be orchestrated and instantiated. Flexibility and technology neutrality are key goals of this architecture, mirroring the Internet, where user services are independent of the underlying network control mechanisms or infrastructure. We outline some of the major trends in networking research and commercial deployments that provide an evolutionary path towards Networks without Borders. These trends include virtualization, reliance on small cells, dynamic spectrum sharing, crowdsourcing of wireless access, and inter-mobile operator resource sharing.

3 Di Francesco, P., S. McGettrick, K. Anyanwu, J. C. O'Sullivan, A. B. MacKenzie, and L. A. DaSilva, "A Split Architecture for Random Access MAC for SDR Platforms", *8th Intl. Conf. on Cognitive Radio Oriented Wireless Networks (CROWNCOM)*, Washington, DC, July 2013.

Publication & presentation

Abstract:
Implementation of carrier-sensing-based medium access control (MAC) protocols on inexpensive reconfigurable radio platforms has proven challenging due to long and unpredictable delays associated with both signal processing on a general purpose processor (GPP) and the interface between the RF front-end and the GPP. This paper describes the development and implementation of a split-functionality architecture for a contention-based carrier-sensing MAC, in which some of the functions reside on an FPGA (field programmable gate array) and others reside in the GPP. We provide an FPGA-based implementation of a

carrier sensing block and develop two versions of a CSMA MAC protocol based upon this block. We experimentally test the performance of the resulting protocols in a multihop environment in terms of end-to-end throughput and required frame retransmissions. We cross-validate these results with a network simulator with modules modified to reflect the mean and variance of delays measured in components of the real software-defined radio system.

4 Kibilda, J., J. Tallon, K. Nolan, and L. A. DaSilva, "Whitespace Networks Relying on Dynamic Control Channels", *8th Intl. Conf. on Cognitive Radio Oriented Wireless Networks (CROWNCOM)*, Washington, DC, July 2013.

Publication & presentation
Abstract:
The emergence of whitespace networks, and whitespace communications in general, provides an opportunity to, at least partially, meet the ever-growing demand for mobile data communication. Most of the whitespace network solutions proposed so far realize coordination and rendezvous over licensed or unlicensed spectrum. In this paper we propose a protocol for networks that rely solely on whitespace spectrum. The proposed protocol allows both communication to the broader network (via the access point) and direct device-to-device links over whitespaces. To showcase the capabilities of the proposed solution we have implemented a proof-of-concept software defined radio experiment. Using the experimental platform we have evaluated the overheads of whitespace operation, which come in the form of an extra delay in association and a throughput loss of around 15% of that achievable with licensed spectrum. Our goal is to provide the groundwork for future radio systems that will operate in whitespace spectrum.

5 Chwalisz, M., Hauer, J., and Handziski, V., "Demo Abstract: An Infrastructure for Automated BAN Experimentation", *Proc. of 10th European Conference on Wireless Sensor Networks (EWSN'13)*, February 2013.

Publication & presentation
Abstract: We demonstrate an infrastructure for experimenting with Body Area Network (BAN) communication protocols and applications without the involvement of human test-person. The core of our infrastructure consists of a mobile robot, on which a simplistic human structure equipped with BAN nodes is located. This set-up can emulate human movements within a controlled RF interference in-door environment. Both, the robot movements and the RF environment, can be remotely controlled via standard Internet access. As a representative usage example, we compare different frequency selection schemes for BAN communication.
Note: Best paper award

6 Liu, W., Mehari, M., Bouckaert, B., Tytgat, L., Moerman, I. and Demeester, P. "Demo Abstract: A Proof of Concept Implementation for Cognitive Wireless Sensor Network on a Large-scale Wireless Testbed", *Proc. of 10th European Conference on Wireless Sensor Networks (EWSN'13)*, February 2013.

Publication & presentation
Abstract: One of the major issues arising when a IEEE 802.15.4 (ZigBee) based wireless sensor network is deployed in a typical office building is the interference it receives from the omnipresent IEEE 802.11 (Wi-Fi) devices. Cognitive Radio (CR) allows a wireless device to adapt dynamically to its environment in order to deliver the requested quality of service with minimum cost. One typical mechanism to reduce the impact of Wi- Fi on the ZigBee network is to avoid its interference in the frequency domain. A large scale WSN deployed in a typical office building will suffer from a multitude of Wi-Fi devices, operating on a number of channels, resulting in the lack of a single interference free channel for the WSN to operate on. Receiver Directed Transmission (RDT) is a cognitive solution for wireless sensor networks developed under the FP7 CONSERN project. RDT lets every device select its own receive

channel while still maintaining full mesh communication. Hence every node can optimally avoid the interference at its own location, given it has sufficient channel knowledge to reliably predict the expected packet loss. In this demo we showcase an RDT-based cognitive WSN on a large scale wireless testbed. The channel knowledge is retrieved through distributed and heterogeneous spectral sensing. We compare the performance of the cognitive WSN against regular WSN. We further explore how the energy detection threshold can influence the performance of the RDT solution. The experiment is conducted via a set of benchmarking tools, developed under the European project CREW.

7 Šolc, T. and Padrah, Z., "Network design for the LOG-a-TEC outdoor testbed", *2nd International Workshop on Measurement-based Experimental Research, Methodology and Tools (MERMAT)*, May 2013.

Presentation
Abstract: We present steps involved in planning a wireless sensor network for the LOG-a-TEC outdoor testbed, part of the CREW federation for cognitive radio experiments. Based on initial testbed requirements and estimates of the management network load we have selected two clusters of locations from a large pool of possible locations. We have then performed a verification step. By measuring signal strength and packet loss with a mobile setup we have verified that nodes in the chosen testbed configuration would be able to form a usable mesh network. Finally, we compare our initial estimates of network performance with measurements obtained from the deployed testbed.

8 Heller, C. and Blümm, C., "A Cognitive Radio Enabled Wireless Cabin Communication System", *Proc. of 32nd IEEE Digital Avionics Systems Conference (DASC'13)*, October 2013.

Publication & upcoming presentation
Abstract: This paper presents a wireless aircraft cabin system operating in the 2.4 GHz ISM band and uses cognitive radio techniques to increase system robustness by actively and dynamically avoiding interfering signals in the same frequency band. The implementation of the basic cognitive radio functions spectrum sensing, policy enforcement and decision making, as well as their integration on a software defined radio platform together with the communication functions is presented and discussed. Finally, the cognitive approach is validated using a demonstrator setup and a controlled interference scenario.

9 Avez, P., Van Wesemael, P., Bourdoux, A., Chiumento, A., Pollin, S. and Moeyaert, V., "Tuning the Longley-Rice propagation model for improved TV white space detection," *IEEE 19th Symposium on Communications and Vehicular Technology in the Benelux (SCVT)*, pp.1,6, 16-16 November 2012

Publication & presentation
Abstract: The secondary use of the frequency band below 1 GHz is gaining a lot of interest for wireless communications due to the attractive propagation characteristics in this band. Optimal reuse relies partially on the reliable detection of unused channels. We propose to detect unused channels based on prediction with the Longley-Rice channel model of which the parameters are tuned thanks to a limited amount of measurements with a low-cost, low-power sensing device.

10 Michailow, N., Depierre, D., and Fettweis, G., "Multi-Antenna LTE detection for Dynamic Spectrum Access: A Proof of Concept", *Institute of Electronics, Information and Communication Engineers (IEICE)*, 17 October 2012.

Publication & presentation
Abstract: Detection of occupied frequency bands is the foundation for applications of dynamic spectrum access (DSA). In order to convince network operators that DSA is feasible

in cellular frequencies, it has to be shown that a reliable detection of their primary signals is possible. In this paper, we present the results of experimental validation of an algorithm and hardware, which can detect the presence of a Long Term Evolution (LTE) signal. In contrast to the classical mono antenna approach, an array of antennas is used, which allows to enhance the detection capabilities, particularly when besides the useful signal there is also interference.

11 Liu, W., Keranidis, S., Mehari, M., Gerwen, J. V., Bouckaert, S., Yaron, O. and Moerman, I., "Various Detection Techniques and Platforms for Monitoring Interference Condition in a Wireless Testbed", in *LNCS of the Workshop in Measurement and Measurement Tools 2012*, Aalborg, Denmark, May 2012.

