Cognitive Radio Experimentation World

Project Deliverable D7.4.4

Showcase of experiment ready (Demonstrator)

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Abstract: This deliverable demonstrates a working implementation of the experiment, hereby clearly showcasing the functionalities and benefits of the CREW federation for experimental validation of cognitive solutions.

Keywords: Web-based geo-location database, TVWS, experimental testbed, communication protocol, spectrum sensing

REVISION HISTORY

Version	Date	Author	Description
1.0	05/04/2014	Rogério Dionísio (IT)	Initial draft with first inputs
1.1	18/04/2014	Tomaž Šolc (JSI)	Revisions and comments

List of Figures

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Executive Summary

For this demonstration, we showcase the **combination of a TVWS geo-location database access with the sensing information from the LOG-a-TEC outdoor sensor network**. We first verify TVWS availability by querying the geo-location database. For that purpose, we have developed and implemented a signaling protocol inspired by PAWS. The message exchange may be visualized from a web-based environment. Then, the nodes from the LOG-a-TEC testbed are remotely configured to sense the spectrum, or to emulate wireless microphones signals. This last functionality is useful when wireless microphone activity is needed for coexistence analysis. The overall experiment can be interactively configured to select different nodes as generators and to vary the sensing threshold of the sensor nodes, through a web-based graphical user interface.

A communication protocol between the LOG-a-TEC network and the geo-location database, based on an API written in JAVA language, gathers sensing data and sends it to the geo-location database, where a distributed sensing algorithm combines data from spectrum measurements. If a wireless microphone is detected, the corresponding DVB-T channel is removed from the list of available channels, and an exclusion area is created around the wireless microphone location that detected it for that particular channel. This way, we can test the ability of the geo-location database to **automatically create protection areas around detected wireless microphones** devices using real-time information from the sensing network.

List of Acronyms and Abbreviations

API	Application Programming Interface
CMSF	Célia Maria Santos Ferreira (software company)
CREW	Cognitive Radio Experimentation World
DVB-T	Digital Video Broadcasting - Terrestrial
DTV	Digital Television
ECC	Electronic Communications Committee
EIRP	Effective Isotropic Radiated Power
GUI	Graphical User Interface
IETF	Internet Engineering Task Force
ISM	Industrial Scientific and Medical (band)
IT	Instituto de Telecomunicações
JSI	Jožef Stefan Institute
PAWS	Protocol to Access White Spaces
PMSE	Programme Making and Special Events
PU	Public
REST	Representational State Transfer Interface
RSSI	Received Signal Strength Indication
TUD	Technical University of Dresden
TV	Television
TVWS	TV White Spaces
UHF	Ultra High Frequency
VESNA	Versatile platform for sensor network applications
WP	Working Package
WSD	White Space Device

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1 System Architecture

Figure 1 represents the block diagram of the demonstration platform. The Log-a-Tec sensor network [1] is one of the open test platform from the FP7-CREW project [2]. Located in Slovenia, this network is an outdoor heterogeneous ISM / TVWS testbed that can be accessed and configured remotely through the Internet with a Representational state transfer (REST) interface. The spectrum sensing is implemented on a Versatile Platform for Sensor Network Applications (VESNA), which is a hardware platform with high processing capability and flexible radio. It supports a broad range of sensors and signal generators for the UHF band. In the scope of this demonstration, two special modules are used:

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- SNE-ISMTV-UHF modules to detect wireless microphones activity from 470 to 790 MHz, using RSSI-based spectrum sensing.
- SNE-ISMTV-868 modules to emulate the presence of a wireless microphone by direct digital signal synthesis. Due to hardware limitations, the frequency range is limited between 780 and 862 MHz.

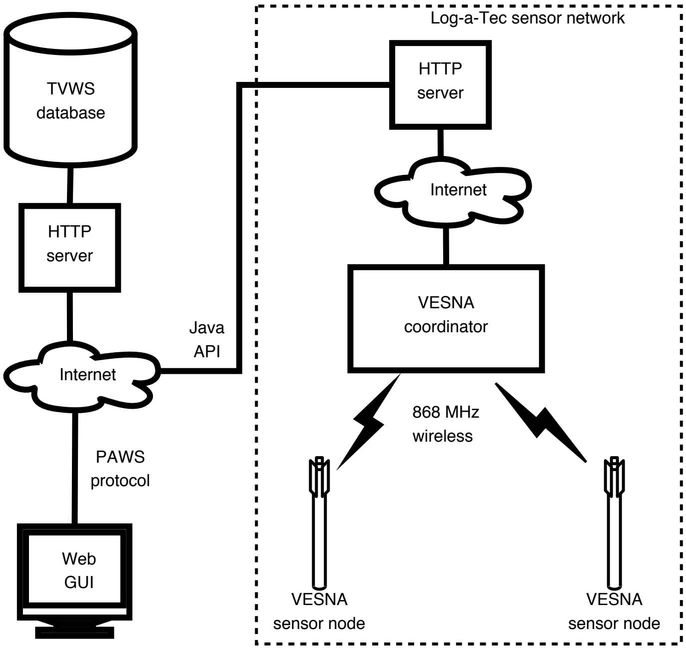

Figure 1 - Diagram of the demonstration platform

Each VESNA node is installed with omnidirectional antennas on a light pole at 10 m height, and communicates with a coordinator node using ZigBee communication module at 868 MHz.