Publication & presentation

Abstract: Recently the constant growth of the wireless communication technology has caused a huge demand for experimental facilities. Hence many research institutes setup public accessible experimental facilities, known as testbeds. Compared to the facilities developed by individual researchers, a testbed typically offers more resources, more flexibilities. However, due to the fact that equipments are located remotely and experiments involve more complex scenarios, the required complexity for analysis is also higher. A deep insight on the underlying wireless environment of the testbed becomes necessary for comprehensive analysis. In this paper, we present a framework and associated techniques for monitoring the wireless environment in an OMF enabled testbed. The framework utilizes most common resources in the testbed, such as WIFI nodes, as well as some high-end software-defined radio platforms. Information from both physical layer and network layer are taken into account. Furthermore we explored the added value of distributed sensing system. The performance is mainly analyzed experimentally.

12 Mohorčič, M., Smolnikar, M. and Javornik, T., "Wireless Sensor Network Based Infrastructure for Experimentally Driven Research", in *The Tenth International Symposium on Wireless Communication Systems (ISWCS 2013)*, Ilmenau, Germany, August 2013.

Publication & presentation

Abstract: The availability of suitable infrastructure represents one of the key factors for sustainable development of society and economy. The concept of smart cities exposed the importance of sensorial infrastructure combined with powerful analytical data processing to enable deep insight and better understanding of natural and social processes to provide various services to citizens. The aim of this paper is to present the LOG-a-TEC sensor network and its role in experimentally driven research and development. The LOG-a-TEC testbed is based on wireless sensor network technology and its initial phase was deployed on public infrastructure in Logatec, Slovenia, subsequently being complemented with additional locations for different application areas. In all cases the wireless sensor network implementation is based on the VESNA platform, a versatile platform for sensor network applications. To support the evaluation of different principles and solutions, the VESNA platform allows remote reprogramming as well as expansion with new sensors and other functional modules. As an example we present LOG-a-TEC experimental infrastructure based applications for radio spectrum occupancy sensing, environmental monitoring, smart grids and the sensors as a service concept making sensors and their measurements directly accessible for ad hoc use.

13 Pesko, M., Benedicic, L., Javornik, T., Košir, A., Štular, M. and Mohorčič, M., "An indirect self-tuning method for constructing the radio frequency layer of radio environment map", submitted to *IET Letters* in August 2013, under review.

Publication under review

Abstract: A new indirect construction method for radio frequency layer of radio environment map (RF-REM) is proposed. It extends known RF-REM construction methods by taking into account the characteristics of an environment and by introducing a self-tuning capability on

spatially distributed measurements. The method carries out joint estimation of the transmitter and empirical propagation model parameters in an optimization process minimizing the difference between the measured and the predicted signal strengths. Simulation based comparison of the proposed method with several state-of-the-art direct and indirect RF-REM construction methods shows its superior performance already at moderate number of measurements, which can be attributed to its adaptation to operating environment.

14 Fortuna, C., De Poorter, E., Moerman, I., DaSilva, L. and Mohorčič, M., "Open framework for prototyping modular self-configurable networks", submitted to *IEEE Network Special Issue on Open Source for Networking: Development and Experimentation* in August 2013, under review.

Publication under review

Abstract: Existing software tools for wireless experimentation are designed mainly for the evaluation and optimization of traditional PHY and MAC layers. As a result, experimentation platforms do not support the evaluation of programmable and dynamic (cognitive) network stacks. To remedy this situation, we describe an open source framework that enables the design, development and prototyping of modular self-configurable wireless networks. The concepts put forth are possible by using a combination of two existing open networking tools: a modular protocol stack called ProtoStack and an existing testbed called LOG-a-TEC based on the VESNA hardware platform. Supporting the development of more efficient and flexible network technology is achieved through two main concepts: modular network functionality and intelligent configuration. The framework thus enables (1) research about reconfigurable network stacks and (2) cognitive networking research that includes software configurable radios. We report on the design and development choices, feasible experimental set-ups on existing infrastructures of constrained devices and illustrate research directions enabled by the open source framework.

15 Fortuna, C. and Mohorčič, M., "A Framework for Dynamic Composition of Communication Services", submitted to *IEEE Transactions on Sensor Networks* in May 2013, under review.

Publication under review

Abstract: In this paper we propose a framework for dynamic composition of communication services which is well suited for facilitating research and prototyping on real experimental infrastructures of remotely configurable embedded devices. By using the concept of composeability, our framework supports modular component development for various networking functions, therefore promoting code re-use. The framework consists of four components: the physical testbed, the module library, the declarative language and the workbench. Its reference implementation is ProtoStack, a tool that supports experimentation on sensor platform based infrastructures. We show, through feedback collection from first time users, that the ProtoStack tool can significantly speed up prototyping and testing of new stacks and is friendly to novice and advanced users. The cost of increased flexibility and prototyping speed of the protocol stack is paid in terms of increased memory footprint, processing speed and energy consumption. The Crime library used by ProtoStack has 16 to 17% larger footprint, it takes 2.4 times longer to execute an open -> send -> recv -> close sequence and consumes 1.6% more power in doing so. Even though with ProtoStack more resources are consumed by the node, the tradeoff in terms of prototyping speed pays it off.

3 Contributions to standardization fora

16 Moerman, I., “IP CREW - Cognitive Radio Experimentation World”, *ETSI workshop on Reconfigurable Radio System*, 12 December 2012.

Presentation

17 Salous, S., “Propagation data and prediction methods for the planning of indoor radio communication systems and radio local area networks in the frequency range 900 MHz to 100 GHz”, *draft revision to recommendation ITU-R P. 1238-7*, June 2013.

Approved draft revision to recommendation ITU-R P. 1238-7

4 Other presentations

Some of the presentations below are presentations on invitation, not linked to any peer-reviewed publication. Nevertheless, these presentations contributed to the dissemination of the CREW project and are therefore important to list. These presentations are also often used to announce open calls.

Still other presentations below are a result of a peer-reviewed extended abstract (without “official” publication).

18 Kalil, M.A., Puschmann, A., Mitschele-Thiel, A., Van Wesemael, P., Pollin, S. and Desmet, M. , “Improving the Performance of MAC Protocols in Cognitive Radio Networks through Sensing Accuracy Enhancement”, *FIRE engineering workshop*, 6-7 November 2012.

Presentation
Abstract: In this paper, we aim at enhancing the sensing capabilities of a software implementation of a Carrier Sense Multiple Access (CSMA) based MAC protocol by using a dedicated spectrum sensing engine provided by IMEC. This work is a part of the European project-Cognitive Radio Experimentation World (CREW).

19 Mehari, M., Liu, W., Bouckaert, S., Moerman, I, Keranidis, S., Korakis, T., Koutsopoulos, I., Van Wesemael. P., and Pollin, S., "A Benchmarking Framework for Easy and Reliable Wireless Experimentations" on *FIRE Engineering Workshop*, 6-7 November 2012.

Presentation
Abstract: This paper presents a benchmarking framework for wireless experimentations developed within the EU FP7 CREW project. It consists of two parts: The first part — experimentation description section, allows the experimenter to define and execute an experiment; The second part — benchmarking section, allows the experimenter to com- pare the results (i.e. benchmarking scores) of multiple experiments. Additionally an interference detection system running at the background more is used to monitor the experiments. The benchmarking framework frees the experimenters from trivial setup configurations, allows more focus on the solutions under test (SUT), hence improves the overall efficiency of experimentations

20 Moerman, I., “General overview of the CREW project”, *CREW workshop on TV White Spaces*, Brussels, Belgium, February 2013.

Presentation

Abstract: In this presentation a general overview of the CREW project will be given. The main target of FP7-CREW is to establish an open federated test platform, which facilitates experimentally-driven research on advanced spectrum sensing, cognitive radio and cognitive networking strategies in view of horizontal and vertical spectrum sharing in licensed and unlicensed bands. The following topics will be addressed: (1) problems CREW can solve; (2) overview of the wireless facilities and advanced cognitive components of the CREW federation; (3) main federation functionalities; (4) some examples explaining the benefits of CREW.

21 Cruz Lopes Miranda, J.P., "Towards White Space Use: What Does CREW Bring To The Table", *CREW workshop on TV White Spaces*, Brussels, Belgium, February 2013.

Presentation
Abstract: The radio frequency spectrum constitutes a finite resource that is vital for a number of applications relying on wireless communications. Spectral portions useful for a given application are determined by the fundamental tradeoff between range and bandwidth. Despite of this physical limitation, different measurement campaigns point out that large amounts of premium spectral resources currently show any or only sporadic activity. While such underutilization may be seen with some worry, it raises a major issue when the latest traffic growth projections come into play: How can we accommodate the increasing traffic demands introduced along with new generations of high-end mobile devices while at the same time improving spectrum efficiency? This talk deals with white spaces, a term used to denote spectral resources that are not being used at a particular time in a particular area. We'll initially be overviewing the latest advances towards white space use in policy, technology, and standardization. From the perspective of an overlay access model, under which lower priority unlicensed users share spectrum with higher priority licensed users, we'll then summarize the most promising methods for enabling coexistence between these two types of users. The second part of the talk highlights the importance of practical experiments in the assessment of the methods surveyed in the first part. Specifically, we'll explain how the federation of testbeds being created within the scope of CREW can be used in experimentally-driven performance assessments. We'll wrap up the talk with a description of real experiments, some carried out in the first two years of the project, others representing ongoing work..

22 Mohorčič, M., "LOG-a-TEC testbed applications in TVWS", *CREW workshop on TV White Spaces*, Brussels, Belgium, February 2013.

Presentation
Abstract: LOG-a-TEC testbed is part of Jožef Stefan Institute's contribution to the CREW federation. The testbed is based on the VESNA wireless sensor network platform and consists of 50 remotely-controlled VESNA devices deployed in an out-door environment on public lighting infrastructure in the town Logatec. VESNA devices form a wireless mesh network and are equipped with three different types of radio transceivers that allow experimentation with novel radio-frequency communication technologies. Two clusters, one in a city centre and one in an industrial zone, enable experimenters to evaluate their solutions in realistic environments. In addition to supporting experiments in the unlicensed 868 MHz and 2.4 GHz bands, a subset of devices in the testbed also supports operation in the TV part of the UHF band. This allows the testbed to be used in research into TV white spaces with a focus on spectrum sensing using low-cost, low-complexity devices. Integration of the testbed with the GRASS/RaPlaT radio planning tool further makes possible to plan experiments and compare results with predictions based on various propagation models.
Thus far, the LOG-a-TEC testbed has been used within the project to compare the DVB-T and wireless microphone detection capabilities of different spectrum sensing equipment used in the CREW federation as well as two radio propagation planning tools. In the second CREW open call an external experiment has been accepted in which the testbed will be used in creation of a dynamic white spaces geo-location database. By merging static information

obtained from Slovenian broadcasters with near real-time channel occupancy data obtained from the LOG-a-TEC sensor network a database will be established that will provide white-space spectrum opportunities to mobile devices, taking into account exclusion areas for both registered and primary users detected through spectrum sensing.
This presentation will focus on functional capabilities of the testbed and on the example experiments conducted so far using the testbed.

23 Moerman, I., "The CREW project and its realizations so far.", *CREW Training Days*, Brussels, Belgium, February 2013.

Presentation
Abstract: During this talk, an introduction to the CREW project will be provided. The relevance to the different stakeholders of CREW (facilities, experimenters, standardization bodies, regulators) will be highlighted.

24 Thao, S., Sanchez, A., "TCS / WInnF Transceiver Facility (Transceiver API) - SDR applications Fast-prototyping on Ettus Research USRP platform", *CREW Training Days*, Brussels, Belgium, 19 February 2013.

Presentation
Abstract: The TCS Transceiver API (from the WInnF Transceiver Facility) is an interface specification [1] that provides a reference API addressing the common programming needs of radio transceivers. Thanks to the abstraction of the Transceiver implementation architecture offered by the WInnF Transceiver Facility, SDR applications (waveforms, sensing modules, …) will be ported faster into WInnF Transceiver Facility compliant radio equipments, such as the widely available and used platform as Ettus Research USRP.
For industrial standardisation requirements and to master architectures, the Transceiver API was specified in the Wireless Innovation Forum (WInnF) by Thales Communications & Security (TCS). Thus, while the Transceiver API doesn't provide any additional experimental functionality, it has the key benefit to standardise the interface between the Modem (any waveform application) and the Transceiver Subsystem (any transceiver device, as was done, as part of the TECNALIA Open Call 1 experiment in CREW Task 7.3 of Work package 7 for example, with several Ettus Research USRP platforms used as sensing nodes). The Transceiver API implementation source code is provided as a common reference base for the Ettus Research USRP2 platform.
[1] E. Nicollet, S. Pothin and A. Sanchez, "Transceiver Facility Specification", *Wireless Innovation Forum*, 2 February 2009, "SDRF-08-S-0008-V1_0_0_Transceiver_Facility_ Specification.pdf". [Online]. Available: "http://groups.winnforum.org/p/cm/ld/fid=85".

25 Thao, S., Depierre, D., "TCS multi-antenna LTE sensing agent.", *CREW Training Days*, Brussels, Belgium, 19 February 2013.

Presentation
Abstract: The feasibility of parallel sensing performed by an opportunistic device on a LTE incumbent system has been proven in CREW Usage Scenario (US) 5 - Cognitive systems and cellular networks. Thanks to the use of an antenna array (up to 4 Rx antennas) and smart antenna processing, no quiet time slot needs to be inserted in the waveform of the opportunistic system in order to perform sensing. Indeed, thanks to the spatial rejection capability of the TCS multi-antenna system, the opportunistic device can detect the presence of a LTE incumbent system even if it also receives the (opportunistic) signal dedicated to it, even with a very low signal to interference ratio.

26 Desmet, M., "A Versatile Spectrum Sensing Engine for mobile devices", *CREW Training Days*, Brussels, Belgium, February 2013.

Presentation
Abstract: To allow for dynamic spectrum access, sensing techniques are crucial. IMEC's Sensing Engine can add such sensing techniques to radio systems and enables the evaluation of cognitive network solutions. The Sensing Engine consists of a flexible analog frontend or RFIC, combined with a digital frontend with sensing capabilities. Currently, there are two types of Sensing Engines integrated in the CREW infrastructure, provided by iMinds: one with IMEC's analog frontend Scaldio2b coupled to IMEC's digital frontend DIFFS, and one with the WARP analog frontend coupled to DIFFS. Both Sensing Engines can perform different modes of sensing. During the training, the Sensing Engine will be presented to the audience with a detailed description of its capabilities. A demonstration will be given, after which a hands-on tutorial will conclude the training.

27 Moerman, I., "Wireless experimentation: An experimenter's viewpoint", *2nd International Workshop on Measurement-based Experimental Research, Methodology and Tools (MERMAT)*, May 2013.

Invited presentation
Abstract: Today, many CR/CN concepts have been conceptually validated, mostly through simulations of theoretical analysis. However, mechanisms like interference and spectrum sharing are very complex and hard to model, leading to oversimplified models in theoretical studies or simulations. Radio transceiver characteristics and spectrum sensing characteristics are further very dependent on hardware capabilities (timing, accuracy, sensitivity parameters, processing & memory capabilities…). Experimentally-supported research is hence crucial for validation of new cognitive radio (CR) and cognitive networking (CN) concepts.
The CREW federated platform offers open access to very exciting research facilities equipped with very advanced CR components. However, for a starting experimenter the threshold for using such facilities is rather high, because It takes quite some time to familiarise with a specific facility and its available CR hardware. In this presentation we want to show how we can lower the threshold for a wireless experimenter by introducing a common CR language. We will illustrate the common CR language approach for a distributed spectrum sensing experiment.

28 Moerman, I., "General overview of the CREW project", *Workshop on Cognitive Radio*, Lisbon, Portugal, 19-20 September 2013.

Presentation
Abstract: In this presentation a general overview of the CREW project will be given. The main target of FP7-CREW is to establish an open federated test platform, which facilitates experimentally-driven research on advanced spectrum sensing, cognitive radio and cognitive networking strategies in view of horizontal and vertical spectrum sharing in licensed and unlicensed bands. The following topics will be addressed: (1) problems CREW can solve; (2) overview of the wireless facilities and advanced cognitive components of the CREW federation; (3) main federation functionalities; (4) some examples explaining the benefits of CREW.

29 Šolc, T., "VESNA in kognitivni radio", *Kiberpipini odprti termini*, Ljubljana, Slovenia, October 2012. [in Slovene]

Presentation
Abstract: SensorLab at the Jožef Stefan Institute developed an open platform for sensor networks called VESNA. On top of this platform experimental equipment for cognitive radio research has been developed. We have deployed two wireless sensor testbed clusters in the city of Logatec under the scope of the FP7 CREW project. These clusters are open to domestic and foreign researchers looking to test new radio technologies in practice. This talk will give

an overview of cognitive radio and the current research topics. Finally, the open source software and hardware we developed at SensorLab will be demonstrated.

30 Smolnikar, M., "Testbeds and experimental research using VESNA wireless sensor network platform", *Living bits and things 2012* in Ljubljana, Slovenia, November 2012.

Presentation; no abstract available.