On the other side, the geo-location database stores TVWS maps of the same region as the Log-a-Tec sensor network, from UHF channel 20 to 60 (470-790 MHz). TVWS maps are produced according to the algorithm and procedure described in ECC Report 186 [3], with a 200 m resolution grid. The communication with the geo-location database is based on a protocol inspired from IETF PAWS [4]. The main objective of this protocol is to allow a WSD to request spectrum from the geo-location database, and retrieve a list of available channel to operate as a secondary user. For demonstration

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2 Working Demonstration

This section describes the procedure and actions to run the experiment. The geo-location database and the sensor network are remotely accessed using secured https connections. The demonstration flow follows:

1) Remote setup: Six VESNA nodes are previously configured as generators, and may emulate a wireless microphone signal with 200 kHz bandwidth with 12 dBm EIRP. Central frequency is user selectable between 774 and 790 MHz. These nodes are represented as wireless microphones on the web interface, as shown in Figure 2. Additionally, seven VESNA nodes are configured as sensors for the range 470 to 790 MHz, with 1.7 MHz filter bandwidth and 50 ms per measurement. These nodes appear as green flags on the web interface.

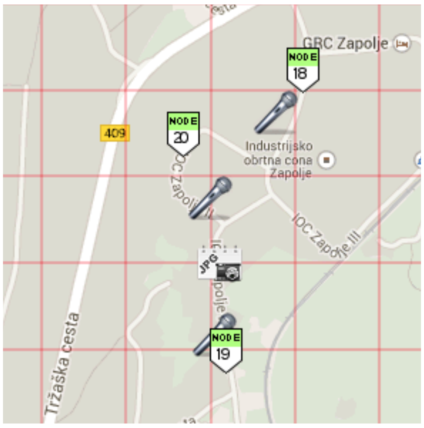


Figure 2 – GUI showing 3 sensor nodes and 3 potential wireless microphones for use.

2) Generator selection. By clicking on a wireless microphone symbol on the GUI, the corresponding VESNA generator node is remotely instructed to broadcast a wireless microphone signal, and the symbol starts to blink (Figure 3).

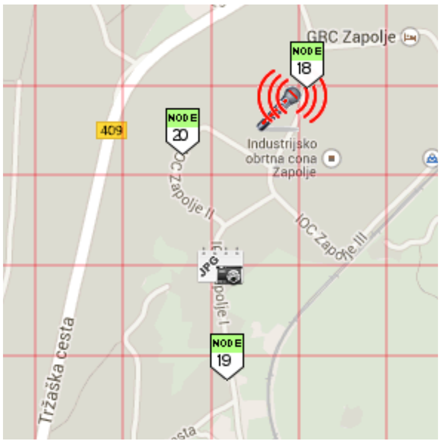


Figure 3 – GUI with VESNA node emulating a wireless microphone, remotely activated.

3) Sensing process: The user starts the sensing process by clicking on the "Start Sensing" button. The sensing threshold is variable from the web interface. All sensing nodes are remotely commanded to scan the spectrum in TV bands, from channel 21 to 60. Then, after collecting all the sensing data, the network communicates the results to the TVWS database in RAW format for post processing, through the java API.

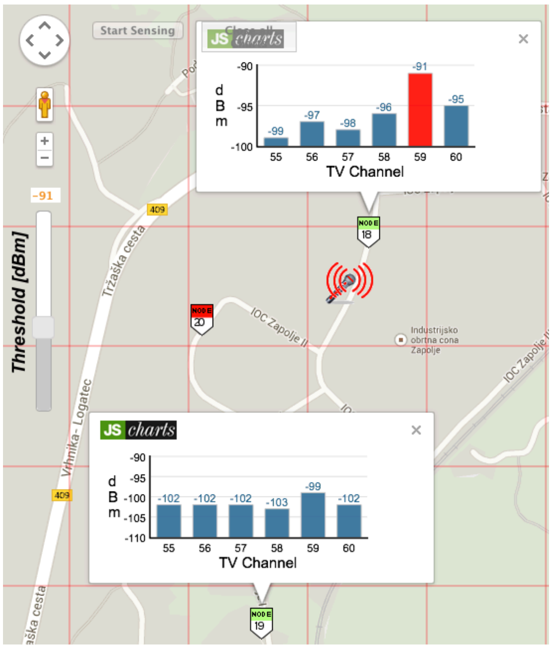


Figure 4 – GUI with an active wireless microphone and two sensing nodes with spectrum measurements.