5 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 publication. In this section, additional CREW posters and demonstrations –those that are not attached to peer-reviewed publications– are listed:

31 Pareit, D., Moerman, I., "CREW - Cognitive Radio Experimentation World" *Hands-on-FIRE! Demo session* organized at the *Future Internet Assembly (FIA)* in Dublin, Ireland, May 2013.

Poster; no abstract available.

32 Liu, W., Desmet, M., "Building a radio environment map for tracking a moving interfering robot" *Hands-on-FIRE! Demo session* organized at the *Future Internet Assembly (FIA)* in Dublin, Ireland, May 2013.

Demonstration & poster
Abstract: Coexistence of wireless technologies (Wi-Fi, Bluetooth, ZigBee…) in ISM bands is hard, because different technologies are interfering with each other. To improve coexistence devices should be capable to detect co-located interferers, which can be mobile devices moving around. By using distributed spectrum sensing device at different nearby locations, a radio environment map (REM) can be created showing the spatial spectrum occupation. This demo will show a moving robot, which generates interference, that is sensed by advanced distributed spectrum sensing devices (both common USRP and proprietary IMEC) and visualized in a REM.
Video: http://www.youtube.com/watch?v=hA9ojLx16XY

33 Tallon, J., Da Silva, L., "Receiver-driven handover in independent networks" *Hands-on-FIRE! Demo session* organized at the *Future Internet Assembly (FIA)* in Dublin, Ireland, May 2013.

Demonstration & poster
Abstract: The purpose of this demonstration is to showcase the capabilities of the Iris software radio platform with an implementation of handover with continuous service between two independent base-station entities belonging to different operators. The handover occurs without any link layer connection between the base-stations and without prior knowledge of base-station operating frequencies or channelization on the part of the receiver. For this to work the receiver must be a cognitive receiver, i.e. a cognitive radio device that intelligently determines the frequencies at which the target base station is operating on, and execute the handover itself. The implementation consists of three radios, two transmitters and a cognitive receiver, all of which are full radio chains that have been implemented completely with the Iris software radio platform.
Video: http://www.youtube.com/watch?v=4ivAnPqh7aI

34 Alonso, A., "Collaborative spectrum sensing" *Hands-on-FIRE! Demo session* organized at the *Future Internet Assembly (FIA)* in Dublin, Ireland, May 2013.

Demonstration & poster
Abstract: The demonstration will show a limited example of collaborative spectrum sensing, i.e. information of different sensors at different locations is integrated to have a picture of the spectrum occupation. Measurements from the different sensors are integrated through different algorithms in order to feed a data base of spectrum occupation. Users on a dynamic spectrum access system could connect to this data base and know which frequency bands are already occupied and which are free and could therefore be employed by them. Different CREW testbed facilities have been mixed in order to build this system.
Video: http://www.youtube.com/watch?v=vGBG5NWkG3Y

35 Mohamed-Abd-Rabou-Ahmed, K., "Clear Channel Assessment agent in a CSMA MAC using Iris" *Hands-on-FIRE! Demo session* organized at the *Future Internet Assembly (FIA)* in Dublin, Ireland, May 2013.

Demonstration & poster
Abstract: This demonstration showcases the integration of the IMEC sensing engine (SE) as a clear channel assessment (CCA) agent into a carrier sense multiple access (CSMA) based medium access control (MAC) protocol implemented on the basis of Iris. In particular, the demo shows how the MAC, in conjunction with the SE, coordinates access to the shared medium and allows a live video conference over the system.
Video: http://www.youtube.com/watch?v=O-y52JRblsg

36 Salous, S., "Device sensitivity and environment measurements" *Hands-on-FIRE! Demo session* organized at the *Future Internet Assembly (FIA)* in Dublin, Ireland, May 2013.

Demonstration & poster
Abstract: Cognitive radio (CR) relies on sensing its environment to identify unoccupied frequencies. The success of CR depends on the sensitivity of the used devices to detect the primary user, and the environment which can cause the signal to be undetectable due to either blockage by buildings or terrain or due to the presence of multiple paths connecting the transmitter to the receiver. To avoid causing interference to the primary user, the experiments at Durham University tested several devices to identify their sensitivity and measured three environments: the air cabin at EADS, TUB and iMinds.
Video: http://www.youtube.com/watch?v=xpf1g4A4lRE

37 Gallo, P. and Tinnirello, I., "The Wireless MAC Processor over CREW: enabling Cognitive Access BenchmarkINg (CABIN-CREW)" *Hands-on-FIRE! Demo session* organized at the *Future Internet Assembly (FIA)* in Dublin, Ireland, May 2013.

½ poster; no abstract available

38 Keranidis, S., , "Online Monitoring of Spectrum Sensing Delay and Energy Consumption in the CREW Benchmarking Framework" *Hands-on-FIRE! Demo session* organized at the *Future Internet Assembly (FIA)* in Dublin, Ireland, May 2013.

½ poster; no abstract available

39 Georgakopoulos, A. , "Experiment-based Validation of Control Channels for Cognitive Radio Systems (EVOLVE)" *Hands-on-FIRE! Demo session* organized at the *Future Internet Assembly (FIA)* in Dublin, Ireland, May 2013.

½ poster; no abstract available

40 Dionisio, R. , “Experimental coexistence study in TV bands (CREW-TV)” *Hands-on-FIRE! Demo session* organized at the *Future Internet Assembly (FIA)* in Dublin, Ireland, May 2013.

½ poster; no abstract available

41 Pareit, D. and Moerman, I. , “CREW - Cognitive Radio Experimentation World”, *Future Network & Mobile Summit 2013*, Lisbon, Portugal, July 2013.

Poster; no abstract available

42 Pierluigi, G., "The Wireless MAC Processor over CREW: enabling Cognitive Access BenchmarkINg (CABIN-CREW)", *Future Network & Mobile Summit 2013*, Lisbon, Portugal, July 2013.

Demonstration & ½ poster
Video: http://www.youtube.com/watch?v=Cr4K4_mCBJ8

43 Georgakopoulos, A., "Experiment-based Validation of Control Channels for Cognitive Radio Systems (EVOLVE)", *Future Network & Mobile Summit 2013*, Lisbon, Portugal, July 2013.

Demonstration & poster
Video: http://www.youtube.com/watch?v=WwALwYOnq8A

44 Keranidis, S., "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
Video: http://www.youtube.com/watch?v=SiZEk3ze4NE

45 Liu, W. (刘 薇) and Hollevoet, L., "Building a radio environment map for tracking a moving interfering robot", *Future Network & Mobile Summit 2013*, Lisbon, Portugal, July 2013.

Demonstration & poster; no abstract available

46 Dionisio, R. , “Experimental coexistence study in TV bands (CREW-TV)”, *Future Network & Mobile Summit 2013*, Lisbon, Portugal, July 2013.

½ poster; no abstract available

47 Dionisio, R. , “Experimental coexistence study in TV bands (CREW-TV)”, *Conference on Spectrum Management*, Lisbon, Portugal, 19-20 September 2013.

Poster; no abstract available

48 Pareit, D. and Moerman, I. , “CREW - Cognitive Radio Experimentation World”, *Conference on Spectrum Management*, Lisbon, Portugal, 19-20 September 2013.

Poster; no abstract available

49 Šolc, T., "SNE-ISMTV: VESNA wireless sensor node expansion for cognitive radio experiments", *The Tenth International Symposium on Wireless Communication Systems (ISWCS 2013)* in Ilmenau, Germany, August 2013.

Demonstration & poster

Abstract: This demonstration shows how VESNA wireless sensor nodes can be used for cognitive radio experiments involving wireless sensor networks. SNE-ISMTV is a radio frontend that has been developed for this purpose. Spectrum sensing capability in the TV white-spaces and 2.4 GHz ISM band is demonstrated by running receivers in a swept-tuned spectrum analyzer configuration and displaying measured spectrograms on a laptop PC. Analogue signal transmission simulating a wireless microphone is demonstrated by executing a direct digital synthesis algorithm on the sensor node microprocessor, transmitting the modulated signal using a narrow-band sub-1 GHz transceiver and monitoring the transmission using an USRP.

50 Šolc, T. and Fortuna, C., "Cognitive Radio Experimentation World and the LOG-a-TEC testbed", *Cognitive Platform Day* in Athens, Greece, June 2013.

Demonstration & poster
no abstract available.

6 Workshops & Tutorials

The tutorials below were given during the 'CREW Training Days', which were organized by the CREW consortium in Brussels on February 19-20, 2013. These were mainly intended to familiarize the new Open Call 2 partners with the CREW testbeds, but the tutorials were open to all and presented to broader audience.

51 Sutton, P., "An Introduction to the Iris Cognitive Radio Networking Architecture", *CREW Training Days*, Brussels, Belgium, February 2013.