Geo-location update: A distributed sensing algorithm combines data from spectrum sensing measurements. If a wireless microphone is detected, the corresponding DVB-T channel is removed from the list of available channels, and an exclusion area is created around the wireless microphone location for that particular channel.

The channel list on the right side of the GUI is also automatically updated with sensing results, and the channel that is now occupied with a wireless microphone appears as red, with a wireless microphone symbol on it. (Figure 5)

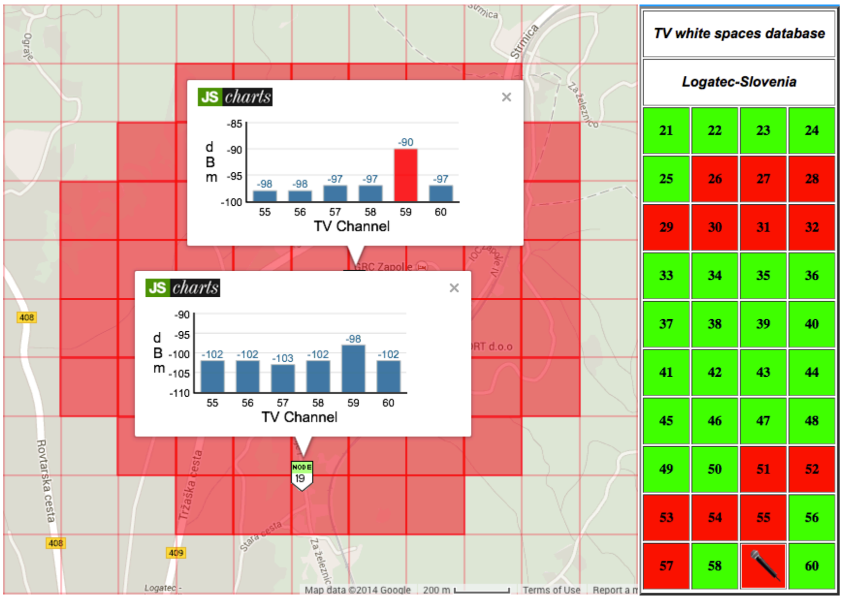


Figure 5 – Exclusion area created around the active wireless microphone, after a sensing decision.

4) Database query: A second GUI tab allows querying the geo-location database for available TV channels, presenting the message exchange between the geo-location database and a laptop emulating a WSD (Figure 6).