Tutorial
Abstract: This workshop will provide an overview of Iris, an open-source software architecture for building highly reconfigurable radio networks. Iris has formed the basis for a wide range of dynamic spectrum access and cognitive radio demonstration systems presented at international conferences over the past 5 years. Focusing on runtime reconfiguration, Iris offers support for all layers of the network stack and provides a platform for the development of not only reconfigurable point-to-point radio links but complete networks of cognitive radios. Presented by Paul Sutton, the workshop will include hands-on development and testing of live over-the-air waveforms. Topics will include Iris PHY and MAC component design, as well as component development paths and waveform testing strategies. Learn how to quickly move your algorithms from simulation to experimentation using the Iris architecture.

52 Becue, P., Liu, W. (刘 薇), Sercu, V. and Desmet, M. "Performing cognitive radio experiments on the w-iLab.t wireless testbed", *CREW Training Days*, Brussels, Belgium, February 2013.

Hands-on tutorial
Abstract: The w-iLab.t wireless testbed, part of the iMinds technical research centre iLab.t (http://ilabt.iminds.be), allows flexible testing of the functionality and performance of wireless networking protocols and systems in a time-effective way, by providing hardware and the

means to install and configure firmware and software on (a selection of) nodes, schedule automated experiments, and collect, visualize and process results. Thanks to an in-house designed hardware control device, unique features of the testbed include the triggering of repeatable digital or analog I/O events at the sensor nodes, real-time monitoring of the power consumption, and battery capacity emulation.
At a first location, the "w-iLab.t Office" consists of a wireless Wi-Fi (IEEE 802.11a/b/g) and sensor network (IEEE 802.15.4) testbed infrastructure, deployed across three 90 m x 18 m floors of the iMinds office building in Ghent, Belgium. At 200 places throughout the office spaces, meeting rooms and corridors, wireless hardware is mounted to the ceiling.
In Zwijnaarde, Belgium, located approximately 5 km away from the "w-iLab.t Office", a second location is equipped with another 60 wireless nodes, with IEEE 802.11a/b/g/n, IEEE802.15.4 and IEEE802.15.1 (Bluetooth) interfaces. The location also hosts software defined radio platforms (USRP) and spectrum scanning engines developed by IMEC. The participant to this session will learn about the high-level characteristics of w-iLab.t and will learn where to find detailed information on the testbed. As most of the cognitive devices are located in the Zwijnaarde environment, a hands-on session will teach the participants how to run experiments in w-iLab.t Zwijnaarde using the OMF tools (http://mytestbed.net/).
More specifically, the participants will reserve nodes, schedule a cognitive radio experiment involving USRP devices and/or IMEC sensing nodes, and collect results. Participants will also learn how different solutions can be compared using the CREW benchmarking framework.

53 Chwalisz, M., “Conducting cognitive sensor network experiments in the TUB testbed”, *CREW Training Days*, Brussels, Belgium, February 2013.

Tutorial
Abstract: In this tutorial we will show how the TUB testbed can be accessed remotely by an experimenter to conduct cognitive sensor network experiments. To this end we will explain how the testbed web interface can be used to reserve a job, to install custom sensor node images and how to extract data from a sensor network application during an experiment in real-time. As an example, we will visualize the multi-hop routing topology of a simple data collection in real-time. In addition, we will generate controlled RF interference and demonstrate its effect on the routing topology. In parallel we will use CR devices to extract spectrum sensing information, which can be used to assess the spectrum occupancy during an experiment and thus validate the RF interference conditions.

54 Šolc, T., “Performing cognitive radio experiments on the LOG-a-TEC sensor network testbed”, *CREW Training Days*, Brussels, Belgium, February 2013.

Tutorial
Abstract: LOG-a-TEC is an experimental outdoor sensor network testbed for spectrum sensing and cognitive radio applications. It consists of 50 remotely-controlled VESNA sensor nodes mounted on light poles in two clusters (city center and industrial zone) in the municipality of Logatec. Nodes are equipped with 72 MHz ARM Cortex-M3 processors, local non-volatile storage and versatile reprogrammable radio transceivers for 868 MHz, 2.4 GHz and UHF TV bands. Thus the testbed allows experimentation with distributed spectrum sensing, spectrum sharing and dynamic spectrum access, cognitive radio and networking protocols in realistic environments in both licensed and unlicensed frequency bands.
This tutorial aims to demonstrate the use of LOG-a-TEC testbed through the interfaces available to the experimenter. After describing the capabilities of the hardware provided by the testbed, we will start with the manual approach to communicating with sensor nodes through the CREW portal and the web interface. Next, open-source Python modules for testbed control will be introduced, allowing experiments to be written in a high-level programming language. As part of the tutorial a script performing a simple experiment will be written, explained and ran on a local computer, controlling the testbed remotely over the Internet. We will conclude with a brief description of the possibility of running native

applications on sensor nodes themselves, making possible experiments that have tighter latency and throughput requirements.

55 Fortuna, C., "ProtoStack: A tool for remote composition, reconfiguration and reprogramming of modular protocol stacks on the VESNA platform", *CREW Training Days*, Brussels, Belgium, February 2013.

Tutorial
Abstract: This tutorial aims to demonstrate the use of VESNA-based testbed extension for supporting experimentation with cognitive networking on MAC and higher layers. Attendees will be first introduced to a conceptual framework for quick and efficient prototyping and deployment of modular protocol stacks. The reference implementation of the conceptual framework, the ProtoStack tool, will be presented, consisting of: (i) the physical testbed based on VESNA platforms with Contiki OS; (ii) the module library CRime (Composeable Rime) inspired by the Rime stack; (iii) the declarative language based on the Resource Description Framework (RDF) with a custom built vocabulary; and (iv) the workbench implemented as a web based portal which allows easy, graphically supported configuration of a stack from the available CRime modules. As part of the tutorial attendees will have a chance to get a hands-on experience with using the ProtoStack tool for remote composition, reconfiguration and reprogramming of CRime protocol stack.

Other workshops and tutorials:

56 Sutton, P., "An Introduction to the Iris Cognitive Radio Networking Architecture", *Workshop on Cognitive Radio*, Lisbon, Portugal, 19-20 September 2013.

Tutorial
Abstract:
The focus of this tutorial is our experimentation platform known as Iris, which has a runtime reconfigurable software radio at its core. This platform enables a wide variety of tests and experimentation in the fields of dynamic spectrum access and cognitive radio. The tutorial charts the progress of the Iris system since its inception as well as details of some of the experiments and trials conducted using this platform. The goal of the tutorial is to enable participants to utilize Iris in their experimental research on dynamic spectrum access .

57 Moerman, I., "Experiments with wilab.t", *Workshop on Cognitive Radio*, Lisbon, Portugal, 19-20 September 2013.

Tutorial
Abstract: This tutorial gives an overview of the different features at w-iLab.t concerning cognitive radio, with a focus on scenarios which are interesting for regulators. Different example experiments are given. One notable example is the introduction of interference at the ISM band, using a mobile robot.

58 Dionisio, R., Fortuna, C., "CREW-TV Experiment at Log-a-tec", *Workshop on Cognitive Radio*, Lisbon, Portugal, 19-20 September 2013.

Tutorial
Abstract: This presentation will overview all the components of the LOG-a-TEC outdoor testbed for cognitive radio experimentation and then will focus on the functionality provided with respect to TV white spaces. This includes the location and topology of the testbed, the hardware components and software infrastructure that operate the facility. The last part will provide example experiments that can be performed on LOG-a-TEC emphasizing the ones that have already been done.

59 Smolnikar, M., Mohorčič, M.: "Vloga eksperimentalnega senzorskega omrežja LOG-a-TEC pri razvoju senzorske infrastrukture in storitev", *VITEL - 28th Telecommunications Workshop*, Bled, Slovenia, 12-13 November 2012. [in Slovene]

Workshop
Abstract: Availability of suitable infrastructure represents one of the key factors for sustainable development of society and economy. In the context of cities or urban areas in general, the term infrastructure traditionally refers to transport, utility and energy infrastructure. Besides these, the information and communication infrastructure has been gaining in importance over the last decade. While broadband Internet access is already understood as something obvious and omnipresent, the concept of smart cities exposed the importance of sensorial infrastructure for acquisition and monitoring of various quantities, phenomena and events. The purpose of this paper is to present the role of LOG-a-TEC testbed in research and development of functional building blocks for smart cities services. LOG-a-TEC is based on wireless sensor network technology and is deployed on public infrastructure of the Municipality of Logatec. VESNA platform represents the basis of the wireless sensor network implementation and in the current configuration installed on the poles of public lights enables monitoring of radio spectrum occupancy and testing of cognitive radio principles. To support the evaluation of different principles and solutions it allows remote reprogramming as well as expansion with new sensors. In this respect, the development plan for new functionalities follows the direction of air quality monitoring, assessment of noise pollution and public lighting remote control.

60 Šolc, T., "Platforms in the CREW federation of cognitive radio testbeds", *Cognitive Platform Day,* Athens, Greece, 21 June 2013.

Workshop
no abstract available

61 Fortuna, C., Tosic, M., Chwalisz, M., De Valck, P., Seskar, I., "Spectrum sensing experiment specification ontology", *The 4th Workshop of COST Action IC0902 Cognitive Radio and Networking for Cooperative Coexistence of Heterogeneous Wireless Networks*, Rome, Italy, 9-11 October 2013.

Workshop
no abstract available

62 Pesko, M., Javornik, T., Štular, M. and Mohorčič, M., "The comparison of methods for constructing the radio frequency layer of radio environment map using participatory measurements", *The 4th Workshop of COST Action IC0902 Cognitive Radio and Networking for Cooperative Coexistence of Heterogeneous Wireless Networks*, Rome, Italy, 9-11 October 2013.

Workshop
Abstract: Construction of the radio frequency layer of radio environment map (RF-REM) is one of the essential steps in building REM, required for the dynamic spectrum access based on geo-location and database approach. In this paper we consider participatory measurements based RF-REM construction and present performance evaluation of several existing construction methods and a novel method which takes into account characteristics of the operating environment and estimates operating parameters of the transmitter.

7 Open Calls

7.1 Networking at events and presentations

During several of the presentations and workshops mentioned above, the third CREW open call was promoted by adding open call slides to the slide deck. Especially during tutorials and workshops, but by extension whenever there was a possibility and a relevant target audience during other events and meetings (not necessarily linked to CREW), the CREW third open call was also discussed and/or promoted.

In addition to these planned and opportunistic promotion opportunities mentioned above, a dedicated announcement session for the third CREW open call was organized at the Future Network and Mobile Summit in Lisbon, Portugal, July 4 2013. During this event, details on the third open call were shared. The presentation and the relevant documentation are available from the open call website, http://www.crew-project.eu/opencall3.

During the same event in Lisbon, there was also a CREW booth from July 3 to July 5 2013. At this booth, participants of the conference could not only take a look at the demonstrations: the opportunity was also offered to talk with members of the CREW consortium about the open call 3.

7.2 Additional ways of promoting the open call 3

- **CREW website:** The old open call pages were archived, and a new open call section was added to the website (http://www.crew-project.eu/opencall3). From the website statistics, it can be seen that this page has the most page views (apart from the home page), as can be observed in Figure 1. While most web site visitors are Europeans, it can be seen in Figure 2 that the website also attracts a lot of visitors worldwide.
- **CREW flyers:** The third Open Call is mentioned in a separate section on the general CREW flyer, Figure 3, which is distributed on all events where CREW has an exhibition booth. Furthermore, a dedicated Open Call 3 flyer, Figure 4, was created and handed out at the FuNeMS 2013 event in Lisbon, where Open Call 3 was officially announced.
- **CREW mailing list:** People expressing their interest in the open call during events and conferences are encouraged to subscribe to the CREW mailing list. The open call events are promoted on the CREW mailing list (http://www.crew-project.eu/subscribe).
- **Social media:** advertisements were posted at social media websites.
    - **Facebook:** https://www.facebook.com/FP7ictCREW
    - **YouTube:** http://www.youtube.com/user/FP7ictCREW
    - **Twitter:** https://twitter.com/FP7ictCREW
    - **LinkedIn:** http://linkedin.com/groups/CREW-FP7-ICT-project-5137585
- **Previous submissions:** The third open call information was distributed to everyone who had submitted a proposal (successful or unsuccessful) for the previous Open Calls.
- **External project mailing lists:** The third open call information was distributed to the mailing lists of following projects: 5GNOW STREP, ABSOLUTE IP, ACROPOLIS NoE, CORASAT STREP, CROWD STREP, CRS-i CA, DIWINE STREP, DUPLO STREP, E3NETWORK STREP, EMPHATIC STREP, HARP STREP, IJOIN STREP, LEXNET IP, MCN, METIS IP, MOTO STREP, NEWCOM NoE, PHYLAWS STREP, SEMAFOUR STREP, SODALES STREP, TROPIC STREP, MCN IP, EU-Japan, FED4FIRE, FLAVIA, COST IC0902, WUN CogCOM, COST IC1004, COST IC0906, QoCON, CoPLASM.

- **European regulators:** The third open call information was distributed to the participants of the Radio Spectrum Committee meeting (9 July 2013), in which the telecom regulators of the different EU countries are represented.
- **External electronic newsletters:** Information about Open Call 3 was also distributed via the electronic newsletter of iMinds.
- **Other EU networks:** The third Open Call was announced at the www.ict-fire.eu website, Figure 5, via the FIRESTATION/AMPLIFIRE project and it was announced at the www.ict-ras.eu website, Figure 6, of the Radio Access and Spectrum (RAS) cluster.