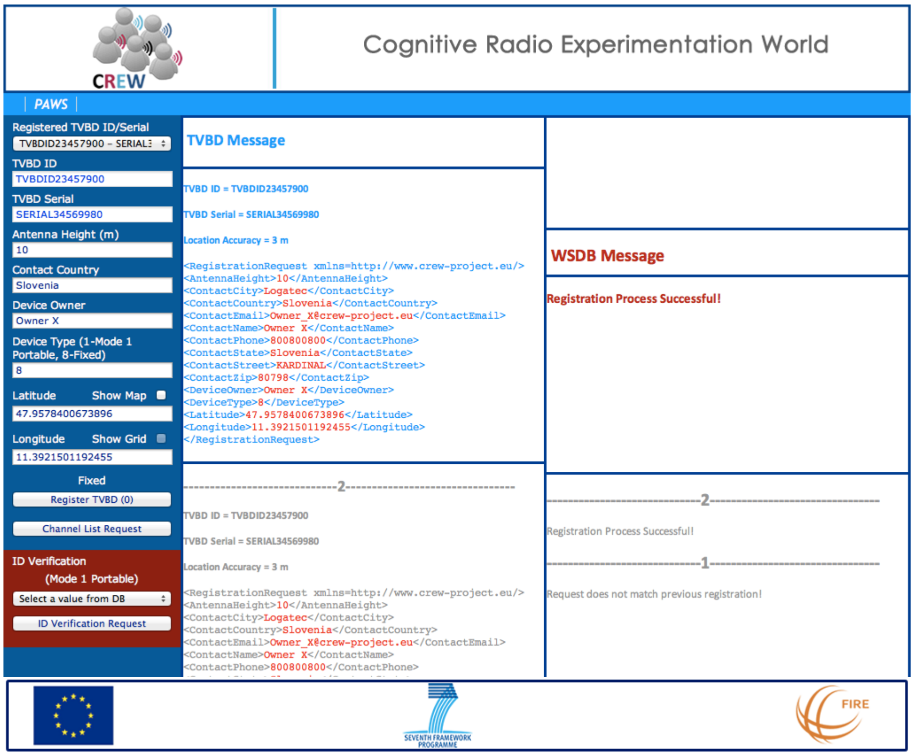
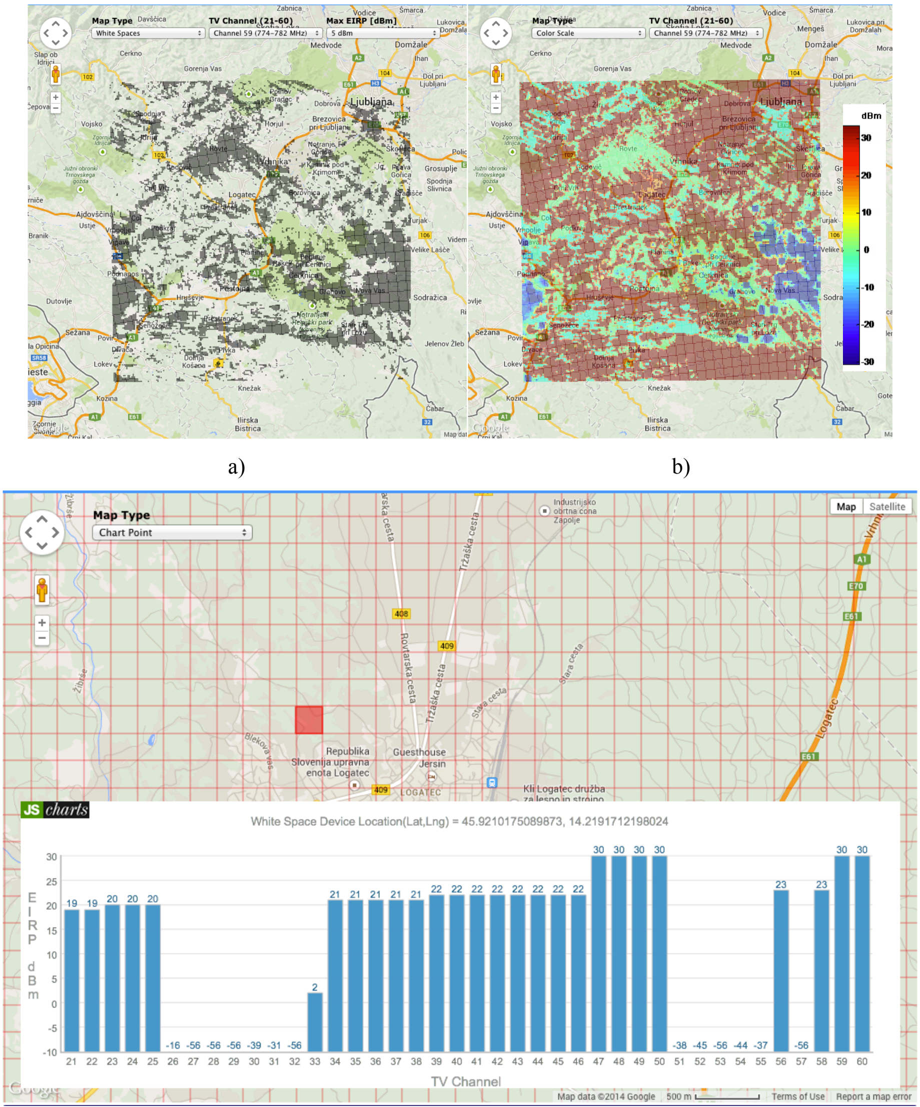


Figure 6 – PAWS GUI with message exchange session, between the geo-location DB and a WSD

5) *View White Spaces:* On this GUI tab, the TVWS availability may be consulted for a region around the testbed (50 km^2), using 4 different methods:

- White space: A black-and-white map shows TVWS availability for the selected DVB-T channel and the maximum allowed EIRP in dBm. The white color area represents the locations where secondary users can operate, the black areas are forbidden for the selected amount of power (Figure 7-a).
- Color/gray scale: This option presents the maximum power that can be transmitted in a selected DVB-T channel, for all pixels in the chosen area (Figure 7-b). A color/gray bar is used to measure the maximum allowed power, in dBm.
- Chart point: This feature shows a pixel grid with 200 m resolution, overlaid to a Google map. By clicking on a pixel, a new chart gives information of the maximum power available for all channels in the database, for that pixel (Figure 7-c).

The TVWS information selected in each method may be also downloaded in text format.



a) b)

c)

Figure 7 – Examples of the 'Show White Spaces' tab, using a) 'white space', b) 'color scale', or c) 'chart point' to represent TVWS availability.

3 Conclusion

This deliverable report gave a description of a working implementation of the CREW-TV experiment, hereby clearly showcasing the functionalities and benefits of the LOG-a-TEC testbed, as part of the CREW federation, for experimental validation of cognitive solutions in TVWS.

References

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