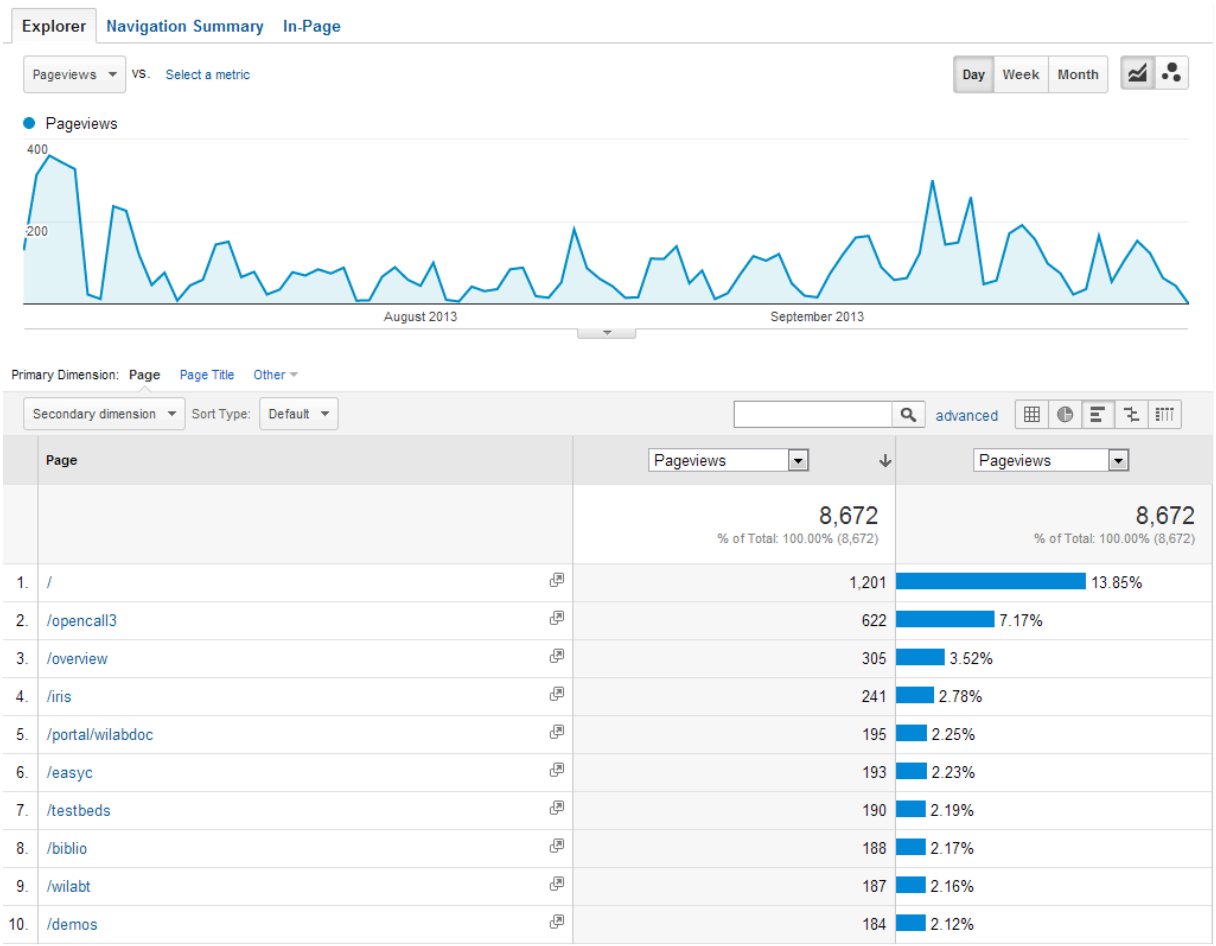
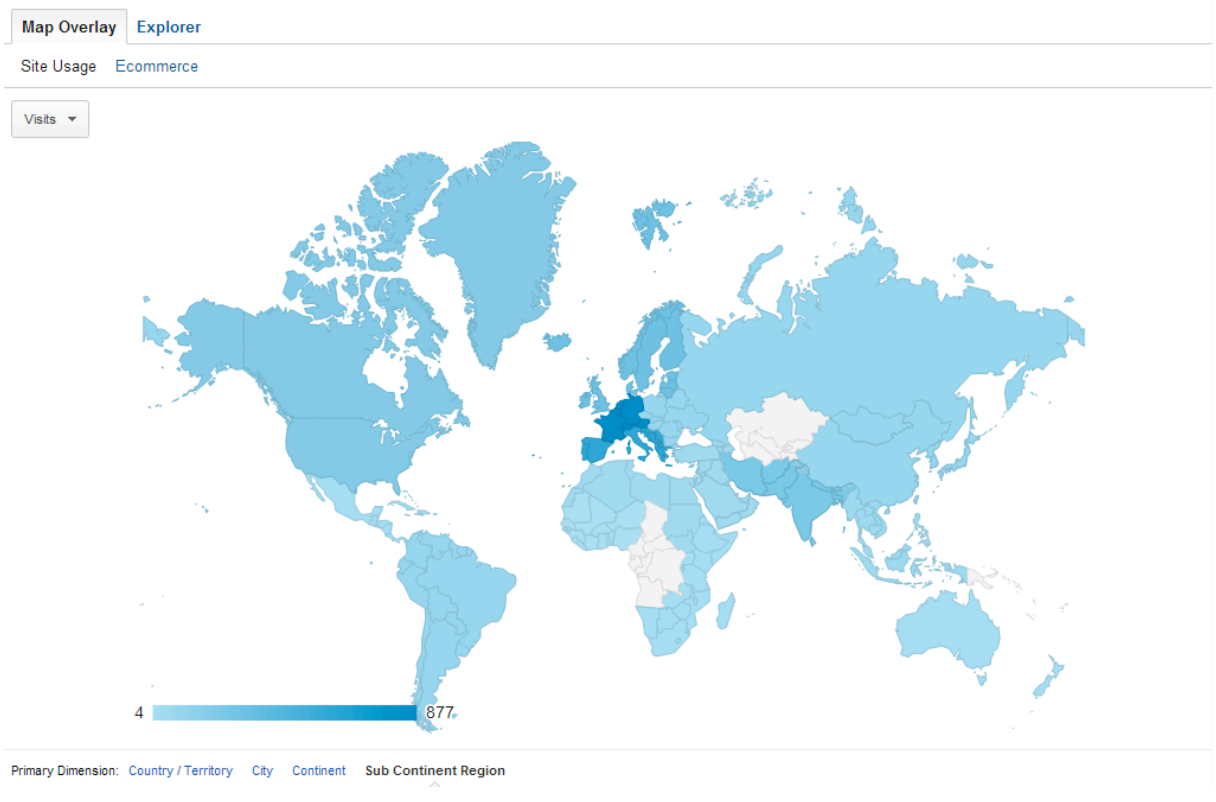


Figure 1: Page views at the CREW website from 1 July 2013 until 30 September 2013.



Primary Dimension: Country / Territory City Continent **Sub Continent Region**

Secondary dimension ▾ advanced

	Sub Continent Region	Visits ▾	Visits
		2,700 % of Total: 100.00% (2,700)	2,700 % of Total: 100.00% (2,700)
1.	Western Europe	877	32.48%
2.	Southern Europe	602	22.30%
3.	Northern Europe	301	11.15%
4.	Southern Asia	229	8.48%
5.	Northern America	201	7.44%
6.	Eastern Europe	90	3.33%
7.	South America	89	3.30%
8.	Eastern Asia	89	3.30%
9.	South-Eastern Asia	55	2.04%
10.	Western Asia	51	1.89%

Figure 2: Demographics of CREW web site visitors from 1 July 2013 until 30 September 2013.

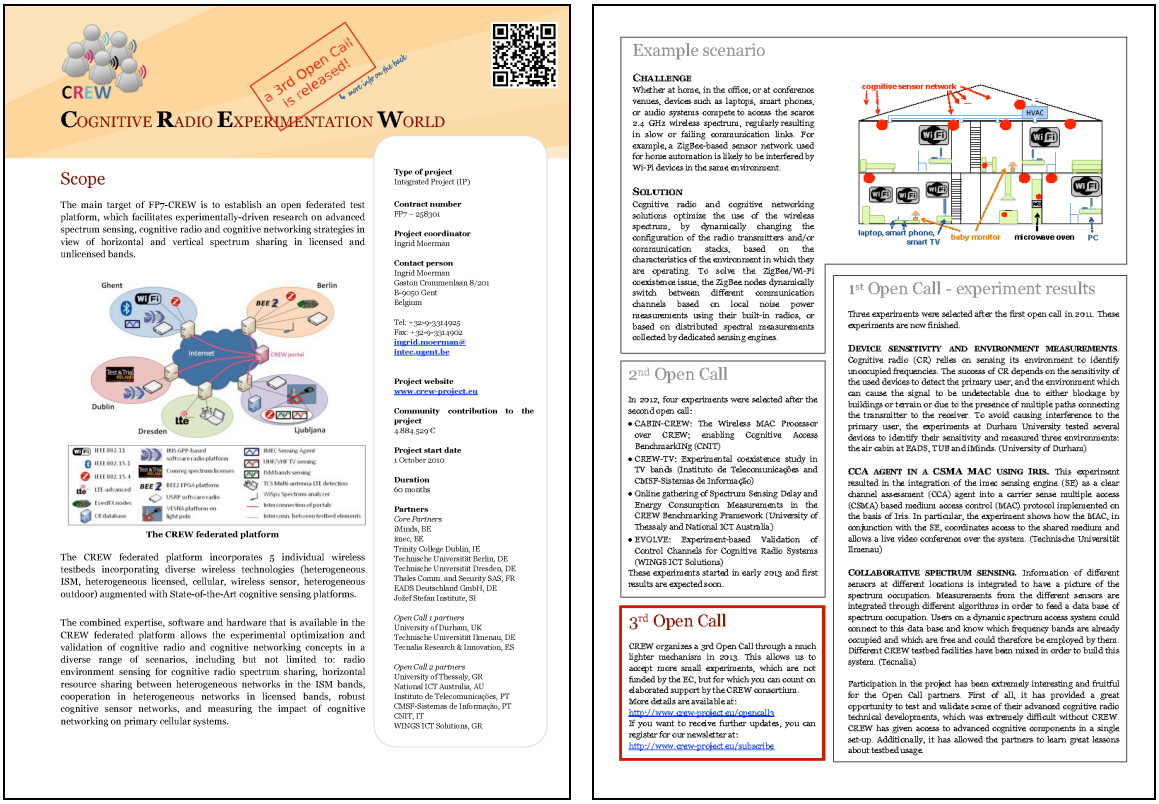


Figure 3: General CREW flyer with a special section on Open Call 3.

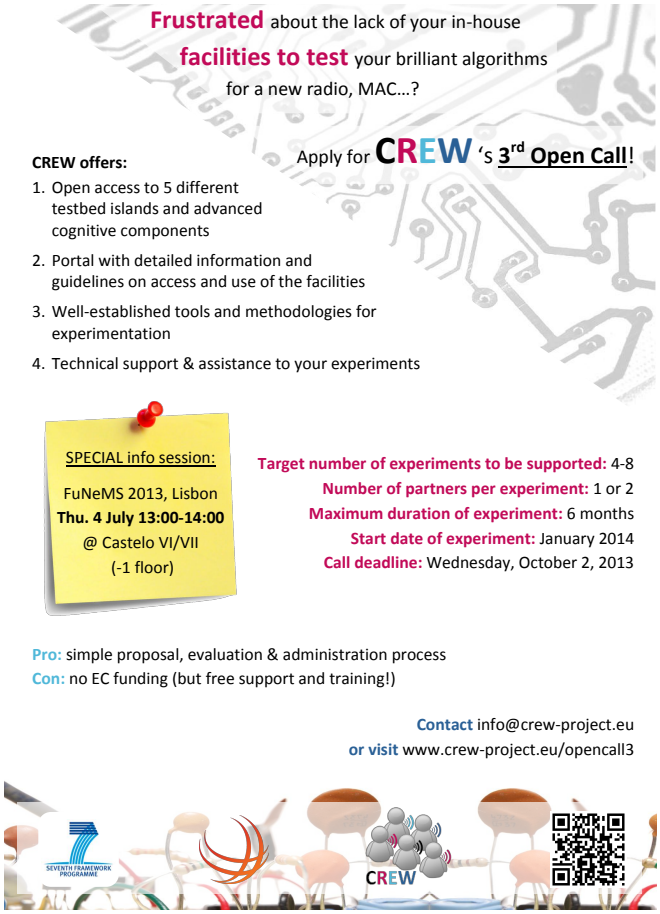


Figure 4: Dedicated Open Call 3 flyer, as handed out to visitors at FuNeMS 2013 in Lisbon.

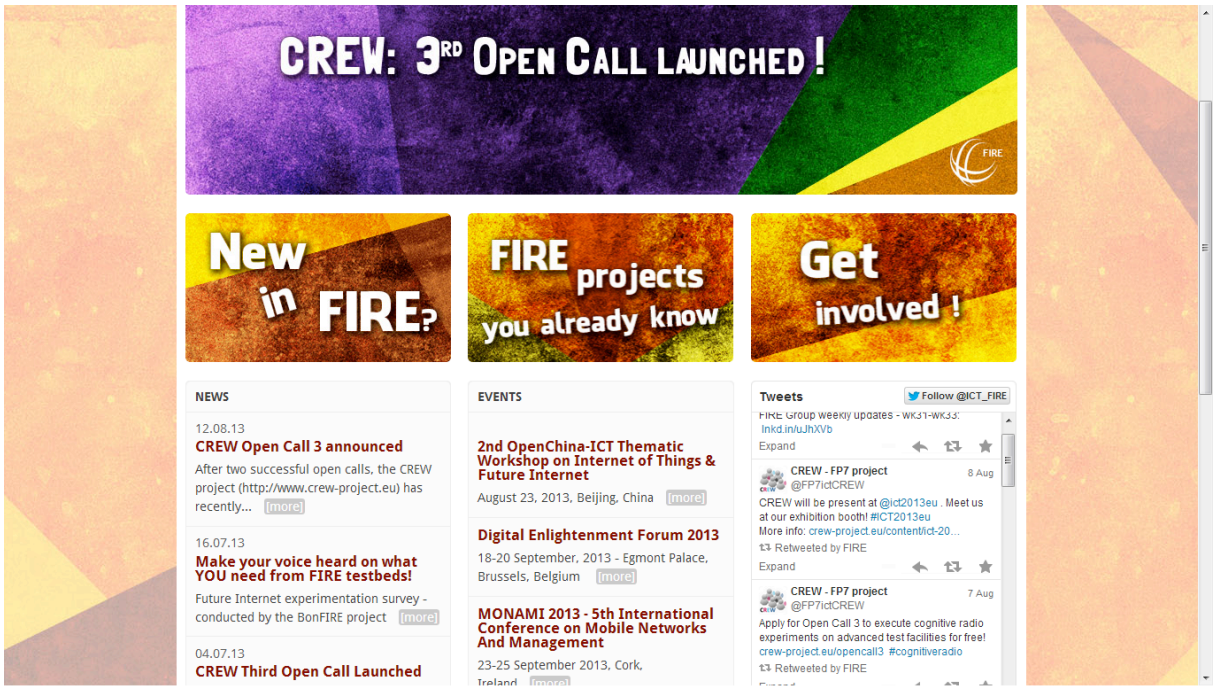


Figure 5: CREW Open Call 3 announcement at www.ict-fire.eu.

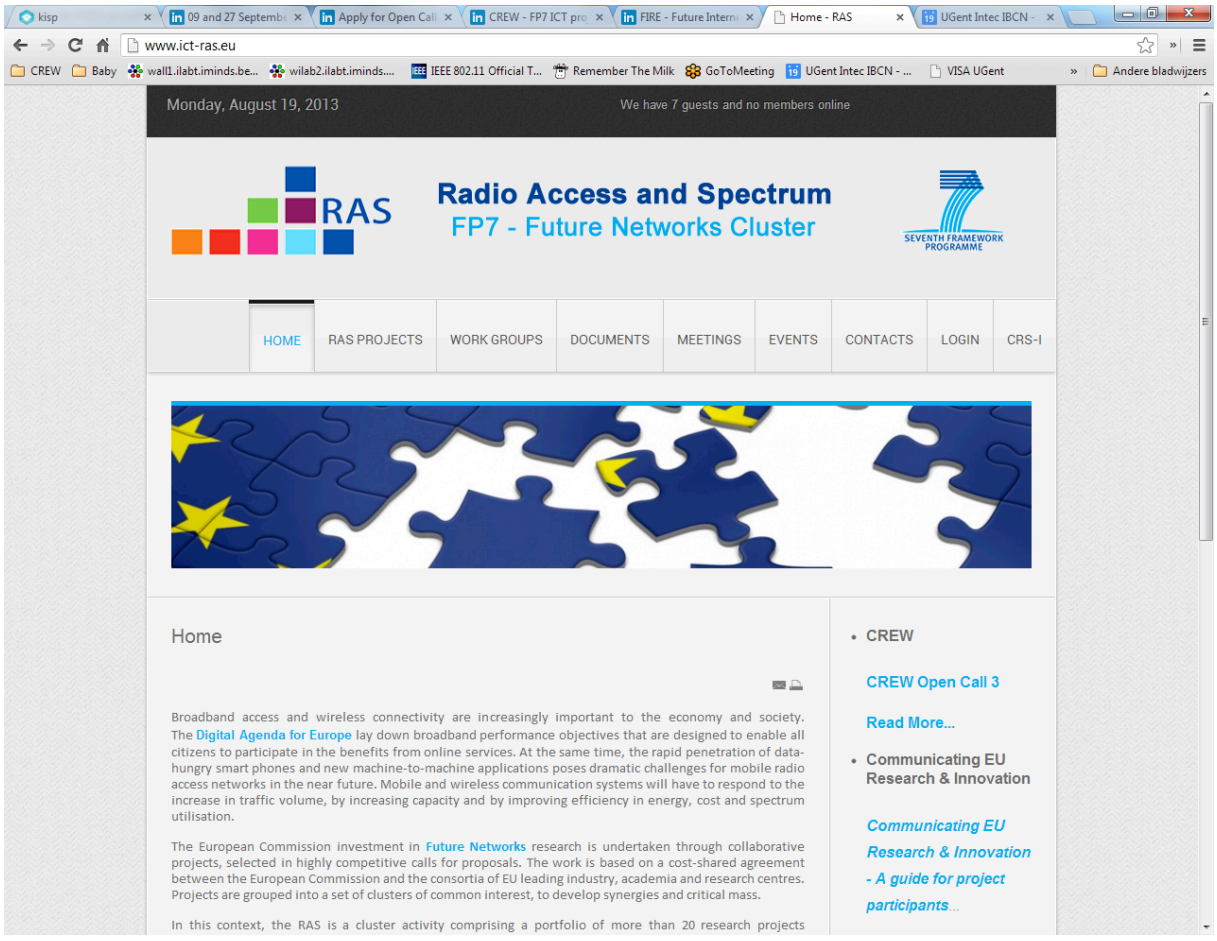


Figure 6: CREW Open Call 3 announcement at www.ict-ras.eu.

8 Further Promotion and Dissemination

Considering the current DoW and its amendments, this is the last deliverable concerning promotion and dissemination by the core consortium within the CREW context. Fortunately, we are not standing still and are already preparing new publications, presentations and demonstrations. In this regard, we will have e.g. new demonstrations at the ICT 2013 event in Vilnius, Lithuania. We will update the public CREW website with new publications (http://www.crew-project.eu/biblio) and demonstrations videos (http://www.crew-project.eu/demos) as well as posting important updates on social media too for the remainder of this project.

Furthermore, dissemination and promotion activities by the Open Call 2 partners will be reported in separate deliverables (D8.8.4, D8.8.5, D8.8.6 and D8.8.7), authored by the open call 2 partners.

9 Conclusion

From the list of events and publications above (15 scientific publications, 2 contributions to standardization fora, 13 presentations, 20 demonstrations & posters, 12 workshops & tutorials) it can be seen that CREW continued its dissemination activities during the third year. As last year, the open call was launched in a sufficiently early stage, advertisements were published, and the website was updated as to reflect the actual state of the CREW federation.